The Incidence of Pressure Ulcers in Surgical Patients of the Last 5 Years: A Systematic Review

Hong-Lin Chen; Xiao-Yan Chen; Juan Wu

Abstract: This systematic review looks at the incidence of pressure ulcers in surgical patients of the last 5 years. Methods. The authors searched Pubmed and Web of Science for studies published after 2005. Screening and data abstraction were performed independently by 2 reviewers. Results. Seventeen studies (5,451 patients) met the inclusion criteria. The incidence of surgery-related pressure ulcers ranged from 0.003 to 0.574. The pooled incidence was 0.15 (95% CI 0.14-0.16, $I^2 = 98.2\%$). For cardiac surgery, hip fracture surgery, and patients on the surgical intensive care unit, the pooled incidence was 0.18 (95% CI 0.14-0.22, $I^2 = 62.8\%$), 0.22 (95% CI 0.20-0.24, $I^2 = 98.4\%$), and 0.11 (95% CI 0.09-0.13, $I^2 = 98.5\%$), respectively. Conclusion. The data on the incidence of surgery-related pressure ulcers indicates that appropriate monitoring and treatment need to be performed.

Pressure ulcers are a common problem for patients, causing significant pain and additional costs. Many studies have investigated the incidence and the prevalence of pressure ulcers. The incidence of pressure ulcers is 0.4% to 38%; within long-term care, 2.2% to 23.9%; and in home care, 0% to 17%.¹²

Patients undergoing an operation are prone to develop pressure ulcers during the procedure.³ It has been accepted that pressure ulcers are caused by 3 different tissue forces: pressure, shear force, and friction, all of which have an important role in the occurrence of surgery-related pressure ulcers. Contributing factors to the incidence of surgery-related pressure ulcers include the fact that during surgery, patients are immobile, and not able to feel pain caused by prolonged pressure on the operating table; the use of anesthetic agents can cause a loss of muscle tone that increases pressure over bony prominences; and prolonged pressure causes decreased perfusion, leading to ischemia and tissue necrosis. In addition, shearing and friction injury can occur as patients are repositioned on tables then transported. Shear force can cause the pinching off of blood vessels, which may aggravate ischemia and tissue necrosis, and friction may cause excess shedding of layers of epidermis. Some cardiac surgery patients have to use intra-aortic balloon pumps postoperatively; movement is not allowed when these are in use. This
combination of factors may cause surgery-related pressure ulcers, which exhibit some different epidemiological characteristics compared with general pressure ulcers.

In 1999, a national survey on 104 usable facilities with a total of 1,128 surgical patients showed the overall incidence based on a beta binomial was 8.5% (95% confidence interval: 6.1% to 10.9%). But after that, there wasn’t a large-scale survey to show the incidence of surgery-related pressure ulcers.

Over the past decade, pressure ulcer prevention and treatment strategies have changed as many new methods are emerging. The objective of this systematic review was to describe the incidence of surgery-related pressure ulcers.

Methods

Data sources and search strategy. The authors searched Pubmed and Web of Science databases. A search strategy of (“pressure ulcer”[MeSH Terms] AND “surgical procedures, operative”[MeSH Terms] AND (“incidence”[TW] OR “prevalence”[TW]) AND “humans”[MeSH Terms]) was used in Pubmed advanced search. A search strategy of (TS = (Pressure SAME Ulcer*) or TS = (Pressure SAME Sore*) or TS = (Bed SAME Sore*) or TS = (Decubitus SAME Ulcer*) AND TS = (Surg* or Operat*) AND TS = (incidence or prevalence)) was used in Web of Science advanced search. The time span was set from 2005 to 2011 in the 2 databases. The searches were performed on August 3, 2011.

