Predicting pressure ulcers: cases missed using a new clinical prediction rule

Lisette Schoonhoven RN PhD
Assistant Professor, Centre for Quality of Care Research, Department of Nursing Science, University Medical Centre Nijmegen, Nijmegen, The Netherlands

Diederick E. Grobbee MD PhD
Professor of Clinical Epidemiology, Julius Centre for Health Sciences and Primary Care, University Medical Centre Utrecht, Utrecht, The Netherlands

Mente T. Bousema MD
Dermatologist, Department of Dermatology, Meander Medical Centre Amersfoort, Amersfoort, The Netherlands

Erik Buskens MD PhD
Associate Professor of Medical Technology Assessment, Julius Centre for Health Sciences and Primary Care, University Medical Centre Utrecht, Utrecht, The Netherlands

on behalf of the prePURSE study group

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Correspondence:
Erik Buskens,
University Medical Centre Utrecht,
Julius Centre for Health Sciences and Primary Care,
D01.335,
PO Box 85500,
3508 GA Utrecht,
The Netherlands.
E-mail: e.buskens@umcutrecht.nl

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Predicting pressure ulcers: cases missed using a new clinical prediction rule

Aim. The aim of this paper is to report a study describing patients with pressure ulcers that were incorrectly classified as 'not at risk' by the prediction rule and comparing them with patients who were correctly classified as 'not at risk'.

Background. Patients admitted to hospital are at risk of developing pressure ulcers. Although the majority of pressure ulcers can be predicted using a recently developed prediction rule, up to 30% of patients with pressure ulcers may still be misclassified.

Methods. Between January 1999 and June 2000 a prospective cohort study was conducted in two large hospitals in the Netherlands. Patients admitted to neurology, internal, surgical, and elder care wards for more than 5 days were included ($n = 1229$), and were examined weekly. Information on potential prognostic determinants for pressure ulcers mentioned in the literature was recorded. Outcome was defined as occurrence of a pressure ulcer grade 2 or worse during hospital admission.

Results. Patients who developed pressure ulcers experienced more problems with 'friction and shear' and underwent surgery more often and longer. Also, they were more often admitted because of malignant conditions.

Conclusion. We found no specific characteristics that clearly distinguished patients with pressure ulcers that were incorrectly classified as 'not at risk' by the prediction rule from patients who were correctly classified as 'not at risk'. It appears difficult to improve further on the prediction of pressure ulcers using available clinical information.

Keywords: pressure ulcers, prediction, hospitalized patients, cohort study, nursing

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Introduction

Pressure ulcers frequently occur in hospitalized patients. The prevalence of pressure ulcers of grades 1–4 ranges from 10% to 23% in hospitalized patients, depending on the population studied [Edwards 1994, National Pressure Ulcer Advisory Panel (NPUAP) 2001, Bours *et al.* 2002]. The proportion of newly hospitalized patients developing pressure ulcers varies between 0·4% and 38% (NPUAP 2001). Pressure ulcers may be prevented if effective preventive measures are taken in time. As these measures are expensive and labour intensive, they should only be used with patients actually at risk of development of pressure ulcers.

Background

Several pressure ulcer risk assessment scales have been developed to detect high-risk patients [Edwards 1994, European Pressure Ulcer Advisory Panel (EPUAP) 1999a], and, according to Nixon and McGough (2001), at least 40 such scales have been described. Most scales reflect expert opinion, literature review or adaptation of an existing scale. Neither the risk factors nor the weights attributed to them have been determined using empirical data and adequate statistical techniques (Haalboom *et al.* 1999; Nixon & McGough 2001). Only six risk assessment scales have been tested for predictive validity (Nixon & McGough 2001). Of these six, the Norton and Waterlow scales have been tested twice and the Braden scale nine times. The results vary and little evidence of predictive value or accuracy of the scales is available (Clark & Farrar 1991, Hamilton 1992, Edwards 1994, 1996; Haalboom *et al.* 1999; Nixon & McGough 2001). Moreover, the majority of studies evaluating risk assessment scales had methodological limitations (Nixon & McGough 2001). They were small and conducted with varying populations. Also, in some studies the researchers did not make sure that the nurses responsible for daily care of the patient did not know what that patient's score was, nor were the results adjusted to take account of preventive measures. In a recent analysis we showed that the most commonly used risk assessment scales do not predict pressure ulcer development satisfactorily in hospitalised patients (Schoonhoven *et al.* 2002a). Consequently, the broadly advocated advice to use risk assessment scales and base decisions about measures to prevent pressure ulcers on the outcome of these scales appears to lead to ineffective and inefficient preventive measures for the majority of patients. Therefore, we developed a new prediction rule based on empirical data from a prospective cohort of 1229 hospitalised patients. The eventual rule comprised five easily obtainable patient characteristics: age, weight at admission, abnormal appearance of the skin, friction and shear, and planned surgery in the coming week. Although many currently available risk assessment scales include one or more of these characteristics, none uses all of these predictors. Furthermore, this new prediction rule was based on regression modelling, thus accounting for associations between predictors. Moreover, the weights we assigned to each of the predictors were based on the regression coefficients. Using this prediction rule, 70% of the patients hospitalised in general wards can be correctly classified as being at risk or not. Also, at the cut-off point deemed most efficient, 70% of pressure ulcers can be predicted.

