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STATE HEALTH PLANNING AND DEVELOPMENT AGENCY

APPLICATION FOR STATE HEALTH PLAN ADJUSTMENT TO ADD INPATIENT REHABILITATION BEDS IN HEALTH PLANNING REGION I

Submitted by:

RHCP-Florence, LLC d/b/a/ North Alabama Shoals Hospital
&
Rehabilitation Hospital of North Alabama d/b/a/ Encompass Rehabilitation Hospital of North Alabama

Sydney H. Willmann
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205.521.8298 direct

Bradley

April 21, 2023

PA2023-003

RECEIVED
April 21, 2023
STATE HEALTH PLANNING AND DEVELOPMENT AGENCY

VIA E-MAIL:
Emily T. Marsal
Executive Director
State Health Planning & Development Agency
100 North Union St., Suite 870
Montgomery AL 36104

Re: PA2023-003 - Response to Request for Additional Information
Encompass Rehabilitation Hospital of North Alabama &
North Alabama Shoals Hospital

Dear Ms. Marsal:

On behalf of Rehabilitation Hospital of North Alabama d/b/a/ Encompass Rehabilitation Hospital of North Alabama ("Encompass North Alabama") and RHCP-Florence, LLC d/b/a/ North Alabama Shoals Hospital ("Shoals Hospital") (collectively the "Applicants"), this letter is submitted in response to the Alabama State Health Planning and Development Agency's ("SHPDA") April 20, 2023, request for additional information relating to the State Health Plan Adjustment Application which proposes to add twenty-one (21) inpatient rehabilitation beds in Health Planning Region 1 (the "Application").

First, the request for additional information requests that the Applicants correct the 2028 Region 1 total population provided on page 6, Table 1. Please find enclosed as **Attachment A** the corrected application page.

Second, the request for additional information requests that Applicants correct the "CY22 Average Occupancy" on page 9, Table 4, and page 11, Table 5. Please find enclosed as **Attachment B** the corrected application pages.

Finally, the request for additional information requests that Applicants designate a lead applicant for the Application. Encompass North Alabama will serve as the lead applicant. Please send all inquiries and requests for information to counsel for Encompass North Alabama at jclark@bradley.com and swillmann@bradley.com.

Should you have any questions regarding this correspondence, or the Application, please do not hesitate to contact me at the email listed above or by calling (205) 521-8298.

With Warm Regards,

/s Sydney H. Willmann

Sydney H. Willmann

SHW

Cc: Jennifer Clark (jclark@bradley.com)
David Belser (dbelser@davidbelserlaw.com)

I. IDENTIFICATION OF APPLICANTS

A. RCHP-Florence LLC d/b/a/ North Alabama Shoals Hospital

Applicant Name:	RHCP-Florence, LLC d/b/a/ North Alabama Shoals Hospital ("Shoals Hospital")
Address:	201 W. Avalon Ave. Muscle Shoals, Alabama 35661
Telephone:	(256) 386-1600
Contact:	Russell Pigg, Chief Executive Officer Russell.Pigg@namccares.com

B. Rehabilitation Hospital of North Alabama d/b/a/ Encompass Rehabilitation Hospital of North Alabama

Applicant Name:	Rehabilitation Hospital of North Alabama d/b/a/ Encompass Rehabilitation Hospital of North Alabama ("Encompass North Alabama")
Address:	1490 Highway 72 E. Huntsville, Alabama 35811
Telephone:	(256) 535-2300
Contact:	Brent Mills, Chief Executive Officer Brent.Mills@encompasshealth.com
Fee:	$3,500 payable to the State Health Planning and Development Agency, delivery under separate cover

II. Project Description

Provide a narrative statement explaining the nature of the request, with details of the plan adjustment desired. (If the request is for additional beds, indicate the number and type, i.e., Psychiatric, Rehabilitation, Pediatric, Nursing Home, etc.) The narrative should address availability, accessibility, cost, quality of the health care in question, and state with specificity the proposed language of the adjustment. (Ala. Admin. Code r. 410-2-5-.05(1)(b)).

A. Overview

Rehabilitation Hospital of North Alabama d/b/a/ Encompass Rehabilitation Hospital of North Alabama ("Encompass North Alabama") and RHCP-Florence, LLC d/b/a North Alabama Shoals Hospital ("Shoals Hospital") are jointly petitioning the Alabama Statewide Health Coordinating Council ("SHCC") for an adjustment to the Inpatient Physical Rehabilitation Section of the State Health Plan, Ala. Admin. Code r. 410-2-4-.08, to add twenty-one (21) inpatient rehabilitation beds in inpatient rehabilitation health planning Region I ("Region I") to reflect the significant need for additional inpatient rehabilitation beds in north Alabama (collectively, the "State Health Plan Adjustment").

Inpatient rehabilitation hospitals provide specialized, intensive rehabilitative care to patients recovering from a wide array of injuries and illnesses, including stroke, traumatic brain injury, spinal cord injury, amputations, orthopedic surgery or injury, cardiac episodes, and pulmonary conditions. Inpatient rehabilitation hospitals use an interdisciplinary team approach that includes physical, speech and occupational therapists, rehabilitation physicians, rehabilitation nurses, case managers, dietitians, pharmacists, and other specialized clinicians. Inpatient rehabilitation hospitals achieve meaningful results for patients using specialized clinical equipment, advanced technology, and rehabilitation-focused expertise to deliver high quality and effective rehabilitation to its patients.

This proposed State Health Plan Adjustment will help reduce the burden on the existing providers of inpatient physical rehabilitation services in Region I, both of which are experiencing high census rates. Additional capacity is needed to meet the time-sensitive, rehabilitative medical needs of patients residing in Region I. The proposed State Health Plan Adjustment will also protect the public health, safety, and welfare of residents in Region I and the surrounding area.

Encompass North Alabama currently operates eighty-five (85) beds at its inpatient physical rehabilitation hospital in Madison County, Alabama. Encompass North Alabama currently operates at virtual capacity. To date in 2023, Encompass North Alabama is operating at 98.1% occupancy.

Shoals Hospital currently houses thirty-two (32) inpatient rehabilitation beds at its J.W. Sommer Rehabilitation Unit (the "Shoals Rehab Unit") in Colbert County, Alabama. The Shoals Rehab Unit is located within the acute care hospital, which also operates a comprehensive emergency department. Shoals Rehab Unit has consistently experienced sustained high occupancy rates. To date in 2023, Shoals Rehab Unit's occupancy rate is 81.7 %.

B. Availability

The Inpatient Physical Rehabilitation Section of the State Health Plan includes a one-time regional bed availability assurance rule that allows for the addition of (5) five inpatient rehabilitation beds within a health planning region if that region's existing inpatient rehabilitation beds have an average of 80% occupancy or higher for the most recent year. Ala. Admin. Code r. 410-2-4-.08(5). Importantly, this provision can only be utilized one time per planning region and cannot be used to address recurring or growing needs in a specific area of the state. *See Id.*[1] In 2021, Shoals Hospital and Encompass North Alabama added a total of five (5) beds, the maximum number of inpatient physical rehabilitation beds available via the regional bed availability rule. However, even with the additional beds, Shoals Hospital and Encompass North Alabama are still operating at virtual capacity. The proposed State Health Plan Adjustment is necessary to protect the public health, safety, and welfare of residents in Region I and the surrounding area by ensuring availability of these essential inpatient rehabilitation services for patients in northern Alabama.

The Inpatient Physical Rehabilitation Section of the State Health Plan indicates that a region's occupancy "should be at least seventy-five percent (75%) before the SHCC considers any requests for plan adjustments for additional bed capacity." *See* Ala. Admin. Code r. 410-2-4-.08(4)(a). As described, Region I's average occupancy well exceeds 75%, even with the five (5) additional beds added through the one-time regional bed availability rule, showing the significant need for additional beds at these two facilities.

C. Accessibility

Encompass North Alabama and Shoals Hospital are located in Region I, which includes the following counties: Lauderdale, Limestone, Madison, Jackson, Colbert, Franklin, Lawrence, Morgan, and Marshall. These inpatient rehabilitation providers are well-positioned in the most populous areas of Region I and are in easily accessible locations, but the patients who need these services are not able to access the hospitals' inpatient rehabilitation care due to the limited number of available inpatient rehabilitation beds. This forces many patients in need of inpatient rehabilitation to either remain in the acute care setting for a longer period of time while awaiting an available inpatient rehabilitation bed, utilize a less intensive and less appropriate post-acute setting, or forego rehabilitation care entirely. Increased capacity is needed to meet the time-sensitive, rehabilitative medical needs of patients residing in Region I and the surrounding area.

[1] The regional bed availability rule "may only be utilized one (1) time per region during the initial four (4) years following the effective date of this Section . . . ." Ala. Admin. Code r. 410-2-4-.08(6)(b). However, the methodology contemplates that the regional bed availability rule will be revised once SHPDA has collected and analyzed three years' worth of inpatient rehabilitation hospital data. Once SHPDA has collected and analyzed the data, the methodology states that "SHPDA shall present to the SHCC an analysis of utilization of all inpatient rehabilitation resources in the state, including those at IRFs, acute care hospitals with inpatient rehabilitation units, and nursing homes. This analysis should also include a proposed replacement for [the regional bed availability rule] to provide a mechanism for those hospitals providing inpatient rehabilitation services to expand should such a mechanism be proven to be necessary." *Id.* If a replacement provision is not proposed within four years from the date of the implementation of the regional bed availability rule, "any region meeting the criteria shall qualify for one (1) additional five (5) bed expansion during the subsequent four (4) year period." *Id.*

D. Cost

Encompass North Alabama and Shoals Hospital currently operate inpatient rehabilitation facilities that can be efficiently and effectively expanded to offer additional capacity to patients in need of inpatient rehabilitation services. In the event that this Plan Adjustment is approved and the hospitals are each able to obtain a certificate of need to add the additional beds, the hospitals will work expeditiously to implement the beds. Both hospitals can efficiently renovate and expand their existing facilities to accommodate the additional beds. Thus, the addition of needed inpatient rehabilitation beds within the existing facilities of Region I providers is a cost-effective solution to meet the need for additional beds in this region.

E. Quality of Care

The quality of inpatient rehabilitation care in Region I is high, and the additional inpatient rehabilitation beds will increase the availability of this high-quality, specialized care for residents of North Alabama who need these services.

Encompass North Alabama is licensed by the Alabama Department of Public Health, certified to participate in the Medicare and Medicaid programs, and is accredited by the Joint Commission. Encompass North Alabama currently delivers high quality rehabilitation care and has earned the Joint Commission disease-specific certifications in stroke rehabilitation, hip fracture rehabilitation, amputee rehabilitation, and brain injury rehabilitation. Further, Encompass North Alabama employs over 300 medical professionals and technical staff to serve patients in Region I. The proposed Plan Adjustment will make these specialized, intensive rehabilitation services more accessible for the patients in Region I and the surrounding area.

Shoals Hospital is licensed by the Alabama Department of Public Health and is certified to participate in the Medicaid and Medicare programs. The proposed project will improve the quality and continuity of care for patients in Region I by increasing the inpatient rehabilitation bed availability.

F. Proposed Adjustment Language

The language of the proposed Plan Adjustment is attached as **Exhibit A**.

III. Service Area

Describe the geographical area to be served. (Provide an 8 ½ " x 11" map of the service area. The map should indicate the location of other similar health care facilities in the area.) (Ala. Admin. Code 410-2-5-.05(1)(c)).

The service area is Inpatient Rehabilitation Health Planning Region I, as defined in Section 410-2-4-.08 of the State Health Plan. Region I consists of Lauderdale, Limestone, Madison, Jackson, Colbert, Franklin, Lawrence, Morgan and Marshall Counties. The geographic area to be served will be Region I and surrounding areas. A map of the service area is attached hereto as **Exhibit B**.

IV. Population Projections

Provide population projections for the service area. In the case of beds for a specific age group, such as pediatric beds or nursing home beds, document the existence of the affected population. An example for nursing home beds is the number of persons 65 and older. The applicant must include the source of all information provided. (Ala. Admin. Code 410-2-5-.05(1)d)).

This plan adjustment will primarily serve the adult population of Region I. Region I contains some of the most populous and rapidly growing counties in Alabama.

The large, increasing, and aging population in Region I supports the need for the proposed plan adjustment. As shown, Region I is currently home to more than 1 million residents, with 1.05 million residents projected in 2028. Notably, the Region I total population comprises approximately 20% of the state's total population, and is projected to increase faster than the state's total population between now (2023) and 2028.

Table 1
Region I Total Population, 2023-2028

County	2023	2028	% Change
Colbert	57,572	58,149	1.0%
Franklin	32,254	32,490	0.7%
Jackson	52,410	52,128	-0.5%
Lauderdale	94,403	95,805	1.5%
Lawrence	32,840	32,453	-1.2%
Limestone	108,937	118,043	8.4%
Madison	404,031	430,868	6.6%
Marshall	99,836	103,571	3.7%
Morgan	125,232	128,266	2.4%
Total	**1,007,515**	**1,051,773**	**4.4%**
Alabama	*5,108,492*	*5,249,642*	*2.8%*

Source: U.S. Census Bureau and Center for Business and Economic Research ("CBER"), The University of Alabama, August 2022.
Note: Population forecasted based on 2020, 2025, and 2030 population estimates from CBER using average annual growth rates.

In addition to the total population, the high utilization of inpatient rehabilitation services by the population of those aged 65 and older is a critical factor driving need for the proposed additional beds.

The most recent CBER county-level population projections (August 2022) are for total population only, with no available age cohort projections (e.g., population ages 65 and over). Thus, the following table shows the percentage of population ages 65 and over in each county now (2023) and projected for 2028 based on Claritas data.

Table 2
Percentage of Population Ages 65 and Over by Region I County, 2023-2028

County	2023	2028
Colbert	21.6%	23.9%
Franklin	18.4%	20.0%
Jackson	22.3%	24.7%
Lauderdale	22.1%	24.4%
Lawrence	20.5%	23.0%
Limestone	17.1%	19.6%
Madison	16.9%	19.3%
Marshall	18.5%	20.3%
Morgan	19.5%	21.7%

Source: Environics Analytics and Claritas.

The following table projects the 2023 and 2028 population ages 65 and over by applying the estimated percentage of population ages 65 and over from Claritas to the CBER total population projections. As shown below and in the prior table, the population ages 65 and over is large and increasing both in number of persons and as a percentage of the total population.

Table 3
Region I Population Ages 65 and Older, 2023-2028

County	2023	2028	% Change
Colbert	12,447	13,897	11.7%
Franklin	5,928	6,491	9.5%
Jackson	11,703	12,881	10.1%
Lauderdale	20,891	23,415	12.1%
Lawrence	6,729	7,448	10.7%
Limestone	18,574	23,172	24.8%
Madison	68,160	83,115	21.9%
Marshall	18,420	21,056	14.3%
Morgan	24,358	27,872	14.4%
Total	**187,210**	**219,347**	**17.2%**

Source: U.S. Census Bureau and Center for Business and Economic Research ("CBER"), The University of Alabama, August 2022; and Environics Analytics and Claritas (for percentage of 2023 and 2028 county population ages 65 and older).

Thus, as demonstrated, the large, increasing, and aging population that will be served in Region I supports the need for the proposed Plan Adjustment, particularly considering the high utilization of inpatient rehabilitation services by the population ages 65 and over.

V. Need for the Adjustment

Address the current need methodology. If the application is to increase beds or services in a planning area, give evidence that those beds or services have not been available and/or accessible to the population of the area. (Ala. Admin. Code 410-2-5-.05(1)(e)).

As demonstrated below, average regional occupancy rates for the most recent 15 months (CY22 through March 31, 2023) are high and increasing, with the providers' combined occupancy averaging 89.6% in CY22 and an even higher occupancy rate of 93.4% in 2023 year-to-date. Region I's high and increasing occupancy rates demonstrate the need for the proposed additional 21 beds, which would increase Region I's inpatient physical rehabilitation beds from the current 119 CON-authorized beds to the proposed 140 beds.

Table 4 Region I Inpatient Rehabilitation Beds are Highly-Utilized		
Region I Utilization	**CY22[2]**	**YTD23**
Patient Days	37,529	10,004
Beds	119	119
Avg. Daily Census ("ADC")	102.8	111.2
Average Occupancy	89.6%	93.4%
Source: Internal data. Note: Year-to-date data is for January 1 through March 31, 2023.		

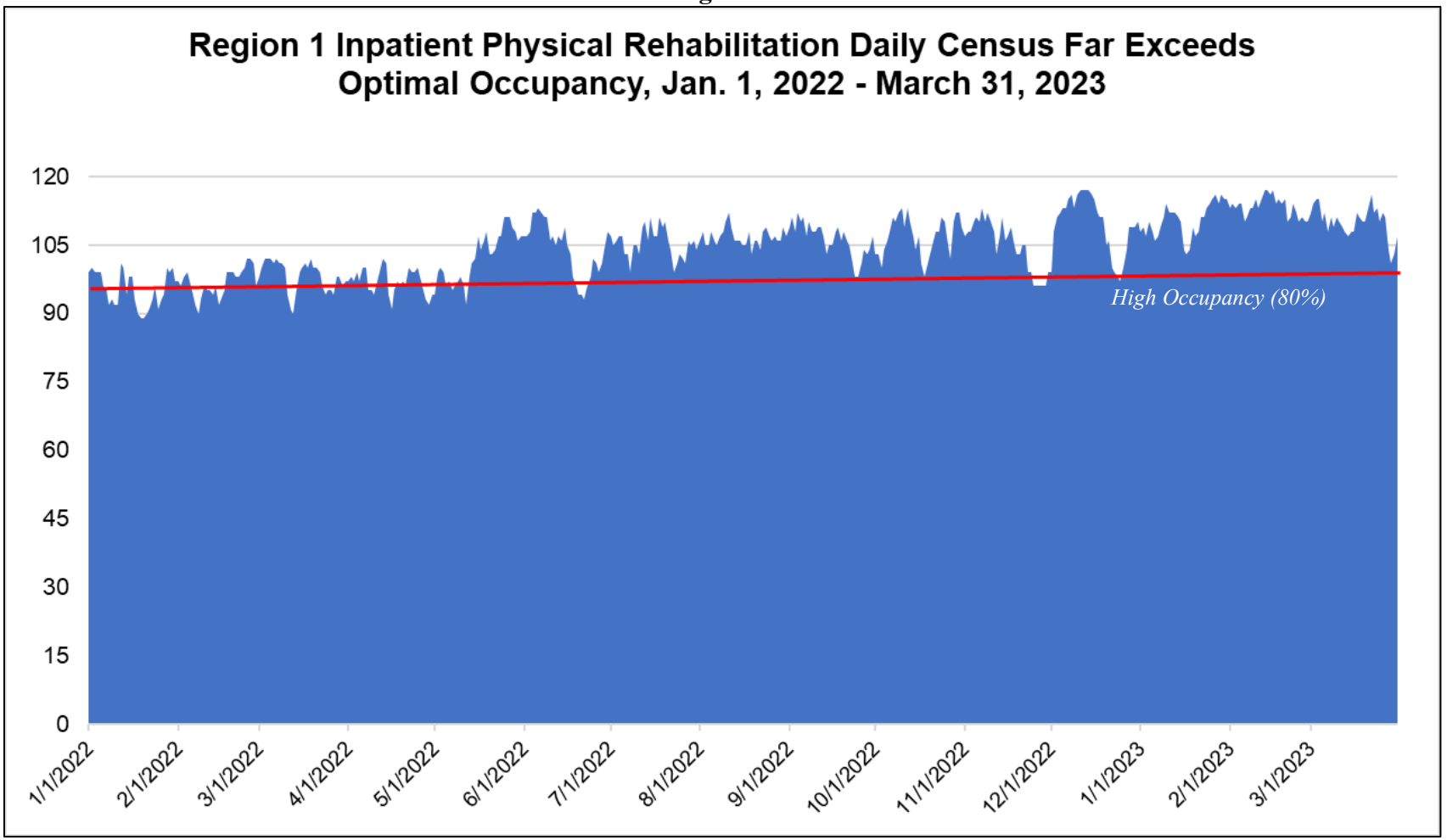
Alabama's State Health Plan generally regards hospitals operating above 80% occupancy as having "high census levels" that impact bed availability for patients in need of service. Of note is that the 2023 ADC for the two Region I providers combined supports the immediate need for 139 inpatient physician rehabilitation beds to simply bring Region I's average occupancy rate down to 80%, even before considering the increasing and aging population of the Region.[3]

The current daily occupancy in Region I further supports and demonstrates the need for additional beds. As shown below, the daily occupancy of Region I inpatient physical rehabilitation beds far exceeds the high occupancy rate of 80%, which is indicated by the red horizontal line on the following graph.

[2] CY22 occupancy is based, in part, on 41,890 available bed days due to Encompass North Alabama increasing from a 70-bed facility to an 85-bed replacement hospital on April 14, 2022.

[3] Bed need calculation is based on the YTD23 ADC of 111.2 divided by an average occupancy rate of 80%, resulting in a current bed need of 139 inpatient physical rehabilitation beds in Region I to bring the average occupancy rate down to 80% even before the increasing and aging of the population is considered.

Figure 1



Source: Internal Data.

VI. Current and Projected Utilization

Provide current and projected utilization of similar facilities or services within the proposed service area. (Ala. Admin. Code 410-2-5-.05(1)(f)).

This application for a State Health Plan Adjustment is necessary to address the unmet need for inpatient physical rehabilitation care for adults in Region I. As shown below and discussed previously, both Encompass North Alabama and Shoals Hospital are currently highly utilized, with their average occupancy rates well above the high occupancy threshold of 80% occupancy. Assuming that the providers' recent growth will continue in the future, the proposed total 140 beds (119 current CON-authorized beds plus proposed 21 additional beds) will be highly utilized at 93%. Thus, there is a significant need for the proposed Plan Adjustment to protect the public health, safety, and welfare of residents in Region I and the surrounding area.

Table 5
Region I Projected Utilization, Inpatient Physical Rehab Beds

Inpatient Rehabilitation	CY22 Actual[4]	YTD23 Actual	CY23 Annualized	CY25 Projected
Patient Days	37,529	10,004	40,572	47,517
Beds	119	119	119	140
Avg. Daily Census	102.8	111.2	111.2	130.2
Occupancy	89.6%	93.4%	93.4%	93.0%

Source: internal data. Year-to-date data is for January 1 through March 31, 2023.

VII. Staffing

If additional staffing will be required to support the additional need, indicate the availability of such staffing. (Ala. Admin. Code 410-2-5-.05(1)(g)).

The majority of the personnel necessary to operate the additional inpatient rehabilitation beds are already working at Encompass North Alabama and Shoals Hospital. However, if additional staffing is necessary, Encompass North Alabama and Shoals Hospital do not anticipate any issues in recruiting additional staff through their existing resources to provide services for this specialized patient population.

Encompass North Alabama utilizes an interdisciplinary approach to patient care. The interdisciplinary treatment team includes, but is not limited to, physical, speech and occupational therapists, rehabilitation physicians, rehabilitation nurses, case managers, dietitians, pharmacists, and other specialized clinicians. To sustain this specialized workforce, Encompass develops relationships with local universities and colleges, community colleges and other training agencies through collaborative training programs. Through Encompass's more than 600 affiliation

[4] CY22 occupancy is based, in part, on 41,890 available bed days due to Encompass North Alabama increasing from a 70-bed facility to an 85-bed replacement hospital on April 14, 2022.

prospective employees become acquainted with Encompass Health, and Encompass's existing hospitals become familiar with the skills these prospective employees possess. These same affiliation relationships provide students in physical therapy, occupational therapy, speech language pathology, nursing, and other programs the opportunity to participate in clinical and technical rotations at Encompass hospitals around the country. Encompass Health's clinical affiliation coordinator works with field experience coordinators and department chairs at academic institutions to ensure the clinical training program is meeting the specific needs of the affiliated school.

Similarly, Shoals Hospital uses the following clinical staff to deliver quality inpatient rehabilitation care to its specialized patient population: registered nurses, physicians, physical therapists, occupational therapists, speech therapists, respiratory therapists, and registered dietitians. Shoals Hospital also serves as a clinical rotation site for clinical and nursing training programs at Northwest Shoals Community College and the University of North Alabama.

VIII. Effect on Existing Facilities or Services

Address the impact this plan adjustment will have on other facilities in the area both in occupancy and manpower. (Ala. Admin. Code 410-2-5-.05(1)(h)).

The proposed Plan Adjustment will not adversely impact any provider of inpatient physical rehabilitation services in Region I. Instead, the proposed State Health Plan Adjustment will help the existing providers in Region I that are currently operating at virtual capacity to ensure availability of these crucial inpatient physical rehabilitation services. In sum, expanded capacity is needed to meet the time-sensitive, rehabilitative medical needs of patients residing in Region I.

IX. Community Reaction

Give evidence of project support demonstrated by local community, civic and other organizations. (Testimony and/or comments regarding plan adjustment provided by community leaders, health care professionals, and other interested citizens.) (Ala. Admin. Code 410-2-5-.05(1)(i)).

The proposed State Health Plan Adjustment has overwhelming support from the Region I community, including elected officials, community leaders, and the physicians and staff who practice at Encompass North Alabama and Shoals Hospital. Letters of Support for this project will be submitted directly to SHPDA. Additionally, at the public hearing on this adjustment, Encompass North Alabama and Shoals Hospital will provide testimony from community members, health care professionals, and leadership from both hospitals regarding the overwhelming support for this proposed adjustment to the Alabama State Health Plan.

X. Additional Information

Provide any other information or data available in justification of the plan adjustment request. (Ala. Admin. Code 410-2-5-.05(1)(j)).

A number of highly regarded studies have demonstrated that not only do a variety of patients receive significant benefits from intensive medical rehabilitation services after a general acute care stay, but also that comparatively intensive medical rehabilitation services provided in a comprehensive inpatient rehabilitation hospital are superior to the care provided in other post-acute care settings. Please refer to **Exhibit C** for select articles.

EXHIBIT A

Proposed Language
State Health Plan Adjustment

NOTE: The current rule is in regular typeface. **The proposed adjustment language is in bold typeface and underlined**

410-2-4-.08 Inpatient Physician Rehabilitation

(1) Definition. Inpatient physical rehabilitation services are those designed to be provided on an integrated basis by a multidisciplinary rehabilitation team to restore the disabled individual to the highest physical usefulness of which he is capable. These services may be provided in a distinct part unit of a hospital, as defined in the Medicare and Medicaid Guidelines, or in a free-standing rehabilitation hospital.

(2) General. Rehabilitation can be viewed as the third phase of the medical care continuum, with the first being the prevention of illness, the second, the actual treatment of disease, and the third, rehabilitation or a constructive system of treatment designed to enable individuals to attain their highest degree of functioning. In many cases, all three phases can occur simultaneously. For the purposes of this section of the State Health Plan, only the need for and inventory of inpatient rehabilitation beds will be addressed.

(3) Need Determination. The Statewide Health Coordinating Council (SHCC) has determined that there is a need for 12 rehabilitation beds per 100,000 population for each region.

(4) Planning Policies

a. Planning Policy. Regional occupancy for the most recent reporting year should be at least seventy-five percent (75%) before the SHCC considers any requests for plan adjustments for additional bed capacity.

b. Planning Policy. Conversion of existing hospital beds to rehabilitation beds should be given priority consideration over new construction when the conversion is significantly less costly, and the existing structure can meet licensure and certification requirements.

(5) Bed Availability Assurance.

a. It is the determination of SHPDA that accurate data related to provision of and need for inpatient rehabilitation services does not currently exist. The SHCC is also aware, however, that the elder-care population (those aged 65 and over) in Alabama is growing at an increasing rate, and that more citizens may need these services moving forward. Therefore, to allow time for more data to be collected by SHPDA for review of rehabilitation services, the SHCC approves the following one-time mechanism for the expansion of existing inpatient rehabilitation providers, with the understanding that additional data shall be submitted by both inpatient rehabilitation providers and nursing homes based on the conditions laid out herein.

b. If the occupancy rate for a single region, including all inpatient rehabilitation facilities ("IRF") and inpatient rehabilitation units of existing acute care hospitals, is greater than eighty percent (80%) utilizing the census data reported on the most recent full year Annual Report for Hospitals and Related Facilities (Form BHD-134A) published by or filed with SHPDA, up to five (5) additional beds may be approved for the expansion of a facility in that region. This expansion may be used by any qualifying IRF or hospital operating an inpatient rehabilitation unit only one (1) time during the initial four (4) year period for which this Plan is effective and only one (1) time per region during that same period. The expansion, however, may not be applied for by any rehabilitation provider until the earlier of (i) the data to be collected pursuant to this section, as defined in paragraph (6) below, has been determined and voted upon by the Health Care Information and Data Advisory Council ("Data Council"), or (ii) October 1, 2020 (the "trigger date"). Upon the earlier of the approval of the data to be collected by the Data Council or the trigger date, SHPDA shall inform the Chair of the SHCC and the Chair of the Certificate of Need Review Board that this one-time expansion provision is available to be applied for by providers meeting the conditions defined in this paragraph.

c. Any inpatient physical rehabilitation beds granted under this section shall only be added at or upon the existing campus of the applicant facility and cannot be sold or transferred to another provider or location. The only exception to this rule is in the case of an IRF or acute care hospital with an inpatient rehabilitation unit applying for a Certificate of Need to relocate or otherwise create a replacement facility that is consistent with all other parts of this Plan.

(6) The SHCC requires that the Data Council make any changes to the Annual Reports filed by hospitals necessary to capture the data used by Medicare Administrative Contractors to determine presumptive compliance with the inpatient rehabilitation facility compliance threshold requirement, also known as the "60% Rule", including the diagnosis, comorbidities and impairment for each patient. The SHCC requires that the Data Council make any changes to the Annual Reports filed by nursing homes to include comparable patient origin level data to allow for comparison between hospital and nursing home providers. The data supplied should allow for an analysis of current utilization in such a manner as to reflect all inpatient rehabilitative services being offered, regardless of location or facility type, and should therefore be collected from both hospitals and nursing homes. The data collected should not only provide information related to occupancy rate but should also provide information related to the acuity of patients treated at each facility and should, as closely as possible, collect data that is similar in both type and format to allow for as accurate a comparison as possible, while representing as many patients receiving inpatient rehabilitation services as possible.

a. Any IRF or acute care hospital that does not substantially comply with any data request made on behalf of SHPDA related to this section shall not be allowed to apply for additional beds under the provisions set forth in paragraph (5) above. Any such application shall be deemed to be inconsistent with this Plan. Furthermore, any nursing home that does not substantially comply with any data request on

behalf of SHPDA related to this section shall not be allowed to oppose any application filed on behalf of an IRF or an acute care hospital for additional beds under the provisions set forth in paragraph (5) above. Such barriers to an application for a Certificate of Need, or inability to intervene or oppose an application for a Certificate of Need, shall be applied in a manner consistent with the provisions set forth in Ala. Admin r. 410-1-3-.11.

b. The provisions set forth in paragraph (5) may only be utilized one (1) time per region during the initial four (4) years following the effective date of this Section, which should allow for a minimum of three (3) years' worth of data to have been collected and analyzed by SHPDA. Once three (3) years' worth of data have been collected by SHPDA according to the provisions set forth in this section, SHPDA shall present to the SHCC an analysis of utilization of all inpatient rehabilitation resources in the state, including those at IRFs, acute care hospitals with inpatient rehabilitation units, and nursing homes. This analysis should also include a proposed replacement for the provisions set forth in paragraph (5) above to provide a mechanism for those hospitals providing inpatient rehabilitation services to expand should such a mechanism be proven to be necessary.

c. If SHPDA fails to present such an analysis and proposed replacement for the provisions set forth in paragraph (5) within the four (4) year period following the date this Plan becomes effective, the provisions set forth in paragraph (5) shall be renewed and any region meeting the criteria shall qualify for one (1) additional five (5) bed expansion during the subsequent four (4) year period.

(7) Plan Adjustments. On [ ], the SHCC approved an adjustment adding twenty-one (21) inpatient physical rehabilitation beds to expand existing providers on existing campuses in Region I due to the identified need for additional beds above and beyond the bed expansion allowed by the Bed Availability Assurance rule provided above.

Author: Statewide Health Coordinating Council (SHCC)
1. Credits
Statutory Authority: Code of Ala. 1975, § 22-21-260(4).
History: Effective March 11, 1993. Amended: Filed June 19, 1996; effective July 25, 1996. Repealed and New Rule: Filed October 18, 2004; effective November 22, 2004. Amended: Filed June 30, 2006; effective August 4, 2006. Amended (SHP Year Only): Filed December 2, 2014; effective January 6, 2015. Repealed and New Rule: Published March 31, 2020; effective May 15, 2020. Amended: Published June 30, 2020; effective August 14, 2020.

Ala. Admin. Code 410-2-4-.08

EXHIBIT B

Map
Inpatient Rehabilitation Health Planning Region I

Inpatient Rehabilitation Health Planning Region I

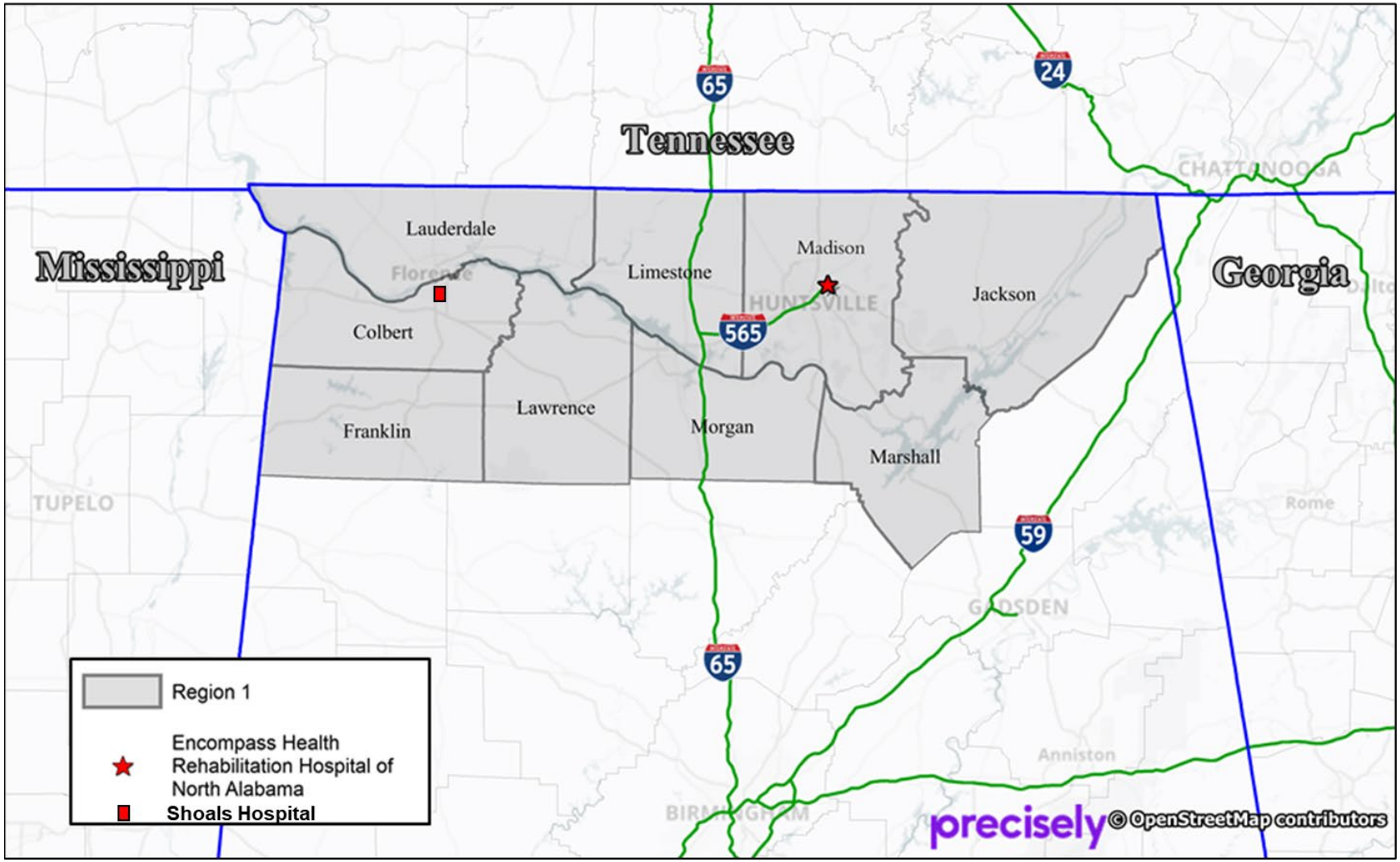


EXHIBIT C

Inpatient Rehabilitation Hospital Outcome Studies

Rehabilitation Hospitals Deliver Higher Quality Care, Better Results

Patients who need medical rehabilitation often must choose between receiving care at a rehabilitation hospital and nursing home. Although these two settings serve similar patients, rehabilitation hospitals provide a far higher level of care that leads to better outcomes.

	Rehabilitation Hospitals	Nursing Homes
Close medical supervision by a physician with specialized training in rehabilitation	Required	Not Required
Multidisciplinary team approach that includes 24-hour rehabilitation nursing	Required	Not Required
Three hours of intensive therapy daily	Required	Not Required
Licensed and accredited for hospital level rehabilitation care	Required	Not Required

Study Shows Improved Outcomes and Quality of Life

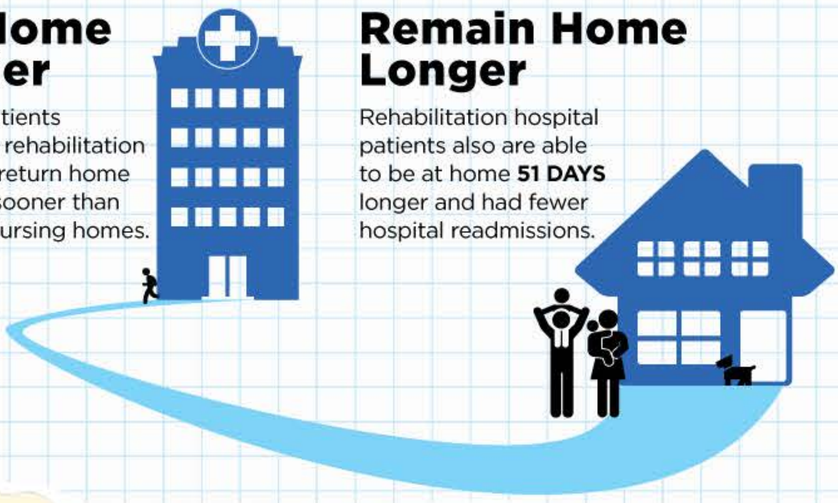
A new study shows that patients treated in rehabilitation hospitals and units have better clinical outcomes and quality of life than those treated in nursing homes. The study compared clinically similar patients over a two year period following discharge from rehabilitation hospitals or nursing homes.

Go Home Earlier

Similar patients treated in rehabilitation hospitals return home **14 DAYS** sooner than those in nursing homes.

Remain Home Longer

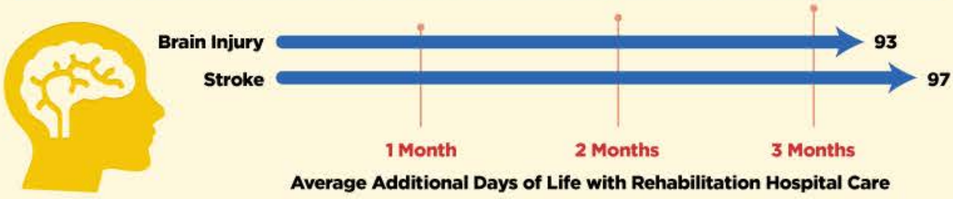
Rehabilitation hospital patients also are able to be at home **51 DAYS** longer and had fewer hospital readmissions.



Live Longer

Patients who receive early, intense, coordinated treatment in a rehabilitation hospital live **52 DAYS** longer.

Patients who experience a brain injury or stroke live more than 3 months longer



Average Additional Days of Life with Rehabilitation Hospital Care

Every day matters. Make the right choice.

Assessment of Patient Outcomes of Rehabilitative Care Provided in Inpatient Rehabilitation Facilities (IRFs) and After Discharge is the most comprehensive national study to date examining the long-term patient outcomes of clinically similar patients treated in inpatient rehabilitation hospitals and nursing homes. The sample is comprised of more than 100,000 matched pairs of clinically similar patients in the two care settings. It was conducted by Dobson DaVanzo & Associates, LLC.

American Medical Rehabilitation Providers Association

Dobson|DaVanzo

Assessment of Patient Outcomes of Rehabilitative Care Provided in Inpatient Rehabilitation Facilities and After Discharge

Study Highlights

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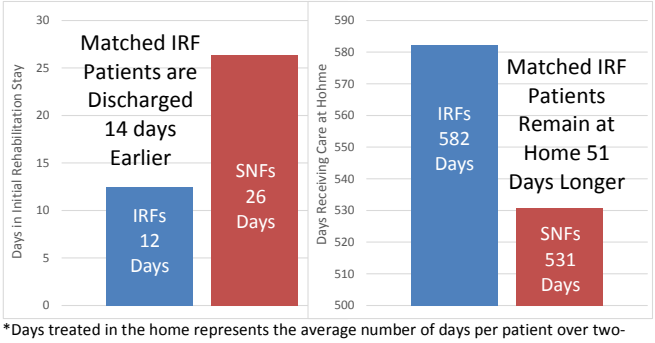
Synopsis of Key Findings

We found that patients treated in IRFs had better long-term clinical outcomes than those treated in SNFs following the implementation of the revised 60% Rule. We used Medicare fee-for-service claims data to compare the clinical outcomes and Medicare payments for patients who received rehabilitation in an inpatient rehabilitation facility (IRF) to clinically similar matched patients who received services in a skilled nursing facility (SNF).

- Over a two-year study period, IRF patients who were clinically comparable to SNF patients, on average:[1]
  - Returned home from their initial stay **two weeks earlier**
  - Remained home nearly **two months longer**
  - Stayed alive nearly **two months longer**
- Of matched patients treated:[2]
  - IRF patients experienced an **8% lower mortality rate** during the two-year study period than SNF patients
  - IRF patients experienced **5% fewer emergency room (ER) visits per year** than SNF patients
  - For five of the 13 conditions, IRF patients experienced **significantly fewer hospital readmissions per year** than SNF patients
- Better clinical outcomes could be achieved by treating patients in an IRF with an additional cost to Medicare of $12.59 per day (while patients are alive during the two-year study period), across all conditions.[1]

Matched IRF and SNF Patients: Number of Days during Initial Rehabilitation Stay and Number of Days Treated in the Home*[1]

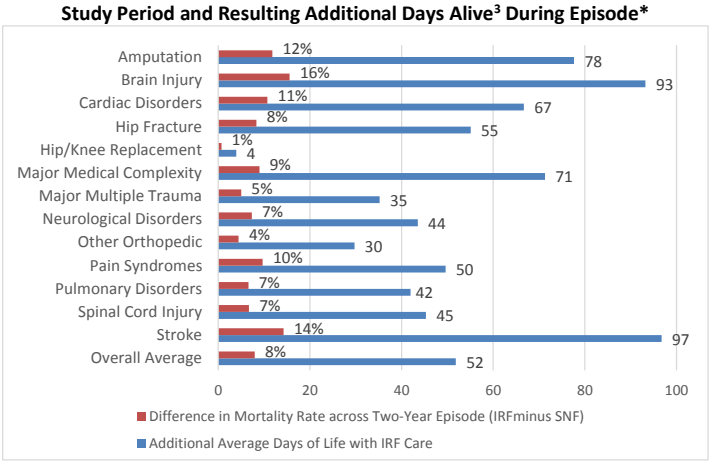


*Days treated in the home represents the average number of days per patient over two-year study period not spent in a hospital, IRF, SNF, or LTCH.

- This study serves as the most comprehensive national analysis to date examining the long-term clinical outcomes of clinically similar patient populations treated in IRFs and SNFs, utilizing a sample size of more than 100,000 matched pairs drawn from Medicare administrative claims.
- The focused, intense, and standardized rehabilitation led by physicians in IRFs is consistent with patients achieving significantly better outcomes in a shorter amount of time than patients treated in SNFs.

When patients are matched on demographic and clinical characteristics, rehabilitation in IRFs leads to lower mortality, fewer readmissions and ER visits, and more days at home (not in a hospital, IRF, SNF, or LTCH) than rehabilitation in SNFs for the same condition. This suggests that the care delivered is not the same between IRFs and SNFs. Therefore, different post-acute care settings affect patient outcomes.

Matched IRF and SNF Patients: Difference in Mortality Rate[1] across Two-Year Study Period and Resulting Additional Days Alive[3] During Episode*



*Difference in the mortality rate of matched IRF patients to matched SNF patients over the two-year study period. As a result of the lower mortality rate, additional average days of life represent the difference in the average episode length (after accounting for mortality) across groups (IRF average episode length in days minus SNF).

[1] Differences are statistically significant at p<0.0001.
[2] Differences are statistically significant at p<0.0001 with the exception of the number of readmissions per year, which are significant at p<0.01 for five of the 13 conditions.
[3] Differences are statistically significant at p<0.0001 with the exception of major multiple trauma, which is significant at p< 0.01.

Source: Dobson | DaVanzo analysis of research identifiable 20% sample of Medicare beneficiaries, 2005-2009.

July 10, 2014

The Issue

To qualify for Medicare payment under the IRF prospective payment system (PPS) at least 60% of an IRF's admissions in a single cost reporting period must be in one or more of 13 CMS specified clinical conditions ("known as the "60% Rule").[1] As a result of this policy, some Medicare beneficiaries with certain conditions previously treated in the IRF are now treated in an alternative setting, such as a SNF. The Medicare Payment Advisory Commission (MedPAC) found, for instance, that the proportion of IRF patients treated for lower joint replacements decreased by 16%, while SNF admissions of this diagnosis increased by the same rate between 2004 and 2011.[2]

There is a significant difference in medical rehabilitation care practices between the two settings.[3] Treatment provided in IRFs is under the direction of a physician and specialized nursing staff.[4] Care plans are structured, focused, and time sensitive to reflect the pathophysiology of recovery, avoid patient deconditioning, and maximize potential functional gain. On the other hand, SNFs exhibit greater diversity in practice patterns with lower intensity rehabilitation,[5] possibly due to limited presence of an onsite physician and no regulatory rehabilitation standards.

The implication of the 60% Rule on long-term beneficiary health outcomes and health care utilization has not been thoroughly investigated.

Despite limited information concerning the rule's effect on beneficiaries, policymakers are considering revisions to IRF payment policy. One revision would raise the current compliance threshold from 60% to 75%, a more restrictive standard. Under a second proposal, MedPAC is developing a recommendation to reduce the difference in Medicare payments between IRFs and SNFs by reimbursing IRFs the SNF payment rate for three specific clinical conditions, some of which are included in the 13 conditions under the 60% Rule: major joint replacement without complications or comorbidities (CC), hip fracture with CC, and stroke with CC.

About the Study

The ARA Research Institute (an affiliate of the American Medical Rehabilitation Providers Association – AMRPA) commissioned Dobson DaVanzo & Associates, LLC to conduct a retrospective study of IRF patients and clinically similar SNF patients to examine the downstream comparative utilization and effectiveness of post-acute care pathways, as well as total cost of treatment for the five years following implementation of the 60% Rule.

Conclusions in Brief:

- **The care provided in IRFs and SNFs differs, as patients treated in IRFs experienced different outcomes than matched patients treated in SNFs.**
- **Patients treated in a SNF as a result of the 60% Rule who could have otherwise been treated in an IRF might be adversely affected by an increased risk of death, increased use of facility-based care, and more ER visits and hospital readmissions.**
- **Continuation or expansion of the 60% Rule or aligning the payment across the SNF and IRF PPSs without understanding the impact on patient outcomes is ill advised and could negatively impact Medicare beneficiaries.**

Using a 20% sample of Medicare beneficiaries, this study analyzed all Medicare Parts A and B claims across all care settings (excluding physicians and durable medical equipment) from 2005 through 2009. Patient episodes were created to track all health care utilization and payments following discharge from a post-acute rehabilitation stay in an IRF and a SNF. Patients admitted to an IRF following an acute care hospital stay were matched to clinically and demographically similar SNF patients. Patient outcomes were tracked for two years following discharge from the rehabilitation stay. This study period allowed us to capture the long-term impact of the rehabilitation, including meaningful differences in mortality, use of downstream facility-based care, and patients' ability to remain at home.

To aid in the interpretation and clinical validation of this analysis, the Dobson | DaVanzo team worked with a clinical expert panel comprised of practicing post-acute care clinicians.

Study Limitations

Medicare fee-for-service claims do not include care covered and reimbursed by Medicaid and third-parties or detailed clinical information. Therefore, non-Medicare services, such as long-term nursing home stays, are not captured in this analysis. This omission may have overestimated the calculated number of days a patient remained at home, and underestimated the cost of their health care to the federal and state governments.

Additionally, the results of this study are not generalizable to the universe of SNF patients within the studied clinical conditions. Analyses suggest that SNF patients who are clinically similar and matched to IRF patients have different health care utilization and Medicare payments than those who were not matched.

[1] The compliance threshold was originally set at 75% and was to be phased in over a three-year period, but compliance was capped at 60% following the Medicare, Medicaid, and SCHIP Extension Act of 2007. While the policy has retained its namesake at the "75% Rule" despite the cap at 60%, this study refers to it as the "60% Rule".

[2] Medicare Payment Advisory Commission (MedPAC). 2013. *Report to Congress:* Medicare Payment Policy. Washington, D.C.

[3] Keith RA. (1997). Treatment strength in rehabilitation. *Arch Phys Med Rehabil*: 90; 1269-1283.

[4] Harvey RL. (2010, January). Inpatient rehab facilities benefit post-stroke care. *Managed Care.*

[5] DeJong G, Hsieh C, Gassaway J, et al. (2009). Characterizing rehabilitation services for patients with knee and hip replacement in skilled nursing facilities and inpatient rehabilitation facilities. *Arch Phys Med Rehabil*: 90; 1269-1283.

Assessment of Patient Outcomes of Rehabilitative Care Provided in Inpatient Rehabilitation Facilities (IRFs) and After Discharge

Dobson | DaVanzo

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Assessment of Patient Outcomes of Rehabilitative Care Provided in Inpatient Rehabilitation Facilities (IRFs) and After Discharge

Submitted to:
ARA Research Institute

Submitted by:

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Thursday, July 10, 2014 — *Final Report*

Acknowledgements

This report was prepared with the assistance of a clinical advisory panel, whose thoughtful insights throughout the study contributed signficantly to the final product. The efforts of the panel are greatly appreciated.

The clinical advisory panel consisted of AMRPA staff and post-acute care clinicians and researchers from Bacharach Institute for Rehabilitation, Burke Rehabilitation Hospital, Good Shepherd Rehabilitation Network, Kessler Institute for Rehabilitation, Madonna Rehabilitation Hospital, and Sunnyview Rehabilitation Hospital.

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Executive Summary

To qualify for Medicare payment under the inpatient rehabilitation facility (IRF) prospective payment system (PPS) at least 60 percent of an IRF's admissions in a single cost reporting period must be in one or more of 13 clinical conditions specified by the Centers of Medicare & Medicaid Services (CMS) (known as the "60 Percent Rule").[1] As a result of this policy, some Medicare beneficiaries with certain conditions previously treated in the IRF are now treated in an alternative setting, such as a skilled nursing facility (SNF). However, the implication of the 60 Percent Rule on long-term beneficiary health outcomes and health care utilization has not been thoroughly investigated.

The medical rehabilitation care practices between IRFs and SNFs differ significantly.[2] Treatment provided in IRFs is under the direction of a physician trained in rehabilitation medicine and specialized nursing staff.[3] Care plans are structured, focused, and time sensitive to reflect the pathophysiology of recovery, avoid patient deconditioning, and maximize potential functional gain. On the other hand, possibly due to limited presence of an onsite physician and no regulatory rehabilitation standards, SNFs exhibit greater diversity in practice patterns with lower intensity rehabilitation.[4]

Despite clear differences in the Medicare Conditions of Participation and classification criteria between IRFs and SNFs, there have been proposals among policymakers about site-neutral payment that aligns IRF payments with those in SNFs for specific clinical conditions. Some of these are included in the 13 conditions under the 60 Percent Rule, such as major lower extremity joint replacement without complications or comorbidities

When patients are matched on demographic and clinical characteristics, rehabilitation in IRFs leads to lower mortality, fewer readmissions and ER visits, and more days at home (not in a hospital, IRF, SNF, or LTCH) than rehabilitation in SNFs for the same condition. This suggests that the care delivered is not the same between IRFs and SNFs. Therefore, different post-acute care settings affect patient outcomes.

[1] The compliance threshold was originally set at 75 percent and was to be phased in over a three-year period, but compliance was capped at 60 percent following the Medicare, Medicaid, and SCHIP Extension Act of 2007. While the policy has retained its namesake at the "75 Percent Rule" despite the cap at 60 percent, this study refers to it as the "60 Percent Rule".

[2] Keith RA. (1997). Treatment strength in rehabilitation. *Arch Phys Med Rehabil*: 90; 1269-1283.

[3] Harvey RL. (2010, January). Inpatient rehab facilities benefit post-stroke care. *Managed Care.*

[4] DeJong G, Hsieh C, Gassaway J, et al. (2009). Characterizing rehabilitation services for patients with knee and hip replacement in skilled nursing facilities and inpatient rehabilitation facilities. *Arch Phys Med Rehabil*: 90; 1269-1283.

(CC), hip fracture with CC, and stroke with CC.[5] Another policy revision discussed would raise the current compliance threshold for IRFs from 60 percent to 75 percent, a more restrictive standard.

Study Purpose

The implication of the 60% Rule on long-term beneficiary health outcomes and health care utilization has not been thoroughly investigated.

The ARA Research Institute, an affiliate of the American Medical Rehabilitation Providers Association (AMRPA), commissioned Dobson DaVanzo & Associates, LLC (Dobson | DaVanzo) to investigate the possible impact of the 60 Percent Rule on clinical outcomes and Medicare payment for post-acute care (PAC) beneficiaries during the years immediately following the Rule's implementation.

Dobson | DaVanzo conducted two types of analyses of Medicare beneficiaries: 1) a cross-sectional analysis examining the relative distribution of conditions for patients receiving post-acute care between the years 2005 and 2009, and 2) a longitudinal analysis comparing the long-term (two-year) clinical and Medicare payment outcomes of clinically and demographically similar beneficiaries who received care in either an IRF or a SNF during those years.

Using a 20 percent sample of Medicare beneficiaries (augmented with a 100 percent sample of IRF and LTCH beneficiaries), this study analyzed all Medicare Parts A and B claims across all care settings (excluding physicians and durable medical equipment) from 2005 through 2009.[6] Clinical condition categories were defined to capture all conditions treated within IRFs, based on the Inpatient Rehabilitation Facility Patient Assessment Instrument (IRF-PAI) Training Manual. While all clinical condition categories were defined, only those with: 1) adequate sample size and 2) well-defined clinical algorithms to confidently identify patients with these conditions in other PAC settings were included in the cross-sectional and longitudinal analyses. Therefore, the results presented in this report focus on a subset of conditions. Within the longitudinal analysis, we focus on 13 conditions, some of which are conditions included in the 60 Percent Rule.

For the cross-sectional analysis, the change in the proportion of patients by clinical condition category was compared across PAC settings (IRFs, SNFs, long-term care hospitals – LTCHs, and home health agencies – HHAs) and years.

For the longitudinal analysis, patient episodes were created to track all Medicare services and payments following discharge from a post-acute rehabilitation stay in an IRF and a SNF. Patients admitted to a SNF following an acute care hospital stay were matched to

[5] The FY 2007 President's Budget included a proposal to reduce the excessive difference in payment between IRFs and SNFs for total knee and hip replacements.

[6] Data was obtained through CMS under DUA #25720.

clinically and demographically similar IRF patients using a one-to-one propensity score match. Patient outcomes were tracked for two years following discharge from the rehabilitation stay. This study period allowed us to capture the long-term impact of the rehabilitation, including meaningful differences in mortality, use of downstream facility-based care, and patients' ability to remain at home for matched IRF-SNF patients.

This study serves as the most comprehensive national analysis to date examining the long-term clinical outcomes of clinically and demographically similar patient populations treated in IRFs and SNFs, utilizing a sample size of more than 100,000 matched pairs drawn from Medicare administrative claims.

Summary of Findings

Results of the cross-sectional analysis confirmed that the proportion of patients treated in IRFs by clinical condition category shifted significantly between 2005 and 2009. The most significant change in proportion was among lower extremity major joint (hip/knee) replacement patients, which decreased from 25.4 percent of patients treated in IRFs in 2005 to 14.5 percent in 2009. According to the Medicare Payment Advisory Commission (MedPAC), this trend continued through 2013.[7] This decrease was offset by an increase in the proportion of patients treated for hip/knee replacements in SNFs over the same time period.

Results of the longitudinal analysis demonstrated that matched patients treated in IRFs had better long-term clinical outcomes than those treated in SNFs following the implementation of the revised 60 Percent Rule. Over a two-year study period, IRF patients who were clinically comparable to SNF patients, on average:

- Returned home from their initial stay **two weeks earlier** ($p<0.0001$)
- Remained home nearly **two months longer** ($p<0.0001$)
- Stayed alive nearly **two months longer** ($p<0.0001$)

Furthermore, of matched patients treated:

- IRF patients experienced an **8 percentage point lower mortality rate** during the two-year study period than SNF patients ($p<0.0001$)
- IRF patients experienced **5 percent fewer emergency room (ER) visits per year** than SNF patients ($p<0.0001$)
- For five of the 13 conditions, IRF patients experienced **significantly fewer hospital readmissions per year** than SNF patients ($p<0.01$)

[7] Medicare Payment Advisory Commission (Report to the Congress). Medicare Payment Policy. March 2014.

