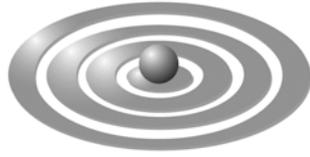


THE JOANNA BRIGGS INSTITUTE

**Pressure ulcers – prevention of  
pressure related tissue damage**

**Technical report**

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# THE JOANNA BRIGGS INSTITUTE

## JBI Best Practice Technical Reports

### Joanna Briggs Institute Evidence Based Publications

The Joanna Briggs Institute is involved in the development and dissemination of a number of publications that inform health professionals about clinical practice and specifically what constitutes best practice in health care. These serials include the *International Journal of Evidence Based Healthcare* (formerly JBI Reports) published by Blackwell Publishing and available online at <http://www.blackwell-synergy.com>. Systematic reviews conducted by Collaborating Centres of the Joanna Briggs Institute are published in the *International Journal of Evidence Based Healthcare*. These systematic review reports are further abstracted and published by Blackwell Publishing as the series *Best Practice Information Sheets for Health Professionals*. All *Best Practice Information Sheets* are derived from systematic reviews of health care research literature either conducted by the Joanna Briggs Institute Collaborating Centres or in some cases by an external source.

#### *Aims and scope of the Technical Report*

The conduct of systematic reviews and the development of *Best Practice Information Sheets* involve rigorous, standardised methods to ensure that all information provided to health professionals is of the highest standard and constitutes best practice. The conduct of a systematic review and development of the corresponding *Best Practice* issue are two parts of a staged process. All aspects of the conduct of the systematic review and the development of the accompanying *Best Practice* issue are documented so that these methods may be scrutinised. The processes involved in conducting Joanna Briggs Institute systematic reviews, including review methods are documented within the systematic review report. The format of *Best Practice* precludes it from including detailed information regarding the abstraction of evidence and development of recommendations embodied in the publication. For this reason *JBI Best Practice Technical Reports* are provided as a complementary publication to document all aspects of the development of *Best Practice Information Sheets*. In determining the quality of the Joanna Briggs Institute *Best Practice Information Sheets* the information provided in the Technical Report and the Systematic Review Report should also be considered.

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# Pressure ulcers- prevention of pressure related tissue damage: *Technical report*

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## Introduction

The aim of Joanna Briggs Institute evidence publications is to provide the best available evidence relating to clinical questions that are important to health professionals and consumers. Although the publications relate to the same clinical question/s and are therefore complementary they serve different purposes and so are of a different scope and format. The *Best Practice* Information Sheets are targeted to base level health professionals and are restricted to a six-page format, recognising the time constraints on today's clinicians. This prevents details of the development process being presented in the *Best Practice* Information Sheets. The *Best Practice* Information Sheet Technical Report provides this detail to allow scrutiny of the development process. The development of these publications is essentially a stepped process involving first the identification and synthesis of the evidence (Systematic Review) and then the abstraction of the evidence and development of recommendations for practice (*Best Practice* Information Sheets). In examining the methods and processes that ultimately produce practice recommendations the reader should consider the information available in the both the Systematic Review Report and the *Best Practice* Information Sheet Technical Report for a given information sheet.

This technical report details the development process for the following *Best Practice* Information sheet:

Joanna Briggs Institute (2008). Pressure ulcers – prevention of pressure related tissue damage. *Best Practice Evidence Based Information Sheets for Health Professionals*, 12(2): 1-4.

## **Best Practice Information Sheets development methods**

All Joanna Briggs *Best Practice* Information Sheets are developed by staff of the Joanna Briggs Institute in collaboration with staff from one of the Joanna Briggs Collaborating Centres with the assistance of an advisory panel of clinicians and other experts.

## **Acknowledgements**

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## Identification and synthesis of the evidence

All *Best Practice* Information Sheets are derived from systematic reviews of the best available evidence. This information sheet is based on four systematic reviews, which are as follows:

Cullum N, McInnes E, Bell-Syer SEM, Legood R. Support surfaces for pressure ulcer prevention. *Cochrane Database of Systematic Reviews* 2004, Issue 3. Art. No.: CD001735. DOI: 10.1002/14651858.CD001735.pub2.

