

The effect of pressure-relieving surfaces on the prevention of heel ulcers in a variety of settings: a meta-analysis

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ABSTRACT

This meta-analysis investigated the effectiveness of a pressure-relieving intervention on the incidence of heel pressure ulcers in a variety of settings. Literature searches of Cumulative Index to Nursing and Allied Health Literature, MEDLINE, PubMed, EMBASE and Cochrane databases were conducted for English-language articles that investigated the effect of pressure relief interventions with or without concurrent prevention programs on the number of heel ulcers occurring on adult humans in a controlled clinical design. Full articles were selected from citations based upon consensus between at least two independent reviewers. Methodological quality of each study was assessed using the Jadad and PEDro scales. A quantitative analysis was performed to determine and compare relative risk (RR) between pressure relief programs/devices that were classified according to similarity of interventions. Fourteen studies that involved a total of 1457 subjects were selected from a total of 105 full articles reviewed. Pressure-reducing/relieving surfaces were associated with a significantly lower incidence of heel ulcers compared with standard hospital mattresses (RR = 0.50, 95% CI = 0.26–0.93, $P < 0.03$). Foam mattresses also significantly reduced the risk of developing heel ulcers. There is evidence to support the use of certain air or foam mattresses/overlays in the prevention of heel pressure ulcers when compared with a standard hospital mattress. There is insufficient research available at this time to determine if heel-protective devices can prevent heel pressure ulcers. These results need to be interpreted with caution given the relatively low number and poor quality of research articles available to date.

Key words: Heels • Incidence • Mattress • Pressure ulcers • Prevention

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INTRODUCTION

Pressure sores, or decubitus ulcers, are areas of localised cellular necrosis that develop when soft tissue is compressed for prolonged periods between a bony prominence and a firm surface (1). It was recently reported that the prevalence of pressure ulcers in Canada was 25.1% in acute care, 29.9% in non acute care, 15.1% in community/home care and 22.1% in mixed health care settings (2). Approximately 1.6 million individuals develop pressure ulcers in acute care settings in the United States of America annually. Factors that increase the risk

Key Points

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Key Points

- heel ulcers are the second most common site of pressure ulcers and the incidence is increasing
- possible reasons to explain this increase include patients' use of the heel as a pivot point for bed mobility, as well as high pressures on the heel when patients are recumbent because of uneven body weight distribution across bony prominences
- although numerous prevention strategies exist, pressure ulcers continue to represent a costly problem
- in addition to the fiscal costs associated with pressure ulcers, emotional burdens include pain, social exclusion, malodor and growing limitations of activity and mobility, all of which lead to a reduction in the quality of life of those individuals
- the aim of this meta-analysis was to investigate the effectiveness of various prevention interventions in reducing the incidence of heel pressure ulcers in a variety of settings
- a systematic search of five databases was conducted for original articles that assessed the effectiveness of prevention programs, devices, mattresses and overlays on the incidence of heel pressure ulcers in adults in a variety of health care settings

of developing pressure ulcers are moisture, pressure, shear, friction, heat, malnutrition, impaired sensory perception, chronicity, impaired mobility, decreased mental status, hypoperfusion, low serum albumin, hematocrit, weight and body mass (3–8). Populations at higher risk for developing pressure ulcers include the elderly and those with a spinal cord injury or an orthopaedic condition or surgical procedure.

Pressure ulcers most often occur over bony prominences of the trunk (sacral/coccygeal area), and heel ulcers are the second most common site of pressure ulcers (9). A recent survey suggests that the incidence of heel pressure ulcers is increasing (9). Possible reasons to explain this increase include patients' use of the heel as a pivot point for bed mobility, as well as high pressures on the heel when patients are recumbent because of uneven body weight distribution across bony prominences (10,11). In addition, the small surface area of the heel predisposes it as a prime site for pressure ulcer development (11).

There are numerous strategies to address prevention of pressure ulcers in general, including nutrition and education programs, repositioning/turning schedules, cushions/pillows, speciality beds/mattresses and overlays (12–14). In addition to these global strategies, there are also site-specific prevention measures, including heel boots or heel protective devices (15).