Study selection criteria. To identify relevant studies, a list of inclusion and exclusion criteria was generated. The authors included studies: (1) that investigated the incidence of surgery-related pressure ulcers of all stages, not including suspected deep tissue injury, in the last 5 years; (2) were conducted for purposes other than determining the prevalence and incidence of surgery-related pressure ulcers, but from which the authors could extract the data of the surgery-related pressure ulcers incidence; (3) were cross-sectional, cohort, case control studies, and randomized clinical trials. The authors excluded studies that: (1) only investigated the prevalence of surgery-related pressure ulcers, but did not include incidence data; (2) investigated the incidence of pressure ulcers, not only for surgery-related pressure ulcers, such as data from medical and surgery centers, and data from comprehensive ICUs; (3) investigated the incidence of pressure ulcers complicated by a kind of disease which included patients not treated with surgery, such as spinal cord injury or hip fracture; and (4) investigated the incidence of pressure ulcers, not including stage I.

Statistical analysis. For each of the selected studies, the incidence with 95% confidence intervals (CI) was computed. For the meta-analysis, the overall pooled incidence with 95% CI was estimated by Der Simonian and Laird’s random-effects model. The heterogeneity was analyzed by Cochran’s Q test and I² statistic. A P < 0.05 by Cochran’s Q test indicated significant heterogeneity; an I² > 50% indicated substantial heterogeneity. Analyses were all performed using Meta DiSc 1.4 (version 0.6).

Results

Eligible studies. The authors initially retrieved 84 potentially relevant articles from Pubmed, and 222 articles from Web of Science. A total of 67 repeated articles were excluded. Of these 239 articles, 191 were inappropriate and excluded. An additional 31 articles did not meet the eligibility criteria and were excluded. Thus, 17 articles with 5,451 patients were included for analysis (Figure 1). Table 1 summarizes the major characteristics of the included studies. Study sample sizes ranged from 60 to 896. Included studies represented a great diversity across many countries: 5 studies from the United States, 3 studies from the Netherlands, 2 studies from Brazil, and the remaining 7 studies were from the Czech Republic, Canada, Korea, United Kingdom, Turkey, Sweden, or Pan-European countries. Patients included are divided into 4 categories: patients who underwent cardiac surgery; patients who underwent surgery for hip fracture; patients on the surgical ICU; and those

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Keypoints

- Over the past decade, pressure ulcer prevention and treatment strategies have changed as many new methods are emerging. The objective of this systematic review was to describe the incidence of surgery-related pressure ulcers reported in prospective longitudinal studies of the last 5 years.
who underwent other procedures, including orthopedic, neuro-, cardiothoracic, general, vascular, ob-gyn, or shoulder surgeries).

**Pooled incidence of surgery-related pressure ulcers.** The incidence of surgery-related pressure ulcers of the included studies ranged from 0.003 to 0.574. The pooled incidence of surgery-related pressure ulcers of the 17 included studies was 0.15 (95% CI 0.14 - 0.16, $I^2 = 98.2\%$). (Figure 2A)

Two studies\(^7,22\) assessed the pressure ulcer incidence for cardiac surgery. The incidence of the 2 studies was 0.21 (95% CI 0.15 - 0.28) and 0.14 (95% CI 0.15 - 0.28), respectively. The pooled incidence was 0.18 (95% CI 0.14 - 0.22, $I^2 = 62.8\%$). (Figure 2B)

Three studies\(^8,15-16\) assessed the pressure ulcer incidence for hip fracture surgery. The incidence of the 3 studies was 0.34 (95% CI 0.29 - 0.40), 0.08 (95% CI 0.06 - 0.11), and 0.30 (95% CI 0.26 - 0.33), respectively. The pooled incidence was 0.22 (95% CI 0.20 - 0.24, $I^2 = 98.4\%$). (Figure 2C)

Three studies\(^9,13,17\) assessed the pressure ulcer incidence for the surgical ICU. The incidence of the 3 studies was 0.24 (95% CI 0.29 - 0.40), 0.18 (95% CI 0.13 - 0.24), and 0.03 (95% CI 0.02 - 0.04), respectively. The pooled incidence was 0.11 (95% CI 0.09 - 0.13, $I^2 = 98.5\%$). (Figure 2D)

The other 8 studies\(^{10,12,14,18,20,21,23}\) assessed the pressure ulcer incidence for orthopedic, neuro-, cardiothoracic, general, vascular, or ob-gyn surgeries. The surgery-related pressure ulcers incidence ranged from 0.032 to 0.548.

