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Early home-supported discharge of stroke patients: A health technology assessment

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Objectives: A comprehensive and systematic assessment (HTA) of *early home-supported discharge by a multidisciplinary team that plans, coordinates, and delivers care at home* (EHSD) was undertaken and the results were compared with that of conventional rehabilitation at stroke units.
Methods: A systematic literature search for randomized trials (RCTs) on "early supported discharge" was closed in April 2005. RCTs on EHSD without information on (i) death or institution at follow-up, (ii) change in Barthél Index, (iii) length of hospital stay, (iv) intensity of home rehabilitation, or (v) baseline data are excluded. Seven RCTs on EHSD with 1,108 patients followed 3–12 months after discharge are selected for statistical meta-analysis of outcomes. The costs are calculated as a function of the average number of home training sessions. Economic evaluation is organized as a test of dominance (both better outcomes *and* lower costs).
Results: The odds ratio (OR) for "Death or institution" is reduced significantly by EHSD: OR = .75 (confidence interval [CI], .46–.95), and number needed to treat (NNT) = 14. Referrals to institution have OR = .45 (CI, .31–.96) and NNT = 20. The reduction of the rate of death is not significant. Length of stay is significantly reduced by 10 days (CI, 2.6–18 days). All outcomes have a nonsignificant positive covariance. The median number of home sessions is eleven, and the average cost per EHSD is 1,340 USD. The "action mechanism" and financial barriers to EHSD are discussed.
Conclusions: EHSD is evidenced as a dominant health intervention. However, financial barriers between municipalities and health authorities have to be overcome. For qualitative reasons, a learning path of implementation is recommended where one stroke unit in a region initiates EHSD for dissemination of new experience to the other stroke units.

Keywords: Early supported discharge, Home care service, Stroke unit, Systematic review

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Early supported discharge (ESD) is a promising alternative to conventional stroke rehabilitation according to the ESD Trialists (9). On behalf of the ESD Trialists, Langhorne et al. (14) have published recently an extended study demonstrating a significant effect on poor outcomes and length of stay. First, our study elaborates on these results and sharpens the intervention in accordance with qualitative studies of the "action mechanism" as advanced by Burton (7), stating that the better accelerated discharge has to be supported by a multidisciplinary team that plans, coordinates, and delivers patient care explicitly*at home* (EHSD); this statement implicates that purely municipal alternatives without domiciliary training are excluded. Second, as a recent economic review by Brady et al. (6) questions the evidence on the cost savings of ESD, we aim to verify the hypothesis that EHSD is a dominant intervention in comparison with conventional stroke unit rehabilitation, including the most recent evidence in the field.

An EHSD team comprises physiotherapists and occupational therapists supported by speech therapists, physicians, nurses, and social workers whose teamwork is coordinated by regular meetings. Often the EHSD begins with one or more predischarge home visits, continues the day of discharge, and goes on with more home sessions per week based on a patient-held recovery plan.

Finally, it should be emphasized that EHSD is not considered an alternative to a stroke unit. EHSD is considered as an extension of stroke unit services following the concept of Indredavik (13). So, the study aims to compare the effectiveness and efficiency of stroke units with or without the EHSD extension. It was not designed to determine a difference in whether the stroke unit has an outpatient training service or a day hospital.

METHODS

Data Sources

Departing from the Cochrane Review (9), the literature search has been limited to identify EHSD studies published after January 1, 2000. For this purpose, the search strategy has been to identify a gross sample of studies in the established field of ESD consecutively selecting the subgroup of EHSD RCTs. The literature search has used PubMed for the combined search terms (i) *early supported discharge stroke* or (ii) *home-based rehabilitation stroke* for (iii) *randomized trials* (RCTs). The latest update of these searches is April 2005. The evidence from RCTs on EHSD is supplemented by qualitative studies of organization and patient conditions in a Danish implementation of EHSD.

