

## Implementation of a guideline for pressure ulcer prevention in home care: pretest–post-test study

Louis Paquay, Sabine Verstraete, Renild Wouters, Frank Buntinx, Katrien Vanderwee, Tom Defloor and Hendrik Van Gansbeke

**Aims and objectives.** To investigate the effect of the implementation of a patient and family education programme for pressure ulcer prevention in an organisation for home care nursing on guideline adherence and on prevalence and severity of pressure ulcers and to examine the determining factors for the application of measures for pressure ulcer prevention.

**Background.** Quality improvement programmes in pressure ulcer prevention are not always successful.

**Design.** Implementation study using a pretest–post-test design. Data were collected in three probability samples. The first post-test data collection was held after six months, the second after 18 months.

**Method.** Statistical analysis was used, comparing the pretest sample and the second post-test sample.

**Results.** After 18 months, the proportion of subjects with adherent measures had increased from 10·4–13·9%, the proportion of subjects with non-adherent measures decreased from 45·7–36·0%, the proportion of subjects without pressure ulcer prevention increased from 43·9–50·1% ( $p < 0\cdot0001$ , Chi-square test). Sub-analysis revealed that a positive change in guideline adherence was observed principally in the group at risk. Better process-of-care indicators were associated by lower pressure ulcer prevalence and less severe skin lesions. The nurses' judgement of a patient risk status was the most important factor for applying preventive measures. Furthermore, application of pressure ulcer prevention was determined by higher age (from the age category of 70–79 years), higher dependency for the activities of daily living, higher than baseline mobility score and the presence of a pressure ulcer.

**Conclusions.** Guideline adherence in pressure ulcer prevention changed significantly after implementation of the education programme. There might have been inconsistencies in the nurses' risk judgement.

**Relevance to clinical practice.** Quality of pressure ulcer prevention improved, but several items for improvement remain. Adaptation of risk assessment procedures is needed.

**Key words:** caregiver, guideline adherence, home nursing, patient education, pressure ulcer, programme evaluation

Accepted for publication: 8 September 2009

### Introduction

#### Background

Improving the quality of pressure ulcer prevention in patients at risk for developing pressure ulcers is currently a

major focus of attention for many healthcare providers. Several reports documented a wide range of strategies and interventions, which were used for systematic improvement of pressure ulcer prevention in home care, nursing homes and hospitals: staff sensitisation, (computer-assisted) education and implementation of evidence-based clinical practice

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guidelines and prevention policies, introduction of viscoelastic foam mattresses, financial incentives, internet-based survey and feedback, management feedback on staff's guideline adherence and internal benchmarking (Steingaß *et al.* 2002, 2004, Berlowitz *et al.* 2003, Bours *et al.* 2004, Clarke *et al.* 2005, De Laat *et al.* 2005, Rosen *et al.* 2006). However, strategies for promoting best practice were not always successful on the long term or showed mixed results (Xakellis *et al.* 2001, Rosen *et al.* 2006). A healthcare organisation should demonstrate a culture that rewards innovation and teamwork (Berlowitz *et al.* 2003). Key elements for success seemed to rely on acceptance and clinical integration of new preventive programmes. Therefore, adequate nursing education, discussion and reflection should accompany implementation of new policies. Clinical integration of guidelines, which deals with strategic, structural, cultural and technical barriers, is required (Moore 2001, Xakellis *et al.* 2001). Moreover, since home care nurses can only spend limited time at patients' bedside, it is necessary actually to implement patient participation in pressure ulcer prevention. Therefore, nurses should identify, facilitate and support patients' preferences for participation in clinical decision-making as a means to tailor individualised nursing care (Florin *et al.* 2006).

In a previous study, we found that the Belgian Guidelines for Prevention of Decubitus Ulcers (BGPDU, Defloor *et al.* 2002, 2004) were incompletely followed (Paquay *et al.* 2008). Only, 4.4% of patients at risk received recommended preventive measures, 8.6% were administered only non-recommended measures, 56.2% were administered a mix of recommended and non-recommended measures, and prevention was lacking in 30.8% of patients at risk. The administration of preventive measures was significantly associated to characteristics of the subjects at risk. Subjects at risk with prevention were older, had higher dependency in performance of activities of daily living, worse skin condition and more pressure ulcers than at risk subjects without prevention.

