Nordic Health Economics

Pressure ulcers in Sweden

– Research overview and calculation of inpatient care costs

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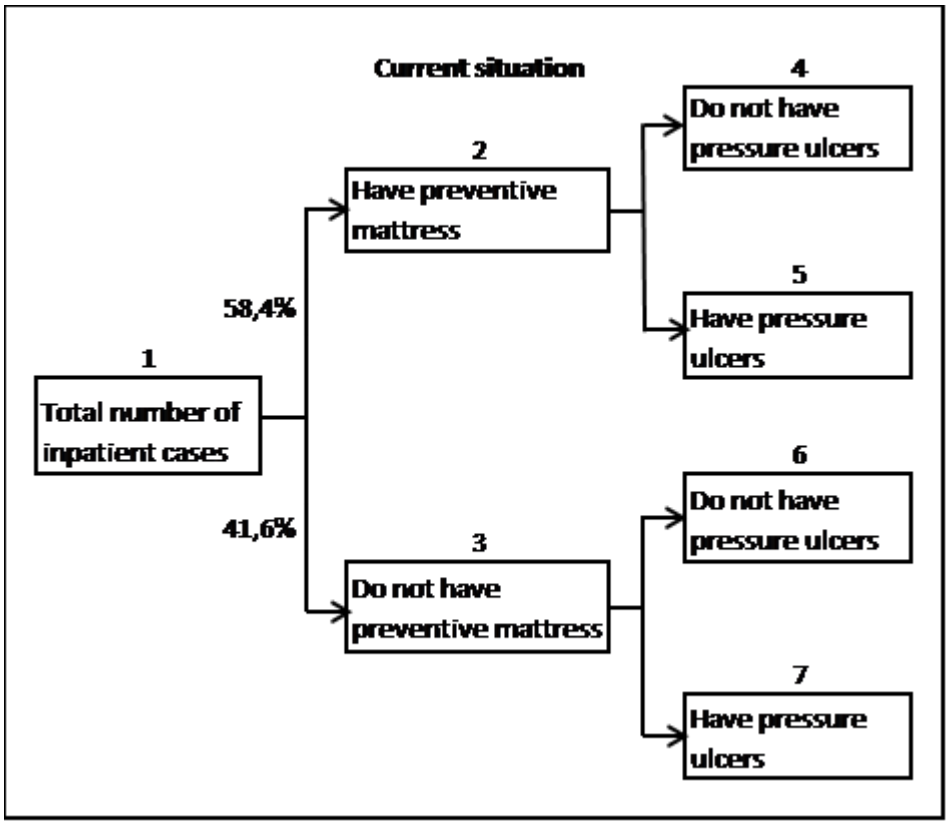

1 Summary

Pressure ulcers form as a result of reduced mobility due to e.g. illness or old age. The condition often causes great suffering for the patient and is accompanied by time-consuming and costly treatment. Studies from several countries have shown that pressure ulcers account for a significant proportion of total expenditure on healthcare, and point prevalence studies show that approximately one in five patients in hospital in Europe have pressure ulcers. Since a large number of these patients have developed pressure ulcers as inpatients, there are opportunities though to prevent the occurrence of those pressure ulcers which could have been avoided by utilising a preventive approach.

This report provides a comprehensive description of pressure ulcers as a problem area in healthcare, their underlying causes and prevalence. In addition, a so-called "Budget Impact Model" for an increased use of pressure ulcer prevention mattresses within inpatient care is presented. The results of the model analysis are presented for Sweden as a whole, but the model's input data can be changed for the input variables so that each county council can be analysed separately. It is also possible to analyse how different scenarios affect the outcome with regard to costs and savings.

The results for the whole country show that if preventive pressure-equalising mattresses were used in all inpatient beds instead of in about 60% of them as the situation is today, the healthcare system would save just over SEK 1.4 billion over a five-year period. If the goal is to put 100% of the risk patients on prevention mattresses, the saving during the same period would amount to almost SEK 400 million. Sensitivity analyses show that the results are very sensitive to the input variables except for the cost of the mattresses, which does not affect the cost saving to any great extent. This means that the model is driven by the cost of treating pressure ulcers. However, the result is robust even in a scenario where the margin for cost savings from introducing prevention mattresses in all inpatient beds is minimised.

2 Introduction

A healthcare injury covers suffering, physical or mental injury, illness or death which could have been avoided if appropriate measures had been taken during the contact with the relevant healthcare provider [1].

Serious and common healthcare injuries include pressure ulcers, identified as one of the six focus areas of the initiative by the Swedish Association of Local Authorities and Regions (SALAR) to improve patient safety [2]. Many of the pressure ulcers that are detected in hospital have also formed in that hospital [3]. The Swedish Patient Safety Act, which came into force on 1 January 2011, stipulates that healthcare providers should take the necessary preventive measures to avoid patients suffering from healthcare injuries. In cases where measures cannot be taken immediately, a timetable for these must be drawn up [1].

At the request of the Swedish government, the National Board of Health and Welfare has produced a list of national quality indicators for the care of older people, as part of enabling open comparisons within geriatric care. Based on the vast knowledge base that supports the relationship with quality of care, pressure ulcers are listed as such an indicator [4]. The prevalence of pressure ulcers is an accepted quality indicator even within other areas of health and medical care [5].

Pressure ulcers are not a new phenomenon, but have been recognised and prevented in healthcare ever since the 16th century [6]. Nevertheless, various studies show that about one in five patients cared for in hospital in Europe has pressure ulcers [7]. The problem is also very topical, since the demographic trend means that the proportion of elderly people in the population is increasing very rapidly, and in addition to great suffering for the individual it is also associated with high healthcare costs [7, 8].

A preventive approach in terms of pressure ulcers is particularly important for patient safety, but can ultimately also have a positive impact on healthcare spending [9].

The purpose of this project is to describe pressure ulcers in more detail in the form of, among other aspects, causes, risk factors, impact on the patient, epidemiology, preventive measures and costs. A model was also constructed to try and identify what pressure ulcer treatment currently costs in Sweden within inpatient care, as well as what it would cost if the use of preventive pressure-equalising mattresses were increased within the same area of healthcare.

This work has been carried out on behalf of Care of Sweden AB.

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3 Pressure ulcers

3.1 Definition

An internationally accepted definition of pressure ulcers is published in a collaboration between the European organisation EPUAP (European Pressure Ulcer Advisory Panel) and the American organisation NPUAP (National Pressure Ulcer Advisory Panel). In this context, a pressure ulcer refers to a localised injury to the skin and/or the underlying tissue, which is caused by pressure or a combination of pressure and shear (displacement of the tissue layers in relation to one another) [10]. Today the term pressure ulcer is used for these injuries, instead of bed sore or decubitus [11].