Langer G, Schloemer G, Knerr A, Kuss O, Behrens J. Nutritional interventions for preventing and treating pressure ulcers. *Cochrane Database of Systematic Reviews* 2003, Issue 4. Art. No.: CD003216. DOI: 10.1002/14651858.CD003216.

Pancorbo-Hidalgo Pedro L, Garcia-Fernandez Francisco Pedro, Lopez-Medina Isabel M, Alvarez-Nieto Carmen. Risk assessment scales for pressure ulcer prevention: a systematic review. *Journal of Advanced Nursing* 2006; 54(1): 94-110.

Reddy M, Gill Sundeep S, Rochon Paula A. Preventing Pressure Ulcers: A Systematic Review. *Journal of the American Medical Association* 2006; 296(8): 974-84.

## Executive summary

### Background

Pressure ulcers or pressure sores, bedsores, decubiti or decubitis ulcers, are areas of localised damage or trauma to the skin and underlying tissue, caused by pressure, friction or shear. They generally occur over bony prominences, for example the base of the spine, heels and hips and are most common in people with impaired mobility, spinal cord injuries, severe acute illness (patients in ICU) and the elderly. The most effective method of confronting the issue is prevention and the quality of nursing care is considered the key factor in managing pressure ulcers. The actual extent to they are preventable, however, is unclear. Prevention measures are commonly divided into several areas: identification of those individuals deemed to be most at risk of developing pressure ulcers, repositioning and use of pressure-reducing support surfaces, and nutrition.

### Objectives

The objectives of the four systematic reviews included in this information sheet were as follows:

- Effectiveness of risk assessment scales
- Repositioning
- Support surfaces (including pressure-relieving cushions, beds, mattress overlays, and mattress replacements)
- Nutritional supplements (including enteral and parenteral nutrition)

### Search strategy

Cullum et al. (2004) searched the Specialised Trials Register of the Cochrane Wounds Group, which is a compilation of databases such as MEDLINE, CINAHL, EMBASE, and

handsearching results of specialist journals and conference proceedings) up to January 2004. Issue 4, 2003 of the Cochrane Central Register of Controlled Trials was also searched.

Langer et al. (2003) also searched the Specialised Trials Register of the Cochrane Wounds Group and Cochrane Central Register of Controlled Trials in September 2002. Furthermore, their search included PubMed and CINAHL, handsearching conference proceedings and journals, relevant articles' bibliographies, contacting manufacturers and experts in the field.

Pancorbo-Hidalgo et al. (2006) conducted a search of 14 databases for the period 1966-2003: DARE; CINAHL; MEDLINE; Current Contents; Indice médico espaéol (IME, Spanish Medical Index); Cochrane Library; EBSCO; ScienceDirect; Springer; InterSciencia; ProQuest; Pascal; Cuiden; and LILACS (Latin-American and Caribbean Information Centre for Health Sciences).

Reddy et al. (2006) searched MEDLINE and CINAHL from inception to June 2006 and Cochrane databases (through Issue 1, 2006), Proquest Digital Dissertations, ISI Web of Science, and Cambridge Scientific Abstracts. Bibliographies of articles were also reviewed.

### **Selection criteria**

The following selection criteria were applicable to Cullum et al (2004):

- RCTs, published and unpublished, assessing the effectiveness of beds, mattresses, mattress overlays, and seating cushions to prevent pressure ulcers for any patient group in any setting
- RCTs included if they reported an objective, clinical outcome measure
- Studies with proxy measure outcomes were excluded.

The following selection criteria were applicable to Langer et al (2003):

- RCTs evaluating the effectiveness of enteral and parenteral nutrition in the prevention and treatment of pressure ulcers via measurement of new ulcers, ulcer healing or changes in pressure ulcer severity
- No restrictions on patients, setting, date, publication status or language.