## Objectives

The main objective of this study was to investigate the effect of the implementation of a patient and family education programme for pressure ulcer prevention in an organisation for home care nursing on guideline adherence by nurses and patients and on prevalence and severity of pressure ulcers. After the implementation, a larger proportion of patients at risk with guideline adherent preventive measures and smaller proportions of patients with non-adherent measures were expected. With regard to pressure ulcers, lower prevalence

and less severe grades of pressure ulcers were expected. The second objective was to examine which patient characteristics were determining factors for the application of measures for pressure ulcer prevention.

## Methods

### Design and setting

A pretest–post-test design was used to evaluate the implementation of the education programme. At three moments, anonymous data about pressure ulcer care were collected. Each time, a different random sample from the target population was drawn. The data of the pretest sample were collected on 27 April 2005, and the data of two post-test samples were collected, respectively, six and 18 months after the start (12 May 2005) of the implementation programme: 30 November 2005 and 29 November 2006. During a preparation phase from June 2004–March 2005, the study was designed by internal evaluators employed by the umbrella organisation under which the five home nursing agencies cooperated, the 'Wit-Gele Kruis' in Flanders, Belgium. Tissue viability nurses from the five home nursing agencies participated in the study design (see Acknowledgements). The study protocol was approved by the ethical committee of the Leuven University Medical School. In accordance with Belgian privacy legislation, all study subjects remained anonymous for the investigators.

### Population and sample

The target population for this study was all patients with an elevated risk for developing pressure ulcers in five autonomous home nursing agencies cooperating under one umbrella organisation. A subject's eligibility for hygienic care, which demonstrated to be a significant indicator of elevated risk for developing pressure ulcers, was the inclusion criterion (Paquay *et al.* 2008). For all patients, eligibility for hygienic care was determined in a formal assessment procedure using the Belgian 'Index of ADL' (BIA) (Arnaert & Delesie 1999). Systematic sampling was used to select probability samples of study subjects (Polit & Hungler 1995): on each of three prefixed dates (pretest and twice post-test), the first three subjects with hygienic care on the nurse's daily schedule were selected by each nurse who was on duty that day. It was assumed that there was no periodicity or priority in the order in which patients were visited. This systematic sampling method had the advantage that it was very simple to be explained to and implemented by a large number of nurses.

## Intervention

The key elements of the intervention aimed at informing and motivating everyone involved in pressure ulcer care for using the BGPDU: sensitisation and education of nurses, making documentation available for nurses, support by reference nurses in each regional nursing unit, making use of a leaflet at the patient's home. The five home care nursing agencies collectively adopted training on pressure ulcer prevention as a priority and training sessions on the BGPDU were organised for all nurses. A leaflet for informing patients and informal caregivers was designed by an interdisciplinary working group of wound care experts and experts in patient teaching. The leaflet was based on the BGPDU. Its usability was pilot tested in five patient situations in each of the home care agencies.

The key elements were implemented through training and education on two levels. First, before the start of the intervention, at least one tissue viability nurse from each of 107 regional departments attended a conference on BGPDU (22 March 2005). Second, on the level of the five agencies and the regional departments, from May–October 2005, the tissue viability nurses organised training sessions for all nurses. Nurses were instructed to use the leaflet to inform and motivate patients and informal caregivers about effective preventive measures for the development of pressure ulcers.

After the first post-test measurement, feedback on the number of patients at risk, the presence of pressure ulcers and guideline adherence was given by means of an automated information report on the level of both, the five organisations and each of the 107 regional departments. Reference nurses were involved in providing feedback and explanation to the regional departments.

## Data collection procedure and assessment instruments

For each patient included in the study, the visiting nurse collected anonymous data by filling out a case report form. The form was derived from European Pressure Ulcer Advisory Panel (EPUAP) registration forms used in previous studies (Clark *et al.* 2002, Paquay *et al.* 2008). It included standardised questions about demographic data (sex and age category), risk factors (dependency, locomotion capacity and pressure ulcer risk), characteristics of pressure ulcers and preventive measures.