These improved clinical outcomes could be achieved by treating patients in an IRF with an additional cost to Medicare of $12.59 per day (while patients are alive during the two-year study period), across all conditions ($p<0.0001$).

Study Limitations

First, administrative claims do not contain detailed, medical record-level clinical information. Given this general limitation, our interpretation of beneficiaries' clinical outcomes relied upon outcomes observable in the claims data (e.g., comorbidities, mortality, emergency room utilization, etc.) that may not fully indicate patients' health or functional outcomes as a result of receiving post-acute care.

Second, Medicare fee-for-service claims do not include care covered and reimbursed by Medicaid and third-parties or detailed clinical information. Therefore, non-Medicare services, such as long-term nursing home stays, are not captured in this analysis. This factor may have resulted in an overestimation of the number of days a patient remained at home, and underestimated the cost of their health care to the federal and state governments.

Additionally, the results of this study are not generalizable to the universe of SNF patients within the studied clinical conditions. Analyses suggest that SNF patients who are clinically similar and matched to IRF patients have different health care utilization and Medicare payments than those who were not matched.

Conclusions in Brief:

- **The care provided in IRFs and SNFs differs, as patients treated in IRFs experienced different outcomes than matched patients treated in SNFs.**
- **Patients treated in a SNF as a result of the 60 Percent Rule who could have otherwise been treated in an IRF might be adversely affected by an increased risk of mortality and more ER visits and hospital readmissions.**
- **Continuation or expansion of the 60 Percent Rule or aligning the Medicare payment across the SNF and IRF-PPSs without understanding the impact on patient outcomes could negatively impact Medicare beneficiaries.**

Introduction

Post-acute care (PAC) refers to a wide range of health care services delivered to patients recently discharged from an acute hospital stay. Unlike patients who return directly to the community following an acute hospitalization, PAC patients require additional treatment that supports either continued recuperation (i.e., as an extension of acute care) or a restoration of functional capabilities that facilitate independent living (i.e., rehabilitation) or both.[8,9]

The Medicare PAC sector grew rapidly after the implementation of the inpatient prospective payment system (IPPS) in 1983. In 2011, the four major PAC providers – inpatient rehabilitation facilities (IRF), skilled nursing facilities (SNFs), home health agencies (HHAs), and long-term care hospitals (LTCHs) – treated 43 percent of Medicare fee-for-service (FFS) patients discharged from acute care hospitals at an estimated cost to Medicare of $61.8 billion (compared to $26.6 billion in 2000).[10] In May 2004, the Centers for Medicare & Medicaid Services (CMS) introduced a revised classification criterion for IRFs treating Medicare beneficiaries. To qualify as an IRF and therefore receive payment under the IRF-PPS, at least 60 percent of a given IRF's Medicare patients in a single cost reporting period must meet one of 13 clinical conditions upon admission to the IRF. The intent of this provision, also referred to as the "60 Percent Rule", was to curtail the volume of less severe patients receiving rehabilitation in IRFs by shifting these cases to lower intensity, lower cost PAC settings, such as SNFs and HHAs.[11]

During the five years immediately following implementation of the new classification criterion and the 60 Percent Rule, patient volume in IRFs decreased by 26.5 percent, spending levels decreased by 8.4 percent, and

> ***"The goal of the Medicare program and these new payment systems is to encourage effective, high-quality care that delivers good clinical outcomes at the lowest cost to society. Without knowing how outcomes are affected by these payment changes it is difficult to judge whether they represent improvements in efficiency or harmful limitations on Medicare beneficiaries' access to PAC"***
>
> - Buntin MB, 2007

[8] Buntin MB. Access to postacute rehabilitation. *Arch Phys Med Rehabil.* 2007; 88:1488-93.
[9] Kane RL. Assessing the effectiveness of postacute care rehabilitation. *Arch Phy Med Rehabil*, 2007; 88:1500-4.
[10] Medicare Payment Advisory Commission (Testimony). Medicare post-acute care reforms. June 2013.
[11] Medicare Payment Advisory Commission (Report to the Congress). Medicare Payment Policy. March 2014.

average payments per case increased by nearly one-quarter (24.5 percent).[12] The relative mix of patient conditions over this period also appeared to shift, with the most marked change seen in the proportion of lower extremity joint (hip or knee) replacement IRF admissions. Under the new criteria, compliant lower extremity joint replacement cases were restricted to more severe and narrowly defined diagnoses, a change that likely caused these admissions to fall from 28 percent of IRF cases in 2004 to 14 percent in 2008. Not surprisingly, average case severity over this period increased, presumably as IRFs began to limit admission of less severe cases.[13] What was not known, however, was the clinical impact on the patients who were diverted to less intense PAC settings from IRFs during the years following the implementation of the 60 Percent Rule.

Study Purpose

Although the degree to which these trends were driven by the new criterion is not entirely clear (i.e., several other PAC payment reforms were also implemented in the late 1990s and early 2000s), researchers and policymakers monitoring these data generally agree that the observed decline in overall patient volume and change in case-mix reflected a provider response to the 60 Percent Rule.[14,15,16] As noted above, there is little understanding of the Rule's impact on patient clinical outcomes. Specifically, there is little research on whether shifting beneficiaries, who in the absence of the Rule would have been admitted to an IRF but were treated in alternative PAC settings, experienced different clinical outcomes.

The ARA Research Institute, an affiliate of the American Medical Rehabilitation Providers Association (AMRPA), commissioned Dobson DaVanzo & Associates, LLC (Dobson | DaVanzo) – an independent health economics and policy consulting firm – to investigate the possible impact of the new criteria on clinical outcomes and Medicare payment for PAC beneficiaries during the years immediately following the Rule's implementation.

Dobson | DaVanzo conducted two types of analyses of Medicare beneficiaries: 1) a cross-sectional analysis examining the relative distribution of conditions for patients receiving post-acute care between the years 2005 and 2009, and 2) a longitudinal analysis comparing the long-term (two-year) clinical and Medicare payment outcomes of

[12] Medicare Payment Advisory Commission (Report to the Congress). Medicare Payment Policy. March 2014.

[13] Medicare Payment Advisory Commission (Report to the Congress). Medicare Payment Policy. March 2014.

[14] Snood N, Huckfeldt PJ, Grabowski DC, et al. The effect of prospective payment on admission and treatment policy: Evidence from inpatient rehabilitation facilities. *J Health Econ*. 2013; 32:965-79.

[15] Grabowski DC, Huckfeldt PJ, Snood N, et al. Medicare postacute care payment reforms have potential to improve efficiency, but may need changes to cut costs. *Health Aff (Milwood)*. 2012; 31(9):1941-50.

[16] Huckfeldt PJ, Sood N, Romley JA, et al. Medicare payment reform and provider entry and exit in the post-acute care market. *Health Serv Res.* 2013; 48(5): 1557-80.

clinically and demographically similar cohorts of beneficiaries who received care in either an IRF or a SNF during those years.

Results from these analyses are intended to provide a better understanding of the impact of the new criterion and Rule on clinical outcomes and Medicare costs. In light of recent discussions around introducing additional payment reform in the PAC sector, this study is also intended to inform policymakers of the potential for adverse beneficiary health outcomes when payment regulations alter certain patient populations' trajectories of care and/or site(s) of service. Disentangling differences in patient outcomes due to the treatment provided in the various PAC settings (as opposed to difference in patient characteristics) requires a statistical methodology that can control for clinical and demographic differences of patient populations.

Study Objectives:

- **Cross-sectional analysis: To identify the patient groups most affected by Medicare policy changes that have shifted patients from IRFs to other PAC settings during the five years following implementation of the revised IRF-PPS (between the years 2005 and 2009).**
- **Longitudinal analysis: To explore the long-term (two-year) clinical and payment outcomes of clinically and demographically similar IRF and SNF patients following implementation of the 60 Percent Rule (between the years 2005 and 2009).**

Differences in Conditions of Participations and Classification Criteria for SNF and IRFs

In considering the extent to which patients were shifted out of IRFs into other PAC settings, the Medicare Conditions of Participation and classification criteria, as well as the services provided in these settings should be noted. Each PAC provider must meet specific Conditions of Participation, and, in some cases, specific additional criteria, in order to be reimbursed by the Medicare program. IRFs must meet the hospital Conditions of Participation plus additional criteria referred to by CMS as classification criteria. As discussed below, these Conditions of Participation and criteria for providing care in an IRF are not the same as for the care provided in a SNF.

Medicare beneficiaries admitted to an IRF must be able to tolerate and benefit from at least three hours of rehabilitative therapy per day. A physician trained in rehabilitative medicine must establish a plan of care before the IRF initiates any treatment (42 C.F.R. §485.58(b)). At a minimum, a coordinated rehabilitation program must include physicians' services, physical therapy services, and social or psychological services.

The services in an IRF must be furnished by personnel who meet the qualifications of 42 C.F.R. §485.70 and the number of qualified (licensed) personnel must be adequate for the volume and diversity of services offered. Personnel who do not meet these qualifications may be used by the facility in assisting qualified staff; however, a qualified individual must be on the premises and must instruct these individuals in appropriate patient care techniques and retain responsibility for their activities.[17] Physicians with specialized training in rehabilitation medicine see patients throughout their stay in an IRF, often every day.

The regulations for SNF care are very different from those regulating IRFs.[18] In a SNF, "staff" is defined as licensed nurses (registered nurses – RNs and/or licensed practical/vocational nurses – LPNs/LVNs) and nurse aides. These licensed personnel and nurse aides (who are required to have some training and competency) are able to provide services prior to (or without) the consultation or formal care plan of a rehabilitation physician, as required in an IRF. SNF residents must be seen by a physician at least once every 30 days for the first 90 days after admission, and at least once every 60 days thereafter.[19] RN services must be available in a SNF eight consecutive hours per day, seven days a week (unless this requirement has been waived). "Supervising the medical care of residents" in a SNF refers to a physician providing consultation or treatment when requested by the facility.

The presence of multiple coverage criteria and definitional standards regarding either the types of patients or processes of care provided in each of the PAC settings has raised concerns among policymakers. Despite clear differences in the Medicare Conditions of Participation and classification criteria between IRFs and SNFs in terms of staffing requirements and the type of care provided, recent policy discussions in reforming PAC have included site-neutral payment proposals to align IRF payments with those paid to a SNF.[20]

Impact of Site of Service on Patient Outcomes

While the Conditions of Participation, classification criteria, treatment protocols, and staffing requirements differ across PAC settings, targeted research has been conducted to compare the outcomes for patients treated in an IRF to those treated in a SNF. While evidence for differences in patient outcomes based on the PAC rehabilitation setting is mixed for some patient conditions, it is more conclusive for others.

[17] 48 FR 56293, Dec. 15, 1982, as amended at 56 FR 8852, Mar. 1, 1991; 57 FR 7137, Feb. 28, 1992; 73 FR 69941, Nov. 19, 2008

[18] Buntin MB. Access to postacute rehabilitation. *Arch Phys Med Rehabil.* 2007; 88:1488-93.

[19] State Operations Manual, Appendix PP. Guidance to Surveyors for Long Term Care Facilities.

[20] The FY 2007 President's Budget included a proposal to reduce the excessive difference in payment between Inpatient Rehabilitation Facilities (IRFs) and Skilled Nursing Facilities for total knee and hip replacements.

For lower extremity joint replacement patients, several studies examining the setting effects between IRF and SNF care observe minimal or no differences in functional independence gains between rehabilitated patients despite differences in length of stay and cost.[21,22,23,24] Other studies of improvement in several functional independence metrics indicate differences in long-term outcomes that favored IRF over SNF rehabilitation, but the benefits based on other metrics were not consistently observed.[25,26,27]

The effect of PAC placement on outcomes for stroke and hip fracture patients is clearer. Several comparative studies indicate better recovery, lower mortality, and higher likelihood of returning home for stroke patients that received IRF rehabilitation compared to nursing home care and SNF rehabilitation.[28,29,30] Similarly, in a study of hip fracture patients, IRF rehabilitated patients were nearly two times more likely to be discharged home and four and a half times less likely to require extended nursing home care than comparable SNF hip fracture patients.[31,32]

Where there appears to be evidence of setting effects driving differences in patient outcomes, two general explanations have been offered: 1) differences in PAC patient-level characteristics (i.e., demographic and clinical characteristics); and 2) differences in provider-level factors, such as variation in the intensity of therapy delivered (i.e., frequency and duration of rehabilitation sessions and physician-led care) are leading to differences in outcomes. The contribution of this study is that the propensity score matching of IRF and SNF patients controls for observed differences in patient characteristics, thereby isolating the impact of the PAC setting.

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[21] Tian W, DeJong G, Horn SD, et al. Efficient rehabilitation care for joint replacement patients: skilled nursing facility or inpatient rehabilitation facility? *Med Decis Making*. 2012; 32:176-87.

[22] Mallinson T, Deutsch A, Bateman J, et al. A comparison of discharge functional status after rehabilitation in skilled nursing, home health, and medical rehabilitation settings for patients after lower-extremity joint replacement surgery. *Arch Phys Med Rehabil*. 2011; 92:712-20.

[23] Tribe KL, Lapsley HM, Cross MJ, et al. Selection of patients for inpatient rehabilitation or direct home discharge following total joint replacement surgery: a comparison of health status and out-of-pocket expenditure of patients undergoing hip and knee arthroplasty for osteoarthritis. *Chronic Illness*. 2005; 1:289-302.

[24] Buntin MB, Deb P, Escarce J, et al. Comparison of Medicare spending and outcomes for beneficiaries with lower extremity joint replacements. RAND Health. June 2005.

[25] Herbold JA, Bonistall K, Walsh MB. Rehabilitation following total knee replacement, total hip replacement, and hip fracture: A case-controlled comparison. *J Geriatr Phys Ther*. 2011; 34:155-60.

[26] Dejong G, Hsieh CH, Gassaway J, et al. Characterizing rehabilitation services for patients with knee and hip replacement in skilled nursing facilities and inpatient rehabilitation facilities. *Arch Phys Med Rehabil*. 2009; 90:1269-83.

[27] Munin MC, Seligman K, Dew MA, et al. Effect of rehabilitation site on functional recovery after hip fracture. *Arch Phys Med Rehabil*. 2005; 86:367-72.

[28] Chan L, Sandel ME, Jette AM, et al. Does postacute care site matter? A longitudinal study assessing functional recovery after a stroke. *Arch Phys Med Rehabil*. 2013; 94:622-9.

[29] Kramer AM, Steiner JF, Schlenker RE, et al. Outcomes and costs after hip fracture and stroke. *JAMA*. 1997; 277(5):369-404.

[30] Kane RL, Chen Q, Finch M, et al. Functional outcomes of post-hospital care for stroke and hip fracture patients under Medicare. *J Am Geriatr Soc*. 1998; 46:1525-33.

[31] Deutsch A, Granger CV, Fiedler RC, et al. Outcomes and reimbursement of inpatient rehabilitation facilities and subacute rehabilitation programs for Medicare beneficiaries with hip fracture. *Med Care*. 2005; 43(9):892-901.

[32] Munin MC, Seligman K, Dew MA, et al. Effect of rehabilitation site on functional recovery after hip fracture. *Arch Phys Med Rehabil*. 2005; 86:367-72.

Introduction

Report Structure

This report presents the methodology and results of both the cross-sectional and longitudinal analyses. The methodology for both analyses, as well as a description of the data sources and algorithms used to construct clinical condition categories across PAC settings, are presented in the next chapter. We then present the results of the cross-sectional analysis, followed by the results of the longitudinal analysis. The report concludes with a discussion of the impact of the 60 Percent Rule on Medicare beneficiaries during the years 2005 through 2009.

Additional research studying patient outcomes for the years 2010 through 2012 is planned.

Methodology

This study consisted of two separate analyses: 1) analysis of the distribution of clinical conditions across settings in the years following the implementation of the 60 Percent Rule ("cross-sectional analysis"), and 2) a retrospective cohort study of the long-term clinical outcomes and total Medicare payments for patients who received rehabilitation services in the IRF compared to those who received rehabilitation in the SNF ("longitudinal analysis").

Both analyses were completed using Medicare fee-for-service claims for Part A and Part B services obtained from CMS through a data use agreement (DUA).[33] All claims from 2005 through 2009 were received from CMS for a representative 20 percent sample of Medicare beneficiaries. An additional file was employed that included all claims from 2005 through 2009 for 100 percent of beneficiaries who received care in an IRF or LTCH (anytime between 2005 and 2009). This time period was selected for the study because it covers the period immediately following the implementation of the 60 Percent Rule,[34] allowing us to examine its immediate effects on clinical outcomes and payments. The care settings in the datasets included inpatient hospitals, outpatient hospitals, IRFs, SNFs, LTCHs, and HHAs. Physician and durable medical equipment (DME) claims were not included in this analysis.

A clinical advisory panel consisting of practicing post-acute care clinicians and clinical researchers was convened at study initiation to aid in the interpretation and clinical validation of this analysis. The panel's role was to provide clinical input, feedback, and validation throughout the analyses.

[33] Claims data were received through CMS under DUA #25720.

[34] An additional study is currently underway that extends the study period for both analyses through 2012.

Identification of Clinical Condition Categories

Both the cross-sectional and longitudinal analyses required consistent classification of clinical conditions across multiple care settings. The IRF-PAI Training Manual[35] identifies the MS-DRGs, ICD-9, CPT, and HCPCS used by CMS to determine the assignment of UDS_{MR}™ Impairment Group Codes and RIC for each IRF patient. Since SNFs, LTCHs, and HHAs do not use RICs or impairment group codes, the criteria for identifying each condition needed to be deconstructed so it could be applied to patients in alternate settings in a consistent way. In many instances, the algorithms to identify the clinical condition categories rely on a patient's historical diagnostic information or care that he/she received prior to admission to the post-acute care settings (i.e., prior to or during the preceding acute care hospital stay). Since the IRF-PAI Training Manual only classifies conditions treated in IRFs, conditions that may be unique to SNFs, LTCHs, and HHAs, were excluded from both the cross-sectional and longitudinal analyses. While most condition categories were easily identified using the ICD-9s contained in the IRF-PAI Training Manual, the classification of cases that qualified under multiple condition groups required clinical expertise from the advisory panel to interpret secondary and tertiary ICD-9 information in order to accurately classify these cases.

The definition for each clinical condition category is contained in Appendix A. Some of the conditions included were ones specified in the 60 Percent Rule (e.g., hip/knee replacements, stroke, brain injury), and others were not (e.g., cardiac disorders, major medical complexity). While all clinical condition categories were defined, only those with: 1) adequate sample size and 2) well defined clinical algorithms that allowed us to confidently identify patients with these conditions in other settings were included in the cross-sectional and longitudinal analyses. Therefore, the results presented in this report focus on a subset of conditions. Within the longitudinal analysis, we focus on 13 conditions, many of which are contained in the 13 conditions specified in the 60 Percent Rule. The conditions included in the longitudinal analysis are shown in Exhibit 2.1, including their inclusion or exclusion in the 60 Percent Rule.

The clinical advisory panel was heavily involved in the development and validation of the algorithms used to identify the clinical condition categories. Clinical advisory panel members with first-hand experience in identifying patient's RICs or impairment codes were consulted to confirm the logic used to identify patients across settings. Additionally, the relationship between each of the clinical condition categories was reviewed to ensure

[35] IRF-PAI Training Manual, Appendix B: ICD-9-CM Codes Related to Specific Impairment Groups.

patients were classified by the most accurate condition (in the event a patient presented with more than one clinical condition category).

Exhibit 2.1: Clinical Condition Categories included in Longitudinal Analysis

Clinical Condition Category	RIC	Impairment Group	Included in 60 Percent Rule?*
Amputation	AMPNLE (11) AMPLE (10)	Amputation of Limb	Yes
Brain Injury	TBI (02), NTBI (03)	Brain Dysfunction	Yes
Cardiac Disorder	Cardiac (14)	Cardiac Disorders	No
Hip Fracture	FracLE (07)	Orthopedic Conditions	Yes
Hip/Knee Replacement	ReplLE (08), Ortho (09)	Orthopedic Conditions	Yes
Major Medical Complexity	Misc (20)	Medically Complex Conditions	No
Major Multiple Trauma	MMT-BSCI (18), MMT-NBSCI (17)	Major Multiple Trauma	Yes
Neurological Disorders	Neuro (06)	Neurological Conditions	Yes
Other Orthopedic	Ortho (09)	Orthopedic Conditions	No
Pain Syndromes	Pain (16)	Pain Syndromes	No
Pulmonary Disorders	Pulmonary (16)	Pulmonary Disorders	No
Spinal Cord Injuries	NTSCI (05), TSCI (04)	Spinal Cord Dysfunction	Yes
Stroke	Stroke (01)	Stroke	Yes
Other Conditions not Included in Analyses			
Osteoarthritis	OsteoA (12), RheumA (13)	Arthritis	Yes
Debility	Debility (16)	Debility	No
Neurological Conditions (Guillain-Barre Syndrome)	GB (19)	Neurological Condition (Guillain-Barre Syndrome)	No
Congenital Deformities	Misc (20)	Congenital Deformities	Yes
Developmental Disability	Misc (20)	Developmental Disability	No
Other Disabling Conditions	Misc (20)	Other Disabling Conditions	No
Systemic Vasculidities	Misc (20)	Medically Complex Conditions	Yes
Burns	Burns (21)	Burns	Yes

* The indicator for whether the condition is included in the 60 Percent Rule does not imply that every patient within that condition meets 60 Percent Rule eligibility. For example, while hip/knee replacement is a condition included in the 60 Percent Rule, only patients who meet specific clinical criteria (i.e., over 85 years old, received bilateral replacement surgery, or patient with BMI >50) are included towards a provider's 60 percent threshold. Two of the 13 conditions contained within the 60 Percent Rule are included within the Arthritis Impairment Group, therefore the chart only identifies 12 impairment groups with a "Yes" indicator.

Cross-Sectional Analysis

Cross sectional analyses compare the distribution of clinical conditions across PAC settings, years, and geographic areas following the implementation of the 60 Percent Rule. The goal of this analysis is to determine the extent to which the 60 Percent Rule shifted patients treated in IRFs with certain conditions to alternative care settings, including SNFs, LTCHs, or HHAs. This analysis is conducted for each year between 2005 and 2009 using a 100 percent sample of IRF and LTCH patients,[36] and a representative 20 percent sample of SNF and HHA patients.

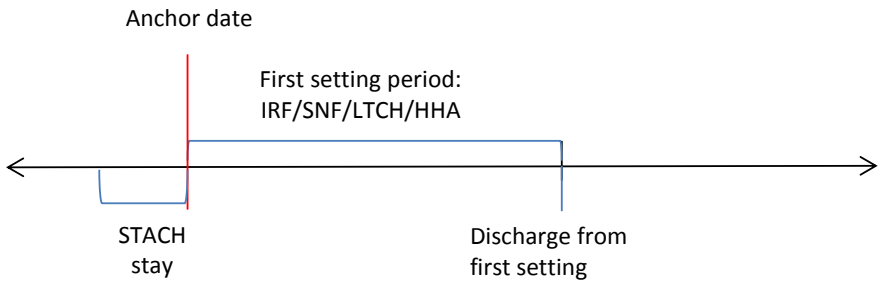
Developing Patient Episodes for Cross-Sectional Analysis

In conducting this analysis, episodes of care were developed for all patients identified using the clinical condition category algorithms. Only patients who were discharged from the short term acute care hospital (STACH) and admitted to one of the post-acute care settings within three days of hospital discharge were included in the analysis, ensuring that patients were at a similar stage in their rehabilitation care. This analysis does not control for patient risk within or across settings; rather, it determines the change in the proportion of patients treated in each setting by condition category, by year.

Exhibit 2.2 below shows the framework of the cross-sectional patient episodes. Patients who fit this framework were included in the analysis regardless of the care they received prior to their STACH stay (referred to as the "look back period"). The anchor date refers to the patient's admission to an IRF, SNF, LTCH, or HHA. At the time of the anchor date, the patient episode is defined either by the clinical condition category identified for which admission to the PAC is required or by the clinical diagnosis that initiated the preceding STACH admission. In the event that the clinical condition that initiated the acute care hospital admission differed from the clinical condition driving the need for post-acute care, the condition for which the patient is treated in the PAC setting is used to clinically define him/her.

[36] 100 percent of patients treated in either an IRF or LTCH was included in this analysis due to their relative low volume among Medicare beneficiaries, compared to SNF and HHA patients.

Exhibit 2.2: Patient Episode Framework for Cross-Sectional Analysis



Conducting Cross-Sectional Analysis

Using the patient episodes, defined by clinical condition categories, we determined the proportion of patients by condition by year for each setting (IRF, SNF, LTCH, and HHA). The analysis then compared the changes in the proportions over time within and across settings. Further sub-analyses were conducted that compared the changes in the distribution of conditions by geographic area, using the four census regions (i.e., Northeast, South, Midwest, and West).

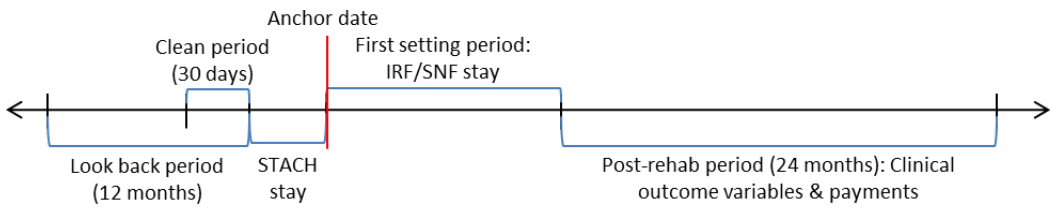
Longitudinal Analysis

The longitudinal analysis compares the long-term clinical outcomes and Medicare payments for patients who received rehabilitation services in the IRF compared to those who received rehabilitation in the SNF. Through the development of patient episodes using Medicare claims data for a 100 percent sample of IRF patients and a 20 percent sample of SNF patients from 2005 through 2009, we were able to risk-adjust the patients treated in each setting and compared their long-term clinical outcomes and Medicare payments.

Developing Patient Episodes for Longitudinal Analysis

Episodes of care were developed for all patients treated in either an IRF or SNF that could be identified using the clinical condition category algorithms. Exhibit 2.3 below shows the framework of the longitudinal patient episodes.

Exhibit 2.3: Patient Episode Framework for Longitudinal Analysis



All patient episodes contained the following key features:

- **STACH stay**: The STACH stay represents the acute care hospital admission that results in the need for post-acute care. Diagnostic and MS-DRG information was used to define each patient's clinical condition category and to risk-adjust the two patient populations. Similar to the cross-sectional analysis, only patients who were discharged from a STACH and admitted to an IRF or SNF within three days were included in the analysis, ensuring that patients were at a similar stage in their rehabilitation care (i.e., the time between the discharge from the acute care hospital and the anchor date is three or fewer days).
- **Anchor date**: The anchor date refers to the patient's admission to the IRF or SNF following discharge from the STACH. The patient episode is defined by the clinical condition category for which the patient was treated in the preceding acute care hospital admission or the category in the PAC setting.
- **Look back period**: The look back period captures health care utilization and clinical characteristics for one year (12 months) prior to admission to the acute care hospital. During the look back period, acute care hospitalizations or medical events related to the patient's clinical condition were used during the propensity score matching process to control for patient severity across the two settings (discussed further below). Diagnostic information (ICD-9s), procedural information (CPT and HCPCS from outpatient claims), and prior stays in facility-based settings are examples of the variables captured during the look back period.
- **Clean period**: Only patients with no facility-based care (STACH, IRF, SNF, or LTCH) within the 30 days immediately preceding the patient's admission to the STACH were considered for this analysis (referred to as the "clean period"). The purpose of the clean period is to ensure that the STACH admission is not a readmission from a prior admission and to ensure that the patient was not receiving facility-based care prior to the hospitalization. This is an important component of the episode as it better ensures appropriate attribution of outcomes to the rehabilitation care that follows hospital discharge.
- **First setting period:** The intervening days between admission to the IRF and SNF and discharge to another PAC setting or the community describe an episode's "first setting period." The length of the first setting period will vary by patient and setting. We examined the claims that occurred during this period in order to understand the care that the patient received during the first setting and its impact on clinical outcomes and Medicare payment.

- **Post-rehabilitation period:** The post-rehabilitation period is initiated by discharge from the IRF or SNF setting, and extends for 24 months. Claims during this period are examined to determine outcomes and Medicare episode payment. In order to be included in the analysis, each patient must have the opportunity for 24 months of claims to be available. That is, even if a patient expired during the two-year study period there needed to have been an opportunity for two years of service use if the patient had survived.

Based on this episode framework, we developed patient episodes for IRF and SNF first setting patients for each of the clinical condition categories. In the next section, we discuss how we controlled for patient demographics and severity and how we matched SNF to IRF patients.

Developing Patient Cohorts

Based on the patient episode framework described above, we identified two patient cohorts for each clinical condition category: 1) those who received care in an IRF as their first setting (i.e., the study group), and 2) those who received care in a SNF as their first setting (i.e., the comparison group). The comparison group was matched to the study group through propensity score matching techniques based on patient characteristics, comorbidities, and historical health care utilization one year prior to the admission to the acute care hospital stay.

Propensity score matching techniques are widely used in observational studies when randomized controlled trials (RCTs) are not possible or able to be generalized to the population, or are unethical or impractical to administer.[37] Literature suggests that applying these techniques to observational studies removes observable selection bias among treatment and comparison groups and can replicate findings produced by RCTs.[38,39,40,41]

We used propensity scores to create a one-to-one match across study group and comparison group patients within each clinical condition. We used an optimized "nearest neighbor" method that iteratively increased the caliper width used to identify patient matches. Consistent with the methods traditionally used in the literature, any matched pair with a difference in propensity scores beyond 0.2 standard deviations of the logit

[37] Trojano M, Pellegrini F, Paolicelli D, Fuiani A, Di Renzo V: Observational studies: propensity score analysis of non-randomized data. *International MS Journal.* 2009; 16:90-7.

[38] Austin PC: An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behavioral Research.* 2011; 46:399-424.

[39] Kuss O, Legler T, Borgermann J: Treatments effects from randomized trials and propensity score analyses were similar in similar populations in an example from cardiac surgery. *J Clin Epidemiol.* 2011; 64(10):1076-84.

[40] Dehejia R, Wahba S: Propensity score-matching methods for nonexperimental causal studies. *The Review of Economics and Statistic.* 2002; 84(1):151-61.

[41] Rosenbaum PR, Rubin DB: The central role of the propensity score in observational studies for causal effects. *Biometrika.* 1983; 70(1):41-55.

function was excluded from the analysis.[42] The rigor of the matching techniques isolated the effect of site of service from other correlated observable effects. Patients who were not able to be matched were excluded from the analysis.

The variables used to determine the propensity score are presented in Exhibit 2.4. These variables were collected during the look back period or during the acute care hospitalization. Each clinical condition category used a slightly different equation to determine the propensity score based on the clinical algorithms, but all condition categories used the same variables in the claims to determine the patient matches (to the extent that a given variable was significant in determining the propensity score). Mortality was not used in the matching process to control for patient severity across settings because it was used as a clinical outcome.

Exhibit 2.4: Variables Used to Determine Propensity Score for Each Clinical Condition Category

Covariates
Age
Gender
Race
Hierarchical Condition Categories (HCC) and Community, Institutional, and New Enrollee Scores
Specific HCC Categories e.g., Major complications of medical care and trauma; Schizophrenia; Seizure disorders and convulsions
Berenson-Eggers Type of Service (BETOS) Code (clustering of procedure codes – CPTs & HCPCS) e.g., Standard imaging; Laboratory tests; Minor procedures
Clinical Classification Software (CCS) Code (clinical clustering of ICD-9s) e.g., Diabetes mellitus without complication; Essential hypertension; Coronary atherosclerosis
Charges by Revenue Center e.g., Pharmacy; Operating room; Imaging; Therapy (Physical, Occupational, and Speech)

Generally, due to the difference in volume of patients treated in IRFs and SNFs, SNF patients within each clinical condition category were able to be matched to IRF patients with the same demographic or clinical characteristics (i.e., there were enough SNF patients to find a match for each IRF patient). However, additional restrictions were made during the matching process, as appropriate. For example, within the brain injury condition category, a patient treated in an SNF for ***traumatic*** brain injury was matched only to a patient treated in an IRF for a traumatic brain injury (as opposed to a *non-traumatic* brain injury). In the example of the lower extremity major joint replacement condition category, hip replacement patients were only matched to other hip replacement patients, as opposed to knee replacement patients.

[42] Austin PC: Optimal caliper widths for propensity-score matching when estimating differences in means and differences in proportions in observational studies. *Pharm Stat.* 2011; 10:150-161.

Since a one-to-one match was used, the number of matched pairs was limited by the number of IRF patients. As IRFs are the smaller of the two PAC settings, this did not allow for all clinically-similar SNF patients to be included in the analysis.

Exhibit 2.5 below shows the number of IRF and SNF patients by clinical condition category before and after matching. Across all condition categories, 100,491 matched pairs were created, which represents 89.6 percent of all IRF patients and 19.6 percent of SNF patients contained within the 20 percent sample of Medicare beneficiaries. Across clinical condition categories, the percent of SNF patients able to be matched to clinically and demographically similar IRF patients ranged between 71.5 percent (neurological disorders and pain syndromes) and 100 percent (cardiac disorders and major medical complexity). However, due to the volume of SNF patients, between 3.2 percent (major medical complexity) and 50.9 percent (major multiple trauma) of SNF patients contained within the 20 percent sample of beneficiaries were able to be matched to clinically and demographically similar IRF patients.

Exhibit 2.5: Distribution of Matched Pairs by Clinical Condition Category and Percent of IRF Universe and SNF Sample of Patients

	Unmatched (Total Patients)		Matched	Matched Pairs as a % of Unmatched	
Condition	**IRF**	**SNF**	**Pairs**	**IRF**	**SNF**
Amputation	1,971	6,234	1,756	89.1%	28.2%
Brain Injury	6,231	19,459	5,364	86.1%	27.6%
Cardiac Disorder	5,197	89,219	5,195	100.0%	5.8%
Hip Fracture	21,190	59,884	20,970	99.0%	35.0%
Hip/Knee Replacement	22,744	46,650	21,485	94.5%	46.1%
Major Medical Complexity	5,675	177,835	5,675	100.0%	3.2%
Major Multiple Trauma	1,681	3,142	1,600	95.2%	50.9%
Neurological Disorders	6,676	10,552	4,771	71.5%	45.2%
Other Orthopedic	6,311	11,949	6,030	95.5%	50.5%
Pain Syndromes	6,676	10,552	4,771	71.5%	45.2%
Pulmonary Disorders	1,827	34,107	1,821	99.7%	5.3%
Spinal Cord Injuries	4,669	8,594	4,068	87.1%	47.3%
Stroke	21,268	35,379	16,985	79.9%	48.0%
Overall	**112,116**	**513,556**	**100,491**	**89.6%**	**19.6%**

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Notes: In the IRF-PAI training Manual, Hip Fracture and Hip/Knee Replacement are sub-categories within Orthopedic Conditions, and Major Medical Complexity is referred to as "Medically Complex Conditions."

Calculating Descriptive Statistics and Analyzing Overall Patient Medicare Expenditures

Descriptive statistics were calculated for the study and comparison cohorts after the propensity score matching. Long-term health care utilization and outcomes were compared across the IRF and SNF patient cohorts and clinical condition categories, and the differences were tested for statistical significance. The study and comparison groups were compared on two types of outcomes. First, clinical indicators were used, which included mortality rate, average number of days in the home/community and facility-based care days, prevalence of falls with injuries, pressure ulcers, and emergency room and hospital admissions.

Second, the groups were compared on utilization and per-member-per-month (PMPM) Medicare payments, as well as the average Medicare episode payment per day.

The outcome variables are defined in Exhibit 2.6.

Exhibit 2.6: Outcomes used to Compare Long-Term Impact of IRF Compared to SNF Care

Outcome	Definition
Mortality rate	Percent of patients who died within two-year study period
Average additional days of life	Average days of life per person over two-year study period, including patients who died
Length of stay during first setting	Average length of stay in initial IRF/SNF stay
Number of facility-based days	Average number of days per patient over two-year episode spent in a hospital, IRF, SNF, or LTCH
Number of community-based days (days at home)	Average number of days per patient over two-year episode not spent in a hospital, IRF, SNF, or LTCH. (Lack of nursing home claims in the data may overestimate the calculated number of days at home)
Emergency room and hospital admissions per 1,000 beneficiaries per year	Average number of emergency room visits and hospital admissions per 1,000 beneficiaries per year
Per-member-per-month (PMPM) payment by setting	Sum of the payments divided by the sum of the member months
Average Medicare episode payment per day	Total Medicare payment across all settings (including the anchor) divided by total number of patient days

Data Limitations

Our analyses have several key limitations that may affect the interpretation of our results. First, while administrative claims data offer a robust and representative study population, these data do not contain detailed, medical record-level clinical information. Given this general limitation, our interpretation of beneficiaries' clinical outcomes relied upon outcomes observable in the claims data (e.g., comorbidities, mortality, emergency room

utilization, etc.) that may not fully indicate patients' health or functional outcomes as a result of receiving post-acute care. Although we used rigorous propensity matching techniques to control for patient demographic characteristics and severity, the lack of clinical information may exclude or may bias certain characteristics that are not observed within the claims.

Second, the data files used in this analysis could not be augmented with the PAC assessment data, which could have allowed us to compare beneficiaries' functional independence changes (during and/or) following rehabilitation. For instance, using claims data we were unable to identify beneficiaries' live-alone status, which is a social characteristic that studies have shown to correlate with patients' PAC discharge destination.[43]

Lastly, Medicare fee-for-service claims do not include care covered and reimbursed by Medicare Advantage plans, Medicaid, or third-party payers. Thus, non-Medicare services, such as long-term nursing home care, were not captured in this analysis. This omission may have overestimated the calculated number of days a patient remained at home, and underestimated the cost of their health care to the federal and state governments.

In the next chapters, we present the results of our cross-sectional and longitudinal analysis.

[43] Pablo PD, Losina E, Phillips CB, et al. Determinants of discharge destination following elective total hip replacement. *Arthritis Rheum* 2004; 51(6):1009-14.

Cross-Sectional Analysis Results

The purpose of the cross-sectional analysis is to determine the distribution of clinical condition categories within IRFs and other PAC settings, and to identify any trends or changes in this distribution during the five years following implementation of the 60 Percent Rule. This analysis serves as the first analytic step towards the broader study goal of understanding the differences in long-term patient outcomes based on where patients receive rehabilitative care. A shift in the distribution of clinical condition categories within and across PAC settings following the implementation of the 60 Percent Rule would provide insight into how PAC providers changed practice patterns to adhere with the revised IRF-PPS.

This analysis was performed across the four PAC settings (IRFs, SNF, LTCHs, and HHA). Only the clinical condition categories with algorithms that could accurately be applied to non-IRF settings were included in this analysis. Therefore, the proportions presented do not reflect all patient cases treated in SNFs, LTCHs, and HHAs, but are representative of IRF conditions.

Distribution of Clinical Condition Categories among IRFs

The distribution of IRF clinical condition categories between 2005 and 2009 is shown in Exhibit 3.1. In 2005, the three largest clinical condition categories – lower extremity joint replacement (hip/knee replacement), stroke, and fracture of lower extremity (hip fracture) – represented 60.4 percent of all IRF admissions. Hip/knee replacement patients represented 25.4 percent, while stroke and hip fracture patients represented 18.3 percent and 16.7 percent of total IRF admissions in 2005, respectively. All other condition categories represent less than 6 percent of all IRF patients with clinical condition categories included in this analysis.

The relative proportion of the three largest condition categories steadily decreased, and by 2009 represented only 52.4 percent of all IRF patients. This trend was driven by the

marked 10.9 percentage point decrease in the proportion of patients treated for hip/knee replacements. While the proportion of other conditions fluctuated over the study period, no other condition category experienced such a large change.

Appendix B presents results for the other individual PAC setting – SNFs, HHAs, and LTCHs.

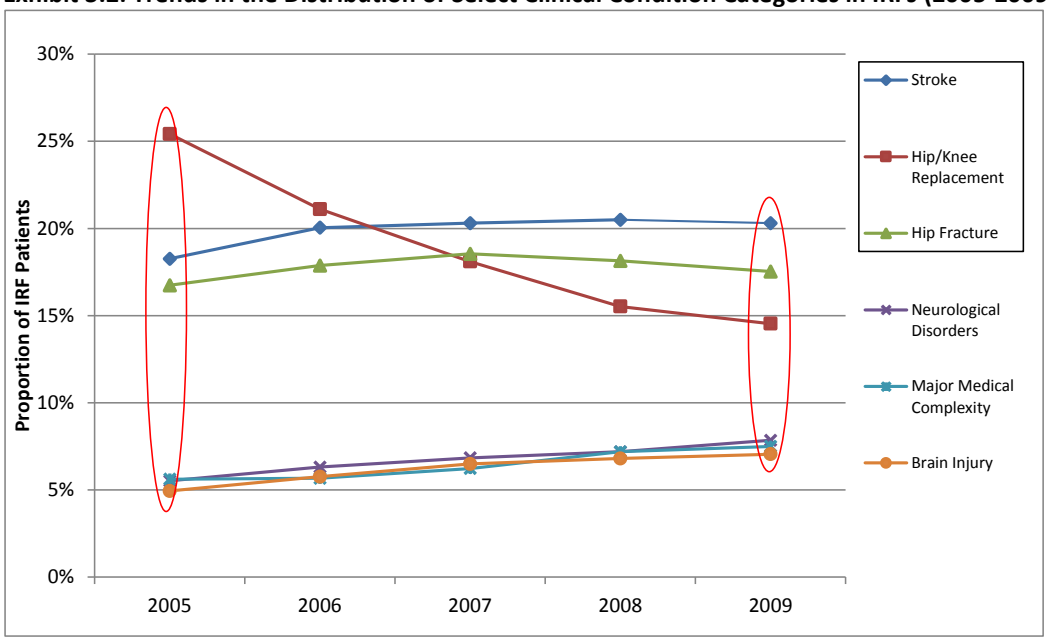
Exhibit 3.1: Distribution of Clinical Condition Categories among IRFs (2005-2009) (Ranked by Proportion in 2005)

Clinical Condition Category	2005	2006	2007	2008	2009	Percentage Point Change (2005-2009)
Hip/Knee Replacement (Lower Extremity Joint Replacement)	25.4%	21.1%	18.1%	15.5%	14.5%	-10.9%
Stroke	18.3%	20.0%	20.3%	20.5%	20.3%	2.0%
Hip Fracture (Fracture of Lower Extremity)	16.7%	17.9%	18.5%	18.1%	17.5%	0.8%
Major Medical Complexity	5.6%	5.7%	6.2%	7.2%	7.5%	1.9%
Cardiac Disorder	5.6%	5.2%	5.4%	6.0%	6.3%	0.7%
Neurological Disorders	5.5%	6.3%	6.8%	7.2%	7.9%	2.3%
Other Orthopedic	5.3%	5.6%	5.8%	6.4%	6.6%	1.3%
Brain Injury	4.9%	5.8%	6.5%	6.8%	7.1%	2.1%
Spinal Cord Injury	4.3%	4.4%	4.4%	4.1%	4.3%	0.0%
Amputation	2.6%	2.6%	2.5%	2.5%	2.5%	-0.2%
Pulmonary Disorders	2.1%	2.0%	2.0%	2.2%	2.2%	0.1%
Pain Syndromes	1.9%	1.8%	1.6%	1.6%	1.4%	-0.6%
Major Multiple Trauma	1.3%	1.5%	1.6%	1.7%	1.8%	0.5%
Debility	0.3%	0.2%	0.2%	0.2%	0.2%	-0.1%
All Other	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%

Percentages may not total 100 percent due to rounding.
Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

The large decrease in lower extremity joint replacement cases is offset by smaller proportional increases in other condition categories (Exhibit 3.2). Between 2005 and 2009, stroke, major medical complexity, neurological disorders, and brain injury condition categories each increased by approximately two percentage points. This produced a more even distribution of clinical condition categories each year following the implementation of the 60 Percent Rule.

Exhibit 3.2: Trends in the Distribution of Select Clinical Condition Categories in IRFs (2005-2009)



Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Comparison of the Distribution of Clinical Condition Categories between IRFs and SNFs

Researchers and policymakers anticipated that the implementation of the 60 Percent Rule would lead to a relative decrease in patients with certain conditions in IRFs, offset by an increase in corresponding patient conditions in SNFs. Exhibit 3.3 presents the distribution of clinical condition categories in IRFs and SNFs by year.

Similar to the distribution of clinical condition categories in IRFs, three condition categories represented almost two-thirds of SNF admissions in a given year. In 2005, major medical complexity (33.8 percent), cardiac conditions (18.1 percent), and hip fractures (10.2 percent) collectively represented 62.1 percent of all SNF admissions. By 2009, the proportion of SNF admissions representing these conditions increased to 64 percent.

Across all years, major medical complexities was the largest clinical condition category treated in SNFs, representing at least one third of all admissions across each year. The proportion of SNF admissions for this condition category increased from 33.8 percent in 2005 to 37.5 percent in 2009. Although major medical complexities represented a significantly smaller proportion of IRF admissions, the relative proportion of this condition also increased, from 5.6 percent to 7.5 percent.

However, the relative change in proportion among SNF patients treated for cardiac conditions may be related to the 60 Percent Rule. As a condition not included in the Rule, the decrease in proportion of cardiac patients treated in SNFs from 2005 to 2009 (a change from 18.1 percent in 2005 to 16.7 percent in 2009) coincided with an increase in IRFs (from 5.6 percent to 6.3 percent). A similar trend was evident among stroke patients. The increased proportion of patients treated in IRFs for stroke (a condition included in the 60 Percent Rule) was accompanied by a decrease in the proportion of patients treated in SNFs, which decreased from 7.1 percent in 2005 to 6.2 percent in 2009.

The significant decrease in the proportion of hip/knee replacement patients in IRFs from 2005 through 2009 was not accompanied by a comparable increase in the proportion of these conditions in SNFs over the same period. From 2005 through 2009, the proportion of patients treated for hip/knee replacements among SNFs only increased from 7.4 percent to 8.0 percent, while the proportion of these patients treated in IRFs decreased from 25.4 percent to 14.5 percent. Our analysis of HHAs, however, shows the distribution of hip/knee replacement cases increased from 10.4 percent in 2005 to 12.8 percent in 2009 (see Appendix B).

Cross-Sectional Analysis Results

Exhibit 3.3: Comparison of IRF and SNF Distribution of Clinical Condition Categories (2005-2009) (Ranked by IRF Proportion in 2005)

	2005		2006		2007		2008		2009		Percentage Point Change (2005-2009)	
Clinical Condition Category	**IRF**	**SNF**	**IRF**	**SNF**	**IRF**	**SNF**	**IRF**	**SNF**	**IRF**	**SNF**	**IRF**	**SNF**
Stroke	18.3%	7.1%	20.0%	6.7%	20.3%	6.5%	20.5%	6.3%	20.3%	6.2%	2.0%	-0.9%
Hip Fracture	16.7%	10.2%	17.9%	10.1%	18.5%	10.1%	18.1%	9.9%	17.5%	9.8%	0.8%	-0.4%
Hip/Knee Replacement	25.4%	7.4%	21.1%	7.3%	18.1%	7.5%	15.5%	7.6%	14.5%	8.0%	-10.9%	0.6%
Neurological Disorders	5.5%	1.9%	6.3%	2.0%	6.8%	2.0%	7.2%	2.0%	7.9%	1.9%	2.4%	0.0%
Brain Injury	4.9%	3.5%	5.8%	3.5%	6.5%	3.5%	6.8%	3.5%	7.1%	3.3%	2.2%	-0.2%
Other Orthopedic	5.3%	1.9%	5.6%	2.0%	5.8%	2.2%	6.4%	2.3%	6.6%	2.3%	1.3%	0.4%
Cardiac Disorder	5.6%	18.1%	5.2%	17.8%	5.4%	17.2%	6.0%	17.0%	6.3%	16.7%	0.7%	-1.4%
Spinal Cord Injury	4.3%	1.5%	4.4%	1.5%	4.4%	1.6%	4.1%	1.6%	4.3%	1.6%	0.0%	0.1%
Debility	0.3%	1.9%	0.2%	1.8%	0.2%	1.8%	0.2%	1.8%	0.2%	1.7%	-0.1%	-0.2%
Major Medical Complexity	5.6%	33.8%	5.7%	35.3%	6.2%	36.6%	7.2%	36.9%	7.5%	37.5%	1.9%	3.7%
Amputation	2.6%	2.1%	2.6%	1.7%	2.5%	1.0%	2.5%	0.9%	2.5%	0.9%	-0.1%	-1.2%
Pulmonary Disorders	2.1%	7.5%	2.0%	7.0%	2.0%	6.8%	2.2%	7.0%	2.2%	6.8%	0.1%	-0.7%
Major Multiple Trauma	1.3%	0.5%	1.5%	0.6%	1.6%	0.6%	1.7%	0.6%	1.8%	0.6%	0.5%	0.1%
Pain Syndromes	1.9%	2.4%	1.8%	2.5%	1.6%	2.5%	1.6%	2.5%	1.4%	2.5%	-0.5%	0.1%
All Other	0.1%	0.3%	0.2%	0.3%	0.1%	0.3%	0.1%	0.1%	0.2%	0.2%	-0.5%	0.1%

Percentages may not total 100 percent due to rounding.
Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Comparison of Results to MedPAC Published Estimates

Results from our cross-sectional analysis of the distribution of IRF admissions by clinical condition category are consistent with published MedPAC analyses for the 10 most common IRF conditions (Exhibit 3.4). While the absolute proportions of each clinical condition do not align perfectly, directionally, the results appear consistent, validating the algorithms we used to define each clinical condition category.

The major trends identified in our analysis – the significant decline in the proportion of hip/knee replacements and the increase in the proportion of stroke patients, neurological disorders, and brain injury cases – are also observed in MedPAC's analyses (Exhibit 3.4).

A notable discrepancy across all study years is the difference in the observed proportion of beneficiaries admitted with debility. This large difference is likely due to difficulty defining debility without using the RIC or impairment group codes contained in IRF claims. In our methodology, admissions are classified into clinical condition categories using diagnostic information, not IRF payment classifications. This is a methodological prerequisite, as the conditions needed to be consistently classified in the other PAC settings. Thus, our cross-sectional results do not accurately capture the relative proportion of debility cases across PAC settings. In each setting, the proportion of debility cases is likely underestimated, possibly slightly effecting the relative proportions of all other conditions.

Exhibit 3.4: Comparison of the Distribution of Clinical Condition Categories in Dobson | DaVanzo and MedPAC Analyses (2005-2009)

	2005		2006		2007		2008		2009	
Clinical Condition Category	**D|D**	**MedPAC**	**D|D**	**MedPAC**	**D|D**	**MedPAC**	**D|D**	**MedPAC**	**D|D**	**MedPAC[1]**
Stroke	18.3%	19.0%	20.0%	20.3%	20.3%	20.8%	20.5%	20.5%	20.3%	20.6%
Hip Fracture	16.7%	15.0%	17.9%	16.1%	18.5%	16.4%	18.1%	16.3%	17.5%	15.5%
Hip/Knee Replacement	25.4%	21.3%	21.1%	17.8%	18.1%	15.0%	15.5%	13.2%	14.5%	11.4%
Neurological Disorders	5.5%	6.2%	6.3%	7.0%	6.8%	7.8%	7.2%	7.9%	7.9%	9.0%
Brain Injury	4.9%	5.2%	5.8%	6.0%	6.5%	6.7%	6.8%	6.9%	7.1%	7.3%
Other Orthopedic	5.3%	5.1%	5.6%	5.2%	5.8%	5.5%	6.4%	5.8%	6.6%	6.3%
Cardiac Conditions	5.6%	4.2%	5.2%	4.0%	5.4%	4.2%	6.0%	4.6%	6.3%	4.9%
Spinal Cord Injury	4.3%	4.5%	4.4%	4.6%	4.4%	4.6%	4.1%	4.3%	4.3%	4.3%
Debility*	0.3%	5.8%	0.2%	6.2%	0.2%	7.7%	0.2%	9.1%	0.2%	9.2%
Other**	13.7%	13.8%	13.5%	12.8%	14.0%	11.3%	15.2%	11.4%	15.4%	11.5%

Percentages may not total 100 percent due to rounding.

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Medicare Payment Advisory Commission (Report to the Congress). Medicare Payment Policy. March 2012.

[1] Represents data taken from January through June 2009.

*Defined by the presence of the following ICD-9 codes: 728.2, 728.9, 780.71, 780.79. Due to the difficulty in consistently defining debility using administrative claims across settings, this definition underestimates this patient population, potentially impacting the proportion of patients across all conditions.

**Dobson | DaVanzo column: includes amputation, major multiple trauma, pain syndrome, major medical complexity, pulmonary disorders, rheumatoid arthritis, burns, congenital deformities, and developmental disorders. MedPAC: includes amputations, major multiple trauma, and pain syndrome, but possibly may include additional categories that are not explicitly identified.

This report focuses on the time period immediately following the implementation of the 60 Percent Rule (2005 and 2009). However, distribution of clinical condition categories both within and across PAC settings continues to change following the Rule. MedPAC has continued to track the distribution of clinical condition categories through the first six months of 2013 (Exhibit 3.5). The relative proportion of the three largest clinical condition categories (stroke, hip fracture, and hip/knee replacement) continued to change in proportion from 45.9 percent of total IRF admissions in 2010 to 40.8 percent in 2013. All three condition categories have demonstrated decreases in their proportion of IRF admissions between 2010 and 2013, despite the trends evidenced between 2005 and 2009.

Of these three conditions, hip/knee replacement was the only clinical condition category that decreased in proportion from 2005 through 2009. This trend continued from 2010 through 2013 (from 11.5 percent to 8.8 percent).

The proportion of patients treated for hip fractures and strokes declined from 2010 through 2013, despite the increase in the proportions of these condition categories from 2005 through 2009.

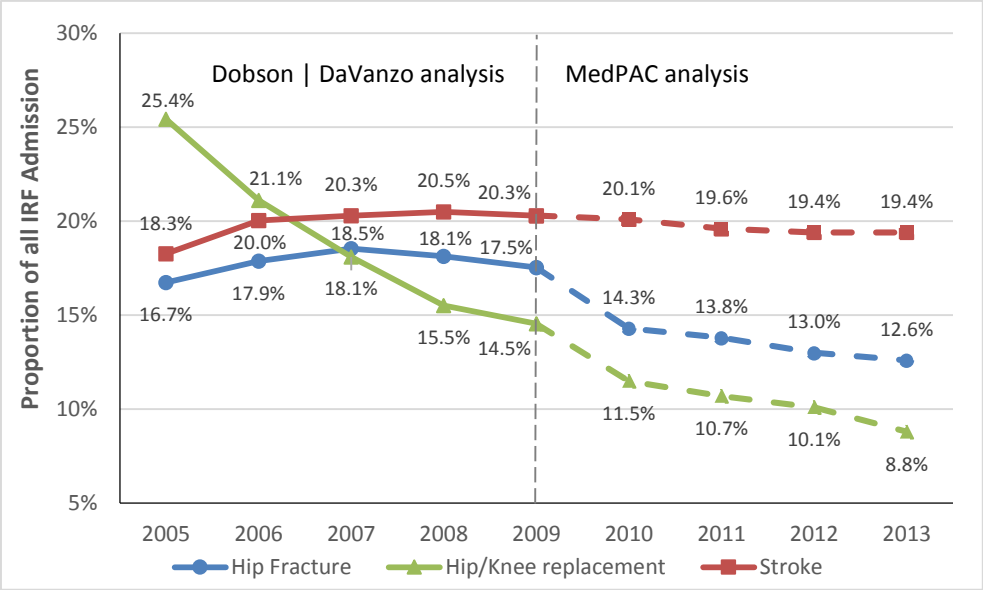
Exhibit 3.5: MedPAC Analysis of Most Common IRF Cases (2010-2013)

Clinical Condition Category	2010	2011	2012	2013[1]	Percentage Point Change (2010-2013)
Stroke	20.1%	19.6%	19.4%	19.4%	-0.7%
Hip Fracture	14.3%	13.8%	13.0%	12.6%	-1.7%
Hip/Knee Replacement	11.5%	10.7%	10.1%	8.8%	-2.7%
Neurological Disorders	9.8%	10.3%	11.6%	12.5%	2.7%
Brain Injury	7.3%	7.6%	7.9%	8.1%	0.8%
Other Orthopedic	6.7%	7.1%	7.5%	7.6%	0.9%
Cardiac Conditions	4.9%	5.1%	5.3%	5.4%	0.5%
Spinal Cord Injury	4.3%	4.5%	4.6%	4.5%	0.2%
Debility	10.0%	10.3%	10.0%	10.3%	0.3%
Other*	11.1%	10.9%	10.6%	10.7%	-0.4%

Percentages may not total 100 percent due to rounding.
Source: Medicare Payment Advisory Commission (Report to the Congress). Medicare Payment Policy. March 2014.
*Includes conditions such as: amputations, MMT, and pain syndrome.