3.2 Causes

Pressure forms in the contact between the surface of the body and the sitting/lying surface (e.g. mattress or cushion) and can then, when it exceeds the capillary blood pressure, cause local oxygen deficiency leading to skin and/or muscle damage. The same effect can also be seen with shear, e.g. when the patient slides down in the chair or bed. In this case, curved formations (folds) in the blood vessels or small haemorrhages can instead impair the blood supply to the affected area. The inadequate blood supply in turn gives rise to oxygen deficiency and associated damage to the cells. Pressure ulcers often occur in the skin over bony prominences, where the pressure-distributing tissue is thin, such as the sacrum, heels, ischial tuberosities, bony prominences on the thighs, the back of the head or elbows [12].

3.3 Classification

EPUAP has developed a classification scale for pressure ulcers according to severity, where pressure ulcers are sorted into one of four categories (Table 1) [10].

Table 1. Classification of pressure ulcers according to EPUAP

Category	Definition	Description
1	*Non-blanchable erythema*	Localised area ofskin with redness that remains when the pressure is relieved. Skin is intact.
2	*Partial thickness skin loss*	Shallow open ulcer without fibrin slough. Pinkish-red wound bed. May also present as an intact or ruptured blister.
3	*Full thickness skin loss*	Subcutaneous fat visible but bone, tendon or muscle is not exposed. Fibrin slough may be visible.
4	*Full thickness tissue loss*	Damage involving bone, tendon or muscle. There may be visible fibrin or necrosis.

3.4 Risk factors

Usually it is a combination of various risk factors which together with external pressure cause a pressure ulcer to form [13]. Reduced mobility (immobility) does, however, stand out as a major single contributory cause [14, 15], which is why pressure ulcers tend to follow old age, illness and disability [12].

Alongside this, surgical procedures increase the risk of developing pressure ulcers even in people who are not otherwise at risk. This is because of the patient's inability to change their position or feel pain.

The risk of post-operative pressure ulcers increases proportionally with the length of the operation [16].

Although pressure ulcers are associated with the elderly, they can affect people of all ages. On the other hand, the greater incidence of risk factors in the elderly does mean a higher risk of pressure ulcers [13, 15]. For instance, the elderly often have reduced mobility, which makes it more difficult for them to change position. The ability to perceive the signals of pain and discomfort that cause a change in position may also be impaired [15, 17]. Nutritional status also comes into play here, where malnutrition is correlated with both an increased risk of developing pressure ulcers and an impaired ability to heal [15]. With increasing age, lung capacity and oxygenation also deteriorate [18], which entails a risk factor for pressure ulcers by hypoxia (oxygen deficiency) occurring in the tissue [12]. Hypotension gives the same effect due to the external pressure more easily exceeding the pressure in the tissue, leading to reduced perfusion and oxygenation [12, 19]. A summary of the risk factors for the occurrence of pressure ulcers is set out in the table below (Table 2).

Table 2. Significant risk factors for the occurrence of pressure ulcers

Risk factor	Contributory cause
Reduced mobility [12, 14, 15, 17]	Reduced relief of pressure points [12, 17]
Sensory impairment [12, 15, 17]	Reduced awareness of persistent pressure [12, 15]
Poor nutritional status [13, 15, 17, 20]	Reduction in pressure-distributing tissue, poorer healing ability [13, 15, 20]
Reduced level of consciousness [12, 13, 15]	The interaction of factors such as reduced mobility and sensory impairment [12]
Elevated body temperature [12, 13]	Increased metabolism leads to greater need for oxygen and nutrients to the cells [12]
Hypotension [12, 19]	Impaired perfusion of the skin and other tissue under external pressure [12, 17]
Reduced respiratory ability [12]	Lower oxygenation of the blood, tissue hypoxia [12]
Previous history of pressure ulcers [13, 15]	Healed pressure ulcers have a residual sensitivity [13]
Cardiovascular disease [15, 17, 20]	Impeded blood flow and decreased perfusion of the skin [17, 20]

3.5 Risk assessment

According to international guidelines, on arrival at hospital patients should undergo a risk assessment for risk of pressure ulcers. A structured process is thus recommended in which a thorough skin assessment and clinical assessment are complemented by the use of a risk assessment instrument specifically for pressure ulcers [10]. About 40 such instruments are described, of which the Norton Scale, Braden Scale and Waterlow Scale are the most widely used internationally [13, 21].

In Sweden a modified Norton Scale or a further development of this called RAPS (Risk Assessment Pressure Sore) is also used in these assessments [7]. The Norton Scale was the first risk assessment scale for pressure ulcers and came into use in the early 1960s. In addition to mobility, it also covers activity, incontinence, mental status and physical health [22]. The modified version of the Norton Scale was introduced in Sweden in 1987, and also assesses the intake of food and drink alongside the

factors in the original version [23, 24]. RAPS (Risk Assessment Pressure Sore) was presented by Lindgren *et al.* in 2002 and includes variables from the Norton Scale, Modified Norton, the Braden Scale and other research [23].

Although the implementation of various risk assessment instruments has been shown to reduce the incidence of pressure ulcers, there are a number of questions and criticism surrounding their use. The criticism is mainly targeted at a lack of evaluation, because it is unclear whether it is the instrument itself or the associated training of staff that has an effect. Nor has it been shown that the use of an instrument is always superior to a clinical assessment by an experienced nurse [22]. Accordingly it is believed that the routine use of risk assessment instruments could also lead to the under-use of preventive measures [21].

The different variables covered by each risk assessment scale [15, 21, 23] are summarised in Table 3.

Table 3. Variables measured using the Norton, Braden, Waterlow, Modified Norton and RAPS scales

Variable	Norton	Braden	Waterlow	Modified Norton	RAPS
general condition	x			x	x
mental status	x			x	
physical activity	x	x		x	x
mobility	x	x	x	x	x
incontinence	x		x	x	
food intake				x	x
fluid intake				x	x
nutritional status		x	x		
moisture		x			x
sensation		x	x		x
friction or shear		x			x
skin type			x		x
body type			x		x
body temperature					x
serum albumin					x
medication			x		
age			x		
predisposing diseases			x		
prolonged pressure			x		
smoking			x		

4 Implications for the patient

Health-related quality of life, or HRQoL, is a recognised measure in the evaluation of healthcare, and has had great influence on improvement in several areas. In an extensive review of 31 studies (n = 2,463), it was found that pressure ulcers have a significant impact on HRQoL [25]. As there is often comorbidity, however, it is difficult to address the extra burden of pressure ulcers [26]. But even though the patient often has a serious chronic illness or other serious ailment, the occurrence of pressure ulcers affects different aspects of life – physically, socially, emotionally and mentally.