Although the majority of pressure ulcers can be predicted, 30% of patients with pressure ulcers are misclassified as false negatives. These patients may have uncommon factors that therefore do not feature in the prediction rule but may still be of clinical relevance.

The study

Aim

The aim of the study was to describe patients with pressure ulcers who were incorrectly classified as 'not at risk' by the prediction rule, and to compare them to patients who were correctly classified as 'not at risk'.

Design

A prospective, cohort design was used for this prevention and Pressure Ulcer Risk Score Evaluation study (prePURSE).

Participants

The study included patients admitted to two medical centres in the Netherlands between January 1999 and June 2000. Patients from surgical, internal, neurological, and elder wards were eligible if they satisfied the following conditions: over 18 years of age, an expected admission of at least five days, and no pressure ulcers. Based on the admission figures the total number of potentially eligible patients during the study period was estimated at 6000. Two research nurses visited each ward twice a week and asked all eligible patients admitted within the past 48 hours to participate. A total of 1536 patients (approximately 25%) were visited, of whom 1431 (93·2%) consented to participate. Subsequently, patients were visited by the research nurses once a week until pressure ulcer occurrence, discharge or the length of stay exceeded 12 weeks. Eighteen patients died within the first

week of admission, and 184 were discharged before the first follow-up visit. Finally, 1229 patients (80·0%) had at least one follow-up visit prior to discharge (Table 1).

Data collection

At each visit patients were examined for the presence of pressure ulcers, and information on preventive measures was collected by the two research nurses. Pressure ulcers were classified into four grades following the classification of the EPUAP (1999b). The outcome was defined as the presence of a pressure ulcer grade 2 or worse. Preventive measures were considered present if a patient was being nursed on a pressure-reducing mattress or bed or repositioned regularly at the time the skin was inspected. Information on potential prognostic determinants for pressure ulcers mentioned in literature was also recorded. Attending nurses did not have access to the research nurse's observations.

Ethical considerations

The study was approved by the ethics committees of both hospitals, and all patients gave oral consent following a full explanation of the study requirements and assurance of anonymity and confidentiality.

Data analysis

The 1229 patients yielded 2190 patient weeks of observation time. Patient weeks in which patients received preventive measures and did not develop pressure ulcers ($n = 83$) were excluded from the analysis. In these patients, it was impossible to distinguish effects of prevention from false positive cases. We also excluded patient weeks in which information on preventive measures was missing ($n = 28$). Finally, patient weeks in which the patient was admitted to ICU were excluded ($n = 19$). These exclusions resulted in a database of 2060 patient weeks. The problem of missing data was resolved by carrying out a complete case analysis. Data were missing in only 35 patient weeks (1·7%), including four patient weeks in which pressure ulcers developed. Therefore, the final database consisted of 2025 patient weeks, including 121 patients with pressure ulcers.

In this study, patient weeks which were not considered at risk by the new prediction rule but in which a pressure ulcer did develop ($n = 36$), i.e. false-negatives, were compared with patient weeks which were not considered at risk and in which a pressure ulcer did not develop ($n = 1147$), i.e. true-negatives. We compared these two groups on general characteristics and on prognostic determinants that were initially considered for the new prediction rule (Table 2). These determinants were observed frequently, were relatively easy to obtain in nursing practice, and appeared to be associated with pressure ulcer development in a univariate logistic regression analysis (P value $< 0{\cdot}15$) of the entire data set.

