Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company’s public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Dialysis

Quality Improvement Through the Introduction of Interdisciplinary Geriatric Hemodialysis Rehabilitation Care

Marilyn Li, MD,1 Eveline Porter, BScN, MN,1 Robert Lam, MD,2 and Sarbjit V. Jassal, MB, MD1,2

Background: Provision of rehabilitation with the aim of restoring personal independence in elderly hemodialysis patients faces several challenges.

Design: Quality improvement report.

Setting & Participants: First 3 years of experience of an inpatient geriatric hemodialysis rehabilitation program in Toronto. Patients with new-onset disability from prolonged illness or an acute event rendering them incapable of living independently.

Quality Improvement Plan: Provision of in-patient rehabilitation with on-site dialysis; a simplified referral system; preferential admission of elderly dialysis patients; short daily dialysis sessions; integrated multidisciplinary care by experts in rehabilitation, geriatric medicine, and nephrology; and reciprocal continued medical education among staff.

Measures: Outcome measures were percentage of patients discharged home, score on the Functional Independence Measure, and attainment of rehabilitation goals.

Results: In the first 36 months, 164 dialysis patients aged 74.5 ± 7.8 years were admitted. On admission, patients had a mean Charlson comorbidity score of 7.8 ± 2.5, 98% had difficulty walking, and 84% required help with bed-to-chair transfers. After a median of 48.5 days, 111 patients (69%) were discharged home; 15 patients (9%), to an assisted-living setting; 20 patients (12%), to a long-term care facility; and 18 patients (11%), to other facilities for acute or palliative care. Of those completing therapy, 82% met some or all of their rehabilitation goals.

Limitations: The program relied on the leadership and drive of key personnel. Discharge disposition as an outcome can be affected by many factors, and definition of attainment of rehabilitation goals is arbitrary.

Conclusion: The introduction of an integrated dialysis rehabilitation service can help older dialysis patients with new-onset functional decline return to their home. Am J Kidney Dis 00:00-00 Am J Kidney Dis 50:90-97. © 2007 by the National Kidney Foundation, Inc.

INDEX WORDS: Quality improvement report; hemodialysis; geriatric rehabilitation; functional impairment measure; nursing home.
Patients is associated with a 35% decreased risk of cardiac mortality\textsuperscript{16}; however, few data are available showing the outcome with geriatric rehabilitation services. Studies of geriatric rehabilitation in dialysis patients are limited to a few case reports or retrospective studies with small sample sizes ranging from 3 to 40 subjects.\textsuperscript{17-23} Assuming studies from the nondialysis literature\textsuperscript{24,25} are applicable to the dialysis population, one would predict that geriatric rehabilitation could limit functional impairment, prolong personal independence, and decrease the need for nursing home care in dialysis patients.

In 2002, the Toronto Rehabilitation Institute, in partnership with the University Health Network, developed a dedicated dialysis rehabilitation service. This report describes the experience of the program during its first 3 years of operation.

**METHODS**

**Perceived Barriers**

Until 2001, rehabilitation was available for dialysis patients in Toronto in either acute-care medical/geriatric units or nondialysis rehabilitation units. Most commonly, patients remained in the acute-care hospital ward and therapists would come and deliver therapy for short periods on the acute-ward floor. Therapy sessions occurred on average 2 to 5 times a week, but ranged in duration from 15 to 40 minutes according to the acute-care workload. Less commonly, patients were transferred to specialized rehabilitation units where they would receive formal therapy sessions in an environment promoting independence. Patients would be temporarily discharged to attend their 3-times-weekly dialysis treatment at offsite dialysis units. It appeared that in many cases, the need to make acute-care beds available and the perception that dialysis patients did poorly with rehabilitation meant that patients often were not given sufficient opportunities for rehabilitation before being advised to seek nursing home placement.

