



# Static Air Support Surfaces to Prevent Pressure Injuries

## *A Multicenter Cohort Study in Belgian Nursing Homes*

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### ABSTRACT

**PURPOSE:** The aim of this study was to investigate the incidence and risk factors for developing pressure injuries (PIs) in patients placed on a static air support surfaces: mattress overlay, heel wedge, and seat cushion.

**DESIGN:** Multicenter cohort study.

**SUBJECTS AND SETTING:** The sample comprised 176 residents; their mean age was 87 (SD = 6.76) years; their mean Braden Scale score was 14 (SD = 2.54). The study was performed on a convenience sample of 6 nursing homes in Belgium.

**METHODS:** Data were collected on 23 care units. The primary outcome measure, cumulative PI incidence (category [stage] II-IV) over a 30-day observation period, was calculated. Pressure injury occurrence was defined according to the 2014 European and US National Pressure Injury Advisory panels, Pan Pacific Pressure Injury Alliance classification system.

**RESULTS:** The PI incidence for category (stage) II-IV was 5.1%. Six residents (3.4%) developed a category II PI, and 3 (1.7%) developed a category III PI; no category IV ulcers occurred. No significant risk factors for category II-IV PIs were identified using multivariate logistic regression. Time of sitting in a chair was found to be a risk factor for development of nonblanchable erythema (category I PI) (odds ratio = 21.608; 95% confidence interval [CI], 20.510-22.812;  $P = .013$ ). The median time to develop a category II-IV PI was 16 days (interquartile range = 2-26). The interrater reliability between the observations of the researcher and nurses on-site was almost perfect (0.86; 95% CI, 0.81-0.91).

**CONCLUSION:** We found a low incidence of PIs when using a static air overlay mattress for patients at risk in a nursing home population. Static air support surfaces, alongside patient-tailored patient repositioning protocols, should be considered to prevent PIs in this patient population.

**KEY WORDS:** Incidence, Pressure injuries, Pressure injuries, Prevention, Reactive air overlay mattress, Risk factors, Static air support surfaces.

### INTRODUCTION

Pressure injuries (PIs) are associated with prolonged exposure to an applied external mechanical load.<sup>1</sup> This load comprises all types of external forces applied to the patient's skin and underlying tissue due to contact with support surfaces. The extent of skin and/or tissue damage depends on the duration and magnitude of the applied load (pressure and shear). A high mechanical load for a short period, as well as a low mechanical load applied for a long period, can lead to tissue damage.<sup>2</sup>

A Cochrane systematic review defined multiple groups of pressure redistribution materials: low-tech (not electrically driven) constant low-pressure supports, high-tech supported surfaces, and other supported surfaces (operating table mattress pad,

rotating beds, cushions, and limb protectors).<sup>3</sup> Static or reactive overlay mattresses are an example of a low-tech constant low-pressure support. Static air mattresses maintain a continuous low air pressure that exerts a pressure-redistributing effect. There are 2 main principles for the way the pressure redistribution takes place by constant low-pressure supports: immersion and envelopment.<sup>4</sup> Static air mattresses are always overlay mattress. The mattress overlay is compact and low in weight. It consists of several compartments; the air moves over a large area when a person lies on the mattress.<sup>5-7</sup> High-tech support surfaces are also defined as dynamic mattresses.<sup>8,9</sup> An active support surface is a powered surface that achieves load distribution by cyclic inflation and deflation of air cells, with or without body weight of the patient resting on the surface.<sup>9</sup> Immersion and envelopment are less applicable for dynamic mattresses.<sup>4</sup>

We reviewed the literature and found limited evidence concerning the effectiveness of static air mattresses for prevention of PIs. Five randomized controlled trials showed a lower incidence of PIs in individuals placed on a static air mattress compared to different control groups.<sup>10-14</sup> One study compared a static mattress to a dynamic mattress, and the other 4 compared the air static mattress to another form of static mattress such as standard hospital mattress, foam mattress, viscoelastic mattress, or microfluid mattress overlay.