Inclusion and Exclusion Criteria

The literature searches for EHSD identify nine of eleven RCTs on ESD included in Langhorne et al. (14). A FASTAR ESD trial included in the Langhorne et al. study (14) is not published. Another RCT from Bangkok reported by Suwanwela et al. (23) is just a follow-home project without therapeutic training, which is not representative for EHSD. Another RCT by Ronning and Guldvog (20) does not meet the necessary EHSD inclusion criteria and is excluded from our study because the intervention consists of stationary and outpatient municipal training facilities without domiciliary training. Finally, an EHSD trial from Belfast reported by Donnelly et al. (8) has to be excluded from this study due to lack of information on poor outcomes (death or institution at follow-up). In all, seven remaining RCTs remain for meta-analysis—references 10 through 17—comprising 1,108 newly diagnosed stroke patients (see Table 1). These patients constituted 44 percent of all patients who were considered to fulfill the criteria for home-based rehabilitation. The main reasons for exclusion of patients from the trials were death within 1 week (10 percent), recovery from symptoms within 1 week (30 percent), and medical and/or personal reasons (16 percent).

Our secondary outcome criteria for inclusion is changes in functional status as indicated by the Barthél Index (BI), which provides an aggregated score for ten basic functions (bowels, bladder, grooming, toilet use, feeding, transfer bed–chair, walking, dressing, stairs, and bathing and still maintains validity and reliability as investigated by Hobart et al. [11]). BI is normally scored by the physician in charge of the patient independently of the therapists performing the physical training. BI is applied originally as BI 20 with the simple alternatives 0, 1, or 2 for most dimensions. An extended version is BI 100, enabling a differentiation from 0 to 10 for each of the same basic dimensions. Scores on BI 20 and BI 100 are converted by the factor 5.

The organization of the intervention required for inclusion is a common feature in the formation of multidisciplinary teams for coordination as well as delivery of EHSD. However, although the coordination team in all but one trial is hospital-based, the delivery of services varies between hospital and municipal teams. In the Newcastle trial reported by Rodgers et al. (19), the same municipal team coordinates and delivers EHSD and the contact with the patient was established in the hospital before discharge. The control group consists in all trials but two of dedicated stroke unit rehabilitation for all patients. In the Newcastle trial reported by Rodgers et al. (19), 33 percent of the control group is rehabilitated in a dedicated stroke unit, only. In all, 80 percent of the control group was rehabilitated in dedicated stroke units.

The demographic data in terms of mean age, sex, and living arrangement (living alone) of the study population show no significant differences except for the Montreal study, which was restricted to patients with a carer giving consent. In the Oslo study, inclusion was restricted to patients who were stable 72 hours after admission. Otherwise inclusion varies from 30 percent to 68 percent according to specific medical criteria on the severity of the stroke. Moreover, the follow-up time of the RCTs varies from 3 to 12 months, with

Table 1. Randomized Controlled Trials of Early Home-Supported Discharge after Stroke

No. RCT/ author[a]/ reference	Inclusion criteria[b]	Patients included (% of all diagnosed patients)	Demography mean male living alone age			Organization of the intervention		Control group	Follow-up time (mo)
			Years	%	%	Coordination/ planning	Delivery of service		
1. Rudd (21) Beech (5)	Standard	331 (45%)	71	56	34	Hospital team	Municipal team	Stroke unit: 50%	12
2. Rodgers (19) McNamee (17)	Standard + OHS < 4 + admittance < 72 hr after stroke	92 (30%)	73	55	47	Municipal team	Municipal team	Stroke unit: 33%	3
3. von Koch (26;27) Thorsén (25)	Standard	83 (37%)	72	55	31	Hospital team	Hospital team	Stroke unit: 100%	6, 12 and 60
4. Anderson (1;2)	(I) Sufficient Physical & mental resources (II) Consent of carer	86 (30%)	72	55	41	Hospital team	Hospital team	Stroke unit: 100%	6
5. Indredavik (13) Fjartoft (10)	$2 <$ SSS < 57	320 (68%)	74	49	42	Hospital team	Municipal team	Stroke unit: 100%	6, 12
6. Bautz-Holtert (4)	(I) $4 <$ BI < 20 & stable after 72 hr (II) OHS < 4	82 (22%)	79	45	60	Hospital team	Municipal team	Stroke unit: 100%	3, 6
7. Mayo (16) Teng (24)	Standard + carer with consent	114 (13%)	70	68	0	Hospital team	Hospital team	Stroke unit: 100%.	3
8. I alt		1.108 (44%)	70–79 years						3–12 and 60 months