The following barriers were noted by S.V.J. during the preceding years of training and practicing in geriatric medicine and nephrology:

1. Limited number of available beds in designated rehabilitation facilities that accepted hemodialysis patients.
2. Reluctance to admit dialysis patients to rehabilitation beds because of medical complexity and the need for special drug and diet regimens.
3. Under-referral; because nephrology staff were unsure of the appropriateness of candidates, the referral system was confusing and time consuming and acceptance rates were low.
4. Shortened or cancelled therapy sessions because therapists viewed patients as too unwell; patients reported dyspnea before dialysis or fatigue after dialysis; patients were anxious, particularly about not missing their dialysis session; and too-early or too-late transportation.
5. Lack of integration of treatment goals for acute medical care and rehabilitation therapy. When patients remained in acute care for ongoing rehabilitation therapy, the focus of the main health care team was acute medical management, and when patients were transferred to rehabilitation units, the main focus was rehabilitation care with little attention given to ongoing medical issues.
6. Limited interdisciplinary communication about acute medical problems that interfered with the ability to participate in rehabilitation therapy; for example, pain management in the face of renal failure, edema resulting in decreased ankle mobility, dyspnea with exertion, orthostasis, and effects of sedative medications.

**Program Description**

Program goals were to: (1) increase the number of elderly dialysis patients who remained independent in the community after acute or subacute functional decline, and (2) limit the use of acute-care facilities for these patients during rehabilitation therapy.

Key planning personnel included S.V.J., nephrology and rehabilitation program leaders, and senior executives from both institutions. Discussions and planning started in July 2000. Approval and funding (from the Ontario Ministry of Health and Long Term Care) was secured in January 2001, and construction began in November 2001. A 6-station dialysis suite was built in preexisting space 2 floors below the inpatient ward unit within the rehabilitation hospital. The program was designed with several unique features, including 12 dedicated nephrology rehabilitation beds, a simplified timely referral process, and the ability to provide short daily dialysis on site. The first patient was admitted to the service in May 2002.

The program offered inpatient geriatric rehabilitation services to hemodialysis-dependent seniors who had a history of complex medical problems and an acute functional decline. Staffing included occupational therapy and physiotherapy (ratio, 1:6 patients), dietitian and pharmacist (both staffed at 0.2 full-time equivalent), and access to other services, including nurses, speech and language therapists, social workers, and geriatric medicine specialists, as required. Dialysis care was provided by the University Health Network in the form of a satellite unit that offered on-site dialysis services on a daily basis. Medical coverage for the ward and dialysis units was provided by a hospitalist (from Toronto Rehabilitation Institute) and a nephrologist (from University Health Network). Both attended on a part-time basis and provided emergency coverage. Weekly interdisciplinary team meetings led by the nephrologist involved staff from rehabilitation, geriatric, and nephrology disciplines.

Patient eligibility was determined on an individual basis. Referrals were received by the ward admissions officer, screened by the social worker, and reviewed weekly by members of the rehabilitation team, which included nursing, physiotherapy, occupational therapy, social work professionals, and physicians. Approval for admission was granted.
within 24 hours of the meeting and was based on the ability of a patient to participate in rehabilitation sessions and clearly identify rehabilitation goals. Patients requiring ventilation, inotropic support, or cardiac monitoring, as well as those with untunneled hemodialysis catheters, were not eligible. Feeding tubes, tracheostomies, or lack of social support and stable mild cognitive impairment or dementia were not contraindications. Initially, the program was designed for those older than 65 years; however, with time, this age limit was lowered to those older than 55 years, with priority for those aged 65-plus years. The program goal was to accept only those who, at the time of transfer to rehabilitation, would be considered unable to manage their own personal care if returned to their usual home setting.

Formal daily physical and/or cognitive exercises were scheduled on average twice daily, lasting from 30 to 60 minutes per session depending on patient tolerance. Informal and self-directed therapy was provided throughout the full day. Each patient was dialyzed for 2 hours 6 times weekly. In all cases, dialysis was scheduled either early (8:00 AM to 10:00 AM) or late (4:00 PM to 6:00 PM) in the day to limit interference with rehabilitation sessions. Strict renal diets often were liberalized to improve nutritional balance, patient morale, and participation. Each patient was assessed by the pharmacist to streamline medication regimens and minimize or avoid adverse drug effects.

MEASURES

We used 3 outcome measures to evaluate the program. The first was whether patients met the rehabilitation goals. At the time of admission, the patient and staff jointly identified rehabilitation goals for the admission. These goals were individualized and based upon personal lifestyle and living circumstances. Examples of such goals ranged from personal care needs, such as the ability to toilet and wash independently, to higher functional goals, such as climb stairs within the home or walk to the store independently. Because goals varied from individual to individual, we determined whether goals had been met by using a 3-point scale (did not meet goals; met some, but not all goals; and met all admission goals). This score was based on the consensus of the team at the time of discharge.

