JTT 0401/09

ORIGINAL ARTICLE

Automatic fall detectors and the fear of falling

Simon Brownsell and Mark S Hawley

Department of Medical Physics and Clinical Engineering, Barnsley District General Hospital NHS Trust, UK

Correspondence:
Simon Brownsell
Department of Medical Physics and Clinical Engineering
Barnsley District General Hospital NHS Trust
Barnsley S75 2EP
UK
(Fax: +44 1226 208 159; Email: simon.brownsell@bdgh-tr.trent.nhs.uk)

Accepted:

Summary
We studied the effect of automatic fall detection units on the fear of falling amongst community alarm users living in the community. A total of 55 community alarm users, at increased risk of falling were recruited: 34 received fall detectors (intervention group) and there were 21 in a control group. On intention to treat analysis, there was no significant difference between the intervention and control group on change in fear of falls (40.3 vs 37.5, difference 2.8, 95% CI –6.2 to 11.8), health-related quality of life or morale. Differences in fear of falling, between a group who wore their detector regularly (62%) and those who did not, suggest that some people may benefit from a fall detector; conversely, others may lose confidence if provided with a fall detector. Most users who wore their detectors regularly felt more confident and independent and considered that the detector improved their safety.

Introduction
Approximately 33% of older people fall each year [1] and it has been suggested that falls account for up to 40% of residential care home admissions [2]. Fear of falling is also important. Between 30 and 50% of independently living older people are fearful of falling [3]. The fear of falling alone decreases quality of life [4] and increases the speed of decline in the ability to perform activities of daily living [5]. It can also lead to self-imposed isolation and refusal of mobility that can restrict the user's quality of life and add to the caregiver's burden [6].

Community alarm systems are typically triggered from a radio pendant worn around the neck. Users can summon assistance through the telephone system from a call centre. Recently automatic fall detectors have been developed that are worn on the waist and are about the size and weight of a pager (Fig 1). When a fall is detected the community alarm control centre can be contacted automatically, thus removing the reliance on the user to instigate a call for assistance.

The aims of the present study were to assess whether automatic fall detectors would reduce the fear of falling, and improve health and morale, amongst existing community alarm system users.

Methods
The study was approved by the appropriate research ethics committee. Participants were existing community alarm users living in the community (aged over 75 years), or alarm users who had experienced a fall in the previous six months (aged 60-74 years). Participants were selected by randomly choosing a surname letter and then approaching eligible subjects, in sequential order, according to their records. Telephone contact was made by community alarm staff and, upon approval, details forwarded to the research team who provided additional information and an opportunity to ask questions before obtaining consent to take part in the study. Thirty one percent of those originally approached consented to take part; the main reason cited for declining involvement was that people were happy with the technology they had already.

Subjects were assigned to control and intervention groups based on age, the number of self-reported falls in the previous six months and the score from completing the Falls

Efficacy Scale (FES). The FES [7] scores the fear of falling when conducting ten every day activities such as walking short distances, using stairs and having a bath. The FES tool uses a self-scoring system, where 0 indicates not confident at all, 5 fairly confident, and 10 completely confident of doing ten everyday activities without falling. The tool scores from 0 to 100.

Sixty six people commenced the project but due to withdrawal (9) and death (2), there were 55 people who completed the study and there was ultimately an imbalance between the groups in terms of falls history and FES score, as indicated in Table 1. 78% of the subjects lived alone.

Participants were visited and asked to keep a record of any falls they experienced and to complete a questionnaire. This contained 29-items, covering topics such as self perceived health, current compliance with pendant usage, use of home based technologies, mobility and feelings of safety. In addition, two other tools were used. These were the Philadelphia Geriatric Centre Morale Scale (Anglicised version) to measure morale [8] and the EQ-5D health-related quality of life measure [9]. A comparison of post-fall scores was conducted for the FES scores, the EQ-5D scores and the Philadelphia scale using analysis of covariance to adjust for pre-fall monitor values [10].

After these baseline tests were completed, participants in the intervention group received a fall detector from one of three suppliers (Attendo, Tunstall or Tynetec). As far as the user was concerned these devices all worked in a similar manner, were worn on the waist, and had similar weight and size. The installation of equipment and training of participants was conducted by a community alarm installer from the control centre, following training from the manufacturers.

During the monitoring period, which typically lasted 17 weeks (SD 3.1), call activation records from the control centre were forwarded to the research team every two weeks. These call records were compared with subjects' self-reported experience to determine the number of successful activations, false positive activations (i.e. where the fall detector raised an alert but no fall had occurred) and false negative activations (i.e. where a fall had occurred but the detector did not raise an alert). At the end of this period interviews were conducted with all of the participants and the questionnaires repeated.