[a] The first author given is the first author of the clinical paper, and the second author given is the first author of eventual, independent economic paper.
[b] Standard criteria are minimal criteria as specified in (1) and comprise: acute, stabilized stroke; in need of rehabilitation; local, private domicile; and informed consent.
EHSD, early home-supported discharge; OHS, Oxford Handicap Score; SSS, Scandinavian Stroke Scale; BI, Barthel Index; Rankin Scale, measure of global independence.

a single RCT in Stockholm following up 60 months after admission. A study on the time course of health-related quality of life (QoL) as determined 3, 6, and 12 months after stroke concludes that "despite stable neural function and disability, global as well as domain-specific measures of QoL deteriorated over the 12-months" as reported by Suenkeler et al. (22). This study indicates that the difference in follow-up time is not significant to the assessment of disability indices as "poor outcome" and BI.

Data Extraction from RCT

Data on poor outcomes are extracted from the individual studies calculating the odds ratio (OR) and number of patients needed to treat (NNT) to avoid one poor outcome for the aggregated data across studies. A subanalysis is undertaken calculating the specific odds ratio for referral to institutions. By this method, the meta-analysis is based on individual data pooled into one aggregate RCT. The effects on BI and length of stay are compared across trials as the average difference between the EHSD and control groups relative to their pooled standard deviation, in accordance with the statistical concept of "effect size" advanced by Lipsey and Wilson (15).

Significant results from the meta-analyses are used in the economic analysis. Assuming that EHSD is a rather special health economic case of a dominant intervention a standard cost-effectiveness analysis is not plausible. The dominance hypothesis is falsified, calculating the net saving by critical assumptions on the EHSD effects. A dominant intervention is supposed to fulfill the criteria stated in equation 1: Pr[Net saving <0] <5 percent, supposing outcome is not deteriorated.

The calculation of costs and savings are restricted to average changes in a period of 12 months from randomization. The calculation of costs are based on input data that are extracted from independent health economic reports from the trials 1 (5), 2 (17), 3 (25), 6 (1), and 7 (24) and priced by an international cost standard advanced by Oostenbrink et al. (18) converting EURO to USD by the conversion ratio April 2005: 1 EURO = 1.25 USD. The savings on nursing homes are calculated as constant for the period from randomization (to either EHSD or conventional rehabilitation) until 12 months after discharge from hospital, following the results obtained by Suenkeler et al. (22). As data on resource use (number of domiciliary training sessions) lacks for the Norwegian RCTs (trials 5 [10] and 6

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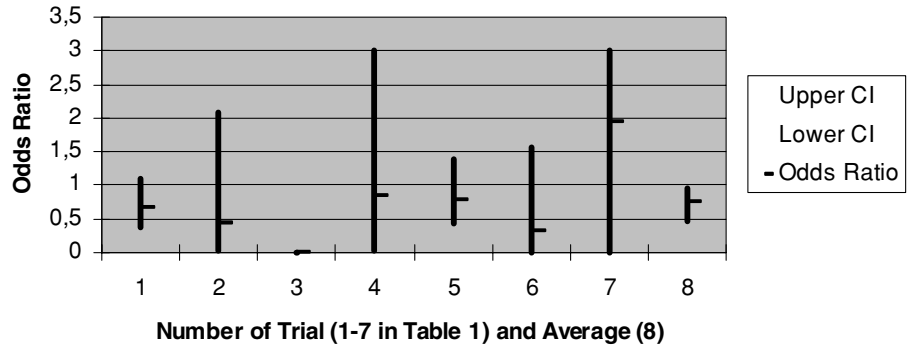

Figure 1. Poor outcomes. CI, confidence interval.