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Pressure injury incidence on a static air mattress overlay was significantly lower compared to a standard hospital mattress (10-cm thick, density 35 kg/m<sup>3</sup>) ( $P \leq .005$ ), a cold foam mattress (15-cm thick) ( $P = .09$ ), and a viscoelastic foam mattress (15-cm thick) ( $P = .09$ ).<sup>11,12,14</sup> In the previous studies, the overall incidence of category II-IV PIs on a static air mattress overlay varied from 0% to 5.2%. Pressure injury occurrence in patients at risk being cared for on static air support surfaces over a longer period of time is missing. The aim of this study was to measure PI incidence on a static air mattress in a nursing home population at risk for PI development over a 30-day period. Our second aim was to identify factors associated with an increased risk for PI development when cared for on static air support surfaces.

## METHODS

A multicenter cohort study was conducted in a convenience sample of 6 Belgian nursing homes; data were collected on 23 care units. Inclusion criteria were bedbound (patients spent >8 hours in bed) and/or chairbound (>8 hours seated in a chair), a Braden Scale score <18 and/or category I PI, aged older than 65 years, weight <139 kg (this cut point was selected based on mattress specification from the manufacturer). Residents were excluded if the expected length of stay was less than 2 weeks, they were receiving palliative care, they had a “do not resuscitate code,” there was a medical contraindication to use of a static mattress overlay, or the person had a PI present on initial evaluation. Study procedures were in accordance with the principles stated in the Declaration of Helsinki. The study was reviewed and approved by the Ethics Committee of Ghent University Hospital. Informed consent was requested for patients or family in conformity with the ethical approval of the Ghent University Hospital Ethics Committee (registration number EC/2013/728).

Study outcomes were PI incidence and risk factors for developing category (stage) II-IV PIs according to the 2014 European and US National Pressure Injury Advisory Panels, Pan Pacific Pressure Injury Alliance classification system.<sup>15</sup> Study end points (completion) were (1) development of a category II-IV PI, (2) occurrence of no PIs after period of 30 days, (3) transfer to a nonparticipating ward, and (4) death or voluntary withdrawal.

## Materials

A Repose static mattress overlay, a seat cushion, and a heel wedge (Frontier Medical Group, South Wales, United Kingdom) were used in this study. The mattress overlay, heel wedge, and seat cushion are a combination of 2 urethane membranes. The inner membrane is inflated and provides static pressure redistribution throughout tubular cells that are oriented along the length of the overlay. The second membrane is formed from a multidirectional stretch, vapor-permeable material. The combination of the 2 membranes provides pressure redistribution. The static air support surfaces come packed inside a pump, which enables it to be inflated and ready for use within seconds and ensures that the product is inflated to the correct pressure. The maximum patient weight on the mattress overlay is 139 kg (306 lb).

## Study Procedures

Approximately 2 weeks before the start of the study, all nurses in the participating nursing homes completed an educational program about PI prevention (pathology, classification, and

differentiation between incontinence-associated dermatitis and the use of the Braden Scale for risk assessment), an introduction to the study aims and protocol, and the use of the data collection instrument in a practical exercise. The purpose of this training was to certify the precision and uniformity of the data collection. Fifty-three caregivers in the 6 nursing homes participated in the training session.

The residents list was reviewed to select the participants who were bed- and/or chairbound. Residents were informed about the aim and study procedure, both orally and in writing. After the informed consent form was signed, baseline characteristics were collected. All data were collected by the researcher from the residents file, discussions with the senior nurse, frontline staff nurse, or study participants.

Participants were maintained on the static air mattress overlay and heel wedges for 30 days. Participants were kept on a standardized 4 hourly repositioning protocol while in bed. The standardized protocol for PI prevention during data collection also included the use of a seat cushion, combined with 2 to 3 hourly repositioning while in the chair, and the use of a heel wedge to relieve pressure at the heel. Daily skin assessments were performed by the unit nurses (qualified nurses and nursing assistants under the supervision of a qualified nurse) during the morning.

The static air mattress overlay, seat cushions, and heel wedge were placed on the first day of the study and skin assessment began the following day. Participants were assessed for category I PIs on the first day of data collection. Observations from day 2 till day 30 focused on identification of PI occurrences within the observation period (PI incidence). We monitored the interrater reliability of observations of the skin on the pressure areas; primary investigator (B.S.) performed weekly unannounced skin observations in a random sample of patients. These observations were compared with the documented skin observations by the nurses. The  $\kappa$  statistic was used to measure interrater reliability.

