Preventive home visits to home-dwelling older people and hospital admissions: a municipality-randomised intervention trial

M. Vass · C. Hendriksen · J. L. Thomsen ·
E. T. Parner · K. Avlund

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Abstract Preventive home visits to older home-dwelling people have been part of national policy in Denmark since 1996. The aim was to evaluate whether education of home visitors and GPs was associated with hospital admission rates. In a population-based prospective controlled intervention trial in 34 municipalities, intervention municipality visitors received regular education during 3 years and GPs were introduced to a short assessment programme. Participation totalled 4,034 75- and 80-year-old home-dwelling persons, of which 3,132 (78%) had no mobility disability at baseline. Complete data on hospital services were obtained for all participants. No difference was observed in time to first admission between older people living in the intervention municipalities compared with people living in the control municipalities, HR 0.93 (95%CI: 0.85, 1.02, $P = 0.17$). Duration of first hospital stay was the same in the two groups (7.3 days). The mean number of admissions was not associated with intervention. Accepting and receiving home visits was associated with a reduced risk of hospital

admission, HR 0.84 (95%CI: 0.76, 0.92), especially among the initially disabled. Hospital admission rates were associated with functional decline patterns. Persons experiencing catastrophic and progressive decline had the highest risk. Persons experiencing reversible functional decline were more often hospitalised in the intervention municipalities, and fewer persons living in the intervention municipalities experienced progressive decline. Education of primary care professionals was not associated with risk for first hospital admission among all older people living in the community, but may be associated with older people's different functional decline patterns.

Keywords Preventive home visits · Older people · Community intervention · Hospital admissions · Functional decline

Introduction

Effective interventions to prevent or delay disability in older persons is a public health priority in most ageing western societies. Since 1996 a preventive home visitation programme has been part of national policy in Denmark, obliging municipalities to offer home visits twice a year to all citizens 75 years and older in order to preserve functional ability and stay independent of help as long as possible. Frail older people require substantial levels of support, and functional decline has a significant impact on healthcare costs. Besides contributing to prolonged autonomy and more quality of life, successful preventive strategies postponing functional decline may therefore have important implications for resource use and costs.

Most likely to benefit from proactive preventive interventions are frail individuals who are not yet disabled and

M. Vass (✉)
Department of General Practice, Institute of Public Health,
University of Copenhagen, Øster Farimagsgade 5,
1014 Copenhagen K, Denmark
e-mail: m.vass@dadlnet.dk

C. Hendriksen · K. Avlund
Department of Social Medicine, Institute of Public Health,
University of Copenhagen, Copenhagen, Denmark

J. L. Thomsen
Department of General Practice, Institute of Public Health,
University of Aarhus, Aarhus, Denmark

E. T. Parner
Department of Biostatistics, Institute of Public Health,
University of Aarhus, Aarhus, Denmark

those with early disability who are at high risk of progression (Ferrucci et al. 2001; Stuck et al. 2002). In 2005 the Danish preventive home visitation programme therefore amended the state law, now only obliging municipalities to offer the visits to older persons not receiving practical as well as personal help, i.e. the group with lower mortality (Stuck et al. 2002). It was argued that the most disabled persons already were in close contact with the home care system and would, if appropriate, be offered comprehensive geriatric assessment after referral by the GP. Hospital, general practice and community services are all fully tax financed in Denmark.

Prior studies have found conflicting results of the effectiveness of preventive home visits where the primary outcomes have mainly been mortality, functional ability and use of institutional care (van Haastregt et al. 2000; Elkan et al. 2001; Stuck et al. 2002; Meinck et al. 2004). In a Danish randomised controlled trial (RCT), preventive home visits to older people aged 75 or older reduced the number of hospital admissions—especially re-admissions—and the number of days spent in hospitals (Hendriksen et al. 1989). A British RCT of case finding and surveillance of older home-dwelling people showed no difference between the intervention and control groups in terms of the total number of hospital admissions, but the duration of hospital stay of patients aged 65 and 74 years was significantly shorter in the intervention group (Pathy et al. 1992). In a Dutch RCT, preventive home visits in a general older population showed an increased risk of admission to hospitals among the controls (van Rossum et al. 1993). Three other controlled trials found no differences in admission rates between intervention and control groups (Fabacher et al. 1994; Stuck et al. 1995; Dalby et al. 2000). A systematic review and meta-analysis of six studies analysing admission to hospital among the general older population suggested that home visits had no significant effect on hospital admissions (Elkan et al. 2001). A meta-analysis from 2005 including 19 preventive home visit trials showed no effects on hospital admission, but a reduced mortality and increased likelihood of continuing to live in the community (Ploeg et al. 2005).