Physically, this effect encompasses comfort, infections and everyday activities (such as moving about and showering) [25, 27]. Almost all sufferers also mention the pain as a central part of having pressure ulcers [25, 27, 28]. The pain, described as cutting or burning, in turn gives rise to worry and anxiety associated with dressing wounds and touching them. The sufferers often feel that their life is controlled and laborious due to the need for relief that the healing process requires. This may involve having to stay in certain positions (e.g. lying on their stomach) or not being able to sit in a chair, which in turn can affect the patient's ability to participate in meals and other social occasions [6, 25]. Patients with pressure ulcers also often feel that they are a burden to others [25].

When the healing process for pressure ulcers requires hospitalisation or a prolonged hospital stay, this often contributes to a feeling of isolation, confinement, detachment and lack of mental stimulation. In addition, hospitalisation may come to be associated with anxiety if the pressure ulcer formed and/or was neglected in the hospital. The perceived care and treatment of the pressure ulcer generally plays a role in HRQoL studies [26].

5 Epidemiology

5.1 Mapping of pressure ulcer prevalence in Sweden

In the spring of 2011, SALAR conducted a point prevalence survey of pressure ulcers in Sweden, where the overall incidence of pressure ulcers was recorded in the same week. The survey was conducted in 21 counties and 85 municipalities. The aim was to identify potential areas for improvement and to enable comparisons between and within counties/regions and municipalities. In this survey it was shown that 16.6% of patients in the counties had one or more pressure ulcers at the time of the survey, over half of which could be classed as category 1 with 9% belonging to the most serious category 4 [29]. In the follow-up in autumn 2011, the proportion of patients with pressure ulcers had fallen to 14.4% [30], but was up to 16.1% again in spring 2012 [31]. In the municipalities, the corresponding proportion of patients with pressure ulcers was 14% in spring 2011, with a similar distribution of severity [29]. A year later, this figure had dropped to 11.5% [32].

These point prevalence surveys are planned to be performed continuously in both spring and autumn for the foreseeable future, so it will be possible to monitor the problem of pressure ulcers in municipalities and counties over time.

As part of an improvement project at Kärnsjukhuset i Skövde – the largest unit of Skaraborg Hospital – a point prevalence study was conducted in June 2008 of 258 patients from all wards except the maternity and children's wards. It was found that 61 patients (23.6%) had pressure ulcers (category 1–4) at the time of the survey. In 33% of cases (26 patients), the ulcer had formed while in hospital [33].

In 2006, a point prevalence survey of six hospitals and six municipalities was conducted in Skåne County. The result was a prevalence of pressure ulcers (category 1–4) of 19% for the hospitals (n = 2,839), which was the same level as in 2005. For all those investigated, the total prevalence had gone down from 18% to 15% over the same period [8].

In 2004, a Swedish study of pressure ulcer prevalence (category 1–4) at a university hospital, a general hospital and a nursing home in Uppsala County was published, where the prevalence was 13.2% (n = 38) for the general hospital, 20% for the nursing home and 23.9% (n = 612) at the university hospital [34]. Four years later, the same university hospital remained at about the same level, 22.9% (n = 632), despite the implementation of a quality improvement programme [35]. The evaluation of such a programme may, however, give a false impression of there being no or even a negative effect from these measures, because of more pressure ulcers than before being recognised and reported. For this reason, proper long-term follow-up must be carried out [13].

5.2 Mapping of pressure ulcer prevalence in other countries

Studies of pressure ulcer incidence have been conducted in many countries. In a large retrospective study of data on pressure ulcer prevalence in Canada between 1990 and 2003, it was estimated that on average 26% of all patients in all healthcare units had pressure ulcers [36]. A few years later, the average prevalence of pressure ulcers at 13 Canadian emergency care hospitals was surveyed, resulting in a figure of 22.9% (n = 3,099), of which the majority of pressure ulcers occurred after admission to hospital [37].

In a review of data from seven annual point prevalence surveys in Germany, a downward trend from 13.9% (in 2001) to 7.3% (in 2007) could be seen. One possible explanation for the decrease was assumed to be an increasing awareness of pressure ulcers as a problem area and associated prevention initiatives [38].

The large number of prevalence studies in different countries are difficult to compare though, as they look at different patient groups, use different definitions or retrieve data in different ways. A comparative study of pressure ulcer prevalence in five European countries (Belgium, Italy, Portugal,

Sweden and the UK) was therefore coordinated to combat this problem. Of a total of 5,947 patients in a total of 25 hospitals, 18.1% were found to have pressure ulcers (category 1–4). Belgium, Sweden and the UK were top of the list with a prevalence between 21.1% and 23%, while Portugal and Italy had significantly lower figures of 12.5%and 8.3% respectively [39].

6 Interventions

6.1 Preventive measures

The majority of pressure ulcers are considered to be preventable by means of preventive measures [13]. By focusing more on preventing their occurrence instead of treating the pressure ulcers once they have appeared, we can ultimately stop the suffering of the individual patient as well as saving healthcare resources [9, 13].

In the point prevalence studies of pressure ulcers in Sweden, the majority of pressure ulcers have been shallow and classified as category 1 [8, 29, 34]. Many mild pressure ulcers do, however, over time turn into more serious categories, resulting in greater difficulties for the patient and escalating costs [40].

In the analysis of the non-effect of a quality improvement programme at a Swedish university hospital, it was noted, however, that few patients received preventive measures as soon as they were admitted [35]. Since pressure ulcers are a major burden for the patient, it is actually of the utmost importance to identify risks and take a preventive approach.

6.1.1 Skin care

Upon arrival at the hospital, the skin should be assessed in order to detect existing or incipient pressure ulcers. This assessment should be part of the risk assessment procedure and allow for early intervention when signs of pressure injury are observed [7, 10]. It is generally recommended that the skin should be kept dry, clean and smooth with gentle cleansing and emollient cream [7, 10, 41].

6.1.2 Nutrition

It is unclear how supplements affect the risk of developing pressure ulcers, but in one study a lower incidence has been demonstrated by administering nutritional supplements to the elderly in acute care settings [42]. Since malnutrition is a risk factor that can be prevented, nutritional supplements are thus recommended for patients at risk of malnutrition and pressure ulcers [7, 10, 41, 42].

