
Effect of a Targeted Education Intervention on the Incidence of Waste-Burning Injuries in a Military Population

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The burning of waste is a common cause of accidental injury on the battlefield. This study was devised to determine the incidence of burns incurred while burning waste during U.S. military operations prior to and following an intervention targeted at reducing such injuries. The intervention consisted of memoranda outlining potential dangers and suggesting improved safety procedures. It was distributed to the combat theater (Iraq and Afghanistan) in March 2004. We reviewed military burn center records from March 2003 to March 2005. Demographics, injury data, and outcomes were recorded and compared between those casualties injured prior to and following the initiative. Twenty-four patients were injured while burning waste, 10% of military casualties admitted to the burn center during the study period. From March 2003 to March 2004, 20 patients were admitted with such injuries. The incidence of 1.67 per month was significantly ($P < .05$) higher than that seen the year after the intervention (four patients, 0.33 per month). TBSA burned was not different between the two time periods ($9.8 \pm 8\%$ before vs $6.3 \pm 7\%$ after, $P = .43$). There were no deaths, and only one patient had an associated nonburn injury. Only 54% of patients returned to military duty. The initiative was followed by a significant decrease in the incidence of waste-burning injuries. We conclude that the initiative was successful and highlights the importance of continued military burn surveillance and prevention efforts. (J Burn Care Res 2009;30:700–704)

Burns are a common mechanism of injury in military operations, comprising between 5 and 20% of injuries incurred in ground combat theaters.^{1,2} Historically, a significant proportion of military burns have resulted from causes unrelated to direct enemy action. In the Vietnam War, these noncombat burns accounted for over half of all injuries treated at an in-theater burn center,³ and this trend continues during ongoing operations.⁴ Noncombat burn injuries may be related to the performance of common military tasks

such as the handling of ammunition and gunpowder, misuse of gasoline and other flammables, and electrical injuries.^{3,4}

Incineration is an approved method for the disposal of waste in austere military environments such as those existing during the initial phases of military operations. During these periods, military living and working environments often lack infrastructure for the disposal of human and other waste material. Personnel frequently live and work in tents or other temporary structures, and sanitary facilities often consist of nothing more than steel drums to collect waste and refuse. Burning is considered by the military to be both an effective and a sanitary method of waste disposal. The procedure of mixing human waste with diesel fuel, lighting the mixture on fire, and stirring the mixture has remained in use and relatively unchanged for more than half a century of military operations, and the procedure remains in use today. Unfortunately, because of the limitations of field training exercises, soldiers deploying to an austere theater of operations sometimes lack realistic training in safe methods of burning waste. This may produce

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a situation in which preventable burn casualties can result from the relatively simple task of burning human waste.

The U.S. Army Burn Center has received all U.S. military burn casualties from current conflicts in Iraq and Afghanistan through the medical evacuation chain. During the early stages of current military operations, the burn center personnel noted a significant number of casualties who had sustained burns while incinerating waste on the battlefield.⁵ In response, the burn center developed a service-member education program and deployed it through the medical chain of command to combat leaders.

This study was devised to test the hypothesis that this intervention was followed by a reduction in the rate of burns related to waste incineration in the combat theaters in Iraq and Afghanistan.

PATIENTS AND METHODS

The education program consisted of a memoranda produced by the clinical staff (physicians, nurses, and ancillary staff) of the U.S. Army Burn Center and distributed to the theater of operations in late March of 2004, 1 year following the arrival of the first casualties at the burn center. The distribution was performed through the extensive in-theater medical chain of command, principally through U.S. Army channels, as these represented most of the medical assets in the theater. The memoranda outlined the potential dangers of burning as a means of waste disposal and suggested improved safety procedures. Safety measures noted in the communications included transition to safer methods of waste disposal as soon as possible, the wearing of fully covering clothing and protective garments, such as goggles and gloves, during the waste-burning procedure and precautions against adding accelerants to the diesel-fuel-human waste mixture.

The data for this study were acquired through a review of institutional burn center records from April 2003 through March 2005. The records of all military patients evacuated to the burn center from the theaters of operations in Iraq and Afghanistan were reviewed. All service members whose records indicated that they had been burned while disposing of waste were identified, and clinical information was placed into a database (Excel, Microsoft, Redmond, WA). The data extracted from the records included demographic information, burn characteristics, and early outcomes. The casualties were divided into two groups: those injured between April 1, 2003 and March 31, 2004 (preintervention period), and those

injured between April 1, 2004 and March 31, 2005 (postintervention period).

