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## *Burns from Warming Devices in Anesthesia*

### *A Closed Claims Analysis*

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**Background:** Prevention of hypothermia is an important aspect of anesthetic management. Methods used for its prevention may, however, cause cutaneous burns. We reviewed the American Society of Anesthesiologists (ASA) Closed Claims Project database to determine if there were recurrent patterns of injury arising from intraoperative warming methods.

**Methods:** The ASA Closed Claims Project database is a collection of closed malpractice claims that have been reviewed in a standardized format. All claims for burns were reviewed.

**Results:** Among the 3,000 total claims there were 54 burns, of which 28 resulted from materials or devices used to warm patients. Intravenous fluid bags or bottles warmed in an oven and then applied to the patient's skin were responsible for 18 of the 28 (64%) burns associated with warming devices. These burns from intravenous fluid bags or bottles occurred in predominantly healthy (ASA physical status 1-2) young (age 38 ± 17 yr, mean ± standard deviation) women undergoing routine gynecologic or peripheral orthopedic surgery under general anesthesia. Of the eight burns from electrically powered warming equipment, five resulted from circulating-water mattresses.

**Conclusions:** Intravenous fluid bags or bottles warmed in an operating room oven represent a hazard to anesthetized patients. Because intravenous fluid bags or bottles are not an efficient method of patient warming, there seems to be little

justification for their use. (Key words: Complications, burns: circulating-water mattresses; warmed intravenous solution bags; warming lights. Equipment: warming devices.)

MAINTENANCE of body temperature is an important aspect of anesthetic management. A number of strategies have been utilized to prevent hypothermia in the anesthetized patient. These include the use of heating lamps, heated humidifiers, circulating-water mattresses, forced-air warming blankets, warm intravenous (iv) solution bags, and warm plastic bottles. The published literature contains few reports of injury due to failure or misapplication of these devices.<sup>1,2</sup> We used the database of the American Society of Anesthesiologists (ASA) Closed Claims Project to conduct an in-depth study of claims for injuries caused by patient warming devices. Of the patient warming methods currently in use, warmed iv solution bags or plastic bottles were responsible for 64% of the 28 thermal injuries in the database. Burns from this source have not been previously reported.

### Materials and Methods

The ASA Closed Claims Project is a structured evaluation of adverse anesthetic outcomes obtained from the closed claims files of 30 United States professional liability insurance carriers. The database for this report consists of 3,000 closed claims collected since 1985, of which 89% of the adverse events occurred between 1977 and 1987. Claims for dental damage were excluded.

Details of the methods, summarized here, have been reported previously.<sup>3</sup> One or more practicing anesthesiologists visited each insurance company to review closed claims according to a detailed set of instructions. The components of a closed claim file include hospital and anesthesia records, narrative statements by the personnel involved, expert and peer review, deposition summaries, outcome reports and the cost of settlement

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or award. A standardized form was used to record detailed information on patient characteristics, surgical procedures, anesthetic agents and techniques, involved personnel, sequences of events, and outcome. Reviewers also made a judgment about the standard of care provided and wrote a brief report of each case that summarized the sequence of events and provided additional details.

For this report claims for burns were extracted from the database and classified into three major categories. Burns caused by materials heated in a warming oven and used for the purpose of generalized or local warming were classified as "heated materials." Burns caused by electrically powered equipment designed to treat hypothermia or provide localized heat were classified as "warming equipment." These two categories, when grouped together were classified as "warming device burns." All other burns were classified as "other burns."

## Results

Burns from heated materials or warming equipment occurred in 28 patients representing 1% of the total database of 3,000 claims. Materials heated in an oven and used for patient warming caused 20 of the 28 burns, with the other eight being caused by electrically powered equipment intended for clinical use in patient warming (table 1).

Warmed iv bags or bottles were responsible for all but two of the 20 burns in the heated materials category (table 1). The other patients in the heated materials group sustained burns from hot packs and compresses applied for the purpose of treating iv infiltrations. Overall, most burns in this group were to the axilla or extremities.