The second measure was the place of discharge as home, assisted-care facilities (group homes, retirement homes, or supervised-living settings), residential facilities (convalescent care, nursing home, home for the aged, or long-term-care facility), and other facilities (temporary accommodation; acute-care, and palliative-care facilities).

The third measure was change in Functional Independence Measure (FIM) score between admission and discharge. In keeping with National Reporting Standards in Canada for all rehabilitation facilities, severity of functional impairment, measured by means of FIM score, was recorded at the time of admission and discharge. Two individuals assumed responsibility for scoring. Consisting of 13 motor and 5 cognitive domains, the FIM instrument is a widely used rehabilitation outcome measure and has well-established validity and reliability for this use. Motor items include disability assessment in feeding, grooming, dressing, toileting, and mobility. Cognitive items assess communication, social interaction, problem solving, and memory (see Appendix). Scores range from 1 (totally dependent) to 7 (totally independent) for each of the 18 items; a maximum score of 126 indicates total functional independence.

Sources of Data

All patients admitted to the program from May 2002 to December 2005 were included in the program evaluation. Clinical and demographic data were collected prospectively on a customized patient-care database (Microsoft Access 2000; Microsoft Corp, Redmond, WA). Data included time since starting renal replacement therapy (dialysis vintage),

---

**Figure 1.** Patients referred, admitted, and not admitted.
reason for acute functional decline necessitating admission, cause of end-stage renal disease, and presence of comorbid conditions (depression, ischemic heart disease, congestive heart failure, arrhythmias, other heart disease [such as valvular lesions], hypertension, cerebrovascular disease, peripheral vascular disease, diabetes mellitus, respiratory disease, malignancy, hepatobiliary disease, gastrointestinal disease, neurological disease [excluding cerebrovascular disease], skin ulcers; arthritis, hematologic disease, endocrinologic disease, human immunodeficiency virus/acquired immunodeficiency syndrome, or renal bone disease). Comorbidity burden was reported as both a total count of all conditions and Charlson Comorbidity Index score.33,34 Baseline blood tests, performed within 48 hours of admission, included hemoglobin, iron stores, creatinine, electrolytes, serum albumin, calcium, phosphate, parathyroid hormone, and C-reactive protein. Data from the clinical database and the hospital administrative database were linked by using the unique hospital file number, date of admission, and date of discharge. Missing or contradictory information was confirmed by means of manual data extraction from the hospital charts by a trained observer.

The local hospital research ethics board approved the evaluation and publication of this quality improvement report.

Statistical Analysis

Demographic data were analyzed using descriptive statistics (mean ± SD for continuous data, percentages for categorical data). Median and quartiles were used to describe values found to have a skewed distribution. We plotted admission FIM score over time starting from May 2002, when the unit opened, to assess whether it changed over time.

RESULTS

One hundred eighty-six referrals were received during a 36-month period. Twenty-two patients were not admitted either because they refused care, their application was withdrawn, or they were not believed to be suitable for rehabilitation (Fig 1). Of those not believed to be suitable for rehabilitation, 8 had ongoing medical problems, 2 were believed to have no rehabilitation goals, and 1 was known to the program from a previous admission and believed to have no motivation to improve. One patient was refused admission on the basis of infection control during the severe acute respiratory syndrome epidemic in Toronto.

A total of 164 patients were admitted from 8 secondary or tertiary-care nephrology units in Toronto and 15 patients (9.1%) were admitted from home, whereas the remaining patients were admitted from acute care institutions (Fig 1). The largest proportion was admitted after acute hospitalizations. Of these, 36 had required intensive-care therapy (eg, for calciphylaxis with sepsis requiring inotrope therapy, pneumonia with sepsis requiring inotrope therapy, end-stage liver cirrhosis with actively bleeding varices, spontaneous bacterial peritonitis and deep-vein thrombosis, fungal peritonitis with bowel obstruction requiring surgical care, and vascular or cardiac bypass surgery with postoperative complications). Only 23 patients had “simple” reasons for