Intervention programmes involve many different dimensions and differences in study design and methodology. Considerable variation in health and social care systems and cultures may explain some of the inconsistencies seen with respect to hospital admissions. If the benefit of intervention exclusively befalls subgroups of older people, the effect should be monitored in these groups alone to avoid effect dilution or maybe even non-discovery. Use of hospital services obviously differ between the ‘fit’ and the ‘frail’ and proactive assessments may influence different parts of a broad causal spectrum. Hip and lens replacements most often improve functional

status considerably and the use of hospital services therefore should be evaluated cautiously also with respect to cost-effectiveness.

Data currently available on proactive assessments of older people in their own homes provide little evidence for which elements are of most value, and it is not clear whether the outcome differs by what is assessed, or whether it is the process and interaction that is effective. It is tempting to speculate that the main reasons for benefits are due to both optimising the ‘system’ through interdisciplinary and coordinated follow-up management of identified problems, as well as optimising the recipient ‘person’. Highly developed self-care, strong social networks, and improved coping as well as a positive experience of one’s own health status appear to provide a better life situation resulting in enhanced life expectancy. With respect to hospital services this would imply that proactive assessments of the fit would lead to fewer hospital admissions of preventable conditions, e.g. fewer fractures of the hip after interventions intensifying physical activity programmes, and proactive assessments of the frail would lead to a lowered use of hospital services due to ‘system’ improvements.

In a controlled feasibility trial in Denmark (1999–2001) we found that education of primary care professionals working with the preventive scheme improved the functional ability of the older people living in the municipalities where this intervention took place (Vass et al. 2005). Functional improvement was documented through a reduced need for help in mobility after 3 as well as 4.5 years especially in the oldest old (80 years at baseline) and among the women (Vass et al. 2004, 2005; Avlund et al. 2007).

In addition, after 4.5 years of follow-up it was possible to categorise non-disabled participants at baseline into clearly defined patterns of functional decline, and we demonstrated that people living in the intervention municipalities experienced less progressive functional decline than people living in the control municipalities (Vass et al. 2007a, b).

To evaluate the impact of educational intervention on the use of hospital care, we therefore hypothesised that the hospital admission rate was associated with older persons not experiencing functional decline and older persons experiencing a *progressive* functional decline.

The aim of this study was to evaluate whether education of municipality-employed preventive home visitors and GPs as part of the national health promotion home visit scheme influenced time to first hospital admission and the length of the first hospital stay of non-disabled as well as disabled older people living in the municipalities, and to evaluate whether possible associations varied by functional decline patterns.

Methods

The study was designed as a controlled 3-year intervention study (1999–2001) with randomisation and educational intervention of home visitors and GPs at municipality level. Outcome was measured among the old persons living in the municipalities. Detailed information about the study design has been published elsewhere (Vass et al. 2002).

Sample size

Power calculations and sample size were based on functional ability as our main outcome. We postulated a variance component model for capturing the expected intra-community correlation in the necessary cluster sampling scheme. Calculations were conservative in that an unpaired design was envisaged, indicating a need for at least 15 municipalities in each group (intervention and control) and at least 100 old persons in each municipality. Specific power calculations with respect to hospitals admissions were not done. A matched design was eventually chosen to allow for the considerable variations in management and organisation of preventive home visits among the municipalities.

Municipalities

Municipalities to be included in the study had to offer preventive home visits according to the Danish legislation from 1996 which obliged municipalities to offer all 75+-year-olds in-home assessment twice a year. Further, they had to have and to offer fair or good rehabilitation and GPs should be able to collaborate within the scheme by contract.