Among the 18 burns caused by a heated iv bag or bottle, 15 involved an iv bag or bottle being used to warm the patient (14 directly and 1 by warming an iv blood transfusion). In the other three claims, a warmed iv bag or bottle was placed on the patient's skin in order to provide local heat. In 5 of the 18 burns caused by iv bags or bottles, the reviewer explicitly stated that the burn was of second- or third-degree severity.

Of the 15 claims for burns caused by the use of warmed iv bags or bottles for generalized warming of the patient, treatment of hypothermia was specified in 5. In three others, maintenance of body temperature was the indication. In the remaining seven claims, the rationale for application of the heated bag or bottle

**Table 1. Source of Burns from Warming Devices**

	N	% of 28
Heated material	20	71
IV bag/bottle	18	64
Hot packs/compresses	2	7
Warming equipment	8	29
Circulating water blanket	5	18
Warming light	1	4
Heated humidifier	1	4
Heating pad	1	4

was stated in more general terms (*e.g.*, to warm the patient). Five of these 15 burns were caused by warmed iv bags or bottles placed by the anesthesiologist, 1 by a certified registered nurse anesthetist and 1 by an operating room nurse (others unknown).

In two of the three claims in which a warmed iv bag or bottle was placed on the patient's skin to provide local heat, the device was used for the purpose of treating the sequelae of an infiltrated iv infusion. In the third claim, a warmed iv bottle was used to cause venous dilation to facilitate placement of an iv catheter. One of these three warmed iv bags or bottles used for local heat was placed by an anesthesiologist and one by an operating room nurse (the third unknown).

The patients who sustained burns from heated materials predominantly underwent surgical procedures in which the risk of significant hypothermia would be expected to be small—*e.g.*, gynecologic (ten cases), peripheral orthopedic (five cases), or hernia (two cases) procedures. The patients were predominantly women (85%), relatively young (age  $38 \pm 17$  yr, mean  $\pm$  standard deviation), healthy (ASA physical status 1–2) and all received general anesthesia. The year in which the injury occurred ranged from 1982 to 1989. The standard of care was judged by the reviewers as less than appropriate in all but one of the iv bag or bottle induced burns. Payment was made in 19 of the 20 claims for the burns due to heated materials (payment data was unavailable in the other claim). The amount of payment ranged from \$3,500 to \$80,000, with a median amount of \$18,000.

Burns from electrically powered warming equipment represent only 29% of the total burns from warming devices (table 1). More than half of the burns in this category were from circulating-water mattresses. In only one of the burns caused by circulating-water mattresses did the reviewer explicitly state that the device was defective. The patients burned by circulating-water

mattresses were at the extremes of age (one infant and four adults older than 60 yr), were mostly ASA physical status 3–4 and with only one exception were undergoing major surgical procedures. Payment was made in all but one of the five burns in the circulating-water mattress group, the largest amount being \$12,500. The reviewers judged the care as appropriate in all but one of these cases.

One burn resulted from a warming light that was being used to treat hypothermia in a 2-day-old infant. The anesthesiologist had removed the diffusing lens from the lamp and placed the lamp 3 m from the patient. The infant sustained third-degree burns despite constant vigilance over skin temperature.

One burn was caused by a heated humidifier. The tubing was padded but came in contact with the arm and a permanent disfiguring scar resulted. The one heating pad burn resulted from treatment of an iv infiltration. The patient sustained scars and underwent multiple surgical procedures.

By way of comparison, there were 26 other claims in the database for thermal burns unrelated to patient warming (table 2). These include seven burns due to electrocautery, five burns from iv bags used to maintain patient body position, two burns due to hot retractors, two burns from warm bottles used to soften endotracheal tubes, and ten burns from other equipment used during anesthesia and surgery.

Payments were made in 18 (69%) of claims for thermal burns unrelated to patient warming. The median payment was \$29,500 (range \$4,000–\$330,000). The largest payment was \$330,000 to a patient who sustained permanent loss of hand function from severe burns caused by a nerve stimulator.

The five burns from iv bags used to maintain patient position occurred in relatively short operations (hip replacement, dental procedure, colectomy and two orthopedic ankle procedures). In two of these five burns the reviewer noted the bag was taken from the warming oven and the temperature “checked” before placement. Three of these burns were axillary, as the iv bags were used as an axillary roll to maintain the patient in the lateral position. Payment was made in all five claims for position related burns with a median amount of \$30,000 and a range of \$15,000–\$91,000.