The patient's dependency was evaluated using the BIA, which is an adaptation of the 'Index of ADL' (Katz *et al.* 1963). The adapted assessment tool evaluates the six original domains of the 'Index of ADL' (bathing, dressing, transfer, toileting, continence and eating) into one of four hierarchical

levels of dependency: baseline level (lowest dependency) and three hierarchical levels, which are coded with the capitals A, B and C (highest dependency). The BIA is the official instrument used for reimbursement of nursing care by the federal Belgian health insurance (Arnaert & Delesie 1999). One question addressed the subject's locomotion capabilities into four levels (no difficulty, with assistive device, with help, bedridden).

One item questioned the clinical judgement of the nurse about the subject's risk status into two categories: at risk or no risk. The rationale for this question was that, in the previous study, the nurses' clinical judgement demonstrated substantial agreement with the risk status according to the Braden scale: the kappa statistic for the agreement between the nurses' clinical judgement about pressure ulcer risk and the risk determination of the Braden scale cut-off ( $\leq 18$ ) was 0.71 (95% CI 0.68–0.74). The observed agreement was 90% of all risk assessments.

Characteristics of the pressure ulcers were evaluated using the EPUAP grading system: grade 1, non-blanchable erythema of intact skin, grade 2, blister, partial thickness skin loss involving epidermis, dermis, or both, grade 3, superficial ulcer, full thickness skin loss involving damage necrosis of subcutaneous tissue that may extend down to, but not through, underlying fascia, grade 4, deep ulcer with extensive destruction, tissue necrosis, or damage to muscle, bone or supporting structures with or without full thickness skin loss. For each study subject, a checklist of the applied preventive measures was completed, including both materials used and interventions by home care nurses and informal caregivers. The BGPDU was used as reference standard to evaluate guideline adherence of the applied preventive measures.

Based on a subject's combination of preventive materials and measures, a SAS-algorithm developed by the authors (Paquay *et al.* 2008), was used to generate a summary evaluation score into three categories about the guideline adherence of the pressure ulcer prevention for that subject. The three categories were adherence, no adherence and no preventive measures:

- 1 Adherence: all measures and materials present in the patient situation for the prevention of pressure ulcers were adherent to the BGPDU.
- 2 No adherence: some or all measures and materials present in the patient situation for the prevention of pressure ulcers were not adherent to the BGPDU or not recommended for pressure ulcer prevention by the BGPDU.
- 3 No prevention: there were no measures or materials for the prevention of pressure ulcers in the patient situation.

A graphical presentation of a subanalysis of guideline adherence according to the risk status was performed. The

paper-based registration data were captured with the software package Teleform 7.0 (Cardiff Software 2000).

### Statistical analysis

The main analysis was based on a comparison between the final post-test data (after 18 months) and the baseline data. The chi-square test and the Wilcoxon test were used to test for differences between the baseline measures (27 April 2005) and the second post-test measures after 18 months (29 November 2006). Multiple logistic regression analysis was performed to search for determinants of the presence of measures for pressure ulcer prevention. Variables used in the logistic regressions were age, sex, ADL dependency, mobility, pressure ulcer risk status, presence of a pressure ulcer;  $p < 0.01$  was considered statistically significant. The SAS System version 8.2 (SAS Institute Inc., Cary, NC, USA) was used for statistical analysis.

## Results

### Response and study samples

At baseline, data on 6287 subjects were collected. Because of missing data, 288 (4.6%) of the cases were excluded. After six months, at the first post-test follow-up, there were data on 6166 subjects of which 272 (4.4%) were excluded for reasons of missing data. After 18 months, at the second post-test follow-up, data were collected on 6380 persons of which 283 (4.4%) were excluded for reasons of missing data. The final analysis was performed on the data of 17980 study subjects: 5999 subjects pretest, 5894 subjects of the first post-test sample and 6097 subjects of the second post-test sample (Table 1). Because each nurse collected data on three clients, it can be assumed that approximately 2000 nurses have collected the data in each study stage.