Consent to participation was obtained from 34 out of 50 eligible municipalities in four counties. No demographic differences were seen between these and the remaining 16 municipalities. Randomisation was carried out following *paired matching* of intra-county municipalities, urban/rural type, size and geriatric services (Vass et al. 2002, 2004). After randomisation there were no differences in baseline characteristics between intervention and control municipalities in terms of municipality size, population density, expenses per 75+ inhabitant, participation rates in the study, and preventive home visitor staffing. A hospital was accessible in six of the intervention municipalities and in three of the control municipalities (Table 1).

Participants

Altogether, 5,788 non-institutionalized citizens living in the 34 municipalities and born in 1918 or 1923/1924 were

Table 1 Municipality characteristics

	Intervention (n = 17)	Control (n = 17)
Inhabitants <10,000	9	9
10,000–20,000	3	5
>20,000	5	3
County		
Roskilde	3	3
West Zealand	5	5
Storstroem	5	5
South Jutland	4	4
Rural	10	12
Urban	7	5
Economy		
Gross expenses in € per 75+ inhabitants (mean)	4,746	4,826
Staffing prev. home visits (h/100 75+, mean)	3.8	3.8
Hospital situated in the municipality	6	3
Geriatric department situated in the municipality	3	2
Separate municipality preventive home visit department	7	13

invited to participate in the study, which was presented as a study aiming at helping people to remain independent and at contributing to a better understanding of how best to manage the national preventive home visitation scheme. Addresses were drawn from the Civil Registration Office. Written consent was obtained from 4,060 persons (participation rate 70.1%). Twenty-two persons died and four were institutionalized before the intervention started, leaving 4,034 in the study population. 3,132 persons had no mobility disability at baseline and 902 persons reported need of help at baseline for at least one of the following activities: transfer, getting outdoors, walking indoors, walking outdoors in nice and poor weather, and walking on stairs.

A CONSORT diagram of the derivation of the study municipalities and study population is presented in Fig. 1.

Intervention

In the intervention municipalities, the visitors were offered education and training twice a year during the study period and the GPs were offered one educational session at the beginning of the study. Thus, intervention municipality employees were expected to focus and react on early signs of disability while respecting individual variation, and endeavouring inter-disciplinary coordinated follow-up in the local setting, primarily underlining cooperation with

Fig. 1 Derivation of study municipalities

the GP. The control municipalities were not offered any education or training and carried out the preventive home visitation programmes as usual.

Details of the education and the training programme have been published elsewhere (Vass et al. 2002, 2004). Briefly, updated geriatric and gerontological knowledge was discussed interactively during six 1-day sessions during the three intervention years and standard assessment tools were introduced. Ongoing process evaluation secured that intervention was performed as planned and that the educational recommendations were actually followed. From the beginning the visitors were trained to interpret unexplained tiredness in daily activities as an early sign of disability that should alert the visitor to search for the reason for such tiredness in the health, mental, or social domains. Any suspicion of a health or medication problem should result in contact to the GP. The GPs were urged to take encounters initiated by preventive home visitors seriously and to incorporate a short geriatric assessment in their usual clinical practice (Vass et al. 2002, 2004).

Outcome measures among the old individuals living in the municipalities

We collected complete data during the three intervention years (1999–2001) on inpatient and outpatient treatment and on visits to hospital accident and emergency wards from the Danish National Hospital Register of all discharges of patients from public and private hospitals. Transfer between different hospital departments occurring the same day was classified as only one hospital admission and the length of the first hospital stay was calculated as days spent in hospital. We extracted all records for all participants in the study by their personal identification number and data were entered into a file that protected study participants from identification. In the analysis, intervention versus control refers to whether participating older persons were living in the control or the intervention municipalities.

Functional ability was measured with questionnaires at baseline and after three and 4.5 years using a validated

mobility scale included as a dichotomised variable: able to manage all activities without help versus need of help for one or more activities (Avlund et al. 1995, 1996; Era et al. 1997).