| Table 1: Baseline Clinical Characteristics of Patients Admitted to the Rehabilitation Program |
|-----------------------------------------------|
| Demographic data | N = 164 |
| Age (y) | 74.5 ± 7.8 |
| Women | 84 (51) |
| Fluent in English | 134 (82) |
| Dialysis vintage (y) | 1.4 (0.2-5.0) |
| Cause of end-stage renal disease | |
| Diabetes (or combination of diabetes mellitus and hypertension) | 64 (39) |
| Glomerulonephritis or vasculitis | 34 (21) |
| Hypertension | 32 (20) |
| Other | 26 (16) |
| Unknown | 8 (5) |
| Concomitant comorbid condition(s) | |
| Hypertension | 139 (84.8) |
| Ischemic heart disease | 101 (61.6) |
| Diabetes | 84 (51.2) |
| Cognitive impairment* | 76 (46.3) |
| Peripheral vascular disease | 71 (43.3) |
| Congestive heart failure | 69 (42.1) |
| Chronic lung disease | 61 (37.2) |
| Cerebrovascular disease | 60 (36.6) |
| Depression | 53 (32.3) |
| Obesity | 21 (12.8) |
| Laboratory results at baseline | |
| Hemoglobin (g/dL) | 11.0 ± 1.4 |
| Ferritin (ng/mL) | 178 (69-352) |
| Iron saturation | 0.16 (0.12-0.27) |
| Albumin (g/dL) | 3.37 ± 0.43 |
| Calcium (mg/L) | 9.5 ± 0.8 |
| Phosphate (mg/L) | 4.4 ± 3.0 |
| Intact parathyroid hormone (μg/mL) | 18.2 (8.7-48.7) |
| C-Reactive protein (mg/L) | 15.5 (5.0-36.2) |

Note: Values expressed as mean ± SD, number (percent), or median (quartiles). To convert hemoglobin in g/dL to g/L, multiply by 10; ferritin in ng/mL to μg/L, multiply by 1; albumin in g/dL to g/L, multiply by 10; calcium in mg/L to mmol/L, multiply by 0.2495; phosphate in mg/L to mmol/L, multiply by 0.3229, parathyroid hormone in pg/mL to ng/L, multiply by 1.

*Defined as either a clinical diagnosis of dementia made by the primary physician or a Mini-Mental State Examination score of 24 or less.
their prior hospital admission. These included patients with vasculitis (n = 3), myeloma (n = 1), joint arthroplasty (n = 1), tuberculous peritonitis (n = 1), uncomplicated fungal peritonitis (n = 2), and more common conditions, such as catheter sepsis, nausea and vomiting, fluid overload, and pneumonia.

Patients had a mean age of 74.5 years (range, 58 to 92 years) at the time of admission. Most (51.2%) were women, 51.2% had diabetes, and 17.7% were not fluent in English (Table 1). Thirty-four percent of patients had started hemodialysis therapy within 6 months of admission for rehabilitation. Before admission, 96.5% of all patients lived in a private home or apartment, and 3.6% lived in either an assisted-living or long-term-care setting. All patients had multiple comorbidities, with a mean of 7.9 ± 2.4 comorbid conditions and Charlson comorbidity score of 7.8 ± 2.5 (Table 1). Serum chemistry test results suggested a high incidence of malnutrition and/or inflammation because 42.1% of patients had ferritin values of 223 ng/mL (µg/L) or greater, 25.6% had a C-reactive protein level greater than the laboratory normal range (≥13 mg/L), 20.1% had a serum albumin level of 3 g/dL or less (≤30 mmol/L), and 17.1% had a hemoglobin level less than 9.5 mg/dL (<95 g/L) despite therapy with an erythropoietic agent and iron.

Median length of stay (LOS) was 48.5 days (quartiles, 32 to 72 days). Rehabilitation outcomes are listed in Table 2. Admission FIM scores were available for all patients (mean score, 76.4 ± 19.6; median, 77; range, 37 to 121; Table 3). To our surprise, admission scores did not change over time (Fig 2). Discharge FIM scores were available for only 9.