[4]), this parameter is calculated from the remaining five RCTs.

RESULTS

Meta-Analyses of Outcomes

The effect on poor outcomes is illustrated in Figure 1, comprising seven trials with 1,108 patients. The incidence of poor outcomes is reduced from 21.7 percent in the conventional stroke unit rehabilitation group to 14.5 percent in the EHSD group. No single trial has a significant reduction in poor outcome, but when the data are pooled, OR = .75 (CI, .46–.95) and NNT = 14.

Referrals to nursing home/institution are reduced by 5 percent from 11.3 percent to 6.3 percent. The odds ratio for institutional referrals is significantly reduced with OR = .45 (CI, .31–.96) and NNT = 20 (see Figure 2). The specific odds ratio for death is OR = .78 (not significant).

A comparable ESD study by Langhorne et al. (14) includes 11 trials with 1,597 patients. Only seven of these studies are included in our meta-analysis, see section on Study Selection. However, the result of Langhorne et al. (14) is close to our study for the subgroup of nine studies with 1,398 patients (including Suwanwela et al. (23) and Donnelly et al. (8), which are excluded in our study): OR = .79 (CI, .56–.96). Moreover, it is concluded in accordance with our study selection that the results of studies without a coordinated multidisciplinary ESD team, such as Suwanwela et al. (23) and Donnelly et al. (8), are weaker.

In six of the seven studies, the average length of stay at the hospital is significantly reduced, as illustrated in Figure 3. The pooled effect sizes have a significantly shortened length of initial stay by 10 days (CI, 2.6–18 days) to an average of 22 days, including both the acute phase and the subsequent stroke unit rehabilitation. No significant results are observed on the frequency of readmissions.

Drop-out rates are generally very low regarding hard end points as death or institution, that is, Rudd et al. (21) states that 9 persons corresponding to 3 percent have moved away from the area. Regarding the completion of follow-up scores such as BI, some patients refuse due to practical barriers such as language. Approximately 13 percent refuse the follow-up scores in Bautz-Holtert (4) and Mayo et al. (16); however, the trial reports discuss this problem and present evidence on their baseline data, indicating that these losses deteriorate rather than improve the assessment of outcomes. The trials von Koch et al. (26), Anderson et al. (2), and Fjartoft et al. (10) have low losses, even on follow-up scores. However, Rudd et al. (21) lacks 20 percent of the follow-up scores on BI, but they were equally distributed between ESD and controls and, therefore, were assessed as "unlikely to have affected the results."

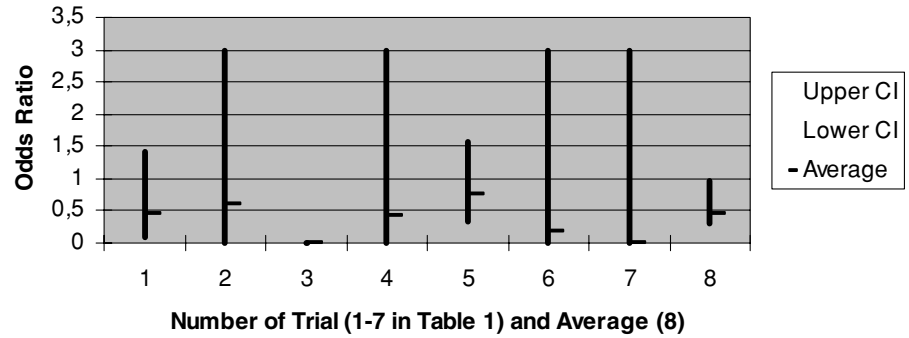

Figure 2. Referrals to nursing homes. CI, confidence interval.