One study\(^19\) assessed 896 patients having ar-

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**Figure 1.** Flow diagram showing selection of studies.
### Table 1. Characteristics of the included studies.

<table>
<thead>
<tr>
<th>First Author</th>
<th>Published Year</th>
<th>Country</th>
<th>Number of Events</th>
<th>Sample Size</th>
<th>Incidence</th>
<th>Type of Patient</th>
<th>Gender</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carneiro, GA</td>
<td>2011</td>
<td>Brazil</td>
<td>38</td>
<td>182</td>
<td>20.9%</td>
<td>Cardiac surgery</td>
<td>Not mentioned</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Kopp, L</td>
<td>2011</td>
<td>Czech Republic</td>
<td>92</td>
<td>269</td>
<td>34.2%</td>
<td>Surgery for hip fracture</td>
<td>50 male (13.6%) and 219 female (81.4%)</td>
<td>81 (70 - 99)</td>
</tr>
<tr>
<td>Slowikowski, GC</td>
<td>2010</td>
<td>United States</td>
<td>88</td>
<td>369</td>
<td>23.9%</td>
<td>Surgical ICU</td>
<td>208 male (56.4%) and 161 female (43.6%)</td>
<td>58.3 ± 19.3</td>
</tr>
<tr>
<td>Campbell, KE</td>
<td>2010</td>
<td>Canada</td>
<td>12</td>
<td>72</td>
<td>16.7%</td>
<td>Orthopedic surgery</td>
<td>29 male (40.0%) and 43 women (60%)</td>
<td>76 ± 16</td>
</tr>
<tr>
<td>Diccini, S</td>
<td>2009</td>
<td>Brazil</td>
<td>8</td>
<td>60</td>
<td>13.3%</td>
<td>Neurosurgical surgery</td>
<td>26 male (43.4%) and 34 female (56.6%)</td>
<td>49 (19 -78)</td>
</tr>
<tr>
<td>Schuurman, JP</td>
<td>2009</td>
<td>Netherlands</td>
<td>117</td>
<td>204</td>
<td>57.4%</td>
<td>Cardiothoracic surgery</td>
<td>129 male (63.2%) and 75 female (36.8%)</td>
<td>68.1 ± 9.6</td>
</tr>
<tr>
<td>Kim, EK</td>
<td>2009</td>
<td>Korea</td>
<td>40</td>
<td>219</td>
<td>18.3%</td>
<td>Surgical ICU</td>
<td>145 male (66.2%) and 74 female (33.8%)</td>
<td>58.1 ± 1.2 (16 - 98)</td>
</tr>
<tr>
<td>Grisell, M</td>
<td>2008</td>
<td>United States</td>
<td>10</td>
<td>66</td>
<td>15.1%</td>
<td>Thoracic and/or lumbar surgery</td>
<td>Not mentioned</td>
<td>18 - 65</td>
</tr>
<tr>
<td>Lindholm, C</td>
<td>2008</td>
<td>Pan-European</td>
<td>54</td>
<td>635</td>
<td>8.5%</td>
<td>Surgery for hip fracture</td>
<td>159 male (25.0%) and 476 female (75.0%)</td>
<td>80 (37 - 99)</td>
</tr>
<tr>
<td>Rademakers, LMF</td>
<td>2007</td>
<td>Netherlands</td>
<td>214</td>
<td>722</td>
<td>29.6%</td>
<td>Surgery for hip fracture</td>
<td>171 male (23.7%) and 551 female (76.3%)</td>
<td>82.2 (76.9 - 87.5)</td>
</tr>
<tr>
<td>Frankel, H</td>
<td>2007</td>
<td>United States</td>
<td>25</td>
<td>820</td>
<td>3.0%</td>
<td>Surgical ICU</td>
<td>Not mentioned</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Aronovitch, SA</td>
<td>2007</td>
<td>United States</td>
<td>9</td>
<td>281</td>
<td>3.2%</td>
<td>Cardiac, general, orthopedic, and vascular surgeries</td>
<td>Not mentioned</td>
<td>Not mentioned</td>
</tr>
</tbody>
</table>
throscopic or combined arthroscopic and open shoulder procedures. Each patient had an axillary roll during surgery. Three pressure ulcers occurred. The incidence was 0.003 (95% CI 0.000 - 0.010).