Discharge FIM scores followed a skewed distribution, suggesting possible ceiling effects, with a median score of 101.5 (quartiles, 81 to 114; range, 15 to 124). Mean change in FIM score was 21.5 ± 16.1 (range, −24 to +64). Eleven patients had no change in or worsening of their functional status despite rehabilitation therapy.

Forty individuals were transferred to acute care, on 46 occasions. Thirty-six transfers were attributable to an acute medical illness (eg, myocardial infarction, sepsis, or gangrene) requiring hospitalization, 8 were for treatment of a dialysis access–related complication (eg, bleeding, thrombosis, or stenosis), and 2 patients were transferred to await palliative care. Eighteen patients did not return to rehabilitation after transfer. Of those who returned, median time in acute care was 7.5 days (quartiles, 3.3 to 12.0). One patient was kept in acute care for 79 days before his or her return.

**DISCUSSION**

In this report, we describe our experience with a specialized dialysis rehabilitation program designed for older dialysis patients with functional limitations. Our data suggest that geriatric rehabilitation is feasible for older hemodialysis patients after acute care hospitalization or acute loss of function, and a substantial proportion of patients can return to their homes. Based on the impressions of the authors (S.V.J., R.L.), providing dialysis in short daily sessions and integrating care...
in a multidisciplinary team were key ingredients for success of the program. Whereas short daily dialysis was designed primarily to increase rehabilitation efficiency by limiting scheduling conflicts and interference between medical and rehabilitation treatments, we heard from patients that they preferred daily dialysis and reported higher energy levels. We believe short daily dialysis may have been less exhausting for patients, allowed more dietary flexibility, and improved fluid and electrolyte control. In addition, patients seemed less anxious about their dialysis schedule and overall were very willing to participate in rehabilitation treatments. We also noted increased collaboration between caregivers over time, with detailed discussion of the goals, achievements, and challenges for each patient in the weekly team meetings. We noted reciprocal continued medical education between staff of different disciplines and close collaboration between the various health professions involved in dialysis and rehabilitation care.

Randomized controlled trials showed that rehabilitation prevented admissions to nursing homes and shortened the length of hospitalizations. Our data suggest this also may be true for dialysis patients. Comparisons with previously published studies are limited because most studies were small, involved younger dialysis patients, and omitted clinical details about concurrent comorbid illnesses, diabetes status, and so on. Only 1 study involved dialysis patients with an average age older than 70 years. In that study, 80% of patients did poorly with rehabilitation. In other studies, dialysis patients were often 10 to 15 years younger and were admitted after acute surgical procedures. The largest of these, by Forrest et al., reported outcomes for 40 dialysis patients. In their study, only 8 of 40 patients were reported as “medically complicated.” Average LOS was 12 days, substantially shorter than the LOS in our population (average LOS, 48 days). Age, patient comorbidity, and differences in health care systems may
explain these discrepancies. In Canada, health care is provincially funded and therefore accessible to all regardless of health insurance coverage. Therefore, we believe a more appropriate comparison group may be nondialysis patients admitted to a geriatric facility within Canada. One such study is by Patrick et al. In that study, non-dialysis-dependent geriatric patients admitted for rehabilitation after an acute hospitalization had similar overall improvements in raw FIM scores from the time of admission to discharge. LOS also was similar.

Some features of our program are unique and may be difficult to reproduce in other centers. In particular, both the nephrologist (S.V.J.) and the hospitalist (R.L.) involved in our program had a strong interest in rehabilitation and care of older dialysis patients, and their enthusiasm may have had a significant role to generate momentum, particularly in the early stages of the program. Our outcome measures of achieving prespecified rehabilitation goals and the discharge destination are subjective, and although they have face validity, they are not validated. Furthermore, the discharge destination may be influenced by many factors, including social and financial resources. However, use of the FIM score is mandated across Canada and previously was validated. Although ordinal and prone to a high incidence of both ceiling and floor effects, use of the FIM score allows comparisons of our data with those of other units.

In conclusion, our data suggest that older hemodialysis patients can benefit from specialized geriatric dialysis rehabilitation. We are continuing to monitor the quality of our program. We also are planning extensions to the program to include access for younger patients and incorporation of musculoskeletal and acute brain injury rehabilitation services.

ACKNOWLEDGEMENTS

Support: None.
Financial Disclosure: None.