6.1.3 Changing position

Where it is possible for the patient to change their position in bed or a chair themselves, this should be encouraged by providing information about the risk of pressure ulcers and the importance of pressure relief [6]. In cases of reduced mobility, however, it is essential that all patients at risk of pressure ulcers receive help to change position (repositioning) to relieve exposed areas [7, 10, 42]. Based on a study of different turning intervals, a schedule is often applied in which the patient is turned at two-hourly intervals [42]. It is advisable here to place the patient in a position that does not put stress on the prominences of the thigh bones, such as the so-called 30-degree angle position, where the patient is tilted slightly to the side and pillows are used for support and relief. This method has, in combination with a three-hour turning schedule, been shown to significantly reduce the incidence of pressure ulcers compared with conventional prevention practice involving 90-degree turning [43], and is recommended by international guidelines [10].

6.1.4 Different types of surface

An important aspect of prevention is the use of specially designed aids, such as pressure-relieving or pressure-equalising mattresses, beds, covers and cushions [10]. These aids do not replace the need to change position, but the use of a pressure-equalising or pressure-relieving mattress can, for example, increase the time intervals for turning of the patient, and thus entail the time spent and stress for both the patient and staff being at a reasonable level [44].

The study conducted by SALAR in spring 2012 revealed that 80% of all risk patients in the county councils, and 73.3% in the municipalities, are now given some form of prevention mattress [31, 32]. If you look at the total number of patients in the county, around 58% are given a prevention mattress [29-31].

There are several variants of prevention surface, the common denominator being that they are designed to redistribute pressure, reduce shear effects and control the microclimate. The different strategies in the design of these surfaces are to reduce either the magnitude or duration of the pressure between the patient and the surface. We therefore distinguish between surfaces that mould around the body to increase the contact surface (pressure-equalising), thereby reducing the pressure, and surfaces that through varying pressure reduce the duration of the pressure (pressure-relieving). The former types are called constant low pressure devices, or CLP, while the latter types are called alternating pressure devices, or AP [45].

CLP devices are also grouped by construction, such as foam, foam + air, foam + gel, or hammocks. They may also be more technically advanced (high specification), such as air-fluidised beds. High-specification solutions also include AP devices. In these the pressure at the boundary between the body and surface is varied, by separate cells in the mattress or cover being alternately filled with air [45].

6.2 Evidence for preventive measures

In a Cochrane review from 2011, 53 studies of different surfaces for pressure ulcer prevention are summarised, detailing the incidence and severity of new pressure ulcers as primary outcomes. Secondary outcomes included, among others, the cost of the device, comfort for the patient, the device's durability and also the patient's quality of life. The review states that most studies unfortunately are of poor quality. The only conclusion we can safely draw is that high-specification foam mattresses significantly reduce the likelihood of risk patients developing pressure ulcers, compared with ordinary hospital standard foam mattresses. The incidence of pressure ulcers decreases in such instances by around 60% (relative risk = 0.4). In three of the studies it has been shown that genuine medical sheepskin covers also have a preventive effect. Furthermore, three of five studies show that the risk of postoperative pressure ulcers is reduced when surfaces designed to prevent pressure ulcers are used during surgical procedures [45]. The benefits of pressure-relieving and pressure-equalising mattresses are confirmed in other review articles dealing with pressure ulcer prevention interventions. They also provide support for the use of pressure ulcer prevention surfaces during surgical procedures and the use of genuine medical sheepskin [42, 46].

There are good examples of a structured preventive approach giving excellent results. At a hospital in the Netherlands, a study was carried out that looked at the effects of the implementation of a new pressure ulcer policy, which included new guidelines and the training of staff. All patients who were judged to be in the risk group for pressure ulcers were also placed on a pressure-equalising mattress. After 11 months, the proportion of pressure ulcers occurring in the hospital had fallen from 18% to 11%. During the same period, inadequate prevention also fell from 19% to 6%, with a satisfactory procedure including both a schedule for repositioning and placing patients at risk on a special mattress. The significance of this decrease, however, was entirely dependent on the patients being put on a special mattress [47]. Another study of critically ill patients confirmed how significant putting the patient on a special mattress at the right time is to the incidence of pressure ulcers, i.e. when the occurrence of pressure ulcers is still preventable [48].

6.3 Guidelines

The recommendations in the guidelines for pressure ulcer prevention produced by the European EPUAP and American NPUAP organisations (and also translated into Swedish by SSiS, a Swedish association for nurses interested in wounds) are based on different strength of evidence ratings (A, B,

C). Table 4 provides a summary of recommended interventions with an A or B strength of evidence rating. These are based on scientific evidence from well-designed, published studies on pressure ulcers which present statistical results that consistently support the recommendations in the guidelines. Recommendations with an A strength of evidence rating are based on large randomised trials with clear-cut results and a low risk of error. For B strength of evidence ratings, however, the underlying data can be small randomised trials with uncertain results, non-randomised trials with concurrent/historical controls or case series with no controls [10]. The summary below (Table 4) does not contain recommendations with C strength of evidence ratings, which are based on indirect evidence [10].

Table 4. Guidelines for pressure ulcer prevention according to EPUAP/NPUAP, A and B strength of evidence ratings

Recommendations
Strength of evidence, A rating:
Provide nutritional supplement with high protein content in addition to the usual diet to people at risk of malnutrition and pressure ulcers.
Perform repositioning to reduce the duration and force of the pressure over exposed areas of the body.
Adjust the frequency of the repositioning according to the pressure-relieving or pressure-equalising surface used (shorter intervals without a special mattress).
Use a high-specification foam mattress rather than a standard mattress for all people considered to be at risk of developing pressure ulcers.
Strength of evidence, B rating:
Train staff in correct and reliable risk assessment and how to conduct a comprehensive assessment of the skin.
Inspect skin regularly.
Use emollients to hydrate the skin and reduce the risk of skin damage.
Limit the time a person spends sitting in a chair without pressure relief. Use pressure-redistributing seat cushions for people sitting in chairs and who run a risk of getting pressure ulcers.
Use an active pressure-equalising or pressure-relieving surface (cushion or mattress) for patients at high risk of developing pressure ulcers and where frequent manual changes of position are not possible.
Use a pillow under the calves to raise heels.
Natural sheepskin can help to prevent pressure ulcers.
Use a pressure-redistributing mattress on the operating table for all people at risk of developing pressure ulcers.

As shown in the table above, the use of a high-specification foam mattress rather than a standard mattress for risk patients is recommended with an A strength of evidence rating.