Although numerous prevention strategies exist, pressure ulcers continue to represent a costly problem. The overall costs of hospital-acquired pressure ulcers are estimated between \$2.2 and \$3.6 billion annually to the US health care system (16) and £320 million in National Health Service of the United Kingdom (17). In addition to the fiscal costs associated with pressure ulcers, emotional burdens include pain, social exclusion, malodour and growing limitations of activity and mobility, all of which lead to a reduction in the quality of life of those individuals with pressure ulcers (18). Langemo et al. (19) found that pressure ulcers had a profound impact upon the subjects' lives, specifically physical, emotional, social and financial status. As well, there was an associated change of body image and/or loss of independence and control.

Numerous studies and review articles investigating the prevention of pressure ulcers are

available. In 2003, the Cochrane Library's systematic review of the effectiveness of beds, mattresses and cushions for pressure sore prevention and treatment reported that high-specification foam was more effective than a standard hospital mattress in the prevention of pressure ulcers in general (14). The superiority of foam versus a standard hospital mattress was again shown in a 2004 Cochrane Library systematic review of support surfaces for pressure ulcer prevention (20). These Cochrane reviews did not clarify the most effective surface in preventing pressure ulcer development, as the value of various alternating and constant low-pressure devices for pressure ulcer prevention remains unclear (14).

To date, it is not known if the use of specific heel devices, programs, pillows/cushions, beds, mattresses and overlays reduces the incidence of heel pressure ulcers. Therefore, the aim of this meta-analysis was to investigate the effectiveness of various prevention interventions in reducing the incidence of heel pressure ulcers in a variety of settings.

METHODS

Literature search

A systematic search of five databases (Cumulative Index to Nursing and Allied Health Literature, PubMed, MEDLINE, EMBASE and Cochrane) was conducted for original articles that assessed the effectiveness of prevention programs, devices, mattresses and overlays on the incidence of heel pressure ulcers in adults in a variety of health care settings. Searches were limited to controlled clinical trials published in the English language between January 1980 and May 2005 (inclusive). A list of search terms used to locate appropriate articles in existing databases is provided in Table 1. Studies located using the database search were excluded if either it was not possible to calculate the number of new heel ulcers that developed in the patient population undergoing each type of prevention program or data were mixed with subjects who had diabetic foot ulcers. We also excluded studies that examined the effectiveness of wound care treatment programs that promote closure of existing heel ulcers.

Using the aforementioned inclusion and exclusion criteria, each abstract was reviewed independently by at least two reviewers to

Table 1 Search terms

Population	Intervention	Outcome	Study design
Foot Ulcer	Primary prevention	Incidence	randomized control trial
Skin Ulcer	prevention and control	occurrence	control trial
Skin Necrosis	Secondary prevention	effectiveness	Controlled Study
skin sore	Prevent\$		Clinical Trial
decubitus sore	Prophylaxis		randomized trial
decubitus ulcer	protective device\$		
heel sore	Protective Equipment		
heel ulcer	pressure relieving device		
foot sore	foam		
bed ulcer	Bed		
bed sore	mattress\$		
pressure ulcer	heel boot		
pressure sore	boot		
skin breakdown	pressure relief		
chronic wound	pressure relie\$		
	pressure reduction		
	pressure reduc\$		
	protective footwear		
	foot protect\$		

Key Points

- the complete articles of all selected abstracts were further reviewed to verify that they met the inclusion and exclusion criteria (Table 2)
- the methodological quality of each included study was assessed by at least two researchers using both the Jadad and the PEDro scales

determine if the full article should be retrieved. If an agreement was not initially obtained, the abstract was discussed by the reviewing researchers and a decision was made through a documented consensus process. In cases where the abstract alone was insufficient to determine the eligibility of the article, it was provisionally accepted until a copy of the full article could be obtained.

The complete articles of all selected abstracts were further reviewed to verify that they met the inclusion and exclusion criteria (Table 2). From the full article, it was determined if it was possible to identify either the number of

heel pressure ulcers or the number of subjects with heel pressure ulcers per study group. A similar consensus process was conducted between two independent reviewers to determine its eligibility. Decisions on the final list of included articles were confirmed by all members of the research team.