For illustrative purposes, we combine our cross-sectional results of 2005 through 2009 IRF data for hip/knee replacement, stroke, and hip fracture cases with MedPAC's analyses of the same conditions from 2010 through 2013 (Exhibit 3.6). Despite our results being approximately two percentage points above MedPAC's results for hip fractures and hip/knee replacements due to methodological differences, this graph shows the general trends of these conditions through 2013.

Exhibit 3.6: Change in Distribution of Clinical Condition Categories among IRFs – Dobson | DaVanzo (2005-2009) and MedPAC (2010-2013) Estimates for Select Conditions



Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.
Medicare Payment Advisory Commission (Report to the Congress). Medicare Payment Policy. March 2014.
Note: MedPAC estimates for hip fractures and hip/knee replacements are generally lower than Dobson | DaVanzo's estimates by about two percentage points due to methodology differences. Therefore, a portion of the decrease between 2009 and 2010 may not reflect true decreases in volume in these conditions.

Comparison of the Distribution of IRF Clinical Condition Categories by Geographic Region

To determine if the overall IRF provider response to the 60 Percent Rule was a national trend or driven by select geographic regions, we examined the distribution of IRF conditions by the four census regions: Northeast, South, Midwest, and West. Detailed results of this analysis are presented in Appendix B. These data show that the relative proportion of IRF patients by clinical condition category across census regions reflect the nationwide distribution for each study year. In each region, hip/knee replacement, stroke, and hip fracture conditions represented the greatest relative proportion of IRF cases. The marked decline in the proportion of hip/knee replacements is also observed across census regions, although this change appears somewhat less pronounced in the Northeast (a reduction in proportion of 6.5 percent) compared to the Midwest, South, and West, with a reduction in proportions of 11.5 percent, 12.6 percent, and 11.6 percent, respectively.

Cross-Sectional Analysis Summary and Discussion

Our analysis of the Medicare claims data following implementation of the 60 Percent Rule (2005 through 2009) shows the relative change in the distribution of clinical condition categories across settings. The most notable trend is the significant decrease in the relative proportion in the hip/knee replacement clinical condition category among IRFs, which is offset by smaller proportional increases in stroke, major medical complexity, neurological disorder, and brain injury in the same condition category among SNFs. Additionally, as the proportion decreases within IRFs, other condition categories show a modest relative increase from 2005 through 2009. Despite the relative decline in lower extremity joint replacement cases, the three most common conditions – hip/knee replacement, stroke, and hip fractures – continued to represent the majority of all IRF admissions during the study period.

In extending our analyses using MedPAC's published estimates, the results suggest that the trends evidenced from 2005 through 2009 continued through 2013. As noted above, the strongest evidence for patient shifting from IRFs to other PAC settings is seen among the hip/knee replacement clinical condition category. While our analysis and MedPAC's data appear to show declining volume of IRF hip fracture cases from 2007 through 2013, corresponding changes are not observed in other PAC settings.

Longitudinal Analysis Results

The goal of our longitudinal analysis is to compare the long-term clinical outcomes and Medicare payments for patients who received rehabilitation services in the IRF to those who are clinically and demographically similar but received rehabilitation in the SNF. In this analysis, we compare the length of the initial rehabilitation stay of these two patient populations, but focus on the examination of longer-term outcomes during the two-year study period following discharge from the initial rehabilitation stay.

Differences in Length of Stay during the Initial Rehabilitation Stay

The focus of the longitudinal analysis is to compare selected patient outcomes and Medicare spending for the two-year study period after discharge from the initial rehabilitation stay (IRF versus SNF). However, the care that is provided during the initial rehabilitation stay positions the patient for the continued rehabilitation progress upon discharge. Exhibit 4.1 shows the average length of stay by clinical condition category for patients treated in an IRF as compared to a SNF. On average across all conditions, patients treated in an IRF have a length of stay that is less than half as long as those treated in a SNF (12.4 days for IRF patients compared to 26.4 days for SNF patients). The shorter average length of rehabilitation stay observed in this study is consistent with published literature that notes shorter average stays for IRF hip/knee replacement[44,45,46] and hip fracture[47,48]

[44] DeJong G, Tian W, Smout RJ, et al. Long-term outcomes of joint replacement rehabilitation patients discharged from skilled nursing and inpatient rehabilitation facilities. *Arch Phys Med Rehabil*. 2009; 90:1306-16.

[45] Tian W, DeJong G, Horn SD, et al. Efficient rehabilitation care for joint replacement patients: skilled nursing facility or inpatient rehabilitation facility? *Med Decis Making*. 2012; 32:176-87.

[46] Walsh MB, Herbold J. Outcome after rehabilitation for total joint replacement at IRF and SNF: A case controlled comparison. *Am J Phys Med Rehabil*. 2006; 85(1):1-5.

[47] Munin MC, Seligman K, Dew MA, et al. Effect of rehabilitation site on functional recovery after hip fracture. *Arch Phys Med Rehabil*. 2005; 86:367-72.

[48] Herbold JA, Bonistall K, Walsh MB. Rehabilitation following total knee replacement, total hip replacement, and hip fracture: A case-controlled comparison. *J Geriatr Phys Ther*. 2011; 34:155-60.

patients than comparable SNF patients' stays. These investigators suggest that this two-week shorter length of stay (13.9 days; p<0.0001) may be attributable to more intensive rehabilitation provided in IRFs compared to that provided in SNFs. The longer length of stay within the SNF may be due, in part, to per diem payments in addition to patient copayments commencing on day 21 of the SNF stay.

This trend is consistent within all clinical condition categories. The differences in the average length of stay ranges from 5.3 fewer days for IRF patients treated for hip/knee replacements to 23.1 fewer days for patients treated in IRFs for multiple medical complexity. These differences are statistically significant for every condition category.

Exhibit 4.1: Difference in Average Length of Stay for Initial IRF/SNF Rehabilitation Stay: Matched IRF and SNF Patients

Clinical Condition Category	IRF	SNF	Difference (IRF minus SNF)	P-value
Amputation	14.0	29.6	-15.7	<.0001
Brain Injury	13.7	30.7	-16.9	<.0001
Cardiac Disorder	11.2	23.1	-11.9	<.0001
Hip Fracture	13.3	32.7	-19.4	<.0001
Hip/Knee Replacement	9.3	14.7	-5.3	<.0001
Major Medical Complexity	12.0	24.9	-12.9	<.0001
Major Multiple Trauma	14.5	37.7	-23.1	<.0001
Neurological Disorders	13.0	32.2	-19.2	<.0001
Other Orthopedic	11.8	26.2	-14.3	<.0001
Pain Syndromes	10.7	25.2	-14.5	<.0001
Pulmonary Disorders	11.3	24.3	-13.0	<.0001
Spinal Cord Injuries	13.5	22.2	-8.7	<.0001
Stroke	15.5	32.1	-16.5	<.0001
Overall Average	**12.4**	**26.4**	**-13.9**	**<.0001**

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Differences in Clinical Outcomes during the Post-Rehabilitation Period

The longitudinal analysis primarily focuses on longer term patient outcomes for matched cohorts of clinically and demographically comparable IRF and SNF patients following discharge from the initial rehabilitation stay. Since results indicate that patients who are treated in an IRF are discharged nearly two weeks earlier than patients treated in a SNF, the post-rehabilitation period starts at different times in the patients' recovery. Generally, results suggest that patients treated in IRFs had better long-term clinical outcomes (over the two-year study period) on a series of validated outcome measures than those treated in SNFs following the implementation of the 60 Percent Rule.

Mortality Rates and Additional Days Preserved

Risk of mortality and the additional days of life are two measures used to compare the long-term outcomes of patients treated in IRFs to clinically and demographically comparable patients treated in SNFs. As shown in Exhibit 4.2, patients who were treated in an IRF experienced a 7.9 percentage point lower mortality rate during the two-year study period than SNF patients ($p<0.0001$). Again, the results are directionally consistent across all clinical condition categories, with significantly lower mortality rates among IRF patients than SNF patients.

The largest difference in mortality rates was among brain injury patients, in which 35.1 percent of patients died within two years after discharge from the IRF, while 50.7 percent of patients died after discharge from the SNF (a difference of 15.5 percentage points). As patients were matched based on demographics and clinical severity, the severity level of the patients was highly comparable.

Another large difference in mortality rates was among stroke patients, in which 34.2 percent of patients died within two years of discharge from the IRF, while 48.4 percent of patients died within discharge from the SNF (a difference of 14.3 percentage points).

Other conditions had smaller, yet significant differences in mortality rates, such as patients treated for hip/knee replacements, other orthopedic conditions, and major multiple trauma.

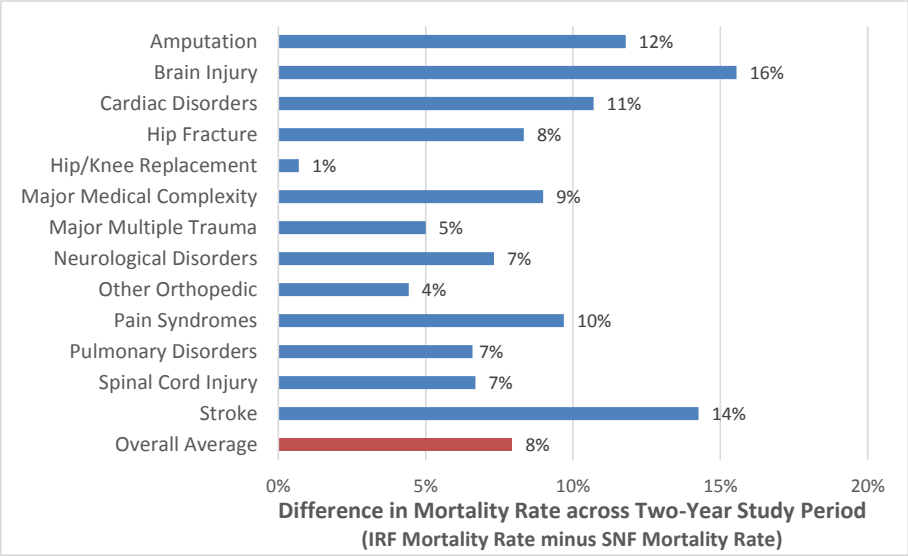
Exhibit 4.2: Mortality Rate across Two-Year Study Period: Matched IRF and SNF Patients

Clinical Condition Category	IRF	SNF	Difference (IRF minus SNF)	P value
Amputation	36.6%	48.4%	-11.8%	<0.0001
Brain Injury	35.1%	50.7%	-15.5%	<0.0001
Cardiac Disorder	34.1%	44.9%	-10.7%	<0.0001
Hip Fracture	25.4%	33.7%	-8.3%	<0.0001
Hip/Knee Replacement	5.2%	5.9%	-0.7%	0.0016
Major Medical Complexity	42.8%	51.8%	-9.0%	<0.0001
Major Multiple Trauma	19.1%	24.1%	-5.0%	0.0006
Neurological Disorders	32.3%	39.6%	-7.3%	<0.0001
Other Orthopedic	18.1%	22.6%	-4.4%	<0.0001
Pain Syndromes	19.8%	29.5%	-9.7%	<0.0001
Pulmonary Disorders	45.3%	51.9%	-6.6%	<0.0001
Spinal Cord Injuries	19.4%	26.1%	-6.7%	<0.0001
Stroke	34.2%	48.4%	-14.3%	<0.0001
Overall Average	**24.3%**	**32.3%**	**-7.9%**	**<0.0001**

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Overall, four conditions had a difference in mortality rate of more than 10 percentage points – amputations, brain injury, cardiac disorders, and stroke (Exhibit 4.3).

Exhibit 4.3: Percentage Point Difference in Mortality Rate* across Two-Year Study Period: Matched IRF and SNF Patients



Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.
*All differences are statistically significant at p<0.001.

Consistent with the reduced mortality rate of patients treated in an IRF, IRF patients survived nearly two months longer (51.9 days) than comparable patients treated in a SNF over the two-year period (Exhibit 4.4).[49] On average, IRF patients survive 621.0 days (about 20.7 months) after discharge from the initial rehabilitation stay while SNF patients survive 569.1 days (18.9 months).

It is important to note that this analysis only compares the number of days alive during the two-year study period. Therefore, if the study period were to be extended, the differences between the settings could change. This was an important outcome measure to compare, as a large average difference in the number of days alive between the settings may indicate a systematic difference in the timing of the patients' death (i.e., death later, as opposed to earlier, in the study period).

The results are directionally consistent for each clinical condition category, but values vary significantly. By clinical condition category, IRF patients treated for hip/knee replacements are alive an average of 3.9 days longer than SNF patients, while IRF

[49] This algorithm calculates the average days alive for each patient (including those who survived the entire episode), then calculates an average within each clinical condition category.

patients treated for strokes are alive an average of 96.8 days longer than SNF patients during the two-year study period. The results across all clinical condition categories are significant ($p<0.001$).

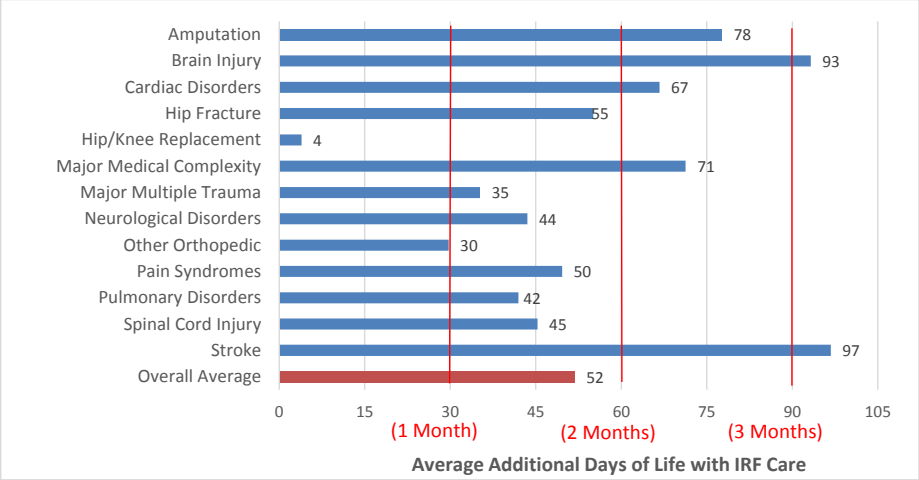
Exhibit 4.4: Average Days Alive Following Discharge from Initial Rehabilitation Stay: Matched IRF and SNF Patients

Clinical Condition Category	IRF	SNF	Difference (IRF minus SNF)	P value
Amputation	562.9	485.3	77.7	<.0001
Brain Injury	561.5	468.3	93.2	<.0001
Cardiac Disorder	568.4	501.7	66.7	<.0001
Hip Fracture	622.4	567.3	55.1	<.0001
Hip/Knee Replacement	712.2	708.3	3.9	<.0001
Major Medical Complexity	527.0	455.7	71.3	<.0001
Major Multiple Trauma	648.5	613.2	35.2	0.0036
Neurological Disorders	585.6	542.1	43.5	<.0001
Other Orthopedic	653.0	623.3	29.7	<.0001
Pain Syndromes	646.4	596.8	49.6	<.0001
Pulmonary Disorders	515.0	473.0	42.0	<.0001
Spinal Cord Injuries	637.8	592.5	45.3	<.0001
Stroke	572.2	475.5	96.8	<.0001
Overall Average	**621.0**	**569.1**	**51.9**	**<.0001**

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Patients treated in IRFs for two clinical condition categories – brain injury and stroke – stayed alive more than three months longer on average than those treated in SNFs (Exhibit 4.5). Patients treated in IRFs for three additional clinical condition categories – amputations, cardiac disorders, and major medical complexity – stay alive over two months longer on average than those treated in SNFs.

Exhibit 4.5: Average Additional Days of Life when Receiving IRF Care: Matched IRF and SNF Patients



Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Ability to Remain at Home

One measure used to determine the long-term impact of the rehabilitative care was the length of time patients were able to reside in their homes without facility-based care. Over the two-year study period, IRF patients who were clinically comparable to SNF patients remained home, on average, almost two months longer (51.5 days) than patients treated in SNFs (Exhibit 4.6). Days at home represent the average number of days per patient not spent in a hospital, IRF, SNF, or LTCH over a two-year episode.[50] These days may not necessarily be continuous; rather, they are the average total number of days throughout the episode. On average, IRF patients remained at home 582.3 days (about 19.4 months), while SNF patients remained at home 530.8 days (about 17.6 months).

While all clinical condition categories showed directionally the same results – patients treated in the IRFs had more days at home – the range of days and statistical significance varied. For three clinical condition categories – amputations, brain injury, and stroke – IRF patients remained at home on average three months (90.8 days) longer than SNF patients ($p<0.0001$). For several conditions – hip/knee replacements, major multiple trauma, and other orthopedic conditions – the difference in the number of days at home was not statistically significant.

However, as discussed in the Methodology section, the claims data used in these analyses only contain services covered by fee-for-service Medicare. Therefore, Medicaid services,

[50] This algorithm factors in patient death, in that the number of days at home is calculated for each patient based on the number of days alive within the two-year episode, then averaged across all patients within the clinical condition category.

such as nursing home services, are not considered in the calculation of facility-based care days. To the extent that SNF patients convert and receive nursing home services, the number of days a patient remained at home may be overestimated for the patients.

Exhibit 4.6: Difference in Number of Days at Home:* Matched IRF and SNF Patients

Clinical Condition Category	IRF	SNF	Difference (IRF minus SNF)	P value
Amputation	510.6	425.2	85.4	<.0001
Brain Injury	517.0	422.0	95.0	<.0001
Cardiac Disorder	529.5	457.4	72.1	<.0001
Hip Fracture	581.2	528.4	52.8	<.0001
Hip/Knee Replacement	698.0	693.9	4.1	0.5188
Major Medical Complexity	478.7	405.9	72.8	<.0001
Major Multiple Trauma	611.2	576.4	34.8	0.0626
Neurological Disorders	533.0	487.6	45.4	<.0001
Other Orthopedic	616.3	587.5	28.8	0.0707
Pain Syndromes	602.9	546.0	56.9	<.0001
Pulmonary Disorders	464.0	416.2	47.7	<.0001
Spinal Cord Injuries	597.9	556.8	41.0	<.0001
Stroke	518.4	426.4	92.0	<.0001
Overall Average	**582.3**	**530.8**	**51.5**	**<.0001**

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.
*Days in the home represents the average number of days per patient over two-year episode not spent in a hospital, IRF, SNF, or LTCH.

When factoring in the average days alive by condition for the two patient cohorts, results suggest that patients treated in both settings have comparable use of facility-based care and the additional days at home is a function of remaining alive a larger portion of the two-year study period. As shown in Exhibit 4.4, patients treated in IRFs are alive 621.0 days, of which 582.3 days are spent at home (Exhibit 4.6). Therefore, on average, IRF patients reside in facility-based care 38.7 days over their post-rehabilitation episode. Similarly, patients treated in SNFs are alive 569.1 days, of which 530.8 days are spent at home. Therefore, these patients are in facility-based care for about 38.3 days.

The average difference in the number of facility-based care days varies by clinical condition category (data not shown). For example, patients treated for an amputation in an IRF have about 52.3 facility-based care days, compared to 60.0 facility-based care days for patients treated in a SNF. On the other hand, patients treated for spinal cord injuries or stroke in the IRF have slightly more facility-based care days over the two-year study period than patients treated in a SNF (4.3 and 4.7 more facility-based care days, respectively).

Emergency Room and Readmission Rates

Emergency room (ER) and readmission rates are sometimes used as a proxy for unsuccessful patient recovery. The rate of emergency room visits per 1,000 patients per year was compared for matched patients treated in IRFs and SNFs. Across all clinical condition categories, IRF patients experienced 642.7 emergency visits per 1,000 patients per year (Exhibit 4.7). That is, about 64 percent of IRF patients visited the ER each year during the two years following their initial rehabilitation stay. SNF patients averaged 688.2 ER visits per 1,000 patients per year – or about 69 percent of SNF patients visiting an ER each year during the study window. These results indicate that, on average, patients treated in an IRF experienced 4.5 percent fewer ER visits per year (or avoided 45.5 visits per 1,000 patients per year) than SNF patients ($p<0.0001$).

We note that ER visits captured in this analysis do not result in hospital admissions. Therefore, these are outpatient visits for acute issues or trauma. The presence of ER visits is not unexpected among rehabilitation patients, as ER visits due to falls or injury may be an indicator of greater patient ambulation.

Exhibit 4.7: Number of ER Visits per 1,000 Patients per Year: Matched IRF and SNF Patients

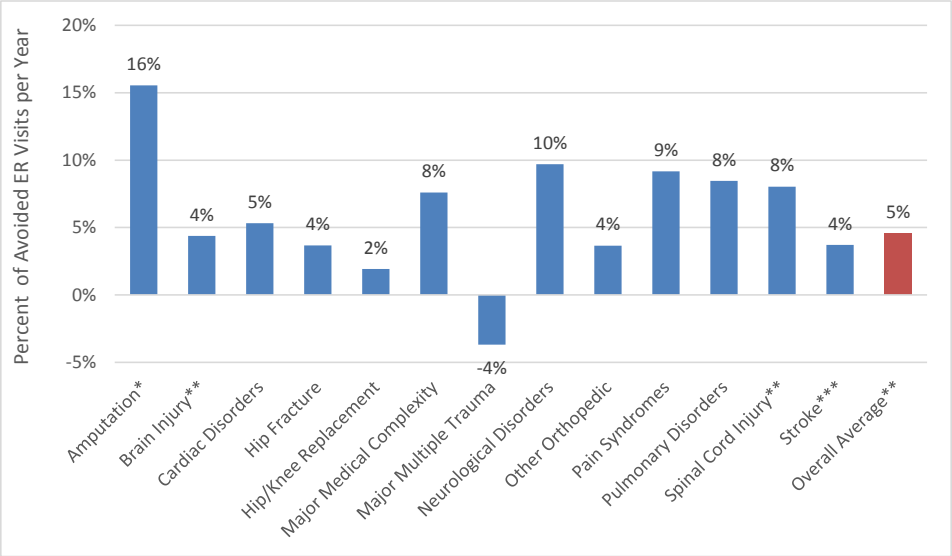
Clinical Condition Category	IRF	SNF	Difference (IRF minus SNF)	P value
Amputation	861.3	1016.7	-155.4	0.0473
Brain Injury	782.0	825.9	-43.9	0.0024
Cardiac Disorder	753.6	807.0	-53.3	0.1268
Hip Fracture	576.5	613.3	-36.8	0.1247
Hip/Knee Replacement	413.1	432.3	-19.3	0.3124
Major Medical Complexity	796.2	872.3	-76.1	0.1094
Major Multiple Trauma	680.4	643.6	36.8	0.6101
Neurological Disorders	772.0	868.9	-96.9	0.8629
Other Orthopedic	609.3	645.8	-36.6	0.8490
Pain Syndromes	745.0	836.6	-91.6	0.0687
Pulmonary Disorders	881.7	966.3	-84.6	0.1255
Spinal Cord Injuries	621.3	701.6	-80.3	0.0051
Stroke	785.9	823.0	-37.1	<.0001
Overall Average	**642.7**	**688.2**	**-45.5**	**<.0001**

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

While the overall difference in the number of ER visits per 1,000 patients per year is statistically significant, indicating that IRF patient experience fewer ER visits per year, the results and statistical significance by clinical condition category is varied (Exhibit 4.8). IRF patients have statistically lower ER rates for four conditions – amputation, brain injury,

spinal cord injury, and stroke ($p<0.05$). IRF patients treated for major multiple trauma appear to have higher rates of ER visits, but the difference is not statistically significant.

Exhibit 4.8: Average Percent Difference in Number of ER Visits per Year: Matched IRF and SNF Patients



Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.
* = Differences are statistically significant at p-value < 0.05; ** = Differences are statistically significant at p-value < 0.01; *** = Differences are statistically significant at p-value < 0.0001

A hospital readmission indicates a severe or sudden change in a patient's medical stability. While there is no significant difference in the overall hospital readmission rate of patients treated in IRFs compared to SNFs across all conditions (957.7 readmissions per 1,000 patients per year for IRF patients compared to 1,008.1 readmissions per 1,000 patients per year for SNF patients), there are several clinical condition categories that have a significant difference in the hospital readmission rate (Exhibit 4.9).

For five of the 13 conditions, IRF patients experienced significantly fewer hospital readmissions per year than SNF patients – amputation, brain injury, hip fracture, major medical complexity, and pain syndrome (Exhibit 4.10). Patients treated for amputations had the largest difference in hospital readmission rates with IRF patients experiencing 428.3 (or about 43 percent) fewer readmissions per 1,000 patients per year than patients treated in SNFs ($p<0.0001$). Patients treated for pain syndrome in IRFs also had a 10.6 percent lower rate of readmissions per 1,000 patients per year than patients treated in SNFs (a difference of 106.9 readmissions per 1,000 patients per year; $p<0.01$).

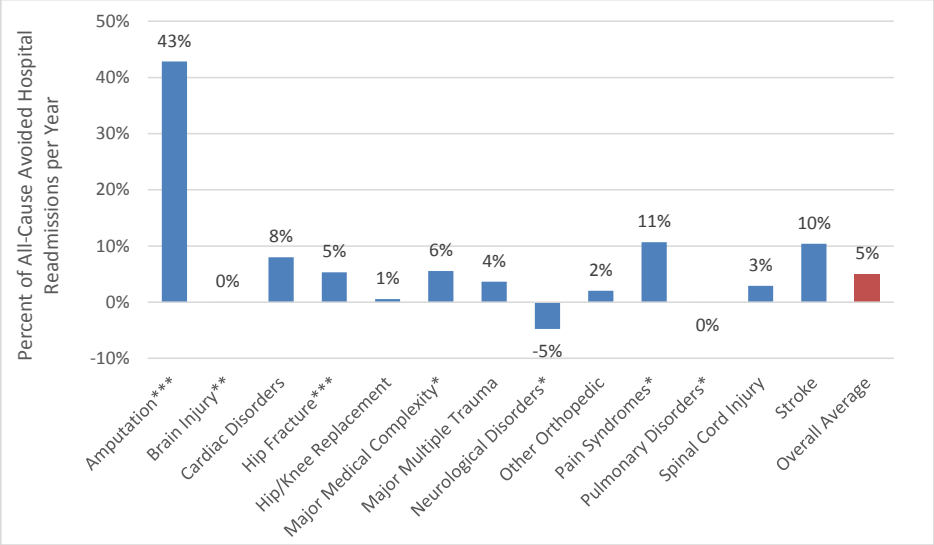
Patients treated for neurological disorders and pulmonary disorders in IRFs experienced significantly higher hospital readmissions than patients treated in the SNFs ($p<0.01$).

Exhibit 4.9: Number of Hospital Readmissions per 1,000 Patients per Year: Matched IRF and SNF Patients

Clinical Condition Category	IRF	SNF	Difference (IRF minus SNF)	P value
Amputation	1538.3	1966.6	-428.3	<.0001
Brain Injury	1094.4	1094.7	-0.3	0.0009
Cardiac Disorder	1351.5	1431.6	-80.1	0.5519
Hip Fracture	838.1	891.1	-53.1	<.0001
Hip/Knee Replacement	499.9	505.2	-5.4	0.0775
Major Medical Complexity	1587.4	1643.1	-55.7	0.0017
Major Multiple Trauma	778.9	815.5	-36.6	0.3360
Neurological Disorders	1234.8	1187.0	47.8	0.0041
Other Orthopedic	866.0	886.4	-20.5	0.9868
Pain Syndromes	1034.8	1141.7	-106.9	0.0053
Pulmonary Disorders	1798.8	1797.6	1.2	0.0058
Spinal Cord Injuries	904.5	933.6	-29.1	0.8471
Stroke	1123.1	1227.1	-104.1	0.9040
Overall Average	**957.7**	**1008.1**	**-50.4**	**0.8931**

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Exhibit 4.10: Average Percent Difference in Number of Hospital Readmissions per Year: Matched IRF and SNF Patients



Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.
* = Differences are statistically significant at p-value < 0.01; ** = Differences are statistically significant at p-value < 0.001; *** = Differences are statistically significant at p-value < 0.0001

Differences in Medicare Payment during the Initial Rehabilitation Stay

In addition to comparing the clinical outcomes of patients treated in an IRF to those treated in a SNF, we compared the Medicare payments on a PMPM basis for the initial rehabilitation stay and the two-year post-rehabilitation period. The care settings included in the PMPM Medicare payments are: inpatient hospital; outpatient hospital; IRF; SNF; HHA; and LTCH.

Despite the shorter length of stay for the initial rehabilitation stay in an IRF compared to a SNF, the Medicare payments are significantly different. Across all clinical condition categories, Medicare payment for patients treated in an IRF is, on average, about $5,975 higher than the payment for patients treated in a SNF ($p<0.0001$) (Exhibit 4.11). This difference in payment could be due to differences in treatment protocols, clinician staffing, and intensity of rehabilitation services. However, it is possible that the intensity of services provided during the rehabilitation stay leads to the significantly better patient outcomes observed in this study.

Exhibit 4.11: Average Medicare Payment for Initial Rehabilitation Stay: Matched IRF and SNF Patients

Clinical Condition Category	IRF	SNF	Difference (IRF minus SNF)	P value
Amputation	$17,387	$9,051	$8,335	<.0001
Brain Injury	$17,390	$9,012	$8,378	<.0001
Cardiac Disorder	$13,627	$7,568	$6,059	<.0001
Hip Fracture	$15,183	$11,019	$4,164	<.0001
Hip/Knee Replacement	$10,716	$6,056	$4,660	<.0001
Major Medical Complexity	$14,951	$7,802	$7,150	<.0001
Major Multiple Trauma	$16,805	$12,279	$4,527	<.0001
Neurological Disorders	$15,423	$9,707	$5,716	<.0001
Other Orthopedic	$13,619	$9,034	$4,585	<.0001
Pain Syndromes	$12,522	$8,047	$4,475	<.0001
Pulmonary Disorders	$14,763	$7,400	$7,363	<.0001
Spinal Cord Injuries	$16,802	$7,660	$9,142	<.0001
Stroke	$19,149	$10,482	$8,667	<.0001
Overall Average	$14,836	$8,861	$5,975	<.0001

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Differences in Medicare Payment during the Post-Rehabilitation Period

Exhibit 4.12 shows the average PMPM Medicare payment for patients treated in both settings by clinical condition category. While patients treated in an IRF generally have higher PMPM Medicare payments than patients treated in a SNF, the magnitude of the difference and its statistical significance varies by clinical condition category. For example, patients treated for hip/knee replacements have very similar PMPM Medicare payments, with a difference of $43 per month, which is not statistically significant. This suggests that hip/knee replacement patients treated in an IRF have comparable Medicare payments for the two years following the initial rehabilitation stay, and are still able to achieve better clinical outcomes, as described above. However, the difference in PMPM Medicare payment for patients treated for brain injury is greater ($234 PMPM) and is statistically significant. It should be noted that we did find that patients treated for brain injury in an IRF had better outcomes on all measures analyzed than patients treated in SNFs, including lower risk of mortality, more days at home, and fewer ER visits and hospital readmissions.

Exhibit 4.12: Average Medicare Payment PMPM for Post-Rehabilitation Period: Matched IRF and SNF Patients

Clinical Condition Category	IRF	SNF	Difference (IRF minus SNF)	P value
Amputation	$3,313	$3,693	-$380	0.0114
Brain Injury	$2,199	$1,965	$234	<.0001
Cardiac Disorder	$2,162	$2,186	-$24	0.1889
Hip Fracture	$1,679	$1,598	$80	<.0001
Hip/Knee Replacement	$887	$844	$43	0.3236
Major Medical Complexity	$2,847	$2,696	$151	<.0001
Major Multiple Trauma	$1,609	$1,509	$101	0.0484
Neurological Disorders	$2,401	$2,102	$299	<.0001
Other Orthopedic	$1,639	$1,578	$61	0.0072
Pain Syndromes	$1,794	$1,868	-$74	0.0247
Pulmonary Disorders	$2,918	$2,649	$269	<.0001
Spinal Cord Injuries	$1,848	$1,644	$204	0.0037
Stroke	$2,227	$2,162	$65	<.0001
Overall Average	$1,815	$1,736	$79	N/A*

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.
* Calculated as weighted average across all conditions based on volume (number of matched pairs). Therefore, significance of the difference is not available.

Two additional analyses were conducted to better explain the difference in the PMPM Medicare payments between the two patient cohorts. First, we compared the distribution of PMPM Medicare payments by site of service to determine if the differences in total PMPM payments could be attributed to different utilization patterns (using more or fewer services) or different treatment protocols (using different services). Second, we compared the PMPM Medicare payments over time to see if there are systematic changes in care during the post-rehabilitation period.

The results of the first analysis suggested that patients treated in IRFs consistently used more home health care than the clinically and demographically similar matched patients treated in SNFs. The difference in HHA PMPM payments ranged from $12 more PMPM for hip/knee replacement patients treated in IRFs to $127 more PMPM for neurological disorder patients treated in IRFs ($p<0.0001$). It is interesting to note that patients treated in a SNF consistently had higher use of hospice services, ranging from $4 more PMPM payments for hip/knee replacement patients ($p<0.001$) to $99 more PMPM payments for brain injury patients ($p<0.0001$). Trends in utilization of care across the other settings varied by clinical condition.

Results of the second analysis indicated that after the first month following discharge from the initial rehabilitation stay, the average PMPM payment by month for each patient cohort

(within each clinical condition category) was comparable. That is, in the month following discharge from the IRF or SNF, the average Medicare payment per month is consistent across patient groups. The driver of the difference in overall PMPM Medicare payments is due to the increased services IRF patients receive immediately (within one month) upon discharge from the initial rehabilitation stay.

Average Medicare Payment per Day

With differences in the average length of stay during the initial rehabilitation stay and the average days alive during the post-rehabilitation period between IRF and SNF patients, we calculated the average difference in Medicare payment per day for the entire episode of care (initial rehabilitation stay plus the post-rehabilitation period). Across all clinical condition categories, patients treated in an IRF experience their significantly improved patient outcomes at an additional cost to Medicare of $12.59 per day while patients are alive over the two-year study window. That is, IRF patients have an average Medicare payment per day of $82.65, compared to $70.06 for patients treated in SNFs (Exhibit 4.13). The average Medicare payment per day is calculated for each individual patient, then averaged across all patients within a clinical condition category. The overall average is calculated as the weighted average payment across all clinical condition categories.

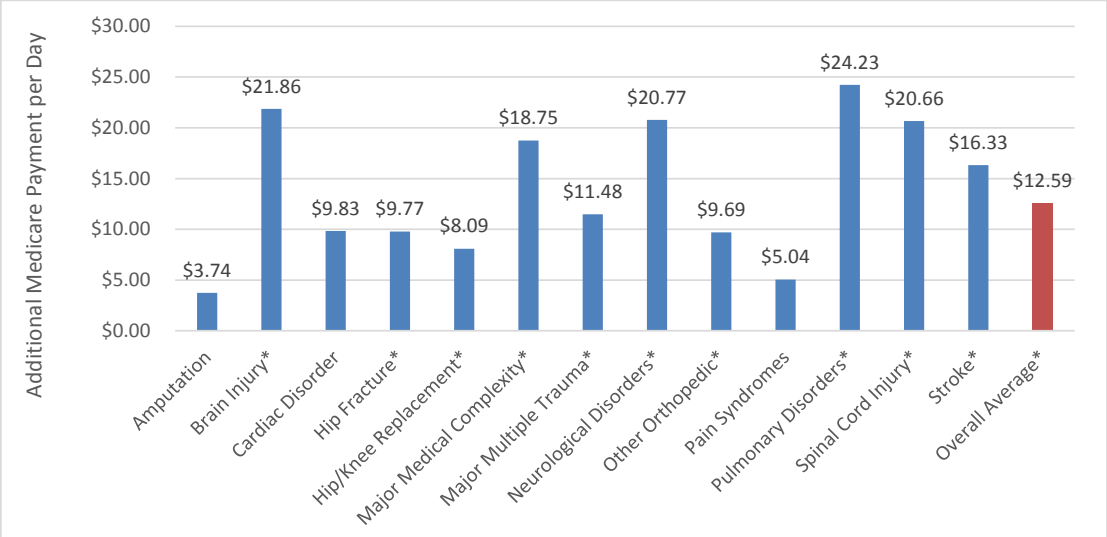
Exhibit 4.13: Average Medicare Payment per Day for Initial Rehabilitation Stay and Post-Rehabilitation Period: Matched IRF and SNF Patients

Clinical Condition Category	IRF	SNF	Difference (IRF minus SNF)	P value
Amputation	$137.27	$133.53	$3.74	0.1732
Brain Injury	$101.36	$79.50	$21.86	<.0001
Cardiac Disorder	$93.75	$83.92	$9.83	0.0683
Hip Fracture	$78.17	$68.40	$9.77	<.0001
Hip/Knee Replacement	$43.64	$35.55	$8.09	<.0001
Major Medical Complexity	$120.27	$101.52	$18.75	<.0001
Major Multiple Trauma	$77.26	$65.78	$11.48	<.0001
Neurological Disorders	$103.51	$82.74	$20.77	<.0001
Other Orthopedic	$73.57	$63.88	$9.69	<.0001
Pain Syndromes	$77.26	$72.22	$5.04	0.4849
Pulmonary Disorders	$123.05	$98.82	$24.23	<.0001
Spinal Cord Injuries	$85.49	$64.83	$20.66	<.0001
Stroke	$104.41	$88.08	$16.33	0.0008
Overall Average	**$82.65**	**$70.06**	**$12.59**	**<.0001**

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

The difference in the average Medicare payment per day varies greatly across conditions. Patients treated for an amputation or pain syndromes in an IRF have an additional cost to Medicare of $3.74 and $5.04 per day, respectively, which are not statistically significant. However, patients treated in IRFs for pulmonary disorders have an average additional Medicare payment of $24.23 per day, which is significant (p<0.0001) (Exhibit 4.14).

Exhibit 4.14: Average Additional Medicare Payment per Day for IRF Care Compared to SNF Care: Matched IRF and SNF Patients



Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.
* = Differences are statistically significant at p-value < 0.001

Longitudinal Analysis Summary and Discussion

The results of this longitudinal study suggest that when patients are matched on demographic and clinical characteristics, rehabilitation in IRFs leads to lower mortality, longer life, fewer ER visits and, in some instances, fewer readmissions than rehabilitation in SNFs for the same condition. However, these improved patient outcomes are often associated with statistically greater PMPM or per-day costs to Medicare. The literature and regulations indicate that the care delivered in an IRF is not the same as care delivered in a SNF. Our results suggest that different PAC settings affect patient outcomes.

Exhibit 4.15 summarizes the differences in outcomes for two key clinical condition categories - stroke and cardiac, as well as all conditions overall. Patients with cardiac conditions were discharged significantly sooner from IRFs than patients treated in SNFs (11.9 days earlier). During the post-rehabilitation period, the IRF patients have significantly lower mortality rates, survive their episode longer, and remain in the home longer. While the Medicare payment for their initial rehabilitation stay is higher than

comparable patients treated in a SNF, there is no significant difference in the average PMPM payment during the post-rehabilitation period. Furthermore, in considering the total payment for the initial rehabilitation stay and post-rehabilitation period, there is no significant difference in the Medicare payment per day. Together, these results suggest that patients treated in the SNF (as opposed to the IRF) are likely to experience worse clinical outcomes at a comparable cost to Medicare.

Stroke patients treated in IRFs are also discharged significantly sooner than patients treated in SNFs (16.5 days earlier). During the post-rehabilitation period, these patients have lower mortality rates, remain in the home longer, and have significantly fewer ER visits. While the Medicare payment for their initial rehabilitation stay and post-rehabilitation period are higher than comparable patients treated in a SNF, these outcomes can be achieved with an additional cost to Medicare of $16.33 per day (over the two-year study period while alive) ($p<0.001$).

Exhibit 4.15: Difference in Outcomes for Patients Treated in IRFs as Compared to SNFs during Two-Year Study Period – Cardiac Conditions, Stroke, and Overall Average (All Conditions)

Difference in Patient Outcomes (Compared to SNF Patients) IRF Patients had:	Cardiac Conditions	Stroke	Overall Average	
Discharge from Initial Rehabilitation Stay	11.9**	16.5**	13.9**	days earlier discharge
Mortality Rate	10.7%**	14.3%**	7.9%**	lower mortality
Additional Days Alive	66.7**	96.8**	51.9**	additional days alive
Additional Days at Home	72.1**	92.0**	51.5**	additional days at home
ER Visits per 1,000 beneficiaries per Year	5.3%	3.7%**	4.5%**	fewer ER visits
Hospital Readmissions per 1,000 beneficiaries per Year	8.0%	10.4%	5.0%	fewer readmissions
Medicare Payment during Initial Rehabilitation Stay for IRF Care	$6,059**	$8,335**	$5,975**	higher Medicare payment
Medicare PMPM Payment during Post-Rehabilitation Period for IRF Care	-$24	$65**	$79	higher Medicare payment PMPM
Medicare Payment per Day for IRF Care (Initial Rehabilitation Plus Post-Rehabilitation)	$9.83	$16.33*	$12.59**	higher Medicare payment per day

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

* = Differences are statistically significance at $p<0.001$; ** = Differences are statistically significance at $p<0.0001$.

Discussion

One purpose of this research was to determine how the distribution of clinical condition categories changed within and across PAC settings following the implementation of the 60 Percent Rule. Once these trends had been identified, we examined the long-term impact on patient outcomes for receiving rehabilitative care in SNFs as opposed to IRFs for a variety of clinical condition categories. This study serves as the most comprehensive national analysis to date examining the long-term clinical outcomes of clinically similar patient populations treated in IRFs and SNFs, utilizing a sample size of more than 100,000 matched pairs drawn from Medicare administrative claims.

The implementation of the 60 Percent Rule led to an overall decrease in the number of patients treated in IRFs.[51] This impact is consistent with policymakers' goal of redirecting lower severity patients receiving rehabilitation in IRFs into lower cost setting such as SNFs and HHAs.[52] While the proportion of patients treated in IRFs for hip/knee replacements showed the most significant change (a decrease from 25.4 percent of all IRF patients in 2005 to 14.5 percent in 2009), the distribution of other conditions changed as well.

The long-term impact on Medicare beneficiaries for such policies must be considered. Providing rehabilitation in an IRF is generally associated with higher Medicare payments than providing rehabilitation for a comparable patient in a SNF, likely due to differences in cost structures, staffing arrangements, and treatment protocols. However, policies that may incentivize patients to receive care in SNFs as opposed to IRFs may have unintended consequences.

When patients are matched on demographic and clinical characteristics, rehabilitation in IRFs leads to lower mortality, fewer readmissions and ER visits, and more days at home (not in a hospital, IRF, SNF, or LTCH) than rehabilitation in SNFs for the same condition.

This suggests that the care delivered in an IRF is not the same as care delivered in a SNF.

Our results suggest that different PAC settings affect patient outcomes.

[51] Utilization Trends in Inpatient Rehabilitation: Update Through Q2: 2011. (2011). The Moran Company.

[52] Medicare Payment Advisory Commission (Report to the Congress). Medicare Payment Policy. March 2014.

Discussion

This study demonstrated that for many clinical condition categories, patients treated in IRFs experienced improved patient outcomes including but not limited to lower risk of mortality, more days at home, and lower ER visits and readmission rates. Furthermore, patients with some of these conditions are able to experience these superior outcomes without a negative impact on Medicare payments (considering the Medicare cost for the initial rehabilitation stay and two-year post-rehabilitation period). Therefore, patients redirected from the IRF to the SNF in an attempt to reduce Medicare payments for the initial rehabilitation stay may suffer diminished patient outcomes that impact their quality of life and, in some cases, with comparable long-term Medicare payments.

Through rigorous propensity score matching techniques, patient demographic and clinical characteristics were controlled in order to isolate the impact of the setting in which the patient received care – an IRF or a SNF. There is a notable difference in medical rehabilitation care practices between the two settings.[53] Treatment provided in IRFs is under the direction of a physician and specialized nursing staff.[54] On the other hand, SNFs exhibit greater diversity in practice patterns and lower intensity rehabilitation.[55]

MedPAC and other policymakers are currently considering payment policies that could greatly impact the site of service in which Medicare beneficiaries receive rehabilitation. For instance, under the site-neutral payment policy, Medicare would reimburse IRFs and SNFs the same payment rate for patients treated for strokes, hip fractures, and hip/knee replacements. In the 2014 IRF-PPS Final Rule, CMS noted that "the 13 medical conditions that are listed in [the 60 Percent Rule] are conditions that ''typically'' require the level of intensive rehabilitation that provide the basis of need to differentiate the services offered in IRFs from those offered in other care settings."[56] Despite the acknowledgement that medical rehabilitative services differ in SNFs and IRFs, stroke is included in the site-neutral payment proposals ***and*** is one of the 13 conditions within the 60 Percent Rule. Therefore, based on the results of our analyses, stroke patients treated in SNFs as opposed to IRFs could be harmed. Furthermore, across other clinical conditions, a "pure" site-neutral payment might not adequately compensate IRF providers for certain cases and may contribute the shifting of patients into SNF. (Some proposals, however, provide higher payments to IRFs based on IRF-SNF cost differences).

While our analysis focuses on the immediate implementation of the 60 Percent Rule (2005 through 2009), MedPAC suggests that these trends have continued through 2013, and literature suggests that the outcomes are different between IRFs and SNFs for select

[53] Keith RA. Treatment strength in rehabilitation. *Arch Phys Med Rehabil*. 1997; 90:1269-83.

[54] Harvey RL. Inpatient rehab facilities benefit post-stroke care. *Manag Care*. 2010; 19(1):39-41.

[55] DeJong G, Hsieh C, Gassaway J, et al. Characterizing rehabilitation services for patients with knee and hip replacement in skilled nursing facilities and inpatient rehabilitation facilities. *Arch Phys Med Rehabil*: 2009; 90:1269-83.

[56] 2014 IRF-PPS Final Rule, Federal Register, Volume 78, pg 47844.

conditions. Therefore, if our longitudinal results are indicative of the current disparity in clinical outcomes between SNFs and IRFs, payment reforms that lead to shifting sites of services for Medicare beneficiaries could adversely and quite significantly affect Medicare beneficiaries' health outcomes.

Appendix A: Algorithms to Define Clinical Condition Categories

Exhibit A-1: Algorithms for Identifying Clinical Condition Categories across All PAC Settings

Clinical Condition Category	Criteria	ICD-9
Stroke	Presence of Stroke (ICD-9s)	430, 431, 432.0-432.9, 433.x1, 434.x1, 436
	or Effects of Stroke (ICD-9s)	438.0-438.9 (late effects of cerebrovascular disease)
Congenital Deformities	Presence of Congenital Deformities (ICD-9s)	741.00-741.03, 741.90-741.93, 728.3, 742.0-742.8, 754.1-754.89, 755.0-755.9, 756.0-756.9
Spinal Cord Injury	Presence of Spinal Cord Injury (ICD-9s)	0.150, 170.2, 192.2-192.3, 198.3, 198.4, 225.3, 225.4, 237.5, 237.6, 239.7, 323.9, 324.1, 441.00-441.03, 441.1, 441.3, 441.5, 441.6, 721.1, 721.41, 721.42, 721.91, 722.71-722.73, 723.0, 724.00-724.09, 806.00-806.9, 953.0-953.8, 952.00-952.8
	or Effects of Spinal Cord Injury (ICD-9s)	907.2 (late effect of spinal cord injury)
	or NTSCI/TSCI RIC	04.110-04.130, 04.210-04.230 NTSCI RIC: 05; TSCI: 04
Amputation	Presence of Amputation (ICD-9s)	ICD 9 Procedure code :- 84.00 – 84.19 or DRG codes :- 474, 475, 476
Brain Injury	Presence of Brain Injury (ICD-9s)	036.0, 0.36.1, 049.0-049.9, 191.0-191.9, 192.1, 198.3, 225.0, 225.1, 225.2, 237.5, 237.6, 239.6, 323.0-323.9, 324.0, 331.0, 331.2, 331.3, 348.1, 800.60-800.99, 801.60-801.99, 803.60-803.99, 851.10-851.19, 851.30-851.39, 851.50-851.59, 851.70-851.79, 851.90-851.99, 852.10-852.19, 852.30-852.39, 852.50-852.59, 853.00-853.09, 853.10-853.19, 854.10-854.19, 800.10-800.49, 801.10-801.49, 803.10-803.49, 850.0-850.9, 851.00-851.09, 851.20-851.29, 851.40-851.49, 851.60-851.69, 851.80-851.89, 852.00-852.09, 852.20-852.29, 852.40-852.49, 854.00-854.09
	or Effects of Brain Injury (ICD-9s)	905.0 (late effect of fracture of skull and face bones)907.0 (late effect of intracranial injury without mention of skull fracture)
Knee/Hip Replacement	Hip Replacement(s) or Knee Replacement(s)	696.0, 711.0, 714-714.2, 714.30-714.33, 714.4, 715.x5, 715.x6, 716.x5, 716.x6, 720.0; MS-DRG 469-470; ICD-9 procedure code: 81.51-81.55 Note: if admission is following revision of implant, use: 996.4, 996.66, 996.67, 996.77-996.79

Appendix A

Clinical Condition Category	Criteria	ICD-9
	Other Orthopedic	170.2-170.8, 198.5, 719.5, 719.00-719.89, 733.11-733.19, 754.2, 823.00-823.91; MS-DRG 466-468
Major Multiple Trauma	2 or More: TBI, TSCI, or Multiple Fractures	2 or more ICD-9-CM codes for traumatic impairment codes 2 or more ICD-9-CM codes for trauma to multiple systems or sites, but not brain or spinal cord 823-828 (all)
Hip Fracture	Presence of Hip Fracture (ICD-9s), femur, pelvis	820.00-820.9, 821.00-821.11, 821.20-821.39, 808
Burns	Presence of Burns (ICD-9s)	941.00-941.59, 942.00-942.59, 943.00-943.59, 944.00-944.58, 945.00-945.59, 946.0-946.5
Neurological Disorders	Presence of Neurological Disorders (ICD-9s)	340, 332.0-332.1, 356.0-356.8, 357.5-357.8, 343.0-343.8, 335.20-335.9, 358.0, 359.0-359.4, 333.0-333.7, 333.80-333.99, 334.0-334.3, 334.8, 337.0, 337.20-337.29, 337.3, 337.9, 341.0-341.8, 357.0
	or Effects of Neurological Disorders (ICD-9s)	(Very low volume)
Rheumatoid and Other Arthritis (likely secondary condition)	Presence of Rheumatoid and Other Arthritis (ICD-9s)	714.0-714.2, 714.30-714.33, 714.4, , 696.0, 710.0, 710.1, 710.3, 710.4, 711.0, 716.00-716.99, 720.0
	and Significant Functional Impairment of ambulation	Reduced performance on ADLs
	and Therapy Preceding IRF Admission	Revenue center: 420, 421, 422, 423, 424, 429, (430-434, 439,) 530, 531, 539
Osteoarthritis	2 or more joints – elbow, hip, knee, shoulder – not with prosthetic	
	Joint deformity	
	Substantial loss of range of motion, atrophy, significant functional impairment	(Very low volume)
	Osteoarthrosis and allied disorders	715.00 – 715.99
Systemic Vasculidities	Presence of Systemic Vasculidities (ICD-9s)	446, 446.0, 446.1, 446.2, 446.20, 446.21, 446.29, 446.3, 446.4, 446.5, 446.6, 446.7
	and Significant Functional Impairment	(Very low volume)
	and Therapy Preceding IRF Admission (Revenue Centers)	0118, 0128, 0138, 0148, 0158 420, 421, 422, 423, 424, 429, (430-434, 439)
Pain Syndromes	Presence of pain (ICD-9s)	721.0-721.91, 722.0-722.93, 723.0-723.8, 724.00-724.9, 729.0-729.5, 846.0-846.9, 847.0-847.4
Cardiac Disorders	Presence of cardiac disorders (ICD-9s)	410.00-410.92, 411.0-411.89, 414.00-414.07, 414.10-414.9, 427.0-427.9, 428.0-428.9
Pulmonary Disorders	Presence of pulmonary disorders (ICD-9s)	491.0-491.8, 492.0-492.8, 493.00-493.92, 494.0-494.1, 496
Other Disabling Impairments	Presence of other disabling impairments "not elsewhere defined"	
Developmental Disability	Presence of developmental disorders (ICD-9s)	317, 318.0-318.2, 319
Debility	Presence of debility (ICD-9s)	728.2, 728.9, 780.71, 780.79 ("code specific medical condition primarily responsible for the patient's debility")

Appendix A

Clinical Condition Category	Criteria	ICD-9
Medically Complex Conditions	Presence of infections (ICD-9s)	0.13.0-013.9, 0.38.0-038.9, 041.00-041.09, 041.10-041.19, 041.81-041.9, 042
	Presence of neoplasms (ICD-9s)	Two or more of: 140.0-149.9, 150.0-159.9, 160.0-165.9, 170.0-170.9, 171.0-171.9, 172.0-172.9, 173.0-173.9, 174.0-174.9, 175.0-175.9, 176.0-176.9, 179-189.9, 200.00-200.88, 201.00-201.98, 202.00-202.98, 203.00-203.81, 204.00-204.91, 205.00-205.91, 206.00-206.91, 207.00-208.91, V58.0, V58.1
	Presence of nutrition (ICD-9s)	250.00-250.93, 276.0-276.9
	Presence of circulatory disorders (ICD-9s)	403.00-403.91, 404.00-404.93, 414.00-414.07, 428.0-428.9, 443.0-443.9, 453.0-453.9
	Presence of respiratory disorders (ICD-9s)	480.0-480.9, 481.0-486, 507.0-507.8, 518.0-518.89
	Presence of terminal care (ICD-9s)	"End-stage conditions –e.g., cancer, Alzheimer's disease, renal failure, congestive heart failure, stroke, acquired immunodeficiency syndrome (AIDS), Parkinsonism, emphysema"
	Presence of skin disorders (ICD-9s)	681.10-681.11, 682.0-682.8, 707.0, 707.10-707.8, 870.0-879.9, 890.0-894.2
	Presence of medical/surgical complications (ICD-9s)	996.00-996.79, 996.80-996.89, 996.90-996.99, 997.00-997.99, 998.0-998.9
	Presence of other medically complex conditions (ICD-9s)	584.5-584.9, 585.x, 595.0-595.89, 597.0-597.89

Appendix B: Cross-Sectional Results in Other PAC Settings

Exhibit B.1 presents the distribution of clinical condition categories among SNFs between 2005 and 2009. Across all years, major medical complexities was the largest clinical condition category, representing at least one third of all admissions each year. The proportion of this condition increased from 33.8 percent in 2005 to 37.5 percent in 2009. The proportion of patients treated for hip/knee replacements in SNFs had a modest increase from 2005 to 2009, while hip fractures and cardiac disorders all decreased as a proportion of all patients.

Exhibit B.1: Distribution of Clinical Condition Categories among SNFs (2005-2009)

Clinical Condition Category	2005	2006	2007	2008	2009	Percentage Point Change (2005-2009)
Hip/Knee Replacement	7.4%	7.3%	7.5%	7.6%	8.0%	0.6%
Stroke	7.1%	6.7%	6.5%	6.3%	6.2%	-1.0%
Hip Fracture	10.2%	10.1%	10.1%	9.9%	9.8%	-0.4%
Major Medical Complexity	33.8%	35.3%	36.6%	36.9%	37.5%	3.7%
Cardiac Disorders	18.1%	17.8%	17.2%	17.0%	16.7%	-1.4%
Neurological Disorders	1.9%	2.0%	2.0%	2.0%	1.9%	0.0%
Other Orthopedic	1.9%	2.0%	2.2%	2.3%	2.3%	0.5%
Brain Injury	3.5%	3.5%	3.5%	3.5%	3.3%	-0.2%
Spinal Cord Injury	1.5%	1.5%	1.6%	1.6%	1.6%	0.1%
Amputation	2.1%	1.7%	1.0%	0.9%	0.9%	-1.2%
Pulmonary Disorders	7.5%	7.0%	6.8%	7.0%	6.8%	-0.7%
Pain Syndromes	2.4%	2.5%	2.5%	2.5%	2.5%	0.0%
Major Multiple Trauma	0.5%	0.6%	0.6%	0.6%	0.6%	0.1%
Debility	1.9%	1.8%	1.8%	1.8%	1.7%	-0.2%
All Other	0.3%	0.3%	0.3%	0.2%	0.2%	0.0%

Percentages may not total 100 percent due to rounding.
Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Appendix B

Exhibit B.2 presents the distribution of clinical condition categories among HHAs between 2005 and 2009. The proportion of major medical complexity and cardiac disorders represented the majority of admissions each year. The proportion of patients treated for major medical complexities increased by 1.4 percentage points, while the proportion for cardiac disorders decreased by 2.7 percentage points over this period. The proportion of hip/knee replacements increased from 10.4 percent in 2005 to 12.8 percent in 2009. This suggest that as the proportion of patients treated for hip/knee replacements decreased significantly among IRFs, the proportion among SNFs and HHAs increased.