The following selection criteria were applicable to Pancorbo-Hidalgo et al (2006):

- Controlled clinical trials and prospective cohort studies
- Percentage of patients followed up was over 75%
- Studies offering data on the predictive validity of the scales or the raw data necessary to do the calculations
- Studies published in Spanish, English, French and Portuguese.

The following selection criteria were applicable to Reddy et al (2006):

- RCTs that reported objective, clinically relevant outcomes, for example incidence of pressure ulcers
- No restrictions on language, publication date, or setting.

### **Data collection and analysis**

In Cullum et al. (2004) trial data were extracted by one researcher and checked by a second. Each study's results were presented as a relative risk for dichotomous variables. Similar studies were pooled into a meta-analysis where it was deemed appropriate.

In Langer et al. (2003) abstracts were independently inspected and full articles obtained of potentially relevant studies. In case of disagreement advice was sought from a third person. The three reviewers extracted data and assessed the quality of the studies independently.

In Pancorbo-Hidalgo et al. (2006) the data from each selected study were transferred to a data extraction sheet. Two researchers independently extracted the data from each study and to minimize bias, a list was made of operational definitions of the variables considered. Whenever possible, the authors re-calculated the validity indicator scores (sensitivity, specificity, positive prediction value, negative prediction value, effectiveness and area under the ROC curve) in order to check them against the raw data offered by each author.

In Reddy et al. (2006) 59 RCTs were selected. Interventions assessed in these studies were grouped into 3 categories, i.e, those addressing impairments in mobility, nutrition, or skin health. Methodological quality for the RCTs varied and was generally suboptimal. Effective strategies that looked at impaired mobility included the use of support surfaces, mattress overlays on operating tables, and specialized foam and specialized sheepskin overlays. While repositioning is a mainstay in most pressure ulcer prevention protocols, there is insufficient evidence to recommend specific turning regimens for patients with impaired mobility. In patients with nutritional impairments, dietary supplements may be beneficial. Incremental benefit of specific topical agents over simple moisturizers for patients with impaired skin health is unclear.

## **Main results**

Cullum et al. (2004) found that from an evaluation of 41 RCTs, foam alternatives to the standard hospital foam mattress can reduce the incidence of pressure ulcers in people at risk. The relative merits of alternating and constant low pressure devices, and of the different alternating pressure devices for pressure ulcer prevention are unclear. Pressure-relieving overlays on the operating table can reduce post-operative pressure ulcer incidence, although one study indicated that an overlay resulted in adverse skin changes. One trial indicated that Australian standard medical sheepskins prevented pressure ulcers. Evidence is insufficient to make conclusions on the value of seat cushions, limb protectors and various constant low pressure devices as pressure ulcer prevention strategies. A study of Accident & Emergency trolley overlays did not identify a reduction in pressure ulcer incidence. It can be suggested that foot waffle heel elevators, a particular low air loss hydrotherapy mattress and an operating theatre overlay are harmful.

Langer et al (2003) found that most of the 8 trials included are small and of poor methodological quality. Regarding prevention, 4 studies compared a combination of nutritional supplements, consisting of a minimum of energy and protein in different dosages, for the prevention of pressure ulcers. The largest study found that nutritional supplements reduced the number of new pressure ulcers. The three smaller studies lacked power. For treatment, 4 studies evaluated the effects of nutritional supplements on existing pressure ulcers: one trial examined mixed nutritional supplements, one trial examined zinc, another the effect of proteins, and two studies compared ascorbic acid. The trials included are heterogeneous with regard to participants, interventions and outcomes. It was therefore considered inappropriate to perform a meta-analysis.

Pancorbo-Hidalgo et al (2006) discovered that no decrease in pressure ulcer incidence was found which might be attributed to using an assessment scale. However, the use of scales increases the intensity and effectiveness of prevention interventions. The Braden Scale shows optimal validation and the best sensitivity/specificity balance; its score is a good pressure ulcer risk predictor. The Norton Scale has reasonable scores for sensitivity, specificity and risk prediction. The Waterlow Scale offers a high sensitivity score but low specificity; with a good risk prediction score. Nurses' clinical judgement (in three studies) provided moderate scores for sensitivity and specificity, but is not a good pressure ulcer risk predictor.

