

Prevention of hip fracture by external hip protectors: an intervention in 17 nursing homes in two municipalities in Norway

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Aims: This study was undertaken to estimate the effect of hip protectors on the incidence of hip fracture when introduced into nursing homes as a regular part of the healthcare for all residents. **Methods:** A pre-test/test design was used. The pre-intervention period lasted 18 months from May 1996. The intervention period lasted 18 months from May 1998. During the intervention period all residents (965 beds) in nursing homes in two municipalities in Norway were offered free use of hip protectors. The project manager provided motivational activities in the nursing homes during the whole period, aimed at increasing the participation rate. **Results:** The intervention period showed a 39% reduction in the hip fracture incidence when compared with the pre-intervention period ($p=0.003$). The percentage of daily users of the protector varied from 35% during the first months to 22% at the end of the period. Among the 61 persons who suffered a hip fracture 31 were registered as daily users. Fourteen of the 31 users were not wearing the protector when the hip fracture occurred, while five of the 31 had the protector on their knees. Twelve of the 31 suffered a hip fracture while properly wearing the protector. **Conclusions:** This non-randomized study showed that hip protectors introduced to all residents in nursing homes considerably reduced the incidence of hip fracture. It may be possible to achieve higher compliance and a further reduction in the incidence of hip fractures if the producers of hip protectors increase the comfort of the protector without reducing its effect. In addition, it is important that health workers encourage more individuals at high risk to use the protector.

Key words: accidental falls, frail elderly, hip fractures, patient compliance, protective clothing (hip protectors).

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INTRODUCTION

Norway has one of the highest incidences of hip fracture in the world (1, 2), and the incidence has increased during recent decades (3–5). Several prognoses estimate that the number of hip fractures will increase significantly during the next 25 years if preventive measures are not improved (6–8).

About 10 years ago two different studies showed that external hip protectors could reduce the number of hip fractures by approximately 50% in randomized controlled trials in high-risk groups of elderly persons (9, 10). More recently, a Cochrane systematic review concluded that hip protectors appeared to reduce the risk of hip fracture within a selected population at high risk of sustaining hip fractures (11). However, in randomized controlled trials the hip protector is tested

under special study conditions, often with low external validity.

The aim of the present study was to estimate the effect of hip protectors on the incidence of hip fracture when offered as a regular part of the healthcare for all the residents in nursing homes.

MATERIALS AND METHODS

The external hip protectors used in this study (SafeHip[®]) divert a direct impact away from the greater trochanter during falls from standing heights. At impact the protector transmits released energy to the soft tissue and muscles anterior and posterior to the femoral bone. The outer shield is made of stiff polypropylene and the inner part is made of

soft plastozote. The protector is fixed in special underwear (12).

These external hip protectors were introduced in 1998 into all nursing homes in two municipalities outside the capital of Oslo (13). The healthcare authorities offered hip protectors free of charge to all residents in 17 nursing homes including a total of 965 beds (mean age of residents 82 years, 69% women (13)). The Norwegian Institute of Public Health was asked to perform an external and independent evaluation of this health service initiative.

Implementation of hip protectors

Although hip protectors were offered free of charge, only a few of the nursing homes registered an interest in participating in the programme. A chief council nurse who was a member of the project's administration and well known among the nursing home managers contacted the manager at each nursing home and requested his/her participation. During the first months of 1998 the employees at the nursing homes received instruction concerning the use of hip protectors (13). First, the project manager gave a one-hour lesson to employees from the nursing homes. The topics included fracture and fall prevention in general and the use of hip protectors. Second, the manager visited each nursing home and gave one to four hours of additional instruction. By 1 May 1998 all 17 nursing homes were involved in the project.