Characteristics	All study subjects			<i>p</i> -value
	Pretest ( <i>n</i> = 5999) <i>n</i> (%)	Post-test		
		After six months ( <i>n</i> = 5894) <i>n</i> (%)	After 18 months ( <i>n</i> = 6097) <i>n</i> (%)	
Women	4144 (69.1)	4072 (69.1)	4188 (68.7)	0.64*
Age category				
0–49 years	289 (4.8)	312 (5.3)	327 (5.4)	0.03†
50–59 years	264 (4.4)	246 (4.2)	282 (4.6)	
60–69 years	540 (9.0)	551 (9.4)	574 (9.4)	
70–79 years	1852 (30.9)	1844 (31.3)	1862 (30.5)	
80–89 years	2404 (40.1)	2340 (39.7)	2491 (40.9)	
90–99 years	633 (10.6)	576 (9.8)	542 (8.9)	
≥100 years	17 (0.3)	25 (0.4)	19 (0.3)	
ADL dependency‡				
Baseline level	1118 (18.6)	1091 (18.5)	1095 (18.0)	0.13‡
Level A	2121 (35.4)	2042 (34.7)	2090 (34.3)	
Level B	1780 (29.7)	1796 (30.5)	1894 (31.1)	
Level C	980 (16.3)	965 (16.4)	1018 (16.7)	
Mobility				
No difficulty	758 (12.6)	738 (12.5)	799 (13.1)	0.14‡
With assistive device	1539 (25.7)	1586 (26.9)	1561 (25.6)	
With help	1757 (29.3)	1861 (31.6)	1990 (32.6)	
Bedridden	1527 (25.5)	1415 (24.0)	1424 (23.4)	
Missing	418 (7.0)	294 (5.0)	323 (5.3)	
Persons at risk for developing pressure ulcers§	2620 (36.8)	2494 (35.0)	2016 (28.3)	<0.0001*

**Table 1** Characteristics of subjects included in the pretest and the post-test samples: number of subjects and percentage. Statistical tests were used for testing the significance of differences between the pretest and the 18 months post-test sample

\*Calculated using the Chi-square test.

†Calculated using the Wilcoxon two sample test.

‡ADL dependency was evaluated using the Belgian Index of ADL. Each subject was assigned one of four hierarchical dependency levels. Baseline level was the lowest, level C was the highest level.

§Based the nurses' clinical judgement.

## Descriptive analysis of study samples

Demographic and clinical characteristics of the study subjects are represented in Table 1. The distribution of sex, age, dependency levels and locomotion capacities was not different between the pretest sample and the second post-test sample. The proportion of subjects at risk for developing pressure ulcers was significantly smaller in the second post-test sample than in the pretest sample (Table 1: 28.3 vs. 36.8%, Chi-square = 0.21,  $df = 1$ ,  $p < 0.0001$ ).

## Outcome measures

The application of preventive measures and materials is shown in detail in Table 2. The application of most of the recommended measures and materials improved significantly.

After 18 months, there were significantly larger proportions of subjects with a polyurethane foam mattress and pad, or with an alternating mattress. Elevating heels and motivating patients and caregivers occurred significantly more frequently. In the category of recommended measures, there was no significant improvement in the use of air mattresses, air cushions and in daily skin observation. In contrast with the recommended measures mentioned earlier, repositioning in bed and in the armchair decreased significantly.

The application of most of the non-recommended measures decreased significantly: foam and water mattresses or pads, gel cushions, sheep skins, heel muffs, transparent film dressing, massage, barrier cream or lotion. In the category of the non-recommended measures, there was no significant evolution in the use of nutritional supplements, ice friction and local temperature.

**Table 2** Application of effective and ineffective preventive measures and materials, pretest and post-test. The Chi-square test was used to test for differences between the pretest sample and the 18 months post-test sample