Exhibit B.2: Distribution of Clinical Condition Categories among HHAs (2005-2009)

Clinical Condition Category	2005	2006	2007	2008	2009	Percentage Point Change (2005-2095)
Hip/Knee Replacement	10.4%	10.6%	11.4%	11.5%	12.8%	2.4%
Stroke	4.0%	3.9%	3.8%	4.1%	4.0%	0.0%
Hip Fracture	1.5%	1.5%	1.5%	1.4%	1.3%	-0.2%
Major Medical Complexity	34.2%	35.3%	36.1%	35.8%	35.6%	1.4%
Cardiac Disorders	27.3%	26.6%	25.5%	24.9%	24.6%	-2.7%
Neurological Disorders	1.4%	1.4%	1.5%	1.5%	1.4%	0.0%
Other Orthopedic	2.1%	2.2%	2.4%	2.4%	2.5%	0.4%
Brain Injury	1.9%	1.9%	1.9%	1.8%	1.8%	-0.1%
Spinal Cord Injury	1.6%	1.7%	1.7%	1.7%	1.7%	0.1%
Amputation	1.7%	1.4%	0.8%	0.7%	0.7%	-1.0%
Pulmonary Disorders	10.7%	10.1%	10.1%	10.9%	10.6%	-0.1%
Pain Syndromes	2.2%	2.2%	2.2%	2.2%	2.0%	-0.1%
Major Multiple Trauma	0.2%	0.2%	0.2%	0.2%	0.2%	0.0%
Debility	0.6%	0.8%	0.8%	0.6%	0.6%	0.0%
All Other	0.3%	0.3%	0.3%	0.2%	0.2%	0.0%

Percentages may not total 100 percent due to rounding.

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Exhibit B.3 presents the distribution of clinical condition categories among LTCHs between 2005 and 2009. Major medical complexity represented the largest proportion of LTCH admission each year, with an increasing proportion between 2005 and 2008. This proportion increased markedly from 55.9 percent in 2005 to 67.1 percent in 2009. The increase in major medical complexity proportions appeared to be offset by smaller proportional decreases in amputation, cardiac disorder, stroke, and hip fracture cases.

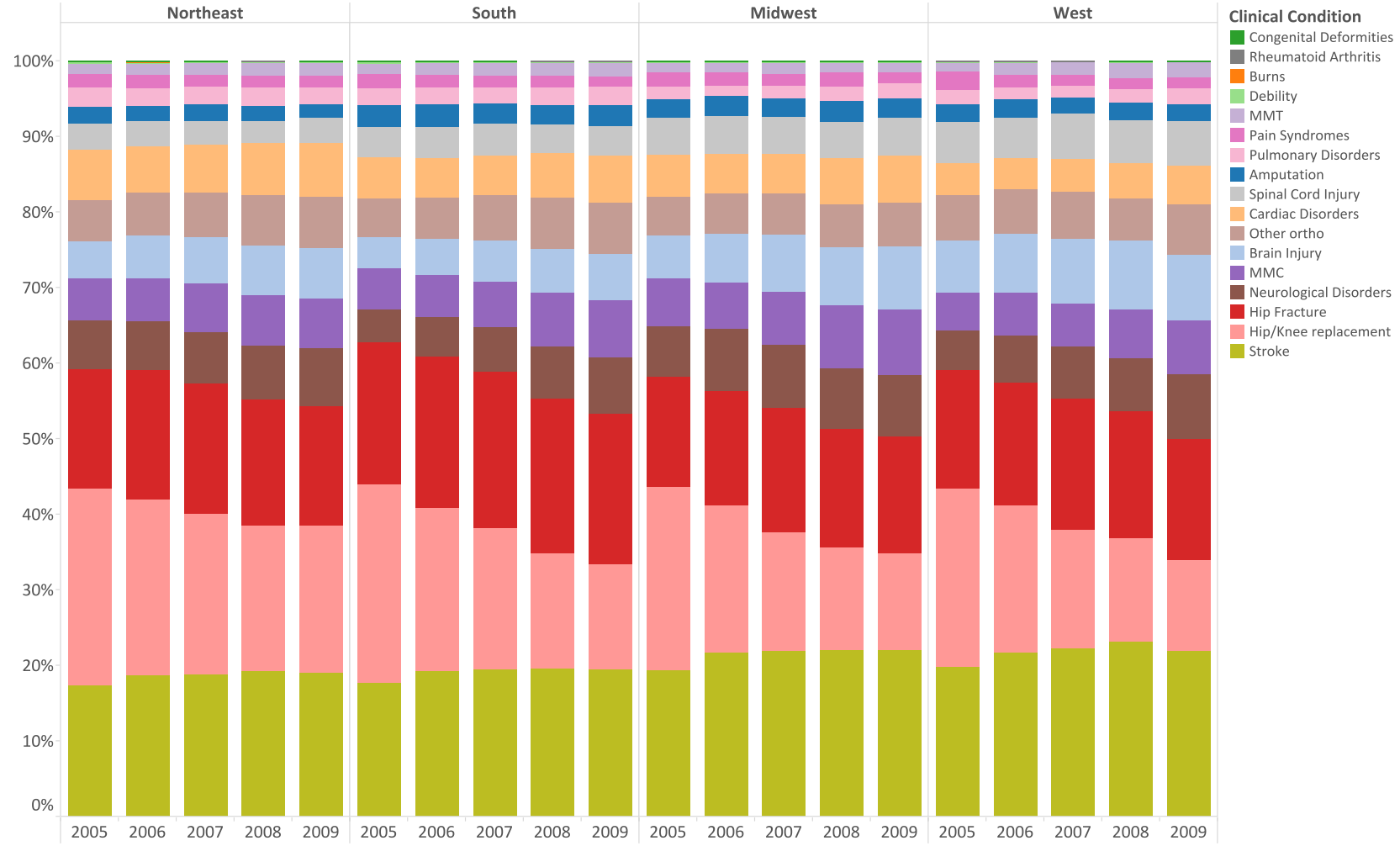
Exhibit B.3: Distribution of Clinical Condition Categories among LTCHs (2005-2009)

Clinical Condition Category	2005	2006	2007	2008	2009	Percentage Point Change (2005-2009)
Hip/Knee Replacement	1.6%	1.1%	0.9%	0.6%	0.4%	-1.2%
Stroke	6.2%	5.7%	4.9%	4.8%	4.2%	-2.0%
Hip Fracture	3.8%	3.2%	2.9%	2.2%	2.0%	-1.8%
Major Medical Complexity	55.9%	59.9%	64.8%	66.6%	67.1%	11.2%
Cardiac Disorders	11.4%	10.9%	10.0%	9.1%	9.0%	-2.4%
Neurological Disorders	0.8%	0.7%	0.7%	0.6%	0.7%	-0.1%
Other Orthopedic	1.5%	1.5%	1.4%	1.3%	1.6%	0.2%
Brain Injury	1.7%	2.0%	1.8%	1.9%	1.9%	0.1%
Spinal Cord Injury	1.4%	1.4%	1.2%	1.3%	1.2%	-0.2%
Amputation	6.7%	5.7%	2.7%	2.6%	3.0%	-3.7%
Pulmonary Disorders	7.2%	6.5%	7.0%	7.1%	7.3%	0.0%
Pain Syndromes	0.6%	0.5%	0.6%	0.6%	0.5%	-0.1%
Major Multiple Trauma	0.5%	0.5%	0.5%	0.5%	0.5%	0.0%
Debility	0.2%	0.1%	0.1%	0.1%	0.1%	-0.1%
All Other	0.5%	0.5%	0.6%	0.6%	0.7%	0.2%

Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Exhibit B.4 shows that the relative proportion of IRF patients by clinical condition category across four census regions (i.e., Northeast, South, Midwest, and West) reflect the nationwide distribution for each study year. In each region, hip/knee replacement, stroke, and hip fracture conditions represented the greatest relative proportion of IRF cases. The marked decline in the proportion of hip/knee replacements is also observed across census regions, although this change appears somewhat less pronounced in the Northeast (a reduction in proportion of 6.5 percent) compared to the Midwest, South, and West, with a reduction in proportions of 11.5 percent, 12.6 percent, and 11.6 percent, respectively.

Exhibit B.4: Distribution of Clinical Condition Categories among IRFs by Census Region (2005-2009)



Source: Dobson | DaVanzo analysis of research identifiable 20 percent sample of Medicare beneficiaries (and 100 percent sample of IRF beneficiaries), 2005-2009.

Guidelines for Adult Stroke Rehabilitation and Recovery

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

Endorsed by the American Academy of Physical Medicine and Rehabilitation and the American Society of Neurorehabilitation

The American Academy of Neurology affirms the value of this guideline as an educational tool for neurologists and the American Congress of Rehabilitation Medicine also affirms the educational value of these guidelines for its members

Accepted by the American Speech-Language-Hearing Association

Carolee J. Winstein, PhD, PT, Chair; Joel Stein, MD, Vice Chair; Ross Arena, PhD, PT, FAHA; Barbara Bates, MD, MBA; Leora R. Cherney, PhD; Steven C. Cramer, MD; Frank Deruyter, PhD; Janice J. Eng, PhD, BSc; Beth Fisher, PhD, PT; Richard L. Harvey, MD; Catherine E. Lang, PhD, PT; Marilyn MacKay-Lyons, BSc, MScPT, PhD; Kenneth J. Ottenbacher, PhD, OTR; Sue Pugh, MSN, RN, CNS-BC, CRRN, CNRN, FAHA; Mathew J. Reeves, PhD, DVM, FAHA; Lorie G. Richards, PhD, OTR/L; William Stiers, PhD, ABPP (RP); Richard D. Zorowitz, MD; on behalf of the American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Quality of Care and Outcomes Research

Purpose—The aim of this guideline is to provide a synopsis of best clinical practices in the rehabilitative care of adults recovering from stroke.

Methods—Writing group members were nominated by the committee chair on the basis of their previous work in relevant topic areas and were approved by the American Heart Association (AHA) Stroke Council's Scientific Statement Oversight Committee and the AHA's Manuscript Oversight Committee. The panel reviewed relevant articles on adults using computerized searches of the medical literature through 2014. The evidence is organized within the context of the AHA framework and is classified according to the joint AHA/American College of Cardiology and supplementary AHA methods of classifying the level of certainty and the class and level of evidence. The document underwent extensive AHA internal and external peer review, Stroke Council Leadership review, and Scientific Statements Oversight Committee review before consideration and approval by the AHA Science Advisory and Coordinating Committee.

Results—Stroke rehabilitation requires a sustained and coordinated effort from a large team, including the patient and his or her goals, family and friends, other caregivers (eg, personal care attendants), physicians, nurses, physical and occupational therapists, speech-language pathologists, recreation therapists, psychologists, nutritionists, social workers, and others. Communication and coordination among these team members are paramount in maximizing the effectiveness

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

This guideline was approved by the American Heart Association Science Advisory and Coordinating Committee on January 4, 2016, and the American Heart Association Executive Committee on February 23, 2016. A copy of the document is available at http://professional.heart.org/statements by using either "Search for Guidelines & Statements" or the "Browse by Topic" area. To purchase additional reprints, call 843-216-2533 or e-mail kelle.ramsay@wolterskluwer.com.

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and efficiency of rehabilitation and underlie this entire guideline. Without communication and coordination, isolated efforts to rehabilitate the stroke survivor are unlikely to achieve their full potential.

Conclusions—As systems of care evolve in response to healthcare reform efforts, postacute care and rehabilitation are often considered a costly area of care to be trimmed but without recognition of their clinical impact and ability to reduce the risk of downstream medical morbidity resulting from immobility, depression, loss of autonomy, and reduced functional independence. The provision of comprehensive rehabilitation programs with adequate resources, dose, and duration is an essential aspect of stroke care and should be a priority in these redesign efforts. **(*Stroke.* 2016;47:e98-e169. DOI: 10.1161/STR.0000000000000098.)**

Key Words: AHA Scientific Statements ■ exercise ■ paresis ■ recovery of function ■ rehabilitation ■ stroke

Between 2000 and 2010, the relative rate of stroke deaths dropped by 35.8% in the United States.[1] However, each year stroke affects nearly 800 000 individuals, with many survivors experiencing persistent difficulty with daily tasks as a direct consequence. More than two thirds of stroke survivors receive rehabilitation services after hospitalization.[2] Despite the development of stroke center designation and improved systems to recognize stroke symptoms and deliver care promptly, only a minority of patients with acute stroke receive thrombolytic therapy, and many of them remain with residual functional deficits. Thus, the need for effective stroke rehabilitation is likely to remain an essential part of the continuum of stroke care for the foreseeable future.

Despite the extensive resources devoted to stroke rehabilitation and aftercare, large-scale, rigorous, clinical trials in this field have been few and have been conducted only in the past decade or so. Thus, many gaps continue to be seen in the evidence base for stroke rehabilitation, for which smaller trials of less rigorous design provide the only available data, and in some cases, even these are not yet available. Certain aspects of stroke rehabilitation care are well established in clinical practice and constitute a standard of care that is unlikely to be directly tested in a randomized, clinical trial, for example, the provision of physical therapy (PT) to early stroke survivors with impaired walking ability. Thus, practice guidelines such as this one will likely rely on a mixture of evidence and consensus. It is hoped that the relative proportion of recommendations based on rigorous evidence will grow over time.

This guideline uses the framework established by the American Heart Association (AHA) concerning classes and levels of evidence for use in guidelines, as shown in Tables 1 and 2.

We have organized this guideline into 5 major sections: (1) The Rehabilitation Program, which includes system-level sections (eg, organization, levels of care); (2) Prevention and Medical Management of Comorbidities, in which reference is made to other published guidelines (eg, hypertension); (3) Assessment, focused on the body function/structure level of the *International Classification of Functioning, Disability, and Health* (*ICF*)[3]; (4) Sensorimotor Impairments and Activities (treatment/interventions), focused on the activity level of the *ICF*; and (5) Transitions in Care and Community Rehabilitation, focused primarily on the participation level of the *ICF*.

Published guidelines are, by their very nature, a reflection of clinical practice at a particular point in time and the evidence base available. As new information becomes available, best practice can change quickly, and it is incumbent on the users of these guidelines to keep the ever-changing nature of clinical knowledge in mind. Equally important, no guideline can substitute for the careful evaluation of the individual patient by an experienced clinician, in which the art and science of medicine intersect. Guidelines that are correct in the aggregate may not represent the best care for any specific individual, and careful individualization is needed at the point of care.

We have benefited from the published Veterans Affairs/Department of Defense stroke rehabilitation guidelines[4] and several of the prior AHA stroke-related guidelines.[4a] Although the current guideline is a fundamentally new work, it certainly reflects the insights and judgments of these prior guidelines.

Because stroke is fundamentally a chronic condition, we have attempted to span the entire course of rehabilitation, from the early actions taken in the acute care hospital through reintegration into the community. The end of formal rehabilitation (commonly by 3–4 months after stroke) should not mean the end of the restorative process. In many respects, stroke has been managed medically as a temporary or transient condition instead of a chronic condition that warrants monitoring after the acute event. Currently, unmet needs persist in many domains, including social reintegration, health-related quality of life, maintenance of activity, and self-efficacy (ie, belief in one's capability to carry out a behavior). Apathy is manifested in >50% of survivors at 1 year after stroke[5]; fatigue is a common and debilitating symptom in chronic stroke[6]; daily physical activity of community-living stroke survivors is low[7]; and depressive symptomology is high.[8] By 4 years after onset, >30% of stroke survivors report persistent participation restrictions (eg, difficulty with autonomy, engagement, or fulfilling societal roles).[9]

The Rehabilitation Program

Organization of Poststroke Rehabilitation Care (Levels of Care)

Rehabilitation services are the primary mechanism by which functional recovery and the achievement of independence are promoted in patients with acute stroke. The array of rehabilitation services delivered to stroke patients in the United States is broad and highly heterogeneous, varying in the type of care settings used; in the duration, intensity, and type of interventions delivered; and in the degree of involvement of specific medical, nursing, and other rehabilitation specialists. The nature and organization of rehabilitation stroke services in the United States have changed considerably over time in response to various forces, including the increasing integration of hospital and outpatient care delivery systems (at both local and regional levels), the organization of medical and other specialty rehabilitation groups, and most important, repeated changes to the federal reimbursement fee structure (specifically, Centers for Medicare & Medicaid Services), which is

Table 1. Applying Classification of Recommendations and Level of Evidence

ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT	SIZE OF TREATMENT EFFECT: CLASS I *Benefit >>> Risk* Procedure/Treatment **SHOULD** be performed/ administered	CLASS IIa *Benefit >> Risk* *Additional studies with focused objectives needed* **IT IS REASONABLE** to perform procedure/administer treatment	CLASS IIb *Benefit ≥ Risk* *Additional studies with broad objectives needed; additional registry data would be helpful* Procedure/Treatment **MAY BE CONSIDERED**	CLASS III *No Benefit* or CLASS III *Harm* Procedure/Test / Treatment COR III: No benefit — Not Helpful / No Proven Benefit COR III: Harm — Excess Cost w/o Benefit or Harmful / Harmful to Patients
LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	■ Recommendation that procedure or treatment is useful/effective ■ Sufficient evidence from multiple randomized trials or meta-analyses	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Sufficient evidence from multiple randomized trials or meta-analyses
LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is useful/effective ■ Evidence from single randomized trial or nonrandomized studies	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Evidence from single randomized trial or nonrandomized studies
LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	■ Recommendation that procedure or treatment is useful/effective ■ Only expert opinion, case studies, or standard of care	■ Recommendation in favor of treatment or procedure being useful/effective ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation's usefulness/efficacy less well established ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Only expert opinion, case studies, or standard of care
Suggested phrases for writing recommendations	should is recommended is indicated is useful/effective/beneficial	is reasonable can be useful/effective/beneficial is probably recommended or indicated	may/might be considered may/might be reasonable usefulness/effectiveness is unknown/unclear/uncertain or not well established	COR III: No Benefit: is not recommended; is not indicated; should not be performed/ administered/ other; is not useful/ beneficial/ effective COR III: Harm: potentially harmful; causes harm; associated with excess morbidity/mortality; should not be performed/ administered/ other
Comparative effectiveness phrases†	treatment/strategy A is recommended/indicated in preference to treatment B treatment A should be chosen over treatment B	treatment/strategy A is probably recommended/indicated in preference to treatment B it is reasonable to choose treatment A over treatment B		

A recommendation with Level of Evidence B or C does not imply that the recommendation is weak. Many important clinical questions addressed in the guidelines do not lend themselves to clinical trials. Although randomized trials are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

*Data available from clinical trials or registries about the usefulness/efficacy in different subpopulations, such as sex, age, history of diabetes, history of prior myocardial infarction, history of heart failure, and prior aspirin use.

†For comparative effectiveness recommendations (Class I and IIa; Level of Evidence A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

the central driver of much of the system's organization and structure. Further systems-level changes are inevitable, given the ongoing federal changes to the healthcare system and the recent focus on "episodes of care," which promises to result in wholesale changes to the organization of medical care delivery in the United States.[10]

The highly heterogeneous organizational structure of stroke rehabilitation care in the United States brings with it challenges in terms of determining the quality of care delivered by the system (ie, timeliness, effectiveness, efficiency, safety, fairness, and patient-centeredness). The unique and somewhat idiosyncratic nature of the stroke rehabilitation system in the United States also presents challenges in terms of assessment of which research findings, among the expanding evidence base of stroke rehabilitation care, are applicable to the system. For example, much of the research documenting the benefits of stroke units and other aspects of organized integrated interprofessional models of stroke care was developed in Europe and elsewhere, and the degree to which these findings are directly applicable to the US system of stroke care is often debated.

Organization of Acute and Postacute Rehabilitation Care in the United States

An excellent review of the current organizational structure of stroke rehabilitation care in the United States can be found in

Table 2. Definition of Classes and Levels of Evidence Used in AHA/ASA Recommendations

Class I	Conditions for which there is evidence for and/or general agreement that the procedure or treatment is useful and effective
Class II	Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment
Class IIa	The weight of evidence or opinion is in favor of the procedure or treatment
Class IIb	Usefulness/efficacy is less well established by evidence or opinion
Class III	Conditions for which there is evidence and/or general agreement that the procedure or treatment is not useful/effective and in some cases may be harmful
Therapeutic recommendations	
Level of Evidence A	Data derived from multiple randomized, clinical trials or meta-analyses
Level of Evidence B	Data derived from a single randomized trial or nonrandomized studies
Level of Evidence C	Consensus opinion of experts, case studies, or standard of care
Diagnostic recommendations	
Level of Evidence A	Data derived from multiple prospective cohort studies using a reference standard applied by a masked evaluator
Level of Evidence B	Data derived from a single grade A study, ≥1 case-control studies, or studies using a reference standard applied by an unmasked evaluator
Level of Evidence C	Consensus opinion of experts

AHA/ASA indicates American Heart Association/American Stroke Association.

the 2010 AHA scientific statement "Comprehensive Overview of Nursing and Interdisciplinary Rehabilitation Care of the Stroke Patient."[11] We briefly review the different stroke neurology, rehabilitation care settings that are essential components of this system (Appendix 1).

Ideally, rehabilitation services are delivered by a multidisciplinary team of healthcare providers with training in neurology, rehabilitation nursing, occupational therapy (OT), PT, and speech and language therapy (SLT). Such teams are directed under the leadership of physicians trained in physical medicine and rehabilitation (physiatrist) or by neurologists who have specialized training or board certification in rehabilitation medicine. Other health professionals who play an essential role in the process include social workers, psychologists, psychiatrists, and counselors.[11]

Health care provided during the acute hospital stay is focused primarily on the acute stabilization of the patient, the delivery of acute stroke treatments, and the initiation of prophylactic and preventive measures. Although the delivery of rehabilitation therapies (OT/PT/SLT) is generally not the first priority, data strongly suggest that there are benefits to starting rehabilitation as soon as the patient is ready and can tolerate it.[11] The cardinal feature of acute inpatient care for stroke patients in the United States is its brevity; the median length of stay for patients with ischemic stroke in only 4 days. Regardless of whether rehabilitation is started during the inpatient stay, all patients should undergo a formal assessment (often conducted by the OT/PT/SLT services) of the patient's rehabilitation needs before discharge.[12] The discharge process may also involve rehabilitation nursing case managers and social workers who can assess psychosocial issues that may influence the transition.

Healthcare services provided after hospital discharge are referred to as postacute care services and are designed to support patients in their transition from the hospital to home and in their pursuit of achieving the highest level of functioning possible. In addition to the rehabilitation care provided by OT/PT/SLT, care may include physiatrists or other physicians, rehabilitation nurses, and nursing aides. The intensity of rehabilitation care varies widely, depending on the setting, with the most intensive rehabilitation care provided in inpatient rehabilitation facilities (IRFs), followed by skilled nursing facilities (SNFs), which provide "subacute" rehabilitation.

IRFs provide hospital-level care to stroke survivors who need intensive, 24-hour-a-day, interdisciplinary rehabilitation care that is provided under the direct supervision of a physician. Medicare (Centers for Medicare & Medicaid Services) regulations specify that admission to IRFs should be limited to patients for whom significant improvement is expected within a reasonable length of time and who are likely to return to a community setting (rather than being transferred to another setting such as a SNF or long-term care facility). Medicare regulations also generally dictate that IRFs provide at least 3 hours of rehabilitation therapy (defined as PT, OT, and SLT) per day for at least 5 d/wk.[11] Physicians are expected to have training or experience in rehabilitation, and daily physician visits are typical. Registered nurses are present on a continuous basis and commonly have specialty certification in rehabilitation nursing. An IRF can be located as a geographically distinct unit within an acute care hospital or as a free-standing facility.

SNFs (also known as subacute rehabilitation) provide rehabilitation care to stroke survivors who need daily skilled nursing or rehabilitation services. Admission to SNFs may be requested for patients who the rehabilitation team determines may not reach full or partial recovery or if skilled nursing services are required to maintain or prevent deterioration of the patient. SNFs are required to have rehabilitation nursing on site for a minimum of 8 h/d, and care must still follow a physician's plan, although there is no requirement for direct daily supervision by a physician.[13] SNFs can be stand-alone facilities, but when located within an existing nursing home or hospital, they must be physically distinguishable from the larger institution (eg, a separate designated wing, ward, or building).

Nursing homes provide long-term residential care for individuals who are unable to live in the community. Many individuals who reside in nursing homes initially enter the facility under their Medicare short-term SNF benefit and then transition to long-term care once the needs for skilled nursing are no longer present. Medicare will provide insurance coverage for up to 100 days in an SNF but does not cover long-term nursing home care, which is generally paid out of pocket, by long-term care insurance, or through the Medicaid program.

Long-term acute care hospitals are another inpatient setting that delivers postacute rehabilitation care. Long-term acute care hospitals provide extended medical and rehabilitative care to stroke patients with complex medical needs resulting from a combination of acute and chronic conditions (eg, ventilator-dependent care, pain management). As a consequence of this high-needs patient population, facilities must demonstrate an average length of stay of at least 25 days.[14,15] Because of these requirements, long-term acute care hospitals provide care to a relatively small but growing minority of stroke patients.[14]

For stroke patients who go home after an acute hospitalization, rehabilitation care can be provided in the community either by a home healthcare agency (HHCA) or through outpatient offices and clinics. The intensity of rehabilitation care can vary tremendously across these 2 settings. For patients in the Medicare program to be eligible for HHCA services, they must be certified as being homebound by a physician (defined by the Centers for Medicare & Medicaid Services as unable to leave the home except to receive medical care or to have occasional nonmedical trips). HHCAs focus on delivering skilled nursing care and rehabilitation therapy (eg, OT, PT, SLT), as well as some limited assistance with daily tasks provided by home health aides supervised by nurses. Care encompasses medical and social needs and services that are designed to assist the patient in living in his or her own home.[13] Currently, home healthcare services are reimbursed under a prospective payment system that covers up to 60 days of services. These services may be extended if they can be clinically justified. Home healthcare services may also be performed in assisted living facilities or other group homes but are not reimbursed if the services are duplicative of the services of another facility or agency.

Appropriateness of Early Supported Discharge Rehabilitation Services

For selected stroke patients, early discharge to a community setting for ongoing rehabilitation may provide outcomes similar to those achieved in an inpatient rehabilitation unit. This early supported discharge (ESD) model of care links inpatient care with community services and allows certain patients to be discharged home sooner with support of the rehabilitation team.

The efficacy of ESD for patients with acute stroke was evaluated in the ESD Trialists' systematic review.[16] This 2012 review concluded that "appropriately resourced ESD services provided for a selected group of stroke patients can reduce long-term dependency and admission to institutional care as well as reducing the length of hospital stay." No adverse impacts were identified on either mood or the subjective health status of patients or caregivers with ESD. ESD has been studied primarily in Europe and Australia/New Zealand, where systems of care are different than in the United States and where the average acute care hospitalization length of stay for stroke is longer than in the United States. Extrapolation of these results to the United States should take these distinctions into account.

A meta-analysis conducted by Langhorne et al[17] and updated by Langhorne and Holmqvist[18] found that ESD services reduce inpatient length of stay and adverse events (eg, readmission rates) while increasing the likelihood of independence and living at home. Several recent systematic reviews have also reported that ESD after stroke was associated with shorter hospital lengths of stay, lower overall costs of care, lower risk of institutionalization, and no adverse effects on functional recovery.[19–21]

To be effective, ESD should be considered for patients with mild to moderate stroke when adequate community services for both rehabilitation and caregiver support are available and can provide the level of intensity of rehabilitation service needed.[22] Patients should remain in an inpatient setting for their rehabilitation care if they are in need of skilled nursing services, regular contact by a physician, and multiple therapeutic interventions.

Examples for need of skilled nursing services include (but are not limited to) the following:

- Bowel and bladder impairment
- Skin breakdown or high risk for skin breakdown
- Impaired bed mobility
- Dependence for activities of daily living (ADLs)
- Inability to manage medications
- High risk for nutritional deficits

Examples for need of regular contact by a physician include (but are not limited to) the following:

- Medical comorbidities not optimally managed (eg, diabetes mellitus and hypertension)
- Complex rehabilitation issues (eg, orthotics, spasticity, and bowel/bladder)
- Acute illness (but not severe enough to prevent rehabilitation care)
- Pain management issues

Examples for need of multiple therapeutic interventions include (but are not limited to) the following:

- Moderate to severe motor/sensory deficits, and/or
- Cognitive deficits, and/or
- Communication deficits

Outpatient therapies require patients to travel from their home to obtain care at hospital-based or free-standing facilities. All outpatient OT, PT, and SLT services must be certified by a physician who is responsible for establishing a planned set of therapy services. These therapies must be complex enough that they can be performed only by a qualified healthcare professional. Treatment plans need to be reviewed and recertified every 30 days.

Multiple transitions in care are typical for individuals recovering from stroke and pose particular challenges for healthcare providers, stroke survivors, and their caregivers in terms of maintaining continuity of care and avoiding undesirable lapses in the rehabilitation program of care. Moreover, stroke survivors need to navigate the transition from a medical model of treatment to a more community-based model that includes return to work (for some), leisure activities, and exercise for fitness. The Transitions in Care and Community Rehabilitation section addresses transitions to the community after discharge.

Trends in the Use of Acute and Postacute Stroke Rehabilitation in the United States

The organization of rehabilitation stroke services in the United States has changed considerably over time in response to the frequent changes to the federal reimbursement fee structure for both acute (inpatient) and postacute

care. Currently, ≈70% of Medicare beneficiaries discharged for acute stroke use Medicare-covered postacute care,[23] with most receiving rehabilitation care from multiple providers in several different settings.[24,25] Considering the first setting after the acute hospitalization, the largest proportion of stroke patients are referred for rehabilitation to an SNF (32%), followed by an IRF (22%) and then HHCA (15%).[26] Major changes in the Medicare postacute care reimbursement policies starting in the 1990s dramatically affected use patterns,[26] particularly for HHCAs, after the introduction of an interim payment system in 1997 with extensive changes to its rules and regulations in 2000. The introduction of prospective payment systems for SNFs (1998), IRFs (2002), and long-term acute care hospitals (2002) also affected their use.[13,27] Between 1996 and 2003, the proportion of Medicare stroke patients who received care from HHCAs declined by >25% during this period (from 20% to 15%),[26] whereas the proportion who received SNF or IRF care remained relatively unchanged. However, the proportion of stroke patients not referred to any postacute care increased from 26% to 31% during this period,[26] and an analysis of 2006 Medicare data found that this proportion had increased to 42%.[28] Although legislated payment changes have had major influences on where rehabilitation services are provided, several other nonclinical factors affect the use of postacute care rehabilitation services. There is considerable geographic variability in the use of these services in the United States,[29] which is driven in part by local differences in the availability of postacute care settings and regulatory practices.[29–33] Factors such as the daily census, case mix, teaching status, ownership, and urbanicity of the hospital and the percentage of patients served by Medicare have been shown to influence use patterns of postacute services.[30,34,35] At the patient level, sociodemographic factors such as age, income, race, and living circumstances have also been shown to affect the use and type of rehabilitation services provided.[30–33,36–38]

Of central interest to researchers and policy makers is the need for a better understanding of the impact of rehabilitation care at these different rehabilitation settings on patient outcomes, especially relative to resource use and costs. The studies that have compared outcomes in hospitalized stroke patients first discharged to an IRF, an SNF, or a nursing home have generally shown that IRF patients have higher rates of return to community living[39,40] and greater functional recovery,[39–42] whereas patients discharged to an SNF or a nursing home have higher rehospitalization rates[43] and substantially poorer survival.[44,45] However, all of these studies have limitations resulting from their observational designs, which rely on administrative data[39–41] or data from a limited number of facilities.[42] Importantly, most of these studies demonstrate substantial baseline differences in patient case mix between settings, with IRF patients having a more favorable prognostic outlook because of their younger age, lower prestroke disability, fewer comorbidities, and greater caregiver/family support and because they have been selected for their potential to return to the community.[39–41,45] These differences serve to illustrate that the decision to refer a stroke patient to a particular setting after discharge is dictated by a complex set of demographic, clinical, and nonclinical factors that are also inevitably related to patient outcomes. This inherent confounding or channeling bias[46] has been addressed by these studies through the application of complex statistical methods.[39–41] However, uncertainty remains about how much of the final difference in outcome is attributable to residual confounding resulting from unmeasured factors (particularly stroke severity and prestroke disability). Despite these concerns, the consistency of the findings in favor of IRF referral suggests that stroke survivors who qualify for IRF services should receive this care in preference to SNF-based care.

Recommendations: Organization of Poststroke Rehabilitation Care (Levels of Care)	Class	Level of Evidence
It is recommended that stroke patients who are candidates for postacute rehabilitation receive organized, coordinated, interprofessional care.	I	A
It is recommended that stroke survivors who qualify for and have access to IRF care receive treatment in an IRF in preference to a SNF.	I	B
Organized community-based and coordinated interprofessional rehabilitation care is recommended in the outpatient or home-based settings.	I	C
ESD services may be reasonable for people with mild to moderate disability.	IIb	B

Rehabilitation Interventions in the Inpatient Hospital Setting

There is strong evidence that organized, interprofessional stroke care not only reduces mortality rates and the likelihood of institutional care and long-term disability but also enhances recovery and increases independence in ADLs.[47–50] Although many small, randomized, clinical trials have studied interventions in the acute rehabilitation phase, the only large, randomized, clinical trials in stroke recovery and rehabilitation have focused on the chronic recovery phase.[51,52] This section updates the scientific statement on the comprehensive overview of nursing and interprofessional rehabilitation care of the stroke patient and previously summarized recommendations for care of the stroke survivor in the inpatient rehabilitation phase.[11]

Although acute stroke units have higher levels of nurse staffing, earlier assessments of stroke type and treatment, and more intensive physiological monitoring, rehabilitation units (including comprehensive stroke units in Europe) emphasize recovery and rehabilitation, involving rehabilitation physicians and allied health professionals, increased interprofessional staff education and training, greater patient and caregiver participation in rehabilitation, and early mobilization protocols.[53] Age, cognition, functional level after stroke, and to a lesser extent continence have shown consistent associations with poststroke outcomes, and stroke severity is associated with acute discharge disposition, final discharge disposition, and functional level.[54] In recent years, lengths of stay in IRFs have decreased significantly, but in survivors with mild to moderate stroke, patient satisfaction does not appear to be diminished, and recovery actually may be faster.[55] In the United States, data after the initiation of prospective payment for rehabilitation in 2002 suggest that discharges from IRFs to institutional settings have increased.[56]

Timing and intensity of acute rehabilitation also are important issues in poststroke functional outcomes but remain controversial. Overall, a 2009 meta-analysis demonstrated insufficient evidence to support or refute the efficacy of routine very early mobilization after stroke compared with conventional care.[57] In the recently completed randomized, controlled trial (RCT) of the efficacy and safety of very early mobilization within 24 hours of stroke onset (A Very Early Rehabilitation Trial [AVERT]), the high-dose, very early mobilization protocol was associated with a reduction in the odds of a favorable outcome at 3 months.[58] Early mobilization after stroke is recommended in many clinical practice guidelines worldwide. The AVERT findings should affect clinical practice by refining present guidelines, but clinical recommendations should be informed by future analyses of dose-response associations.

The only evidence assessing the intensity of stroke rehabilitation comes from literature comparing IRFs with subacute rehabilitation. In a study of 222 subjects, Chan et al[59] reported that subjects whose care included an IRF stay experienced functional scores at least 8 points higher (twice the minimally detectable change) on the Activity Measure for Post-Acute Care than those who went to SNFs or received home health/outpatient care. A retrospective cohort study of 360 subjects demonstrated that subjects who received >3.0 hours of therapy daily made significantly more functional gains than those receiving <3.0 hours daily, although hemorrhagic stroke, left-sided brain injury, earlier IRF admission, and longer IRF stay also were associated with total functional improvement.[60]

Finally, the efficacy of complementary medicine techniques has been studied in the IRF environment. In a randomized, clinical trial of 274 subjects receiving acupuncture, PT, or both, no synergistic effect was found when acupuncture was added to PT, although all subjects exhibited functional gains.[61] An RCT of 53 subjects receiving whole-body somatosensory stimulation or exercise therapy in addition to conventional rehabilitation demonstrated no significant increases in the recovery of balance and ADLs.[62]

For evidence pertaining to dysphagia; interventions for upper limb rehabilitation, including upper extremity activities (ie, ADLs, instrumental ADLs [IADLs]), touch, and proprioception; lower extremity rehabilitation, including mobility (eg, locomotion) and balance/vestibular rehabilitation; and therapies for cognitive impairments and hemi-spatial neglect, the reader is directed to those subsections in The Rehabilitation Program section.

Recommendations: Rehabilitation Interventions in the Inpatient Hospital Setting	Class	Level of Evidence
It is recommended that early rehabilitation for hospitalized stroke patients be provided in environments with organized, interprofessional stroke care.	I	A
It is recommended that stroke survivors receive rehabilitation at an intensity commensurate with anticipated benefit and tolerance.	I	B
High-dose, very early mobilization within 24 hours of stroke onset can reduce the odds of a favorable outcome at 3 months and is not recommended.	III	A

Prevention and Medical Management of Comorbidities

Prevention of Skin Breakdown and Contractures

Hemiparesis, sensory changes, and altered levels of consciousness place the patient with stroke at risk for joint and muscle contractures and skin breakdown. Pressure ulcers are also associated with impaired circulation, older age, and incontinence. Regular assessment of skin and the use of objective scales of risk such as the Braden scale are valuable in the prevention of skin injury and should be followed by regular skin inspection with documentation.[63] Agency for Healthcare Research and Quality (AHRQ) guidelines recommend minimizing or eliminating friction, minimizing pressure, providing appropriate support surfaces, avoiding excessive moisture, and maintaining adequate nutrition and hydration.[63] Specific measures include regular turning (at least every 2 hours), good hygiene, and the use of special mattresses and proper wheelchair seating to prevent skin injury.[11]

After stroke with hemiparesis, 60% of patients will develop joint contracture on the affected side within the first year, with wrist contractures occurring most commonly in patients who do not recover functional hand use.[65,66] The occurrence of elbow contractures within the first year after stroke is associated with the presence of spasticity within the first 4 months.[67] These contractures can cause pain and make self-care, including dressing and hygiene, difficult. Many clinicians recommend daily stretching of the hemiplegic limbs to avoid contractures, and patients and families should be taught proper stretching techniques to avoid injury and to maximize effectiveness. Resting hand splints are often applied to prevent contractures in hemiplegic wrist and fingers, but their effectiveness is not well established.[68,69] There is controversy over the benefit of resting hand splints such that the Royal College of Physicians National Institute for Clinical Excellence guidelines recommend against the use of resting hand splints but the Veterans Affairs/Department of Defense clinical practice guidelines recommend their use.[4,70,71] Application of resting hand splints combined with other treatments, including early botulinum toxin injection to wrist and finger flexors, may be beneficial.[72] Early after stroke, positioning of the hemiplegic shoulder in maximum external rotation for 30 minutes each day either in bed or in a chair can be useful for preventing shoulder contracture.[73,74] Applying serial casting or static adjustable splints may be beneficial in preventing elbow or wrist contractures, although data are conflicting.[4,72,75,76] Surgical release of the brachialis, brachioradialis, and biceps muscles is a reasonable option to treat pain and range-of-motion limitations in patients with substantial established elbow flexor contractures.[77]

Ankle plantarflexion contractures after stroke can affect gait quality and safety. The use of an ankle-foot orthosis (AFO) can improve gait in patients with active plantarflexion during the swing phase of gait but also may be beneficial in preventing ankle contracture.[78] For nonambulatory patients, the use of a resting ankle splint at night, set in the plantigrade position (ankle at 90° and subtalar neutral), or

standing on a tilt table for 30 min/d is probably useful in preventing contracture.[78]

Recommendations: Prevention of Skin Breakdown and Contractures	Class	Level of Evidence
During hospitalization and inpatient rehabilitation, regular skin assessments are recommended with objective scales of risk such as the Braden scale.	I	C
It is recommended to minimize or eliminate skin friction, to minimize skin pressure, to provide appropriate support surfaces, to avoid excessive moisture, and to maintain adequate nutrition and hydration to prevent skin breakdown. Regular turning, good skin hygiene, and use of specialized mattresses, wheelchair cushions, and seating are recommended until mobility returns.	I	C
Patients, staff, and caregivers should be educated about the prevention of skin breakdown.	I	C
Positioning of hemiplegic shoulder in maximum external rotation while the patient is either sitting or in bed for 30 minutes daily is probably indicated.	IIa	B
Resting hand/wrist splints, along with regular stretching and spasticity management in patients lacking active hand movement, may be considered.	IIb	C
Use of serial casting or static adjustable splints may be considered to reduce mild to moderate elbow and wrist contractures.	IIb	C
Surgical release of brachialis, brachioradialis, and biceps muscles may be considered for substantial elbow contractures and associated pain.	IIb	B
Resting ankle splints used at night and during assisted standing may be considered for prevention of ankle contracture in the hemiplegic limb.	IIb	B

Prevention of Deep Venous Thrombosis

Survivors of acute stroke are at high risk of deep venous thrombosis (DVT) and pulmonary embolism (PE) as a result of a combination of limb immobility and reduced activity level.[79] Prevention of DVT and PE can be divided into pharmacological and mechanical methods in both ischemic and hemorrhage strokes. Prophylactic treatment is initiated depending on the type of stroke and use of thrombolytic therapy. Therapy usually is continued throughout the rehabilitation stay or until the stroke survivor regains mobility, with few studies examining the optimal duration of prophylaxis. For patients with mild motor impairments who are discharged directly home from the hospital, DVT prophylaxis may not be needed. For patients discharged to an SNF with a stay that extends beyond the active rehabilitation program, the duration of prophylactic treatment remains at the discretion of the treating physician.

Recommendations for the prevention of DVT and PE in ischemic stroke are delineated in great detail in the American College of Chest Physicians' "Antithrombotic Therapy and Prevention of Thrombosis, 9th edition."[80] One meta-analysis of 16 trials involving 23 043 patients with acute ischemic stroke compared stroke survivors receiving varying amounts of unfractionated heparin (UFH) with control subjects.[81] The use of high-dose UFH (>15 000 U/d) was associated with a reduction in PE (odds ratio [OR], 0.49; 95% confidence interval [CI], 0.29–0.83) but also with an increased risk of intracerebral hemorrhage (ICH; OR, 3.86; 95% CI, 2.41–6.19) and extracerebral hemorrhage (ECH; OR, 4.74; 95% CI, 2.88–7.78). Low-dose UFH (<15 000 U/D) decreased the thrombosis risk (OR, 0.17; 95% CI, 0.11–0.26) but had no influence on the risk of PE (OR, 0.83; 95% CI, 0.53–1.31). The risk of ICH or ECH was not significantly increased (OR, 1.67; 95% CI, 0.97–2.87 for ICH; OR, 1.58; 95% CI, 0.89–2.81 for ECH) with prophylactic-dose UFH.

Adjusted-dose low-molecular-weight heparin (LMWH) decreased the risk of both DVT (OR, 0.07; 95% CI, 0.02–0.29) and PE (0.44; 95% CI, 0.18–1.11), but this benefit was offset by an increased risk of ICH (OR, 2.01; 95% CI, 1.02–3.96) and ECH (OR, 1.78; 95% CI, 0.99–3.17). Prophylactic-dose LMWH (defined as 3000–6000 IU/d) reduced the incidence of both DVT (OR, 0.34; 95% CI, 0.19–0.59) and PE (OR, 0.36; 95% CI, 0.15–0.87) without an increased risk of ICH (OR, 1.39; 95% CI, 0.53–3.67) or ECH (OR, 1.44; 95% CI, 0.13–16). For prophylactic-dose LMWH, the number needed to treat to avoid 1 event was 7 for DVT and 38 for PE.

Overall, the guidelines of the American College of Chest Physicians (9th edition) found an estimated reduction in overall mortality of 12 deaths per 1000 individuals receiving either UFH or LMWH compared with no anticoagulation[80]; no form of prophylaxis is 100% effective in preventing venous thromboembolism in this population, however.

A meta-analysis[82] and a Cochrane systematic review of 9 trials involving 3137 subjects confirmed the superiority of LMWH over UFH.[83] Only 1 high-quality cost-effectiveness analysis comparing LMWH with UFH in acutely ill medical subjects (not stroke) demonstrated fewer complications with LMWH at a lower overall cost.[84]

Intermittent pneumatic compression or sequential compression devices are designed to spur blood flow by intermittently applying pressure on the calf muscles and vasculature. One Cochrane systematic review of 2 small studies including 177 subjects demonstrated a nonsignificant trend toward a lower risk of DVT (OR, 0.45; 95% CI, 0.19–1.10) with no significant effect on mortality (OR, 1.04; 95% CI, 0.37–2.89).[85]

Elastic compression stockings, also referred to as graduated compression stockings, are designed to promote venous blood flow by applying a pressure gradient from the ankle more proximally. One large, randomized, clinical trial involving 2518 subjects failed to demonstrate a positive or negative effect on the occurrence of symptomatic proximal DVT or PE.[86] However, subjects using elastic compression stockings had an increase in skin complications (relative risk [RR], 4.18; 95% CI, 2.4–7.3). One Cochrane systematic review of 2 trials including 2615 subjects demonstrated no significant reduction in DVT (OR, 0.88; 95% CI, 0.72–1.08) or death (OR, 1.13; 95% CI, 0.87–1.47).[85]

The addition of elastic compression stockings to intermittent pneumatic compression has been studied in a few small studies but has failed to demonstrate a positive or negative effect.[87] Studies in other patient populations have demonstrated

that the combination of elastic compression stockings and pharmacological prophylaxis significantly reduced the incidence of symptomatic or asymptomatic DVT (OR, 0.40; 95% CI, 0.25–0.65). However, the benefit of treatment should be weighed against the increase in skin complications observed with the use of elastic compression stockings.[88]

With respect to hemorrhagic stroke, prophylactic-dose heparin does not increase the risk of recurrent intracranial bleeding significantly, although the overall quality of the evidence is low.[80] In 1 small study comparing the initiation of prophylactic heparin on the second and fourth hospital days, there were no harmful or beneficial effects on any outcomes.[89] This study provides very low-quality evidence that early use of prophylactic-dose heparin is safe in stroke survivors with primary ICH.

Comparisons of the effects between UFH and LMWH and the effects of intermittent pneumatic compression and elastic compression stockings have not been done in stroke survivors with primary ICH. Therefore, recommendations are consistent with those of ischemic stroke.[80]

Recommendations: Prevention of DVT	Class	Level of Evidence
In ischemic stroke, prophylactic-dose subcutaneous heparin (UFH or LMWH) should be used for the duration of the acute and rehabilitation hospital stay or until the stroke survivor regains mobility.	I	A
In ischemic stroke, it is reasonable to use prophylactic-dose LMWH over prophylactic-dose UFH for prevention of DVT.	IIa	A
In ischemic stroke, it may be reasonable to use intermittent pneumatic compression over no prophylaxis during the acute hospitalization.	IIb	B
In ICH, it may be reasonable to use prophylactic-dose subcutaneous heparin (UFH or LMWH) started between days 2 and 4 over no prophylaxis.	IIb	C
In ICH, it may be reasonable to use prophylactic-dose LMWH over prophylactic-dose UFH.	IIb	C
In ICH, it may be reasonable to use intermittent pneumatic compression devices over no prophylaxis.	IIb	C
In ischemic stroke, it is not useful to use elastic compression stockings.	III	B
In ICH, it is not useful to use elastic compression stockings.	III	C

Treatment of Bowel and Bladder Incontinence

Urinary incontinence and fecal incontinence are common problems after stroke. Approximately 40% to 60% of stroke patients have urinary incontinence during their acute admission for stroke, falling to 25% by hospital discharge. At 1 year, 15% will remain incontinent of urine.[90] Age, cognition, and motor impairments are risk factors for bladder incontinence. Fecal incontinence prevalence is ≈40% acutely but diminishes to 20% by discharge from rehabilitation. Age and functional impairment are risk factors for fecal incontinence on admission for stroke.[91] Impaired awareness of urinary incontinence is correlated with mortality[92] and the need for nursing home care 3 months after stroke.[93] On a positive note, many patients recover continence after stroke. Because of the risk of skin breakdown, the social stigma, and the burden of care associated with incontinence, management of bowel and bladder continence is an essential part of the rehabilitation process.

Although considerable data on the rate of urinary incontinence exist, there is a paucity of published studies on therapeutic interventions to improve rates of continence. The recommendation to remove indwelling urinary catheters within 24 hours is based on the Centers for Disease Control and Prevention recommendations for all hospitalized patients to prevent catheter-associated urinary tract infections and is not specific to stroke.[94]

The studies reported by Pettersen et al[92] and Myint et al[95] combined multiple recommendations representing "best practice" for bladder management and applied them to a modest-sized population of stroke patients. Their studies showed success but limited generalizability because of study design. It is impossible to ascertain which of the multiple interventions were responsible for the improvements seen.

Cognitive awareness plays a role in continence and ultimately in overall stroke outcome. There are many types and causes of incontinence, ranging from impaired awareness of the need to void to difficulty with mobility in reaching the bathroom to communication difficulties resulting from aphasia.

We were unable to identify any high-quality studies of treatment for fecal incontinence after stroke, and recommendations are based on the general population of adults.[96]

Recommendations: Treatment of Bowel and Bladder Incontinence	Class	Level of Evidence
Assessment of bladder function in acutely hospitalized stroke patients is recommended.		
A history of urological issues before stroke should be obtained.	I	B
Assessment of urinary retention through bladder scanning or intermittent catheterizations after voiding while recording volumes is recommended for patients with urinary incontinence or retention.	I	B
Assessment of cognitive awareness of need to void or having voided is reasonable.	IIa	B
Removal of the Foley catheter (if any) within 24 hours after admission for acute stroke is recommended.	I	B
It is reasonable to use the following treatment interventions to improve bladder incontinence in stroke patients:	IIa	B
Prompted voiding		
Pelvic floor muscle training (after discharge home)		
It may be reasonable to assess prior bowel function in acutely hospitalized stroke patients and include the following:	IIb	C
Stool consistency, frequency, and timing (before stroke)		
Bowel care practices before stroke		

Assessment, Prevention, and Treatment of Hemiplegic Shoulder Pain

Shoulder pain is common after stroke, with an incidence during the first year of 1% to 22%.[97,98] The reported prevalence of shoulder pain varies between 5% and 84%, depending on the acuity and definition of shoulder pain used.[99] The development of shoulder pain after stroke is associated with shoulder subluxation and motor weakness. Importantly, these 2 factors have strong covariance, suggesting that motor impairment may be the more important predictive factor.[100] However, motor weakness is not predictive of pain severity in the hemiplegic shoulder. Spasticity is believed to contribute to the genesis of shoulder pain in some patients, although a causal relationship has not been confirmed. Other predictors of shoulder pain include older age, left hemiplegia, the presence of tactile extinction and reduced proprioception in the painful limb, early complaints of pain, reduced passive shoulder abduction and external rotation of glenohumeral joint, a positive Neer impingement sign (shoulder pain with passive abduction of the internally rotated arm), and tenderness to palpation over the biceps tendon and supraspinatus.[101–105]

Hemiplegic shoulder pain is multifactorial. Pain is associated with shoulder tissue injury, abnormal joint mechanics, and central nociceptive hypersensitivity. About one third of patients with acute stroke have abnormal ultrasound findings in the hemiplegic shoulder when studied at the time of admission to acute inpatient rehabilitation, including effusion in biceps tendon or subacromial bursa; tendinopathy of biceps, supraspinatus, or subscapularis; and rotator cuff tear.[106,107] Such findings are more prevalent in the hemiplegic shoulder than in the nonhemiplegic shoulder and in those with more severe hemiplegia, subluxation, spasticity, limited joint range, and shoulder pain.[106] The frequency of abnormal ultrasound findings in the hemiplegic shoulder increases over the course of rehabilitation in patients with more severe motor impairment.[106,107] Although there is an association between abnormal findings on shoulder ultrasound and hemiplegic shoulder pain in patients with acute stroke, a causal association has not been established. Among patients with acute and chronic stroke with hemiplegic shoulder pain, the presence of shoulder tissue injury on imaging is not associated with the severity of pain.[108,109]

Patients with stroke-related hemiplegia demonstrate altered movement patterns at certain stages of recovery. In the acute phase of stroke, shoulder subluxation is associated with pain. In those with chronic stroke and hemiplegic shoulder pain, there is capsular stiffness and altered resting position of the scapula in lateral rotation.[103,110] Compared with those without voluntary movement, patients with some movement in the painful hemiparetic shoulder have a higher rate of shoulder joint tissue injury on magnetic resonance imaging, suggesting that more physical activity promotes injury.[109] However, the relationship between altered kinematics and pain in the hemiparetic shoulder has not been established. For example, shoulder joint kinematics are altered with spasticity, yet there are no clear correlations between reductions in Ashworth and pain scores or reductions in subluxation and pain.[111] Thus, the exclusive role of peripheral nociceptive pain in the mechanically altered hemiplegic shoulder has been questioned.[112]

There is recent evidence supporting both a peripheral and a central neuropathic role for shoulder pain.[112–114] Patients with hemiplegic shoulder pain have a higher prevalence of altered somatosensory function with reduced sensory thresholds and decreased kinesthesia than patients without pain and normal control subjects.[105,115–117] In addition, patients with shoulder pain have higher rates of allodynia and hyperpathia on both the affected and less affected sides than stroke patients without pain.[116,117] Patients with painful shoulders also have higher heat pain thresholds and lower pain pressure thresholds.[117,118] Soo Hoo and colleagues[118] found lower pain pressure thresholds on the affected and less affected sides in patients with shoulder pain. Somatosensory evoked responses from the affected upper limb differ between stroke patients with and those without shoulder pain.[119] Although diagnostically distinct from hemiplegic shoulder pain, complex regional pain syndrome (also called shoulder-hand syndrome) is characterized by allodynia and hyperpathia and includes shoulder pain as a key component. Thus, there is growing recognition that hemiplegic shoulder pain is a syndrome with biomechanical and central nervous system components and overlaps with complex regional pain syndrome.

Interventions to prevent the onset of and to treat shoulder pain in patients with stroke-related hemiplegia include proper positioning, maintenance of shoulder range of motion, and motor retraining. For people in wheelchairs, lap trays and arm troughs might be useful positioning devices to reduce shoulder pain and subluxation. Some suggest that consistent performance of aggressive passive range-of-motion exercises may reduce or prevent later shoulder problems, but the evidence in support of or against this suggestion is missing. Aggressive range of motion of the complex shoulder joint, if done improperly, could do more harm than good. The use of slings, especially during ambulation training to protect the shoulder from traction injury, may be considered, and the use of overhead pulley exercises should be avoided.[70,120] Research has focused on several adjuvant treatments, including strapping, acupuncture, and neuromuscular electrical stimulation (NMES). There are a few RCTs with mixed results on shoulder strapping for the prevention of shoulder pain after acute stroke.[121–123] Each study used different strapping (or taping) techniques and measured different pain outcomes. In the largest of these, Pandian and others[123] randomized 162 patients with acute stroke to either shoulder taping or sham taping. There was a trend toward a difference in visual analog pain scale and pain-related disability scores over 30 days, but these differences were not statistically or clinically significant. Currently, there is insufficient evidence to support or refute the efficacy of shoulder strapping (taping) for the prevention of hemiplegic shoulder pain.

Acupuncture in combination with standard therapeutic exercise may be a safe and effective adjuvant for the treatment of hemiplegic shoulder pain. This was suggested by Lee and colleagues[124] in a recent systematic review of this topic. They found 7 RCTs, all showing positive effects. However, they could not recommend concrete conclusions because of the limited number of available trials.

Various types of skin surface electrical stimulation have been evaluated for the treatment of hemiplegic shoulder pain, including transcutaneous electrical nerve stimulation (TENS) and NMES. These modalities have not been evaluated sufficiently, and their efficacy for pain prevention and treatment

remains inconclusive.[125] The largest RCT to date testing surface NMES to a hemiplegic shoulder showed no effect on pain prevention in patients with acute stroke; however, pain was not a primary outcome measure in this study.[126] Compliance with the use of surface NMES has been variable in these studies, and surface NMES has been shown to be less well tolerated than intramuscular NMES.[126–128] Intramuscular NMES for 6 h/d over 6 weeks with 4 implanted electrodes showed efficacy in 2 open-label trials.[129,130] Pain differences between treatment and control groups remained significant 12 months after treatment, and NMES was more effective in patients with less chronic stroke (defined as <77 months after stroke in this study).[131,132] Although fully implanted intramuscular stimulators for hemiplegic shoulder have been developed, there are insufficient data to support efficacy to date.[133]

Corticosteroid injection into glenohumeral joint or subacromial space is commonly used to treat shoulder pain. There are limited studies on the use of steroid injection in the painful hemiplegic shoulder. Observational studies have shown a significant reduction in hemiplegic shoulder pain after either glenohumeral or subacromial injection, but the long-term pain reduction has not been verified.[134,135] These injections result in superior short-term pain reduction compared with standard care.[136] There are only 2 randomized trials of shoulder joint injections for pain. Snels and colleagues[137] showed no significant effect on pain reduction after glenohumeral injection. In contrast, Rah and others[138] showed a significant reduction in pain after corticosteroid injection compared with placebo. In the latter study, Rah et al selected only patients with shoulder joint pathology that was verified by ultrasonography.

Botulinum toxin injections into the shoulder musculature have shown mixed results in the management of shoulder pain. de Boer and colleagues[139] showed no impact of botulinum toxin injection into the subscapularis of painful hemiplegic shoulders, whereas Yelnick and colleagues[140] showed significant reductions in pain scores in patients treated for shoulder spasticity. Some investigators have noted reduced pain with shoulder movement after botulinum toxin injections to the pectoralis major and biceps brachii, but others found no change in reported pain scores after pectoralis major injection.[141–143] Lim et al[144] found botulinum toxin injections to the pectoralis major, infraspinatus, and subscapularis muscles superior to glenohumeral steroid injection. Botulinum toxin injections may decrease shoulder spasticity and pain associated with spasticity-related joint mobility restrictions but are not sufficient to reduce shoulder pain in general.