During the intervention period the project manager provided motivational activities in the nursing homes aimed at encouraging and supporting participation in the project. The manager had a contact person among the employees in each nursing home. The contact persons received a small fee for their project activities, which were performed in addition to their daily duties. All the nursing home employees were instructed to encourage the residents at high risk of sustaining a hip fracture to use the hip protector. The employees regularly completed questionnaires concerning the use of hip protectors and regarding falls among the residents. The intervention period ended on 31 October 1999, although many nursing homes continued project activities as they still had hip protectors. All residents who suffered a hip fracture in the nursing homes included in this study were sent to Bærum Hospital.

Study design and data

To evaluate this intervention project in Asker and Bærum we decided to conduct a pre-test/test design because we were not able to find comparable data from any control municipality. The incidence of hip fracture in the nursing homes during the intervention

period was compared with the incidence of hip fracture before the project started. Therefore, we registered hip fractures during two 18-month periods in the 17 nursing homes. The two periods had to be comparable with regard to season and number of months. The pre-intervention period started on 1 May 1996 and ended on 31 October 1997. The intervention period started on 1 May 1998 and ended on 31 October 1999. Several sources of information were used. In the hospital patient register (HPR) at Bærum Hospital all the patients with hip fractures during the pre-intervention period and the intervention period were selected (ICD-9 code 820 and after 1 January 1999 ICD-10 codes S72.0 and S72.1, fractura colli femoris/fractura pertrochanterica). The patient records of the participants were studied to find hip fractures that had occurred in the 17 nursing homes during the actual periods. Next, the surgery protocols were investigated to see if there were patients with hip fracture surgery that were not registered in the HPR. These fractures were also verified later in the patient records. In addition, the project manager registered hip fractures manually, but only during the intervention period. The project manager had continuous contact with all the nursing homes and the hospital during the whole intervention period. This register includes information about the use of the hip protectors among the hip fracture patients. The project manager found five additional patients with new hip fractures as compared with the HPR and surgery protocols. On the other hand, the HPR and surgery protocols included four additional patients who were not identified through the manual investigation. Thus, there was one more hip fracture reported in the manual register than in the HPR. In our main analysis we have used information from the HPR since this source of information registered hip fractures during the pre-intervention and intervention periods in the same manner. We have, however, used the manual register when dealing with use of hip protectors, since this is the only register that includes information on adherence.

The two 18-month periods were comparable in respect of the number of beds in the nursing homes since the intervention period had only six more bed months than the pre-intervention period.

The Data Inspectorate of Norway and the Norwegian Board of Health approved the study, and the proposal was presented to the Regional Committee for Medical Research Ethics.

Statistical methods

We have based our analyses on the concept "occurrence/exposure rate" but we could not follow the

residents from the day they entered the nursing homes until the day they eventually left the homes. Instead of computing "person time" for exposure we introduced the concept "bed month". In this way we were able to compute the rate "number of hip fractures per number of bed months". However, in comparing the intervention period and the pre-intervention period we primarily used the numerator "number of hip fractures" since the denominator "number of bed months" was nearly constant in the two periods of time.

Hip fractures during the two 18-month periods were first regarded as events in two Poisson processes. The numbers of hip fractures in the first period and in the second period were assumed to follow Poisson distributions with means μ_1 and μ_2 , respectively. The null hypothesis, $H_0: \mu_1 = \mu_2$, was tested (14) and 95% approximate confidence intervals (95% CI) for the ratio μ_1/μ_2 was reported (15, 16). In addition, we performed three different pair tests on the 18 pairs with corresponding months during the two 18-month periods. The three tests were Student's paired *t*-test, the Wilcoxon signed ranks procedure and the permutation test. A trend analysis for the differences in hip fracture incidence over the two 18-month periods by means of regression analysis was also performed.

RESULTS

According to the HPR, 60 hip fractures had occurred in the 17 nursing homes during the 18 month intervention period (Table I). The corresponding number for the 18-month pre-intervention period was 98. Thus, there was an absolute reduction from 98 to 60 (39%) in the number of hip fractures during the intervention period compared with the pre-intervention period. The residents in the nursing homes had a relative risk of 0.6 (95% CI $\pm 0.4-0.9$) of sustaining a hip fracture during the intervention period compared with the pre-intervention period. On average there were two more hip fractures per month during the pre-intervention period compared with the intervention period. Student's *t*-test, the Wilcoxon test and permutation test all yielded $p < 0.02$ for this difference.