Preventive measures and materials	Recommendation for use in pressure ulcer prevention by the BGPDU?	All study subjects			<i>p</i> -value
		Pretest ( <i>n</i> = 5999) <i>n</i> (%)	Post-test		
			After six months ( <i>n</i> = 5894) <i>n</i> (%)	After 18 months ( <i>n</i> = 6097) <i>n</i> (%)	
<b>In bed</b>					
Visco elastic foam mattress	R	340 (5.7)	389 (6.6)	467 (7.7)	<0.0001
Air mattress	R	142 (2.4)	129 (2.2)	133 (2.2)	0.49
Alternating mattress	R	384 (6.4)	418 (7.1)	502 (8.2)	<0.0001
Repositioning	R	1763 (29.4)	1682 (28.5)	1557 (25.5)	<0.0001
Foam mattress	NR	566 (9.4)	520 (8.8)	452 (7.4)	<0.0001
Water mattress	NR	122 (2.0)	91 (1.5)	51 (0.8)	<0.0001
Sheep skin	NR	404 (6.7)	258 (4.4)	226 (3.7)	<0.0001
<b>In armchair</b>					
Visco elastic foam cushion	R	194 (3.2)	317 (5.4)	429 (7.0)	<0.0001
Air cushion	R	221 (3.7)	257 (4.4)	278 (4.6)	0.02
Repositioning	R	1448 (24.1)	1399 (23.7)	1310 (21.5)	0.0005
Foam cushion	NR	389 (6.5)	315 (5.3)	260 (4.3)	<0.0001
Water cushion	NR	136 (2.3)	87 (1.5)	76 (1.3)	<0.0001
Gel cushion	NR	360 (6.0)	315 (5.3)	396 (6.5)	0.26
Sheep skin	NR	259 (4.3)	187 (3.2)	172 (2.8)	<0.0001
<b>Other</b>					
Daily skin observation	R	2397 (40.0)	2303 (39.1)	2404 (39.4)	0.55
Motivating patient & caregivers	R	860 (14.3)	962 (16.3)	1069 (17.5)	<0.0001
Floating heels	R	425 (7.1)	568 (9.6)	595 (9.8)	<0.0001
Heel muff	NR	329 (5.5)	232 (3.9)	204 (3.4)	<0.0001
Transparent film dressing	NR	219 (3.7)	154 (2.6)	154 (2.5)	0.0003
Nutritional supplements	NR	213 (3.6)	167 (2.8)	222 (3.6)	0.79
Massage	NR	382 (6.4)	284 (4.8)	272 (4.5)	<0.0001
Ice friction and föhn	NR	26 (0.4)	15 (0.3)	14 (0.2)	0.051
Barrier cream or lotion	NR	1929 (32.2)	1358 (23.0)	1390 (22.8)	<0.0001
Local temperature	NR	40 (0.7)	37 (0.6)	28 (0.5)	0.13

BGPDU, Belgian Guideline for the Prevention of Decubitus Ulcers; R, recommended for use in pressure ulcer prevention according to BGPDU; NR, not recommended for use in pressure ulcer prevention according to BGPDU.

The mean number of preventive measures per subject was 2.26 in the pretest sample, and it was significantly lower after 18 months: 2.08 measures per subject ( $p < 0.0001$ , Wilcoxon test). The evolution of the mean number of measures per subjects was different for recommended and non-recommended measures. The mean number of recommended preventive measures per subject was 1.36 in the pretest sample and not significantly different in the second post-test sample: 1.43 recommended measures per subject ( $p = 0.47$ , Wilcoxon test). The mean number of non-recommended measures per subject was 0.90 at pretest and significantly lower after 18 months: 0.64 non-recommended measures per subject ( $p < 0.0001$ , Wilcoxon test).

After 18 months, the distribution of the summary score for guideline adherence had changed significantly. The proportion of subjects with adherent measures had increased from 10.4–13.9%, the proportion of subjects with non-adherent measures decreased from 45.7–36.0%, the proportion of subjects without pressure ulcer prevention increased from 43.9–50.1% (Table 3). A subgroup analysis of guideline adherence according to the risk status is presented in Fig. 1. The presence of measures for pressure ulcer prevention was different according to the risk status: in the three study samples, approximately 10% of persons at risk had no preventive measures, in persons not at risk, approximately

70% had no preventive measures. Although the proportion of subjects at risk was much smaller after 18 months (28.3% of all subjects, Table 1) compared to the pretest sample, when 36.8% of all subjects were at risk, the distribution of the guideline adherence summary score remained stable in the two post-test sample of subjects at risk. In the category of subjects not at risk, a similar stable distribution was found in the two post-test samples.

The distribution of the most severe skin condition per subject and the number of pressure ulcer grade 1–4 lesions per subject changed significantly (Table 3). Prevalence of grade 1–4 ulcers was significantly lower after 18 months: 11.2% (685 subjects) vs. 15.6% (937 subjects,  $p < 0.0001$ , Chi-square test). The presence of a grade 2 or higher lesion was also significantly lower after 18 months: 8.4% (675 subjects) vs. 11.3% (514 subjects,  $p < 0.0001$ , Chi-square test).