**Discussion**

Some available evidence showed that, due to more effective strategies and better prevention, the pressure ulcer prevalence and incidence in long-term care facilities and other health care facilities decreased in the last 10 years.24,25 Surgery-related pressure ulcers are the most common hospital-acquired ulcers. The principle finding from this systematic review is that the pooled incidence of the included studies was 0.15 (95% CI 0.14 - 0.16). The data from a national survey4 of surgery-related pressure ulcers in 1999 indicated that among the 1,128 included patients, of the 544 (48%) patients that had no comorbidities, 7% developed ulcers; of the 584 (52%) with at least one comorbidity, 9.1% developed ulcers; and the overall incidence was 8.5% (95% CI 60.1% - 10.9%). Compared with this survey 10 years ago, the current study’s results show the incidence of surgery-related pressure ulcers has not decreased, but increased. Studies confirmed that an age > 60 years, complications with diabetes or renal insufficiency, low American Society of Anesthesiologists (ASA) or New York Heart Association (NYHA) Functional Classification scores, and length of surgery, were the independent risk factors for surgery-related pressure ulcers.17,23,26 Due to the development of surgical techniques, the number of elderly surgical patients, surgical patients with complex complications, and patients needing surgery of a longer

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<th>Age</th>
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<tr>
<td>Keyurapan, E</td>
<td>2007</td>
<td>United States</td>
<td>3</td>
<td>896</td>
<td>0.3%</td>
<td>Shoulder surgery</td>
<td>Not mentioned</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Nixon, J</td>
<td>2007</td>
<td>United Kingdom</td>
<td>12</td>
<td>109</td>
<td>11.0%</td>
<td>General, vascular, and orthopaedic</td>
<td>Not mentioned</td>
<td>&gt; 55 years</td>
</tr>
<tr>
<td>Karadag, M</td>
<td>2006</td>
<td>Turkey</td>
<td>46</td>
<td>84</td>
<td>54.8%</td>
<td>Ob-Gyn, neurosurgery, general surgery; thoracic/cardiovascular surgery; orthopaedic</td>
<td>32 male (39.2%) and 52 female (61.9%)</td>
<td>48 ± 13.3 (20 - 74)</td>
</tr>
<tr>
<td>Feuchtinger, J</td>
<td>2006</td>
<td>Netherlands</td>
<td>25</td>
<td>175</td>
<td>14.3%</td>
<td>Cardiac surgery</td>
<td>125 male (71.4%) and 50 female (28.6%)</td>
<td>33 - 92</td>
</tr>
<tr>
<td>Lindgren, M</td>
<td>2005</td>
<td>Sweden</td>
<td>41</td>
<td>286</td>
<td>14.3%</td>
<td>Orthopaedic (121), abdominal (80), or cardiovascular surgery (60), and the remainder (25)</td>
<td>157 male (54.9%) and 129 female (45.1%)</td>
<td>67.1 ± 13.1</td>
</tr>
</tbody>
</table>

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**Key Points**

- Compared with a survey 10 years ago, the current study’s results show the incidence of surgery-related pressure ulcers has not decreased, but increased. Studies confirmed that an age > 60 years, complications with diabetes or renal insufficiency, low American Society of Anesthesiologists (ASA) or New York Heart Association (NYHA) Functional Classification scores, and length of surgery, were the independent risk factors for surgery-related pressure ulcers.17,23,26
duration, increased. The result may be the increased incidence of surgery-related pressure ulcers of the last 5 years. The results show appropriate monitoring and treatment for surgery-related pressure ulcers needs to be performed in order to lower surgery-related pressure ulcer incidence.