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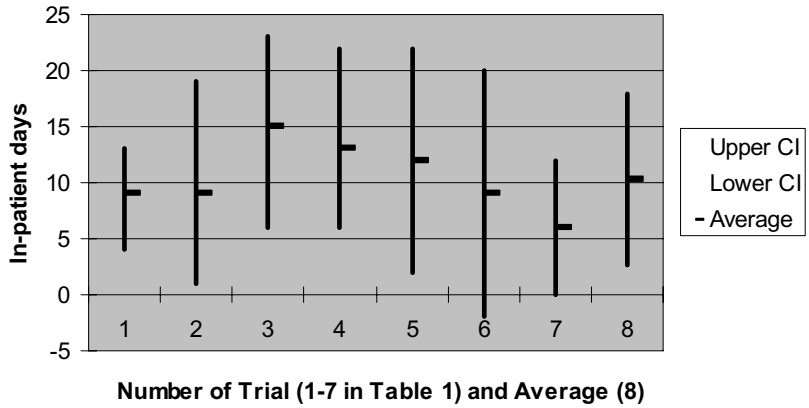

Figure 3. Effect on length of stay. CI, confidence interval.

Economic Evaluation

The stroke intervention for evaluation is defined by the ESD Trialists as a "multidisciplinary team that plans, coordinates, and delivers patient care at home" (9). The costs of this specific teamwork are calculated as a simple function of the number of home sessions per patient (Table 2). EHSD patients in the five RCTs with the relevant information received on average eleven home-based rehabilitation sessions, which were usually associated with an equivalent reduction in the number of hospital training sessions. The variability of this average ranges as little as from 10 to 12, despite large variations from patient to patient. The consumption of time per home session is rarely specified in the studies. However, Anderson et al. (3) assume an average of 3 hours per home session for a therapist, including travel time, considering that the home is within a 50-km radius of the hospital. An extra hour per home session for the special internal and external coordination activities related to EHSD is added in our calculation, accounting for in all forty-four therapist hours per patient in EHSD. The pricing of the therapist hours is based on Oostenbrink et al. (18), adding an overhead of 25 percent, including a special remuneration for the outgoing therapists. The transport costs are calculated at a minimum rate for private driving and parking Oostenbrink et al. (18), whereas some of the real transport costs might be outbalanced by savings on the patients' transport from their home to outpatient rehabilitation. Based on these verified assumptions, the costs for an average home rehabilitation patient amounts to 1,340 USD (April, 2005). This cost level is in line with an estimated use of 3.07 whole-time staff per 100 patients in a multidisciplinary EHSD team (see Langhorne et al. [14]).

The calculated cost of the intervention has to be compared with the savings in bed days and nursing homes. The value of saved bed days within a perspective of 12 months might cautiously be priced as a variable saving corresponding to an alternative use as simple nursing days. So, the same unit price of 170 USD is applied for saved inpatient days and

Table 2. Calculated Costs per Patient in EHSD

Cost factor	Quantity	References
Number of home sessions	11	Median of: Trial 1: 12; Trial 2: 10; Trial 3: 11; Trial 4: 10; Trial 7: 12
Therapist hours per home session	4	3 hours direct time (26) + 1 coordination
Total number of therapist hours	44	(2) estimates the use of 3.07 whole-time staff (with 1,540 working hours per year [25]) for 100 new patients per year, which corresponds to 47 hours per patient.
		Standard price for therapists by Oostenbrink et al. (18): 18 EURO + 25% OH = 22.5 EURO
Total salary for therapists	990 EURO	
Net transport costs	85 EURO	In average 50 km per visit by private car (.12 EURO per km)
		Parking: 1.15 EURO per visit by Oostenbrink et al. (18)
Total costs per EHSD	1.075 EURO	Standard price per day by Oostenbrink et al. (18)
Nursing home 135 EURO		Exchange ratio April 2005
1 EURO is converted to 1.25 USD		

EHSD, early home-supported discharge; OH, overhead.