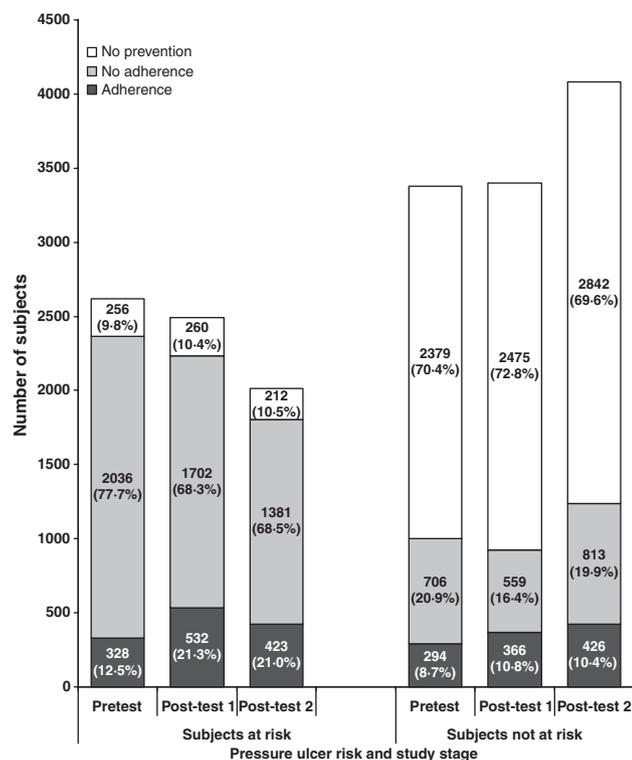
The results of the multiple logistic regression analysis of the determinants of the presence of preventive measures are presented in Table 4. Application of pressure ulcer prevention was determined by higher age (from the age category of 70–79 years), higher ADL dependency, higher than baseline mobility score, pressure ulcer risk according to the nurses' clinical judgement, the presence of a pressure ulcer.

Outcome measure	All study subjects			<i>p</i> -value
	Pretest ( <i>n</i> = 5999)	Post-test		
		After six months ( <i>n</i> = 5894)	After 18 months ( <i>n</i> = 6097)	
Guideline adherence: number of subjects (%)				
Adherence	622 (10.4)	898 (15.2)	849 (13.9)	<0.0001*
No adherence	2742 (45.7)	2261 (38.4)	2194 (36.0)	
No prevention	2635 (43.9)	2735 (46.4)	3054 (50.1)	
Most severe skin condition per subject: number of subjects (%)				
Normal skin	3959 (66.0)	4219 (71.6)	4556 (74.7)	<0.0001†
Blanchable erythema	1103 (18.4)	988 (16.8)	856 (14.0)	
Grade 1: non-blanchable erythema	262 (4.4)	194 (3.3)	171 (2.8)	
Grade 2: blister	215 (3.6)	143 (2.4)	155 (2.5)	
Grade 3: superficial lesion	348 (5.8)	266 (4.5)	273 (4.5)	
Grade 4: deep lesion	112 (1.9)	84 (1.4)	86 (1.4)	
Number of lesions per subject: number of subjects (%)				
No lesion	5062 (84.4)	5207 (88.3)	5412 (88.8)	<0.0001†
1 lesion	717 (12.0)	559 (9.5)	558 (9.2)	
2 lesions	168 (2.8)	109 (1.9)	100 (1.6)	
3 lesions	43 (0.7)	17 (0.3)	23 (0.4)	
4 lesions	9 (0.2)	2 (0.03)	4 (0.1)	

\*Calculated using the Chi-square test.

†Calculated using the Wilcoxon two sample test.

**Table 3** Outcome measures in a study population of subjects with elevated risk for developing pressure ulcers: summary score for guideline adherence of pressure ulcer prevention, the most severe pressure ulcer lesion per subject and number of pressure ulcer grade 1 to 4 lesions per subject. Statistical tests were used to test for differences between the pretest sample and the 18 months post-test sample



**Figure 1** Distribution of a summary score for pressure ulcer guideline adherence in 17980 subjects at risk and not at risk for developing pressure ulcers. Determination of the risk status was based on the nurses' clinical judgement. Data were collected in three subsequent samples: pretest, after six months (post-test 1) and after 18 months (post-test 2). The number of subjects and the proportion in each combination of risk status and study stage are presented in the vertical bars.