Reddy et al (2006) identified 59 RCTs evaluating interventions to prevent pressure ulcers. Our review suggests that the methodology for pressure ulcer prevention trials is suboptimal overall, although more recent studies have shown improvements in methodological quality. In pressure ulcer prevention trials, it is sometimes not feasible to ensure that participants are blinded, and other aspects of these trials may be difficult to standardize. To address these issues, we used the CLEAR NPT quality-rating guidelines developed specifically for non-pharmacological interventions. Only 3 of the 58 RCTs in this review fulfilled all of the criteria we selected from the CLEAR NPT checklist. The trials reviewed were generally short, but follow-up ranged from 1 to 224 days. Although pressure ulcers can develop within 2-6 hours, the incidence of pressure ulcers has been found to rise with increasing duration of stay in LTC, and continues to rise for at least 2 years. While days or weeks of follow-up may be adequate for patients with reversible risk factors (eg, relatively healthy patients in

perioperative settings), patients with indefinite immobility (eg, paraplegia) may require longer follow-up.

### **Reviewers' conclusions**

Cullum et al. (2004) concluded that in people at high risk of pressure ulcer development, consideration should be given to using higher specification foam mattresses rather than standard hospital foam mattresses. The relative merits of higher-tech constant low pressure and alternating pressure for prevention are unclear. Healthcare organisations might consider using pressure relief for high risk patients in the operating theatre, as this is linked to reduced post-operative incidence of pressure ulcers. Seat cushions and overlays designed for use in Accident & Emergency settings have not been adequately evaluated.

Langer et al. (2003) concluded that firm conclusions could not be made regarding the effect of enteral and parenteral nutrition on the prevention and treatment of pressure ulcers. More trials with high methodological rigour are required.

Pancorbo-Hidalgo et al. (2006) concluded that there is not enough evidence to claim that use of a risk assessment scale (RAS) in clinical practice decreases pressure ulcer incidence. The use of a validated RAS, the Norton Scale, as a criterion for prevention intervention (pressure-reducing support surfaces) increases both its effectiveness and the application of a greater number of early prevention interventions. The Braden and Norton Scales were better risk prediction tools than nurses' clinical judgement. The weighted analysis and meta-analysis of the validation studies suggested the Braden Scale as offering the best sensitivity/specificity balance and the highest prediction capacity. There is presently no evidence that nurses' clinical judgement on its own can predict pressure ulcer development risk in patients.

Reddy et al. (2006) concluded that given current evidence, using support surfaces, repositioning the patient, optimizing nutritional status, and moisturizing sacral skin are good strategies to prevent pressure ulcers. While a number of RCTs have evaluated preventive strategies for pressure ulcers, many had important methodological limitations. There is a need for well-designed RCTs that follow standard criteria for reporting non-pharmacological interventions and that provide data on cost-effectiveness for these interventions.

**Key Words:** pressure ulcers, pressure sores, decubitis, tissue load, skin assessment, risk assessment scale, nutrition, tissue damage, skin changes

## **Abstraction of the evidence and development of practice recommendations**

All Joanna Briggs Institute *Best Practice* Information Sheets are a standardised format that includes a background to the clinical question, a summary of the evidence from the systematic review, recommendations and/or implications for practice (graded using the Joanna Briggs Institute Feasibility, Appropriateness, Meaningfulness and Effectiveness scale). The recommendations arising from the evidence in the systematic review and embodied in the *Best Practice* Information Sheets are developed by the *Best Practice* Information Sheets developers with the assistance of the expert advisory panel. Essentially the recommendations for *Best Practice* Information Sheets are where possible evidence based. The developers and the advisory panel consider the evidence and the context in which the evidence may be used and then develop recommendations for practice. Where no evidence is identified in the systematic review the developers and the expert panel develop consensus statements to inform practice. At this point the *Best Practice* Information Sheet is subjected to an extensive review process external to the developers and advisory panel.