Results

Fear of falling

The mean baseline value for all participants in both the intervention and control arms at the commencement of the project was 29 (range 1-71). There were no significant differences in post-intervention FES score between the intervention and control group after adjusting for pre-intervention scores using analysis of covariance, Table 2. A Kruskal-Wallis test was used to investigate whether there was any difference between the three manufacturers in terms of the fear of falling (i.e. the FES score). There was no significant difference (Kruskal-Wallis $X^2 = 4.1$, df = 4, P=0.4).

Most participants (62%) wore their fall detector regularly, as intended in the research protocol (Table 3). Although the differences were not statistically significant, a per

protocol analysis based on self-reported compliance indicated that those subjects who had worn their fall detector appropriately showed a larger increase in falls efficacy (14.6) than the control group (10.6), whereas those who had not worn it appropriately showed a smaller increase than controls (2.3) ($P = 0.24$).

Morale and health-related quality of life
There were no significant differences in the Philadelphia scale or the EQ-5D score between the intervention and control group, Table 2.

User acceptance
38% of the subjects reported problems in attaching or wearing the device. Belts from the manufacturers enabled the fall detector to be permanently housed in the belt, therefore reducing the reliance on fine motor control. These were offered to all and used by 65% of participants in the intervention group. However only 27% indicated this improved matters.

Perceived benefits
Participants were asked specific questions on the benefits that the fall detectors gave them (Table 4). Of those who wore the fall detector regularly:

- 58% thought it improved their independence;
- 85% considered it improved their safety;
- 72% felt more confident;
- 90% were pleased they had a fall detector.

Device performance
The control centre data revealed 138 false positive activations, or approximately 1 per user per month. The reported activities being undertaken at the time (Table 5) suggest that the majority of false activations arose when clothing was being moved. It is interesting that the participant diaries reported 147 false activations, the discrepancy being that, with one manufacturer's equipment, participants soon realised that they could cancel false activations without the control centre being contacted. This functionality appeared to be viewed positively.

There were three reported instances of false negative activations, where the user reported a fall but the fall detector did not activate. On one occasion the pendant was activated and may have over-ridden the fall detector, while the other two incidents were experienced by the same user and in both instances the person fell backwards. On one occasion a fall was reported and the detector correctly raised a call for assistance, with assistance being promptly provided.

Discussion
Both the intervention and control groups showed an increase in the FES score and therefore an apparent reduction in the fear of falling, with no significant difference between the two groups. The decrease in fear of falling in the control group is

interesting. It was shown in another study[3] that a counselling and advice intervention, plus a light exercise regime, produced a significant increase in falls efficacy. It may be that simply visiting the subjects to interview them about their attitudes to falling had an effect on their confidence in relation to falls. There may also have been a seasonal effect as the baseline testing was conducted in winter and the follow up data were collected in late spring. It is likely that older people are more fearful of falling in winter, as it is known that more falls occur during the winter period [11].

Within the intervention group, there was a sub-group whose compliance was good and a second whose compliance was poor. The compliant group, on average, increased their FES score above that of the control group whereas, in the non-compliant group, the FES score increased less than in the control group. These results, although not statistically significant, suggest that some people may benefit from a fall detector, in terms of their fear of falling, and that, conversely, others may lose confidence if provided with a fall detector. These points are supported by comments made by participants, for example whilst one commented, *"I would say that it's one of the best safety nets someone could have"*, another commented, *"it made me feel vulnerable, more so than normal, because it made me more aware of the possibility that I might fall."* If this is confirmed by further research, it would suggest that fall detectors should not be provided to all vulnerable older people. Rather, careful assessment will be crucial in determining whether such provision is likely to be beneficial or not.

The effect of fall detectors on the fear of falling is likely to be substantially affected by user perception of the reliability and accuracy of the detector. Difficulties in wearing the device and the level of false alerts, both false positive and false negative, are a cause for concern, but it is not possible to quantify the effect of detector performance on the results obtained in the present study. On the single occasion when an alert was correctly raised, the alert led to assistance being provided in a timely manner, which gives some cause for optimism. Despite these difficulties, those who wore the fall detectors appropriately reported that they felt more confident and independent, and considered that the detector improved their safety. They also felt pleased that they had a fall detector, backing up the findings of a previous study which suggested that community alarm users would welcome automatic fall detection units [12].

Acknowledgements
We are grateful to the South Yorkshire Coalfields Health Action Zone for funding this work, to staff of the local community alarm centres for their assistance, to Emma Kelly for assistance with interviews, to Tracey Young for statistical assistance, and to all the service users who kindly consented to participate in the project.