## Data Collection Form

Clinical observations were performed based on procedures advocated by the European Pressure Injury Advisory Panel.<sup>15</sup> The data collection instrument included 4 categories: patient data, risk assessment, skin observation, and prevention. Patient data collected included age, gender, incontinence, weight, principal comorbid conditions, sleep medications, tranquilizers, number of hours in bed/chair, and preventive strategies. Pressure injury risk assessment was completed using the Braden Scale for pressure sore risk.<sup>16</sup> Skin inspections were completed daily over the 30-day data collection period; the location and category of all PI occurrences were recorded.

## Data Analysis

Descriptive data are presented as frequencies (percentages) and means (standard deviation, SD) when data were distributed normally and medians (interquartile range, IQR) if data were not distributed normally. The primary outcome measure, cumulative incidence of category (stage) II-IV PIs, over a 30-day observation period was calculated as the percentage of patients developing a new category II-IV PI. The Fisher exact test and the  $\chi^2$  test were calculated for categorical variables. The level of significance for univariate analyses was  $P < .05$ . Univariate  $\chi^2$  test and multivariate logistic regression analyses were performed to investigate factors associated with an increased likelihood of developing a PI. Analyses were conducted using SPSS 22.0 (IBM Corporation, Somers, New York);  $P$  values less than .05 were deemed statistically significant.

**RESULTS**

Eight hundred sixty-seven residents were screened for participation, and 259 met the inclusion criteria. Seventy residents did not give consent to participate. Baseline measurement was performed in 188 residents. For various reasons, summarized in Figure 1, there was a dropout of 12 residents; the final sample size was 176 residents.

Most of the participants (77%; n = 135) were female; their mean age was 87 (SD = 6.76) years. The mean risk assessment score on the Braden Scale was 14 (SD = 2.54). The 4 most frequent comorbid conditions were cardiovascular, nervous system, and digestive system diseases or disorders and mobility deficits. An overview of the patient characteristics is provided in Table 1.

Before the study, 31% (n = 59) of the participants received no specified PI prevention and 43% (n = 80) had been placed on viscoelastic mattress. Forty-five participants (24%) had been placed on a dynamic air mattress, and 2% (n = 4) were using a static air mattress.

During the study, 9 participants (5.1%) developed a category II-IV PI. Specifically, 6 participants (3.4%) developed a category II PI, and 3 (1.7%) developed a category III PI. None developed a category IV PI (Table 2). Most of the PIs developed in the sacral area (n = 8; 89%); the median time to develop an incident PI was 16 days (IQR = 2-26).

Risk factors for incident PIs could not be determined because of the low occurrence rates noted earlier. If category I PIs were included in the analysis, time of sitting in a chair was found to be a significant risk factor for PI development. Sixty-four percent of participants who developed a PI sat in a chair for more than 6 hours daily. Sitting in a chair for 4 to 6 hours, sitting for 4 hours, and being bedbound was also associated with an increased likelihood of experiencing any category of PI (occurrence rates were 10%, 12%, and 14% of the participants, respectively (odds ratio = 21.608; 85% confidence interval [CI], 20.510-22.812; P = .013).

Because observations completed by the unit-based nurses and the researcher were independent, we calculated the degree

**TABLE 1.**  
Participant Characteristics (N = 176)

Characteristics	Mean (SD)
Mean age, y	87 (6.76)
Risk assessment score on the Braden Scale	14 (2.54)
	n (%)
Gender: Female	135 (77)
Medication	
Tranquilizers/sleep medication	117 (67)
Corticosteroid	26 (15)
Incontinence status	
Urinary incontinence	170 (97)
Fecal incontinence	122 (69)
Disease-related characteristics	
Cardiovascular system	99 (56)
Nervous system	65 (37)
Digestive system	56 (32)
Mobility disorders	46 (26)

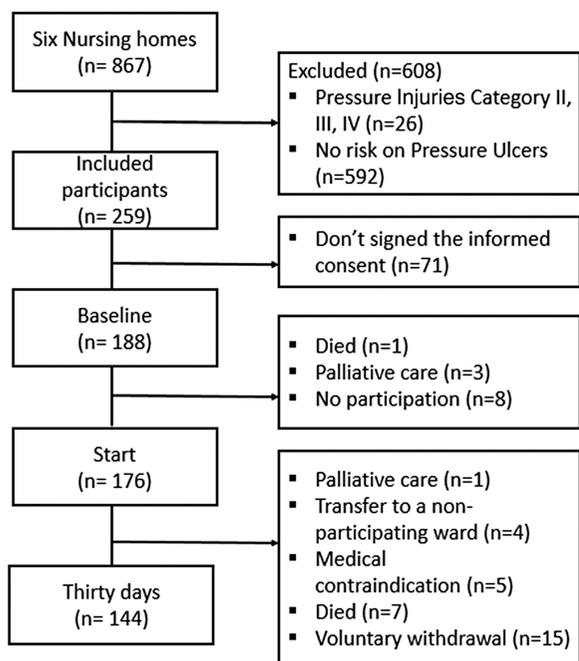
of agreement and the interrater reliability (Cohen  $\kappa$ ) based on PI classification. The interpretation of the  $\kappa$  value was based on the techniques described by Landis and Koch.<sup>17</sup> The interrater reliability of the classification of PIs among ward nurses and the researcher was almost perfect:  $\kappa = 0.86$  (95% CI, 0.81-0.91).