### **Peer review**

All Joanna Briggs Institute evidence publications are subjected to a rigorous peer review process. This process begins with the submission of the protocol for the systematic review to the Joanna Briggs Institute Collaboration Support Unit. The protocol is peer reviewed by members of the Support Unit not involved in the review itself. When the systematic review is

at draft report stage it is peer reviewed the Joanna Briggs Institute Collaboration Support Unit staff who appraised the protocol initially. In addition the systematic review report is subjected to additional external blinded peer review before publication in the *JBI Library of Systematic Reviews*.

The Collaboration Support Unit along with members of the *Best Practice* review panel and other staff of the Joanna Briggs Institute also review the draft *Best Practice* information sheet. The *Best Practice* information sheet is then distributed to all other Joanna Briggs Collaborating Centres for comment with regard to cultural, professional and organisational issues that may impact on the implementation of the *Best Practice* information sheet recommendations/implications within their constituency.

### ***Best Practice Information Sheets ongoing review/update***

All Joanna Briggs Institute evidence publications are based on the best available evidence at the time of publication. When using the publications to inform practice the reader should consider the date of publication and the possibility that recent research may have implications about the strength or direction of recommendations. All Joanna Briggs Institute systematic reviews on which the Best Practice Information Sheets are based are assessed for update at five years post publication and at this time the relevant Best Practice Information Sheets is also reviewed.

### **Funding**

Although the majority of Joanna Briggs Institute systematic reviews and *Best Practice* Information Sheets are funded by corporate membership funds and/or by the Joanna Briggs Collaborating Centres, external funding is occasionally used. In these cases the internal and external peer review processes ensure that editorial independence from the funding body is maintained.

### **Conflict of interest**

Any conflict of interest by Joanna Briggs Collaborating Centre staff and/or advisory panel members is declared in a statement within the systematic review report.

## Appendix 1 – Grades of Recommendation and Implications for Practice

It is the policy of the Joanna Briggs Institute that all *Best Practice* Information Sheets will utilise the Joanna Briggs Institute Grades of Recommendation with the specific hierarchy corresponding to the implication for practice provided. See recommendation tables below.

Implications for Practice	Feasibility	Appropriateness	Meaningfulness	Effectiveness
A	Strong support that merits application			
B	Moderate support that warrants consideration of application			
C	Not supported	Not supported	Not supported	Not supported

The following implications for this *Best Practice* Information Sheet are based on the JBI developed **Grades of Effectiveness** (column far right above):

- Positioning and repositioning should aim to avoid direct pressure on bony prominences or surfaces of the body (**Grade B**)
- Risk assessment with a validated tool should be performed on admission to hospital and at least daily and include an assessment of nutrition (**Grade B**)
- The administration of 2 oral nutritional supplements daily may benefit elderly people recovering from acute illness in reducing the incidence of pressure ulcers (**Grade B**)
- The Braden Scale indicates optimal validation in pressure ulcer risk prediction (**Grade B**)
- Foam mattresses may reduce the incidence of pressure ulcers in people at risk compared to standard hospital mattresses (**Grade B**)