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Table 3. Standard Course for EHSD Patients[a]

Admission	Preliminary planning	First home visit	Discharge	Dialogue/conference with municipal therapists
Contact to EHSD therapists	Preliminary rehabilitation plan (First week at the hospital)	Training both at hospital and at home	Final rehabilitation plan (3 weeks of stay at the hospital)	Termination of training at home and/or at the hospital

[a] Six months after discharge, outpatient follow-up visit; with functional test and interview on patient/carer satisfaction.

saved nursing home days. Referring to Figure 2 and 3, the minimal expected savings representing the lower CI are 3.2 inpatient days and 1.5 percent of a nursing home for 1 year, corresponding to 5.5 days amounting to 8.7 nursing home days having a value of $8.7 \times 170 = 1{,}480$ USD.

In summary, the criteria stated in equation 1 is verified comparing the cost of intervention amounting to 1,340 USD with the expected savings at the level of 5 percent significance amounting to 1,480 USD, or 140 USD more than the costs. Expecting the significant savings to more than outbalance the costs and everything else remaining unchanged, the intervention is evidenced as dominant. Moreover, this finding is associated with increased satisfaction of patients and carers, as claimed by Mayo et al. (16). In the calculation of savings, the duration of the savings on nursing homes is 1 year. However, a recent 5-year follow-up of one of the included studies, McNamee et al. (17), demonstrates a significant advantage for the EHSD group regarding independence in activities of daily living. This finding indicates that the calculated savings on nursing homes should be extended beyond 1 year, increasing the expected net savings.

Our general conclusion of EHSD as dominant to conventional stroke unit rehabilitation is in line with an earlier economic review by Anderson et al. (3). However, their conclusion is based on a central expectation of 13 saved inpatient days at a price of 260 USD in 1999. Applying the criteria in equation 1 to the data in Anderson et al. (3) gives no support to the conclusion of that study.

The incidence of stroke is actually approximately 2.2 per thousand, with an expected rate of growth of 2 percent per annum, due to the aging of the population. More than 40 percent or approximately 1 per thousand inhabitants per year might benefit from EHSD focusing on patients with a moderate to moderate/severe stroke in accordance with clinical findings by Fjartoft et al. (10). Just in the industrialized world (OECD), this rate amounts to more than one million patients per year. However, in many countries the introduction of EHSD might be retarded, distorted, or simply blocked by a conflict of financial interests between hospitals and municipal authorities: A financial burden of EHSD is likely to be loaded on the hospitals, whereas the municipalities save money on nursing homes and similar care facilities. To overcome this constraint, agreements on financial compensation could be made between the respective authorities of municipalities and hospitals based on local implementation projects.

Qualitative Aspects Regarding Organization and Patient Conditions

Home-based rehabilitation according to the EHSD concept represents a new organizational orientation of rehabilitation, with the focus on the patient, which corresponds to the Human–relation–school modern management theory of Warlow et al. (28). Movement science (MS) represents a parallel in rehabilitation to this early management finding. MS is a multidisciplinary science studying the development, control, and learning of movement. MS is operated by the ABC concept, referring to the founders: the neuropsychologist Affolter, the therapist Bobath, and the logopedian Coombs in accordance with a neurophysiologic basis of physical exercise therapy referring to Hummelsheim and Mauritz (12). Table 3 presents the main phases of EHSD organized in accordance with the ABC concept as operated in our implementation project in Svendborg, Denmark.

To reach the best results, the rehabilitation must start as soon as the patient is stabilized. There should be a "transition phase" before discharge where the patient is stepwise staying in his or her own home for longer and longer periods of time until the patient and the relatives feel equipped to cope with the discharge. The home-based rehabilitation continues after the discharge until coordination with the municipal therapists is secured, and a transition phase may be relevant to provide a smooth transfer of the future responsibilities for continued rehabilitation and resocialization. Finally, the rehabilitation efforts of the hospital should not be regarded as completed before a follow-up contact has been performed in the patient's home or in the outpatient clinic 6 months after discharge.

