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## Burns Caused by Medical Therapy

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A burn injury may occur as an unexpected consequence of medical treatment. We examined the burn prevention implications of injuries received in a medical treatment facility or as a direct result of medical care. The records of 4510 consecutive admissions to 1 burn center between January 1978 and July 1997 were retrospectively reviewed. A cohort of 54 patients burned as a result of medical therapy was identified and stratified by location (home vs medical facility) and by mechanism of injury. Twenty-two patients were burned in a medical treatment facility, including 12 patients who were burned as a result of careless or unsupervised use of tobacco products. Thirty-two patients were burned as a result of home medical therapy, including 9 patients who had scald injuries from vaporizers, 8 patients who were burned by simultaneous use of cigarettes and home nasal oxygen therapy, and 11 patients who were burned by therapeutic application of heat. In contrast to previous studies, no patient was burned by the use of medical laser devices. To further decrease burn risk from medical therapy we advocate the prohibition of cigarette smoking in any medical facility. Continued tobacco use may represent a contraindication to home oxygen therapy. Given the lack of proof of efficacy combined with the potential for burn injury, the use of vaporizers to treat upper respiratory symptoms should be discouraged. Patients with diminished sensation or altered mental status are at increased risk of burn injury from bathing or topical heat application and merit closer monitoring during these activities. (*J Burn Care Rehabil* 2000;21:269-73)

The goal of medical therapy is an improvement in health; however, burn injury may occur during hospitalization or as a result of medical treatment. These unexpected injuries are unsettling to the patient, to the healthcare provider, and to the facility involved. Because of fear of litigation, patients with such injuries, even if the injuries are minor, are often referred to a burn center for care.

Burn injury associated with medical therapy may be intentional or accidental. Several folk remedies, including moxibustion,<sup>1</sup> cupping,<sup>1,2</sup> and maqua,<sup>3</sup>

involve the deliberate application of warm or hot objects to the skin. Accidental burn injury may occur as a result of laser treatment or misuse or malfunction of electrocautery or from ignition of drapes or oxygen devices in the operating room. Although the fire hazards inherent in the operating suite have been recognized, few studies have addressed the potential burn hazards found elsewhere in the hospital. Even fewer studies have addressed the burn risks posed by medical therapy administered at home.

The number of medical conditions that can be managed at home has increased from approximately 30 to more than 1200 in the last 15 years.<sup>4</sup> The trend of early hospital discharge combined with home-based therapy may be expected to accelerate as the mean age of the population increases and as managed care assumes greater prominence. A question currently unanswered is who should be responsible for the safe operation of medical devices used in the home care setting.<sup>4</sup>

We examined the circumstances of burn injuries that occurred as a result of inpatient or home med-

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ical therapy to determine how these injuries might have been prevented.

## METHODS

The records of 4510 consecutive admissions to 1 burn center between January 1978 and July 1997 were retrospectively reviewed. A cohort of 54 patients who were burned as a result of medical therapy was identified and stratified by location (home vs medical facility) and by mechanism of injury. The average age of the 54 patients was 48.1 years (range, 0.2-92 years). The patients had an average burn size of 13.6% total body surface area (TBSA; range, 0.1%-73.5%) and an average full-thickness burn of 7.1% (range, 0%-71.5%). The burn center length-of-stay averaged 20.2 days, with a range of 1 to 102 days.

Six patients had associated smoke inhalation injury diagnosed by fiberoptic bronchoscopy or xenon lung scan. All patients with inhalation injury were burned in incidents related to the use of tobacco products. There were 12 fatalities, including 3 patients with smoke inhalation injury.

Twenty-two patients were burned in medical treatment facilities, including 14 patients who were burned in hospitals and 8 patients who were burned in nursing homes. Thirty-two patients were burned as a result of home medical therapy, either self-prescribed or performed on the advice of a health care professional.

## RESULTS

Twenty-two patients were burned in a hospital or nursing home setting (Table 1). For these patients, the most common mechanism of injury was a fire started by smoking materials (12 patients). Most were smoking surreptitiously or in an unsupervised setting. Seven patients were burned while smoking in bed, in a chair, or in a wheelchair, including 1 patient who was restrained at the time of the fire. Nearly two thirds of this group died from their burn injuries. Advanced age and pre-existing medical conditions were factors in this high mortality rate.