## Appendix 2 – Tables of included studies

### Langer et al (2003) and Cullum et al (2006)

Study	Type of Study	Patients	Intervention	Outcomes
Andersen 1982	RCT with 10 day follow-up	Acute setting at high risk of pressure ulcer development and no existing ulcers	1. Standard hospital mattress 2. Alternating air mattress 3. Water filled mattress	Incidence of pressure ulcers; Grade 2 or greater ulcers; alternating mattress; water mattress; standard mattress
Aronovitch 1999	Prevention trial; 7 days follow-up	18 years old, undergoing elective surgery of at least 3 hours; no significant baseline differences	1. AP system intra and postop 2. Conventional management comprised use of a gel pad in the operating room and replacement mattress post-op	Micropulse system 1%; Conventional management (7 patients developed 11 ulcers)
Bourdel 2000	Multicentre, RCT	672 patients > 65 in acute phase of illness	1. Nutrition 2. Control group	Pressure ulcers recorded each using 4 grades
Collier 1996	Prevention trial; RCT comparing 8 different foam mattresses	Patients on general medical ward	Comparison of 8 different kinds of foam mattresses	Incidence of pressure ulcers and assessed weekly throughout hospital stay; no patient developed any grade of pressure ulcer
Conine 1993	Prevention trial with 3 mth. follow-up	Extended care patients > 60 years	1. Alternating pressure overlay 2. Silicore overlay	1. Jay Cushion (25%) 2. Foam Cushion (41%)
Conine 1994	Prevention trial; RCT with 3 mth. follow-up	Elderly patients average age 82 in extended care hospital	1. Jay cushion 2. Foam cushion	Unable to present incidence data re number of patients affected by Grade 2 or above pressure ulcers
Cooper 1998	Prevention trial; RCT with 7 day follow-up	100 patients over 65 years with no pressure ulcers	1. Dry flotation mattress (Roho) 2. Dry flotation mattress (Sofflex)	Grade 2 ulcer and above; Grade 1 ulcer
Daechsel 1985	Prevention trial; RCT with 3 mth. follow-up	32 patients with chronic neurological conditions in long-term care hospital	1. Alternating pressure mattress 2. Spenco overlay	Grade 1 ulcers; alternating overlay (25%); Spenco overlay (25%)
Delmi 1990	RCT	59 elderly patients > 60 in orthopaedic unit	1. Standard hospital diet with oral nutrition supps. 2. Standard hospital diet	Frequency of complications (eg. death, pressure ulcer, severe anaemia)
Ewing 1964	Prevention and treatment trial; RCT with 6 mth. follow-up	Elderly patients, average age 72.5 years	1. Adjusting sheepskins to support legs on woolly fleece 2. Control without sheepskins	Study too small to detect any difference
Goldstone 1982	Prevention trial	Participants >60 with femur fracture	1. Beaufort bead bed system 2. Standard supports in A&E	Grading of ulcers not given; Beaufort bed (16%); standard surface (49%)

Gray & Campbell 1994	Prevention trial; RCT with 10 day follow-up	Patients from orthopaedic trauma, vascular and medical oncology units	1. Softfoam mattress 2. Standard 130 mm NHS foam mattress	Grade 2 or greater: Softfoam (7%); Standard (34%)
	RCT	140 patients with hip fracture	1. Standard hospital diet with tube-fed protein. 2. Standard hospital diet	Development and severity of pressure sores
Hofman et al 1994	Prevention trial; RCT with 2 week follow-up	Patients with femoral-neck fracture	1. Cubed foam mattress 2. Standard hospital mattress	Incidence of pressure ulcers of Grade 2 or more at 2 weeks
Houwing 2003	Double-blind, randomised, placebo-controlled trial	103 hip fracture patients	1. Nutrition suppl. 2. Placebo	Presence and stage of pressure ulcers assessed daily for 28 days
Laurent 1997	Prevention trial; RCT with factorial design	Adults > 15 for major cardiovascular surgery	2 X 2 Factorial design	Incidence of ulcers of Grade 2 or above
Lazzara 1991	Prevention and Treatment trial; RCT	Nursing home residents at risk of pressure ulcers	1. Air-filled overlay 2. Gel mattress	Grade 2 or greater ulcers: air overlay (16%); gel mattress (15%)
Lim 1988	Prevention trial; RCT with 5 month follow-up	62 residents of an extended care facility, 60 or older	1. Foam slab cushion 2. Contoured foam	Included Grade 1 ulcers: slab foam (73%); contoured foam (69%)
McGowan et al 2000	Prevention trial	Orthopaedic inpatients 60 or older	1. Standard hospital mattress with Aust. sheepskin overlay 2. Standard hospital mattress with low tech constant pressure devices	Sheepskin group: ulcers developed, no more severe than stage 1; Control group: more ulcers developed
Nixon et al 1998	Prevention trial; RCT with 8 day follow-up	Patients 55 years and older for elective major surgery	1. Dry visco-elastic polymer pad on operating table 2. Standard operating theatre table mattress	Visco-elastic polymer (11%); Standard mattress
Russell 2000	Prevention trial; RCT with 7 day follow-up	Patients at least 18 years got cardiothoracic surgery	1. MicroPulse system 2. Conventional care	Micropulse System (2%); Conventional management (7%)
Russell 2002	Median days presented by group in hospital; central allocation of trials office	Elderly acute, orthopaedic and rehab wards, > 65 years	1. Visco-polymer energy absorbing foam mattress 2. Standard mattress/cushion combination	Development of non-blanching erythema or worse
Santy 1994	Prevention trial; RCT with 14 day follow-up	Patients aged >55 with hip fracture	1. Clinifloat 2. NHS contract 3. Vaperm 4. Therarest 5. Transfoam	1. Clinifloat (9%) 2. NHS contract (27%) 3. Vaperm (8%) 4. Therarest (11%) 5. Transfoam (10%)
Schultz 1999	Follow-up 6 days	Patients for surgery lasting at least 2 hours	1. Experimental mattress overlay 2. Usual care	Ulcers of Stage 2 ulcers (6) reported in experimental group; 3 Stage 2 ulcers reported in control group