Functional decline patterns during 4.5 years

Functional decline patterns were derived after an algorithm based on functional ability measured at baseline, after 1.5, 3, and 4.5 years (Fig. 2). Non-decline was defined as no disability at all four assessments (Fig. 2a). *Progressive disability* was defined as a pattern of decline going from no disability at baseline via moderate disability to severe disability (Fig. 2b). *Catastrophic disability* was defined as a pattern of decline going from no disability to severe disability or death without moderate disability at any measurement (Fig. 2c). *Reversible decline* was defined as no disability at baseline, moderate or severe disability at 1.5 and/or 3 years of follow-up and no disability at 4.5 year follow-up (Fig. 2d). If disability trajectories could not be categorised according to these definitions, patterns were classified as mixed, which most often included both progressive and catastrophic decline patterns (Fig. 2e).

Covariates

Covariates were: *sex* (specified from the Civil Registration Office), *age* (born in 1918 or 1923/1924). The 17 *pairs of municipalities* were based on the matched randomisation (1–17). *Living alone* was measured with a ‘yes’ or ‘no’ answer to a question asked at baseline, and persons *accepting and receiving at least one preventive home visit*

during the 3 years of intervention were compared with persons not receiving preventive home visits.

Statistical analysis

All analyses were based on intention-to-treat. Cox proportional hazard regression analyses were used to evaluate the association of intervention and time with the *first* admission to hospital within 3 years of follow-up. Persons were censored according to their first admission, death before first admission, or study end. A hazard rate ratio (HR) above 1 indicates a higher probability of hospital admission. Adjustment for the cluster sampling in the Cox proportional hazard model was performed by including information on municipality pairs as a categorical variable in the model. The length of the first admission and the number of admissions were compared in the intervention and control group using the bootstrap method. All tests were two-tailed with $P < 0.05$ indicating statistical significance. Stata statistical software version 9.2 was used.

Ethics

The study complies with the declaration of Helsinki and was approved by the relevant Regional Research Ethical Committees.

Results

All participants

Among 4,034 home-dwelling older people 1,920 persons (48%) were hospitalised at least once during a 3-year period, 21% ($n = 844$) once, 10% ($n = 399$) twice and 17% ($n = 677$) more than twice. There were no differences in admissions to hospital between persons living in intervention or control municipalities, 47% versus 48%; $P = 0.82$ (Table 2).

The mean length of first admission stay was 7.3 days (range 1–132). No differences were seen between older people living in the intervention and control municipalities and the mean number of admissions during 3 years was almost identical (2.5 vs. 2.4 admissions) between older people living in the intervention and control municipalities (Table 2).

The percentages of persons living in the individual intervention municipalities admitted to hospital during the 3 years varied from 28 to 65%. The common HR comparing the intervention group and the control group in the 17 matched municipality pairs was 0.96 (95%CI: 0.88,

Fig. 2 Functional decline patterns: a theoretical model aggregating 3,129 older persons into five functional trajectories during 4.5 years relating to the Mob-H scale

Table 2 Admission to hospital and use of hospital services during 3 years (1999–2001) in 75- and 80-year-old men and women