Critical review

The methodological quality of each included study was assessed by at least two researchers using both the Jadad and PEDro scales. The Jadad scale is a three-item instrument that scores studies from 0 to 5. Jadad et al. (21) stated that studies judged as methodologically poor were given a score of 2 or less, whereas studies with excellent methodological quality were given a score greater than 2 points. The items assessed in the Jadad scale include randomisation, double blinding, and withdrawals and/or dropouts, with additional points allotted to appropriateness of randomisation and double-blinding processes (21). The PEDro scale ranks the studies on a ten-point scale regarding the integrity of randomisation process, subject and assessor blinding, validity of outcome measures, appropriateness of treatment interventions and statistical analysis and documentation of drop-outs (22). It can be assumed that there is a positive relationship between the PEDro scale score and the

Table 2 Inclusion/exclusion criteria

Inclusion criteria	Exclusion criteria
Incidence	Paediatric population (<18 years of age)
Prevention of heel ulcers	Diabetic foot ulcers
Randomized controlled trial	Presence of heel ulcers prior to commencement of observation
Interventions with or without concurrent therapies	Wound treatments of heel ulcers
Ability to determine the number of heel ulcers per group	Inability to determine the number of heel ulcers per group

Key Points

- all studies included in this meta-analysis were prospective studies in which a pressure-relieving intervention was compared with either a control group or another pressure-relieving intervention
- one hundred and sixty-seven full articles were selected for review from a total of 1119 citations obtained from the five databases (see flow diagram attached, Figure 1)
- group, patient and treatment characteristics, as well as the results of the selected studies, are listed in Table 3

methodological quality; the higher the score, the greater the quality of the study.

Data analysis

From the studies, data were extracted by at least two reviewers with respect to study population, design, type of intervention and results as displayed in Table 3. All studies included in this meta-analysis were prospective studies in which a pressure-relieving intervention was compared with either a control group or another pressure-relieving intervention. All articles comparing similar intervention types (foam mattresses, overlays, devices, air mattresses) were grouped together for quantitative analysis. Two studies investigated the preventative benefits of a combination of pressure-relieving/reducing surfaces and therefore could not be assigned to any particular group (23,24).

The relative risk (RR) and the associated 95% confidence interval (CI) were computed for each study. The RR is a ratio that describes how many times more likely persons exposed to a pressure-relieving intervention were to acquire a heel pressure ulcer versus those who were not exposed. Interventions that compared heel ulcer incidence with a control group (i.e. standard hospital mattress) were entered into Review Manager 4-025 to construct forest plots displaying overall RRs and the related 95% CI and provide a Z value for overall effect.

RESULTS

Identification of heel pressure ulcer prevention articles

Two hundred and twenty-six citations were selected for review from a total of 1118 citations obtained from the five databases (see flow diagram attached, Figure 1). Several of the full articles selected were located in more than one database (duplicates). From 105 unique full articles that were read, a total of 14 studies were included in the final analysis (1,3,11,24–34), all of which were prospective, controlled clinical trials in which a pressure ulcer prevention program was compared with either a control group or another pressure relief program or system and the number of heel ulcers in each intervention group could be determined.

Group, patient and treatment characteristics, as well as the results of the selected studies, are

listed in Table 3. The 14 included studies surveyed a total number of 1457 subjects, where 1006 subjects received a pressure ulcer prevention program, mattress or device and 451 were control subjects. Four studies compared heel ulcer incidence with air mattresses versus standard hospital mattresses (1,3,31,33). Three studies investigated the ability of foam mattresses to reduce the number of heel ulcers that occurred in acute and long-term care settings compared with standard hospital mattresses (28,29,34). Three reports investigated the number of heel ulcers that occurred in individuals using mattress overlays (25,26,32). However, only one of these studies compared heel ulcer occurrence rates with those occurring on patients placed on standard hospital pillows (32). There were two reports included in this meta-analysis that investigated the cost-effectiveness of a combination of mattresses and overlays in preventing heel ulcers (24,30).

There were only two studies that investigated the ability of heel protection devices to prevent heel ulcers (11,27). One of these reports compared three different heel devices (27), and the other compared a heel protective device with a standard hospital pillow (11). The relative risk was 0.33 (95% CI 0.01, 7.82) $P = 0.50$. There is insufficient evidence available at this time to support the claim that heel boots have the ability to reduce the risk of heel ulcers.