**DISCUSSION**

The aims of this study were to measure incidence and factors associated with developing category II-IV PIs in patients placed on a static air support surfaces: mattress overlay, seat cushion, and heel wedge. The incidence of category II-IV PIs was 5.1%, and no category IV PIs occurred. These findings are similar to those reported by others.<sup>5,10-14,18,19</sup> In addition, 3 of these studies found significant difference when incidence rates were compared to a control group.<sup>11,12,14</sup> Well-designed randomized controlled trials are needed to compare the effectiveness of the different types of pressure redistribution support surfaces for patients at risk for PI development. The Belgian PI prevention guidelines conclude that constant low-pressure support (group of static air overlay) and the dynamic pressure support (high-tech) are more effective than standard foam mattresses for the prevention of PIs.<sup>20</sup> Nevertheless, methodological weaknesses were identified in these studies, including the lack of clear standards concerning the pressure-redistributing properties (or absence of such properties) of a standard mattress.<sup>20</sup>

**TABLE 2.**  
Incidence of Category I-IV Pressure Injuries

	n (%)
Category I: Nonblanchable redness of intact skin	41 (23.3)
Category II: Partial-thickness skin loss or blister	6 (3.4)
Category III: Full-thickness skin loss (fat visible)	3 (1.7)
Category IV: Full-thickness tissue loss (muscle/bone visible)	0 (0)



**Figure 1.** Flow diagram of participants.

Risk factors for category II-IV PI development in this population could not be determined because of the low occurrence rate. Studies involving significantly larger samples are needed to more clearly identify risk factors for PI development in this population. If category I PIs were included in the analysis, time spent sitting in a chair was associated with a higher likelihood of developing a PI. Sixty-four percent of participants who developed a category II-IV PI during the study sat in a chair for more than 6 hours daily. When sitting in chair, a high proportion of body weight is distributed over a comparatively small area. Additional study is needed to determine whether limiting sitting time is needed to reduce PI risk or whether a protocol of regular repositioning is effective for PI prevention. Findings from our study suggest that time spent sitting in a chair should be limited for patients at risk. Patient repositioning is a possible alternative to this recommendation; repositioning is defined as relieving pressure and shear on particular body parts at risk for PI development.<sup>20</sup> A study recommended repositioning of patients minimum every hour when sitting in a chair.<sup>21</sup> Clinicians should position the lower extremities in an optimal alignment (eg, 90° at the hips, knees, and feet) and avoid positioning the hips at an angle of more than 90°.<sup>22</sup> The feet should be placed on the ground or on a footrest when the feet do not reach the floor. When sitting in an armchair, the individual should be positioned with the feet up and heels offloaded.<sup>20</sup>

### Study Limitations

We did not measure PI incidence before the start of our study. Skin assessment began on the first day when the static air mattress overlay, seat cushions, and heel wedge were placed. The prospective cohort study design we used is limited by the absence of random allocation of subjects to control group(s) and may have a higher risk of selection bias and attrition bias (loss of follow-up or withdrawals). A larger sample size also may have reduced the risk of bias.

### CONCLUSION

We measured the incidence of PIs in a group of 176 nursing home residents. The incidence of category II-IV PIs was 5.1% (n = 9) on static air support surfaces: mattress overlay, seat cushion, and heel wedge. Specific risk factors for category II-IV PIs could not be determined because of the low PI occurrence rate. However, if category I PIs were taken into account, the time of sitting in a chair was found to be a significant risk factor for PI development. Static air support surfaces, alongside patient-tailored patient-repositioning protocols, should be considered to prevent PIs in this specific patient population.

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