The national survey in 1999 also showed the most common surgical procedures related to pressure ulcers were cardiac (29.3%), general/thoracic (27.7%), orthopedic (20.6%), and vascular (9.8%). The author's systematic review included patients who underwent cardiac surgery; patients who underwent surgery for hip fracture; patients on the surgical ICU; and those who underwent orthopedic, neuro-, cardiothoracic, general, vascular, ob-gyn, or shoulder surgery.

This systematic review showed the pooled incidence for cardiac surgery-related pressure ulcers was 0.18 (95% CI 0.14 - 0.22, $I^2 = 62.8\%$). A literature review indicated that except for pressure, shear force, and friction, additional risk factors for pressure ulcers included the tissue tolerance for oxygen as temperature manipulation; vasoactive drugs; hypotensive periods; reduced hemoglobin and hematocrit levels; time on the operating room table; frequency of repositioning; immobility time; age; low albumin level; and corticosteroid use. Prevention measures for cardiac surgery-related pressure ulcers should be aimed at supporting tissue tolerance for pressure and oxygen, and relieving devices on the operating room table or postoperatively in bed.

In this systematic review, the pooled incidence for hip fracture surgery-related pressure ulcers was 0.22 (95% CI 0.20 - 0.24, $I^2 = 98.4\%$). Hip surgery complicated with pressure ulcers resulted in delayed patient mobilization. Some intrinsic patient characteristics (e.g., nutritional status and continence status) and the extrinsic exposures (e.g., longer interval between admission and surgery, longer duration of surgical anesthesia, comprehensive measures of comorbidity, and disease severity) are the risk factors for hip fracture surgery-related pressure ulcers. Hip fracture surgical patients are still associated with a high risk of pressure ulcers. For preventing and treating hip fracture surgery-relat-
ed pressure ulcers, Lindholm recommended performing risk assessment and skin observation with special attention to patients > 71 years\textsuperscript{15}, or with significant Braden risk factors; observing and correcting dehydration; and observing patients with diabetes mellitus and cardiovascular and pulmonary diseases.

In this systematic review, the pooled incidence of pressure ulcers in the surgical ICU was 0.11 (95% CI 0.09 - 0.13, $I^2 = 98.5\%$). Studies showed the risk factors for pressure ulcers were the same as other procedures: elderly age, diabetes, and low Braden Scale score.\textsuperscript{9,17}

In addition to these 3 types of surgery, orthopedic, neuro-, cardiothoracic, general, vascular, and ob-gyn surgery were included to review the incidence of surgery-related pressure ulcers. The incidence of surgery-related pressure ulcers with these procedures ranged from 0.032 to 0.548. Because only 1 study of each type of surgery was included, the authors cannot conduct the meta-analysis. However, the authors found the surgery that most frequently becomes complicated with pressure ulcers is vascular surgery. A study that assessed the incidence of pressure ulcers after arthroscopic or combined arthroscopic and open shoulder procedures was included. The incidence was 0.003 (95% CI 0.000 - 0.010). Pressure ulcers occurred because of axillary roll position for the duration of a long operation. While the incidence of pressure ulcers was low, this surgery can easily be complicated with pressure ulcers.

**References**

12. Schuurman JP, Schoonhoven L, Keller BP, van Ramshorst

**Limitations**

First, the included studies were not all special surveys for the incidence of surgery-related pressure ulcers, but clinical studies which reflected the incidence of surgery-related pressure ulcers. This may have resulted in the imprecision of the pooled data. Second, it was found that the $F$ of each meta-analysis was > 50%, which indicated substantial heterogeneity. This may have resulted in some degree of measurement bias.

**Conclusion**

The findings suggest pressure ulcers are still one of the more common complications of these surgical procedures. Appropriate monitoring and treatment for surgery-related pressure ulcers needs to be performed in order to lower surgery-related pressure ulcer incidence. This pooled incidence data may provide a benchmark to evaluate surgery-related pressure ulcers.

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