Six patients were burned during surgical or gynecologic procedures. No case involved oxygen or laser equipment. Three patients were burned by the application of an incorrect topical medication or surgical preparation solution. Three patients were burned by the intraoperative use of the following: a tourniquet (1 patient), a heat lamp (1 patient), and an electrocautery-grounding pad (1 patient).

Two patients, including 1 fatality, were scalded

while being bathed in nursing homes. The average age of patients burned by this mechanism was 67.7 years. The temperature of the bath water involved was unavailable from the burn center patient records.

Two health care workers were burned at work. One case was caused by steam exposure from an autoclave, and the other was caused by exposure to therapeutic radiation. The patient records did not indicate whether or not proper procedures were being followed at the time of the burn injury or whether or not an equipment malfunction occurred.

Thirty-two patients were burned as a result of home medical therapy. The most common injury seen was a scald burn incurred while hot water vapor was inhaled to treat upper respiratory symptoms. The heat source was a vaporizer in 5 cases and a pot, pan, or cup of hot or boiling water in 4 cases. The type of vaporizer (steam vs cold mist) was not recorded in burn center patient records.

The second most common at-home injury (8 patients) involved the behavior of smoking a cigarette while using outpatient nasal oxygen. In at least 1 case, the burn injury occurred when the patient was leaning over a gas stove and attempting to light a cigarette while on nasal oxygen. This group comprised mostly older individuals with significant chronic medical disease. Fifty percent had associated smoke inhalation injury, and 2 patients (25%) died. The average total burn size and length-of-stay data were skewed by 1 individual with a total burn size of 73.5% TBSA. The remaining patients had a total burn size of 3% TBSA or less and an average length-of-stay of 2.6 days.

A number of burns in the home resulted from the therapeutic application of heat, including 6 patients burned by heating pads, 1 patient burned by a heat lamp, and 4 patients burned by contact with hot water bottles or soaks. Contributing factors were advanced age, chronic illness, limited mobility, and altered skin sensation. The average hospital length-of-stay for this group (22.9 days) was excessive in comparison with the average total burn size of 3.0% TBSA.

An unexpected finding was that 4 patients were burned when flammable medication ignited. All cases involved the use of rubbing alcohol or hot oil as a topical agent. Ignition sources included the bathroom hot water heater, cigarettes, and candles.

## DISCUSSION

Previous reports of burn injuries that result from medical therapy have centered on the operating room environment and, in particular, on the hazards of elec-

Table 1 Burns related to medical therapy

	n	Mean age (y)	Mean burn size		Mean length of stay (days)	Inhalation	
			Total	Third degree		Injury	Survival
Burned in the medical facility							
Smoking-related	12	64.9	27.6%	21.3%	29.5	16.6%	41.6%
Surgical/gyn procedure	6	21.9	2.8%	0.9%	21.5	0%	100%
Scald during bathing	2	67.7	20.3%	3.0%	29.0	0%	50%
Occupational injury	2	45.0	5.7%	0%	15.5	0%	100%
Burned at home							
Smoking while on nasal oxygen	8	62.6	10.7%	9.2%	2.8	50%	75%
Vaporizer	9	6.6	10.0%	0.7%	19.4	0%	100%
Heating pad	6	67.8	1.4%	1.4%	20.5	0%	100%
Hot water bottle or soak	4	43.3	6.0%	0.5%	21.5	0%	100%
Ignition of flammable medication	4	61.7	31.8%	7.5%	18.0	0%	50%
Heat lamp	1	74.0	1.0%	0%	43.0	0%	100%

trocater or laser devices used in the presence of oxygen or nitrous oxide.<sup>5-22</sup> Burn injury has also been reported in association with the use of cardiac defibrillators,<sup>23,24</sup> ultraviolet phototherapy,<sup>25</sup> transillumination devices,<sup>26-28</sup> pulse oximetry,<sup>29-36</sup> and other monitoring equipment,<sup>32,37,38</sup> or from the intentional misuse of psoralens as a photosensitizing agent.<sup>39,40</sup>

Our study is remarkable for the relative absence of patients who were burned by any of these previously reported mechanisms, which may reflect referral patterns specific to this unit or may represent increased vigilance on the part of surgeons and anesthesiologists. Most of the patients in our study were burned by the use of tobacco products, the inhalation of water vapor, or the local application of heat.