The two burns from warm bottles used to soften endotracheal tubes both involved nasal intubation for oral surgery. In both cases the warm bottle used to soften the tube came in direct contact with the patient's skin. Both burns involved the upper extremities, with one

**Table 2. Thermal Burns from Operating Room and Anesthesia Equipment Not Used for Patient Warming**

	N	% of 26
Electrocautery	7	27
IV bag to maintain body position	5	19
Bottle to soften nasal tracheal tube	2	8
Hot retractor	2	8
Nerve stimulator	1	4
Electrocardiogram	1	4
Radiofrequency generator	1	4
Pulse oximeter probe	1	4
Laser surgery	1	4
Lamp to transilluminate hand	1	4
Lamp, unknown purpose	1	4
Cardioversion paddles	1	4
Unknown cause	2	8
Total	26	

necessitating a skin graft. Payments to these patients were \$4,000 and \$38,000, the latter payment involving the more serious burn and skin graft.

## Discussion

The surprising finding of this analysis of claims for injuries due to patient warming devices is that 64% of the burns were due to warmed iv bags or plastic bottles. Also of note was that the injuries occurred primarily in young healthy women undergoing gynecologic surgery.

Before interpretation of the data it should be emphasized that closed claims analysis has certain limitations. The most notable limitation is that there is no denominator of the number of patients at risk of injury. There is no way of estimating the total number of anesthetics administered nor the number of patients who had warming devices applied during the years that the claims were made, preventing calculation of any general estimate of the risk of anesthetic injury. Also, claims are included in the ASA Closed Claims Project database only if there is sufficient information in the file to reconstruct the sequence of events and determine nature of the injury. Therefore, it is possible that many claims for minor burns were excluded because no lawsuit was filed and the relatively mild nature of the injury may not have been worth the cost of investigation by the insurance company. This may explain why the incidence of payment was so high among this collection of claims in that only the most severe burns were en-

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tered into the database. Other limitations of closed claims analysis include the lack of a control group and geographic balance in the source of claims.

It is not surprising that more than half of the thermal burns in the ASA Closed Claims database would be related to warming devices or materials intended for application of generalized or localized heat. The database consists of claims filed against anesthesiologists and anesthesiologists are generally responsible for monitoring and maintaining the patient's body temperature intraoperatively. Claims for burns from electrosurgical units and other nonanesthesia equipment would generally be filed against the hospital, surgeon, or equipment manufacturer. This may explain the small number of such claims in the ASA Closed Claims database.

In spite of the aforementioned limitations, certain conclusions can be drawn from the data. The most obvious is that warm iv bags or plastic bottles are a hazard to the anesthetized patient when placed in contact with the skin. There seems little justification for their use as a patient warming device as an iv bag or bottle covers only a small area of the skin and would therefore make an insignificant contribution to the prevention of heat loss or restoration of body temperature.<sup>4</sup> Patient hypothermia (either treatment or prevention) was the indication for use of the warm iv bags or bottles in 15 of the 25 total burns resulting from their use. In the remainder of the iv bag or bottle burns, three claims involved the use of warm iv bags or bottles for the application of local heat, in five they were used to maintain patient position and in two claims they were being used to warm nasotracheal tubes. It is difficult to see the rationale for utilizing warmed iv bags to maintain patient position.

It is notable that a review of the literature from 1970 to 1993 revealed no reports of burns from warm iv bags or plastic bottles. There is one case report of a third-degree burn to a 3-yr-old child from a heated cryogel pack applied to treat an iv infiltration.<sup>5</sup> Thermal burns have been reported in dogs under anesthesia who had latex surgical gloves filled with warm water applied to relatively hairless skin.<sup>6</sup> It may be that burns from warm iv bags or bottles are usually minor or relatively rare. Although cutaneous burns are certainly less serious than the other complications already reported in the closed claims database (death, brain damage, and permanent nerve damage),<sup>3</sup> they do represent a source of morbidity to the patient, a liability risk to the anesthesiologist and a source of financial loss to the insurance company.