References

1 Nevitt MC, Cummings SR, Kidd S, Black D. Risk factors for recurrent nonsyncopal falls. A prospective study. *Journal of the American Medical Association* 1989; **261**: 2663–8
2 Bezon J, Echevarria KH, Smith GB. Nursing outcome indicator: preventing falls for elderly people. *Outcomes Management for Nursing Practice* 1999; **3**: 112-6
3 Tennstedt S, Howland J, Lachman M, Peterson E, Kasten L, Jette A. A randomized controlled trial of a group intervention to reduce fear of falling and associated

activity restriction in older adults. *Journals of Gerontology. Series B, Psychological Sciences and Social Sciences* 1998; **53**: 384-92

4 Salkeld G, Cameron ID, Cumming RG, *et al*. Quality of life related to fear of falling and hip fracture in older women: a time trade off study. *British Medical Journal* 2000; **320**: 341-6

5 Cumming RG, Salkeld G, Thomas M, Szonyi G. Prospective study of the impact of fear of falling on activities of daily living, SF-36 scores, and nursing home admission. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 2000; **55**: M299-305

6 Wyckoff R. Behaviour management alert: The fear of falling. *Gero Services* http://www.geroservices.com/articles/falling.asp. Last checked 16 March 2004

7 Tinetti ME, Richman D, Powell L. Falls efficacy as a measure of fear of falling. *Journal of Gerontology* 1990; **45**: 239-43

8 Lawton MP. Philadelphia Geriatric Center Morale Scale: revision. *Journal of Gerontology* 1975; **30**: 85-9

9 *EuroQol Group. "EQ-5D"* . http://www.euroqol.org/. Last checked 17 March 2004

10 Altman DG, Machin D, Bryant TN, Gardner MJ. *Statistics with Confidence*. Second edition. London: BMJ books, 2000

11 Campbell AJ, Spears GF, Borrie MJ, Fitzgerald JL. Falls, elderly women and the cold. *Gerontology* 1988; **34**: 205-8

12 Brownsell SJ, Bradley DA, Bragg R, Catlin P, and Carlier J. Do community alarm users want telecare? *Journal of Telemedicine and Telecare.* 2000; **6**: 199-204

Table 1. Characteristics of the control and intervention groups

	Control (n=21)	**Intervention (n=34)**
Mean age (years)	80	78
Age range (years)	60-95	60-94
Proportion of group who experienced at least one fall in the previous six months (%)	64	79
Mean FES score	24.7	31.7
FES range	2-67	1-71

Table 2. Results for the control and intervention groups, and for the adjusted differences

	Control pre-	**Control post-**	**Control adjusted†**	**Intervention pre-**	**Intervention post-**	**Intervention adjusted†**	**Mean adjusted post-difference**	**95% CI**	***P*-value****
(a) FES	24.1	34.7	37.5	31.3	41.2	40.3	2.8	-6.2 to 11.8	0.59
(b) EQ-5D	51.1	56.2	56.0	60.9	60.2	60.3	4.3	-7.2 to 15.8	0.83
(c) Philadelphia*	9.1	8.9	8.7	8.6	8.2	8.3	-0.3	-1.8 to 1.2	0.68

†Post scores after adjusting for pre scores using analysis of covariance
*One person in the intervention group did not complete this questionnaire during follow up as it caused distress
**P-values are for adjusted difference in scores after analysis of covariance

Table 3. Responses to the question; how often do you wear the fall detector?

Frequently	**Occasionally**	**When feeling unwell/ when carer not present**	**Hardly ever**	**Never**	**Tried it, but didn't like it**
38% (n=13)	12% (n=4)	12% (n=4)	6% (n=2)	18% (n=6)	15% (n=5)

Table 4. Responses to the questions: Do you feel more independent/safer/confident because of your fall detector? (n=34)

	Yes, definitely (%)	**Mainly yes (%)**	**No change (%)**	**No, not really (%)**	**No (%)**
Independent					
Intervention	*21*	*24*	*38*	*6*	*12*
Per protocol	29	29	29	5	10
Not per protocol	8	15	54	8	15
Safer					
Intervention	*35*	*26*	*26*	*6*	*6*
Per protocol	52	33	10	-	5
Not per protocol	8	15	54	15	8
Confident					
Intervention	*32*	*15*	*24*	*9*	*21*
Per protocol	48	24	14	10	5
Not per protocol	8	-	38	8	46

Table 5. Participants' activities when false alerts occurred

Activity	**n**
Getting dressed/undressed	19
Removing trousers to use toilet	11
Dropped on floor or knocked over	11
Sitting in chair	10
Attaching or removing the detector from clothes or belt	6
Activated while in the kitchen	3
Getting in or out of bed	2
Bending over	2
Fall detector or belt fell off	2
Low battery	1
Bending down	1
Actual fall	1
Unknown	78
Total	*147*

Figure legend

1. An example of wearing one of the fall detectors