Sideranko 1992	Prevention trial; RCT with 9.4 days mean follow-up	Adult, surgical ICU patients	1. Alternating air overlay 2. Static air mattress 3. Water mattress	1. Alternating air overlay (25%) 2. Static air mattress (5%) 3. Water mattress (12%)
Stapleton 1986	Prevention trial	Female elderly patients with fractured neck of femur	1. Large Cell Ripple 2. Polyether foam pad 3. Spenco pad	Ulcers of Grade 2 and Grade 3 greater
Takala 1996	Prevention trial; RCT with 14 day follow-up	Non-trauma patients in ICU to stay > 5 days	1. Carital Optima 2. Standard hospital foam mattress	1. No ulcers; in 2. 13 ulcers developed (9 Grade 1A; 4 Grade 1B)
Tymec 1997	Prevention trial	52 patients in a large hospital	1. Foot Waffle 2. Hospital pillow under both legs	No. of pressure ulcers 1. Foot Waffle, 6 2. Hospital pillow, 2

### Pancorbo-Hidalgo et al review

Study	RAS	Setting	Sampling	Sample size	Average Years	Pressure Ulcer Prevention
Andersen et al 1982	Andersen $\geq 2$	Hospital (acute observation)	Systematic	3398	ND	ND
Bergstrom et al 1987a	Braden $\leq 16$	Hospital (medical surgical units)	Systematic	100	50.5	Yes
Bergstrom et al 1987a	Braden $\leq 16$	Hospital (medical surgical units)	Systematic	100	57.2	Yes
Bergstrom et al 1987b	Braden $\leq 16$	Hospital (ICU)	Systematic	60	58.5	Yes
Stotts 1988	Norton $\leq 14$	Hospital (cardiovascular surgery and neurosurgery)	Systematic	387	53.1	ND
Towey and Erland 1988	Knoll 12	Long-term care facility	Convenience	60	81.3	ND
Smith 1989	Norton $\leq 16$ ; Waterlow $\geq 2$ ; Clinical judgement	Hospital (orthopaedic surgery)	Random	100	ND	ND
Lowthian 1989	PSPS $> 6$	Hospital (orthopaedics)	Systematic	1244	ND	ND
Langemo et al 1991	Braden $\leq 16$	Hospital (medical-surgical and orthopaedics unit)	Convenience	74	66	Yes
Langemo et al 1991	Braden $\leq 18$	Home care, Hospice	Convenience	25	66	Yes
Salvadarena et al 1992	Braden $\leq 16$ ; Clinical judgement	Hospital (acute care medical unit)	Convenience	100	72	Yes
Barnes and Payton 1993	Braden $\leq 16$	Hospital (medical and cardiovascular)	Systematic	361	68.4	Yes
Braden and Bergstrom 1994	Braden $\leq 18$	Hospital (extended care)	Random	123	75.9	ND
Ramundo (1995)	Braden $\leq 18$	Home care	Convenience	48	ND	ND
Edwards 1995	Waterlow ND	Community	Random	31	83.1	ND
Capobianco &	Braden $\leq 18$	Hospital (medical surgical units)	Convenience	50	66.9	ND