Methodological quality of included studies

Total PEDro scores assigned to the 14 clinical trials included in this study ranged between 4 and 8 (out of a maximum of 10), with 6 of 14 of studies assigned a total score between 5 and 6 (Table 3). Total Jadad scores assigned to the included studies ranged between 0 and 3, with the majority receiving a score of 2 out of 5, according to Jadad (21). These relatively low scores reflected difficulties associated with double-blinding interventions such as heel boots and mattresses. Furthermore, many study results were confounded by concurrent therapies that were administered in addition to the pressure-reducing interventions. Most studies randomly allocated subjects into study groups and had similar baseline measures before the commencement of study interventions. All studies specified eligibility criteria

Table 3 Study characteristics of 14 controlled clinical trials on the prevention of heel ulcers

Type of intervention	Reference (total N)	Country	E/C or E2 (N)	Mean age (E/C) (year)	Population	Type of intervention for experimental	Type of intervention for control or E2/E3	Additional intervention	Results n/N	PEDro/10	Jadad/5
Air mattress	Aronovitch et al. (1)	USA	E = 112, C = 105	63.5 ± 11.9	Cardio Sx	Air Mattress	Gel pad = OR, SHM = post-OR	None	E = 0/112, C = 3/105	3	0
	Jesurum et al. (3)	South central USA	E = 16, C = 20	64.7 ± 11.8	Cardio Sx	Air Mattress	SHM and Foam	TS	E = 4/16, C = 2/20	4	2
	Russell et al. (31)	Canada	E = 98, C = 100	69 ± 2.31	Cardio Sx	Air Mattress	Gel pad = OR, SHM = post-OR	None	E = 0/98, C = 1/100	6	3
	Takala et al. (33)	Finland	E = 11, C = 13	65.2 ± 10.9	ICU	Air Mattress	SHM	SRC	E = 0/11, C = 2/13	5	2
Devices	Gilcreast et al. (27)	USA	E1 = 77, E2 = 87, E3 = 76	63 ± 12	ICU, Med Surg ward, cardiology	Bunny Boot	Egg Crate, Foot Waffle	SHP	E1 = 3/77, E2 = 4/87, E3 = 5/76	4	1
	Tymec et al. (11)	USA	E = 26, C = 26	Data not available	Mixed	Device-FW	Device-SHP	SRC	E = 0/26, C = 1/26	3	2
	Gray and Smith (28)	UK	E = 50, C = 50	66.6 ± 16.5	Surg/Ortho, Med wards	Foam Mattress	SHM	SRC, AD	E = 0/50, C = 1/50	6	3
	Gunningberg et al. (29)	Sweden	E = 48, C = 53	61 ± 4.1	Surg/Ortho, Med wards	Foam Mattress	SHM	SRC, AD	E = 3/48, C = 5/53	5	3
Overlays	Vyhilal et al. (34)	USA	E = 20, C = 20	85 (67–96)	LTC	Foam Mattress	SHM	SRC	E = 2/20, C = 8/20	5	2
	Conine et al. (25)	Canada	E1 = 76, E2 = 72	74.25 ± 17.49	Neuro	Silicone Overlay	Air Overlay	SRC, TS, AD	E1 = 18/76, E2 = 19/72	4	2
	Daechsel and Conine (26)	Canada	E1 = 16, E2 = 16	38.8 ± 13.0	LTC, Neuro	Silicone Overlay	Air Overlay	SRC, TS, AD	E1 = 0/16, E2 = 2/16	5	2
	Sanada et al. (32)	Japan	E1 = 26, E2 = 29, C = 27	42.6 ± 13.7	Mixed	Air Overlay, Air Overlay	SHM	SRC, TS	E1 = 2/26, E2 = 0/29, C = 2/27	4	3
Combined	Gebhardt et al. (24)	UK	E = 23, C = 20	73.9 ± 10.4	ICU	Combined-AP	Combined-CLIP	SRC, TS	E = 0/23, C = 2/20	2	1
	Inman et al. (23,30)	Canada	E = 107, C = 37	69.5 ± 14.7	ICU	Combined-P	Combined-P/R	TS	E = 15/107, C = 4/37	4	3

AD, additional intervention; AP-, alternating pressure; C, control; Cardio Sx, cardiovascular surgery; CLIP, continuous low pressure; Combined, mattress + overlay; DL, double-layer air cell overlay; E, experimental; FW, foot waffle; ICU, intensive care unit; LTC, long-term care; Med wards, medical wards; N, number of people; n/N, number of heel ulcers/number of people; Neuro, neurorehabilitation; OR, operating room; P, purchase; P/R, purchase/rent; Pop, population; Ref, References; SHM, standard hospital mattress; SHP, standard hospital pillow; SL, single-layer air cell overlay; SRC, standard routine care; Surg/Ortho, Surgery/orthopaedics; TS, turning schedule; USA, United States of America; UK, United Kingdom.