REFERENCES

1. Jassal SV, Li M, Cook WL: Survival at what cost? A study of disability in older dialysis subjects. J Am Soc Nephrol 17:S-FP0398, 2006 (abstr)
2. Toronto District Health Council: The Rising Tide of End Stage Renal Disease in Toronto. Toronto, Ontario, Canada, Toronto District Health Council, 2003
3. US Renal Data System: Incidence and prevalence of ESRD in patients 75 or over, in USRDS 2005 Annual Data Report, chap 2. The National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2005, pp 76-77
4. US Renal Data System: Morbidity and mortality, in USRDS 2006 Annual Data Report, chap 6. The National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2006, pp 121-144
5. Jassal SV, Douglas JF, Stout RW: Increasing dependency on dialysis: An age old problem, in 4th International Conference in Geriatric Nephrology and Urology, Toronto, Canada, International Society of Geriatric Nephrology, 1996, p 10 (abstr)
6. Naglie G, Jassal SV, Tomlinson G, Richardson R: Frailty in elderly hemodialysis patients at a large university hospital dialysis center. Gerontologist 42:239-240, 2002 (special issue 1)
7. Cook WL, Jassal SV: Prevalence of falls amongst seniors maintained on hemodialysis. Int Urol Nephrol 37:649-652, 2005
8. Cook WL, Tomlinson G, Donaldson M, et al: Falls and fall-related injuries in older dialysis patients. Clin J Am Soc Nephrol 1:1197-1204, 2006
9. Jamal SA, Leiter RE, Jassal V, Hamilton CJ, Bauer DC: Impaired muscle strength is associated with fractures in hemodialysis patients. Osteoporos Int 17:1390-1397, 2006
10. Altuteppe L, Levendoglu F, Okudan N, et al: Physical disability, psychological status, and health-related quality of life in older hemodialysis patients and age-matched controls. Hemodial Int 10:260-266, 2006
11. Sterky E, Stegmayr BG: Elderly patients on haemodialysis have 50% less functional capacity than gender- and age-matched healthy subjects. Scand J Urol Nephrol 39:423-430, 2006
12. Kravitz RL, Greenfield S, Rogers W, et al: Differences in the mix of patients among medical specialties and systems of care. Results from the Medical Outcomes Study. JAMA 267:1617-1623, 1992
13. Fried TR, Bradley EH, Williams CS, Tinetti ME: Functional disability and health care expenditures for older persons. Arch Intern Med 161:2602-2607, 2001
14. Gill TM, Gahlbauer EA, Allore HG, Han L: Transitions between frailty states among community-living older persons. Arch Intern Med 166:418-423, 2006
15. Gill TM, Allore HG, Hardy SE, Guo Z: The dynamic nature of mobility disability in older persons. J Am Geriatr Soc 54:248-254, 2006
16. Kutner NG, Zhang R, Huang Y, Herzog CA: Cardiac rehabilitation and survival of dialysis patients after coronary bypass. J Am Soc Nephrol 17:1175-1180, 2006
17. Forrest G, Nagao M, Iqbal A, Kakar R: Inpatient rehabilitation of patients requiring hemodialysis: Improving efficiency of care. Arch Phys Med Rehabil 86:1949-1952, 2005
18. Forrest GP: Inpatient rehabilitation of patients requiring hemodialysis. Arch Phys Med Rehabil 85:51-53, 2004
19. Garrison SJ, Merritt BS: Functional outcome of quadruple amputees with end-stage renal disease. Am J Phys Med Rehabil 76:226-230, 1997
20. Frank C, Morton AR: Rehabilitation of geriatric patients on hemodialysis: A case series. Geriatr Today 5:136-139, 2002

21. Greenspun B, Harmon RL: Rehabilitation of patients with end-stage renal failure after lower extremity amputation. Arch Phys Med Rehabil 67:336-338, 1986

22. Cowen TD, Huang CT, Lebow J, et al: Functional outcomes after inpatient rehabilitation of patients with end-stage renal disease. Arch Phys Med Rehabil 76:355-359, 1995

23. Czyrny JJ, Merrill A: Rehabilitation of amputees with end-stage renal disease. Functional outcome and cost. Am J Phys Med Rehabil 73:353-357, 1994