## Discussion

In this study, guideline adherence of pressure ulcer prevention in five home nursing agencies changed significantly after implementation of a patient and family education programme. On the one hand, a shift towards more frequent use of recommended measures was observed: from 10.4% of all subjects at pretest to 13.9% of all subjects after 18 months, while the mean number of recommended measures per subject remained constant. On the other hand, less frequent use of non-recommended measures post-test was observed together with less frequent presence of preventive measures. This conclusion was drawn based on the finding that at post-test measures were present in fewer subjects (49.9% of all subjects) than at pretest (56.1% of all subjects). Application of pressure ulcer prevention and evolution of guideline adherence were different according to the nurses' clinical judgement on the patient's risk status: in persons at risk, measures for pressure ulcer prevention were present in approximately 90% of the

subjects and guideline adherence shifted from 12.5% pretest to approximately 21% in both post-test samples (Fig. 1), in persons not at risk, approximately 70% received no prevention in the three subsequent samples, and guideline adherence was present in 8.7–10.8% of persons not at risk. These findings support the conclusion that the effect of guideline implementation was observed principally in persons who were considered at risk for developing pressure ulcers. However, it was obvious that the nurses' clinical judgement on a patient's risk status had changed at the end of the study: while there were no significant differences between the second post-test study sample and the pretest sample for sex, age category, ADL dependency and locomotion, the proportion of patients at risk was significantly smaller 18 months after the implementation of the guidelines than before (Table 1). As the assessment of a patient's pressure ulcer risk depended on the nurses' clinical judgement solely, these results might highlight the need for a formal evaluation of pressure ulcer risk using a standardised assessment instrument such as the Braden scale or the transparent disc method (Vanderwee *et al.* 2006).

An unexpected result was that in the category of recommended preventive measures, repositioning in bed and in the armchair decreased significantly, while almost all other recommended measures were applied significantly more frequently. Probably, nurses and informal caregivers judged that the availability of better preventive materials was sufficient to substitute regular repositioning in bed and in the armchair.

In this study, guideline implementation resulting in less non-recommended preventive measures was followed by better performance with regard to the outcome of pressure ulcer prevention in the post-test samples, fewer persons had pressure ulcers, there were fewer pressure ulcers per person, and the severity of pressure ulcers was lower. These findings confirm the finding of Bours *et al.* (2004) who stated that the percentage of patients receiving adequate prevention were intermediate factors in decreasing the prevalence. However, because of the study design, a causal relation between higher guideline adherence and lower pressure ulcer outcome could not be ascertained in the present study. First, in the absence of a control group, it is not certain to which extent the improvements observed were a result of the intervention, or chance or other non-specific confounding factor. Furthermore, as with any multifaceted intervention, it is not possible from our data to determine in detail the relative effect of each key element towards achieving the outcome (Øvretveit 1998). Additionally, using only one source of information is another weakness of the study design. The choice to have the nurses collect the data was made for practical reasons. Having a researcher to perform the observations would involve high costs and be

**Table 4** Application of measures for pressure ulcer prevention in the three study samples ( $n = 17980$ ). Results of the multiple logistic regression for independent determinants of the presence of measures for pressure ulcer prevention