7 Costs

In addition to the stress and suffering that pressure ulcers mean for the person affected, the condition requires a great deal of healthcare resources and costs the same as running a medium-sized hospital for one year in Sweden [49]. In a study from the Netherlands, the cost of pressure ulcers is the third most expensive expenditure item in healthcare, after cancer and cardiovascular disease [42]. The cost of pressure ulcers during a normal healing process generally increases with their severity. When a pressure ulcer gets worse, this also increases the risk of complications, which has been identified as a major cost driver [40, 50, 51]. Increased treatment costs and prolonged hospital stays both account for this factor [40]. Since a pressure ulcer that has formed is both difficult to heal and easily becomes more serious, the preventive work is extremely important [13]. Several studies have also shown that there are significant cost savings to be made by preventing pressure ulcers [40, 52-54].

7.1 Cost items

The resources used for a pressure ulcer consist of nurses' time (for risk assessment, dressing of wounds and repositioning of the patient), dressings, antibiotics, diagnostic testing, pressure-equalising or pressure-relieving surface and the extra number of days in hospital when this is necessary [40]. Nurses' time in particular dominates the total cost, while the cost of materials for dressing wounds and pressure relief contributes to a lesser extent. Pressure ulcers of a greater severity force up the cost because of complications and/or extended care [40, 55, 56].

In a comparison of two hospitals in the Netherlands with two different strategies for preventing pressure ulcers, it has been shown that it is more cost-effective to take a technical rather than a labour-intensive approach. In the study, both strategies resulted in a similar incidence of pressure ulcers (category 2 or higher), while the technical solution (mattresses, dressings and hydration of the skin) cost significantly less than the policy where the emphasis was instead on turning the patient frequently [50].

Pressure ulcers forming during a hospital stay can result in the length of stay lasting an extra 4.3 to 10.8 days [51, 57], while pressure ulcers as the primary diagnosis may mean a length of stay for an average of 13.8 days (range 1–134 days) [3]. With a serious pressure ulcer, the length of stay can actually be extended by up to 170 days [54]. Approximately 50% of all pressure ulcers in category 2 and 95% of all pressure ulcers in category 3 and 4 will take more than eight weeks to completely heal [51].

7.2 Quantification of costs in Sweden

The Jönköping County Council healthcare management group commissioned a calculation of the cost of pressure ulcers to the county in 2006. The number of inpatients there with pressure ulcers has been calculated as about 4,200 a year, of which over 80% of the pressure ulcers are classified as category 1–2. The purpose of calculating the value of these was to highlight the economic impact of any systematic preventive approach. By using time studies of staff resources and recording materials used, the cost of pressure ulcers was calculated and broken down by category (Table 5), with the total cost of pressure ulcers in Jönköping County coming to SEK 53 million per year [49].

Table 5. Annual cost of pressure ulcers in Jönköping County

Category	Number of care episodes	Cost (SEK million)
4	210	9
3	580	15
2	1,260	13

1	2,210	16
1–4	4,260	53

At Kärnsjukhuset i Skövde (KSS) there is a special ward for pressure ulcers requiring inpatient care. In 2007 there were 16 cases at the hospital where the primary diagnosis was pressure ulcers, which cost a total of SEK 1,469,166 when only inpatient treatment cost was calculated. In the same year, 44 pressure ulcers were recorded as a secondary diagnosis. These were calculated to require a total of 26 working hours for wound dressing and SEK 2,200 in material cost (dressings) per day [33].

7.3 Quantification of costs in other countries

Some studies have been carried out in order to try and quantify the cost of pressure ulcers at a national level. In the Netherlands, a cost-of-illness study was conducted in 2002. Depending on various estimates of the cost of treatment and prevention, the total cost of pressure ulcers was estimated to be between 1.2% (conservative estimate) and 6.6% (upper limit) of total healthcare costs in the Netherlands [55].

In 2004, Bennett *et al.* presented a study of the cost of treatment for pressure ulcers in the UK. When the cost for 1999/2000 was examined, this amount was estimated to be 4% of the country's total expenditure on healthcare. Most of the cost, 90%, could be attributed to nurses' time. If the cost was broken down into different categories, the cost of nurses' time for category 1–2 pressure ulcers amounted to 96%, while the cost for category 3–4 pressure ulcers was greatly affected by hospital admission due to complications (30% of the total cost). The cost of other resources such as dressings, antibiotics and pressure-equalising or pressure-relieving equipment contributed only 3.3% to the total cost [40].

In a Spanish study, a marked increase in the cost for more serious pressure ulcers was observed. In this case, the cost of hospital treatment for a category 1 pressure ulcer began at EUR 24, while a category 4 pressure ulcer on average cost EUR 6,800. Overall it was found that spending on treatment for pressure ulcers in Spain accounted for almost 5% of total healthcare costs in the country. As in other studies, materials accounted for a smaller proportion than the cost of nurses' time. The major cost driver was, however, hospitalisation due to complications [56].

8 Budget Impact Model

8.1 Purpose of the model

In Sweden, there are no studies that present the costs of treating pressure ulcers in a wider context. As described above, foreign cost-of-illness studies have shown that treating pressure ulcers is very expensive.

In an attempt to identify what pressure ulcer treatment currently costs in Sweden within inpatient care, and also what it would cost if the use of preventive pressure-equalising mattresses were increased in the same area, a model was constructed to calculate the costs and savings for healthcare in Sweden.

8.2 Introduction to the model

At the time of writing, the majority of all inpatients assessed as being risk patients for development of pressure ulcers are given a preventive pressure-equalising mattress. In 2011–2012 this figure was approximately 78% for the whole country, but it does vary greatly from county to county (46–99%). Approximately 58% of all inpatients are given a preventive mattress [29-31].

To illustrate the impact on healthcare costs if all risk patients and all patients in inpatient care respectively were put on a pressure-equalising mattress, we present here a so-called Budget Impact Model (BIM), where the total cost for the county councils is adjusted against the cost savings achieved by the effect the preventive pressure-equalising mattresses would have in reducing the occurrence of pressure ulcers. Costs that fall outside county councila are not included as this is a BIM, which follows a county council-based cost perspective.

In the model, both costs and effects are broken down so that the input data can be changed for different contexts.

In the results section, we present how the county council costs for inpatient care across Sweden would change if prevention mattresses were used in all hospital beds and in all beds with identified risk patients respectively.

8.3 Model structure and function

The model was created in Microsoft Excel in order for it to be transparent.

The first sheet is an introduction sheet.

After that is the “Input” sheet, on which all the data required to run the model are inserted.

The sheet after that presents the results per year for five years and also the overall results over a five-year period. The period of five years was chosen on the basis that it would be the average life span of a preventive pressure-equalising mattress within inpatient care (estimated by Care of Sweden).