	Number of individuals		Mean length of first admission in days (range)		Mean number of admissions (range)	
	Intervention <i>n</i> = 2,092	Control <i>n</i> = 1,942	Intervention <i>n</i> = 985	Control <i>n</i> = 935	Intervention <i>n</i> = 985	Control <i>n</i> = 935
All participants (<i>n</i> = 4,034)						
Not admitted to hospital	52.9% (<i>n</i> = 1,107)	51.9% (<i>n</i> = 1,007)				
Admitted to hospital	47.1% (<i>n</i> = 985)	48.1% (<i>n</i> = 935)	7.3 (1–78)	7.3 (1–132)	2.5 (1–15)	2.4 (1–19)
	<i>P</i> = 0.82		<i>P</i> = 0.85		<i>P</i> = 0.65	
No mobility disability at baseline (<i>n</i> = 3,132)	<i>n</i> = 1,641	<i>n</i> = 1,491	<i>n</i> = 682	<i>n</i> = 634	<i>n</i> = 682	<i>n</i> = 634
Not admitted to hospital	58.4% (<i>n</i> = 959)	57.5% (<i>n</i> = 857)				
Admitted to hospital	41.6% (<i>n</i> = 682)	42.5% (<i>n</i> = 634)	6.6 (1–63)	7.0 (1–132)	2.3 (1–15)	2.3 (1–19)
	<i>P</i> = 0.87		<i>P</i> = 0.39		<i>P</i> = 0.86	
Mobility disability at baseline (<i>n</i> = 902)	<i>n</i> = 451	<i>n</i> = 451	<i>n</i> = 303	<i>n</i> = 301	<i>N</i> = 303	<i>n</i> = 301
Not admitted to hospital	32.8% (<i>n</i> = 148)	33.3% (<i>n</i> = 150)				
Admitted to hospital	67.2% (<i>n</i> = 303)	66.7% (<i>n</i> = 301)	9.1 (1–78)	7.9 (1–45)	3.0 (1–15)	2.8 (1–12)
	<i>P</i> = 0.99		<i>P</i> = 0.09		<i>P</i> = 0.31	

1.05, *P* = 0.34). Differences in admission rates varied randomly in both directions across the 17 pairs (Wald-test for interaction, *P* = 0.03).

In a Cox proportional hazards regression model including age, sex, living alone, and accepting the offered visits, and adjusted for cluster municipality effects, HR estimates for first hospital admission showed no significant differences between persons living in intervention and control municipalities (HR = 0.93, 95%CI: 0.85, 1.02, *P* = 0.14). More men than women and more older than younger were hospitalised. Living alone was not associated with risk of hospitalisation. Accepting and receiving at least one preventive home visit was associated with a reduced risk of admission to hospital (Table 3).

Stratification according to sex revealed no significant differences in HR between men in the intervention groups and men in the control group, (0.91, 95%CI: 0.80, 1.04, *P* = 0.17). Nor were there any difference in HR among

women in the intervention and the control group, (HR 0.95, 95%CI: 0.84, 1.08, *P* = 0.46). Among the 75- and 80-year-olds there were no difference in HR's between intervention and control municipalities (HR₇₅ = 0.97, 95%CI: 0.87, 1.08, *P* = 0.58 and HR₈₀ = 0.87 95%CI: 0.74, 1.01, *P* = 0.08), respectively.

Neither municipality size, population density, accessibility of hospital services in the municipality, nor availability of a geriatric department in the municipality (Table 1) were significantly associated with time to first admission during the 3 years of follow-up (data not shown).

Hospital admission and no mobility disability at baseline

Among 3,132 non-disabled older persons, 42% (*n* = 1,316) were hospitalised during 3 years. In total, 682 persons

Table 3 Adjusted hazard ratios estimates for first admission to hospital during 3 years of follow-up in 75- and 80-year-olds, *n* = 4,034

	Total (<i>n</i> = 4,034) HR (95%CI)	<i>P</i>	No mobility disability at baseline (<i>n</i> = 3,132) HR (95%CI)	<i>P</i>	Mobility disability at baseline (<i>n</i> = 902) HR (95%CI)	<i>P</i>
Intervention vs. control municipalities	0.93 (0.85;1.02)	0.14	0.93 (0.84;1.04)	0.22	1.01 (0.85;1.19)	0.95
Receiving at least one preventive home visit vs. not accepting visits	0.84 (0.76;0.92)	<0.001	0.92 (0.82;1.03)	0.16	0.73 (0.61;0.86)	<0.001
75- vs. 80-year-olds	0.71 (0.64;0.78)	<0.001	0.75 (0.66;0.84)	<0.001	0.82 (0.69;0.98)	0.027
Men vs. women	1.30 (1.18;1.43)	<0.001	1.43 (1.27;1.60)	<0.001	1.40 (1.17;1.67)	<0.001
Living alone vs. not living alone	1.05 (0.95;1.16)	0.33	1.05 (0.93;1.18)	0.41	0.96 (0.81;1.14)	0.65

Cox proportional hazard regression model with all variables in the model and adjusted for cluster effect (municipality pairs)