Key Points

- many study results were confounded by concurrent therapies that were administered in addition to the pressure reducing interventions
- six of the seven studies reported that the proportion of subjects with a heel ulcer was lower if they were on a specialty surface compared with a standard hospital mattress

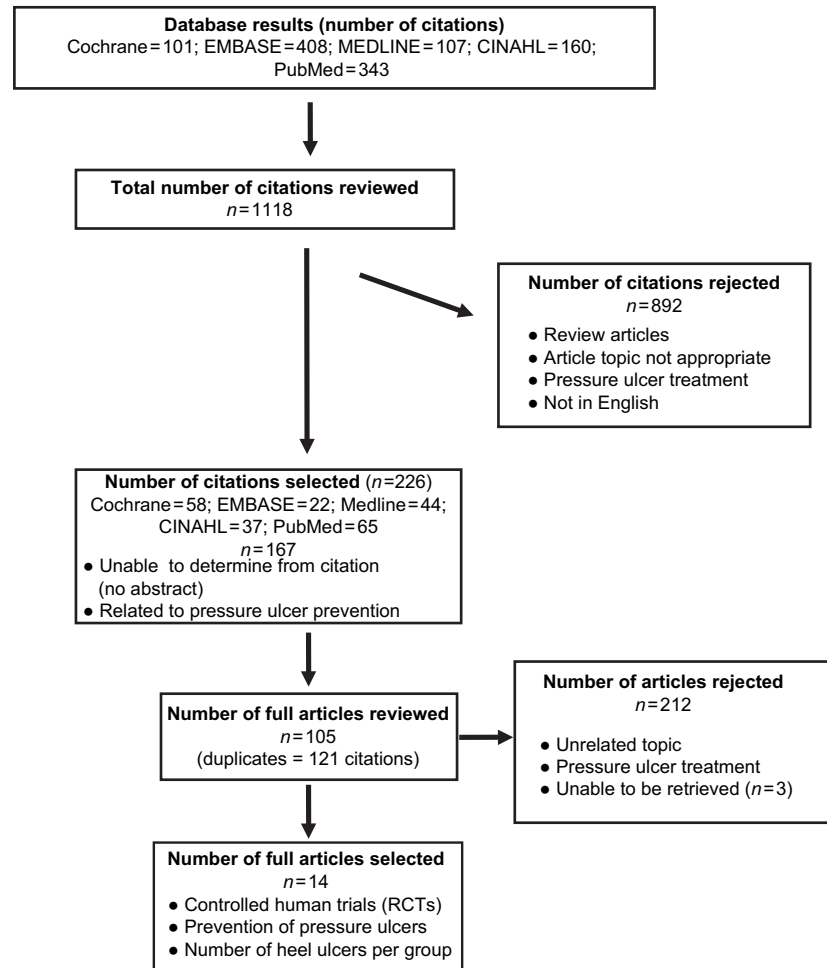


Figure 1. Flow diagram of article selection.

and provided results of between-group statistical comparisons for at least one key outcome.

Effectiveness of heel ulcer prevention programs

The combination of the studies that compared the RR of developing a heel ulcer using an air/foam mattress or overlay (11/440) versus a standard hospital mattress (24/388) produced a significant overall effect ($Z = 2.19$ $P = 0.03$). Using a foam or air speciality support surface was associated with a 50% (95% CI = 0.26–0.93) reduction in the RR of developing a heel ulcer (Figure 2). Six of the seven studies reported that the proportion of subjects with a heel ulcer was lower if they were on a speciality surface compared with a standard hospital mattress (1,28,29,31,33,34). Only one study in which subjects were placed on an air mattress reported an increased incidence of heel ulcers compared with control (3). Three

studies that compared the number of heel ulcers that developed on individuals who were placed on foam mattresses with those placed on standard hospital mattresses all reported lower heel ulcer incidence in those on the foam mattress (28,29,34). The overall effect of the combined results was $Z = 1.97$ which was statistically significant at $P = 0.05$ (Figure 3). The overall effect of combining results from the four studies that examined the heel ulcer incidence on air mattresses versus standard hospital mattresses did not favour either treatment ($P = 0.39$; Figure 4).