The results can be presented for two different scenarios:

1. Increasing the use of prevention mattresses for *all patients*
2. Increasing the use of prevention mattresses for *risk patients*

The model calculates the cost of purchasing x number of preventive pressure-equalising mattresses in order to achieve the percentage of prevention mattresses established in a scenario. It also calculates the cost saving in avoiding y number of pressure ulcers as a result of increasing the use of prevention mattresses according to the same scenario.

After the "Results" sheet are three sheets (tabs in green) in which all the data needed to fill the "Input" sheet with relevant data are available. Data exist in aggregate form for all county councils in Sweden (National) and individually for all 21 county councils.

Finally, there are two sheets on which the effectiveness of preventive pressure-equalising mattresses as well as the costs of category 1–4 pressure ulcers and pressure-equalising mattresses are presented.

Figure 1 and Figure 2 below show the flow chart on which the model bases its calculations for the current situation and scenario.

It can be seen in Figure 1 that only patients who are in stage 7 can be influenced by increasing the extent of prevention mattresses within inpatient care. Consequently the effect of the prevention mattresses will only be applied to the population not lying on a prevention mattress and which would have developed pressure ulcers if the situation was as present.

Figure 1. Flow chart – current situation

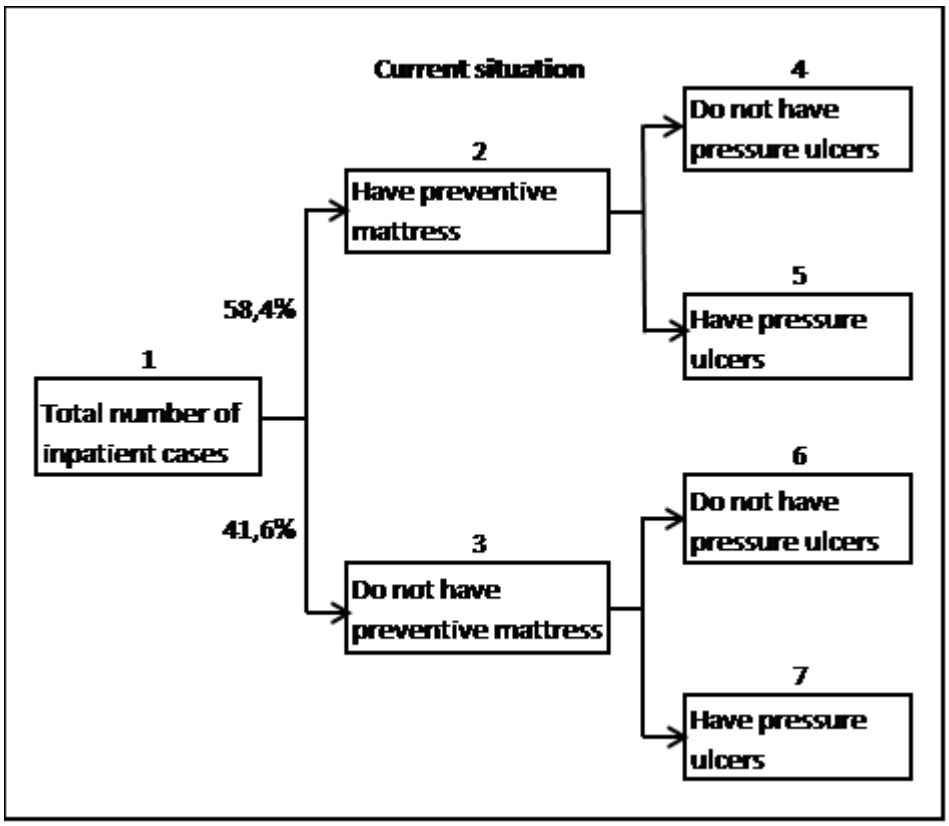
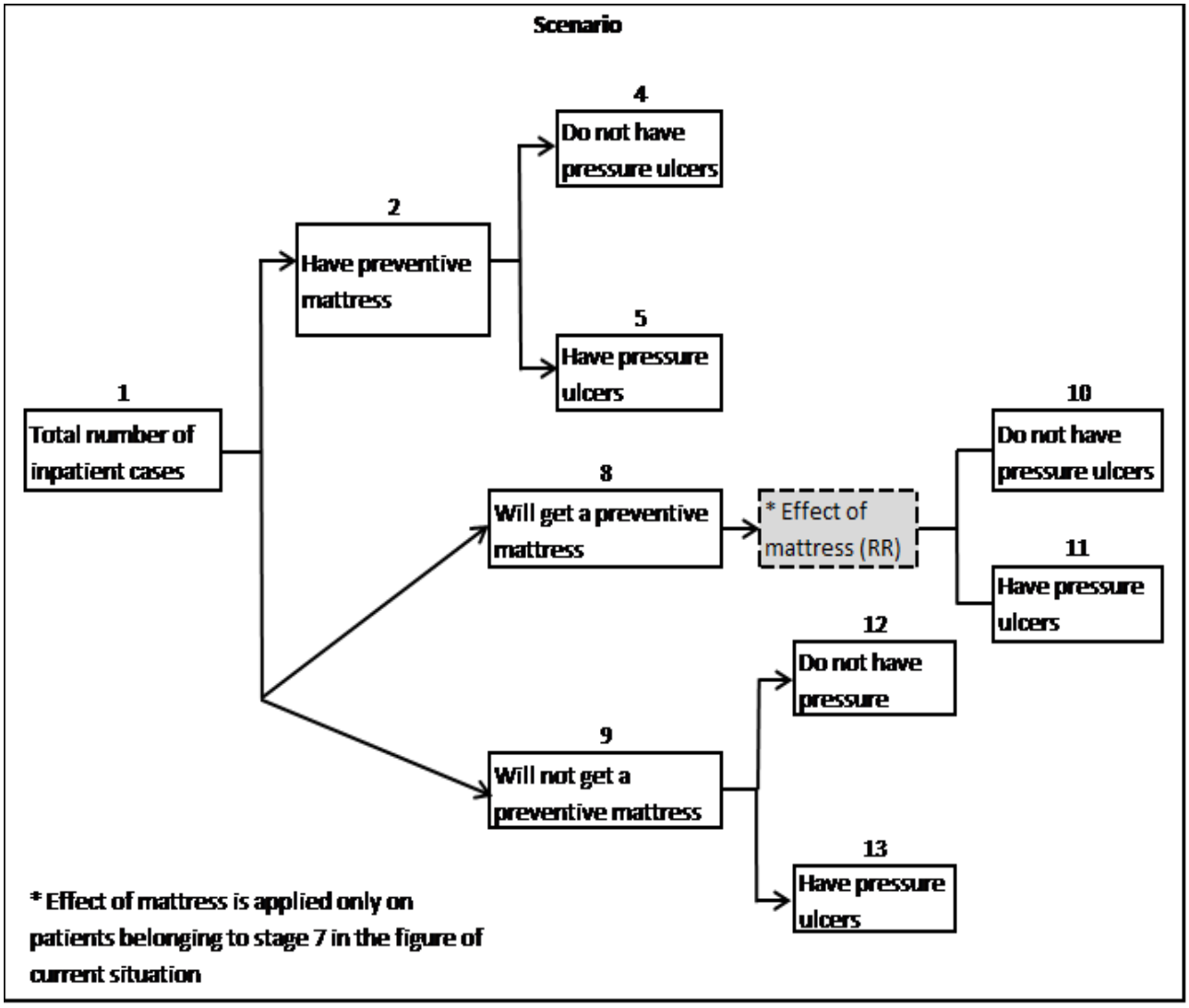