Table 4 Number of persons admitted to hospital among 75- and 80-year-old non-disabled men and women experiencing different patterns of functional decline during 3 years of follow-up

Functional decline patterns of home-dwelling non-disabled older people during 3 years (<i>n</i> = 3,129)	Hospitalised at least once during 3 years (<i>n</i> = 1,316)	Hospitalised living in intervention municipalities (<i>n</i> = 682)	Hospitalised living in control municipalities (<i>n</i> = 634)	Adjusted hazard ratios ^a HR (95%CI)	<i>P</i>
Non decline (<i>n</i> = 1,817)	521 (28.7%)	265 (27.8%)	256 (29.6%)	0.90 (0.76–1.08)	0.26
Reversible decline (<i>n</i> = 218)	92 (42.2%)	55 (46.6%)	37 (37.0%)	1.36 (0.87–2.13)	0.17
Mixed pattern (<i>n</i> = 365)	195 (53.4%)	109 (54.2%)	86 (52.4%)	1.06 (0.80–1.43)	0.67
Progressive decline (<i>n</i> = 207)	125 (60.4%)	49 (55.1%)	76 (64.4%)	0.69 (0.47–1.02)	0.06
Catastrophic decline (<i>n</i> = 522)	383 (73.4%)	204 (73.4%)	179 (73.4%)	0.91 (0.73–1.12)	0.36

^a Cox proportional hazard regression model including age group, sex, living alone, receiving visits, and cluster effect (municipality pairs)

living in the intervention municipalities and 634 persons living in the control municipalities were admitted at least once. Among the 75-year-olds, 19% (*n* = 431) were hospitalised once in the study period and 21% (*n* = 486) more than once. Among the 80-year-olds, 25% (*n* = 201) were hospitalised once and 24% (*n* = 198) more than once.

Hospital admission rates among 3,129 non-disabled, 75- and 80-year-old men and women were analysed according to different patterns of functional decline during 3 years of follow-up (Table 4). Twenty-nine percent of persons not experiencing functional decline were hospitalised as opposed to 73% of persons experiencing catastrophic decline.

When stratifying according to functional decline patterns, the persons in the reversible group were more often hospitalised in the intervention municipalities than persons living in the control municipalities, and fewer persons experienced progressive decline in the intervention municipalities than in the control municipalities (Table 4).

Among all 3,129 non-disabled older people at baseline a Cox proportional hazards regression model including age, sex, living alone, and accepting the offered visits, HR estimates for first hospital admission showed no significant differences between persons living in intervention and control municipalities. However, the subgroup of persons with progressive decline experienced a borderline reduced risk of first admission to hospital in the intervention municipalities compared with persons living in the control municipalities (Table 4), and a borderline lowered risk of first hospital admission among those who received at least one preventive home visit in intervention municipalities compared with those who declined the visits (not shown).

Hospital admission and mobility disability at baseline

Among 902 home-dwelling older disabled people at baseline 604 persons (67%) were hospitalised at least once during a 3-year period, 23% (*n* = 212), 15% (*n* = 134)

twice and 29% (*n* = 258) more than twice. There were no differences in admissions to hospital between persons living in intervention or control municipalities, 67.2 versus 66.7%; *P* = 0.99 (Table 2). The mean length of first admission was 8.5 days (range 1–78). No differences were seen between older people living in the intervention and control municipalities and the mean number of admissions during 3 years was almost identical, (3.0 vs. 2.8 admissions) between older people living in the intervention and control municipalities (Table 2). In a Cox regression model including age, sex, living alone, and accepting the offered visits, HR estimates for first hospital admission showed no significant differences between persons living in intervention and control municipalities, but accepting and receiving home visits was associated with a reduced risk of hospital admissions.

Discussion

Complete data on hospital services during 3 years yielded accurate admission rates of 75- and 80-year-old home-dwelling men and women. The two main results were (1) that education of preventive home visits and GPs did not influence time to first admission to hospital, duration of first hospital stay and mean number of hospital admissions among older persons living in the municipalities and (2) that accepting and receiving home visits, was associated with a reduced risk of hospital admission especially among the initially disabled.