Suprascapular nerve blocks may be effective in reducing shoulder pain through a reduction of both nociceptive and neuropathic pain mechanisms. A recent randomized, clinical trial showed that suprascapular nerve blocks were superior to placebo injections in reducing hemiplegic shoulder pain for up to 12 weeks after treatment.[145,146] In another small, comparison study of patients with nonneuropathic hemiplegic shoulder pain, suprascapular nerve blocks were as effective as glenohumeral triamcinolone injections.[147]

Surgical tenotomy of the pectoralis major, lattisimus dorsi, teres major, and subscapularis muscles may reduce pain in patients with severe hemiplegia and restrictions in shoulder range of motion.[148] In patients with clinical evidence of a central pain component associated with sensory changes, allodynia, and hyperpathia, medication management with neuromodulating medications may be considered.[70,120,149]

Recommendations: Assessment, Prevention, and Treatment of Hemiplegic Shoulder Pain	Class	Level of Evidence
Patient and family education (ie, range of motion, positioning) is recommended for shoulder pain and shoulder care after stroke, particularly before discharge or transitions in care.	I	C
Botulinum toxin injection can be useful to reduce severe hypertonicity in hemiplegic shoulder muscles.	IIa	A
A trial of neuromodulating pain medications is reasonable for patients with hemiplegic shoulder pain who have clinical signs and symptoms of neuropathic pain manifested as sensory change in the shoulder region, allodynia, or hyperpathia.	IIa	A
It is reasonable to consider positioning and use of supportive devices and slings for shoulder subluxation.	IIa	C
A clinical assessment can be useful, including:		
Musculoskeletal evaluation	IIa	C
Evaluation of spasticity	IIa	C
Identification of any subluxation	IIa	C
Testing for regional sensory changes	IIa	C
NMES may be considered (surface or intramuscular) for shoulder pain.	IIb	A
Ultrasound may be considered as a diagnostic tool for shoulder soft tissue injury.	IIb	B
Usefulness of acupuncture as an adjuvant treatment for hemiplegic shoulder pain is of uncertain value.	IIb	B
Usefulness of subacromial or glenohumeral corticosteroid injection for patients with inflammation in these locations is not well established.	IIb	B
Suprascapular nerve block may be considered as an adjunctive treatment for hemiplegic shoulder pain.	IIb	B
Surgical tenotomy of pectoralis major, lattisimus dorsi, teres major, or subscapularis may be considered for patients with severe hemiplegia and restrictions in shoulder range of motion.	IIb	C
The use of overhead pulley exercises is not recommended.	III	C

Central Pain After Stroke

Central poststroke pain is pain that results from a lesion in the somatosensory system rather than from a peripheral nociceptive or psychogenic cause.[150,151] Diagnostic criteria include requirements that the pain occur after stroke, be located in an area of the body that corresponds to the lesion in the central nervous system, and not be accounted for by nociceptive or peripheral neuropathic pain.[100] Central pain is classically associated with thalamic stroke (Dejerine-Roussy syndrome) but can result from a lesion anywhere along the spinothalamic and thalamocortical tracts within the central nervous system.[150] Central pain symptoms are usually described as burning or aching and often include

allodynia associated with touch, cold, or movement.[152–155] Use of diagnostic criteria for central poststroke pain such as those proposed by Klit et al[151] can be helpful. The incidence of central poststroke pain is estimated at 7% to 8%, and it typically begins within a few days after stroke, with the majority of patients becoming symptomatic within the first month.[152,154]

There is limited evidence on the efficacy of proposed treatments for central poststroke pain. Pharmacotherapy combined with therapeutic exercise and psychosocial support is a reasonable approach.[156] Response to treatment is best assessed with standardized serial measurements such as pain diaries, visual analog scales, or pain questionnaires.[157] Pharmacotherapy has relied primarily on antidepressant medications and anticonvulsants. Amitriptyline 75 mg at bedtime has been shown to lower daily pain ratings and to improve global functioning.[158] Lamotrigine can reduce daily pain ratings and cold-induced pain, but only 44% of patients given this medication have a good clinical response.[159] Results for pregabalin have been mixed, with 2 clinical trials finding that daily pain reporting with pregabalin was not significantly better than with placebo.[160,161] Sleep and anxiety were improved with pregabalin, however. Gabapentin has not been well studied for poststroke central pain but has been effective in other forms of neuropathic pain.[162,163] Other options for central pain management include carbamazepine and phenytoin, but their usefulness is not well established.[158,164]

There are few nonpharmacological options for the management of central poststroke pain. TENS was shown to be ineffective in a small trial.[165] Motor cortex stimulation can be given with a surgically implanted dural electrode overlying the motor cortex that is connected to a subcutaneous pulse generator. In several case series, pain reductions of >50% on the visual analog scale were achieved in 50% to 83% of patients, with effectiveness for up to 2 years after implantation.[166–169] However, cortical stimulator implantation is associated with several complications, including infection, hardware failure, postoperative seizures, and long-term epilepsy. Motor cortex stimulation may be an option for intractable central poststroke pain. Deep brain stimulation has conflicting evidence for the management of central pain and currently cannot be recommended.[170,171]

Recommendations: Central Pain After Stroke	Class	Level of Evidence
The diagnosis of central poststroke pain should be based on established diagnostic criteria after other causes of pain have been excluded.	I	C
The choice of pharmacological agent for the treatment of central poststroke pain should be individualized to the patient's needs and response to therapy and any side effects.	I	C
Amitriptyline and lamotrigine are reasonable first-line pharmacological treatments.	IIa	B
Interprofessional pain management is probably useful in conjunction with pharmacotherapy.	IIa	C
Standardized measures may be useful to monitor response to treatment.	IIb	C
Pregabalin, gabapentin, carbamazepine, or phenytoin may be considered as second-line treatments.	IIb	B
TENS has not been established as an effective treatment.	III	B
Motor cortex stimulation might be reasonable for the treatment of intractable central poststroke pain that is not responsive to other treatments in carefully selected patients.	IIb	B
Deep brain stimulation has not been established as an effective treatment.	III	B

Prevention of Falls

A great deal of research literature exists on the epidemiology, risk factors, and development of prevention programs for falls in the general population of older adults.[172] Less information is available for individuals with stroke. Falls and their prevention in individuals with stroke require special considerations.[173] Risk factors, interventions, and prevention programs developed for the community-living older population will not necessarily translate to the population of individuals with stroke. The Balance and Ataxia section provides more discussion.

Up to 70% of individuals with a stroke fall during the first 6 months after discharge from the hospital or rehabilitation facility.[174] Individuals with stroke are also at risk to be repeat fallers and to experience an injury associated with a fall.[175] A larger portion of fractures occurring in individuals with stroke (27%) involve the hip or pelvis compared with <10% of the general population of older adults who fall.[176] The loss of bone mineral density (BMD) associated with stroke may contribute to the higher hip fracture rate for individuals with stroke.[177]

In addition to the physical consequences associated with fractures and related injuries, falls have psychological and social consequences. The impairments in balance, gait, motor control, perception, and vision contribute to a heightened fear of falling in individuals with stroke. Studies indicate that 30% to 80% of individuals with stroke report various levels of fear associated with falling and mobility.[178] Fear of falling can lead to reduced levels of physical activity and deconditioning, creating a cascade that may result in greater declines in physical activity, a decrease in ADLs, a loss of independence, fewer community interactions, social isolation, and depression. Ironically, the reduction in physical activity resulting from fear of falling can itself contribute to an increased risk of falls.[179]

Risk Factors and Assessment

Evaluation of risk factors is widely recognized as the first step in preventing falls. A systematic review[180] of factors contributing independently to falls in the general older population identified previous falls, low muscle strength, impaired gait, poor balance, and use of specific and multiple medications as the strongest risk factors for falls. Research suggests that risk factors in the stroke population are similar overall but with some differences.[173] For example, a history of falls before a stroke does not appear to be as strong a risk factor as it is in the general older population.[173]

The probability of falling also increases with the number of risk factors. Tinetti and others[181] reported that the 1-year risk of falling among the general elderly population increased from a range of 8% to 19% for individuals with no risk factors to >70% for individuals with ≥4 risk factors.

The assessment of risk factors varies across settings and circumstances. For example, a majority of falls for individuals with stroke that occur during hospitalization are associated with transfers and attempting activities without supervision, whereas the majority of falls for individuals with stroke living in the community are associated with walking.[182]

Numerous fall risk assessment tools are available. A recent systematic review[183] identified 8 commonly used fall risk assessment tools with existing reliability and validity. The most commonly used assessment instrument in the 43 prevention studies reviewed was the Morse Fall Scale.[184] The Berg Balance Scale has demonstrated good sensitivity and specificity in predicting falls in individuals with stroke.[185] Several federal and professional associations have developed fall prevention toolkits that include risk assessment instruments and protocols (eg, the National Center of Patient Safety Falls Toolkit, the Centers for Disease Control and Prevention Stopping Elderly Accidents, Deaths and Injuries Toolkit, the AHRQ Preventing Falls in Hospitals–A Toolkit for Improving Quality Care, and the AHRQ Step-Up to Stop Falls Toolkit).

Prevention Programs

The most comprehensive assessment of preventing falls in the general population of older adults is the recent Cochrane database review.[172] The evidence specific for fall prevention in individuals with stroke is limited. A recent randomized trial of a multifactorial falls prevention program for individuals with stroke[186] reported no benefit for this intervention compared with usual care among 156 participants. Tai Chi has been found to be more effective than strength and range-of-movement exercises in a clinical trial.[187] A nonrandomized, small-scale, controlled study found a community-based progressive group exercise program that included walking and strength and balance training for 1 hour 3 times a week for participants with mild to moderate hemiparesis to be safe, feasible, and efficacious in a community setting.[188]

Recommendations: Prevention of Falls	Class	Level of Evidence
It is recommended that individuals with stroke discharged to the community participate in exercise programs with balance training to reduce falls.	I	B
It is recommended that individuals with stroke be provided a formal fall prevention program during hospitalization.	I	A
It is reasonable that individuals with stroke be evaluated for fall risk annually with an established instrument appropriate to the setting.	IIa	B
It is reasonable that individuals with stroke and their caregivers receive information targeted to home and environmental modifications designed to reduce falls.	IIa	B
Tai Chi training may be reasonable for fall prevention.	IIb	B

Seizure Prophylaxis

A new seizure diagnosis after stroke can be classified as early (beginning within the first few days of stroke) or late. A seizure is most likely to arise during the first 24 hours after stroke onset, is usually partial at onset, and has a variable tendency to secondarily generalize. A poststroke seizure is more common with ICH[189] or when the stroke involves cerebral cortex[190]; seizures in patients with lacunar stroke are rare.[191] Estimates of the percentage of patients having a seizure during the first few days after a stroke range from 2% to 23% in various studies, with the true risk toward the lower end of this range.[191,192] A minority of such patients will have a recurrent seizure, and status epilepticus is uncommon.[193]

Estimates for the incidence of a seizure developing late after stroke are even more variable, ranging from 3% to 67%.[192] One study found a 1.5% rate of seizures specifically during inpatient admission for stroke rehabilitation.[194] The probability of a late seizure is higher in patients with preexisting dementia.[195] Seizures with onset within 2 weeks of stroke are usually easy to control medically.[196]

No data are available to guide the utility of prophylactic administration of antiepileptic drugs after stroke, and limited data are available on the efficacy of antiepileptic drugs in the treatment of stroke patients who have experienced a seizure. Any patient who develops a seizure should be treated with standard management approaches, including a search for reversible causes of seizure and any potential antiepileptic drugs. Subclinical seizures can be difficult to detect unless suspected, so the treating physician might consider pursuing this diagnosis in a patient with otherwise unexplained rapidly shifting sensorium or other deficits or transient fluctuations in vital signs.

Prophylactic administration of antiepileptic drugs to prevent a seizure is not recommended for patients with stroke,[192] including patients with ICH.[197] RCTs are also lacking for the prevention or treatment of seizures in patients with subarachnoid hemorrhage.[198] However, prophylactic therapy with antiepileptic drugs is advocated by some on the basis of theoretical concerns such as an association of increased rate of seizures among subgroups of patients with subarachnoid hemorrhage with selected features such as thicker clot or rebleeding.[198]

In all cases, it must be understood that prescribing a new antiepileptic drug carries a significant risk of side effects.[199,200] Furthermore, some data suggest that prophylactic use of antiepileptic drug therapy may be associated with poorer outcome.[199–202] The risk-benefit analysis of antiepileptic drug use after a recent stroke includes an important concern that does not pertain to many neurological settings. Evidence suggests that many of the medicines used to treat seizures, including phenytoin and benzodiazepines, dampen some mechanisms of neural plasticity that contribute to behavioral recovery after stroke.[203–205]

Recommendations: Seizures	Class	Level of Evidence
Any patient who develops a seizure should be treated with standard management approaches, including a search for reversible causes of seizure in addition to potential use of antiepileptic drugs.	I	C
Routine seizure prophylaxis for patients with ischemic or hemorrhagic stroke is not recommended.	III	C

Secondary Stroke Prevention

Stroke shares many risk factors with other forms of cardiovascular disease such as hypertension, smoking, hyperlipidemia, and inactivity.[206] With hospitalization for acute stroke brief, it is particularly important to address the secondary prevention of stroke and other cardiovascular diseases during the postacute rehabilitation phase of care. Readers are directed to the most recent AHA/American Stroke Association (ASA) secondary stroke prevention guideline for further information.[206]

Poststroke Depression, Including Emotional and Behavioral State

In the United States and globally, depression and anxiety are common after stroke and are associated with increased mortality and poor functional outcomes.[207–214] There is evidence that the likelihood of depression increases with stroke severity,[215] but the mechanisms of poststroke depression are incompletely understood. Depression has been reported in up to 33% of stroke survivors compared with 13% of age- and sex-matched control subjects,[216] but reliable estimates of the incidence and prevalence of depression in a stroke cohort are limited.[217] Predictors of poststroke depression include a history of depression, severe disability, cognitive impairment, previous stroke, a positive family history of psychiatric disorder, and female sex.[216–220] As poststroke psychosocial issues are studied, greater understanding of the complexity of the problem is obtained. For example, Vickery et al[214] analyzed how the stability of self-esteem plays a role in the rate of depressive symptoms. The depression and emotionalism section of the 2005 stroke rehabilitation clinical practice guidelines does an excellent job of describing the incidence of poststroke depression and pseudo-bulbar affect.[149] What is clear from the literature is that these issues are real and warrant assessment and treatment as early as possible and on an ongoing basis. The section on poststroke depression in the AHA/ASA "Palliative and End-of-Life Care in Stroke"[221] scientific statement gives highlights of prevention, assessment, and treatment. Here, we highlight how poststroke depression affects stroke rehabilitation and recovery and, vice versa, how rehabilitation and exercise affect depression.

Although data are inconclusive as to whether improvement of poststroke depression is independently associated with functional improvement,[222] depression can negatively affect a patient's ability to actively participate in rehabilitation therapies.[223] It is important to address symptoms early in the rehabilitation process, especially given the recent trend for less time in rehabilitation. Depression frequently coexists with other psychiatric symptoms. Anxiety in particular is found to coexist with depression in the poststroke patient population but frequently goes undiagnosed.[224] Anxiety can create uncomfortable or disabling feelings of worry/fear accompanied by physical symptoms that make participation in therapy more difficult. Shimoda and Robinson[225] reported that generalized anxiety disorder accompanied by poststroke depression delayed recovery from depression, delayed ADL recovery, and reduced overall social functioning. Unfortunately, few studies have been conducted to address the treatment of and recovery from poststroke generalized anxiety disorder.[226] Anxiety symptoms in poststroke patients should be assessed and treated, particularly in those patients with a diagnosed depressive disorder. Any patient diagnosed with 1 form of mood disorder should be assessed for others.

A review of intervention trials for treatment of poststroke depression yielded no evidence of benefits of psychotherapy in treating depression after stroke.[227] de Man-van Ginkel et al[228] identified additional nursing practices that had a positive impact on reducing depression symptoms, including life review therapy, motivational interviewing, nursing support programs, and physical exercise.

Rehabilitation, Exercise, and Recovery

A study with 49 depressed patients (24 treated for depression and 25 not treated as determined by physician preference) was conducted to evaluate the effects of poststroke depression and antidepressant therapy on the improvement of motor scores and disability.[229] Poststroke depression was found to have negative effects on functional recovery, and the pharmacological treatment of depression was found to counterbalance this effect. Similarly, a study with 55 patients with poststroke major or minor depression found that remission of poststroke depression over the first few months after stroke is associated with greater recovery of ADL function than continued depression.[230] Early effective treatment of depression may have a positive effect on the rehabilitation outcome. No larger-scale studies following up on this line of research were found.

Physical exercise may provide a complementary treatment for depression. Exercise may affect depressive symptoms through a number of mechanisms. For example, the hypothalamic-pituitary-adrenal axis may be dysregulated in depression, resulting in elevated cortisol levels. Exercise can improve regulation of hypothalamic-pituitary-adrenal responses.[231] Depression also has direct and indirect consequences on immune function,[232] and regular exercise may serve as a nonpharmacological stimulus for enhancing immune function.[233] Furthermore, social contact through group exercise may be beneficial for individuals with depression.

Meta-analyses in adults with depression (but without stroke) have shown positive effects of exercise on depressive symptoms. A Cochrane review reported a large clinical effect with a standardized mean difference of −0.82 of physical exercise on depressive symptoms.[234] A systematic review suggested that physical exercise was effective in treating depression, especially in individuals with high baseline levels of depression.[235]

In a meta-analysis of 13 studies (n=1022 patients), Eng and Reime[236] found that depressive symptoms after stroke were lower immediately after ≥4 weeks of exercise (standardized mean difference=−0.13 [95% CI, −0.26 to −0.01]). Exercise appeared to have a small beneficial effect on depressive symptoms across both the subacute and chronic stages of stroke recovery, but these effects were not retained after the exercise was terminated. Saunders et al[237] reviewed

8 exercise studies that included a depression outcome in a stroke population and meta-analyzed 3 of these studies. They concluded that the results were inconsistent among the trials. A major criticism is that the majority of the stroke studies used depressive symptoms as a secondary outcome, and as a result, the levels of depressive symptoms varied widely in these studies. Given the strong evidence in nonstroke populations with depression, coupled with the preliminary evidence in stroke populations, exercise may be useful as a potential treatment to reduce depressive symptoms in individuals with stroke.

Depression and other psychological disorders, specifically anxiety, can occur at any time after stroke. Healthcare providers should evaluate these issues during poststroke follow-up visits. One study compared different diagnostic tools to determine whether one was superior over another. Bergersen et al[238] reported that patients and their caregivers fail to discuss psychosocial issues or symptomology with their providers. There are cultural differences in reporting psychosocial issues, resulting in part from perceived cultural morays discouraging personal feelings.[209] Varying poststroke assessments on the basis of cultural background is an important consideration specifically in poststroke depression. Nonpharmacological treatment options can provide some successful outcomes. Unfortunately, there are no well-designed RCTs in which various treatment interventions are compared to determine superiority. Because of the complexity of the psychosocial diseases and limited understanding, a number of treatment options should be tried to determine patient-specific effectiveness. This supports the need for ongoing monitoring after treatment.

Medication

Poststroke depression is treatable with a variety of antidepressant medications, with selective serotonin reuptake inhibitors (SSRIs) and tricyclic antidepressants being the most widely studied.[223,239] Treatment with heterocyclic antidepressant medications and SSRIs appears to be a viable option for poststroke depression, but their absolute or relative efficacy has yet to be fully established.[240] In 1 study of 870 veterans with poststroke depression, poststroke SSRI treatment was associated with longer survival. The authors concluded that after a stroke, SSRI initiation or resumption of treatment should be considered as part of a medication therapy management service, especially if the patient has a history of depression or was taking an SSRI before the stroke.[241] A 2008 Cochrane review analyzing data for 13 pharmaceutical agents, including tricyclic antidepressants, SSRIs, and monoamine oxidase inhibitors, found some benefit of pharmacotherapy in terms of a complete remission of depression and improvement in scores on depression rating scales, but there was also an associated increase in adverse events.[227] The analyses were complicated by a lack of standardized diagnostic and outcome criteria and differing analytic methods. To the best of our knowledge, there have been no studies on the effectiveness of a combined drug intervention (eg, SSRIs) and rehabilitation intervention on recovery outcomes after stroke.

Recommendations: Poststroke Depression, Including Emotional and Behavioral State	Class	Level of Evidence
Administration of a structured depression inventory such as the Patient Health Questionnaire-2 is recommended to routinely screen for poststroke depression.	I	B
Patient education about stroke is recommended. Patients should be provided with information, advice, and the opportunity to talk about the impact of the illness on their lives.	I	B
Patients diagnosed with poststroke depression should be treated with antidepressants in the absence of contraindications and closely monitored to verify effectiveness.	I	B
A therapeutic trial of an SSRI or dextromethorphan/quinidine is reasonable for patients with emotional lability or pseudobulbar affect causing emotional distress.	IIa	A
Periodic reassessment of depression, anxiety, and other psychiatric symptoms may be useful in the care of stroke survivors.	IIa	B
Consultation by a qualified psychiatrist or psychologist for stroke survivors with mood disorders causing persistent distress or worsening disability can be useful.	IIa	C
The usefulness of routine use of prophylactic antidepressant medications is unclear.	IIb	A
Combining pharmacological and nonpharmacological treatments of poststroke depression may be considered.	IIb	A
The efficacy of individual psychotherapy alone in the treatment of poststroke depression is unclear.	IIb	B
Patient education, counseling, and social support may be considered as components of treatment for poststroke depression.	IIb	B
An exercise program of at least 4 weeks duration may be considered as a complementary treatment for poststroke depression.	IIb	B
Early effective treatment of depression may have a positive effect on the rehabilitation outcome.	IIb	B
No recommendation for the use of any particular class of antidepressants is made. SSRIs are commonly used and generally well tolerated in this patient population.	III	A

Poststroke Osteoporosis

BMD and lean tissue mass commonly decline after stroke.[242–244] Although declines in BMD and lean tissue mass can occur in both limbs, changes on the paretic side are more profound. BMD can decrease by >10% in <1 year in the paretic lower limb.[242] Moreover, the decline in BMD, coupled with balance deficits resulting from stroke, increases fracture risk.[245] Changes in BMD after stroke are correlated with functional deficits in the paretic limb(s). Jørgensen et al[246] assessed 40 patients at 6 days, 7 months, and 1 year after stroke. Seventeen patients were

initially nonambulatory, and 23 were ambulatory. Ambulatory status was predictive of changes in BMD 1 year after stroke. The nonambulatory patients had a 10% reduction in BMD in the paretic lower limb compared with a 3% reduction in BMD in ambulatory patients. Moreover, among the 17 patients who were initially nonambulatory, 12 regained walking ability with assistance 2 months after stroke. Those patients who regained ambulation ability had an 8% reduction in BMD in the paretic lower limb compared with a 13% reduction in those who remained nonambulatory. Pang et al[247] found that femur BMD and lean mass were significantly lower and fat mass was significantly higher on the paretic side compared with the nonparetic side in ambulatory men and women who suffered a stroke >1 year earlier. However, the degree to which BMD was preserved in the paretic lower extremity was significantly correlated with 6-minute walk test distance, peak oxygen consumption ($\dot{V}o_2$), and handheld dynamometry. Multiple regression analysis revealed that peak $\dot{V}o_2$ was a significant predictor of paretic limb BMD and lean tissue mass. Paretic upper limbs also demonstrate significant declines in BMD and lean mass after stroke. The decline in BMD and lean mass is associated with paretic upper limb strength assessed by handheld dynamometry.[248]

The US Preventive Services Task Force[249] recommends osteoporosis screening in all women ≥65 years of age; women <65 years of age whose fracture risk is greater than or equal to that of older white women with no additional risk factors should also undergo osteoporosis screening. The US Preventive Services Task Force concludes that there is inconclusive evidence to make any osteoporosis screening recommendations for men. Individuals with stroke have an increased risk for osteoporosis, particularly on the paretic side.[250] The risk of fracture is also increased in patients with stroke.[251] In men with stroke, although osteoporosis and fracture risks are higher, no clear guidance on screening can be provided at this time.[252] The current US Preventive Services Task Force recommendations are appropriate in the stroke population.

Limited research indicates that increased levels of physical activity such as ambulation and resistance training attenuate the decline in, maintain, or increase BMD and lean tissue mass after stroke.[245,246,253–257]

Recommendations: Poststroke Osteoporosis	Class	Level of Evidence
It is recommended that individuals with stroke residing in long-term care facilities be evaluated for calcium and vitamin D supplementation.	I	A
It is recommended that US Preventive Services Task Force osteoporosis screening recommendations be followed in women with stroke.	I	B
Increased levels of physical activity are probably indicated to reduce the risk and severity of poststroke osteoporosis.	IIa	B

Assessment

Level of Disability

Stroke can affect numerous aspects of neural function and structure. Clinically, this most often manifests as weakness, with other common impairments being aphasia, neglect, visual field deficit, cognitive changes such as executive dysfunction or memory loss, major depression, sensory deficits, dysarthria, and problems with coordination.[11,258,259]

Measures of body function tend to be more objective, easier to define, and easier to measure compared with other levels of the World Health Organization's *ICF* but may have less relevance to a patient's function and independence. Limited correlation exists across *ICF* dimensions.[11,260] The reason is that numerous factors have a greater influence on outcome as one moves from body function/structure to activity limitations, participation restrictions, and quality of life.[261] During acute stroke management, the focus tends to be more on measures of body function, whereas toward the more chronic phases, the emphasis shifts to activities and participation.[11] Regardless of *ICF* dimension, formal standardized and validated measures should be used to the extent possible.

Many methods are available to measure loss of body function/structure. Chief among these is the physical examination. Many scales have been devised.[262] Some are global scales that aim to capture all major deficits and to combine the assessment into a single score, whereas others are modality specific. In the United States, the most widely used global assessment of impairment is the National Institutes of Health Stroke Scale, which ranges from 0 to 42, with higher scores indicating more severe loss of body function/structure. Training and formal certification on National Institutes of Health Stroke Scale scoring are widely available, increasing the precision of this measure and permitting the use of this tool by a variety of disciplines. The National Institutes of Health Stroke Scale is a good predictor of short-term and long-term morbidity and mortality[263] and has been found to be sensitive to change in numerous studies. Limitations of the National Institutes of Health Stroke Scale include low granularity for defining differences in level of impairment and insensitivity to many common poststroke deficits such as depression, hand-motor deficits, swallowing, or memory loss.

Many modality-specific measures have been constructed for measuring loss of body function/structure across the many brain neural systems. Common examples include the upper limb motor section of the Fugl-Meyer scale or the Box and Block Test for measuring arm motor deficits; the leg motor section of the Fugl-Meyer scale or gait velocity for measuring leg motor deficits; the Western Aphasia Battery or the Boston Naming Test for language deficits; the Behavioral Inattention Test or The Line Cancellation test for measuring neglect; the Nottingham Sensory Assessment or the sensory section of the Fugl-Meyer scale for measuring somatosensory deficits; the Hamilton Depression Scale or the Beck Depression Inventory II for measuring severity of depression symptoms; and the Mini-Mental Status Exam or Trail Making Tests (A and B) for cognitive deficits. More complete lists of such tests have been compiled.[11,258] In addition, the National Institute of Neurological Disorders and Stroke has compiled a set of common data elements for each dimension of the *ICF*,[3] including the 3 major dimensions of body structures/body functions (impairments), activities (activity limitations), and participation (participation restrictions).

Some scales focus on measures that require specific equipment such as a dynamometer for measuring hand grip strength, various perimetry devices (eg, Humphrey or octopus) for measuring visual field loss, an electric goniometer for measuring

range of motion, or von Frey filaments for measuring tactile sensory deficits. Robotic devices are receiving increasing attention for their ability to quantify loss of body function/structure,[264] in some cases generating data that cannot be obtained by a human examiner.[265] Telemedicine may be used by examiners in remote locations to measure level of disability.[266]

The assessment of body function/structure in a patient recovering from stroke may be performed to predict outcome, to monitor recovery, to monitor response to a new therapy, to guide new treatment decisions, to document clinical status as part of reimbursement, to inform patient stratification such as in selecting postdischarge setting, in the context of a clinical trial, as part of stroke center or rehabilitation ward certification requirements, or in compliance with a stroke care plan protocol. Valid reliable measures have been defined for each of these purposes. Similar considerations apply to choosing the frequency with which impairments are measured.

Assessing Overall Rehabilitation Needs

After acute hospital admission for stroke, patients should have comprehensive assessments of body structures and function, activity limitations, and participation restrictions according to the *ICF*.[11,267,268] These assessments can be performed concurrently with diagnostic testing as soon as 24 hours after admission, as the patient's medical stability allows. Evaluation of a stroke survivor's rehabilitation needs is best performed by an interprofessional team that can include a physician with expertise in rehabilitation, nurses, physical therapists, occupational therapists, speech/language therapists, psychologists, and orthotists.[4,149,258] Prvu Bettger and colleagues[12] noted that among acute hospitals participating in the AHA's Get With The Guidelines program, 90% of patients have an assessment for postacute rehabilitation services documented, but little information is available about the nature or reliability of these assessments. If clinically indicated, appropriate postacute rehabilitation settings include outpatient rehabilitation or day rehabilitation programs, skilled nursing–level rehabilitation, long-term acute care hospitals, and acute rehabilitation hospitals.

Selection of the most appropriate level of care requires consideration of many factors, including the severity of residual neurological deficits, resulting activity limitations, cognitive and communicative ability, psychological status, swallowing ability, premorbid functional ability, medical comorbidities, level of family/caregiver support, likelihood of returning to community living, and ability to participate in a rehabilitation program.[70,269,270] Certain factors such as older age, impaired cognition, lower functional level after stroke, and urinary incontinence are predictors of the need for inpatient rehabilitation care.[54,271] The presence of neglect syndrome can predict a longer rehabilitation stay and lower functional status at discharge.[272] Among patients with less neurological impairment, assessment of balance ability with standardized measures such as the Berg Balance Scale or the Postural Assessment Scale for Stroke can help determine the risk of fall and need for inpatient rehabilitation rather than discharge home with outpatient services[273–275] (The Prevention of Falls section provides more information). For patients who can walk, assessment of gait speed with the 10-m walk test can help determine functional ambulatory ability.[276,277] Risk of fall with ambulation is important for counseling patient and family on safety.

A comprehensive determination of functional abilities appears to be useful before acute hospital discharge with standardized assessments such as the Barthel Index or the Functional Independence Measure (FIM). Both the Barthel Index and the FIM are strong predictors of discharge functional status, discharge destination after inpatient rehabilitation, and length of rehabilitation stay.[278–281] The FIM is the most commonly used functional measure in the United States because it is tied to the prospective payment system of the Centers for Medicare & Medicaid Services.

There currently is no single functional assessment with measurement properties that is used throughout the entire clinical course of stroke care (acute hospital, inpatient rehabilitation, and outpatient care) for tracking stroke rehabilitation outcome. A computerized questionnaire called the Activity Measure for Post-Acute Care is not specific to stroke but has demonstrated feasibility as such a tool in stroke populations.[282] Although it requires cognitive and language ability to complete, proxy responses to the Activity Measure for Post-Acute Care are well correlated with patient responses.[283] Thus, the Activity Measure for Post-Acute Care may prove to be a suitable longitudinal outcome measure for stroke patients, including those with cognitive deficits and aphasia.

ADLs, IADLs, and Disability Measurement

The term ADLs typically refers to routine self-care tasks that people perform as part of their everyday life.[284] ADLs are generally subdivided into those associated with personal self-care and fundamental mobility, often referred to as basic ADLs, and tasks involving more complex domestic, community, and leisure activities, referred to as IADLs.[285]

An evidence-based consensus conference on improving measurement of disability sponsored by the AHRQ concluded that a single consensus definition of disability is not feasible or desirable.[286] The AHRQ report contends that the meaning of disability is dependent on context and the purpose for which the definition will be used. The *ICF* uses disability as a generic term that includes aspects of body functions and structure, activity, and participation within the context of the environment and personal/social factors.[3,287] The recommendations below for ADLs, IADLs, and disability are based on the conceptual approach to disability endorsed by the World Health Organization.[3]

In the 2005 stroke rehabilitation clinical practice guidelines, there were 2 recommendations on the assessment of function. The first was that a standardized assessment tool be used to evaluate functional status in individuals with stroke. The second recommendation was to consider using the FIM as the standardized assessment for function in individuals with stroke.[149]

Over the past decade, there has been substantial progress in 2 general areas pertaining to measurement of function and disability, including ADLs and IADLs. The first is more sophisticated methodological approaches to assessment, specifically the development of methods based on item response theory and computer-adapted testing.[288] The second is the recent attention to patient-centered and patient-reported outcome measures. The emphasis on patient-centered and patient-reported measures is related to healthcare reform and the implementation of the Patient Protection and Affordable Care Act.[289]

New tools for assessment include the Patient-Reported Outcomes Measurement Information System[290] and the NIH Toolbox.[291] Both the Patient-Reported Outcomes Measurement Information System and the NIH Toolbox are designed to help clinicians and healthcare consumers by providing a common platform based on procedures and metrics that will generate outcomes comparable across large populations, including individuals with stroke.

The largest and most comprehensive source of evidence-based reviews and reports focused on stroke rehabilitation is available from the Evidence-Based Review of Stroke Rehabilitation (EBRSR) program supported by the Canadian Stroke Network.[270,292] Information and the evidence-based reports from EBRSR are available online.[292a]

Specific to the assessment of ADLs and IADLs (disability), the EBRSR has produced an evidence-based report titled "Outcome Measures in Stroke Rehabilitation."[292b] All reviewed assessments are classified according to the World Health Organization's *ICF* conceptual framework. The frequently used modified Rankin Scale is included within the Activity/Disability Outcome Measures section. With the use of the *ICF*, each assessment is categorized as providing information at the level of body functions and structure, activities, or participation. All assessment instruments in the EBRSR report are evaluated with 8 criteria. The criteria were derived from a comprehensive review of 413 articles on measurement methodology by the Health Technology Assessment Program.[293] The criteria include operationally defined ratings for appropriateness, reliability, validity, responsiveness, precision, interpretability, acceptability, and feasibility. Appendix 2 includes measures reviewed in the EBRSR report as of November 2012.

Assessment Challenges

The instruments included in Appendix 2 and the evidence-based reviews in the EBRSR are based on traditional measurement models. As noted above, new assessments are being developed with the use of item response theory and computer-adapted testing. These assessments are difficult to evaluate with the traditional criteria such as validity and reliability normally used in evidence-based reviews. For example, Hsueh and colleagues[329] reported the development of a computer-adapted test for evaluating ADLs in individuals with stroke referred to as the ADL-CAT (computer-adapted test). The authors report the ADL-CAT produced scores that were highly correlated with traditional ADL measures such as the Barthel Index but could be completed in one-fifth the time required to administer the Barthel Index.[329] New or refined criteria consistent with advances in measurement approaches need to be developed and incorporated into existing levels of evidence hierarchies to accommodate the evaluation and evidence-based reviews of assessments.

Another challenge in establishing functional assessment guidelines is how to incorporate the growing emphasis on patient reported and patient-centered measures within the assessment of ADLs, IADLs, and other disability measures. The solution to this challenge extends beyond simply asking patients or consumers to respond to traditional ADL questions such as "Can you put on an article of clothing?" Rather, it requires patients and other stakeholders to be active partners in the assessment process and to help identify the items and outcomes that should be measured. Until computer-adapted tests (eg, ADL-CAT) for ADLs and IADLs become routine in practice, a combination of assessments such as a basic ADL measure (eg, the 10-item Barthel Index)[330] or the FIM and an IADL measure (eg, the 15-item Frenchay Activity Index)[331] is recommended to capture the broad spectrum of ADL function. Recently, a Rasch analysis was used to validate a combined measure of basic and extended daily life functioning after stroke.[332] Even those recovering from mild stroke or transient ischemic attack (eg, those scoring 100 on the Barthel Index) continue to demonstrate deficits in health status. Although basic ADL measures may not be sufficiently sensitive to change among the least impaired stroke survivors, the IADL assessment tool will likely be more sensitive to these more subtle deficits at discharge and provide useful information for discharge planning.

Recommendations: Assessment of Disability and Rehabilitation Needs	Class	Level of Evidence
It is recommended that all individuals with stroke be provided a formal assessment of their ADLs and IADLs, communication abilities, and functional mobility before discharge from acute care hospitalization and the findings be incorporated into the care transition and the discharge planning process.	I	B
It is recommended that all individuals with stroke discharged to independent community living from postacute rehabilitation or SNFs receive ADL and IADL assessment directly related to their discharge living setting.	I	B
A functional assessment by a clinician with expertise in rehabilitation is recommended for patients with an acute stroke with residual functional deficits.	I	C
Determination of postacute rehabilitation needs should be based on assessments of residual neurological deficits; activity limitations; cognitive, communicative, and psychological status; swallowing ability; determination of previous functional ability and medical comorbidities; level of family/caregiver support; capacity of family/caregiver to meet the care needs of the stroke survivor; likelihood of returning to community living; and ability to participate in rehabilitation.	I	C
It is reasonable that individuals with stroke discharged from acute and postacute hospitals/centers receive formal follow-up on their ADL and IADL status, communication abilities, and functional mobility within 30 days of discharge.	IIa	B
The routine administration of standardized measures can be useful to document the severity of stroke and resulting disability, starting in the acute phase and progressing over the course of recovery and rehabilitation.	IIa	C
A standardized measure of balance and gait speed (for those who can walk) may be considered for planning postacute rehabilitation care and for safety counseling with the patient and family.	IIb	B

Assessment of Motor Impairment, Activity, and Mobility

Motor impairments are common after stroke and occur when the stroke lesion includes the corticospinal system, that is, the motor cortical areas and the corticospinal tract.[333] Indeed, the

extent of damage to the corticospinal system is predictive of motor outcomes and response to treatment.[334–336] Assessment of motor impairments enables the clinician to understand which aspects of movement and motor control are disrupted after stroke. Assessment of activity such as upper extremity function, balance, and mobility is used to quantify the functional consequences of the motor impairments. Accurate assessment provides prognostic information[337–341] and guides the selection of motor interventions and the tailoring of these interventions to each individual.[294]

Assessment of motor impairments and activity is critical for delivering efficient, high-quality rehabilitation services to individuals with stroke. Assessment results are used to determine who needs further services, what types of services are required, what is the most appropriate setting for those services, which interventions to select, how to tailor the interventions to individual patients, and whether the rehabilitation services are achieving the desired outcomes.[342–344] When standardized assessments are implemented within and across facilities, measures that are familiar and clinician friendly and meet the clinical needs of the service are generally implemented most easily.[345–347]

Technology to objectively measure real-world activity has been emerging over the past decades. Alternatively, clinicians have relied on self-report measures to gain insight into what a person is doing in daily life. The assumption that clinic performance is equivalent to outside-of-clinic performance may not be true.[321] Whereas patient-reported outcomes allow a more patient-centered approach, some self-report measures are prone to reporting biases.[348,349] Commercially available devices to measure movement when people are outside the rehabilitation clinic are now readily available and becoming more user friendly. These devices include wrist-worn accelerometers,[294,326] ankle-worn accelerometers,[325] step-activity monitors,[328,350] and the more economical alternative, pedometers.[327] Recording movements allow the clinician to measure the quantity and sometimes the types of movements occurring in everyday life.

Recommendations: Assessment of Motor Impairment, Activity, and Mobility	Class	Level of Evidence
Motor impairment assessments (paresis/muscle strength, tone, individuated finger movements, coordination) with standardized tools may be useful.	IIb	C
Upper extremity activity/function assessment with a standardized tool may be useful.	IIb	C
Balance assessment with a standardized tool may be useful.	IIb	C
Mobility assessment with a standardized tool may be useful.	IIb	C
The use of standardized questionnaires to assess stroke survivor perception of motor impairments, activity limitations, and participation may be considered.	IIb	C
The use of technology (accelerometers, step-activity monitors, pedometers) as an objective means of assessing real-world activity and participation may be considered.	IIb	C
Periodic assessments with the same standardized tools to document progress in rehabilitation may be useful.	IIb	C

Assessment of Communication Impairment

Communication is a vital aspect of daily functioning, and stroke frequently results in communication impairment. One million people in the United States are estimated to have aphasia, commonly as a result of stroke.[351] Communication impairment can negatively affect participation in life activities immediately after the stroke and can result in long-term deficits. It is important to identify problems early with a thorough and holistic assessment. It is equally important to identify strengths and compensatory strategies that can enable the patient to maximize independence and to reenter life activities with as much competency and confidence as possible.

In recent years, more attention has been given to incorporating the *ICF* framework and principles into the assessment of communication. Communication is required for most daily activities, so everyday life can be significantly affected by impairment. In previous years, assessment focused on disability; now attention is focused on maximizing quality of life and participating in daily activities. Additionally, caregivers are increasingly included in the evaluation process because their skill and attitude have a significant impact on creating successful communication exchanges.

Telerehabilitation is becoming an accepted alternative to face-to-face communication assessment for people with communication impairment; however, telerehabilitation requires adequate technology. Multiple studies have demonstrated that telepractice for communication assessment is feasible and effective.[352–354]

Recommendations: Assessment of Communication Impairment	Class	Level of Evidence
Communication assessment should consist of interview, conversation, observation, standardized tests, or nonstandardized items; assess speech, language, cognitive-communication, pragmatics, reading, and writing; identify communicative strengths and weaknesses; and identify helpful compensatory strategies.	I	B
Telerehabilitation is reasonable when face-to-face assessment is impossible or impractical.	IIa	A
Communication assessment may consider the individual's unique priorities using the *ICF* framework, including quality of life.	IIb	C

Assessment of Cognition and Memory

Cognitive impairment is found in a substantial portion of stroke survivors, affecting more than one third of stroke survivors at 3 and 12 months after stroke.[355] These impairments persist in many individuals for years[356,357] and are associated with poor long-term survival, higher disability, and greater institutionalization rates. Tatemichi et al[358] found that the RR for dependent living associated with cognitive impairment was 2.4 at 3 months after stroke after adjustment for age and physical impairment. Another study found the RR of death associated with dementia 5 years after stroke was 3.11 (95% CI, 1.79–5.41) after adjustment for the effects of demographic factors, cardiac disease, severity of stroke, stroke type, and recurrent stroke.[359] The cognitive domains most likely to be defective in patients with stroke compared with

control subjects were memory, orientation, language, and attention. Because physical and cognitive impairments after stroke have independent prognostic implications, evaluation of both domains should be routine in the clinical care of stroke patients. Prospective studies have shown that cognitive status is an important determinant of poststroke success. The Neurobehavioral Cognitive Status Examination is a brief screening tool that assesses cognition in the ability areas of language, constructions, memory, calculation, and reasoning. A small prospective study found that the Neurobehavioral Cognitive Status Examination both provides a rapid and sensitive measure of cognitive function and appears to predict functional status change as a result of inpatient stroke rehabilitation.[360] A formal neuropsychological examination (including assessment of language, neglect, praxis, memory, emotional responses, and specific cognitive syndromes) may be helpful after the detection of cognitive impairment with a screening instrument. Neuropsychological protocols must be sensitive to a wide range of abilities, especially the assessment of executive and attentional functions. Brief mental status scales inadequately assess executive skills and other higher-level cognitive functions. Specific areas that should be included in this type of assessment include the following:

- Processing speed
- Simple attention and complex attention ("working memory")
- Receptive, expressive, and repetition language abilities
- Praxis (performing skilled actions such as using a tool)
- Perceptual and constructional visual-spatial abilities, including issues related to visual fields and neglect
- Memory, including language-based memory and visual-spatial memory, and differentiating learning, recall, recognition, and forced-choice memory
- Executive functioning, including awareness of strengths and weaknesses, organization and prioritization of tasks, task maintenance and switching, reasoning and problem solving, error awareness and safety judgment, and emotional regulation

Recommendations: Assessment of Cognition and Memory	Class	Level of Evidence
Screening for cognitive deficits is recommended for all stroke patients before discharge home.	I	B
When screening reveals cognitive deficits, a more detailed neuropsychological evaluation to identify areas of cognitive strength and weakness may be beneficial.	IIa	C

Sensory Impairments, Including Touch, Vision and Hearing

Stroke may result in a variety of different types of sensory impairment such as loss of vision, touch, proprioception, hearing, and others. Sensory impairments are often assessed through physical examination, although methods exist for more precise measurement of certain sensory deficits such as automated perimetry for visual field loss or audiometry for hearing loss. Although these are not routinely used, such testing may be useful when a detailed understanding of sensory impairment is needed.

Various forms of sensory deficit are commonly seen after stroke. For example, somatosensory deficits are present in 45%[259] to 80%[362] of patients, and visual field loss occurs in roughly 30%[363] (estimates range from 15%[259]–52%[364]) of patients. The high degree of connectivity[365] in the human brain not only results in loss of function directly in the affected sensory modality but also affects complex behaviors that require distributed multimodal processing such as fine motor control.[362,366] As a result, sensory impairments are directly linked to activity limitations and participation restrictions after stroke[367] and can improve with therapeutic intervention,[368] particularly those based on multimodal interventions such as virtual reality[369] and augmented reality.[370]

Somatosensory Impairments

Somatosensory impairments include tactile, pain, temperature, pressure, vibration, proprioception, stereognosis, and graphesthesia. Tactile deficits may be the most common form of sensory deficit after stroke.[367] In the months after a stroke, patients show substantial but variable somatosensory recovery, especially for proprioception.[371] Studies of experimental stroke in primates[372,373] and rats[374] describe the neurobiological basis of sensory recovery after stroke, with overall similar findings in human subjects scanned with functional magnetic resonance imaging.[375,376] Assessment of sensory deficits remains largely a matter of bedside examination[377]; however, sensory scales are under study,[378,379] and new devices can quantify deficits.[380,381]

Visual Impairments

The most common visual impairment after stroke is visual field loss, affecting ≈30% of stroke survivors.[363] Vision plays a central role in many human functions, so a reduction in vision can affect many roles, quality of life, motivation, and social behaviors.[382] Although assessment of visual field loss is most often obtained with confrontation methods at the bedside, automated perimetry methods are more sensitive and precise and thus may be preferred in settings where such clarity is deemed important such as evaluation for driving.[364] Some degree of spontaneous restoration of visual fields generally occurs after stroke. However, the percentage of patients who achieve significant recovery is uncertain, with estimates ranging from 7% to 85%,[383] and the degree of recovery is variable.[364] As with many features of spontaneous behavioral recovery after stroke, gains are highest early after the injury, with the maximum period of spontaneous recovery of visual fields being reported to be in the first 2 to 10 days,[384] the first month,[385] or the first 3 months.[363] Numerous other forms of visual impairment may be seen after stroke such as abnormal eye movements, reduced visual acuity, diplopia, impaired color vision, difficulty with reading, and deficits in higher-order visual processing.

Hearing Impairments

Stroke can also result in acute hearing loss. This may be present in as many as 21% of patients with posterior circulation ischemia,[386] often resulting from ischemia in the distribution of the anterior inferior cerebellar artery, and in most cases is attributable to infarction in the inner ear. As a result, stroke-related hearing loss is usually accompanied by vertigo and often with additional deficits related to brainstem/cerebellar infarction.[387] Audiometry

is more sensitive than bedside assessment of hearing loss. Neurootologic testing may provide insights by characterizing and measuring associated forms of vestibular dysfunction. Most patients show partial or complete recovery by 1 year after stroke.[388]

Recommendation: Sensory Impairments, Including Touch, Vision, and Hearing	Class	Level of Evidence
Evaluation of stroke patients for sensory impairments, including touch, vision, and hearing, is probably indicated.	IIa	B

Sensorimotor Impairments and Activities

Dysphagia Screening, Management, and Nutritional Support

Dysphagia is common after stroke, affecting 42% to 67% of patients within 3 days after stroke. Of these patients, about half aspirate, and one third of those patients develop pneumonia.[389] Dysphagia or aspiration can lead to pneumonia, malnutrition, dehydration, weight loss, and overall decreased quality of life. Aspiration may be "silent" or "occult" and not clinically obvious. Early identification through screening can reduce the risk of developing these adverse health consequences.[389] Additionally, observational studies suggest that dysphagia screening reduces the risk of pneumonia.[390]

A systematic review of 8 studies demonstrated that the odds of being malnourished were increased if dysphagia was present after stroke.[391] Despite the potential consequences of dysphagia, a review of nursing nutritional care concluded that a functional, supportive, and educational nursing nutritional role was essential, but little evidence was of sufficient quality to support policy and practice development or to inform education.[392]

In 2012, a group of dysphagia experts came to the consensus that early dysphagia screening should be conducted and that although no one screening tool can be recommended, a valid tool should be used.[393] Additional systematic reviews and studies also support early screening for dysphagia. However, because dysphagia screening has not been well standardized and its utility has not been established rigorously in RCTs, it has been removed from The Joint Commission performance standards and from Get With The Guidelines–Stroke performance measures. Nonetheless, it remains an important component of clinical care. Therefore, we include the same recommendation that appears in the most recent "Guidelines for the Early Management of Patients With Acute Ischemic Stroke."[394]

Once dysphagia or aspiration risk has been identified, a clinical bedside evaluation can provide valuable diagnostic information about the swallow mechanism and how to proceed with managing the patient. However, a bedside evaluation alone cannot predict the presence or absence of aspiration because patients can aspirate without overt clinical signs or symptoms.[395]

Instrumental evaluation (videofluoroscopy, fiberoptic endoscopic evaluation of swallowing, or fiberoptic endoscopic evaluation of swallowing with sensory testing) allows the clinician to visualize swallow physiology, thus determining the presence or absence of aspiration, the quantity of aspiration, and the physiological or structural causes for dysphagia. This information is necessary for forming an appropriate and effective treatment plan, which can include swallow therapy and diet recommendations.[396–398] There is no consensus in the literature on a preferred instrumental study. Both videofluoroscopy and fiberoptic endoscopic evaluation of swallowing can be used to evaluate the swallow mechanism.

Additionally, a large cohort study was completed, showing that fiberoptic endoscopic evaluation of swallowing with sensory testing is a relatively safe procedure for evaluating the sensory and motor aspects of dysphagia. Clinical judgment should be used to weigh the advantages and disadvantages of each study for each individual patient.[399]

Multiple systematic reviews showed that behavioral interventions, including "swallowing exercises, environmental modifications such as upright positioning for feeding, safe swallowing advice, and appropriate dietary modifications,"[400] should be considered for the management and treatment of dysphagia.[400,401] A group of dysphagia and swallow rehabilitation experts reviewed 10 principles of neural plasticity and discussed how they should be incorporated into dysphagia rehabilitation strategies and interventions to promote evidence-based practice.[402] Other therapies considered in systematic reviews, including drug therapy, NMES, pharyngeal electric stimulation, physical stimulation, transcranial direct current stimulation (tDCS), and transcranial magnetic stimulation, have no conclusive evidence supporting their use in dysphagia treatment.[400] Additionally, acupuncture may be a beneficial alternative treatment of dysphagia.[403] Cohort studies have shown that oral hygiene protocols may help reduce aspiration pneumonia after stroke.[404,405]

Recently, there have been a series of clinical trials called the Feed or Ordinary Diet (FOOD) trials, which are large, well-designed RCTs that address when and how to feed patients after stroke.[406–408] As a result of underrecruitment, definitive conclusions cannot be made; however, these studies and a Cochrane review[400] offer much information.

Nutritional supplements are recommended only for patients with malnutrition or those at risk of malnutrition. Routine oral nutritional supplements are not associated with improved functional outcome at 6 months after stroke. This clinical trial has found that few participants (8%) were malnourished at baseline and that supplements may contribute to hyperglycemia if the patient is not malnourished.[408]

Early tube feeding (started within 7 days) may increase the survival of dysphagic patients who cannot safely eat by mouth; however, this may keep patients alive "in a severely disabled state when they otherwise would have died."[407] Therefore, to reduce case fatality, providers should initiate early tube feeds; however, they can wait up to 7 days after a stroke to initiate tube feeds, especially when conversations about the goals of care are needed. Tube feeds via nasogastric route are reasonable for the first 2 to 3 weeks after stroke unless there is a strong reason to opt for percutaneous endoscopic gastrostomy placement (eg, cannot pass a nasogastric tube).[407]

Early percutaneous endoscopic gastrostomy placement is not supported for stroke patients.[406] After this time period, percutaneous endoscopic gastrostomy placement is recommended because it is associated with fewer treatment failures, higher feed delivery, and improved albumin concentration.[400]

Recommendations: Dysphagia Screening, Management, and Nutritional Support	Class	Level of Evidence
Early dysphagia screening is recommended for acute stroke patients to identify dysphagia or aspiration, which can lead to pneumonia, malnutrition, dehydration, and other complications.	I	B
Dysphagia screening is reasonable by a speech-language pathologist or other trained healthcare provider.	IIa	C
Assessment of swallowing before the patient begins eating, drinking, or receiving oral medications is recommended.	I	B
An instrumental evaluation is probably indicated for those patients suspected of aspiration to verify the presence/absence of aspiration and to determine the physiological reasons for the dysphagia to guide the treatment plan.	IIa	B
Selection of instrumental study (fiberoptic endoscopic evaluation of swallowing, videofluoroscopy, fiberoptic endoscopic evaluation of swallowing with sensory testing) may be based on availability or other considerations.	IIb	C
Oral hygiene protocols should be implemented to reduce the risk of aspiration pneumonia after stroke.	I	B
Enteral feedings (tube feedings) should be initiated within 7 days after stroke for patients who cannot safely swallow.	I	A
Nasogastric tube feeding should be used for short term (2–3 weeks) nutritional support for patients who cannot swallow safely.	I	B
Percutaneous gastrostomy tubes should be placed in patients with chronic inability to swallow safely.	I	B
Nutritional supplements are reasonable to consider for patients who are malnourished or at risk of malnourishment.	IIa	B
Incorporating principles of neuroplasticity into dysphagia rehabilitation strategies/interventions is reasonable.	IIa	C
Behavioral interventions may be considered as a component of dysphagia treatment.	IIb	A
Acupuncture may be considered as a adjunctive treatment for dysphagia.	IIb	B
Drug therapy, NMES, pharyngeal electrical stimulation, physical stimulation, tDCS, and transcranial magnetic stimulation are of uncertain benefit and not currently recommended.	III	A

Nondrug Therapies for Cognitive Impairment, Including Memory

Impairments in multiple domains of cognition, including attention, processing speed, executive function, verbal and visual memory, language, and perception, occur frequently after stroke. Stroke doubles an individual's risk for dementia (including Alzheimer disease).[409]

Cognitive rehabilitation has been the traditional nonpharmacological method to treat cognitive impairment and has been defined as a "systematic, functionally-oriented service of therapeutic cognitive activities, based on an assessment and understanding of the person's brain-behavior deficits."[410] These treatments are directed at the restoration or reestablishment of cognitive activity, the acquisition of strategies to compensate for impaired cognitive function, and the use of adaptive technique or equipment for increasing independence. Few studies have assessed interventions for cognitive deficits in the IRF environment. An RCT (n=83 at >4 months after stroke) compared a multicomponent cognitive therapy and graded activity training with cognitive therapy alone over 12 weeks and demonstrated that the multicomponent therapy exceeded the cognitive therapy in fatigue reduction and improved physical endurance.[411] A systematic review[412] published in 2011 of cognitive rehabilitation in stroke that searched guidelines in stroke management, other systematic reviews, and clinical RCTs concluded that compensatory strategies can be used to improve memory outcomes. However, use of an external memory aid is in itself a memory task, so those with the greatest need also have the greatest problems using them. One solution to this problem has been the development of a paging system whereby a paging service with a customized set of reminders and appropriate date and time sends out reminders to the individual pager that is carried by the person who needs to be reminded. Recently, this idea has been modernized by the use of text message reminders to one's mobile device. The use of a paging system can significantly reduce everyday failures of memory and planning in stroke survivors. However, there was not enough evidence from RCTs to determine whether cognitive rehabilitation for memory problems after stroke is helpful.

Recently, attention has focused on the application of physical activity and exercise to improve cognitive function after stroke. Meta-analysis suggests that physical activity has a protective effect against cognitive decline[413] and may improve cognitive function in older adults without cognitive impairment.[414] A number of mechanisms have been suggested to explain the effects of exercise on cognition after stroke, including the increase in cerebral blood volume, increased expression of growth factors such as brain-derived neurotrophic factor, and a positive effect on depressive symptoms, which may mediate an improvement in cognitive performance.[415]

In animal models, a stimulating and enriched environment has been shown to improve neurobehavioral function and learning after stroke.[416] Although it is not yet known exactly what type of environment might provide optimal stimulation for a person who has had a stroke, it has been suggested that the setting should be conducive to participating in physical activity and cognitive and social activities.[417]

Cognitive Rehabilitation

Systematic reviews that include people with both traumatic brain injury and stroke are generally more positive on the benefits of cognitive rehabilitation[418] than those involving people with stroke alone.[419–421] This may be due in part to the smaller number of stroke-only studies and the confounding factors of age and vascular involvement with stroke. A Cochrane review of 6 RCTs found a benefit of cognitive rehabilitation after stroke on some aspects of attention deficits at the end of the treatment period.[420] Not all aspects of attention are similarly affected; attention training had a positive effect on divided attention immediately after the intervention (4 studies) but no effect on selective attention (6 studies), alertness (4 studies), or sustained attention (4 studies).[420] Two cognitive rehabilitation RCTs found improvements in subjective measures of attention[422] and mental slowness[423] after stroke immediately after treatment and at follow-up.

The European Federation of Neurological Societies guidelines on cognitive rehabilitation[424] summarized a number of publications related to memory rehabilitation interventions without external memory aids, rehabilitation interventions with nonelectronic external memory aids, and rehabilitation interventions with assistive electronic technologies (the specific number of studies identified and reviewed was not given).