24. Gill TM, Baker DI, Gottschalk M, Peduzzi PN, Allore H, Van Ness PH: A prehabilitation program for the prevention of functional decline: Effect on higher-level physical function. Arch Phys Med Rehabil 85:1043-1049, 2004

25. Stuck AE, Minder CE, Peter-Wuest I, et al: A randomized trial of in-home visits for disability prevention in community-dwelling older people at low and high risk for nursing home admission. Arch Intern Med 160:977-986, 2000

26. Wright, J. The FIM. The Center for Outcome Measurement in Brain Injury. Available at: http://www.tbims.org/combi/FIM. Accessed March 22, 2007

27. Dodds TA, Martin DP, Stolov WC, Deyo RA: A validation of the Functional Independence Measurement and its performance among rehabilitation inpatients. Arch Phys Med Rehabil 74:531-536, 1993

28. Ottenbacher KJ, Hsu Y, Granger CV, Fiedler RC: The reliability of the Functional Independence Measure: A quantitative review. Arch Phys Med Rehabil 77:1226-1232, 1996

29. Pollak N, Rheault W, Stoecker JL: Reliability and validity of the FIM for persons aged 80 years and above from a multilevel continuing care retirement community. Arch Phys Med Rehabil 77:1056-1061, 1996

30. Dickson HG, Kohler F: Interrater reliability of the 7-level Functional Independence Measure (FIM). Scand J Rehabil Med 27:253-256, 1995

31. Kidd D, Stewart G, Baldry J, et al: The Functional Independence Measure: A comparative validity and reliability study. Disabil Rehabil 17:10-14, 1995

32. Hamilton BB, Laughlin JA, Fiedler RC, Granger CV: Interrater reliability of the 7-level Functional Independence Measure (FIM). Scand J Rehabil Med 26:115-119, 1994

33. Charlson ME, Pompei P, Ales KL, MacKenzie CR: A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis 40:373-383, 1987

34. Van Manen JG, Korevaar JC, Dekker FW, Boeschoten EW, Bossuyt PM, Krediet RT: Adjustment for comorbidity in studies on health status in ESRD patients: Which comorbidity index to use? J Am Soc Nephrol 14:478-485, 2003

35. Pouwer F, Snoek FJ, Heine RJ: Ceiling effect reduces the validity of the Diabetes Treatment Satisfaction Questionnaire. Diabetes Care 21:2039, 1998

36. Patrick L, Knoefel F, Gaskowski P, R 서로oth D: Medical comorbidity and rehabilitation efficiency in geriatric inpatients. J Am Geriatr Soc 49:1471-1477, 2001

37. Panesar BS, Morrison P, Hunter J: A comparison of three measures of progress in early lower limb amputee rehabilitation. Clin Rehabil 15:157-171, 2001

38. Gosman-Hedstrom G, Svensson E: Parallel reliability of the Functional Independence Measure and the Barthel ADL index. Disabil Rehabil 22:702-715, 2000

39. Dodds TA, Martin DP, Stolov WC, Deyo RA: A validation of the Functional Independence Measurement and its performance among rehabilitation inpatients. Arch Phys Med Rehabil 74:531-536, 1993

**APPENDIX**

Details of Parameters Measured as Part of the Functional Independence Measure

1. Ability to feed oneself.
2. Ability to groom oneself (includes oral hygiene, washing hands and face, combing hair, and shaving or makeup application, if appropriate).
3. Ability to bathe oneself (includes showering).
4. Ability to dress upper body.
5. Ability to dress lower body.
6. Ability to toilet self (includes removing clothing, cleaning, and readjusting clothing).
7. Bladder control.
8. Bowel control.
9. Ability to transfer from bed to chair or vice versa.
10. Ability to get on and off toilet (eg, grab bar or special seat).
11. Ability to get in and out of bath or shower.
12. Ability to walk 50 m.
13. Ability to climb a flight of stairs.
14. Comprehension (of such complex information as family matters or current events).
15. Ability to express complex and abstract ideas (family matters or current events).
16. Social interactions.
17. Problem solving skills (eg, managing bank account or confronting interpersonal problems).
18. Memory, eg, for people, routines, and tasks.