Predicting the risk of hospital admission in older persons, e.g. using the Probability of Repeated Admission (Pra) instrument (Boult et al. 1993), in primary care is not yet routine in health risk management in the Danish national preventive home visitation scheme. Such instruments enjoy good validity for predicting future health service use on a population level in different healthcare settings (Wagner et al. 2006). However, in our interventional education of the preventive home visitors we

underlined the need for paying attention to frailty. Frail older person were defined as persons with disability or persons experiencing functional decline. We emphasised the importance of identifying even sub-clinical disability through alertness to 'tiredness in daily activities'. Furthermore, poor self-rated health, mental problems, having had a fall episode within the previous 6 months and taking more than four kinds of prescription medicine were considered indicators of frailty. Any unclarified question on medication or health-related problem should result in referral to the GP. Efforts should also be made to identify *situations* implying a higher risk for development of frailty arising from, e.g. experiencing bereavement and hospital discharge.

Other studies of preventive home visits have found no convincing effects on hospital admission rates. This is intriguing since many current studies have found beneficial effects on functional outcomes, which would therefore presumably be expected to lead to reduced use of hospital care.

Several explanations may be offered. First, the effect of the intervention may not be sufficiently strong to cause measurable changes in relevant outcomes. Second, a considerable proportion of hospital admissions is aimed at improving functional ability, e.g. hip and lens replacement. When such admissions are evaluated in relation to functional outcomes, these more specific diagnostic subgroups should be taken into account to assess truly preventable conditions. Third, more than 90% of all admissions of elderly persons in Denmark are acute emergencies although many years of geriatric education of primary care professionals has recommended sub-acute and better planned intervention towards older people with disabilities. It seems that it is not possible to predict 'who' and 'when', but the last 10 years have seen several structural changes aimed at avoiding unnecessary admissions. For example, 24-h municipality home care with the possibility of respite care avoids many hospital admissions where the need for social management is most predominant. Bed blockers are therefore rare in the Danish healthcare system, because such patients are transferred to municipality care as soon as their medical condition allows it. This procedure is partly rooted in economic motives and incentives between the regions/counties and the municipalities. Finally, hospital admission rates may be evaluated differently in local healthcare systems as far as the thresholds for admission are concerned. Many small hospitals have been closed down during the past 15 years as part of a restructuring of the healthcare sector to improve service cost-effectiveness. Today's admissions rates therefore must be compared cautiously with rates from 10 to 20 years ago. If evaluation studies of preventive home visits or other forms of proactive intervention to reduce hospital admissions are not properly designed, their conclusions are very likely to be

erroneous, particularly if the proportion of preventable conditions is limited.

A distinction between 'progressive' and 'catastrophic' (rapid-onset) decline has been proposed in other studies (Ferrucci et al. 1996; Guralnik et al. 2001; Onder et al. 2001; Ayis et al. 2006). Both kinds of decline are associated with increased mortality, but risk factors differ and it may therefore be useful to take the pace of disability into account. We identified a clear association of hospital admission rates with functional decline patterns, where persons experiencing catastrophic and progressive decline had the highest risk of hospital admittance. Older persons not experiencing functional decline and older persons experiencing reversible decline had the lowest risk.

A tendency to a lowered risk of first hospital admission was seen in the intervention progressive subgroup. We also have found that our educational intervention was associated with a reduced risk of a progressive functional decline pattern (Vass et al. 2007a, b). This may, indeed, indicate that the intervention focus on frailty could, in fact, influence hospital admission in subgroups of older people. Further longitudinal analysis will be performed to explore this concept with special respect to interactive and modifying effects.

Although almost two thirds of old non-disabled adults at baseline (75- and 80-year-olds) experienced no disability during 3 years, 29% were admitted to hospital and 42% of persons experiencing reversible functional decline were hospitalised (Table 4). Preliminary analyses of our data showed that the ten most frequent diagnoses among all these admissions were pneumonia and chronic obstructive lung disease, atrial fibrillation, heart failure, angina, stroke, acute myocardial infarction, benign hypertrophy and malignancies of the prostate and admissions for general observation. Progressive decline seems to be associated with circulatory, respiratory, musculoskeletal and genitourinary diseases and catastrophic decline with cancer, circulatory and respiratory diseases (data not shown). Further evaluation of longitudinal trajectories taking medication, primary care services and detailed information from hospital admissions including diagnosis and surgical procedures will be done.