To check if the false-negatives developed more or fewer severe pressure ulcers than patients with pressure ulcers who were correctly classified as 'at risk', i.e. true-positives, the severity of the pressure ulcers that developed in the false-negatives was compared with the severity of those in the true-positives.

Data were analysed using SPSS for Windows 11.0.1. Analyses included t-tests and chi-square tests where appropriate.

Table 1 Characteristics of patients

Characteristic	Total ($n = 1229$)
Mean age (years) (SD)	60·1 (16·7)
Female	673 (54·8)
Hospital	
Medical Centre 1	783 (63·7)
Medical Centre 2	446 (36·3)
Ward	
Surgical	759 (61·8)
Internal medicine	275 (22·4)
Neurology	122 (9·9)
Elder care	73 (5·9)

Values are numbers (percentages) unless stated otherwise.

Results

Table 2 summarizes the difference between patient weeks in which pressure ulcers developed ($n = 36$) and did not develop ($n = 1147$) in the total number of patient weeks not considered at risk ($n = 1183$).

In the patient weeks in which pressure ulcers developed, patients experienced significantly more problems with 'friction and shear' and underwent surgery more often. As these two risk factors were already assimilated into the new prediction rule, the score on this rule was significantly higher in the group that developed pressure ulcers but, as expected, was below the cut-off level.

Further differences observed between the groups that did and did not develop pressure ulcers were length of surgery and clinical diagnosis. Length of surgery in the group that developed pressure ulcers was twice as long as in the group that did not develop pressure ulcers. Although not statistically significant, there was also a difference in clinical diagnosis. Malignancies were more frequent in the group

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Table 2 Comparison of patients with and without pressure ulcers in the 'not at risk'-group

Characteristic	Pressure ulcer not at risk ($n = 36$)	No Pressure ulcer not at risk ($n = 1147$)	*t*-test	χ^2	*P* value
Age (mean, SD)	57·9 (18·9)	57·9 (17·6)	−0·01		0·99
Weight (kg) (mean, SD)	73·9 (17·8)	71·5 (15·1)	−0·82		0·42
Female	19 (52·8)	635 (55·4)		0·094	0·76
Medical speciality				0·81	0·85
Surgical	18 (50)	510 (44·5)			
Medicine	11 (30·6)	390 (34)			
Neurology	3 (8·3)	136 (11·9)			
Elder care	4 (11·1)	111 (9·7)			
Mobility				1·96	0·58
No limitation	16 (44·4)	568 (49·5)			
Slightly limited	14 (38·9)	451 (39·3)			
Very limited	4 (11·1)	65 (5·7)			
Completely immobile	2 (5·6)	63 (5·5)			
Activity				2·70	0·61
Walks frequently	14 (38·9)	515 (44·9)			
Walks occasionally	12 (33·3)	261 (22·8)			
Wheelchair	0	19 (1·7)			
Chairfast	3 (8·3)	96 (8·4)			
Bedfast	7 (19·4)	256 (22·3)			
Abnormal appearance of skin	7 (19·4)	168 (14·6)		0·64	0·43
Diabetes mellitus	4 (11·1)	161 (14)		0·62	0·62
Pressure ulcer in past	3 (8·3)	83 (7·3)		0·81	0·81
Incontinence				3·27	0·35
Not	31 (86·1)	1027 (89·8)			
Occasional urine	2 (5·6)	82 (7·2)			
Occasional faeces	2 (5·6)	25 (2·2)			
Urine and faeces	1 (2·8)	10 (0·9)			
Friction/shear				8·21	0·02
No apparent problem	24 (66·7)	893 (77·9)			
Potential problem	7 (19·4)	207 (18)			
Problem	5 (13·9)	47 (4·1)			
Surgery in coming week	10 (27·8)	175 (15·3)		0·04	0·04
Length of surgery in hours (mean, SD)	8:31 (5:11)	4:03 (2:45)	−2·69		0·02
Length of admission	2·4 (1·9)	2·3 (1·9)	−0·41		0·68
Score risk scale (mean, SD)	13·1 (4·2)	10·1 (5·1)	−4·19		> 0·001
Clinical diagnosis				25·06	0·09
Infectious disease or parasitic disorder		10 (0·9)			
Malignant condition	15 (41·7)	287 (25)			
Benign tumour	1 (2·8)	42 (3·7)			
Disease of blood or blood-forming organs	1 (2·8)	5 (0·4)			
Endocrine disease or metabolic and nutritional disorder		18 (1·6)			
Psychiatric or behavioural disorder		32 (2·8)			
Disease of nervous system	1 (2·8)	107 (9·3)			
Disease of eye		1 (0·1)			
Disease of ear and mastoid process		2 (0·2)			
Disease of circulatory system	7 (19·4)	151 (13·2)			
Respiratory disease	3 (8·3)	74 (6·5)			
Disease of digestive system	3 (8·3)	148 (12·9)			
Disease of skin		5 (0·4)			
Musculoskeletal disease	3 (8·3)	158 (13·8)			
Urogenital disease	1 (2·8)	66 (5·8)			
Congenital disorder or chromosomal abnormality	1 (2·8)	2 (0·2)			
General symptoms and laboratory results not classified elsewhere		16 (1·4)			
Injury, poisoning, or complication not classified elsewhere		23 (2·0)			