A trend analysis for the difference in the incidence of hip fractures over the two 18-month periods showed no trend. The regression coefficient was near zero ($b = -0.019$ fracture difference per month, $p = 0.904$).

The percentage of daily users of the hip protector among the residents varied from 35% during the first months of the intervention period to 22% at the end of the period with an average of about 29%. About

Table I. Number of hip fractures during the 18-month pre-intervention period and during the 18-month intervention period in 17 nursing homes in two municipalities in Norway

	Pre-intervention period 1.05.96–31.10.97		Intervention period 1.05.98–31.10.99	
	1996	1997	1998	1999
January		6		4
February		10		3
March		5		3
April		4		4
May	4	6	3	0
June	9	2	2	5
July	4	5	8	4
August	9	6	3	2
September	6	4	2	2
October	4	6	1	5
November	4		5	
December	4		4	
Total for the 18-month periods		98		60
Average no. of cases per month		5.4		3.3

Note: The nursing homes had six more bed months during the intervention period than they had had during the pre-intervention period.

40% of the users used the hip protector continually. The 29% are calculated in respect of *all* the residents in the nursing homes. Among those who suffered a hip fracture during the intervention period, the general use of the protector was higher than this average, namely 51% (31 of 61 from the manual register of hip fracture). Among the 31 users, 14 users were not wearing the protector when they fell and broke their hip, while five of the 31 were wearing the protector on their knees while getting dressed. Twelve of the residents suffered a hip fracture while wearing the protector.

During the pre-intervention period the municipalities had $98 \cdot 12 / (965 \cdot 18) = 0.068$ hip fractures per bed per year in their nursing homes. The corresponding number during the intervention period was 0.041.

DISCUSSION

This study is, to our knowledge, the first large-scale intervention implementing hip protectors as part of the healthcare in all nursing homes in a municipality. The use of hip protectors showed a 39% reduction in the incidence of hip fracture during the intervention period compared with the pre-intervention period. However, we cannot rule out the possibility that the results have been influenced by confounding factors. For example, the focus on falling and the associated

risk of hip fracture during the intervention period may have had a preventive impact. Most of the fracture cases did not use the hip protector when the fracture occurred, but this group of residents had a higher percentage of users of the protector in general than the average. This was expected because the residents at high risk of hip fracture were especially encouraged to use the hip protector. Unfortunately, 45% of the hip fracture patients who were daily users did not use the protector when they fell and broke their hip. Many elderly people find the protector uncomfortable when resting and cumbersome when dressing and undressing (11, 17). This is probably one reason why the users did not wear the hip protector continually. Another problem arises when a hip fracture occurs among residents wearing a hip protector. As a result, it becomes difficult to motivate other residents to use a hip protector. The hip protector can only reduce the risk of hip fracture in falls to the side. Although 76% of the hip fracture patients in a Finnish study (18) reported that they had fallen directly to one side, it is important to realize that the hip protector cannot give 100% protection (19). When a person falls backwards or is osteoporotic to the degree that it is possible to break the hip simply by walking, the hip protector will not provide very effective protection against hip fractures (18). Twelve of the residents in our study suffered a hip fracture while properly wearing the protector. After each of these occurrences some of the employees had difficulty motivating residents to wear the protector. Studies published before our study started had not reported cases with hip fracture while wearing hip protectors, but none of these studies was as large as our study (9, 10). In a more recent study, however, there were four hip fractures among individuals wearing hip protectors (19).