Figure 2. Flow chart – scenario



8.4 Variables

8.4.1 Effect of pressure-equalising mattress

The measure of effectiveness used in the model is taken from the Cochrane review described above (section 6.2) and represents the combined relative risk for five different studies, where alternative foam mattresses have been compared with standard hospital mattresses. The average relative risk here is 0.4, i.e. a 60% reduction in pressure ulcer incidence when a prevention mattress is used compared to when a standard mattress is used [45].

8.4.2 Resources

8.4.2.1 *Number of inpatient cases and length of stay*

The total number of inpatient cases for Sweden as a whole is taken from the National Board of Health and Welfare's statistics database and includes all cases within inpatient care in 2010. The average length of stay per inpatient case is also taken from the database [58]. These two parameters were used to determine the number of inpatient beds in Sweden in 2010.

8.4.2.2 *Pressure ulcer prevalence*

The mean values for how these inpatient cases are distributed among different groups of patients (all patients and risk patients) have been produced from SALAR's point prevalence surveys in the spring and autumn of 2011 and the spring of 2012 [29-31]. These mean values have then been used in calculations of how many patients are categorised as risk patients for developing pressure ulcers, how many patients in total and of risk patients that actually have pressure ulcers, and how many patients in total and of risk patients currently have a prevention mattress. In the example for the whole country, there were a total of 1,497,029 inpatient cases with an average length of stay of 5.43 days in 2010. According to the SALAR surveys, in 19.6% of these cases there is a risk of pressure ulcers. 15.9% have pressure ulcers if you look at all of the patients, while 41.8% of risk patients are affected. A prevention mattress is used for a total of 58.4% of all patients and 78.4% of risk patients.

According to a previously described publication, 33% of pressure ulcers occur during the hospital stay, while the remaining 67% of pressure ulcers had actually occurred before admission (and therefore cannot be prevented with a pressure ulcer prevention mattress after admission) [33]. The model was therefore adjusted accordingly so that cases which can be prevented with a mattress are only those that would have occurred during the stay and other cases that already existed on admission are not affected by the introduction of more relieving mattresses into hospital beds.

Data from SALAR do not show the proportion of all patients with pressure ulcers in the treatment arms "Have prevention mattress" and "Do not have prevention mattress" depicted in Figure 1 above; instead only data for the whole material (aggregated for both arms; including patients with and without prevention mattresses) are shown. This means the model assumes that the distribution is the same across the two treatment arms and that 15.9% of the patients have pressure ulcers in "Have prevention mattress" as well as in "Do not have prevention mattress" treatment arms.

8.4.3 Distribution of pressure ulcers, category 1–4

As the cost of pressure ulcers increases with their severity, the distribution of pressure ulcers by category is included in the model. Since specific data for some county councils are not available in an accessible form, valuesfor the whole country from SALAR's 2011 point prevalence survey (week 12) have been used instead for these county councils, as these are based on the greatest amount of underlying data [29]. These are marked with an asterisk in the model.

For the country as a whole, 53% of patients presented with category 1 damage, 25% category 2 damage, 13% category 3 damage and 9% category 4 damage.

8.4.4 Direct costs

8.4.4.1 *Costs of pressure ulcers*

The costs per pressure ulcer category for one year (Table 6) are taken from the calculations for Jönköping County Council in 2006 [49], and have been adjusted to the 2012 level using the consumer price index. These costs thus include staff resources (time) and material costs during the hospital stay. Costs that may persist after discharge and are taken over by the municipality are not included.

Table 6. Cost per pressure ulcer broken down by category

Category	1	2	3	4
Number of cases	2,210	1,260	580	210
Total cost (SEK)	16,000,000	130,000,00	15,000,000	9,000,000
Cost/pressure ulcer 2006 (SEK)	7,240	10,317	25,862	42,857
Cost/pressure ulcer 2012[1] (SEK)	8,019	11,428	28,645	47,468

[1]The cost calculated using a conversion factor of 1.107593 according to the consumer price index 2006–2012 (source: Statistics Sweden).

8.4.4.2 *Costs of prevention mattresses*

The cost of a preventive pressure-equalising mattress is taken from Care of Sweden's range and refers to the Optimal 5zon model, which is intended to be used for prevention purposes and in the treatment of category 1–2 pressure ulcers. The price of the model is currently SEK 3,490 (excluding VAT) and the estimated average life span of this mattress is five years, which is included in the cost calculation (source: Care of Sweden). The entire cost of the mattress purchase has been allocated to Year 1 in the model.

8.5 Results

The results show the cost savings that would result over five years if the proportion of prevention mattresses were increased to 100% in all beds (for all patients) and to 100% for identified risk patients.

Table 7. Results for the country as a whole presented in millions of Swedish kronor

	Year 1 (SEK m)	**Year 2 (SEK m)**	**Year 3 (SEK m)**	**Year 4 (SEK m)**	**Year 5 (SEK m)**	**Total (SEK m)**
Cost at present:	3,594	3,594	3,594	3,594	3,594	17,974
Cost scenario, patients with prevention mattress:	3,331	3,298	3,298	3,298	3,298	16,526
Cost scenario, risk patients with prevention mattress:	3,518	3,515	3,515	3,515	3,515	17,581
Saving with prevention mattress for patients:	263	296	296	296	296	1,448
Saving with prevention mattress for risk patients:	75	79	79	79	79	392

The results show that if all the county councils in Sweden together invested just over SEK 33 million (Year 1) so that there were preventive pressure-equalising mattresses in all inpatient beds, it would be possible to save a total of almost SEK 1.5 billion by avoiding pressure ulcer costs over a five-year period.

However, if we focus only on risk patients having access to a prevention mattress, an investment of about SEK 4 million in prevention pressure-equalising mattresses (Year 1) would be needed. This would result in a saving of nearly SEK 400 million by avoiding pressure ulcer costs over a five-year period.