Proactive assessment of 'frail' older people seems to have an impact on hospitalisation but self-selection to accept the publicly offered visits must be considered. It is, however, tempting to speculate that comprehensive multi-dimensional assessment including geriatric knowledge combined with primary care management could optimize linkage and system timing—optimising the 'system'.

Assessments of 'fit' older people may also have an impact on hospitalisations due to optimising the 'person'. To demonstrate effective outcomes of proactive interventions however, larger sample sizes may be necessary and

more specific hospital services are needed as outcomes, since preventable fractions attributable to benefit of assessment are small.

The categorisation of older persons into subgroups more prone to benefit from intervention introduces a much more specific concept of prevention in old age. Not only do we need to know the optimal time at which to set in to delay functional decline, we must also individualize and target our intervention on the basis of more knowledge of who will benefit. The development of truly cost-effective strategies requires clear documentation that progressive functional decline is the condition that lends itself most readily to intervention.

An important strength of this study is that it has been conducted in routine primary care settings in different parts of the country. The findings have widespread generalisability in the Scandinavian welfare health and social care context, also because of the highly feasible nature of the intervention design and the use of structured guidelines which paved the way for easy implementation in regional education and training programmes. We do not know, however, whether our findings may be generalised to other, non-Scandinavian contexts.

A further strength of the study is the complete data from official registers, which are of high validity (Andersen et al. 1999; Olivarius et al. 1997) and an extremely low drop-out due to vigorous follow-up. In addition, all self-reported functional outcomes were based on well-validated measures of disability.

Study participation may have caused some biases. We have previously described that non-participants (30%) in this health promotion trial were more disabled and had higher mortality and admission rates to institution than participants (Vass et al. 2007a, b). This was predominantly found in the subgroup of older persons describing themselves as too ill to participate in the study and among those persons who could not be reached for enrolment. These two groups accounted for half of the non-participants. The other half of the non-participants did not differ from the study population. However, no differences were seen between older people living in the intervention municipalities and people living in the control municipalities. We may, therefore, argue that no selection bias was present.

We previously evaluated the cost effectiveness of our educational intervention alongside the 3-year randomised controlled study (Kronborg et al. 2006). The main outcome measure was incremental costs per active life-year gained, but the study did not provide conclusive evidence on the cost effectiveness of the intervention. Estimation of the detailed costs of the whole intervention study including disabled participants at baseline was summarized to be cost-neutral, i.e. improved quality for the same costs. More home help was given, but reduced use of institutions, especially

among the 80-year-olds was seen (Vass et al. 2005). A small reduction in prescription medicine and total hospital costs was also seen. Besides hospital costs bed days also included outpatient visits and accident and emergency department visits. The mean total hospital cost per person (2002 prices) among the 75-year-olds was €6,041 (SD 291) for persons living in the intervention municipalities and €5,819 (SD 300) for persons living in the control municipalities. The mean difference was €222 (CI95%: –1.043 to 2.247). The mean total hospital cost per person among the 80-year-olds was €6,235 ± (SD 593) for persons living in the intervention municipalities and €6,971 (SD 526) for persons living in the control municipalities. The mean difference was €–736 (95% CI: –2.291 to 819). Comprehensive economic evaluation of subgroups of preventable hospital services would accomplish a more precise picture of the ‘real’ cost effectiveness attributable to the preventive intervention.

Conclusion

A brief, feasible educational intervention for preventive home visitors and GPs was not associated with time to first hospital admission or duration of first hospital stay during 3 years. Functional decline patterns were associated with admittance to hospital. Interdisciplinary alertness to identify and react on early signs of functional decline may influence the use of hospital services in the subgroup of older people experiencing progressive functional decline and even prevent the development of further functional decline.

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