Special efforts and additional resources may increase the incidence reduction beyond 39%. The attainable incidence reduction will depend on (a) the preventive effect of the hip protector in a given fall, (b) the percentage of continual users and (c) to which degree all those at risk are among the continual users. We might have reached our highest attainable limit if all such individuals in the nursing homes included in this study had been among the continual users. Thus, it is important to improve the selection process and encourage individuals at high risk to use the protector. Results suggest that the study of Harada et al. has succeeded (20). With 70% day and night use they achieved 85% reduction of hip fractures in the intervention group compared with the control group (1.2% hip fractures per year compared with 9.7, respectively).

The present study was primarily a healthcare initiative and did not have a randomized controlled

trial (RCT) design. Our healthcare authorities wanted to implement the hip protector based on previous results (9, 10) in nursing homes to see if it was possible to reduce the number of hip fracture in a setting without the ideal circumstances as found in a RCT. In spite of the sub-optimal pre-test/test design, we were able to perform the evaluation of this healthcare initiative in that we managed to register hip fractures in a pre-intervention period. Unfortunately, we were not able to find comparable figures for hip fractures among those living in corresponding institutions in a control municipality. We know, however, that there was no reduction in the rate of hip fracture in the neighbouring city of Oslo from 1988–89 to 1998–99 (5).

How convincing the result of our study is depends, among other things, on the quality of hip fracture registration. None of our information sources provided 100% registration. In the HPR at Bærum Hospital we found hip fractures not included in the Hospital Surgery Protocols and vice versa. By combining these sources with the patient records we still missed about 8% of the fractures that were registered manually by the project manager during the intervention period. In the comparison of the hip fractures in the pre-intervention period and the intervention period we were careful to use hip fractures registered precisely in the same way using the HPR. We assume that the misclassifications were approximately the same in the two periods. If we compute a worst-case scenario and add 8% hip fractures to the intervention period and remove 8% hip fractures from the pre-intervention period we still get a significant result ($p=0.05$) with a 28% rather than 39% reduction in the number of hip fractures.

The number of "bed months" in the actual institutions had been nearly constant during the two periods of time and could not explain the 39% reduction in number of hip fractures. We were not able to control for age, sex and health among the residents, but have no reason to believe that the residents were younger and healthier in the last period.

The compliance of the hip protector decreased during the intervention period from around 35% to around 22%, but our trend analysis showed almost no decrease in the monthly difference in the number of hip fractures over the two 18-month periods. It is possible that the employees were more effective in persuading the high-risk individuals to use the protector towards the end of the intervention period. The registration of falls may have increased their attentiveness towards the fallers.

The use of the hip protector may not be as effective when implemented in routine practice (21, 22) as

compared with use in tightly controlled trials run by highly trained staff working under ideal conditions. However, the implementation of hip protectors in all nursing homes in two municipalities of Norway showed a significant reduction in the incidence of hip fracture nearly as great that documented in randomized controlled trials (11).

Today there is considerable evidence indicating the ability of the hip protector to reduce the risk of hip fracture in high-risk groups (11). It is thus important to increase the use of hip protectors among persons at high risk. Another argument for increasing the use of hip protectors is that the device improves self-efficacy in respect of falls (23). As users of hip protectors feel more confident they can complete tasks safely and thus may become more physically active and require less assistance with daily activities.

The employees in the nursing homes included in this study succeeded in encouraging residents at high risk to use hip protectors. Approximately 51% of the hip fracture patients were daily users. Unfortunately, it was difficult to achieve usage 24 hours a day. Improved hip protectors that are more acceptable are needed to increase adherence in nursing homes. Any new hip protector needs to be investigated using well-conducted randomized trials that are also designed as bio-equivalence studies. Such a design will require a very large number of participants. It is no longer ethical to have a control group in which participants do not receive hip protectors. The control group will receive hip protectors proved to be effective against hip fracture, while the intervention group will receive hip protectors proved to be effective in mechanical tests before use in clinical trials. It is a challenge for the producers of hip protectors to increase the protector's comfort without reducing the protection provided.

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