Values are presented as number and percentages unless stated otherwise.

Table 3 Severity of pressure ulcers developed in false-negatives and true-positives

Worst grade	Patient not at risk	Patient at risk
Grade 2	29 (80·6)	86 (87·8)
Grade 3	4 (11·1)	8 (8·2)
Necrosis	3 (8·3)	4 (4·1)

Values are presented as number and percentages.

that developed pressure ulcers. The groups were similar on all other risk factors.

A final point we considered was the severity of the pressure ulcers. Seven patients (19·4%) developed pressure ulcers grade 3 or worse. Most (80·6%) developed grade 2 (Table 3). However, the cases that were missed were not significantly worse than those that were correctly identified.

Discussion

Pressure ulcers remained difficult to predict. Although it was possible to predict them in the majority of hospitalized patients, patients who developed pressure ulcers that were misclassified by the risk score did not display specific characteristics that clearly distinguished them from patients that did not develop pressure ulcers. We, therefore, believe that it would be very difficult to improve further the discriminating ability of our prediction rule using available clinical information.

In order to assess our results, some aspects need to be discussed. First, we did not select patients for the study at random, which may have introduced selection bias. Two research nurses visited each ward twice a week and asked all eligible patients admitted within the past 48 hours to participate. Only patients admitted for more than 5 days were eligible for the study. Most of these patients were admitted according a schedule between Sundays and Thursdays and were included in the study. There was no apparent systematic variation in the pattern of unscheduled admissions over the week. Therefore, we feel that an unselected representative sample of patients was included in the study. Second, we considered the assessments in each patient week as separate and independent information. In the construction of the prediction rule, week of admission had no association with the occurrence of pressure ulcers in both the univariate and multivariate analyses. In the current comparison between patients incorrectly identified as 'not at risk' and those correctly identified as 'not at risk', again no difference was found in the week of admission. Therefore, we suggest that the possible (statistical) dependence between patient weeks, i.e. the possibility that the outcome of one patient week tells us something about subsequent patient weeks, had no major impact on the results of the current study. Third, the number of patient weeks that were missed was small ($n = 36$). It is possible, however, that with larger numbers differences might have become more obvious. Nevertheless, we consider that the construction of the new prediction rule, which was based on 121 patient weeks with pressure ulcer, gave sufficient power for the analyses. Therefore, it is unlikely that other risk factors would have been included in the new prediction rule had we studied more patients.

In principle, the prediction of pressure ulcers could be improved in two ways. We could look for risk factors that occur too infrequently to be relevant for a general clinical risk score but, when present, identify patients at risk. Alternatively, the cut-off score could be altered, resulting in more patients classified as at risk. The latter strategy, however, would not improve on the overall discriminative capacity of the prediction rule, i.e. the area under the ROC curve. The choice of cut-off point is based on other considerations, such as the number of false positive predictions and cost effectiveness.

In searching for additional prognostic determinants that discriminated between patients 'at risk' and 'not at risk', we came across differences in 'friction and shear' and 'imminent surgery'. The false-negative group was exposed to friction and shear more often and underwent surgery more often. However, these factors were already included in the prediction rule and added no new insight. The alternative to improve the proportion of true-positives would be to lower the cut-off value of the score. As already mentioned, this would result in more false positives and thus more patients receiving expensive preventive measures. The (cost) implications of such a policy appear unacceptable at first, and would require full economic evaluation to establish the balance between costs and effects.