Cigarette smoking-related burns accounted for nearly half of the injuries in this study, including 9 of 12 fatalities. This is not surprising, considering that lighted tobacco products (excluding matches or lighters) are the leading cause of all fire deaths in the United States.<sup>41</sup> According to the National Fire Protection Association, in 1995, smoking materials were responsible for an estimated 1122 civilian fire deaths, 27,000 residential structure fires, 8400 non-residential structure fires, 110,400 outdoor or other fires, and \$507 million of direct property damage.<sup>41</sup> Smoking materials were the ignition source for 8 of 15 fatalities from in-hospital fires reported by Bongard et al<sup>42</sup> and for 3 patients burned in the hospital who were smoking while on nasal oxygen reported by Knox and Frable.<sup>43</sup>

For both health and safety reasons, we believe that smoking should be completely prohibited in any health care facility, including nursing homes. A hospital fire started by a patient who smokes endangers

many, including other patients who may be bedridden, disoriented, mobility-limited, or otherwise difficult to evacuate. This gives new meaning to the term "second-hand smoke."

The use of home oxygen therapy by patients who continue to smoke represents another aspect of this problem. Eight patients in this study were burned while smoking on home oxygen therapy. Other reports in the medical and fire literature suggest that this behavior may be more common than appreciated.<sup>4,44,45</sup> Wolf notes that home oxygen use involves risks inherent in storage and handling of cylinders, in transfer of liquid oxygen, and dangers related to inadequate ventilation, smoking, and unsafe use of flame.<sup>4</sup> Formal regulation of home oxygen therapy is lacking, principally because of questions regarding jurisdiction.<sup>4</sup> Continued tobacco use may represent a contraindication to home oxygen therapy.<sup>44,45</sup>

Eleven patients in this study were burned by the therapeutic application of heat by means of hot soaks, hot water bottles, heating pads, or heat lamps. Insensate skin and chronic medical illness such as diabetes mellitus were common risk factors. The scald potential from hydrotherapy in patients with diabetic or other neuropathy is well documented.<sup>46,47</sup> A second group at risk are patients requiring cutaneous, fasciocutaneous, or myocutaneous flap procedures for surgical reconstruction.<sup>48-51</sup> Transposed flap tissue may be insensate and may also have compromised circulation, which interferes with heat dispersal.<sup>51</sup> Also at risk are those unable to react to the sensation of heat or pain. Burns have been accidentally produced in anesthetized, unconscious, or immobilized patients by the use of hydrotherapy, heating blankets, hot water bottles, or other warm-

ing devices both within the hospital and in the field by Emergency Medical Services.<sup>52-56</sup>

The final major mechanism of injury in this study involved the inhalation of hot water vapor to alleviate upper respiratory symptoms in children. This practice is ubiquitous, despite the lack of scientific evidence that hot water vapor or steam inhalation has any therapeutic benefit.<sup>57-60</sup> It is estimated that steam vaporizers cause over 600 burn injuries annually.<sup>57,59</sup> To prevent burn injury "cold mist" vaporizers are now advocated. These devices are more expensive than steam units and are less likely to be used.<sup>59</sup> Four of the patients in this study used containers of hot or boiling water to generate steam, presumably because of financial constraints. Given the lack of proof of efficacy combined with the potential for burn injury, the use of vaporizers to treat upper respiratory symptoms should be discouraged.<sup>57</sup>

Thermal injury is an unexpected, undesirable, and preventable complication of medical therapy. As health care delivery becomes increasingly homecentered, the potential for burn injury may increase. The recognition of the fire hazards inherent in the operating room environment have resulted in better engineering and operating practices, as well as increased safety awareness on the part of practitioners. Similar recognition and awareness is needed for the burn hazards found outside of the operating theater. To this end, we advocate a complete ban on the use of smoking materials in any health care facility. The use of steam vaporizers should be abandoned. Health care providers who prescribe the local application of heat should warn patients of the potential risks involved, particularly in situations involving diminished skin sensation. The inability to abstain from smoking may constitute a contraindication to the prescription of home oxygen therapy.

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