DISCUSSION

The results of this meta-analysis support the use of a foam or air mattress or overlay versus a standard hospital mattress to reduce the risk of developing heel pressure ulcers. In addition, there was sufficient evidence to suggest that

Review: Group comparisons based on Intervention
 Comparison: 09 Intervention (Foam/Air) versus no intervention (SHM)
 Outcome: 01 Heel ulcers versus no heel ulcers

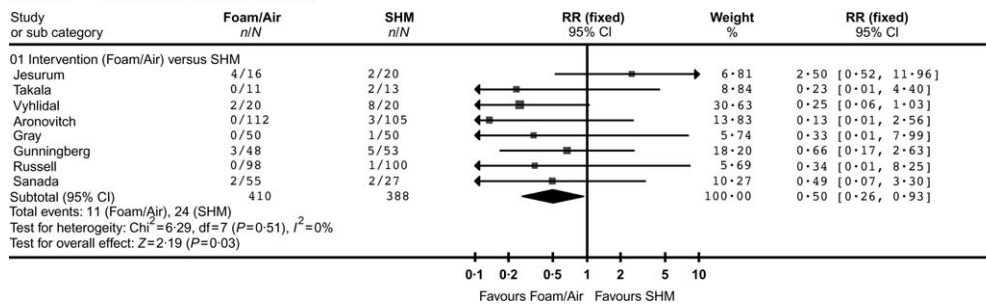


Figure 2. Relative risk (RR) of developing a heel ulcer on either a mattress (foam or air) or overlay compared to a standard hospital mattress (SHM). n/N is the number of heel ulcers over the total number surveyed.

foam mattresses were associated with lower risk of heel ulcer development. A similar benefit of air mattresses was not found, likely because one of the four studies used in the statistical analysis reported an increased incidence of heel ulcers compared with control subjects who were placed on standard hospital mattresses (3).

This exhaustive search localised relatively few articles that examined the ability of prevention interventions to reduce the number of heel ulcers in individuals in a variety of health care settings. While there were several reports that purport the ability of speciality surfaces/devices to prevent pressure ulcers, very few studies have examined their ability to prevent heel ulcers specifically (35,36).

Several reports that investigated the effectiveness of pressure ulcer prevention programs were excluded because they did not report the number of individuals who had heel ulcers in each of the intervention and control groups. Rather, they reported only the proportion of the total number of pressure ulcers identified that were located on the heel. Because more than one heel ulcer can occur per person, it is not possible to determine heel ulcer incidence as defined by the number of people who

developed heel ulcers. Therefore, the results of this meta-analysis can only be expressed in terms of risk reduction rather than absolute values of heel ulcer incidence.

A range of large databases (i.e. PubMed and MEDLINE) and small databases (i.e. Cochrane Clinical trials) were used. The search terms used by all researchers were deemed comprehensive, as many of the same articles were uncovered on multiple databases. It is possible that additional reports that fit the inclusion criteria were not found. Information could have been missed because of a variety of reasons, for example: not yet published, not posted on the databases searched, published in a non indexed journal, could not be located or not written in the English language.

Only 14 of the 105 full articles reviewed were included in this meta-analysis. To reduce selection bias, precise inclusion/exclusion criteria were applied consistently throughout the selection process. Furthermore, articles were reviewed by at least two reviewers independently, and any discrepancies were resolved through a group consensus process.

The quality of the studies included in this meta-analysis was critically appraised using both the PEDro and the Jadad scales. As

Key Points

- the results of this meta-analysis support the use of a foam or air mattress or overlay versus a standard hospital mattress to reduce the risk of developing heel pressure ulcers
- there was sufficient evidence to suggest that foam mattresses were associated with lower risk of heel ulcer development

Review: Group comparisons based on Intervention
 Comparison: 05 Intervention (Foam) versus no intervention (SHM)
 Outcome: 02 Heel ulcers versus no heel ulcers