A point of interest was that the length of surgery was twice as high in the group that developed pressure ulcers. This suggests that not just the fact that a patient undergoes surgery, but also the length of surgery should be considered. This is in accordance with previous studies that found the length of surgery to be a major risk factor in surgical patients (Hicks 1971, Hoyman & Gruber 1992, Hoshowsky & Schramm 1994, Schoonhoven *et al.* 2002b). This determinant was, however, not included in our new prediction rule. The main reason for not including it was that it is based on the actual length of surgery and not the expected length of surgery, while the latter is the measure of interest. As it may be difficult to estimate the length of surgery beforehand, we felt that this was a more complex

What is already known about this topic

- The incidence of pressure ulcers in hospitalized patients varies from 0·4% to 38%.
- Guidelines on pressure ulcer prevention advise that staff and resource intensive preventive measures should be allocated based on the outcome of risk assessment scales.
- A new clinical prediction rule, with five easily obtainable patient characteristics, correctly classifies 70% of hospitalized patients as being at risk or not.

What this paper adds

- No specific patient characteristics clearly distinguish between patients who are not at risk and those who are misclassified as not at risk (false negatives) for pressure ulcer development.
- It is difficult to improve further on pressure ulcer prediction in the average hospital population.
- At present, risk of pressure ulcer development may be best assessed by means of a risk assessment scale in combination with assessment of skin condition and the clinical judgement of nursing staff.

determinant than surgery in the coming week. Moreover, in the univariate analysis preceding the new prediction rule, length of surgery and surgery in coming week were equally good predictors. It may, however, be necessary to take length of surgery into account when preventing pressure ulcers in surgical patients, for example, by using a pressure-reducing mattress on the operating table during longer surgery, or lifting the heels off the surface during surgery.

Finally, we found that patients who developed pressure ulcers were diagnosed with malignancy more often than those who did not develop pressure ulcers. A possible explanation may be that such patients are in a worse nutritional condition than those admitted for other reasons. This suggestion is corroborated by studies confirming the association between nutritional condition and pressure ulcer development (Pinchcofsky-Devin & Kaminski 1986, Berlowitz & Wilking 1989, Allman *et al.* 1995, Anthony *et al.* 2000). In fact, body weight may be considered a proxy for nutritional condition and is included in the prediction rule.

Two additional risk factors frequently mentioned in the literature are mobility and activity [Panel for the Prediction and Prevention of Pressure Ulcers in Adults 1992, EPUAP 1999a, Dutch Institute for Health Care Improvement (CBO) 2002]. In our study, however, no difference was observed between the group that developed pressure ulcers and the group that did not.

The value of a prediction rule identifying only 70% of the patients with pressure ulcers might be questioned. An alternative strategy of starting treatment or prevention once grade 1 ulcers occur might be more efficient. However, this latter strategy would not be expected to reduce the incidence of pressure ulcers unless nurses consciously observed the skin of the patient at least once a day. Further research on the feasibility and (cost-) effectiveness of this approach is required.

Limitations

A limitation of this study was that we compared a moderately high number of covariates. The study was based on a secondary analysis of the data used to develop the new prediction rule. The power of the study was not calculated for these extra comparisons. Therefore, the results, in particular the clinical diagnosis, should be interpreted with some caution.

Conclusions

A prediction rule identifying only 70% of patients with pressure ulcers may not seem ideal. Yet, it offers a major improvement compared with currently available risk assessment scales for hospitalized patients. However, the new prediction rule should only be implemented after proper validation. Also the cost-effectiveness of using the new prediction rule to implement preventive measures needs to be evaluated in practice, in particular in view of the alternative policy of waiting for non-blanchable erythema (grade 1 pressure ulcer). For now, we believe that the risk of pressure ulcer development may be best assessed by means of a risk assessment scale in combination with assessment of skin and the clinical judgement of nursing staff.

Author contributions

All listed authors have contributed directly to this study and this paper. LS managed the project, collected part of the data, analysed and interpreted the data and wrote the article. DEG contributed to the interpretation of the data, supervised the study and revised the article. MTB contributed to the design of the study and supervised the data collection. EB contributed to the design of the study, supervised the study, helped in analysing and interpreting the data and revised the article. All authors reviewed the paper and contributed to the final version.