They concluded the following:

- That memory strategies without electronic aids are possibly effective (Level C recommendation)
- That specific learning strategies such as errorless learning are probably effective (Level B recommendation)
- That nonelectronic external memory aids such as diary or notebook keeping are possibly effective (Level C recommendation)
- That electronic external memory devices such as computers, paging systems, and portable voice organizers are probably effective (Level B recommendation)
- That the use of virtual environments has shown positive effects on verbal, visual, and spatial learning and that memory training in virtual environments is rated as possibly effective (Level C recommendation)
- That a direct comparison of memory training in virtual environments versus nonvirtual environments is still lacking and no recommendation can be made as to the specificity of the technique

An updated review of the literature (2003–2008)[418] concluded that (1) for individuals with mild memory impairments, memory strategy training, including the use of internalized strategies (eg, visual imagery) and external memory compensations (eg, notebooks), is recommended as a practice standard; (2) for individuals with severe memory deficits, the use of external compensations, including assistive technology, with direct application to functional activities is recommended as a practice guideline; and (3) for individuals with severe memory impairments, errorless learning techniques may be effective for learning specific skills or knowledge, although with limited transfer to novel tasks or reduction in overall functional memory problems

However, a recent Cochrane meta-analysis[425] with 13 cognitive rehabilitation RCTs reported no benefit to executive functioning after stroke, whereas other systematic reviews using a broader range of evidence have suggested some limited evidence.[426,427] Current studies are small and have highly varied content, making comparisons difficult. Notably, an RCT delivered strategies focused on problem solving by 3 methods (face to face, online, and computer training) and found that although all improved problem-solving and IADL abilities, the face-to-face training group resulted in the most improvement in problem-solving self-efficacy.[428] Another RCT[429] found that using a pager was effective in increasing goal attainment (ie, medication and appointments) but that stroke participants' performance returned to baseline levels when the pager was discontinued. In contrast, specific aspects of memory (eg, visual-spatial recall, subjective memory experience, verbal and prospective memory, working memory, and attention) have been shown to improve after stroke in 6 different controlled trials that used very diverse cognitive training strategies.[430–435]

A systematic review of the literature (1995–2011) focused specifically on information and communication technology tools for individuals with acquired brain injury, including stroke,[436] reviewed 5 studies that addressed memory problems. The quality of the studies was so low that it was not possible to determine whether the tools were beneficial.

Only 2 studies have examined the effects of tDCS on attention in stroke patients.[437,438] The first study[438] found that anodal tDCS over the left dorsolateral prefrontal cortex was associated with enhanced complex attention (working memory) performance. The second study[437] found that noninvasive anodal tDCS applied to the left dorsolateral prefrontal cortex improved attention compared with sham stimulation. Although improved attention may result in improved memory because people are better able to initially register information, neither addressed whether the performance benefits resulted in improved memory learning and retention.

In summary, most cognitive rehabilitation programs use a variety of activities, including practice requiring attention, planning or working memory with pencil and paper or computerized activities, and teaching of compensatory strategies. Although a growing number of RCTs have addressed immediate effects on standardized psychobehavioral tests, few studies have assessed the durability of treatment effects or relevance to everyday functioning.

Exercise

Cumming et al[415] performed a systematic review through 2011 and found 12 RCTs and controlled, clinical trials that studied the effects of a physical activity or exercise-based intervention on cognitive function in stroke. They concluded that there are reasonably consistent and relatively small positive effects of exercise on cognition, with some studies finding specific positive effects on memory. However, the pool of studies identified was small, and methodological shortcomings were widespread.

Because most studies measured cognition or memory as a secondary outcome, there was a wide range of baseline cognitive abilities, including those without cognitive impairment. The dose and content of the exercise protocols have

been highly diverse,[415,440,441] preventing recommendations on the optimal intensity or timing. Although no longitudinal exercise or physical activity studies have been undertaken to prevent cognitive impairment or dementia after stroke, it would seem reasonable to extend the results of studies in older adults that suggest a protective effect of exercise on cognitive decline.[413]

Enriched Environment

An RCT that modified the stroke rehabilitation environment with the provision of a computer with Internet, books, games, virtual reality gaming technology, and encouragement from staff to use the activities increased the engagement of patients with cognitive activities and reduced time spent inactive and alone.[417] Särkämö et al[442] performed a single-blind RCT to determine whether listening to music everyday can facilitate the recovery of cognitive functions after stroke. Two months of daily listening (95 minutes daily) to self-selected music after acute stroke improved verbal memory, focused attention, and depressive symptoms compared with listening to an audio book or not listening to music.[442]

Four weeks of playing virtual reality games for 30-minute sessions 3 times weekly improved visual attention and short-term visuospatial memory in a very small RCT of patients early after stroke.[443] These games required primarily paretic arm movements (eg, raise a hand to stop soccer balls from entering the goal).

Recommendations: Nondrug Therapies for Cognitive Impairment, Including Memory	Class	Level of Evidence
Enriched environments to increase engagement with cognitive activities are recommended.	I	A
Use of cognitive rehabilitation to improve attention, memory, visual neglect, and executive functioning is reasonable.	IIa	B
Use of cognitive training strategies that consider practice, compensation, and adaptive techniques for increasing independence is reasonable.	IIa	B
Compensatory strategies may be considered to improve memory functions, including the use of internalized strategies (eg, visual imagery, semantic organization, spaced practice) and external memory assistive technology (eg, notebooks, paging systems, computers, other prompting devices).	IIb	A
Some type of specific memory training is reasonable such as promoting global processing in visual-spatial memory and constructing a semantic framework for language-based memory.	IIb	B
Errorless learning techniques may be effective for individuals with severe memory impairments for learning specific skills or knowledge, although there is limited transfer to novel tasks or reduction in overall functional memory problems.	IIb	B
Music therapy may be reasonable for improving verbal memory.	IIb	B
Exercise may be considered as adjunctive therapy to improve cognition and memory after stroke.	IIb	C
Virtual reality training may be considered for verbal, visual, and spatial learning, but its efficacy is not well established.	IIb	C
Anodal tDCS over the left dorsolateral prefrontal cortex to improve language-based complex attention (working memory) remains experimental.	III	B

Use of Drugs to Improve Cognitive Impairments, Including Attention

Several medications are used to treat general cognitive disorders, but little literature addresses their use for poststroke cognitive deficits. Dextroamphetamine has been studied for poststroke motor recovery,[444] but no studies have substantiated its use for cognitive disorders. Although the effect of methylphenidate in 1 small trial might rely partly on an improvement in attention and effort through cingulum modulation,[445] no studies have assessed its use in cognitive rehabilitation after stroke. Modafinil has been studied for the treatment of poststroke depression[446] and fatigue[447] but not cognitive recovery. Atomoxetine also has been studied for the treatment of poststroke depression but not cognitive deficits.

Donepezil has been studied in a small, randomized, clinical trial.[448] Ten right-hemispheric stroke survivors were randomized to receive either 5 mg donepezil or placebo. The donepezil group demonstrated significant improvements on the Mini-Mental Status Examination 1 month after completion of treatment, and functional magnetic resonance imaging showed increased activation in both prefrontal areas, both inferior frontal lobes, and the left inferior parietal lobe.

A pilot study randomized 50 subjects to receive either rivastigmine or placebo.[449] Subjects receiving rivastigmine demonstrated statistically significant improvement (1.70 versus 0.13; P=0.02) on the animal subtask of the verbal fluency measure compared with those on placebo, but a nonsignificant trend toward improvement was observed in the Color Trails II test, described as a culture-fair test of visual attention, graphomotor sequencing, and effortful executive processing abilities.

A study of 47 subjects at least 6 months after stroke were randomized to receive fluoxetine, nortriptyline, or placebo.[450] Although no significant group effect was found at the end of treatment, the placebo group exhibited deterioration in executive functioning 21 months after treatment, whereas the groups who received fluoxetine or nortriptyline significantly improved, independently of depressive symptoms (F=12.1 df=1, 45; P=0.001). The improvement was attributed to possible reorganization of neuronal networks associated with prefrontal functions based on modulation of monoaminergic neurotransmission and the activity of neurotrophins.

Recommendations: Use of Drugs to Improve Cognitive Impairments, Including Attention	Class	Level of Evidence
The usefulness of donepezil in the treatment of poststroke cognitive deficits is not well established.	IIb	B
The usefulness of rivastigmine in the treatment of poststroke cognitive deficits is not well established.	IIb	B
The usefulness of antidepressants in the treatment of poststroke cognitive deficits is not well established.	IIb	B
The usefulness of dextroamphetamine, methylphenidate, modafinil, and atomoxetine in the treatment of poststroke cognitive deficits is unclear.	IIb	C

Limb Apraxia

Limb apraxia is "a decrease or difficulty in performing purposeful, skilled movements" that cannot be attributed to hemiplegia or lack of effort.[451] It is more common after left hemispheric than right hemispheric stroke.[452] Although not traditionally believed to affect daily life function,[453,454] there is now evidence that apraxia is associated with reduced independence in daily life activities.[455–457] Despite its incidence and its impact on independent functioning, there is a paucity of research on therapeutic interventions for limb apraxia. Several systematic reviews have been conducted since 2005,[458–461] reviewing 5 small RCTs across the 4 reviews. Since these reviews, no additional RCTs and only 1 case study have been published.[462] Two reviews concluded that there was not enough information to determine whether interventions for apraxia were efficacious.[458,459] Some studies have found immediate postintervention improvements on apraxia tests or in daily life activities, but few have found lasting advantages for the trained groups.[459]

Recommendations: Limb Apraxia	Class	Level of Evidence
Strategy training or gesture training for apraxia may be considered.	IIb	B
Task practice for apraxia with and without mental rehearsal may be considered.	IIb	C

Hemispatial Neglect or Hemi-Inattention

Hemispatial neglect, also called hemiagnosia, hemineglect, unilateral neglect, spatial neglect, contralateral neglect, unilateral visual inattention, hemi-inattention, neglect syndrome, or contralateral hemispatialagnosia, is a neuropsychological condition in which, after damage to a part of 1 hemisphere of the brain is sustained, a deficit in attention to and awareness of 1 side of space is observed. These symptoms are not attributable to a primary sensory (eg, visual) or motor deficit; they are typically contralateral to the lesion. Hemispatial neglect is common after stroke[463] and significantly impairs the ability to participate effectively in rehabilitation.[464] Although neglect improves over time, neglect symptoms continue to interfere with daily functioning long after stroke.[465–467] The interventions developed for neglect fall into 2 general categories: bottom-up approaches, designed to remediate attention processes for the left hemispace and internal representations of space, and top-down approaches, aimed at teaching the person strategies for compensating for neglect.[468] Most studies of neglect have been plagued by low-quality methods and small sample sizes.

Three systematic reviews have been completed since 2005,[468–470] reviewing 24 unique randomized, clinical trials and 14 additional studies with weaker designs. The interventions studied and outcome measures varied widely in these reviews. Fifteen additional RCTs investigating neglect were found that were not included in those reviews (prism adaptation, 2; virtual reality, 2; limb activation, 2; neck vibration with prism adaptation, 1; visual scanning with limb activation, 1; mental practice, 1; repetitive transcranial magnetic stimulation, 4; and optokinetic stimulation, 2).[471–483] There is evidence for the efficacy of several top-down and bottom-up approaches in improving both immediate performance and long-term performance on standard neglect tests such as cancellation tests and line bisection tests.* These include half-field eye patching, visual scanning training, prism adaptation, limb activation, optokinetic stimulation, mental imagery (but see the work by Welfringer and colleagues[482]), and brain stimulation with repetitive transcranial magnetic stimulation, theta burst transcranial magnetic stimulation, or tDCS. Two randomized, clinical trials of eye patching for unilateral neglect in 35 subjects[487] and 60 subjects[488] did not demonstrate any significant functional improvement. None of these treatments resulted in improvement on all neglect tests.

Few studies have examined the efficacy of these interventions on daily life functioning. Several have used the behavioral tests from the Behavioral Inattention Test[489]or the Baking Tray Test,[490] which are simulated real-life activities. Some studies have examined functional outcomes with the Catherine Bergego Scale,[491] which measures neglect symptoms during everyday activities or paragraph reading tasks. Others have used the less sensitive, general tests of functioning in ADLs such as the Barthel Index[330] and the FIM.[492] There is limited evidence to date that these interventions increase daily life functioning, even when performance on neglect tests has improved,[468,470] although some individual RCTs have found positive results on daily function.[469,471,475,481,484]

Cognitive rehabilitation may have immediate benefits on tests of neglect, as supported by a meta-analysis of 23 RCTs, but it is uncertain whether disability associated with neglect was altered.[419] Finally, a meta-analysis[493] found that compensatory scanning training improved reading and visual scanning in people with visual field defects (and possibly coexisting visual neglect).

It is important to note that in many of the studies, the target intervention was provided in addition to regular therapy or scanning training. Therefore, there is not sufficient evidence to ascertain whether neglect interventions are effective when provided in isolation. In addition, several issues in understanding how to treat neglect exist. These include understanding the heterogeneous response to treatment across clients, the heterogeneous response to treatment across measured tasks, the parameters of treatment (dosing, type of practice activity during or after treatment), and the relative efficacy of the various interventions, either alone or in combination.

*References 469–471, 473, 475, 476, 478, 480, 481, 484–486

Recommendations: Hemispatial Neglect or Hemi-Inattention	Class	Level of Evidence
It is reasonable to provide repeated top-down and bottom-up interventions such as prism adaptation, visual scanning training, optokinetic stimulation, virtual reality, limb activation, mental imagery, and neck vibration combined with prism adaptation to improve neglect symptoms.	IIa	A
Right visual field testing may be considered.	IIb	B
Repetitive transcranial magnetic stimulation of various forms may be considered to ameliorate neglect symptoms.	IIb	B

Communication Disorders

Disorders of communication and related cognitive impairments are common after stroke and include aphasia, cognitive-communication disorders, dysarthria, and apraxia of speech. Communication disorders may affect speaking, listening, reading, writing, gestures, and pragmatics. The presence of a communication disorder may negatively affect social participation, psychosocial well-being, and quality of life.

A certified speech and language pathologist normally performs the evaluation and treatment of communication disorders. The overall goals of speech and language treatment are to facilitate the recovery of communication, to assist patients in developing strategies to compensate for communication disorders, and to counsel and educate people in the patient's environment on assistive communication supports to facilitate communication, to decrease isolation, and to meet the patient's wants and needs. Compensatory and assistive communication supports may range from low-tech strategies such as paper/pencil and communication boards/books to high-tech devices that include smart phones and speech-generating devices.

Cognitive-Communication Disorders

There is great diversity in the presentation of cognitive-communication problems after stroke.[494] A systematic review of cognitive-communication disorders after right hemispheric stroke suggested that many individuals at both the chronic and acute phases of recovery benefit from sentence- or discourse-level communication treatments.[495]

Several reviews summarize research evidence for treatments of attention, visual neglect, memory training, and other cognitive treatments for individuals with acquired brain injuries, including right hemispheric stroke. Although RCTs are lacking,[419,420,425] a systematic review concludes that there is now sufficient information to support evidence-based protocols to implement empirically supported treatments for cognitive and communication disability after stroke.[418] The Nondrug Therapies for Cognitive Impairment, Including Memory section above provides more information on nonpharmacological treatments for cognitive disorders after stroke.

Aphasia

An RCT indicated that daily aphasia therapy in very early stroke recovery (starting at 3 days) improved communication outcomes in people with moderate to severe aphasia.[496] One systematic review of treatment in patients at >6 months after stroke concluded that aphasia therapy continued to be efficacious in the chronic stages,[497] whereas another concluded that there was no significant relationship between time after onset and response to treatment.[498] Insufficient evidence exists to know when treatment should start or how long it should continue.

Several systematic reviews have indicated that intensive treatment is favored,[499–501] but there is no consensus on the optimum amount, intensity, distribution, or duration of treatment.[353] For subacute aphasia, 1 RCT has shown that a short duration (3 weeks) of intensive therapy is efficacious,[502] whereas another RCT indicated that intensive treatment over a longer duration (12 weeks) may not always be feasible.[503] Therefore, intensive therapy should be provided as tolerated and feasible.

A variety of different treatment approaches for aphasia have been developed. Small-group and single-subject studies support their efficacy.[497] A systematic review of RCTs of aphasia treatment stated that no conclusions can be made about the effectiveness of one treatment over another.[499]

Three RCTs evaluated computer-based therapy, with 1 RCT comparing it with no treatment, 1 comparing it with the same treatment provided by a speech and language therapist, and the third comparing it with the same amount of nonlinguistic computer training.[504–506] These 3 trials concluded that computer-based therapy is feasible and efficacious. Therefore, computerized treatment is beneficial and can be used to supplement treatment provided by a speech-language pathologist.

A systematic review concluded that communication partner training is effective in improving communication activities or the participation of the communication partner. It is also probably effective in improving communication activities or the participation of individuals with chronic aphasia when they are interacting with trained communication partners.[507] Communication partners may include family members and caregivers, healthcare professionals, and others in the community or organization. Further studies are needed to examine the impact of communication partner training with individuals with acute aphasia.[507]

Two systematic reviews have addressed group therapy.[499,508] Group treatments for people with aphasia occur across the continuum of care.[508] Overall, results indicate that group participation can improve specific linguistic processes with no significant difference in outcomes between individual one-on-one therapy and group therapy. There is also some evidence that outpatient and community-based group participation can benefit social networks and community access.[508]

Several small RCTs have shown that drug therapy appears to be beneficial in conjunction with SLT, whereas other studies have failed to show a benefit. Drugs showing promise include donepezil,[509] memantine,[510] and galantamine.[511] Bromocriptine[512] and piracetam[513] do not appear beneficial. More extensive studies of pharmacotherapy for aphasia are needed before the routine use of any medication can be

recommended. Further research on the dose and timing of administration is needed.

Brain stimulation techniques, including epidural cortical stimulation, repetitive transcranial magnetic stimulation, and tDCS, have been used to modulate cortical excitability during poststroke language recovery. Small studies have shown therapeutic benefits when brain stimulation techniques are used, typically in combination with behavioral language therapy.[504,514–516] Most studies are small-group or single-subject studies and have been conducted in patients with chronic aphasia. Two RCTs investigating repetitive transcranial magnetic stimulation in acute and subacute aphasia[517,518] found mixed results. Brain stimulation combined with speech language therapy may benefit selected patients, but more information on the site of stimulation and stimulation parameters is needed before it can be used in routine clinical practice.[437,438,516]

Recommendation: Cognitive Communication Disorders	Class	Level of Evidence
Interventions for cognitive-communication disorders are reasonable to consider if they are individually tailored and target:	IIa	B
The overt communication deficit affecting prosody, comprehension, expression of discourse, and pragmatics		
The cognitive deficits that accompany or underlie the communication deficit, including attention, memory, and executive functions		

Recommendations: Aphasia	Class	Level of Evidence
Speech and language therapy is recommended for individuals with aphasia.	I	A
Treatment for aphasia should include communication partner training.	I	B
Intensive treatment is probably indicated, but there is no definitive agreement on the optimum amount, timing, intensity, distribution, or duration of treatment.	IIa	A
Computerized treatment may be considered to supplement treatment provided by a speech-language pathologist.	IIb	A
A variety of different treatment approaches for aphasia may be useful, but their relative effectiveness is not known.	IIb	B
Group treatment may be useful across the continuum of care, including the use of community-based aphasia groups.	IIb	B
Pharmacotherapy for aphasia may be considered on a case-by-case basis in conjunction with speech and language therapy, but no specific regimen is recommended for routine use at this time.	IIb	B
Brain stimulation techniques as adjuncts to behavioral speech and language therapy are considered experimental and therefore are not currently recommended for routine use.	III	B

Motor Speech Disorders: Dysarthria and Apraxia of Speech

Dysarthria is a collective term for a group of speech disorders that result from paralysis, weakness, or incoordination of the speech musculature after neurological damage. Dysarthria can affect, singly or in combination, any of the subsystems underlying speech production: the respiratory, laryngeal, velopharyngeal, and oral-articulatory subsystems. It is estimated that 20% of stroke patients present with dysarthria,[519] although the type of dysarthria and its specific characteristics vary, depending on factors such as lesion site and severity.

Apraxia of speech is a disorder of motor planning or programming resulting in difficulty in volitionally producing the correct sounds of speech. In addition to articulatory disturbances, prosodic deficits such as slow rate of speech and restricted variations in pitch and loudness may be present. Apraxia of speech typically co-occurs with nonfluent aphasia, and the existence of a pure apraxia of speech without aphasia is debatable.

Motor speech disorders affect the intelligibility, naturalness, and efficiency of communication. The presence of a motor speech disorder may negatively affect social participation, psychosocial well-being, and quality of life.

Speech and language therapists use a range of behavioral treatments to address motor speech disorders in individuals after stroke.[520–523] Behavioral treatments for motor speech disorders are diverse in their focus and theoretical underpinnings and should be tailored to the individual's unique strengths, deficits, goals, priorities, and circumstances. Behavioral treatments may focus on improving the physiological support for speech and target impairments in respiration, phonation, articulation, and resonance. Behavioral treatments may also include strategies to increase the precision of articulation, to modify the rate and loudness of speech, and to improve prosody. To date, no randomized, clinical trials have addressed the efficacy of these approaches,[524,525] but small, nonrandomized group studies and carefully designed, single-subject, experimental studies have demonstrated positive results.[521,526–528] Individuals with motor speech disorders may improve as a result of treatment, even when the condition is chronic.[521,522,528,529] There is no consensus on the optimum amount, distribution, or variability of practice or the best type, frequency, and timing of treatment.

Patients with motor speech disorders may benefit from using augmentative and alternative communication devices to supplement their communication. Augmentative and alternative communication devices range from simple picture boards or spelling boards to portable amplification systems and high-tech electronic devices with eye-tracking capability.[522,530] Supplemental strategies such as gesture or writing can be used to enhance communication attempts. Two systematic reviews have concluded that augmentative and alternative communication and speech supplementation techniques may be useful for individuals with motor speech disorders, when speech is insufficient to meet the individual's communication needs.[527,531]

The effects of motor speech disorders after stroke extend beyond the physiological characteristics of the impairment. Studies have shown that the resulting communication difficulties affect social participation and quality of life[532,533] and that the psychosocial impact of a motor speech disorder is disproportionate to the severity of the physiological impairment.[532,533]

Behavioral management of motor speech disorders includes support and counseling. Interventions addressing the broad life implications of motor speech disorders are being developed, and pilot studies are underway.[534]

Addressing environmental factors during rehabilitation is consistent with the *ICF* and warrants consideration.[535–537] For individuals with motor speech disorders, this may include providing education that addresses the knowledge and attitudes of communication partners or modifying the characteristics of the physical environment such as reducing noise levels.[535–537]

Telerehabilitation may be used to overcome barriers of access to services.[538] The quality of telerehabilitation services must be consistent with the quality of services delivered face to face.[538] Studies demonstrating the feasibility of telerehabilitation in the management of dysarthria are emerging.[353]

Recommendations: Motor Speech Disorders: Dysarthria and Apraxia of Speech	Class	Level of Evidence
Interventions for motor speech disorders should be individually tailored and can include behavioral techniques and strategies that target:	I	B
Physiological support for speech, including respiration, phonation, articulation, and resonance		
Global aspects of speech production such as loudness, rate, and prosody		
Augmentative and alternative communication devices and modalities should be used to supplement speech.	I	C
Telerehabilitation may be useful when face-to-face treatment is impossible or impractical.	IIa	C
Environmental modifications, including listener education, may be considered to improve communication effectiveness.	IIb	C
Activities to facilitate social participation and promote psychosocial well-being may be considered.	IIb	C

Spasticity

Spasticity, classically defined as a velocity-dependent resistance to stretch of a muscle, is a component of the upper motor neuron syndrome. Poststroke spasticity may have dystonic features, including involuntary muscle activity and limb positioning. Spasticity is correlated with activity limitations associated with hygiene, dressing, and pain. These activity limitations increase caregiver burden and reduce quality of life as measured by the EuroQol-5.[539]

When spasticity is present, the cost of care is 4 times higher than when spasticity is absent; however, because spasticity is strongly associated with stroke severity, the independent impact of spasticity on costs is not known.[540] Thus, the cost of treating spasticity may not reduce the overall cost of stroke-related care. For example, in 1 study, the use of botulinum toxin injections for upper limb spasticity combined with therapy was not found to be cost-effective compared with therapy alone.[541]

The prevalence of poststroke spasticity in any limb is in the range of 25% to 43% over the first year after stroke.[542–545] For patients who require acute rehabilitation after stroke, the prevalence of spasticity in any limb is 42%.[546] The incidence of upper limb spasticity over the first 3 months in patients admitted to rehabilitation is 33%.[9] The strongest predictor of moderate to severe spasticity (Ashworth scale score ≥2) is severe proximal and distal limb weakness on acute hospital or rehabilitation admission.[543,547]

The use of resting hand splints is not effective for reducing wrist and finger spasticity, and the use of such splints is controversial for the prevention of contracture in the setting of spasticity.[75] For ankle plantarflexor spasticity, a short course of ankle casting may facilitate spasticity reduction after injection of botulinum toxin. Taping, however, has no effect on spasticity after lower limb botulinum toxin injection and is not recommended.[548,549]

NMES combined with therapy may improve spasticity, but there is insufficient evidence that the addition of NMES improves functional gait or hand use.[550] Vibration applied to spastic muscle groups might be considered to reduce spasticity transiently, but it is not effective for long-term reduction of spastic hypertonia.[551–553]

Injection of botulinum toxin is used commonly to treat upper limb spasticity in patients with stroke and is recommended in several recent review articles and previously published guidelines as an important tool in the comprehensive management of poststroke spastic hypertonia.[149,554–557] Injections of botulinum toxin A can reduce spasticity significantly as measured by the Ashworth scale. In a meta-analysis, botulinum toxin was shown to have a small but statistically significant effect on activity as measured by the Disability Assessment Scale after injection into the upper limb.[558] However, improvements were attributable to the lowered resistance to muscle stretch during passive repositioning of the upper limb rather than to the actual skilled functional use of the arm and hand. Thus, there is no evidence to suggest that botulinum toxin injections will improve functional upper limb use, but it may improve limb active or passive limb positioning for activities such as dressing and hygiene.[559,560] Although botulinum toxins are clinically recommended for spasticity reduction, it is not clear that they are a cost-effective means to manage spastic hypertonia compared with physical or occupational therapies alone.[541] However, if a reduction in caregiver burden is taken into account, the use of botulinum toxins with therapy may be cost-effective.[561] The early injection of botulinum toxins as soon as hypertonia appears may be effective in preventing later spasticity, but this needs further study.[562,563]

Botulinum toxins injected into the ankle plantarflexor and inverter muscles significantly reduce lower limb spasticity as measured by the Ashworth scale.[564–566] Injections may also improve gait speed, although only slightly.[567] Botulinum toxin injections into the rectus femoris muscle may improve tonic knee extension during the swing phase of gait in stroke, but further study is needed.[568] Although botulinum toxins have been used to improve orthotic fit, no studies of this application have been reported.

Oral antispasticity agents, including baclofen, dantrolene sodium, and tizanidine, have a marginal effect on reducing generalized spasticity, but dose-limiting side effects such as tiredness and lethargy are common.[569–577] Intrathecal baclofen therapy is effective in reducing generalized spastic

hypertonia in patients with stroke.[570,578–582] A consensus panel in 2006 recommended that intrathecal baclofen therapy is appropriate in those patients with spasticity who do not respond well to other interventions or in patients who experience adverse effects from other treatments. They also concluded that intrathecal baclofen therapy can be considered as early as 3 to 6 months after stroke for patients refractory to other treatments.[583]

Recommendations: Spasticity	Class	Level of Evidence
Targeted injection of botulinum toxin into localized upper limb muscles is recommended to reduce spasticity, to improve passive or active range of motion, and to improve dressing, hygiene, and limb positioning.	I	A
Targeted injection of botulinum toxin into lower limb muscles is recommended to reduce spasticity that interferes with gait function.	I	A
Oral antispasticity agents can be useful for generalized spastic dystonia but may result in dose-limiting sedation or other side effects.	IIa	A
Physical modalities such as NMES or vibration applied to spastic muscles may be reasonable to improve spasticity temporarily as an adjunct to rehabilitation therapy.	IIb	A
Intrathecal baclofen therapy may be useful for severe spastic hypertonia that does not respond to other interventions.	IIb	A
Postural training and task-oriented therapy may be considered for rehabilitation of ataxia.	IIb	C
The use of splints and taping are not recommended for prevention of wrist and finger spasticity after stroke.	III	B

Balance and Ataxia

Balance depends on sensory inputs from the visual, vestibular, and somatosensory systems. These sensory inputs are integrated and used to control anticipatory and reactive motor output to postural disturbances. Balance impairment (inclusive of postural control impairment) is common after stroke[182,584,585] because stroke can affect 1 or more of the sensory and motor networks. Impaired balance makes it difficult to safely complete ADLs, to move about the home and community, and to live independently. A large percentage of people report falling at least once in the first 6 months after stroke.[182,585] People with stroke who fall are twice as likely to sustain a hip fracture compared with those who fall but do not have a stroke.[586] Balance impairments can result in low balance confidence, which in turn may further reduce activity.[587] If left undetected or untreated, balance impairments can result in a cascade of serious, undesirable, and expensive events.[175,245]

Evaluation of balance abilities is considered part of routine clinical practice in individuals with stroke.[308,588,589] Standardized tests of balance challenge different aspects of postural control such as anticipatory postural reactions during a variety of functional behaviors. Specific balance limitations identified during the evaluation will help determine the risk of falling and guide the selection and tailoring of balance-specific interventions.[308,591]

Although balance training programs have been shown to be beneficial after stroke, no specific approach or program has been demonstrated to be superior, nor is the optimal timing clear. Balance training has been successfully implemented as group and one-on-one sessions, circuit training, and hospital- versus home- versus community-based programs. Content of the training typically includes balance-specific activities, (eg, practice responding to challenges in standing) and more general activities (eg, strengthening exercises, gait activities).[592] Shorter, more time-intensive programs appear comparable to longer, less time-intensive programs.[592] Progression to more challenging training activities over the course of training is important. The one type of training that has not been shown to be beneficial for balance is water-based programs.[593]

Studies of balance training have generally been small, typically 10 to 60 subjects. Subjects typically have been able to ambulate independently (with or without an assistive device) and be relatively cognitively intact. Four systematic reviews and meta-analyses have reviewed the effects of various interventions on balance after stroke, with the latest one published in 2013. Findings across these reviews show inconsistent effects on balance outcomes. Subsequent published RCTs have tested a variety of types of balance training devices (sliding board, trunk exercises on a physioball, shoe wedge) or programs (yoga, Tai Chi,[187] gait training, motor imagery). The later studies have similar methodological challenges (8–40 subjects per group) and lead to similar, inconsistent conclusions about the superiority of any 1 specific treatment.[594–604] Likewise, a systematic review of fall prevention after stroke has shown that inconsistencies in outcome measures, intervention type, and implementation in previous research make it difficult to determine the effectiveness of fall prevention programs after stroke.[174] The Prevention of Falls section provides more discussion.

Use of devices and orthotics (eg, cane, AFO) also improves balance.[605] Finally, it should be noted that improving balance alone may not be sufficient for preventing falls because falls may have multiple contributing causes.

Ataxia is a disorder of coordinated muscle activity during voluntary movement associated with injury to the cerebellum, cerebellar peduncles, and brainstem cerebellar tracts. Patients with ataxia have delayed movement initiation, timing errors, abnormal limb trajectories, and dysmetria.[606,607] Ataxia is present in 68% to 86% of patients with brainstem stroke. Ataxia typically improves during acute rehabilitation.[608,609] Ataxia without concurrent hemiparesis has a better prognosis for functional recovery in acute rehabilitation.[610] However, the presence of ataxia with or without weakness does not affect general functional recovery negatively.[608,609] Ataxia can affect the quality of use of the functional hand negatively because patients with cerebellar lesions can have impaired motor learning (eg, reduced skill improvement on a pursuit rotor task or ability to learn a finger sequence).[611,612] Despite this, case studies indicate that intensive task-oriented therapy may improve motor performance and actual use of ataxic limbs in patients with stroke-related ataxia.

After participating in a task-oriented training program, patients improved reaching speed and had reduced trunk motion during reaching.[613] Stoykov and others[606] noted that postural training and provision of trunk support could have a positive impact on upper limb motor control and dexterity in a patient with upper limb ataxia. There is a paucity of research on rehabilitation approaches to limb ataxia, but at present, postural training and task-oriented upper limb training are recommended.

Recommendations: Balance and Ataxia	Class	Level of Evidence
Individuals with stroke who have poor balance, low balance confidence, and fear of falls or are at risk for falls should be provided with a balance training program.	I	A
Individuals with stroke should be prescribed and fit with an assistive device or orthosis if appropriate to improve balance.	I	A
Individuals with stroke should be evaluated for balance, balance confidence, and fall risk.	I	C
Postural training and task-oriented therapy may be considered for rehabilitation of ataxia.	IIb	C

Mobility

The loss or difficulty with ambulation is one of the most devastating sequelae of stroke, and restoration of gait is often one of the primary goals of rehabilitation. Gait-related activities include such tasks as mobility during rising to stand, sitting down, stair climbing, turning, transferring (eg, wheelchair to bed or bed to chair), using a wheelchair after stroke, walking quickly, and walking for specified distances.[614] Limitations in gait and gait-related activities are associated with an increase in fall risk. A number of systematic reviews have demonstrated enhanced outcomes of gait, gait-related activities, and ADLs[615] after intensive, repetitive task training.[616–618] The role of treadmill training and electromechanics-assisted gait training remains under study.[619]

Key training parameters for improving mobility after stroke are activity-specific and functional task practice; practice that is progressively more difficult and challenging; practice that is of sufficient intensity, frequency, and duration; and practice that is at an appropriate time relative to stroke onset.[616,620] These parameters pertain to treadmill training with or without body weight support, circuit training, mobility training, and electromechanics-assisted training.[616]

Dickstein[621] reviewed a variety of mobility training techniques and found that gains were comparable across treatments but generally insufficient for patients to advance to a higher functional walking category on the basis of the categories defined by Perry et al.[277] No benefit was seen for more complex methods such as treadmill and robotic-based interventions compared with more traditional approaches.

Circuit class therapy is a form of group treatment with exercises focused on repetitive practice of functional tasks.[622–624] A 2009 meta-analysis and recent systematic review concluded that circuit class therapy was a safe and effective method for improving mobility after stroke.[623,625]

Treadmill training in the context of task-specific training may be used with or without body weight support or therapists to assist the paretic lower extremity in stepping. A recent systematic review concluded that compared with no intervention or with an intervention with no walking component, treadmill training without body weight support improved walking speed and distance among ambulatory people after stroke. Although these benefits were maintained beyond the intervention period, it is not yet known whether treadmill training is superior to overground walking training.[621,626] Recently, it was demonstrated that treadmill training with body weight support and traditional gait training were equally effective in improving walking and transfers in patients dependent on walking assistance after stroke.[51,627] A recent systematic review, including those <3 months after stroke and unable to walk, reported that those individuals who are earlier after stroke and more severe are more likely to have a better gait recovery outcome with mechanically assisted training compared with overground training and by using a harness in conjunction with the mechanical device. Mechanically assisted walking (eg, treadmill, electromechanical gait trainer, robotic device, servo-motor) with body weight support was found to be more effective than overground walking at increasing independent walking in nonambulatory patients early after stroke.[628]

Lower Extremity Strengthening

A 2007 review concluded that graded strength training improves the ability to generate force but does not transfer to improvements in walking.[618] However, a more recent meta-analysis demonstrated that providing lower limb resistance training to community-dwelling individuals who are 6 months after stroke has the capacity to improve comfortable gait speed and total distance walked.[629] Similarly, a 2008 review concluded that despite limited long-term follow-up data, there is evidence that resistance training produces increased strength, gait speed, and functional outcomes, as well as improved quality of life.[630]

NMES has been used to stimulate the ankle dorsiflexors during the swing phase of the gait cycle. A recent systematic review revealed a small but significant treatment effect of NMES on gait capacity in individuals in the chronic phase after stroke.[631] Similarly, a meta-analysis revealed the effectiveness of NMES at improving gait speed in subjects after stroke.[632] Several RCTs have observed improved recovery of gait function after stroke in the chronic[550,633–635] and acute phases[636,637] when NMES was applied in conjunction with a conventional rehabilitation program. Studies comparing the use of an AFO to NMES in controlling foot drop during walking have found similar results.[638,639] Although subjects preferred the foot drop stimulator used in 2 multisite RCTs, both the stimulator and a conventional AFO produced equivalent functional gains.[638,640,641] Similar results were obtained in a comparison of surface peroneal nerve stimulation and use of an AFO.[642,643] Significant improvements in functional mobility were found with both peroneal nerve stimulation and AFO during the treatment period and were maintained at the 6-month follow-up.

Medications for Motor Recovery

Several medications have been studied as potential contributors to stroke recovery in general and to motor recovery in

particular, including dextroamphetamine, methylphenidate, levodopa, and SSRIs. Fluoxetine was found to be helpful for motor recovery in a double-blind, placebo-controlled trial,[644] and several smaller studies of SSRIs were also suggestive of benefit.[645–648] A systematic review and meta-analysis found evidence of benefit for SSRIs in overall disability after stroke.[649] The overall quality of these studies was not sufficient, however, to make a definitive recommendation, and larger, well-controlled trials are in progress. A randomized, double-blind, placebo-controlled trial of dextroamphetamine in 71 subjects was negative,[444] and a subsequent systematic review of the use of amphetamines for improving motor recovery after stroke found inconsistent findings,[650] and these carry a risk of adverse cardiovascular effects. A randomized, double-blind, placebo-controlled trial of levodopa found short-term benefit of this therapy compared with placebo for motor function but was limited by relatively small size (47 subjects analyzed), baseline differences in stroke severity and patient age between the 2 treatment groups, and the short-term follow-up of only 3 weeks after the completion of therapy.[651]

Acupuncture

The Ottawa Panel recommends that there is good scientific evidence to consider including acupuncture as an adjunct to standard stroke rehabilitation to improve walking mobility.[639] Shiflett[652] reviewed a number of RCTs of acupuncture for stroke recovery and performed a reanalysis suggesting that acupuncture may be effective as an adjunctive treatment for improving walking speed.

Transcutaneous Electrical Nerve Stimulation

TENS provides electrically induced sensory input to the lower limb. A meta-analysis revealed that there was insufficient research to make conclusions about the effectiveness of TENS in improving gait and gait-related activities.[632] Three subsequent RCTs provided evidence of a potential benefit of TENS on physical function after stroke, particularly when combined with task-related activity.[653–655]

Rhythmic Auditory Cueing

Rhythmic auditory cueing is a therapy approach in which overground walking is synchronized to a rhythmic auditory cue to improve temporal and spatial gait measures. An evidence synthesis found moderate evidence of improved velocity and stride length in people with stroke after gait training with rhythmic music. Synchronizing walking to rhythmic auditory cues can result in short-term improvement in gait measures of people with stroke. Further high-quality studies are needed before recommendations for clinical practice can be made.[656]

Use of AFOs

Use of AFOs is an effective method of compensating for motor impairments in the lower limb after stroke.[657–660] The reader is referred to the section below on adaptive equipment for details.

Robotic and Electromechanics-Assisted Training Devices

Robots and electromechanics-assisted training devices have been used in an effort to promote gait recovery after stroke. Most of these devices incorporate body weight support along with treadmills or foot platform pedals analogous to an elliptical trainer. Their main advantage over conventional gait training is that they reduce the need for intensive therapist support. These devices include the Lokomat, the Gait Trainer GT 1, and the AutoAmbulator. A Cochrane systematic review updated in 2013 concluded that patients with stroke who received electromechanics-assisted gait training in combination with PT were more likely to achieve independent walking than patients receiving gait training without these devices, but it did not find an increase in gait velocity.[661] The review concluded that the individuals most likely to benefit from this therapy appear to be those who are within the first 3 months after stroke and those who are unable to walk. In contrast, a study by Hornby et al[662] demonstrated greater improvement in gait velocity and single limb support time on the paretic limb after therapist-assisted locomotor training compared with robotic-assisted locomotor training.[662] A systematic review found improved balance for stroke survivors receiving robotic gait training, but there was insufficient evidence comparing robotic gait training with conventional gait training to determine whether these therapies are similar in this regard.[663]

Exoskeletal wearable lower limb robotic devices are also available for gait training after stroke and allow overground walking with the device. Most of these devices (eg, Ekso, Ekso Bionics, Richmond, CA; Indego, Parker-Hannifin; and ReWalk, Marlborough, MA) are bilateral in design, although unilateral exoskeletal wearable devices have also been developed (eg, Bionic Leg, AlterG, Fremont, CA). Although a pilot study of a unilateral device did not demonstrate benefit compared with conventional exercise therapy,[664] most of the devices in this class have not yet been examined in controlled trials for stroke survivors. Overall, although robotic therapy remains a promising therapy as an adjunct to conventional gait training, further studies are needed to clarify the optimal device type, training protocols, and patient selection to maximize benefits.

Electromyographic Biofeedback

Electromyographic biofeedback is a technique that uses visual or audio signals to provide the patient with feedback on his/her muscle activity. The literature on the use of electromyographic biofeedback plus conventional rehabilitation includes some studies suggesting improved motor power, functional recovery, and gait quality compared with conventional rehabilitation alone. However, a 2007 Cochrane database systematic review did not find a treatment benefit. The results of the systematic review are limited because the trials were small, were generally poorly designed, and used varying outcome measures, making it difficult to compare across studies.[665]

Virtual Reality

Virtual reality is the use of computerized technology to allow patients to engage in specific task practice within a computer-generated visual environment in a naturalistic fashion. An environment that may be more interesting to a subject may enhance motivation to practice. In 2011, the Cochrane Stroke Group concluded that there was insufficient evidence to reach conclusions about the effect of virtual reality and interactive video gaming on gait speed.[666] However, a recent systematic

review[667] suggests that virtual reality promotes changes in gait parameters despite diversity of protocols, participant characteristics, and number of subjects included.

Traditional Physiotherapeutic Approaches (Neurodevelopmental Therapy/Bobath, Brunnstrum, Proprioceptive Neuromuscular Facilitation)

A recent systematic review conducted by Langhammer and Stanghelle[668] assessed the efficacy of the traditional physiotherapeutic approaches. Although improvements in motor function were demonstrated, no trial showed that these approaches were superior to the respective comparison therapies.[668] Similarly, it was concluded that neurodevelopmental approaches were equivalent or inferior to other approaches in improving walking ability in a 2007 systematic review.[618]

Water-Based Exercises

The conclusions drawn in a 2012 Cochrane systematic review revealed that the evidence from RCTs to date does not confirm or refute that water-based exercises after stroke might help to improve gait and gait-related activities.[593]

Recommendations: Mobility	Class	Level of Evidence
Intensive, repetitive, mobility- task training is recommended for all individuals with gait limitations after stroke.	I	A
An AFO after stroke is recommended in individuals with remediable gait impairments (eg, foot drop) to compensate for foot drop and to improve mobility and paretic ankle and knee kinematics, kinetics, and energy cost of walking.	I	A
Group therapy with circuit training is a reasonable approach to improve walking.	IIa	A
Incorporating cardiovascular exercise and strengthening interventions is reasonable to consider for recovery of gait capacity and gait-related mobility tasks.	IIa	A
NMES is reasonable to consider as an alternative to an AFO for foot drop.	IIa	A
Practice walking with either a treadmill (with or without body-weight support) or overground walking exercise training combined with conventional rehabilitation may be reasonable for recovery of walking function.	IIb	A
Robot-assisted movement training to improve motor function and mobility after stroke in combination with conventional therapy may be considered.	IIb	A
Mechanically assisted walking (treadmill, electromechanical gait trainer, robotic device, servo-motor) with body weight support may be considered for patients who are nonambulatory or have low ambulatory ability early after stroke.	IIb	A
There is insufficient evidence to recommend acupuncture for facilitating motor recovery and walking mobility.	IIb	B
The effectiveness of TENS in conjunction with everyday activities for improving mobility, lower extremity strength, and gait speed is uncertain.	IIb	B
The effectiveness of rhythmic auditory cueing to improve walking speed and coordination is uncertain.	IIb	B
The usefulness of electromyography biofeedback during gait training in patients after stroke is uncertain.	IIb	B
Virtual reality may be beneficial for the improvement of gait.	IIb	B
The effectiveness of neurophysiological approaches (ie, neurodevelopmental therapy, proprioceptive neuromuscular facilitation) compared with other treatment approaches for motor retraining after an acute stroke has not been established.	IIb	B
The effectiveness of water-based exercise for motor recovery after an acute stroke is unclear.	IIb	B
The effectiveness of fluoxetine or other SSRIs to enhance motor recovery is not well established.	IIb	B
The effectiveness of levodopa to enhance motor recovery is not well established.	IIb	B
The use of dextroamphetamine or methylphenidate to facilitate motor recovery is not recommended.	III	B

Upper Extremity Activity (Includes ADLs, IADLs, Touch, Proprioception)

The majority of individuals with stroke experience problems with the upper extremity, most commonly paresis,[670,671] which is the key impairment in most cases.[333,337,341,672,673] Only a small portion of people fully recover from upper limb paresis after a stroke, with the remainder left with lingering upper extremity impairments, activity limitations, and participation restrictions.[338,674] An inability to use the upper extremity in daily life can lead to loss of independence with ADLs and of important occupations (eg, work, driving) and can even contribute to institutionalization.

Task-specific training, or functional task practice, is based on the premise that practice of an action results in improved performance of that action and is focused on learning or relearning a motor skill.[675,676] Task-specific practice is an element of or used in combination with many upper extremity interventions such as constraint-induced movement therapy (CIMT) and NMES. Across a large number of studies, the key elements of task-specific training are repeated, challenging practice of functional, goal-oriented activities. Trunk restraint during task-specific training is beneficial in reducing compensatory trunk movements and promoting proximal movement control.[677,678] Strengthening upper extremity muscles may be beneficial as an adjunct to task-specific training,[679,680] when therapy time permits, or when the strengthening activities can be performed outside formal therapy sessions.

CIMT has been demonstrated to improve upper extremity activity, participation, and quality of life in individuals with baseline ability to control wrist and finger extension compared with usual care.[52,678,681–685] It is less clear whether CIMT has

any advantage over dose-matched conventional upper limb therapy.[686,687] CIMT can be delivered in its original form 3 to 6 h/d for 5 d/wk for 2 weeks or in a modified version 1 h/d for 3 d/wk for 10 weeks. The modified CIMT intervention appears to result in improvements that are comparable to the original version, although it has not been as extensively tested.[688–694]

Bilateral upper limb training has not been as well studied as CIMT. Two meta-analyses and more recent trials suggest that there is a small but measurable benefit compared with no intervention, but no consistent evidence of superiority over other task-specific training interventions has been shown.[695–699] Recent trials comparing bilateral training with CIMT or modified CIMT indicate that they may have similar efficacy for individuals with preserved isolated wrist and finger movement.[700–702]

For individuals with more severe paresis, the potential for recovery of upper extremity function is greatly reduced, particularly later after stroke.[674] Robotic therapy can deliver larger amounts of upper extremity movement practice for these individuals. There are a variety of types of upper extremity robots, consisting primarily of workstation devices used in a rehabilitation facility but also including some wearable exoskeletal devices that can be used in a home environment. A Cochrane review updated in 2012 found that upper limb robotic therapy provided benefit with regard to ADLs and arm function but not arm muscle strength.[703] The variation within the trials with regard to duration and amount of training, the specific devices used, and patient populations studied limits the interpretation of these results. Moreover, many of the studies performed with robot-aided therapy have compared it with usual care rather than dose-matched conventional upper limb exercise therapy. Those studies incorporating dose-matched exercise as a comparison treatment show minimal or no differences in the efficacy between these 2 treatments.[704,705] Overall, robotic therapy appears to provide some benefit for upper extremity motor abilities and participation but is of uncertain utility compared with dose-matched conventional upper limb exercise therapies.[706–713]

NMES can be used for those with minimal ability for volitional muscle activation. It may be beneficial for improving upper extremity activity if used in combination with task-specific training, particularly when applied to the wrist and hand muscles.[714–716] Alternatively, it is beneficial in preventing or correcting shoulder subluxation.[125,132,717]

Mental practice, or mental imagery, may be useful as an adjunct to upper extremity exercise therapies.[718–722] Initial training in mental practice occurs within a therapy session, but additional practice can happen outside formal therapy time. It is feasible to integrate mental practice with physical practice.[723] Longer durations of mental practice appear to produce more benefit.[724]

Virtual reality and video gaming have the potential to increase participant engagement and the amount of upper extremity movement practice. Computer-based video games are widely available for recreational purposes for the general public, including those with handheld controllers (eg, Wii) and motion capture systems (Xbox Kinect, Microsoft, Inc). In addition, these systems can be used as remotely monitored telerehabilitation systems.[725] To date, most studies of efficacy have been small and have used a variety of technologies and training programs, making generalization difficult. A Cochrane review[666] found benefit in terms of upper limb function and ADLs but no improvements in upper limb strength. The studies were of low quality in many cases, reducing confidence in this finding. Efficacy of Virtual Reality Exercises in STroke rehabilitation (EVREST),[727] a multicenter, randomized, clinical trial, is under way that may provide more definitive evidence. At present, virtual reality and video gaming are reasonable alternative methods to engage individuals with stroke in the rehabilitation process and to increase the amount of movement practice.[666,728,729,731–733]

A variety of interventions have been the focus of ≥1 studies but have not yet been shown to be consistently beneficial for upper limb motor rehabilitation. These include somatosensory stimulation[734–738] and noninvasive brain stimulation (transcranial magnetic stimulation or tDCS) in combination with upper extremity exercise therapy,[739–746] interventions targeting motor apraxia,[458] and manual therapy approaches such as stretching, passive exercise, and mobilization,[748] although these approaches are a routine part of practice for individuals with more severely affected upper extremities to prevent contractures and to manage spasticity.

Finally, upper extremity rehabilitation programs can be delivered in a variety of settings such as inpatient hospitals and outpatient clinics and within the home. A recent systematic review and subsequent RCT indicate that both outpatient and home service delivery models produce similar results on upper extremity activity, including the ability to perform ADLs.[749,750]

Recommendations: Upper Extremity Activity, Including ADLs, IADLs, Touch, and Proprioception	Class	Level of Evidence
Functional tasks should be practiced; that is, task-specific training, in which the tasks are graded to challenge individual capabilities, practiced repeatedly, and progressed in difficulty on a frequent basis.	I	A
All individuals with stroke should receive ADL training tailored to individual needs and eventual discharge setting.	I	A
All individuals with stroke should receive IADL training tailored to individual needs and eventual discharge setting.	I	B
CIMT or its modified version is reasonable to consider for eligible stroke survivors.	IIa	A
Robotic therapy is reasonable to consider to deliver more intensive practice for individuals with moderate to severe upper limb paresis.	IIa	A
NMES is reasonable to consider for individuals with minimal volitional movement within the first few months after stroke or for individuals with shoulder subluxation.	IIa	A
Mental practice is reasonable to consider as an adjunct to upper extremity rehabilitation services.	IIa	A
Strengthening exercises are reasonable to consider as an adjunct to functional task practice.	IIa	B
Virtual reality is reasonable to consider as a method for delivering upper extremity movement practice.	IIa	B

Recommendations: Upper Extremity Activity, Including ADLs, IADLs, Touch, and Proprioception (Continued)	Class	Level of Evidence
Somatosensory retraining to improve sensory discrimination may be considered for stroke survivors with somatosensory loss.	IIb	B
Bilateral training paradigms may be useful for upper limb therapy.	IIb	A
Acupuncture is not recommended for the improvement of ADLs and upper extremity activity.	III	A

Adaptive Equipment, Durable Medical Devices, Orthotics, and Wheelchairs

Many patients require assistive devices, adaptive equipment, mobility aids, wheelchairs, and orthoses to maximize independent functioning after stroke. Many types of adaptive devices and equipment are available. Type and level of functional deficit, degree of achieved adaptation, and the structural characteristics of the living environment determine the need for a particular item.

A vast array of adaptive devices are available, including devices to make eating, bathing, grooming, and dressing easier for patients with functional limitations. The Convention on the Rights of Persons With Disabilities supports facilitating access by individuals with disabilities to quality mobility aids, devices, and assistive technologies by making them available at affordable cost.[751] Many patients may need to use adaptive devices early during rehabilitation but will not require long-term use. This should be taken into account when the provision of a device is considered. Examples of adaptive devices include (but are not limited to) eating utensils with built-up handles, rocker knives, plate guards, nonskid placemats, long-handled sponges for bathing, handheld showers, tub and shower chairs, grab bars for bathrooms, and elevated toilet seats. A meta-analysis found that OT increased independence in ADLs.[752] The protocols in these studies focused on improving personal ADLs, including the provision and training in the use of adaptive equipment.

Stroke can cause a number of gait impairments; consequently, stroke patients often have an unstable, inefficient walking pattern and a high risk for falls (see the sections Prevention of Falls and Mobility). More than half of stroke patients require an assistive device (cane, walker, wheelchair) to assist mobility, most frequently a cane.[753] Studies that have assessed the immediate effects of different assistive devices provided in random order have shown that ambulatory function (speed, step length, functional ambulation category) was improved with a cane after stroke.[754,755] Patients felt that their walking, walking confidence, and walking safety improved and said they would rather walk with an assistive device than delay walking to achieve a normal gait pattern.[755] Walking devices increase the base of support around a patient's center of gravity and reduce the balance and effort needed to walk. Walking aids include (but are not limited to) the following:

- Single-point cane: a conventional cane that provides 1 point of contact and limited improvement in balance and stability.
- Tripod and quad cane: canes that have 3 or 4 points of contact and offer more stability than a single-point cane but are heavier, bulkier, and more awkward to use. A quad cane has been shown to reduce postural sway more than a single-point cane in patients with stroke.[756]
- Two-wheeled walkers, 4-wheeled walkers, or rollators (ie, 4-wheeled walker with a seat): devices that require the use of both arms and legs. They support more body weight than a cane and are more energy efficient but cannot be used on stairs. They should be lightweight and foldable for use outside the home. Four-wheeled walkers may require hand-motor coordination to manage handbrakes on a downhill slope.

For individuals with stroke who cannot ambulate safely, a wheelchair can enhance mobility. Up to 40% of stroke patients have been reported to use a manual wheelchair at rehabilitation discharge.[757] A wheelchair may be required when a patient is unable to ambulate or when there is concern about his/her ability to ambulate safely or functionally.[758] The patient often propels the chair by using the less affected hand on 1 wheel and foot on the floor. Self-propulsion in a wheelchair early after a stroke has not been shown to be detrimental to muscle tone or functional outcomes.[759] Many stroke survivors also use manual wheelchairs for longer-distance travel such as shopping or physician appointments although they are capable of short-distance ambulation within the home. In these situations, the wheelchair is typically propelled by a caregiver.

Although powered wheelchairs are less commonly used after stroke, many stroke patients can learn to use powered wheelchairs safely with appropriate training.[760] Wheelchair designs vary greatly, and a wheelchair prescription should be specific to the patient's needs and environment and patient and family/caregiver preferences. The prescription of a wheelchair (manual or powered) in the community can increase participation and improve quality of life.[761,762]

A common approach to managing the lower limb motor impairments resulting from a stroke is to use an orthotic device (an orthosis), most commonly an AFO. Meta-analyses have shown a favorable impact of lower limb orthoses on walking disability (speed), walking impairment (step/stride length), and balance (weight distribution in standing).[659,605] However, the included studies examined only the immediate effects while the orthosis was worn.[659] A recent meta-analysis and systematic review suggested the potential mechanism(s) associated with the above effects by demonstrating a positive effect of an AFO on ankle kinematics, knee kinematics in stance phase, kinetics, and energy cost.[658] Two RCTs[763,764] showed that after 3 months of AFO use, AFO users had better mobility while wearing the AFO. One small RCT[764] found that although a dynamic hinged AFO improved ambulatory function over a standard AFO, it induced some dependence; the standard AFO group performed better after 3 months of use when walking without any orthosis. With respect to the patient's perspective, it is important to determine whether an individual is willing to wear an AFO regularly. Considerations to improve compliance with using an AFO

include verification that it fits correctly and comfortably and is acceptable in appearance.

Recommendations: Adaptive Equipment, Durable Medical Devices, Orthotics, and Wheelchairs	Class	Level of Evidence
Ambulatory assistive devices (eg, cane, walker) should be used to help with gait and balance impairments, as well as mobility efficiency and safety, when needed.	I	B
AFOs should be used for ankle instability or dorsiflexor weakness.	I	B
Wheelchairs should be used for nonambulatory individuals or those with limited walking ability.	I	C
Adaptive and assistive devices should be used for safety and function if other methods of performing the task/activity are not available or cannot be learned or if the patient's safety is a concern.	I	C

Motor Impairment and Recovery: Deconditioning and Fitness After Stroke

People having sustained a stroke present with varying degrees of compromised cardiorespiratory fitness, as reflected in peak $\dot{V}o_2$ levels of 8 to 22 mL $O_2 \cdot kg^{-1} \cdot min^{-1}$ (an average of ≈53% of age- and sex-matched normative values).[765] Given that 15 to 18 mL $O_2 \cdot kg^{-1} \cdot min^{-1}$ is deemed necessary for independent living, the state of fitness after stroke is a significant health, functional, and quality-of-life issue.[766] Multiple factors before stroke, at the time of stroke, and after stroke help explain this state. The result is often a profound and persistent deconditioned state that leads to further physical inactivity, reduced socialization, and heightened risk of further vascular events, including a second stroke.