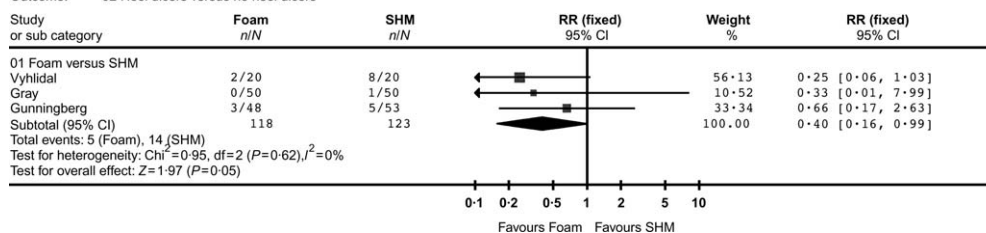


Figure 3. Relative risk (RR) of developing a heel ulcer on a foam mattress compared to a standard hospital mattress (SHM). n/N is the number of heel ulcers over the total number surveyed.

Key Points

- when developing future studies, researchers should consider how to optimise the methodological quality of studies; for example, by ensuring that appropriate randomisation of subjects to groups occurs and taking measures to ensure that blinding of assessors is performed
- given the relatively low number and poor quality of the controlled clinical trials included in this review, results of this meta-analysis should be interpreted with caution and the generalizability of our results is quite limited

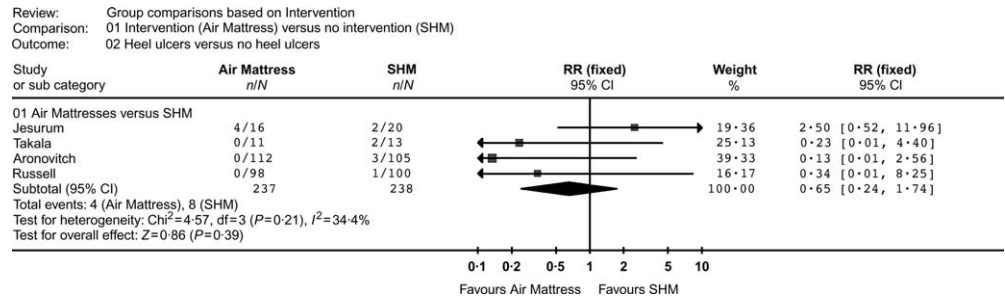


Figure 4. Relative risk (RR) of developing a heel ulcer on a foam mattress compared to a standard hospital mattress (SHM). n/N is the number of heel ulcers over the total number surveyed.

mentioned earlier, many of these studies did not show high methodological quality using the Jadad scale. As of yet, there is no way to classify the quality of a study (poor versus excellent) based on the PEDro score. When developing future studies, researchers should consider how to optimise the methodological quality of studies; for example, by ensuring that appropriate randomisation of subjects to groups occurs and taking measures to ensure that blinding of assessors is performed. Given the relatively low number and poor quality of the controlled clinical trials included in this review, results of this meta-analysis should be interpreted with caution and the generalizability of our results is quite limited.

Several of the intervention programs included other cointerventions consisting of turning schedules, educational programs and added pillows. The presence of these concurrent therapies is often appropriate because of ethical considerations that are often associated with this type of research; however, they limit the ability to be certain that the results are because of the particular surface/device under study. Eight of the 14 studies identified in this meta-analysis compared the preventative effect of two or more interventions and reported little differences between groups. Without comparing heel ulcer incidence rates to a standard care or control group, these reports lend little evidence to support the use of the protective surfaces/devices in reducing the incidence of heel ulcers.

Pressure ulcers located on the heel are often identified as one of the most common sites where skin breakdown can occur. Therefore, it was surprising to find little information about the effectiveness of prevention programs on heel ulcers. It is often assumed by professionals working in this field that heel ulcer

prevention programs require a specialised approach or a heel protective device. However, while many of these protective devices can reduce pressure on the heel, it is not known whether using these devices alone, or as part of a pressure ulcer prevention program, can reduce the incidence of heel ulcers. Whether a particular heel protective device is better at reducing the risk of developing a pressure ulcer than another also remains to be determined. More research to specifically test the ability of pressure ulcer prevention programs, with or without protective heel devices, is needed to determine if these devices can be helpful. Without this information, it will be difficult for clinicians to select a heel protective device and to justify the costs of these prevention programs. This paucity of information about specialised programs for heel ulcers may also explain why the prevalence of heel pressure ulcers is high across settings (10).