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References

Allman R.M., Goode P.S., Patrick M.M., Burst N. & Bartolucci A.A. (1995) Pressure ulcer risk factors among hospitalized patients with activity limitation. *Journal of the American Medical Association* **273**, 865–870.

Anthony D., Reynolds T. & Russell L. (2000) An investigation into the use of serum albumin in pressure sore prediction. *Journal of Advanced Nursing* **32**, 359–365.

Berlowitz D.R. & Wilking S.V. (1989) Risk factors for pressure sores. *Journal of the American Geriatrics Society* **37**, 1043–1050.

Bours G.J.J.W., Halfens R.J.G., Huijer Abu-Saad H. & Grol R.T.P.M. (2002) Prevalence, prevention and treatment of pressure ulcers: descriptive study in 89 institutions in the Netherlands. *Research in Nursing & Health* **25**, 99–110.

Clark M. & Farrar S. (1991) Comparison of pressure sore risk calculators. In *Proceedings of the First European Conference on Advances in Wound Management* (Harding K.G. & Leaper D.L., eds), MacMillan Magazines, Cardiff, London, pp. 158–162.

Dutch Institute for Health Care Improvement (CBO) (2002) *Tweede herziening decubitus [Second Revision Pressure Ulcers]*. CBO, Utrecht, The Netherlands.

Edwards M. (1994) The rationale for the use of risk calculators in pressure sore prevention, and the evidence of the reliability and validity of published scales. *Journal of Advanced Nursing* **20**, 288–296.

Edwards M. (1996) Pressure sore risk calculators: some methodological issues. *Journal of Clinical Nursing* **5**, 307–312.

European Pressure Ulcer Advisory Panel (EPUAP) (1999a) *Guideline on Prevention of Pressure Ulcers*. EPUAP, Oxford. Available at http://www.epuap.org, last accessed 6 August 2002.

European Pressure Ulcer Advisory Panel (EPUAP) (1999b) *Guideline on Treatment of Pressure Ulcers*. EPUAP, Oxford. Available at http://www.epuap.org, last accessed 6 August 2002.

Haalboom J.R., den Boer J. & Buskens E. (1999) Risk assessment tools in the prevention of pressure ulcers. *Ostomy and Wound Management* **45**, 20–24.

Hamilton F. (1992) An analysis of the literature pertaining to pressure sore risk-assessment scales. *Journal of Clinical Nursing* **1**, 185–193.

Hicks D.J. (1971) An incidence study of pressure sores following surgery. In *American Nurses Association Clinical Sessions*, Appleton-Century-Crofts, New York, pp. 49–54.

Hoshowsky V.M. & Schramm C.A. (1994) Intraoperative pressure sore prevention: an analysis of bedding materials'. *Research in Nursing & Health* **17**, 333–339.

Hoyman K. & Gruber N. (1992) A case study of interdepartmental cooperation: operating room–acquired pressure ulcers. *Journal of Nursing Care Quality* **Suppl**. 12–17.

National Pressure Ulcer Advisory Panel (NPUAP) (2001) *Pressure Ulcers in America: Prevalence, Incidence, and Implications for the Future*. NPUAP, Reston, VA.

Nixon J. & McGough A. (2001) Principles of patient assessment: Screening for pressure ulcers and potential risk. In *The Prevention and Treatment of Pressure Ulcers*, 1st edn (Morison M., ed.), Mosby, St Louis, MO, pp. 55–74.

Panel for the Prediction and Prevention of Pressure Ulcers in Adults (1992) *Pressure Ulcers in Adults: Prediction and Prevention*. Clinical practice guideline number 3. Agency for Health Care Policy and Research, Public Health Service, US Department of Health and Human Services, Rockville. AHCPR Publication no. 92–0047.

Pinchcofsky-Devin G.D. & Kaminski M.V.J. (1986) Correlation of pressure sores and nutritional status. *Journal of the American Geriatrics Society* **34**, 435–440.

Schoonhoven L., Haalboom J.R.E., Bousema M.T., Algra A., Grobbee D.E., Grypdonck M.H. & Buskens E. (2002a) Prospective cohort study of routine use of risk assessment scales for prediction of pressure ulcers. *British Medical Journal* **325**, 797–800.

Schoonhoven L., Defloor T., van der Tweel I., Buskens E. & Grypdonck M.H. (2002b) Risk Indicators for Pressure Ulcers During Surgery. *Applied Nursing Research* **16**, 163–173.