The lifetime risk of stroke recurrence among people with stroke is ≈30%, and the risk of either nonstroke vascular death or myocardial infarction is ≈2%/y.[767] Recurrence of stroke has been found to vary by sex: 24% of women and 42% of men experience a recurrence within 5 years of onset.[768,769] The reported rates of vascular risks are high among people who have a recurrence: The prevalence of hypertension (75%), ischemic heart disease (37%), hyperlipidemia (56%), atrial fibrillation (29%), and diabetes mellitus (24%) is significant in individuals who sustain a second stroke.[770] For a comprehensive and timely set of evidence-based recommendations for all clinicians who manage secondary prevention, the reader is directed to the AHA/ASA guidelines for the prevention of stroke in patients with stroke and transient ischemic attack.[206]

Activity level after stroke is an independent predictor of life satisfaction, after controlling for demographic variables and depression.[771] Low levels of physical activity have been documented across the continuum of stroke severity and care, even among people who have had what is considered a mild stroke.[772] A behavioral mapping study revealed that activity out of bed during acute stroke care (ie, <14 days after the onset of stroke) varied widely among the European countries studied, ranging between 2% and 56% of the total time of the observation periods.[773] Stroke rehabilitation sessions have been reported to be of inadequate intensity to induce a cardiovascular training effect,[774,775] with an average of 17 minutes spent in standing and walking per session.[776] Daily ambulatory activity of community-dwelling stroke survivors has been reported to be 50%[777] to 61%[778] of that of nondisabled control subjects, less than that of older adults with other chronic health conditions of the musculoskeletal or cardiovascular system.[779] At the same time, self-reports of physical activity among people with chronic stroke tend to be highly inflated.[780]

Sedentary behavior is defined as a waking behavior such as sitting or lying that involves an energy expenditure of <1.5 metabolic equivalents (METs; 1 MET is the amount of oxygen consumed while sitting at rest and is ≈3.5 mL $O_2 \cdot kg^{-1} \cdot min^{-1}$). Less sedentary behavior has been found to be an independent predictor of successful aging among individuals ≥45 years of age.[781] Moreover, prolonged bouts of sedentary behavior and total amount of physical inactivity appear to be independently related to risk factors associated with metabolic syndrome (eg, increased waist circumference, body mass index, triglycerides, and plasma glucose).[782] To date, little research has been conducted on patterns of sedentary behavior after stroke. A cohort study reported that people after stroke (n=25) spent less time being physically active and had fewer breaks in sedentary behavior at 1 week, 3 months, and 6 months after stroke compared with nondisabled control subjects matched by age, sex, and body mass index.[781]

Intervention strategies are needed to break the relentless poststroke cycle of reduced physical activity leading to further reductions in functional capacity and heightened risk of secondary complications. The central role that aerobic exercise plays in improving cardiorespiratory fitness is well known and strongly supported by evidence.[783] It is now clear that people with mild or moderate stroke are capable of improving their exercise capacity through exercise or structured physical activity.[784–786] Enhanced fitness enables individuals to engage in daily physical activities at a lower percentage of their maximal capacity and hence with a lower physiological burden.[787] Exercise-induced gains in peak $\dot{V}o_2$ have been relatively modest, with the magnitude of improvement ranging from 0.3 METs[788] to 1.2 METs[789] in trials of individuals in the subacute poststroke period and averaging ≈0.5 METs in trials of individuals with chronic stroke. However, even modest improvements in exercise capacity are associated with reduced cardiac complications in people with coronary artery disease[790] and increased survival (10%–25% reduction in mortality for every 1-MET increase in exercise capacity).[791]

Emerging research suggests that aerobic exercise after stroke confers clinically meaningful health benefits in numerous physical and psychosocial domains that extend well beyond the cardiorespiratory system. At the impairment level, some evidence exists that exercise positively affect bone health[792] (but not risk of fracture[253]), fatigue,[411] executive functioning and memory, depressive symptoms,[794,795] and emotional well-being[188] (see the earlier section on the benefits of exercise for poststroke depression). At the activity level, improvements have been noted in walking ability[796] (endurance more than speed[797]) and upper extremity muscle strength.[680] At the participation level, preliminary evidence has reported an association between exercise training after

stroke and social participation,[188] as well as return to work.[799] Finally, a meta-analysis reported that exercise interventions for community-based stroke survivors have significant effects on health-related quality of life, which is arguably the ultimate goal of stroke rehabilitation.[800]

The role of exercise in preventing further vascular events after stroke, including a second stroke, myocardial infarction, and vascular death, has not been firmly established.[786] There is evidence that aerobic exercise as a stand-alone intervention after stroke improves certain vascular risk factors, including glucose intolerance,[801] vascular stiffness,[802] high resting blood pressure,[803,804] and elevated total cholesterol.[803] A multifaceted approach that combines nonpharmacological interventions (ie, exercise, dietary advice, lifestyle counseling, and patient education) and appropriate pharmacological therapy has been encouraged,[805] but the effectiveness of specific nonpharmacological components remains to be investigated.[806] Pilot studies of second stroke prevention using a cardiac rehabilitation approach have demonstrated a reduction in cardiac risk scores[807] and improvements in total cholesterol, body composition, and resting blood pressure,[808] but these results must be confirmed in larger, controlled trials. Despite a lack of robust evidence, exercise and physical activity are regarded as key components of comprehensive stroke risk-reduction efforts.[206]

Individually Tailored Exercise Program Prescription

Active participation in exercise should be initiated early after stroke for several reasons: to minimize the detrimental effects of bedrest and inactivity, to capitalize on heightened neuroplasticity present in the early poststroke period, and to begin the important process of fostering exercise self-efficacy and self-monitoring. Mobilization within 24 hours after stroke has been shown in a phase II trial to accelerate recovery of walking and functional ability[809]; however, a recent study reported possible detrimental effects with such early activity.[810] In the recently completed AVERT RCT, the high-dose, very early mobilization protocol was associated with a reduction in the odds of a favorable outcome at 3 months.[58] In contrast to very early mobilization, there is growing evidence that the initiation of aerobic exercise in the subacute period (ie, a mean of 11–78 days after stroke) is safe and effective in improving exercise capacity and walking endurance.[784,789] Specific recommendations for graded exercise testing can be found in the AHA guideline on stable ischemic heart disease.[811,812] The ASH/ASA scientific statement "Physical Activity and Exercise Recommendations for Stroke Survivors"[813] provides more details on the pre-exercise evaluation.

As with all aspects of stroke rehabilitation, the training regimen should emphasize repetition, gradually progressive task difficulty, and functional practice.[814] The standard parameters of exercise prescription, that is, mode, frequency, duration, and intensity, require careful consideration to ensure a safe intervention that accommodates the individual's functional limitations, comorbidities, motivation, and goals. Because the optimal training parameters have not been determined specifically for the stroke population,[815] current recommendations are based on general exercise guidelines[816] and on protocols shown to be effective in training studies involving people after stroke.[796] A wide range of exercise modes (eg, treadmill, body weight–supported treadmill, recumbent bicycle, cycle ergometer, stepper, aqua aerobics) have been used effectively in training studies.[796] Because overground walking at self-selected speeds after stroke elicits oxidative stress in the range of 2.6 METs[818] to 3.4 METs,[819] it may be an appropriate aerobic modality for people who are moderately unfit. Preliminary evidence also suggests that participants in the chronic poststroke period can achieve low to moderate exercise intensities when playing an active video game (Nintendo Wii Sports).[820] Furthermore, a recent trial involving people with subacute stroke demonstrated greater gains in peak $\dot{V}o_2$ with a combination of robot-assisted gait training and conventional PT than conventional therapy alone.[821]

There is some evidence that the combination of aerobic and strengthening exercises in nonstroke populations enhances health outcomes (eg, reducing resting blood pressure[822] and metabolic syndrome risk factors[823]). However, conclusions from a meta-analysis indicated the need for further investigation to determine whether combining aerobic and strengthening exercises bestows similar advantages in the stroke population.[785] Since then, a small, single-cohort study involving individuals with chronic stroke reported improved muscle strength and walking endurance but no change in peak $\dot{V}o_2$ after an 8-week program of lower extremity strength training at 85% to 95% of 1-repetition maximum.[825]

Benefits derived from aerobic training are dose dependent. The appropriate total volume of exercise, achieved through various combinations of frequency, duration, and intensity, is key to attaining and maintaining cardiorespiratory fitness. Nevertheless, there appears to be a minimal threshold for each parameter to achieve the most favorable outcomes. The frequency of structured aerobic exercise should be at least 3 d/wk for a minimum of 8 weeks, with lighter forms of physical activity (eg, brisk walking, stair climbing) promoted on the other days of the week. The duration of each session should be a minimum of 20 minutes in the training zone in addition to 3- to 5-minute periods of low-intensity warm-up and cool-down. For very deconditioned individuals, including many people after stroke, exercise may be delivered in multiple bouts of ≤5 minutes in a single session or throughout the day.[783]

Exercise intensity is the most challenging parameter to determine but also the most critical to ensure that a dose that is safe, attainable, and adequate to elicit a training effect. Factors that affect intensity are baseline fitness level, neurological and cardiac status, comorbidities, motivation, and goals of the program. Heart rate is typically used to establish and monitor training intensity, with resting rate measured after a minimum of 5 minutes of quiet sitting and exercise heart rate measured with an electronic device. It is important to note that β-blocker medication depresses the heart rate response to exercise and that atrial fibrillation (common after stroke) yields a chronically irregular ventricular rate, thus posing challenges in the prescription of exercise intensity.[826] Various recommendations have been made on the appropriate exercise intensity for patients after stroke, including "moderate training intensities,"[206] 40% to 70% of heart rate reserve (maximal heart rate minus resting heart rate),[827] and 50% to 80% of maximal heart rate.[785] A meta-analysis concluded that for extremely unfit individuals, intensities as low as 30% of heart rate reserve can induce a cardiovascular training

effect.[828] At the other end of the spectrum, 2 pilot exercise studies provided early evidence supporting the safe and effective use, at least in the chronic stroke population, of high-intensity exercise (ie, 60%–80% of heart rate reserve,[829] 85%–95% of peak heart rate[830]). The recent AHA/ASA scientific statement "Physical Activity and Exercise Recommendations for Stroke Survivors"[813] gives more details on exercise/physical activity recommendations for stroke survivors.

Chronic Care Management: Home- and Community-Based Participation

Because exercise confers health benefits even years after stroke, participation in physical activity should be encouraged regardless of how much time has elapsed since stroke onset. The effectiveness of exercise training in the chronic stages of stroke is no longer in question; in fact, the vast majority of fitness trials have involved people at this stage of stroke chronicity.[796] Moreover, it has long been recognized that benefits of training decline significantly without ongoing participation in physical activity.[831] Thus, physical activity designed to promote cardiovascular fitness should be an important aspect of community reintegration after stroke. However, adherence to regular physical activity is influenced by a host of individual factors (eg, stroke severity, preexisting/comorbid conditions, motivation, health beliefs, exercise history, fatigue, depression, adaptability, coping skills, cognition), social/cultural factors (eg, family support, social policies, professionals' attitudes about exercise, social norms and stigmas), and environmental factors (eg, program costs, access to transportation, fitness facilities and equipment).[832,833] These factors must be systematically addressed to achieve the goal of long-term commitment to healthy, active living behaviors among stroke survivors.

Strategies to instill long-term commitment to a physically active lifestyle should be initiated during formal stroke rehabilitation, but evidence to guide intervention is lacking.[834] Considering the high likelihood of a prestroke history of sedentary behavior, fostering exercise self-efficacy is particularly important to ease the transition from structured, institution-based aerobic training to home- and community-based physical activity.[834] Incorporating principles of adult learning (eg, observation, practice, repetition, relevance) and self-management (eg, problem solving, goal setting, making choices, taking action, using available resources) is essential.[835,836] Early participation in fitness training and education on lifestyle choices, risk factor reduction, and secondary prevention may facilitate uptake of healthy behaviors. Myths about exercise (exercise is unsafe, causes second stroke, increases fatigability)[833,837,838] need to be dispelled in the process of rehabilitation. Most important, patients' preferences concerning exercise must be sought out and respected.[839] Finally, stroke survivors who are unable to exercise will need alternative solutions to maintain an active and engaged lifestyle.

The fitness program should be customized on the basis of the participant's functional limitations, long-term health-related goals, and social and environmental factors. Periodic monitoring of the intensity of the program and the participant's fitness level and adherence may be reasonable. Investigations of the effectiveness of predischarge counseling in increasing long-term adherence to activity after stroke have yielded mixed results.[840,841] In addition, a self-guided stroke workbook did not elicit demonstrable changes in physical activity.[842] It appears that passive approaches (professional advice, written material) alone are not adequate to increase physical activity after stroke.[841] Given that the most common motivator to physical activity after stroke is the opportunity to meet other stroke survivors,[833] together with the findings that stroke survivors report greater preferences for exercising in groups and at fitness centers,[839] it is prudent to direct resources to facilitating participation in physical activity in community settings. Developing partnerships between healthcare professionals and fitness centers or community exercise programs could help to address a concern expressed by patients after stroke that exercise instructors must be suitably trained and knowledgeable about stroke.[837] Integrated care models that include periodic liaison between care providers and patients after stroke via telephone or electronic follow-up may be the solution to providing ongoing support for physical activity.[843]

Recommendations: Chronic Care Management: Home- and Community-Based Participation	Class	Level of Evidence
After successful screening, an individually tailored exercise program is indicated to enhance cardiorespiratory fitness and to reduce the risk of stroke recurrence.	I	A (for improved fitness); B (for reduction of stroke risk)
After completion of formal stroke rehabilitation, participation in a program of exercise or physical activity at home or in the community is recommended.	I	A

Treatments/Interventions for Visual Impairments

Treatments and interventions for visual impairments after stroke focus on 3 areas: deficits in eye movements, deficits in visual fields, and deficits in visual-spatial or perceptual deficits. There have been 7 systematic reviews of treatments for visual impairments after stroke.[382,418,493,737,844,846,847] These systematic reviews covered reports up to 2011. The literature is generally limited in this area, and the methodological quality was poor in general or poorly reported, providing insufficient high-quality evidence on which to reach generalizable conclusions. However, limited evidence suggested that compensatory scanning training is effective at improving scanning and reading outcomes but not improving visual field deficits. There was insufficient evidence of the impact of compensatory scanning training on ADLs. There was also insufficient evidence about the benefits of vision restoration therapy (restitutive intervention) after stroke. Across these systematic reviews, 2 studies targeted eye movement deficits, 2 case studies and 1 nonrandomized prospective study assessed interventions for visual field cuts, and 3 studies dealt with perceptual deficits. In general, there was insufficient evidence to reach conclusions about the effectiveness of interventions for patients with any of these visual deficits after stroke. Barrett[844] reviewed the behavioral optometry literature. Behavioral optometry proposes that eye and visual function can be improved through various vision therapy methods, including

eye exercises and the use of lenses, prisms, filters, occluders, specialized instruments, and computer programs to improve vision skills such as eye movement control, eye focusing, and coordination. Barrett concluded that there is a paucity of controlled trials in the literature to support behavioral optometry approaches and that a large majority of behavioral management approaches are not evidence based. However, there was evidence supporting the use of eye exercises for treatment of convergence insufficiency, the use of yoked prisms in stroke patients with visual field cuts, and the use of vision rehabilitation of visual field defects (selecting areas of residual vision that are then stimulated during computer-assisted training to achieve visual field enlargement).

A number of studies included as part of a broader review dealing with rehabilitation of cognitive deficits[418] focused on visual neglect, which is addressed elsewhere in this guideline. However, with regard to other forms of visual deficits, those studies concluded that systematic training of visual organization skills may be considered for individuals with visual perceptual deficits, without visual neglect, and after right hemispheric stroke as part of acute rehabilitation and that computer-based interventions intended to produce extension of damaged visual fields may be considered for people with traumatic brain injury or stroke.

In addition to those covered by the 7 systematic reviews, 3 studies dealt with treatments for visual impairments after stroke.[848–850] Mödden et al[850] concluded that computer-based compensatory therapy improved functional deficits after visual field loss compared with compensation strategies training (ie, standard OT). A 2010 study[848] concluded that multimodal audiovisual exploration training is more effective than exploration training alone. Finally, a 2012 study[849] reported that a virtual reality training group showed a significant difference in all Motor-Free Visual Perception Test raw scores and response times, with improvements in recognizing shapes, solving pictorial puzzles, and object perception.

Recommendations: Treatments/Interventions for Visual Impairments	Class	Level of Evidence
For deficits in eye movements:		
Eye exercises for treatment of convergence insufficiency are recommended.	I	A
Compensatory scanning training may be considered for improving functional ADLs.	IIb	B
Compensatory scanning training may be considered for improving scanning and reading outcomes.	IIb	C
For deficits in visual fields:		
Yoked prisms may be useful to help patients compensate for visual field cuts.	IIb	B
Compensatory scanning training may be considered for improving functional deficits after visual field loss but is not effective at reducing visual field deficits.	IIb	B
Computerized vision restoration training may be considered to expand visual fields, but evidence of its usefulness is lacking.	IIb	C
For visual-spatial/perceptual deficits:		
Multimodal audiovisual spatial exploration training appears to be more effective than visual spatial exploration training alone and is recommended to improve visual scanning	I	B
There is insufficient evidence to support or refute any specific intervention as effective at reducing the impact of impaired perceptual functioning.	IIb	B
The use of virtual reality environments to improve visual-spatial/perceptual functioning may be considered.	IIb	B
The use of behavioral optometry approaches involving eye exercises and the use of lenses and colored filters to improve eye movement control, eye focusing, and eye coordination is not recommended.	III	B

Hearing Loss

The healthcare provider's ability to effectively communicate with a patient who has had a stroke is essential to provide adequate patient care. Unfortunately, hearing impairment is common among stroke patients, and this may significantly affect communication. This impairment must be considered when communicating with patients to provide effective patient-centered care.

Hearing impairment is commonly associated with aging, and the associated communication difficulties are only further exacerbated after stroke. It has been reported that the most common type of communication impairment within an acute hospital stroke unit is a hearing impairment, with estimates that 67% to 90% of these patients have a mild or greater hearing impairment.[851] Although a sudden onset of hearing loss resulting from a stroke is uncommon, stroke patients often have a preexisting or an undiagnosed hearing loss. In some instances, difficulty hearing may simply be caused by cerumen impaction or may be attributable to age-related hearing loss.[851] Stroke patients with communication or cognitive impairments may be unable to relay information about their hearing history. Reports from family or significant others often give healthcare providers some indication of the patient's hearing abilities before the stroke. It is recommended that any noticeable hearing impairment be assessed and documented to improve patient care. Edwards et al[852] reported that 86% of stroke patients in acute care facilities had a hearing impairment that was not documented in their chart.

Amplification can often help patients who have had a stroke to overcome the barrier of a hearing impairment. One study reported that of 52 patients who had suffered a stroke and had a hearing impairment, 11 (21%) owned hearing aids.[851] By verifying that the hearing aids or amplification devices are working and reminding the patients to wear them, healthcare providers will be able to better communicate with these patients. Unfortunately, not all patients with a hearing impairment have hearing aids. In this case, it is important to incorporate communication strategies such as looking at the

patient when talking to him/her and minimizing the level of background noise.

Recommendations: Hearing Loss	Class	Level of Evidence
If a patient is suspected of a hearing impairment, it is reasonable to refer to an audiologist for audiometric testing.	IIa	C
It is reasonable to use some form of amplification (eg, hearing aids).	IIa	C
It is reasonable to use communication strategies such as looking at the patient when speaking.	IIa	C
It is reasonable to minimize the level of background noise in the patient's environment.	IIa	C

Transitions in Care and Community Rehabilitation

Ensuring Medical and Rehabilitation Continuity Through the Rehabilitation Process and Into the Community

The transition from inpatient care to home after a stroke can be difficult for patients and caregivers. Those patients who require ongoing rehabilitation after discharge should continue to be followed up by a care team with expertise in stroke rehabilitation whenever possible. Patients who do not require additional rehabilitation services and are discharged to home or who are profoundly and permanently disabled and discharged to a long-term care setting can be managed by a primary care provider.

One recent systematic review of 9 RCTs looked at the effectiveness of various models of primary care–based follow-up after stroke. The studies included interventions using stroke support workers, care coordinators, or case managers. As a result of the wide variability of the methodological quality of the studies, interpretation was limited. The authors noted that although patients and caregivers receiving follow-up were generally more satisfied with some aspects of communication and had a greater knowledge of stroke, there did not appear to be any gains in physical function, mood, or quality of life compared with those who did not.[853] Another systematic review examining transitional care models after stroke or myocardial infarction showed that hospital-initiated transitional care could improve some outcomes in adults hospitalized for stroke or myocardial infarction.[854]

Although not specific to stroke, a 2012 Cochrane study to determine the effectiveness of discharge planning for patients moving from an acute hospital stay to a home setting evaluated the results of 24 RCTs comparing individualized discharge plans with routine discharge care that was not tailored to the individual patient. Using data from 8098 patients, the investigators found that hospital length of stay and hospital readmissions were "statistically significantly reduced for patients admitted to hospital with a medical diagnosis and who were allocated to discharge planning (mean difference length of stay −0.91, 95% CI −1.55 to −0.27, 10 trials; readmission rates RR 0.82, 95% CI 0.73 to 0.92, 12 trials)." For elderly patients with a medical condition, they found no significant difference between groups with respect to mortality (RR, 0.99; 95% CI, 0.78–1.25, 5 trials) or being discharged from hospital to home (RR, 1.03; 95% CI, 0.93–1.14, 2 trials). The authors concluded that a "discharge plan tailored to the individual patient probably brings about reductions in hospital length of stay and readmission rates for older people admitted to hospital with a medical condition" but that the impact of discharge planning on mortality, health outcomes, and cost remained unclear.[855] For patients who have suffered a stroke and are being discharged from acute care, the discharge planning should include rehabilitation professionals who can identify long-term needs and help organize provision of those services.

Alternative methods of communication and support such as telephone visits, telehealth, or Web-based support are newer options that should be considered, particularly for patients in rural settings who may have difficulty traveling for medical care once they are discharged from formal rehabilitation services.[856] These technologies can be used for long-distance counseling, problem solving, and educational sessions, as well as for transmitting critical data such as blood pressure readings, weight, or laboratory results.

Recommendation: Ensuring Medical and Rehabilitation Continuity Through the Rehabilitation Process and Into the Community	Class	Level of Evidence
It is reasonable to consider individualized discharge planning in the transition from hospital to home.	IIa	B
It is reasonable to consider alternative methods of communication and support (eg, telephone visits, telehealth, or Web-based support), particularly for patients in rural settings.	IIa	B

Social and Family Caregiver Support

As a result of the complexity of the disease, the deficits and disability, and the change in family and significant other dynamics, the caregiver and family are integral to the post-stroke treatment plan. A major challenge is that 12% to 55% of caregivers suffer from some emotional distress,[209] most commonly depression.[238] A growing body of research is focused on the caregiver's quality of life and on treatment strategies to benefit both the caregiver and the stroke survivor.

Families and caregivers of stroke survivors sustain a significant impact on their psychosocial health. Worldwide, depression is observed not only in the patient but also in the caregiver. Untreated depression is associated with a lower quality of life and increased burden for the caregiver and survivor.[857] In Korea, increased burden was related to increased patient depression and insufficient support. In contrast, an American study found that increased caregiver burden is more closely correlated with lack of time for self.[858] Smith and colleagues[859] found that the caregiver needs varied as a function of age. Younger caregivers want information and training and are more inclined to criticize the healthcare system, whereas older caregivers need support to maintain a positive outlook and are less inclined to criticize the healthcare system.

Since the previous guidelines published in 2005, many researchers have investigated the caregiver perspective and better understand the interventions most likely to improve quality of life and to decrease burden. The Cochrane Collaboration

found that information improved the patient's and caregiver's knowledge while also slightly decreasing patient depression. The most effective educational programs included active involvement and follow-up by the educator. Education programs for caregiver and stroke participant should include supportive problem solving and skill development,[860] "how to's" of physical care needs and financial assistance,[861] medications,[862] respite, domestic assistance, and reassurance.[863] Ongoing support for the caregiver favorably affects the stroke survivor and caregiver. This support comes in many different actions. Steiner et al[864] studied physical and emotional support, whereas Campos de Oliveira[865] more clearly defined the support as a needed support structure. The caregivers need either family or friends to provide emotional and physical assistance, and the caregivers need the healthcare providers to help them establish and maintain this over time.[866] Counseling can also be a helpful intervention.[867] In summary, healthcare professionals need to consider the patient, along with a diverse set of support options and treatments for the family and primary caregiver.

Recommendations: Social and Family Caregiver Support	Class	Level of Evidence
It may be useful for the family/caregiver to be an integral component of stroke rehabilitation.	IIb	A
It may be reasonable that family/caregiver support include some or all of the following on a regular basis:	IIb	A
Education		
Training		
Counseling		
Development of a support structure		
Financial assistance		
It may be useful to have the family/caregiver involved in decision making and treatment planning as early as possible and throughout the duration of the rehabilitation process.	IIb	B

Referral to Community Resources

Successful transition to the community requires careful assessment of the match between patient needs and the availability of formal and informal resources. Referral to appropriate local community resources can help to support the needs and priorities of the patient and the family or caregiver. Some services can be organized and in place before hospital discharge, whereas referral to some community resources may be provided on transition to the community. A range of community resources are available that patients and their families/caregivers may desire to access immediately or in the future as their needs change.

Formal referral may be required for services such as vocational counseling, psychological services, social services, sexual health counseling, driver evaluation, or home environment assessment. Referral to a day service program may be appropriate for a patient who may benefit from a structured program and for caregivers who need respite time.

Multiple potential resources may assist stroke patients and their families/caregivers in the management of the long-term effects of stroke such as local stroke survivor and caregiver support groups, leisure and exercise programs, respite care, self-management programs, and home support (eg, Meals on Wheels).

More than 50% of stroke survivors require support with IADLs.[868] A high proportion of stroke survivors 1 to 5 years after injury use community services, with the most frequently accessed being household services (housework, lawn/garden care, and Meals on Wheels) and then therapy services (eg, PT).[868]

Caregivers have identified that it is important to know what resources are available and to be able to access them.[869] Stroke patients and their caregivers can be active in managing their chronic condition if they have appropriate information and resources. If stroke survivors and caregivers are to be active in their decision making and the management of the long-term effects of stroke, appropriate information delivered in a timely and effective format is necessary. It is critical that the process involve assessment of an individual's needs, education about available resources, linking of patient and resources, referrals, and follow-up to ensure the individual receives the necessary services. Health providers may wish to use a checklist to identify whether referral to other services is warranted.[870] A meta-analysis of 21 trials showed that the provision of information (including local resources) to patients and their caregivers may improve aspects of patient satisfaction, improve knowledge of stroke, and reduce patient depression scores.[871]

A systematic review[872] and meta-analysis[873] demonstrated the growing recognition that functional outcomes (including motor, cognitive, and psychosocial function) can be improved or at least maintained in chronic stroke with community interventions. In addition, a meta-analysis of 17 RCTs showed that lifestyle interventions (eg, health promotion or education, lifestyle counseling) may reduce the risks leading to another stroke or cardiovascular event.[874] A meta-analysis of 8 RCTs showed that exercise referral schemes that provide a clear referral by primary care professionals to third-party professionals to increase exercise or physical activity can increase the number of participants who achieve 90 to 150 min/wk of moderate physical activity and reduce depressive symptoms in sedentary individuals with or without a medical diagnosis (obesity, hypertension, depression, diabetes mellitus).[875] In a qualitative study, stroke survivors described great physical and psychological well-being after participation in an exercise referral scheme.[876]

Recommendations: Referral to Community Resources	Class	Level of Evidence
It is recommended that acute care hospitals and rehabilitation facilities maintain up-to-date inventories of community resources.	I	C
Patient and family/caregiver preferences for resources should be considered.	I	C
It is recommended that information about local resources be provided to the patient and family.	I	C
It is recommended that contact with community resources be offered through formal or informal referral.	I	C
Follow-up is recommended to ensure that the patient and family receive the necessary services.	I	C

Rehabilitation in the Community

The Centers for Medicare & Medicaid Services define community as one of the following settings: home, board and care, transitional living, intermediate care, or assisted living residence. More than 80% of the >6 million survivors of stroke in the United States live in the community, most of them at home, and the majority with some residual functional limitations. Studies have documented that 35% to 40% of individuals have limitations in basic ADLs 6 months after a stroke. More than 50% have limitations in ≥1 IADLs.[794,877]

There is substantial evidence that rehabilitation services, particularly exercise-based programs, provided in the community after discharge from acute or institutional care can improve cardiovascular health and decrease the risk of cardiovascular events, leading to increased short-term survival rates for individuals who have experienced a stroke.[878,879] Other community-based intervention trials have demonstrated enhanced ambulation and mobility, better self-care, and greater functional independence.[880]

Benefits associated with community- and home-based rehabilitation programs have been reported for a variety of outcomes, including reduced costs, decreased length of stay in hospitals or institutional settings, more opportunity for patient and family involvement in the treatment process, and less stress on caregivers and family members.[881,882]

It has also been consistently reported that individuals recovering from a stroke and their family members or caregivers prefer home- or community-based rehabilitation programs over center- or institutionally located rehabilitation services for a variety of practical and personal reasons.[881] Patient satisfaction with home-based rehabilitation programs is generally higher than for institutionally based alternatives.[882] Because the potential for recovery exists regardless of age and time after stroke and because fewer financial resources appear to be dedicated to providing optimal care during the later phases of stroke recovery, family caregiver education and support are recommended. Intervention, referrals, and follow-up care based on detailed caregiver assessments conducted during the survivor's inpatient stay are likely to smooth the transition of care to the home setting.[11] There is growing evidence for the effectiveness of stroke family caregiver and dyad (caregiver and patient) interventions.[883] Among the Class I, Level of Evidence A recommendations about caregiver and dyad interventions were the following: (1) Interventions that combine skill building with psycho-educational strategies should be chosen over interventions that only use psycho-educational strategies; (2) interventions that are tailored or individualized on the basis of the needs of stroke caregivers should be chosen over nontailored, one-size-fits-all interventions; (3) postdischarge assessments with tailored interventions based on changing needs should be performed to improve caregiver outcomes; (4) interventions that are delivered face to face or by telephone are recommended; and (5) interventions consisting of 5 to 9 sessions are recommended.

The ability to translate these findings into targeted intervention programs and guidelines for the care of individuals with stroke is complicated by several factors.[884,885] There is substantial variability in the timing of the initiation of home-based treatment programs. Home-based rehabilitation may not be appropriate for all individuals with stroke, depending on level of severity, comorbidities, or the need for specialized treatment or equipment. Existing studies comparing community- and home-based rehabilitation vary substantially in the duration and intensity of the intervention and in the nature and complexity of the treatment programs provided.[881] For example, some treatment programs are single interventions such as exercise; other programs involve multiple components requiring levels of specialized expertise.

Issues related to the fidelity and integrity of the treatment, patient safety, and the lack of equipment and capacity to provide selected interventions in a home or community setting have been identified as concerns associated with home-based rehabilitation.[886] Research-based evidence on potential adverse effects associated with rehabilitation programs conducted in the home and community is limited.

The majority of trials and reviews of community-based rehabilitation programs have compared home-based intervention programs with programs provided in centers or hospital/clinic-based outpatient programs.[881] Several studies published since the 2005 stroke rehabilitation clinical practice guidelines have examined a combination of ESD programs and community rehabilitation and compared these programs with standard inpatient and outpatient rehabilitation services. Langhorne and colleagues[17,18] found that the combination of ESD and community rehabilitation reduced inpatient length of stay and hospital readmission rates and increased functional independence and the ability of patients to live at home and participate in the community.

A systematic review by Hillier and Inglis-Jassiem[881] examined data comparing the benefits of home-based programs and programs in rehabilitation centers for individuals with stroke living in the community. Eleven trials met the inclusion criteria. Functional outcome data were pooled for the Barthel Index across the majority of the trials. Functional status was significantly improved for the home-based cohort at 6 weeks and 3 to 6 months. The difference between home-based and rehabilitation center groups was less clear after 6 months. Cost benefits and caregiver satisfaction were secondary measures and favored the home-based intervention trials.

A widely cited Cochrane Collaboration review[887,888] examined therapy-based rehabilitation services for stroke patients at home (Outpatient Service Trialists). The review examined trials meeting the Cochrane Collaboration criteria and compared home-based therapy with conventional care or no care within 1 year of hospital discharge for individuals with stroke. The primary outcomes were adverse events, deterioration in ability to perform ADLs, and level of improvement in ADL outcomes. The authors concluded that home-based therapy reduced the odds of a poor outcome, that is, death or deterioration in the ability to perform ADLs. Patients in the home-based therapy program also demonstrated improved ADL abilities compared with individuals in the usual or no treatment groups.[887,888]

The majority of trials and reviews examining community- and home-based rehabilitation programs in individuals with stroke have focused on functional, mobility, or motor outcomes. A recent meta-analysis by Graven and others[794] examined the impact of community-based rehabilitation on reducing

depression and increasing participation and health-related quality of life in individuals with stroke. The 54 studies included in the review were divided into 9 intervention categories. Analyses revealed significant reductions in depressive symptoms. The reduction in depressive symptoms was associated with exercise interventions. Treatments involving leisure and recreational activities showed moderate effects for the outcomes of participation and health-related quality of life. Comprehensive, multifactorial rehabilitation interventions demonstrated limited evidence for depression and participation but showed strong evidence for health-related quality-of-life outcomes.[794]

Recommendations: Rehabilitation in the Community	Class	Level of Evidence
Patients with stroke receiving comprehensive ADL, IADL, and mobility assessments, including evaluation of the discharge living setting, should be considered candidates for community- or home-based rehabilitation when feasible. Exclusions include individuals with stroke who require daily nursing services, regular medical interventions, specialized equipment, or interprofessional expertise.	I	A
It is reasonable that caregivers, including family members, be involved in training and education related directly to home-based rehabilitation programs and be included as active partners in the planning and implementation or treatment activities under the supervision of professionals.	IIa	B
A formal plan for monitoring compliance and participation in treatment activities may be useful for individuals with stroke referred for home- or community-based rehabilitation services. A case manager or professional staff person should be assigned to oversee implementation of the plan.	IIb	B

Sexual Function

Sexuality is an important aspect of poststroke quality of life for both patients and their significant others. Although there is substantial individual variation, overall stroke survivors tend to experience a high prevalence of sexual dysfunction. Comorbid medical conditions (eg, diabetes mellitus, hypertension, depression), medication side effects, stroke-related physical and functional deficits, lack of knowledge, and concerns about safety, role changes, and change in libido can affect the patient's sexual function. Healthcare workers need to help the patient and significant other navigate through the issues surrounding sexual function.

Multiple studies indicate that stroke survivors and their significant others have concerns about sexuality but are frequently reluctant to ask their healthcare providers about these concerns.[889] This reluctance may stem from the patient's embarrassment or other cultural barriers, as well as a lack of knowledge on the part of the healthcare provider. The greater the patient's disability is, the greater is the likelihood of sexual dysfunction and decreased sexual life satisfaction.[890] Stroke survivors report a desire for more information about sexuality from healthcare providers, physicians in particular.[891] It is important for the patient and significant other to know that sex is not contraindicated after stroke. The most common sexual dysfunctions after stroke are decreased libido, erection and ejaculation disorders in men, lubrication and orgasm in women, and self-image and role changes for both men and women. Interventions and education about sexuality that address these concerns such as positioning, timing, open communication, and functional treatments can be helpful. Additional training for healthcare providers on this topic, including methods of appropriately approaching patients and their partners to discuss sexuality, may be needed.[892]

Recommendation: Sexual Function	Class	Level of Evidence
An offer to patients and their partners to discuss sexual issues may be useful before discharge home and again after transition to the community. Discussion topics may include safety concerns, changes in libido, physical limitations resulting from stroke, and emotional consequences of stroke.	IIb	B

Recreational and Leisure Activity

Engagement in leisure and recreational pursuits is important to health.[893–896] Active leisure and recreational activities have been targeted as particularly important.[894,895,897] However, individuals with stroke are limited in their ability to engage in leisure and recreational activities, particularly active ones.[779,898–900]

In general, poststroke rehabilitation in the United States provides little attention to leisure and recreation.[902] Individuals with stroke report that they engage in significantly fewer leisure and recreation activities than they did before the stroke.[898,899] In addition, the leisure activities in which they do engage have shifted from active to sedentary activities such as television watching and reading.[898] Limited research examines the efficacy of rehabilitation for increasing participation in leisure and recreation activities. However, several studies (1 qualitative study, 2 RCTs, and 2 systematic reviews) suggest that therapy targeted at leisure/recreation and the provision of some adaptive equipment may facilitate increased engagement in leisure or recreation activities.[794,903,904,906] Although therapy was variable across the studies, in several, the therapy consisted of education about the importance of being physically active, education on community resources, and training in problem solving around barriers to being physically active.[794,903] One study that showed that such programming facilitated long-term increased physical activity engagement offered this kind of programming during rehabilitation, suggesting that such programming could begin early during rehabilitation.[908,909] It must be noted, however, that this study took place in Europe, involved much longer durations of rehabilitation than individuals experience in the United States, and involved individuals with a variety of disabling conditions (only 26% were individuals with stroke); in addition, results were not broken down by disability condition. The provision of a wheelchair may be critical because many individuals with stroke who are able to ambulate do not have the endurance to ambulate for long periods in the community.[906]

Recommendations: Recreational and Leisure Activity	Class	Level of Evidence
It is reasonable to promote engagement in leisure and recreational pursuits, particularly through the provision of information on the importance of maintaining an active and healthy lifestyle.	IIa	B
It is reasonable to foster the development of self-management skills for problem solving for overcoming barriers to engagement in active activities.	IIa	B
It is reasonable to start education and self-management skill development about leisure/recreation activities during and in conjunction with in-patient rehabilitation.	IIa	B

Return to Work

In the United States, ≈20% of strokes occur in individuals who are of vocational age.[910] Vocational roles provide a social identity and contribute to increased self-esteem and life satisfaction.[911] It is estimated that about one third of the economic burden of stroke through the year 2050 will be attributable to lost earnings after stroke.[912]

The percentage of individuals who were working before their stroke who return to work after stroke varies widely across studies, from 20%[913] to 66%.[914] This stems from large differences in sample characteristics, healthcare and social system differences in different countries, various definitions of work, and variable follow-up periods. It is clear, however, that a large percentage of individuals with stroke who are of vocational age do not return to work. It is estimated that one third of the $1.75 trillion in annual costs[1] associated with stroke are attributable to lost earnings in the United States alone.[912] The factors associated with return to work have also varied across different studies. Factors most frequently found to be associated with return to work are younger age, less severe impairments, independence in ADLs, good communication skills, good higher-level cognitive skills and processing speed, and a white collar profession.[915–921] Some of those who do return to work have been able to return full-time to their previous jobs; some have required job modifications or alternative jobs; and others were able to return only part-time.[890,917,919] The ability to resume driving may also be an important factor in being able to return to employment.[915]

Because several of the variables presenting barriers to return to work are modifiable, therapy targeted at vocational goals has the potential to increase return-to-work rates for individuals with stroke. However, no controlled trials have examined the efficacy or effectiveness of therapy targeted at vocational goals or vocational rehabilitation programs, and a structured review found insufficient evidence to support or refute the efficacy of any specific vocational rehabilitation program.[922] Several case studies suggest that for some individuals, therapy targeted at vocational goals can result in successful return to work.[923,924] Chan and colleagues[925] reported that their vocational rehabilitation program facilitates 55% of their enrollees to return to work. However, the lack of enrollee description makes it unclear how to interpret their success rate because several studies have found similar return-to-work rates without formal vocational rehabilitation. Although evidence is limited, many clinicians advise that for individuals considering return to work, an assessment of cognitive, perception, physical, and motor abilities be performed to determine readiness and the needed accommodations to return to work. This assessment should be tailored to the individual's needs and capabilities for the specified job situation and may include executive functions, high-level oral and written communication, and fatigue. Once performance under the best conditions has been assessed, further assessment under conditions of fatigue and stress may be useful to mimic potential job situations.

Discrimination against individuals with disabilities remains common in the workplace and may not be identified by the prospective employer as a reason for denying a disabled candidate employment. Familiarity with the provisions of the Americans With Disabilities Act and its requirements for "reasonable accommodation" is important for individuals seeking to return to a job after stroke or seeking a new position. Rehabilitation professionals can serve as a resource for motivated employers to help overcome workplace barriers for employees with disabilities.

Recommendations: Return to Work	Class	Level of Evidence
Vocationally targeted therapy or vocational rehabilitation is reasonable for individuals with stroke considering a return to work.	IIa	C
An assessment of cognitive, perception, physical, and motor abilities may be considered for stroke survivors considering a return to work.	IIb	C

Return to Driving

Driving is an essential IADL for many individuals in that it has a major impact on participation in activities outside the home.[926] Between one third and two thirds of individuals after stroke resume driving after 1 year.[927,928] However, because driving is a highly complex activity that requires skills in cognition, perception, emotional control, and motor control,[929] the ability to drive is often affected by stroke.[928] State law determines whether someone with a stroke is eligible to drive. The law concerning this topic varies by state. For example, in some states, individuals who have a neurological condition (stroke, traumatic brain injury, Parkinson disease, multiple sclerosis), among other non-neurological health conditions, are required to report their health condition to the appropriate state agency (eg, Department of Transportation or Department of Public Safety). After this reporting, the physician should assess patients' physical or mental impairments that might adversely affect driving abilities. Each case must be evaluated individually because not all impairments may give rise to an obligation on the part of the physician. In other states without self-reporting, physicians must take several initial steps before reporting: have a tactful but candid discussion with the patient and family about the risks of driving, suggest to the patient that he or she seek further treatment such as substance abuse treatment or OT, and encourage the patient and the family to decide on a restricted driving schedule. Efforts made by physicians to inform patients and families, to advise them of their options, and to negotiate a workable plan may render reporting unnecessary. Physicians should use their best judgment

when determining when to report impairments that could limit a patient's ability to drive safely. The physician's role is to report medical conditions that would impair safe driving as dictated by his or her state's mandatory reporting laws and standards of medical practice. Physicians should disclose and explain to their patients this responsibility to report. Physicians should protect patient confidentiality by ensuring that only the minimal amount of information is reported and that reasonable security measures are used in handling that information. Physicians should work with their state medical societies to create statues that uphold the best interests of patients and community and that safeguard physicians from liability when reporting in good faith.[930] The appropriate state agency determines whether the individual is allowed to keep his/her license or obtain a restricted license or whether another option is necessary. However, the decision about return to driving should happen with the physiatrist or primary care provider, patient with stroke, and family. If necessary, a driving rehabilitation specialist can perform a formal driving evaluation. The ASA Driving after Stroke Web site provides information on life after stroke.[930a]

The majority of individuals who sustain a stroke want to and do return to driving within a year after stroke.[927,928,931] Despite a significant number of individuals in whom driving ability is reduced[928,932] and the incidence of reduced self-awareness of driving difficulties after stroke,[933] very few individuals are ever formally assessed for driving, nor is return to driving discussed with them.[72,928,934] This is clearly a neglected area in the current healthcare system surrounding rehabilitation services after stroke.

There are no standardized driving assessment batteries. Many assessments contain both neuropsychological tests and on-the-road testing. There is no clear consensus on whether neuropsychological tests adequately predict the ability to drive. Two recent reviews (1 systematic review,[936] 1 meta-analysis[937]) examined the ability of neuropsychological tests to predict on-the-road driving test performance or voluntary cessation of driving across 37 studies (8 overlapping studies). The only neuropsychological test that was a significant predictor of fitness to drive in both reviews was the Trail Making Test B. There is great variation across studies in sample selection and in which neuropsychological tests were used to predict fitness to drive. For example, finding no effect for vision is likely the result of a biased sample excluding subjects with visual impairments consistent with state laws restricting such individuals from driving.[937] Driving simulators offer the ability to test an individual for fitness to drive in dynamic environments that are safer than on-the-road tests.[938] One cautionary note is that currently few studies have tested to what degree (if any) driving simulator performance is a sufficient predictor of on-the-road driving to determine the safety of return to driving. One study of 23 participants[939] showed that the simulator performance variables of complex reaction time and distance to collision were able to correctly classify 85% of the participants as fit to drive or not. Because there is no single set of neuropsychological tests that can accurately predict fitness to drive, an on-the-road driving test should also be strongly considered, especially for individuals who possess the cognitive ability and are eligible on the basis of local laws.

Several studies have shown that some individuals with stroke who are unable to pass fitness-to-drive tests can do so after intervention.[938,940–942] Intervention programs may involve adaptive equipment and training for the specific impairments interfering with driving (eg, infrared controls for 1-handed driving, cognitive training, vision training) or simulator training, on-road training, or their combination. Although few studies have tested the efficacy of driving training on driving ability, 2 studies have found simulator training to be superior to traditional cognitive training.[938,941] One study showed that visual training with the Dynavision system (Dynavision LLC, West Chester, OH) did not result in increased driving ability.[943] Unfortunately, other studies that investigated vision training and showed improved driving-related visual skills did not include measures of actual driving ability.[944] Thus, the evidence is insufficient to determine whether visual training improves driving performance in those individuals with insufficient visual skills. In general, studies examining the efficacy of driver training suffer from small, heterogeneous samples. In addition, intervention programs in these studies do not appear to be specific to the impairments of the participants.

Recommendations: Return to Driving	Class	Level of Evidence
Individuals who appear to be ready to return to driving, as demonstrated by successful performance on fitness-to-drive tests, should have an on-the-road test administered by an authorized person.	I	C
It is reasonable that individuals be assessed for cognitive, perception, physical, and motor abilities to ascertain readiness to return to driving according to safety and local laws.	IIa	B
It is reasonable that individuals who do not pass an on-the-road driving test be referred to a driver rehabilitation program for training.	IIa	B
A driving simulation assessment may be considered for predicting fitness to drive.	IIb	C

Conclusions

Stroke rehabilitation requires a sustained and coordinated effort from a large team, including the patient and his or her goals, family and friends, other caregivers (eg, personal care attendants), physicians, nurses, physical and occupational therapists, speech-language pathologists, recreation therapists, psychologists, nutritionists, social workers, and others. Communication and coordination among these team members are paramount in maximizing the effectiveness and efficiency of rehabilitation and underlie this entire guideline. Without communication and coordination, isolated efforts to rehabilitate the stroke survivor are unlikely to achieve their full potential.

The evidence base on specific stroke rehabilitation interventions has expanded considerably in recent years, although many gaps remain. In addition to summarizing the current evidence base, this document serves to highlight areas where additional research is needed to clarify the most effective treatment strategies.

Treatment gaps and future research directions identified include the following:

- Investigate multimodal interventions (eg, drug and therapy, brain stimulation, and therapy)
- Consider including multiple outcomes such as patient-centered, self-report outcomes in future intervention effectiveness trials (Patient Reported Outcomes Measurement Information System [PROMIS[290]])
- Consider computer-adapted assessments for personalized and tailored interventions
- Explore effective models of care that consider stroke as a chronic condition rather than simply a single acute event
- Capitalize on newer technologies such as virtual reality, body-worn sensors, and communication resources, including social media
- Develop interventions for individuals with severe stroke
- Develop better predictor models to identify responders and nonresponders to different therapies

As systems of care evolve in response to healthcare reform efforts, postacute care and rehabilitation are often considered a costly area of care to be trimmed, but without recognition of their clinical impact and their ability to reduce the risk of downstream medical morbidity caused by immobility, depression, loss of autonomy, and reduced functional independence. The provision of comprehensive rehabilitation programs with adequate resources, dose, and duration is an essential aspect of stroke care and should be a priority in these redesign efforts. We hope that these guidelines help inform these efforts.

Appendix 1. Structure and Organization of Stroke Rehabilitation Care in the United States

Setting	Admission	Median Length of Stay	Specialist Involvement
Acute inpatient facility (hospital)	Near onset	4 d for ischemic stroke 7 d for hemorrhagic stroke	Major: MD, RN More limited: OT, PT, SLT, SW
IRF	5–7 d	15 d (range, 8–30 d)	Major: MD, RN, OT, PT, SLT More limited: SW
SNF	5–7 d	Highly variable (maximum, 100 d)	Major: LPN/LVN, NA, OT, PT, SLT More limited: MD, RN
Long-term care (nursing home)	Highly variable	Prolonged and highly variable	Major: LPN/LVN, NA More limited: RN, OT, PT, SLT, MD
Long-term care hospital	Variable	25-d average (required)	Major: RN, MD More limited: OT, PT, SLT
HHCA	Variable (typically 5–30 d)	Maximum 60-d episode	Major: NA, RN More limited: OT, PT, SLT, MD
Outpatient office	Variable (typically 5–30 d)	Variable	Major: OT, PT, SLT, MD

HHCA indicates home healthcare agency; IRF, inpatient rehabilitation facility; LPN/LVN, licensed practical or vocational nurse; MD, medical doctor; NA, nurse assistant; OT, occupational therapist; PT, physical therapist; RN, registered nurse (preferably with training in rehabilitation); SLT, speech-language therapist; SNF, skilled nursing facility; and SW, social worker. Modifed from Miller et al.[11]

Appendix 2. Recommended* Measures Table

Construct/Measure	Comments	Approximate Time to Administer, min	References for Further Information
Impairment			
Paresis/strength			
Motricity Index	Consists of strength testing via manual muscle testing at 3 key UE segments and 3 key LE segments; yields a score from 0–100 indicating strength of each limb	<5 for UEs; <5 for LEs	294–299
Muscle strength	Via manual muscle testing, graded on a 0–5 scale or handheld dynamometry	<5	
Grip, pinch dynamometry	Grip and pinch dynamometers are available in most rehabilitation clinics and hospitals; normative data are available for comparison	<5	
Tone			
Modified Ashworth scale	Quantifies spasticity on a scale measuring resistance to passive movement from 0–4, with higher numbers indicating greater severity; can assess at all joints or only a few	10	294, 298, 299

(*Continued*)

Appendix 2. Continued

Construct/Measure	Comments	Approximate Time to Administer, min	References for Further Information
Sensorimotor impairment measures			
Fugl-Meyer	Quantifies sensorimotor impairment of the UE (0–66 points) and LE (0–34 points) on separate subscales; items are rated on ability to move out of abnormal synergies	25	298–302
Chedoke McMaster Stroke Assessment, impairment inventory	Quantifies impairments in 6 dimensions of shoulder pain, postural control, arm, hand, leg, and foot, each on a 7-point scale, with higher scores equalling less impairment	45	
Activity			
UE function			
Action Research Arm Test	Criteria based with 19 items; scores are from 0–57, with normal=57; allows observation of multiple grasps, grips, and pinches	10	294, 298–300, 302–306
Box and Block Test	Score is the number of blocks moved in 1 min; higher scores equal better performance; normative data are available for comparison	<5	
Chedoke Arm and Hand Activity Index	Criterion based with functional items requiring bilateral UE movement; available in 7-, 8-, 9-, and 13-item versions	25	
Wolf Motor Function Test	Time- and criterion-based scores on 15 items; contains some isolated joint movements and some functional tasks	15	
Balance			
Berg Balance Scale	Criterion-based assessment of static and dynamic balance; widely used in multiple settings	15	307–311
Functional Reach Test	A single-item test that measures how far one can reach in standing; normative data are available for comparison	<5	
Mobility			
Walking speed†	Brief and widely used; categories based on speed are: <0.4 m/s=household ambulation 0.4–0.8 m/s=limited community ambulation >0.8 m/s=community ambulation; normative data available for comparison	<5	307, 308, 312–314
Timed Up and Go	Quantifies more than straight walking, including sit/stand and a turn; scored by time to complete; criterion values available for comparison	<5	
6-Min walk test	Quantifies walking endurance; normative and criterion values for community ambulation distances available	<10	
Functional ambulation category	Classification made after observation or self-report of walking ability; 6-point scale with higher equals better walking ability; this tool allows assessment of walking ability in people who are not independent ambulators	<5	
Observational gait analysis	Commonly used in many clinics to plan treatment programs; several standardized formats are available; appropriate to use in conjunction with one of the above more quantifiable measures	5	
Participation			
Self-reported impairments, limitations, and restrictions			
Stroke Impact Scale: Strength, Mobility, ADL, and Hand Function subscales	These 4 subscales measure different aspects of physical performance; people rate their perceived ability to do different items; each subscale ranges from 0–100, with higher scores indicating better abilities	5 per subscale	294, 304, 307, 315
Motor Activity Log	14 or 28 questions about how the affected UE is used in daily life; scores range from 0–5, with 5 equal to similar to before the stroke	20	
Activities-specific Balance Confidence Scale	16 questions in which people with stroke rate their balance confidence during routine activities; scores range from 0–100, with higher scores indicating more confidence	20	316–319

(*Continued*)

Appendix 2. Continued

Construct/Measure	Comments	Approximate Time to Administer, min	References for Further Information
Technology for monitoring activity and participation			
Accelerometers, step activity monitors, pedometers	Numerous commercially available options; issues to consider when purchasing: cost, expected wear and tear, accompanying software, ease of use, wearing comfort; pedometers are the most economic option but need to be checked for ability to register steps of individuals with slow walking speeds	<5 to don/doff; additional processing time	7, 294, 321–328, 350

ADL indicates activity of daily living; LE, lower extremity; and UE, upper extremity.
*Note that it is recommended that clinicians select a single measure for each construct; it is often unnecessary to use >1 measure.
†Generally tested on 5- or 10-m walkways.

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*Modest.

†Significant.

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*Modest.

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Acute Rehabilitation after Trauma: Does it Really Matter?

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BACKGROUND: The impact of post-discharge rehabilitation care for the trauma patient remains poorly investigated. Here we describe the functional outcomes of trauma patients discharged to an inpatient rehabilitation facility (IRF), and compare the likelihood of discharge home, 1-year rehospitalization, and 1-year mortality between patients discharged to an IRF and a propensity score-matched cohort of patients not discharged to an IRF.

STUDY DESIGN: The Washington State Rehabilitation Registry was used to collect data for all trauma patients discharged to an IRF between 2011 and 2012. These charts were linked to the Washington State Trauma Registry and the Comprehensive Hospital Abstract Reporting System database to obtain detailed patient, injury, and mortality data. Propensity score matching was used to identify a control group of patients who were not discharged to an IRF. Primary outcomes measures were improvement in Functional Independence Measure score with inpatient rehabilitation and the likelihood of discharge home, 1-year rehospitalization, and 1-year mortality.

RESULTS: Nine hundred and thirty-three trauma patients were discharged to an IRF between 2011 and 2012. Total functional independence measure scores improved from 63.7 (SD 20.3) to 92.2 (SD 20.9) ($p < 0.001$) with care at an IRF. When patients discharged to an IRF were compared with the propensity score-matched control patients, rehabilitation was found to significantly increase the likelihood of discharge to home (odds ratio = 9.41; 95% CI, 6.80−13.01) and to decrease 1-year mortality (odds ratio = 0.60; 95% CI, 0.39−0.92).

CONCLUSIONS: Acute trauma patients should be recognized as an underserved population that would benefit considerably from inpatient rehabilitation services after discharge from the hospital. (J Am Coll Surg 2016;223:755−763. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Trauma is the most common cause of significant functional impairment, disability, and mortality worldwide. According to the CDC, the annual work-lost cost in the United States for injured patients who survive to hospital discharge is an astonishing $150 billion.[1] These injured patients are typically motivated and productive members of society who almost universally desire recovery of functional independence and return to community living and work. Helping them regain their functional independence has the potential to improve their quality of life considerably, and also decrease the socioeconomic impact of their injuries. The care of these injured patients does not end on discharge from the acute care hospital, and many of these patients require ongoing rehabilitation after discharge. This rehabilitation can occur in one of several settings, including an inpatient rehabilitation facility (IRF), skilled nursing facility (SNF), or in the outpatient setting. The impact of rehabilitation care for the trauma patient in these varied settings is not completely understood.

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Abbreviations and Acronyms

AIS = Abbreviated Injury Score
CMS = Centers for Medicare and Medicaid Services
FIM = Functional Independence Measure
IRF = inpatient rehabilitation facility
ISS = Injury Severity Score
LOS = length of stay
RR = rehabilitation registry
SNF = skilled nursing facility
TBI = traumatic brain injury
TR = trauma registry

Over the past 20 years, there has been a nearly 50% decrease in the number of trauma patients discharged to rehabilitation centers in the state of Washington, with a similar trend on the national level. Today, only approximately 6% of all hospitalized trauma patients in Washington State are discharged to an IRF.[2] No studies to date have evaluated the effect of inpatient rehabilitation after traumatic injury on functional outcomes and the likelihood of subsequent discharge home. Recent evidence does, however, demonstrate that the post-acute care setting can be predictive of long-term outcomes for trauma patients. Specifically, Davidson and colleagues,[2] demonstrate that trauma patients discharged to a SNF are more likely to die after discharge compared with patients discharged home. In contrast, patients discharged to an IRF do not have an increased risk of post-discharge mortality. Despite this, we know from Ayoung-Chee and colleagues,[3] that in the recent past there has been a considerable increase in the number of trauma patients discharged to SNFs compared with IRFs.

In the state of Washington, we now have in place a unique rehabilitation registry that contains demographic and functional outcomes data for all trauma patients discharged to any one of the state's 14 IRFs. Empowered with the ability to track the progress of trauma patients through their rehabilitation course, we sought to describe the characteristics and immediate outcomes of a cohort of trauma patients who received care at an IRF, and to determine the likelihood of eventual discharge home and the likelihood of rehospitalization and death within 1 year for trauma patients who received post-discharge care at an IRF compared with a cohort of propensity score-matched patients who did not receive post-discharge care at an IRF.