Sensitivity analyses of the result of savings achieved by introducing pressure-equalising mattresses in all inpatient beds are shown below for some of the input variables. The variables were tested one at a time and varied by ± 25% of the base case analysis with the exception of the effectiveness where the 95% confidence interval from the publication was used [45].

The results were the least sensitive to variation in the mattress cost while other analyses showed high sensitivity to the value of the variable analysed.

Table 8. One-way sensitivity analyses for the country as a whole

Variable	Base case	Sensitivity analysis	Source	Saving with prevention mattress (SEK m)
Base case analysis				*1,448*
RR effectiveness (low)	0.4	0.21	95% CI	1,917
RR effectiveness (high)	0.4	0.74	95% CI	609
Cost of pressure ulcers (low)		-25%	Assumption	1,078
Cost of pressure ulcers (high)		+25%	Assumption	1,818
Cost of mattress (low)	SEK 3,490	SEK 2,618	Assumption	1,456
Cost of mattress (high)	SEK 3,490	SEK 4,363	Assumption	1,440
Scenario: proportion of patients with preventive mattress (low)	100%	75%	Assumption	577
Proportion of patients with pressure ulcers (low)	15.9%	11.9%	Assumption	1,078
Proportion of patients with pressure ulcers (high)	15.9%	19.9%	Assumption	1,818
Proportion of patients with prevention mattress (low)	58.4%	43.8%	Assumption	1,956
Proportion of patients with prevention mattress (high)	58.4%	73.0%	Assumption	939

8.6 Discussion

In the base case analysis, the current situation regarding the proportion of prevention mattresses in inpatient care and the resulting number of pressure ulcer cases is compared with a scenario where all inpatient beds are equipped with a preventive pressure-equalising mattress and the reduction in the number of pressure ulcers this would entail. The budget impact analysis shows that it could be possible to save nearly SEK 1.5 billion by preventing pressure ulcers and that the investment cost of the mattresses is comparatively low depending on the long life span (assumed to be five years according to Care of Sweden's estimate), the relatively low purchase cost (compared to the cost of treating pressure ulcers) and the fact that many patients can use the same prevention mattress.

Sweden has approximately 22,000 inpatient beds in total and, according to the point prevalence survey, 58.4% of them are already equipped with a prevention mattress. This means that almost 10,000 preventive pressure-equalising mattresses would need to be purchased for the entire country to ensure that 100% of beds have a prevention mattress. The analyses assume that the intention is to

maintain the proportion of pressure ulcer prevention mattresses achieved at present and for this reason the costs of renewing the existing bed park are not included in the calculations.

The results also showed that the county councils can save more by equipping all beds with preventive pressure-equalising mattresses compared with having a target of only all risk patients having a prevention mattress. This is the case at any event under the assumption that the proportion of patients with pressure ulcers is the same among those with and those without a pressure ulcer prevention mattress at present. Unfortunately no data are available on the point prevalence for these two populations but only aggregated for the entire population, so the assumption represents an uncertainty in the model.

The sensitivity analyses show that the results are very sensitive to variations in the tested parameters except for the mattress cost (see reasoning above). This naturally leads to the presented results being uncertain. For example, the cost of treating pressure ulcers is based on a study conducted for Jönköping County Council [49]. The level of detail for the costs presented is low as is the description of what is included in the treatment costs. However, we have been unable to find a better basis for Sweden and it is this presentation which is generally referred to when mention is made of treatment costs in Sweden. With this in mind, we still chose to use these cost data, and the fact that it is the healthcare system itself which has produced the cost estimates also supports their use.

The previously described British cost-of-illness publication reported the cost of pressure ulcers per category (2000 level) as GBP 1,064, GBP 3,948, GBP 6,350 and GBP 7,750 for category 1, 2, 3 and 4 respectively with normal healing [40]. These costs included nurses' time, bandages, antibiotics, diagnostic tests, documentation and extra care days and are on a par with (if not greater than) the Swedish costs we used in the model.

Although the analysis is very sensitive for the majority of the tested variables, an "extreme-case scenario," where all tested variables (see Table 8) are set so that cost savings from the introduction of pressure-equalising mattresses have been minimised, shows that a saving of more than SEK 15 million would still be the result (compared to SEK 1.4 billion for the base analysis).

SALAR's point prevalence data have been used to determine the number of risk patients, (risk) patients with pressure ulcers, (risk) patients with a prevention mattress and the distribution of pressure ulcers by category 1–4 per year. Ideally, it would have been better to use incidence data, but since these are not available in SALAR's material, the point prevalence has been assumed to be the same as the annual incidence. The large number of patients covered in the point prevalence survey indicates that this could be a valid assumption. An adjustment of point prevalence data has, however, been made in the model.

The number of patients with pressure ulcers that occur in hospital has been adjusted downwards to 33% of the point prevalence in accordance with the publication which showed that 33% of pressure ulcers occur after hospitalisation, while the others had actually occurred before admission [33]. The model assumes that it is only possible to prevent pressure ulcers that occur after admission, and it is only in this population that the relative risk of 0.4 is applied for the reduced occurrence of pressure ulcers when the patient is lying on a pressure-equalising mattress compared with a standard mattress. The model has thus not taken into consideration the fact that the prevention mattress in the analysis can also be used to treat category 1 and 2 pressure ulcers and the cost savings this could mean for the healthcare system. Other publications have reported that the majority of pressure ulcers detected in hospital have also developed in hospital [37], but we have chosen to use data from the Swedish study in the model.

Studies where both prevalence and incidence data have been reported have shown that the median category is generally lower for new ulcers (incidence) than the median category for prevalent cases and contain valid point prevalence data compared with incidence data over the distribution of category 1–4 pressure ulcers [40]. Accordingly, the distribution of category 1–4 based on the SALAR

point prevalence survey could possibly overestimate the proportion of higher category ulcers among the ulcers that developed after admission and thus also the costs of treating pressure ulcers.

In summary, the model shows that it is probable that large savings can be made if the use of preventive pressure-equalising mattresses is increased within inpatient care. The exact value of these savings is, however, difficult to comment on as there is an uncertainty in the model, not least with regard to the costs of treating pressure ulcers since the level of detail for included costs was low in the source used. Studies concerning this and other parameters would be able to provide a more certain estimate of the actual costs and savings within inpatient care.

The costs which arise in the local government (municipal) sector when a patient is discharged from inpatient care with an obvious pressure ulcer were not included in the model. This means that all costs deriving from pressure ulcers which developed in inpatient care have not been included in the analysis and therefore have not been presented in this report either.

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