McDonald (1996)						
VandeBosch et al 1996	Braden $\leq$ 17; Clinical judgement	Hospital	Random	103	62.4	ND
Wai-Han et al 1997	Waterlow $\geq$ 10	Geriatric centre	Systematic	185	80.4	Yes
Goodridge et al 1998	Braden $\geq$ 19	Hospital, long-term care facilities	Systematic	330	78.6	Yes
Bergstrom et al 1998	Braden $\leq$ 18	Hospital, Veterans Admin. Medical Centres, skilled nursing facilities	Random	843	63	ND
	Braden $\leq$ 18; Waterlow $\geq$ 16; Norton $\leq$ 16	Rehabilitation Hospital (medical and orthopaedic units)	Convenience	138	ND	ND
	Waterlow $\geq$ 15	Hospital (ICU)	Systematic	594	58.8	Yes
Hasigawa & Barbenel 1999	Braden $\leq$ 16	Hospital (internal medicine)	Systematic	275	ND	Yes
Gunningberg et al 1999	Modified Norton (NMS) $\leq$ 16	Hospital (orthopaedics)	Systematic	81	82	Yes
Lyder et al 1999	Braden $\leq$ 16	Hospital (medical surgical units)	Systematic	84	72	ND
Halfens et al 2000	Braden $\leq$ 20	Hospital (medical surgical units)	Systematic	320	60.9	Yes
Lewicki et al 2000	Braden $\leq$ 14	Hospital (cardiac surgery)	Systematic	337	62	Yes
Bergquist & Franz 2001	Braden $\leq$ 19	Home care	Systematic	1711	78.8	ND
Boyle & Green 2001	Waterlow $\geq$ 15; Cubbin-Jackson $\leq$ 19	Hospital (ICU)	Systematic	314	57.5	Yes
Feuntelsaz Gallego 2001	Emina $\geq$ 4	Hospital	Random	673	ND	ND
Schoonhoven et al 2002	Braden $\leq$ 16; Norton $\leq$ 16; Waterlow $\geq$ 10	Hospital (medical, surgical and geriatric units)	Convenience	1431	60.1	Yes
Lindgren et al 2002	RAPS $\leq$ 36	Hospital (medical, surgical, orthopaedic and geriatric units)	Convenience	530	69.2	ND
Perneger et al 2002	Braden, Norton; Fragment $>$ 3	Hospital (medical, surgical units, ICU)	Systematic	1190	61.4	Yes
Seongsook et al 2004	Braden $\leq$ 16; Cubbin-Jackson $\leq$ 24; Douglas $\leq$ 18	Hospital (ICU)	Convenience	125	62	Yes

## Reddy et al review

Study	Setting	Patients Enrolled (Completed), No.	Intervention	Incidence reduced?
Bourdel-Marchasson et al 2000	Acute care	672 (351)	Standard hospital diet with daily oral nutritional supplement vs. standard hospital diet	Yes
Defloor et al 2005	Long-term care	838 (761)	Repositioning 1. Turning q2h on standard hospital mattress 2. Turning q3h on standard hospital mattress 3. Turning q4h on specialized foam mattress 4. Turning q6h on specialized foam mattress 5. Standard care (based on clinical judgment)	Yes; turning q4h on specialized foam mattress
Delmi et al 1990	Acute care (elderly orthopaedic)	59 (52)	Standard hospital diet and daily oral nutritional supplement vs standard hospital diet	No
Ek et al 1991	Long-term care	501 (403)	Standard hospital diet and daily oral nutritional supplement vs standard hospital diet	No
Hartgrink et al 1998	Acute care (orthopaedic with nasogastric tube feeding)	140 (101)	Standard hospital diet and overnight nasogastric feeding pump vs standard hospital diet	No
Houwing et al 2003	Acute care (orthopaedic)	103 (103)	Nutritional supplement vs non-caloric placebo	No
Young 2004	Acute care	46 (43)	Tilt vs 90 degree side-lying	No

## Appendix 3 - References

These include references from the systematic reviews and additional references used in the development of this Best Practice information sheet.

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