Determinants	Presence of measures for pressure ulcer prevention		B (SE)	Wald chi-square	<i>p</i>	Odds ratio (99% CI)
	Subjects with prevention ( $n = 9566$ , 53.2%) <i>n</i> (row%)	Subjects without prevention ( $n = 8424$ , 46.8%) <i>n</i> (row%)				
<b>Sex</b>						
Women	6405 (51.6)	5999 (48.4)				Reference category
Men	3161 (56.6)	2425 (43.4)	-0.05 (0.04)	1.08	0.30	0.97 (0.85–1.07)
<b>Age category</b>						
0–49 years	583 (62.8)	345 (37.2)				Reference category
50–59 years	444 (56.1)	348 (43.9)	0.18 (0.14)	1.72	0.19	1.20 (0.84–1.71)
60–69 years	880 (52.9)	785 (47.1)	0.26 (0.12)	4.79	0.03	1.29 (0.96–1.75)
70–79 years	2779 (50.0)	2779 (50.0)	0.33 (0.10)	10.06	0.0015	1.39 (1.06–1.82)
80–89 years	3738 (51.7)	3497 (48.3)	0.43 (0.10)	17.30	< 0.0001	1.53 (1.18–2.00)
90–99 years	1099 (62.8)	652 (37.2)	0.63 (0.12)	29.15	< 0.0001	1.88 (1.39–2.54)
≥100 years	43 (70.5)	18 (29.5)	0.21 (0.39)	0.29	0.59	1.23 (0.45–3.35)
<b>ADL dependency</b>						
Baseline level	668 (20.2)	2636 (79.8)				Reference category
Level A	2454 (39.3)	3799 (60.7)	0.43 (0.06)	51.99	< 0.0001	1.54 (1.32–1.80)
Level B	3669 (67.1)	1801 (32.9)	0.81 (0.07)	120.72	< 0.0001	2.26 (1.87–2.73)
Level C	2775 (93.7)	188 (6.3)	1.60 (0.12)	178.85	< 0.0001	4.95 (3.64–6.73)
<b>Mobility</b>						
No difficulty	398 (17.3)	1897 (82.7)				Reference category
With assistive device	1534 (32.7)	3152 (67.3)	0.43 (0.07)	37.53	< 0.0001	1.54 (1.29–1.85)
With help	3174 (56.7)	2430 (43.3)	0.69 (0.08)	76.14	< 0.0001	1.99 (1.62–2.43)
Bedridden	3911 (89.6)	455 (10.4)	1.36 (0.10)	177.99	< 0.0001	3.90 (3.00–5.07)
Missing value	545 (52.7)	490 (47.3)	0.66 (0.10)	43.03	< 0.0001	1.94 (1.49–2.51)
<b>Pressure ulcer risk*</b>						
Patient not at risk	3164 (29.1)	7696 (70.9)				Reference category
Patient at risk	6402 (89.8)	728 (10.2)	2.20 (0.05)	2020.41	< 0.0001	8.99 (7.92–10.19)
<b>Skin condition</b>						
No pressure ulcer	7396 (47.2)	8285 (52.8)				Reference category
Pressure ulcer <sup>†</sup>	2170 (94.0)	139 (6.0)	1.76 (0.10)	308.66	< 0.0001	5.82 (4.49–7.53)

\*Based on the nurses' clinical judgement.

<sup>†</sup>Pressure ulcers were grade 1–4 lesions.

disturbing to the patients (Vanderwee *et al.* 2007). For the participating organisations, involving many nurses in the data collection seemed advantageous in a sense that major proportions of all nurses were repeatedly sensitised and reactivated towards better performance in pressure ulcer prevention.

The nurses' clinical judgement of a patient's risk status was the strongest determinant of the presence of preventive measures. This finding highlights the need for a thorough evaluation of pressure ulcer risk factors to identify high risk patients adequately.

## Conclusions

Implementation of the BGPDU had positive short and mid-term effects on guideline adherence of nurses and patients.

Better process-of-care indicators were associated by lower pressure ulcer prevalence and less severe skin lesions. While the nurses' judgement of a patient risk status was the most important factor for applying preventive measures, study results suggested that there might have been inconsistencies in the nurses' risk judgement.

## Relevance to clinical practice

The present study demonstrated that there were possibilities to improve the quality of pressure ulcer prevention. However, the effects of the education programme were limited and several items for improvement remain. Adaptation of risk assessment procedures seems to require high priority.

## Acknowledgements

We are especially thankful to the registered nurses Carine Ogiers, Ann Onraedt, Myriam Polfliet, Hilde Van Loon, Ann Verberckmoes and Brigitte Wollaert, who coordinated the educational intervention and the data collection for the study. Roseline Debaillie and Ludo Geys provided general support and supervision.

## Contributions

Study design: LP, FB, KV, TD; data collection and analysis: LP, SV, RW and manuscript preparation: LP, SV, FB, KV, TD, HVG.

## Conflict of interest

This work was supported in part by an unconditional collective grant from the Belgian companies Distrac, Huntleigh Healthcare, Medical Scientific Huart and ConvaTec. The study was granted in advance and the companies had no influence on any element of the study. There were no other conflicts of interest reported.

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