A suitable formal framework for the domiciliary rehabilitation in the reference trials has been an interdisciplinary, hospital-based rehabilitation team consisting of care providing staff, physiotherapists, and occupational therapists. This team has the same project leader at all times, but apart from this feature, it's structure is open for the development of interprofessional teamwork in the stroke care unit, if as many therapists as possible participate ad hoc in the home-based rehabilitation. In the interest of intersectional coordination, it is

Table 4. Relationships of the Significant Effects of EHSD

Size of BI effect	No. of patients	Difference from poor outcome	Difference in inpatient days	References
<.2	374 (34%)	3%	9	Trial 2, 4, 6, and 7
>.8	734 (66%)	4%	11	Trial 1, 3, and 5

EHSD, early home-supported discharge; BI, Barthel Index.

desirable if this rehabilitation team also includes a municipal therapist. However, in the Svendborg project, it was not possible to implement this in the early phase. Thus, the municipality is only represented in the project steering group, and a written collaboration agreement had been agreed upon, stating the division of the tasks in the domiciliary rehabilitation courses. This model, according to focus group interviews with both relatives and staff, has worked out satisfactorily.

To aid the planning and coordination of the domiciliary rehabilitation, good information tools are important. A basic element is a plan for goals and rehabilitation that is so simple it can be placed in the immediate surroundings of the patient and be of the immediate disposal for all professionals involved in the rehabilitation. To ease the interprofessional collaboration, it is recommended to use an appropriate functional measure. The functional independence measure (FIM) comprises both physical and intellectual aspects of function. This strategy gives FIM a comparative advantage to BI as a function measure regarding interdisciplinary cxollaboration in EHSD.

An interview series with completed home-based rehabilitation patient courses has been performed by a specialist in qualitative methods. These interviews confirm the expected motivation for and satisfaction with domiciliary rehabilitation. Also, they reveal that EHSD is more than a transfer of some therapeutic services from the hospital to the domicile. EHSD both enables and demands a more individualized rehabilitation program (see the Discussion section).

DISCUSSION

In a meta-analysis, an average effect size of .8 is considered strong, whereas an effect below .2 is weak, according to Lipsey and Wilson (15). The results of the meta-analyses are summarized in Table 4, subgrouping the significant outcomes of randomized trials according to the effect on BI at follow-up. Four trials composing one third of the patients report no effect on BI. Three trials with two thirds of the patients report a strong effect on BI. Trials with a strong effect on BI have also moderately (nonsignificant) better results on both the reduction of poor outcomes and initial length of stay. First, the positive covariance of outcomes minimizes the specific risk of a selection bias for "referrals to institution." Second, it indicates a common underlying "rehabilitation mechanism," which according to Burton (7), is psychological by nature and varies with the psychological skills of the rehabilitation team. More qualitative research in the "therapeutic empathy" of stroke rehabilitation is recommended. Such research should not just focus on patient satisfaction. Rather, it should focus on how to use the obviously good motivation for EHSD by patient, carer, and therapists for more active participation in the rehabilitation process for patient and carer, as indicated by a series of qualitative interviews with patients from a Danish EHSD implementation conducted as part of this study.

CONCLUSION AND RECOMMENDATIONS

This study focuses on an extended rehabilitation service from a stroke unit as a *multidisciplinary team that plans, coordinates, and delivers patient care at home* (EHSD). EHSD reduces both inpatient days and poor outcomes (death or institution) presenting a sharpening of the current concept of early supported discharge (ESD). The calculated savings on nursing homes and hospital beds more than outbalances the costs, making EHSD a dominant intervention. Just in the industrialized world, EHSD is a feasible offer to 1 per 1,000 habitants per year with an expected rate of growth of 2 percent per year. This large scope of application actualizes a problem in many countries of overcoming a financial barrier related to opposing incentives between municipalities and health authorities.

The covariance of outcomes from study to study actualizes the need for more qualitative research in the utilization of the good motivation by all involved parties in EHSD. To develop the appropriate therapeutic empathy, local implementation of EHSD might start from one stroke unit disseminating new competence to the other units in the region.

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