The claims for burns from heated materials were relatively recent (1982–1989). There is generally about a 5-yr lag in closed claims analysis, because it takes several years for claims to close and go through the process of being entered onto the database. These claims are some of the most recent claims in the database. They clearly do not represent an outmoded practice but rather are representative of a contemporary source of anesthetic injury.

The judgment of substandard care by the Closed Claims reviewers in all but one of the burns from the iv bags or bottles is curious in light of the lack of reports of their occurrence in the medical literature. The practitioners who applied those warmed materials presumably would not have had any prior knowledge that cutaneous burns could result. The finding of substandard care may represent outcome bias by the reviewers. We have previously reported that anesthesiologists are influenced by the severity of the outcome in their judgments about standard of care.<sup>7</sup> The more severe the outcome, the more the care is apt to be judged as substandard. The reviewers may have judged the care as substandard because the patient sustained a burn. Furthermore, they may have presumed that the practitioners should have known that warmed iv bags or bottles had the potential to cause cutaneous burns.

The predominance of women undergoing gynecologic surgery in the iv bag or bottle group may be due to a number of factors. It could be that women's skin is more susceptible to burns, or perhaps women may be more concerned than men with the resultant scar and thus more apt to make a claim for burn injury. It is ironic that these burns occurred predominantly in patients undergoing surgeries having a relatively low risk for the development of hypothermia.

Burns from electrically powered warming equipment represent only one third of the total burns from patient warming devices. The circulating-water mattress burns occurred in patients with high-risk factors for both hypothermia and burns; *i.e.*, older age group or infant, vascular disease, and long operation. In only one case was the circulating-water mattress found to be defective, the result of which was a burn from overheating of the device. There are reports in the medical literature of thermal injuries from circulating-water mattresses in two patients undergoing aortoiliac bypass grafts<sup>1</sup> and three patients undergoing open heart surgery.<sup>2</sup> In all cases the blankets were functioning normally, the burns were over bony prominences (as seen in the current report), and were attributed to a combination of heat

and pressure. The relative lack of claims in the current report from burns due to circulating-water mattresses may be due to the equipment manufacturer or hospital being sued rather than the anesthesiologist, although the extent of this problem is unknown.

In conclusion, a major source of claims for burns due to patient warming devices is iv bags or plastic bottles warmed in an operating room warming oven. In addition, warm iv bags or bottles cause burns when used for such other purposes as maintaining body position. These injuries are easily prevented if iv bags or bottles are used only for their original purpose: containing liquid. Prevention and treatment of hypothermia or application of localized heat should be conducted with devices of proven efficacy that have been specifically designed for the safe transfer of heat.

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## Appendix

The authors acknowledge the efforts of the American Society of Anesthesiologists members who served as reviewers. A list of reviewers is available from the authors.

The following organizations have given permission for acknowledgement as a source of closed claims: Anesthesia Service Medical Group (California), Anesthesiologists Professional Assurance Trust (Florida), Armed Forces Institute of Pathology, Controlled Risk Insurance Company (Harvard), COPIC Insurance Company (Colorado),

Doctors Company of Southern California, Illinois State Medical Inter-Insurance Exchange, Massachusetts Medical Professional Insurance Association, Medical Association of Georgia Mutual Insurance Company, Medical Inter-Insurance Exchange of New Jersey, Medical Liability Mutual Insurance Company of New York, Medical Mutual Insurance Company of Maine, Minnesota Mutual Insurance Exchange, Mutual Insurance Company of Arizona, National Capital Reciprocal Insurance Company, NORCAL Mutual Insurance Company (California), Pennsylvania Medical Society Liability Insurance Company, PHICO Insurance Company (Pennsylvania), Physicians Insurance Company of Wisconsin, PIE Mutual Insurance Company (Ohio), St. Paul Fire and Marine Insurance Company, State Volunteer Mutual Insurance Company (Tennessee), University of Texas System, Utah Medical Insurance Association, Veterans Administration, and Washington State Physicians Insurance Exchange Association.

The other organizations serving as sources of closed claims remain anonymous for purposes of confidentiality.

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