METHODS

We performed a retrospective cohort study of injured patients of any age who were treated inclusively at any of the 14 IRFs within the state of Washington during the 2-year period between 2011 and 2012. These data were recorded in a unique Washington State trauma rehabilitation registry (RR) that includes basic demographic data and functional outcomes as measured by the Functional Independence Measure (FIM) score. Patient records from the RR were linked to the Washington State trauma registry (TR), which contains more detailed data for all injured patients admitted to a state-designated trauma hospital (Levels I to V). Washington State does not require that isolated hip fractures in patients older than age 65 years be reported, and primary burn patients were excluded.

The FIM score is a widely used functional assessment scale and has been well validated in the trauma population.[4,5] It consists of 13 motor (eating, grooming, bathing, upper body dressing, lower body dressing, toileting, bladder management, bowel management, bed to chair transfer, toilet transfer, shower transfer, locomotion, stairs) and 5 cognitive (cognitive comprehension, expression, social interaction, problem solving, memory) items designed to assess the amount of functional assistance required for a person to perform basic life activities. Each activity is scored on a scale of 1 to 7, resulting in a total FIM score from 18 to 126, a motor FIM score from 13 to 91, and a cognitive FIM score from 5 to 35. Admission and discharge FIM scores were available for patients in the RR. The modified FIM score is a simplified version of this functional assessment that consists of a 4-point scoring scale assessing locomotion, feeding, and expression, resulting in a total modified FIM score of 3 to 12.[6] The modified FIM score is a variable encoded in the TR and was available for all patients at the time of hospital discharge.

Patient demographics, injury-specific data, and details about the initial inpatient hospitalization were recorded for all injured patients discharged to an IRF in Washington State between 2011 and 2012. This was compared with all trauma patients in the TR during the same period. For patients treated at an IRF after discharge from the hospital, ICD-9 codes from the TR were manually translated into one of several injury categories: traumatic brain injury (TBI), orthopaedic injury (vertebral fracture and/or extremity injury), thoracic injury, abdominal injury, and spinal cord injury. For patients treated at an IRF after discharge from the hospital, FIM scores at the time of admission to, and discharge from, rehabilitation were recorded.

Propensity score matching was used to identify a comparison cohort of patients within the TR who did not receive care at an IRF, despite the same propensity to receive care at an IRF as those who did. Factors used for the propensity score matching included age, insurance

status, mechanism, Injury Severity Score (ISS), Abbreviated Injury Score (AIS), emergency department Glasgow Coma Scale, Charlson Comorbidity Index, number of operative procedures, mechanical ventilation, ICU admission, hospital length of stay (LOS), and modified FIM at discharge from the hospital.

The RR and TR were linked to the Comprehensive Hospital Abstract Reporting System database and to the Washington state death registry using Link Plus, a probabilistic record linkage software program developed at the CDC. Multiple imputation was used to account for any variable that was missing with a frequency of >5%. Multivariable regression analyses were used to determine the effect of several factors (ie age, mechanism, ISS, AIS, emergency department Glasgow Coma Scale, Charlson Comorbidity Index, number of operative procedures, mechanical ventilation, blood product transfusion, ICU admission, hospital LOS, modified FIM at discharge, and discharge to an IRF) on the likelihood of discharge home and the incidence of 1-year unplanned rehospitalization and mortality. Logistic regression with odds ratio was used to predict the discharge outcomes. To account for deaths in the rehospitalization analysis, a competing risk regression analysis was performed using post-discharge deaths as the competing risk factor, and adjusted sub-hazard ratios were calculated. Post-discharge mortality was assessed using a Cox proportional hazard model to provide an adjusted hazard ratio.

All statistical analyses were performed using STATA software, version 13.0 (Stata Corp). Two-sided tests of significance (*Z*-test and Student's *t*-test) were used when appropriate, and results were considered significant with a p value <0.05.

RESULTS

In the 2-year period from 2011 to 2012, there were 1,283 patients recorded in the TR as being discharged to an inpatient rehabilitation center after hospitalization for injury. During the same time period, the RR had records of 2,646 patients categorized as being cared for at a rehabilitation facility after an acute injury. The discrepancy was largely due to some erroneous reporting of noninjured patients to the RR by a few rehabilitation centers. These records were screened and truly injured patients reported in the RR were linked to specific patients within the TR. With this, a total of 1,011 injured patients from the RR were successfully linked to the TR. After excluding 18 patients with isolated burns, there were 993 trauma patients that could be reliably tracked from their initial injury through their inpatient rehabilitation. During the same time period, there were 51,464 total patients hospitalized for treatment of a traumatic injury in the state of Washington.

Descriptive characteristics of patients discharged to an inpatient rehabilitation facility compared with the general Washington State trauma population between 2011 and 2012

Table 1 compares basic patient characteristics for all trauma patients and those who received care at an IRF in Washington State between 2011 and 2012. The mean (SD) age of patients discharged to an IRF was 50.5 (23.5) years. The vast majority of patients had suffered a blunt injury (94.9%). The most common injury was TBI, with 595 (34.2%) patients sustaining an isolated TBI and another 240 (25.7%) suffering a TBI in conjunction with another major injury. Mean (SD) ISS for patients discharged to a rehabilitation facility was 19.8 (11.8) with 53.9% having an ISS between 9 and 24 and 36.0% having an ISS of >25. Head AIS was >3 for 46.9% of patients discharged to an IRF; and AIS for the thorax, abdomen, and extremity was ≤3 for the vast majority of patients. Basic demographic characteristics were similar between those patients discharged to an IRF and the general population during the same time period. However, those discharged to an IRF were more severely injured with higher ISS, body region AIS, and a higher likelihood of being intubated and admitted to the ICU. Additionally, patients admitted to an IRF had lower modified FIM scores at the time of hospital discharge compared with the general trauma population.

Mean (SD) length of inpatient rehabilitation stay was 19 (36) days. Patients having sustained a combined TBI and spinal cord injury had the longest inpatient rehabilitation stay at 54 (97) days (Fig. 1).

Outcomes for trauma patients discharged to an inpatient rehabilitation facility

The FIM scores at admission to and discharge from an IRF were used to determine improvement in functional status with rehabilitation. Total FIM scores (SD) improved by 29 (17.0) points (45%), from 63.7 (20.3) to 92.2 (20.9) ($p < 0.001$) with the majority of this improvement occurring in the motor category (mean [SD] Δ motor FIM 24.6 [14.6], 60% increase; $p < 0.001$) compared with the cognitive category (mean [SD] Δ cognitive FIM 4.6 (5.7), 20% increase; $p < 0.001$) (Fig. 2). Improvements in FIM scores with rehabilitation were notable across injury types (Fig. 3). The vast majority of patients (78.2%) admitted to an acute rehabilitation center after trauma were successfully discharged to home.

Table 1. Characteristics of All Trauma Patients, Those Discharged to an Inpatient Rehabilitation Facility and a Propensity Score-Matched Cohort of Patients Not Discharged to an Inpatient Rehabilitation Facility in Washington State Between 2011 and 2012

	All trauma (n = 51,464)		IRF* (n = 993)		IRF propensity score-matched cohort† (n = 731)		No IRF propensity score-matched cohort‡ (n = 631)	
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Sex, male	30,644	59.5	678	68.3	494	69.3	390	61.8
Age								
0 to 14 y	6,978	13.6	36	3.6	28	3.9	53	8.4
15 to 34 y	12,421	24.1	272	27.4	189	26.5	136	21.6
35 to 54 y	10,371	20.2	221	22.3	155	21.7	134	21.2
55 to 74 y	10,636	20.7	261	26.3	191	26.8	165	26.2
75 to 84 y	5,274	10.3	138	14.0	101	14.2	66	10.5
>85 y	5,779	11.2	65	6.6	49	6.9	77	12.2
Unknown	5	0.01	0	0	0	0	0	0
Insurance								
Commercial	19,699	38.3	379	38.2	284	39.8	259	41.1
Medicare	13,511	26.3	290	29.2	216	30.3	187	29.6
Medicaid	9,998	19.4	247	24.9	166	23.3	144	22.8
None	6,428	12.5	61	6.1	47	6.6	41	6.5
Unknown	1,828	3.6	16	1.6	0	0	0	0
Mechanism								
Blunt	45,638	88.9	942	94.9	676	94.8	598	94.8
Penetrating	3,384	6.5	41	4.1	31	4.4	26	4.1
Other	2,309	4.4	9	0.9	6	0.8	7	1.1
Unknown	75	0.1	1	0.1	0	0	0	0
Injury Severity Score								
0 to 8	29,614	57.5	100	10.1	61	8.6	80	12.7
9 to 15	14,599	28.4	262	26.4	164	23.0	143	22.7
16 to 24	4,182	8.1	273	27.5	181	25.4	152	24.2
25 to 75	2,702	5.3	357	36.0	307	43.1	254	40.4
Unknown	367	0.7	1	0.1	0	0	2	0.3
AIS score								
Head AIS >3	3,869	7.4	466	46.9	335	47.0	265	42
Thorax AIS >3	1,098	2.1	85	8.6	60	8.4	48	7.6
Abdominal AIS >3	608	1.2	43	4.3	24	3.4	22	3.5
Extremity AIS >3	519	1.0	24	2.4	12	1.7	6	1.0
ICU admission, yes	9,613	18.3	713	71.8	530	74.3	453	71.8
Mechanical ventilation, yes	3,267	6.2	250	25.2	169	23.7	129	20.4
Modified FIM at hospital discharge								
Mild dependence (FIM 11 to 12)	20,271	39.4	286	28.8	271	38.0	317	50.4
Moderate dependence (FIM 8 to 10)	7,437	14.5	350	35.3	327	45.9	198	31.4
Severe dependence (FIM 3 to 7)	1,338	2.6	121	12.2	114	16.0	102	16.2
Unknown	22,418	43.6	236	23.8	1	0.1	14	2.2

*Entire cohort of injured patients discharged to an inpatient rehabilitation facility.
†Injured patients discharged to an inpatient rehabilitation facility who were included in propensity score matching.
‡Injured patients not discharged to an inpatient rehabilitation facility identified as propensity score-matched cohort.
AIS, Abbreviated Injury Scale; FIM, Functional Independence Measure; IRF, inpatient rehabilitation facility.

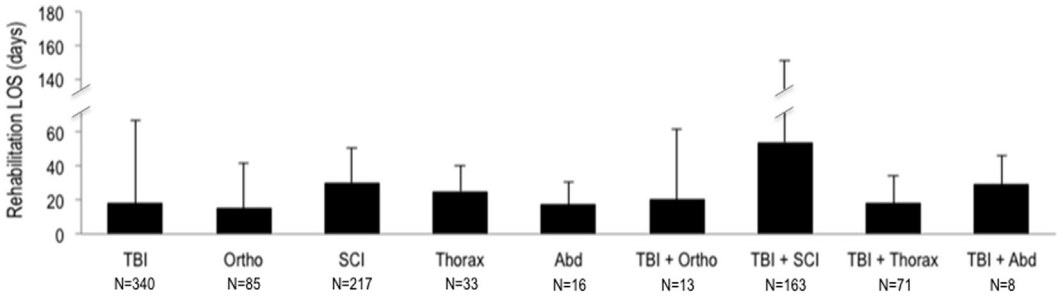

Figure 1. Rehabilitation length of stay (LOS) for trauma patients discharged to inpatient rehabilitation by injury type. All data presented as mean ± SD. Abd, abdominal injury; Ortho, orthopaedic injury (vertebral fracture and/or extremity injury); SCI, spinal cord injury; TBI, traumatic brain injury; Thorax, thoracic injury.

Comparing patients discharged to an inpatient rehabilitation facility with a propensity score-matched cohort of patients who did not receive care at an inpatient rehabilitation facility

With the propensity score matching, 631 patients who did not receive care at an IRF were identified as a propensity score-matched cohort of control patients for comparison with 731 patients who did receive care at an IRF. Characteristics of both groups are shown in Table 1.

Likelihood of discharge home

Multivariable logistic regression analyses were conducted on the combined cohort of patients who received care at an IRF and the propensity score-matched cohort to identify predictors of eventual discharge home. Older age, penetrating trauma, hospital LOS, and moderate or severe dependence on the modified FIM score at hospital discharge were all associated with a lower likelihood of discharge home. The only factor associated with a higher likelihood of discharge home was post-hospital discharge treatment at an IRF, with an OR of 9.41 (95% CI, 6.80−13.01; $p < 0.001$) (Table 2). Additionally, post-hospital discharge care at an IRF significantly increased the likelihood of eventual discharge home for trauma patients of all age groups (15 to 34 years old: OR = 41.46; 95% CI, 14.85−115.77; 35 to 54 years old: OR = 8.50; 95% CI, 3.18−22.73; 55 to 74 years old: OR = 12.70; 95% CI, 6.75−23.90; and 75 years and older: OR = 13.55; 95% CI, 6.88−26.67).

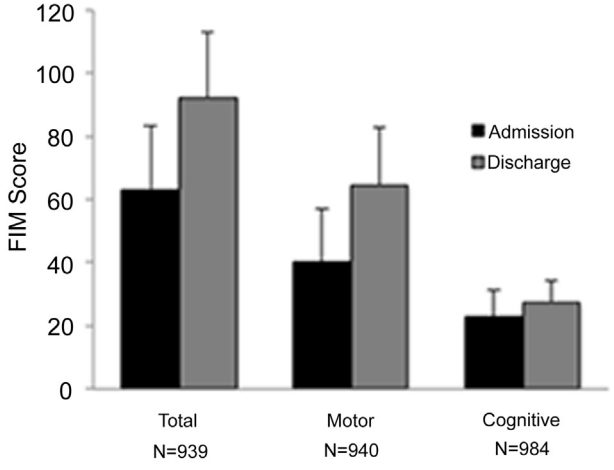

Figure 2. Total, motor, and cognitive Functional Independence Measure (FIM) scores at the time of admission to and discharge from rehabilitation for trauma patients discharged to inpatient rehabilitation. All data presented as mean ± SD.

Unplanned rehospitalization within 1 year

Looking at the cohort of patients who received inpatient rehabilitation and the comparison propensity score-matched cohort, multivariable competing risk regression analysis with death as the competing risk showed that older age and having sustained a ground-level fall or penetrating trauma compared with a non-ground-level fall blunt trauma were associated with a higher likelihood of rehospitalization within 1 year. Care at an IRF did not affect the likelihood of rehospitalization within 1 year (Table 2).

1-Year mortality

Looking at the cohort of patients who received inpatient rehabilitation and the comparison cohort of propensity score-matched patients, multivariable Cox regression analysis was used to identify factors predictive of mortality at 1 year. Older age, penetrating trauma, longer hospital LOS, and severe dependence on the modified FIM at hospital discharge were associated with a higher 1-year mortality. Care at an IRF was the only factor associated with lower 1-year mortality (Table 2).

DISCUSSION

The inpatient mortality for trauma patients has decreased, but post-discharge mortality has actually increased over time,[7-9] which highlights the fact that short-term outcomes measures achieved during the inpatient

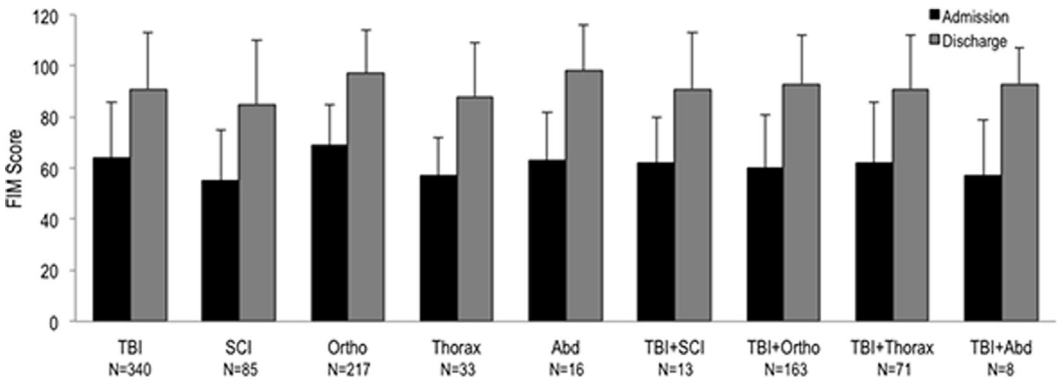

Figure 3. Total Functional Independence Measure (FIM) scores at the time of admission to and discharge from rehabilitation by injury type for trauma patients discharged to inpatient rehabilitation. All data presented as mean ± SD. Abd, abdominal injury; Ortho, orthopaedic injury (vertebral fracture and/or extremity injury); SCI, spinal cord injury; TBI, traumatic brain injury; Thorax, thoracic injury.

hospitalization of the trauma patient are simply not an adequate method for measuring trauma care success. Functional outcomes and quality of life measures are equally important, if not more important, than mortality, but have rarely been evaluated. Traumatic injury has a profound prolonged impact on quality of life and the magnitude and duration of this effect is often severely underestimated.[10] This quality of life is intimately linked with the attainment of functional independence, and discharge to an IRF has the potential to increase the likelihood of functional independence and improve quality of life substantially.

Definitive studies about the optimal post-discharge rehabilitation setting for trauma patients are lacking. In this retrospective database study of adult trauma patients, we sought to gain a better appreciation of the benefits of post-discharge care of the trauma patient at an IRF. We found that injured patients who received post-discharge rehabilitation care at IRFs in Washington State experienced a considerable improvement in functional outcomes during the course of their rehabilitation, and that 78% of these patients were successfully discharged home from the IRF. This is particularly striking when one considers the fact that these are generally older and severely injured patients. We also demonstrate that, compared with a propensity score-matched cohort that did not receive post-discharge care at an IRF, those treated at an IRF had a higher likelihood of eventually being discharged home, with an associated reduction in 1-year mortality.

Previous studies demonstrate that discharge of a trauma patient to a location other than home and specifically to a SNF is an independent predictor of mortality, although patients discharged to an IRF do not have the same increased risk of post-discharge mortality.[2,7,8] Despite this, during the last several years, there has been an increase in the number of trauma patients being discharged to SNFs and a decrease in the number being discharged to IRFs.[3] The data from the current study make this trend particularly concerning. Conversely, patients who suffer strokes are more likely to be discharged to an IRF in comparison with patients suffering a traumatic injury. According to the Centers for Medicare and Medicaid Services (CMS), approximately 20% of all patients who suffer a stroke are discharged to an IRF, and stroke has been the leading diagnosis among Medicare beneficiaries admitted to an IRF. The reasons for this are complex. Earlier studies have demonstrated that stroke patients discharged to an IRF have improved functional outcomes compared with patients discharged to a SNF.[11-15] This evidence has since been translated into clinical practice, and the Joint Commission has required primary stroke centers to evaluate the post-discharge rehabilitation needs for all stroke survivors.

From 2005 to 2011, the number of IRFs has generally been decreasing, with stabilization in the number of facilities between 2011 and 2012.[16] A compliance threshold was created for all IRFs mandating that a certain proportion of all patients in each IRF have diagnoses specified by CMS as requiring intensive inpatient rehabilitation. The enforcement of this rule and additional restrictions has resulted in a substantial decline in the volume of Medicare patients treated in IRFs. Occupancy rates have been steady since 2002, at only approximately 62% to 63%.[16] This has led CMS to declare that the number of IRF facilities and beds is adequate to meet current demand. But, are we getting the most out of this resource, and is it possible that we are depriving certain patient populations the post-discharge care that might allow them to regain enough functional independence to return to their lives? It has been established that stroke patients

Table 2. Predictors of Discharge Home, 1-Year Rehospitalization, and 1-Year Mortality on Multivariable Logistic Regression Analysis

	Discharge home			1-year rehospitalization			1-year mortality		
Predictor	**Odds ratio***	**95% CI**	**p Value**	**Sub-hazard ratio***	**95% CI**	**p Value**	**Hazard ratio***	**95% CI**	**p Value**
Age	0.96	0.95–0.97	<0.001	1.02	1.01–1.03	<0.001	1.05	1.04–1.07	<0.001
Mechanism									
Blunt	1.00	Reference	NA	1.00	Reference	NA	1.00	Reference	NA
Ground-level fall	0.80	0.51–1.25	0.319	1.55	1.05–2.30	0.029	1.41	0.90–2.21	0.138
Penetrating	0.40	0.20–0.78	0.007	2.03	0.94–4.38	0.070	3.97	1.33–11.86	0.013
Emergency department Glasgow Coma Scale score									
14 to 15	1.00	Reference	NA	1.00	Reference	NA	1.00	Reference	NA
9 to 13	1.32	0.61–2.87	0.482	1.07	0.45–2.56	0.871	0.59	0.19–1.78	0.349
3 to 8	1.14	0.60–2.18	0.685	1.44	0.70–2.95	0.320	0.71	0.27–1.90	0.500
Injury Severity Score									
0 to 8	1.00	Reference	NA	1.00	Reference	NA	1.00	Reference	NA
9 to 15	1.30	0.73–2.31	0.370	0.55	0.31–0.98	0.044	1.53	0.66–3.53	0.317
16 to 24	0.84	0.44–1.60	0.594	0.67	0.36–1.26	0.218	1.04	0.39–2.76	0.932
25 to 75	0.68	0.34–1.36	0.279	0.81	0.43–1.52	0.510	1.05	0.37–2.99	0.929
Head Abbreviated Injury Scale score									
≤3	1.00	Reference	NA	1.00	Reference	NA	1.00	Reference	NA
>3	1.27	0.84–1.92	0.260	NA		NA	1.47	0.74–2.90	0.269
Hospital length of stay	0.98	0.97–1.00	0.014	1.00	0.99–1.01	0.684	1.03	1.02–1.03	<0.001
ICU admission									
No	1.00	Reference	NA	1.00	Reference	NA	1.00	Reference	NA
Yes	0.84	0.55–1.31	0.462	1.21	0.74–1.97	0.456	0.86	0.46–1.60	0.885
Mechanical ventilation									
No	1.00	Reference	NA	1.00	Reference	NA	1.00	Reference	NA
Yes	1.10	0.68–1.79	0.689	0.78	0.43–1.43	0.420	1.04	0.48–2.27	0.631
Modified FIM at discharge									
Mild dependence (FIM 11 to 12)	1.00	Reference	NA	1.00	Reference	NA	1.00	Reference	NA
Moderate dependence (FIM 8 to 10)	0.22	0.15–0.31	<0.001	1.01	0.69–1.48	0.950	0.99	0.60–1.62	0.958
Severe dependence (FIM 3 to 7)	0.07	0.04–0.12	<0.001	0.98	0.59–1.62	0.940	2.84	1.63–4.95	<0.001
Rehabilitation									
No	1.00	Reference	NA	1.00	Reference	NA	1.00	Reference	NA
Yes	9.41	6.80–13.01	<0.001	1.25	0.90–1.72	0.182	0.60	0.39–0.92	0.018

For total cohort, n = 1,624, which includes patients discharged to acute inpatient rehabilitation (n = 993) and propensity score-matched control (n = 631).
*Adjusted odds ratio, hazard ratio, and sub-hazard ratio with propensity score matching.
FIM, Functional Independence Measure; NA, not applicable.

and those with neurologic disorders are a cohort of patient that derive substantial functional benefit from inpatient rehabilitation care and this has likely contributed to the high percentage of these patients discharged to rehabilitation centers.[11-15] Until now, the functional benefit that acutely injured patients gain from inpatient rehabilitation after hospital discharge has not been understood. Our data would suggest that post-discharge care at an IRF rather than a SNF has the potential to profoundly improve functional outcomes for acutely injured patients.

One of the limitations of the current study is the fact that our propensity score-matched cohort of patients who did not receive care at an IRF might not be a perfect control group. This method of statistical analysis allows us

to generate a comparison cohort of patients based on factors that we deem to be important and that we are able to measure and quantify. The appropriateness of the comparison cohort depends on our ability to include all of the correct variables in the propensity score analysis. It must be recognized that we were unable to account for whether patients met CMS criteria for discharge to an IRF, which includes 3 basic components: patient must require and be reasonably expected to benefit from intensive rehabilitation therapy that consists of at least 3 hours/day at least 5 days/week; patient must require therapy in at least 2 modalities; and patient must require supervision by a rehabilitation physician. A randomized clinical trial would be the most definitive way of determining whether post-hospital discharge care at an IRF really matters; however, randomizing patients that qualify for rehabilitation to a non-treatment arm (no IRF) is neither ethical nor practical. With the caveat that a randomized controlled trial might not be possible, we believe that this propensity score analysis represents the most rigorous statistical method available to look at the question at hand.

The other potential limitation of this study is the fact that it is a retrospective cohort study and carries with it the same limitations as all other retrospective database studies. The databases used for this study, specifically the RR, TR, and Comprehensive Hospital Abstract Reporting System, are rigorously maintained registries that are continuously monitored to ensure complete and quality data. Despite this, not all data within the registries are complete, which we addressed by using the method of multiple imputations for variables that were missing in >5% of cases. This is a well-validated method of accounting for missing variables and likely results in less bias than excluding missing variables entirely from the analysis.[17,18]

CONCLUSIONS

Inpatient rehabilitation is a scarce resource and every effort should be made to use this relatively scarce resource on patients most likely to benefit from these services. Our data suggest that acute trauma patients should be recognized as a relatively underserved population that would benefit considerably from inpatient rehabilitation services after discharge from the hospital. Given the profound functional benefit that appropriate trauma patients derive from inpatient rehabilitation, it is imperative that we more clearly define the specific cohort of trauma patients that benefits most from this service. This will allow for the development of protocols for trauma centers to consistently identify patients most suitable for rehabilitation services and to maximize the benefit of this service for injured patients.

Author Contributions

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Comparison of Functional Status Improvements Among Patients With Stroke Receiving Postacute Care in Inpatient Rehabilitation vs Skilled Nursing Facilities

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Abstract

IMPORTANCE Health care reform legislation and Medicare plans for unified payment for postacute care highlight the need for research examining service delivery and outcomes.

OBJECTIVE To compare functional outcomes in patients with stroke after postacute care in inpatient rehabilitation facilities (IRF) vs skilled nursing facilities (SNF).

DESIGN, SETTING, AND PARTICIPANTS This cohort study included patients with stroke who were discharged from acute care hospitals to IRF or SNF from January 1, 2013, to November 30, 2014. Medicare claims were used to link to IRF and SNF assessments. Data analyses were conducted from January 17, 2017, through April 25, 2019.

EXPOSURES Inpatient rehabilitation received in IRFs vs SNFs.

MAIN OUTCOMES AND MEASURES Changes in mobility and self-care measures during an IRF or SNF stay were compared using multivariate analyses, inverse probability weighting with propensity score, and instrumental variable analyses. Mortality between 30 and 365 days after discharge was included as a control outcome as an indicator for unmeasured confounders.

RESULTS Among 99 185 patients who experienced a stroke between January 1, 2013, and November 30, 2014, 66 082 patients (66.6%) were admitted to IRFs and 33 103 patients (33.4%) were admitted to SNFs. A higher proportion of women were admitted to SNFs (21 466 [64.8%] women) than IRFs (36 462 [55.2%] women) ($P < .001$). Compared with patients admitted to IRFs, patients admitted to SNFs were older (mean [SD] age, 79.4 [7.6] years vs 83.3 [7.8] years; $P < .001$) and had longer hospital length of stay (mean [SD], 4.6 [3.0] days vs 5.9 [4.2] days; $P < .001$) than those admitted to IRFs. In unadjusted analyses, patients with stroke admitted to IRF compared with those admitted to SNF had higher mean scores for mobility on admission (44.2 [95% CI, 44.1-44.3] points vs 40.8 [95% CI, 40.7-40.9] points) and at discharge (55.8 [95% CI, 55.7-55.9] points vs 44.4 [95% CI, 44.3-44.5] points), and for self-care on admission (45.0 [95% CI, 44.9-45.1] points vs 41.8 [95% CI, 41.7-41.9] points) and at discharge (58.6 [95% CI, 58.5-58.7] points vs 45.1 [95% CI, 45.0-45.2] points). Additionally, patients in IRF compared with those in SNF had larger improvements for mobility score (11.6 [95% CI, 11.5-11.7] points vs 3.5 [95% CI, 3.4-3.6] points) and for self-care score (13.6 [95% CI, 13.5-13.7] points vs 3.2 [95% CI, 3.1-3.3] points). Multivariable, propensity score, and instrumental variable analyses showed a similar magnitude of better improvements in patients admitted to IRF vs those admitted to SNF. The differences between SNF and IRF in odds of 30- to 365-day mortality (unadjusted odds ratio, 0.48 [95% CI, 0.46-0.49]) were reduced but not eliminated in multivariable analysis (adjusted odds ratio, 0.72 [95% CI, 0.69-0.74]) and propensity score analysis (adjusted odds ratio, 0.75 [95% CI, 0.72-0.77]). These differences were no longer statistically significant in the instrumental variable analyses.

(continued)

Key Points

Question Is change in physical function associated with receiving postacute care after a stroke in inpatient rehabilitation vs skilled nursing facilities?

Findings This cohort study included 99 185 patients who received postacute care in inpatient rehabilitation or skilled nursing facilities after a stroke. Care in an inpatient rehabilitation facility was associated with greater improvement in mobility and self-care compared with care in a skilled nursing facility, and a significant difference in functional improvement remained after accounting for patient, clinical, and facility characteristics at admission.

Meaning These findings suggest that there is room for payment reform in postacute care and highlight the need to target decision-making regarding discharge to postacute facilities based on patient needs and potential for recovery.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

Abstract (continued)

CONCLUSIONS AND RELEVANCE In this cohort study of a large national sample, inpatient rehabilitation in IRFs for patients with stroke was associated with substantially improved physical mobility and self-care function compared with rehabilitation in SNFs. This finding raises questions about the value of any policy that would reimburse IRFs or SNFs at the same standard rate for stroke.

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Introduction

More than 40% of Medicare beneficiaries are discharged from acute care hospitals to postacute care each year. Reports by the National Academy of Sciences[1] and the Institute of Medicine[2] have found that postacute care was the largest contributor to geographic variation in Medicare costs. The 2014 Improving Medicare Post-Acute Care Transformation (IMPACT) Act[3] requires the Secretary of the Department of Health and Human Services to establish a unified payment system for postacute care. As a step in this process, the Medicare Payment Advisory Commission recommended that inpatient rehabilitation facilities (IRFs) and skilled nursing facilities (SNFs) explore similar episode-based reimbursement for a given condition. The proposal is based, in part, on the substantial overlap in patient populations served by IRFs and SNFs.[4,5]

The purpose of our study was to examine changes in functional status in a national sample of Medicare beneficiaries with stroke who received inpatient rehabilitation at an IRF or SNF following acute hospital discharge. We selected stroke because it is a major cause of disability in the United States and an important public health issue, patients with stroke have complex neurological disorders that require a range of treatments and expertise, and stroke represents the largest impairment group treated in IRFs.[6]

In this study, we compared functional outcomes of patients with stroke who were discharged from a hospital to an IRF or SNF. There are challenges in comparing outcomes in observational studies, the most important of which is bias by indication, or selection bias. Inpatient rehabilitation facilities have more stringent criteria for admission than do SNFs, including the requirement that patients be able to complete 3 hours of rehabilitation therapy daily. Several studies[7-9] have shown that traditional methods of controlling for patient characteristics, such as logistic regression and propensity analyses, tend not to be effective in the face of strong selection biases. There are several approaches to mitigating this problem. One approach is to assess how large a bias would have to be to eliminate the association observed, which allows the reader to judge whether the existence of such a bias is plausible, such as by use of the E-value.[10] Another approach is to indirectly assess the strength of the bias and whether it is eliminated by a specific analytic approach, such as by using a control outcome, a measure that should not be affected by differences between the 2 treatments but would be affected by selection biases. In this study, we used all-cause mortality between 30 and 365 days after hospital discharge as a control outcome. The control outcome should be strongly related to the underlying health of the patients but only minimally influenced by residence in an IRF vs SNF. If the statistical analyses show significant IRF vs SNF differences in 30- to 365-day mortality, that result would suggest that underlying selection biases remain. A third approach is to use analytic approaches shown to minimize selection biases, such as instrumental variable analysis.[7-9] We used these 3 approaches to compare outcomes of patients with stroke who were discharged from acute care to IRFs vs SNFs.

We hypothesized that patients discharged to IRFs would have larger improvements in mobility and self-care function than those discharged to SNFs.

Methods

This study was approved by the institutional review board of the University of Texas Medical Branch and complies with the Centers for Medicare & Medicaid Services (CMS) Data Use Agreement requirements, which waived the need for informed consent for use of the study data because data were deidentified. We reported the study findings according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Study Data

Our data included Medicare files from 2012 to 2014. These files included Master Beneficiary Summary for patient demographics, Medicare Provider Analysis and Review for claims from hospital and postacute care stays with clinical variables, Inpatient Rehabilitation Facility-Patient Assessment Instrument from IRF,[4,11] Minimum Data Set 3.0 from SNF,[12] and the Provider of Services Current Files for hospital characteristics.

Sample Selection

The study sample included Medicare beneficiaries 66 years or older discharged from January 1, 2013, to November 30, 2014, to an IRF or SNF after an index acute stay for stroke denoted by Medicare Severity Diagnosis Related Group codes 061 to 066 (eFigure in the Supplement).[13] Additional inclusion criteria included Medicare Part A coverage without enrollment in a health maintenance organization in the year before and 1 month after the index stroke discharge, residing in the community prior to the index stroke hospitalization, and full mobility and self-care functional measures at the IRF admission and discharge or SNF admission and last follow-up (eTable 1 and eTable 2 in the Supplement).

Functional Measures: Mobility and Self-Care

Our methods are described in more detail in the eAppendix in the Supplement. We used mobility and self-care items from the Inpatient Rehabilitation Facility-Patient Assessment Instrument and the Minimum Data Set 3.0 (eTable 3 in the Supplement). The Inpatient Rehabilitation Facility-Patient Assessment Instrument includes 5 mobility items and 6 self-care items, with a 7-point rating scale. The Minimum Data Set 3.0 consists of 6 mobility items with a 4-point rating scale and 5 self-care items with a 5-point rating scale.

We used the crosswalk developed by Mallinson et al[14] to construct comparable admission and discharge functional scores for the postacute care settings.[15] The scores at admission and discharge for mobility and self-care are reported on a scale of 0 to 100 points, with higher scores indicating greater functional status. This method has demonstrated efficacy in several settings.[16,17]

Covariates

Patient characteristics included age at admission to IRF or SNF (ie, 66-69, 70-74, 75-79, 80-84, or ≥85 years), sex, race/ethnicity (ie, non-Hispanic white, non-Hispanic black, Hispanic, or other), length of stay (LOS) in acute care (ie, 1-3, 4-7, 8-11, 12-25, or ≥26 days), Medicaid eligibility, type of stroke (ischemic or hemorrhagic) and any stay in intensive care. The race/ethnicity variable was defined by the CMS and was included because some outcomes differ among racial/ethnic groups.[18] The 30 most frequent CMS Hierarchical Condition Categories for comorbidities were identified through diagnoses on the inpatient claims from the previous year and the secondary diagnoses during the index stroke hospitalization (eTable 4 and eTable 5 in the Supplement).[19] In addition, we added 6 diagnoses related to cognitive function (eTable 6 in the Supplement). Hospital characteristics included location (urban or rural), hospital type (ie, for-profit, nonprofit, or other), presence of swing beds (yes or no), rehabilitation unit within hospital (yes or no), teaching hospital (yes or no), number of stroke discharges from the index hospital in the same year of the index stroke discharge, and number of beds in index stroke hospital.

Outcomes

The outcomes were changes in mobility and self-care scores during the IRF or SNF stay. As a control outcome, we assessed mortality between 30 and 365 days after hospital discharge. We selected this outcome to assess how well the analytic techniques controlled for any differences in underlying health status between patients admitted to IRF or SNF. The assumption was that mortality in this time frame would be closely linked to health status and minimally associated with the type of facility.

Statistical Analysis

Data were analyzed from January 17, 2017, through April 25, 2019. We began with unadjusted bivariate analyses of all variables compared across IRF and SNF settings. We used several analytic approaches to control for potential confounders across IRF and SNF settings, including multivariable analysis, inverse probability weighting with propensity scores and instrumental variable analyses. The multivariable approach used ordinary least squares, adjusting for covariates. Next, we used inverse probability treatment weighting with propensity scores with and without multilevel adjustment.

The propensity score was generated with a logistic regression model using an average treatment effect estimation[20] that incorporated all covariates listed in eTable 4 and eTable 5 in the Supplement. If any covariates in the propensity score model were not balanced, we additionally controlled for those covariates in the outcome models. Next, we used hierarchical general linear mixed-effects models to account for patients nested within hospitals. Additionally, we used ordinary least squares models with inverse probability treatment weighting, with propensity scores also adjusted for unbalanced covariates, to compare functional status outcome (ie, mobility and self-care) at discharge from IRF or SNF.

We used instrumental variable analysis to adjust for unmeasured confounders across patients and facilities.[21] The instrumental variables included difference in the distance from the acute care hospital to the nearest IRF vs the nearest SNF, difference in the distance from the beneficiary's residence to the nearest IRF vs nearest SNF, number of stroke patients discharged to an IRF in the hospital referral region (HRR) in 2013 through 2014, and the previous discharge location assignment (IRF or SNF) for patients with the same type of stroke from the same acute care hospital (eTable 7 and eTable 8 in the Supplement). We estimated the parameters using 2-stage least square regression.[22-24] For the control outcome of 30- to 365-day mortality, the parameters were estimated from 2-stage residual inclusion models because the outcome was dichotomous. Lastly, we calculated E-values for mobility scores, self-care scores, and mortality between patients admitted to IRF or SNF, to assess the potential magnitude of unmeasured confounding that might have produced the results.[10] Data were analyzed using SAS statistical software version 9.4 (SAS Institute). *P* values were 2-tailed, and statistical significance was set at less than .05.

Results

A total of 99 185 patients with stroke from 3405 hospitals were included in the study, including 66 082 patients (66.6%) who received stroke rehabilitation in an IRF and 33 103 patients (33.4%) who received stroke rehabilitation in an SNF. **Table 1** presents the baseline differences in the patient characteristics between those admitted to IRFs or SNFs. A higher proportion of women were admitted to SNFs (21 466 [64.8%] women) than IRFs (36 462 [55.2%] women) ($P < .001$). Compared with patients admitted to IRFs, patients admitted to SNFs were older (mean [SD] age, 79.4 [7.6] years vs 83.3 [7.8] years; $P < .001$), had longer hospital LOS (mean [SD], 4.6 [3.0] days vs 5.9 [4.2] days; $P < .001$), and had more comorbidities (mean [SD], 2.8 [2.0] comorbidities vs 3.3 [2.1] comorbidities; $P < .001$) (Table 1; eTable 4 in the Supplement). The LOS in SNFs was more than 2-fold that in IRFs (mean [SD], 38.1 [24.1] days vs 15.2 [7.3] days).

Table 2 presents the unadjusted mobility and self-care scores at admission and discharge for patients in IRFs and SNFs, along with the change in scores between admission and discharge.

Table 1. Characteristics of Patients Admission to IRF and SNF

Variable	Patients, No. (%)		*P* Value[a]
	IRF (n = 66 082)	SNF (n = 33 103)	
Age, mean (SD), y[b]	79.4 (7.6)	83.3 (7.8)	<.001
66-69	7959 (12.0)	1869 (5.6)	
70-74	11 994 (18.2)	3244 (9.8)	
75-79	13 421 (20.3)	4931 (14.9)	
80-84	13 931 (21.1)	6978 (21.1)	
≥85	18 777 (28.4)	16 081 (48.6)	
Sex			
Men	29 620 (44.8)	11 637 (35.2)	<.001
Women	36 462 (55.2)	21 466 (64.8)	
Race/ethnicity			
Non-Hispanic white	52 826 (79.9)	26 775 (80.9)	<.001
Non-Hispanic black	7753 (11.7)	3915 (11.9)	
Hispanic	3202 (4.9)	1371 (4.1)	
Other	2301 (3.5)	1042 (3.1)	
Stroke type			
Ischemic	58 872 (89.1)	29 272 (88.4)	.002
Hemorrhagic	7210 (10.9)	3831 (11.6)	
Length of stay in acute care, mean (SD), d[b]	4.6 (3.0)	5.9 (4.2)	<.001
1-3	28 099 (42.5)	9723 (29.4)	
4-7	29 996 (45.4)	16 403 (49.6)	
8-11	5839 (8.8)	4390 (13.3)	
12-25	2066 (3.1)	2403 (7.3)	
≥26	82 (0.1)	184 (0.6)	
Admission function score, mean (SD)[c]			
Mobility[d]	44.2 (7.4)	40.8 (9.4)	<.001
Self-care[e]	45.0 (11.1)	41.9 (11.7)	<.001
No. of comorbidities, mean (SD)[b]	2.8 (2.0)	3.3 (2.1)	<.001
Medicaid eligible	10 454 (15.8)	7222 (21.8)	<.001
Stayed in ICU or CCU	39 195 (59.3)	17 178 (51.9)	<.001
Urban hospital	60 114 (91.0)	28 207 (85.2)	<.001
Hospital type			
For-profit	9480 (14.3)	4074 (12.3)	<.001
Nonprofit	48815 (73.9)	24 848 (75.1)	
Other	7787 (11.8)	4181 (12.6)	
Swing bed	1710 (2.6)	2023 (6.1)	<.001
Rehabilitation unit in IRF[f]	40 742 (61.7)	14 657 (44.3)	<.001
Teaching hospital	34 919 (52.8)	15 858 (47.9)	<.001
Stroke discharges, No., mean (SD)[b]	248.0 (175.9)	218.7 (174.8)	<.001
Hospital beds, No., mean (SD)[b]	463.0 (329.2)	414.2 (332.0)	<.001

Abbreviations: CCU, cardiac care unit; ICU, intensive care unit; IRF, inpatient rehabilitation facilities; SNF, skilled nursing facilities.

[a] Based on χ^2 test.

[b] Based on Wilcoxon rank sum test.

[c] Scores were scaled on 0- to 100-point scales, with higher scores indicating greater functional status.

[d] Mobility score for IRF measured the level of help needed for transfer to bed, chair, or wheelchair, transfer to toilet, transfer tub or shower, locomotion via walking or a wheelchair, and locomotion on stairs. Mobility score for SNF measured the level of help needed for bed mobility, transfer, walking in a room, walking in a corridor, locomotion on the unit, and locomotion off the unit.

[e] Self-care scores in IRF measured the level of help needed for eating, grooming, bathing, dressing upper body, dressing lower body, and toileting. For SNF, self-care score measured the level of help needed for dressing, eating, toilet use, personal hygiene, and bathing.

[f] Indicates a rehabilitation unit that is part of an acute care hospital rather than a free-standing rehabilitation facility.

Table 2. Unadjusted Admission and Discharge Results

Score	Mean (95% CI)			
	IRF		SNF	
	Mobility	Self-care	Mobility	Self-care
At admission	44.2 (44.1-44.3)	45.0 (44.9-45.1)	40.8 (40.7-40.9)	41.8 (41.7-41.9)
At discharge	55.8 (55.7-55.9)	58.6 (58.5-58.7)	44.4 (44.3-44.5)	45.1 (45.0-45.2)
Change	11.6 (11.5-11.7)	13.6 (13.5-13.7)	3.5 (3.4-3.6)	3.2 (3.1-3.3)

Abbreviations: IRF, inpatient rehabilitation facilities; SNF, skilled nursing facilities.

Compared with patients in IRFs, patients in SNFs had lower mean scores for mobility (44.2 [95% CI, 44.1-44.3] points vs 40.8 [95% CI, 40.7-40.9] points) and self-care (45.0 [95% CI, 44.9-45.1] points vs 41.8 [95% CI, 41.7-41.9] points) at admission and for mobility (55.8 [95% CI, 55.7-55.9] points vs 44.4 [95% CI, 44.3-44.5] points) and self-care (58.6 [95% CI, 58.5-58.7] points vs 45.1 [95% CI, 45.0-45.2] points) at discharge. The changes in mobility and self-care scores were substantially greater among IRF patients. For mobility, the change was 11.6 (95% CI, 11.5-11.7) points for patients in IRFs vs 3.5 (95% CI, 3.4-3.6) points for those in SNFs. For self-care, the change was 13.6 (95% CI, 13.5-13.7) points vs 3.2 (95% CI, 3.1-3.3) points.

After applying propensity score weights, most demographics and comorbidities were balanced between IRF and SNF (49 of 52 variables [94.2%]) (eTable 4 and eTable 5 in the Supplement). **Table 3** presents stroke outcomes by mobility and self-care discharge scores for patients in IRF or SNF. Regardless of covariate adjustment method, the patients with stroke who were discharged from IRF had higher mobility and self-care scores than those discharged from SNF. In multivariate adjustment analysis, the mean (SE) difference in scores between patients from IRF vs SNF was 7.8 (0.05) points for mobility and 9.7 (0.06) points for self-care. In the multilevel multivariate propensity score inverse probability of treatment weighting model, the mean (SE) difference in scores between patients from IRF vs SNF was 8.0 (0.04) points for mobility and 9.9 (0.05) points for self-care. Results of instrumental variable analyses are summarized in Table 3 and show similar results, including by differential distance from acute care hospital to nearest IRF or SNF (mean [SE] difference: mobility score, 8.2 [0.34] points; self-care score, 9.8 [0.39] points), by differential distance from patient's residence to nearest IRF or SNF (mean [SE] difference: mobility score, 5.6 [0.63] points; self-care score, 8.7 [0.72] points), by percentage of IRFs within the acute hospital HRR (mean [SE] difference: mobility score, 10.4 [0.21] points; self-care score, 11.9 [0.25] points), and by previous IRF or SNF assignment by stroke type within each hospital (mean [SE] difference: mobility score, 9.2 [0.30] points; self-care score, 10.7 [0.34] points). In all models, the changes in mobility and self-care scores for those discharged from IRFs were at least 2-fold those for patients discharged from SNFs.

In order to assess the ability of the various analytic techniques to adjust for unmeasured confounders, we assessed mortality between 30 and 365 days as a control outcome (**Table 4**). In unadjusted analyses, patients with stroke who were discharged from IRF had lower mortality than those discharged from SNF (17.5% vs 30.5%, OR, 0.48 [95% CI, 0.46-0.49]). Adjustment for patient and hospital characteristics in a multivariate adjustment model increased the OR to 0.72 (95% CI, 0.69-0.74), which was similar to results of the inverse probability weighted propensity models

Table 3. Change in Score From Admission to Discharge in IRF and SNF

	Score, Mean (SE)					
	IRF		SNF		Difference	
Analysis	Mobility	Self-care	Mobility	Self-care	Mobility	Self-care
Estimation method						
Unadjusted	11.6 (0.03)	13.6 (0.04)	3.5 (0.03)	3.2 (0.04)	8.0 (0.05)	10.4 (0.06)
Multivariate adjustment	11.5 (0.03)	13.4 (0.03)	3.7 (0.04)	3.7 (0.05)	7.8 (0.05)	9.7 (0.06)
Propensity score models						
Multivariate IPTW adjustment[a]	11.5 (0.03)	13.4 (0.03)	3.5 (0.03)	3.4 (0.03)	8.0 (0.04)	9.9 (0.05)
Multilevel multivariate IPTW adjustment	11.4 (0.03)	13.2 (0.04)	3.4 (0.03)	3.4 (0.04)	8.0 (0.04)	9.9 (0.05)
Instrumental variable analysis						
Differential distance from acute to nearest IRF or SNF	11.7 (0.12)	13.4 (0.13)	3.4 (0.23)	3.6 (0.26)	8.2 (0.34)	9.8 (0.39)
Differential distance from beneficiary to nearest IRF or SNF	10.8 (0.21)	13.1 (0.24)	5.2 (0.42)	4.4 (0.48)	5.6 (0.63)	8.7 (0.72)
Percentage of IRFs within acute hospital referral region	12.4 (0.07)	14.2 (0.09)	2.0 (0.14)	2.2 (0.16)	10.4 (0.21)	11.9 (0.25)
Previous IRF or SNF assignment by stroke type within each hospital	12.0 (0.10)	13.7 (0.12)	2.8 (0.20)	3.0 (0.23)	9.2 (0.30)	10.7 (0.34)

Abbreviations: IPTW, inverse probability of treatment weighting; IRF, inpatient rehabilitation facility; SNF, skilled nursing facility.

[a] After applying propensity score weights, most demographics and stroke comorbidities were balanced between IRF and SNF (49 out of 52 variables), except for admission mobility score (IRF mean [SD], 43.3 [6.6]; SNF, 43.7 [12.0]; $P < .001$), admission self-care score (IRF, 44.0 [9.8]; SNF, 44.3 [14.3]; $P = .001$), and hemiplegia or hemiparesis (IRF, 43.7%; SNF, 42.7%; $P = .02$).

(adjusted odds ratio, 0.75 [95% CI, 0.72-0.77]). In contrast, the 4 instrumental variable models resulted in odds of mortality closer to 1.0, with ORs ranging from 0.92 (95% CI, 0.76-1.11) when adjusted for previous IRF or SNF assignment by stroke type within each hospital to 1.25 (95% CI, 0.88-1.76) when adjusted by differential distance from patient's residence to the nearest IRF or SNF (Table 4).

Lastly, for each outcome, we calculated the E-value to assess the minimum strength of association that an unmeasured confounder would need to have with the outcome and postacute care setting to eliminiate the association between postacute care setting and each outcome (eTable 9 in the Supplement). The lower confidence limit of the E-value was 4.0 for the change in mobility and 4.2 for self-care scores. E-values this large indicate that the association between function score change and postacute care setting we observed was strong.[10]

Discussion

Currently, the decision-making process in selecting postacute care services is heavily influenced by nonclinical factors.[25-30] This is shown by the substantial geographic variation in the proportions of patients with stroke discharged to IRFs or SNFs.[28] The choice is associated with measures of availability, such as distance to the nearest facility.[29] The association of IRF vs SNF use with these nonclinical factors allows investigators to use them as instruments in an instrumental variable analysis, which should better control for unmeasured confounders that might be influencing the choice of IRF vs SNF.

Comparative research related to functional outcomes for persons with stroke receiving rehabilitation in IRFs vs SNFs is limited, to our knowledge. A recent systematic review reported better functional outcomes and higher costs for patients in IRFs compared with those in SNFs and emphasized the need for additional research.[4] Limited research has reported generally better functional outcomes associated with patients in IRFs vs SNFs after a stroke.[4,29,31,32] The findings of our study support this trend. In the 4 instrumental variable models, the differences in improvement in mobility scores between IRF and SNF patients between 5 and 10 points and for self-care scores, the difference was between 8 and 12 points. A 10-point difference in self-care in an IRF is the difference between a patient rating of needing maximal assistance vs needing supervision. Maximal assistance requires another person to physically assist the patient. Needing supervision simply involves another person being present to monitor the activity but not provide physical assistance unless required. Patients at the level of needing supervision are usually ready for discharge to home, while patients needing maximal assistance will require continued institutional care or in-home nursing support after discharge from postacute care.[32,33]

We also found differences in functional outcomes between IRF and SNF using logistic regression and propensity scores. However, the inability of more analytical techniques to eliminate the

Table 4. 30- to 365-d Mortality From Hospital Discharge Between IRFs and SNFs

Analysis	Odds Ratio (95% CI)
Estimation method	
Unadjusted	0.48 (0.46-0.49)
Multivariate adjustment	0.72 (0.69-0.74)
Propensity score model	
Multivariate IPTW adjustment	0.75 (0.72-0.77)
Multilevel multivariate IPTW adjustment	0.72 (0.69-0.74)
Instrumental variable	
Differential distance from acute to nearest IRF or SNF	1.01 (0.82-1.23)
Differential distance from beneficiary to nearest IRF or SNF	1.25 (0.88-1.76)
Percentage of IRFs with the acute hospital referral region	1.02 (0.89-1.17)
Previous IRF or SNF assignment by stroke type within each hospital	0.92 (0.76-1.11)

Abbreviations: IPTW, inverse probability of treatment weighting; IRF, inpatient rehabilitation facilities; SNF, skilled nursing facilities.

differences in the control outcome of all-cause mortality between 30 and 365 days suggests that those approaches did not eliminate selection biases. This pattern is consistent with prior comparative effectiveness studies using observational data[7-9] and reinforces the view that such techniques should be avoided in the face of strong selection bias.

Our study adds to the accumulating scientific literature that better functional outcomes, such as mobility and self-care, are associated with discharge from IRFs vs SNFs among stroke survivors.[4,29,31,32] This has not been true for other conditions, such as hip fracture or joint replacement.[34] A study by Mallinson et al[34] comparing mobility and self-care outcomes, which were measured in the same way as in our study, among patients with hip fracture receiving rehabilitation from IRFs, SNFs, or home health agencies found no statistically significant differences in fully adjusted models. The difference in findings between the Mallinson et al study[34] and our study could be related to many factors. We believe the difference in conditions (ie, hip fracture and joint replacement vs stroke) is the most plausible explanation.

Stroke is a complex neurological condition affecting multiple body systems and requiring intensive rehabilitation from several disciplines with different areas of expertise. An IRF is designed to provide intensive rehabilitation to complex patients who need specialized care. To effectively and safely implement unified payment in postacute care,[3] it will be necessary to recognize differences in the rehabilitation needs of patients with stroke and other complex conditions. The CMS 60% rule identifies 13 diagnostic conditions that classify a facility as an IRF for Medicare reimbursement.[35] Stroke is the largest category of these conditions, with 20.5% of all patients in IRFs in 2017.[6]

The instrumental variable analyses in this study describe the outcomes of the marginal patient, that is, those patients who reasonably could have been discharged either to an IRF or SNF. The assumption is that there are patients at the ends of the spectrum who are highly likely to be discharged to an IRF or SNF, but that there are also patients in the middle who could go to either one and for whom the choice is influenced by nonclinical factors. It is not possible to directly measure the size of the population of marginal patients. In a study of Medicare spending and outcomes after postacute care for stroke and hip fracture, Buntin et al[36] estimated the percentage or marginal patients as between 20% to 30% of patients with hip fracture or stroke. One way to estimate the size of the marginal patient population is to examine the distribution in variation in percentage of patients with stroke discharged to an IRF or SNF among HRRs. The assumption is that the underlying health of patients with stroke would vary somewhat among HRRs, but not markedly, and that the variation reflects local availability of the 2 types of facilities along with other medical cultural issues. Our findings are similar to what Buntin et al[36] estimated as the percentage of patients with marginal stroke and hip fracture. Our findings and the research of Buntin et al[36] indicate that it may be possible to improve our ability to identify appropriate candidates for the high-intensity, specialized services provided in IRFs.

Additional research is necessary to confirm our findings and to identify whether any of the other 13 conditions identified by CMS as priority diagnoses for receiving services in IRFs (the 60% rule) may also show differences in functional outcomes based on treatment in IRFs vs SNFs. Our findings also have implications regarding the IMPACT Act.[3] Studies that compare functional outcomes for all patients discharged to postacute care may be missing treatment effects that appear only in some impairment groups requiring the intense or specialized rehabilitation available in IRFs.[30] For many hospital discharges, the postacute care setting may not matter, but our results suggest that, for at least one-third of patients with a stroke, discharge to an IRF vs SNF was associated with a significant difference in self-care and mobility at discharge.

As the IMPACT Act[3] and unified payment are implemented, it will be important to accurately identify subgroups and target patients who would do better in one setting vs another. The current CMS rules for identifying priority patients for IRFs are a good start, but challenges remain, such as the large disparity in the availability of IRFs vs SNFs. Another concern is the current cost differential between postacute care settings. The Medicare Payment Advisory Commission reports[6,37] consistently demonstrate that IRF costs are higher than those of SNF and home health. In a unified

payment system, there would be financial incentives to shift high-cost patients, such as patients with stroke and other complex medical conditions, to lower-cost postacute care options. Effective administrative oversight will be required to ensure patients receive the appropriate care in the right setting.

Limitations

This study has limitations. Our findings are based on Medicare files for IRF and SNF settings only and are not applicable to stroke rehabilitation in other postacute venues (eg, home health care, long-term care hospitals, or outpatient care). We were not able to examine cognitive function before and after the stroke, stroke severity, or location of the stroke. The number of items to measure cognitive function in the IRF and SNF assessment protocols are small, and our preliminary analyses to develop a cocalibrated crosswalk revealed low precision.[16,38] Instead, we included diagnoses associated with cognitive dysfunction in the comorbidities that were controlled for (eTable 6 in the Supplement). The development of a standardized measure of cognitive function is an important area for future research and is included as part of the IMPACT Act.[3] Previous investigations have consistently reported that the costs for rehabilitation services provided in SNFs are significantly lower than in IRFs, even when the longer LOSs associated with SNFs are considered.[4,36] We did not conduct cost comparisons or cost benefit analyses associated with outcomes across the 2 postacute settings. This is an important topic for future research.

Conclusions

This cohort study found that Medicare beneficiaries who received services at an IRF after a stroke demonstrated greater improvement in mobility and self-care compared with patients who received inpatient rehabilitation at a SNF. A significant difference in functional improvement remained after accounting for patient, clinical, and facility characteristics at admission. Our findings indicate the need to carefully manage discharge to postacute care based on the patient's needs and potential for recovery. Postacute care reform based on the IMPACT Act[3] must avoid a payment system that shifts patients with stroke who could benefit from intensive inpatient rehabilitation to lower cost settings.

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SUPPLEMENT.

eFigure. Study Flow Diagram for the Sample
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