CONCLUSION

There is evidence to support the use of certain air or foam mattresses/overlays in the prevention of heel pressure ulcers when compared with a standard hospital mattress. There is insufficient research available at this time to determine if heel protective devices can prevent heel pressure ulcers. These conclusions need to be interpreted with caution because of the very limited number and relatively poor quality of studies that are available in the current research literature.

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APPENDIX I

SAMPLE SEARCH STRATEGY FOR DATABASES

Ovid: Search Results

CINAHL — Cumulative Index to Nursing & Allied Health Literature <1982 to May week 1 2005>

#Search History Results

- 1 "pressure ulcer\$.mp. or exp Pressure Ulcer/(4217)
- 2 "heel ulcer\$.mp.(107)
- 3 "foot ulcer\$.mp. or exp Foot Ulcer/(1923)
- 4 "decubitus ulcer\$.mp.(152)
- 5 "pressure sore\$.mp.(1257)
- 6 "chronic wound\$.mp. or exp Wounds, Chronic/(898)
- 7 exp Necrosis/or "skin necrosis".mp.(867)
- 8 "skin breakdown".mp.(169)
- 9 "skin ulcer\$.mp. or exp Skin Ulcer/(7485)
- 10 "bed sore\$.mp. (20)
- 11 "heel".mp. or exp HEEL/(893)
- 12 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 (9184)
- 13 11 and 12 (174)
- 14 "occurrence".mp. (3924)
- 15 "incidence".mp. or exp INCIDENCE/(15473)
- 16 exp Preventive Health Care/or "primary prevention".mp.(55335)
- 17 "prevent\$.mp.(46877)
- 18 "protective devices".mp. or exp Protective Devices/(5172)
- 19 "prevention".mp. or exp "PRESSURE ULCER PREVENTION (IOWA NIC)"/(25729)
- 20 ("beds and mattresses" or "pressure reduction").mp. [mp = title, subject heading word, abstract, instrumentation](1322)
- 21 "beds and mattresses".mp. or exp "Beds and Mattresses"/(1484)
- 22 exp "Beds and Mattresses"/or "pressure reduction".mp.(1598)
- 23 "pressure relief".mp. or exp "Pillows and Cushions"/(391)
- 24 "bedding and linens".mp. or exp "Bedding and Linens"/(317)
- 25 "product evaluation".mp. or exp Product Evaluation/(4778)
- 26 "flotation beds".mp. or exp Flotation Beds/(128)
- 27 23 or 24 or 25 or 26 (5470)
- 28 "prophylactic".mp.1356
- 29 "prophylaxis".mp.2895
- 30 "pressure ulcer\$ prevent\$.mp.222
- 31 "secondary prevent\$.mp.856
- 32 "protective equipment".mp. or exp Protective Devices/5247
- 33 "heel boot\$.mp.0
- 34 "heel protector\$.mp.7
- 35 "foot protector\$.mp.2
- 36 "protective footwear".mp.7
- 37 "foam".mp. or exp FOAM DRESSINGS/466
- 38 "foot protect\$.mp.39
- 39 "heel cup".mp.2

40 14 or 15 or 16 or 17 or 18 or 19 or 22 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 (119116)
 41 12 and 40 (2917)
 42 13 and 40 (104)
 43 14 and 15 (630)
 44 16 or 17 or 19 or 28 or 29 or 30 or 31 (95537)
 45 18 or 32 or 34 or 35 or 36 or 38 or 34 or 39 (5289)
 46 37 or 27 or 22 (6808)
 47 13 and 43 (2)
 48 13 and 44 (59)
 49 13 and 45 (17)
 50 13 and 46 (71)
 51 limit 42 to (english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over>"))42
 52 limit 51 to clinical trial0
 53 limit 41 to (english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over>"))896
 54 limit 53 to clinical trial56
 55 limit 43 to (english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over>"))336
 56 limit 47 to (english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over>"))1
 57 limit 48 to (english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over>"))16
 58 limit 57 to clinical trial0
 59 limit 49 to (english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over>"))8
 60 limit 59 to clinical trial0
 61 limit 50 to (english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over>"))31
 62 limit 61 to clinical trial0
 63 from 42 keep 1–104
 64 from 54 keep 1–56

Results of your search: from 63 keep 1–104.