For statistical analysis, comparisons using Student's *t*-test were made between patients injured during the two periods. All tests were two tailed, and the threshold for statistical significance was set at $P < .05$. Results are presented as mean \pm standard deviation.

RESULTS

During the period from March 1, 2003 to March 31, 2005, there were a total of 232 military burn casualties evacuated to the burn center from Iraq and Afghanistan. Ninety-seven (42%) of these burns did not occur as a result of enemy action and were considered to be noncombat injuries. Of these, 24 patients (25% of noncombat injured) were burned while incinerating waste and formed the study population. Twenty of these were burned during the preintervention period and four during the postintervention period. All of the waste incineration casualties that preceded the intervention occurred in the U.S. Army soldiers. All four occurring after the intervention were in the U.S. Marines. The incidence of the admission of casualties with waste-burning injuries 12 months prior to the intervention was 1.67 admissions per month. Following the intervention, the incidence was 0.33 per month. This difference represented a statistically significant ($P < .05$) decrease in incidence following the education intervention. The peak incidence was reached in June 2003, when four patients were admitted to the burn center with injuries sustained while incinerating waste. With the exception of January 2004, at least one patient per month from April 2003 through April 2004 was admitted with such an injury (Figure 1).

Prior to the intervention, the mean TBSA burned was $9.8 \pm 8.0\%$. This declined to $6.3 \pm 7.3\%$ in the postintervention period. Full-thickness burn size decreased from $3.5 \pm 7.4\%$ to $1.4 \pm 2.8\%$. These differences were not statistically significant. Reflecting the smaller, more superficial burns, the number of patients requiring operations decreased from 13 in the 20 preintervention patients (65%) to one in the postintervention group of four (25%). Corresponding to the difference in severity of injury, hospital length of stay decreased from 17 to 6 days following intervention.

For the entire population, the most frequently burned areas of the body were the hands and forearms, representing 71 and 67% of casualties, respectively. These were followed by the face, with 54% (Figure 2). There were no inpatient deaths in the population. There were three complications (13%),

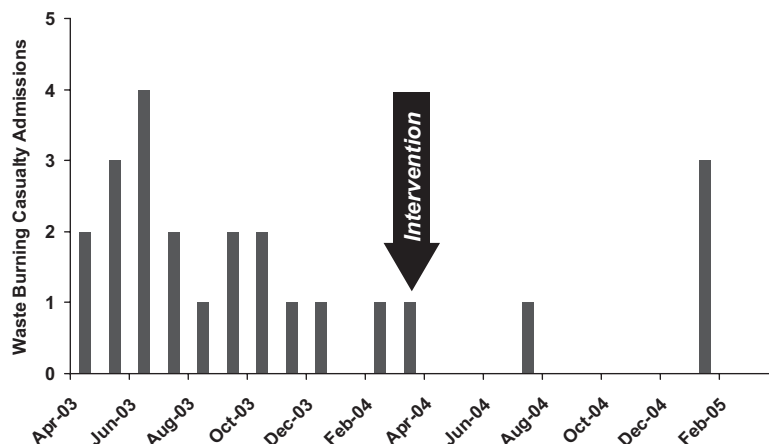


Figure 1. Monthly incidence of waste-burning injuries from April 2003 to March 2005. A significant decrease in incidence is noted after the educational intervention made in March 2004.

all occurring in patients injured prior to the intervention. Two patients had burn wound cellulites and one had ventilator-associated pneumonia that resulted in gram-negative bacteremia. This patient was the only intubated patient and the only one who required intensive care unit admission. All patients were discharged home and able to care for themselves and 13 (54%) returned to military duty.

DISCUSSION

Burns, particularly those not related to combat action, remain a vexing problem for military health care providers during current operations. These types of injuries are generally considered to be preventable, yet they have been a persistent part of military operations for decades. During the Vietnam era, a group of military surgeons from the forward-deployed military burn center in Japan reported on the epidemiology and treatment of burn casualties. Their report

identified that between 1966 and 1968 approximately half of the burn casualties (1005 of 1963) were injured in an event unrelated to combat, and that of these noncombat events, 33 (3%) involved burning waste.³

Our data demonstrate that at least in the initial stages of current military operations, little if anything had changed since Vietnam. Noncombat burns were frequent, and the burning of waste resulted in a significant proportion of these injuries. Our study likely underestimates the overall incidence of these injuries because we only had access to records of patients who were evacuated out of the combat theater to the burn center, and thus we may have missed some patients with minor injuries deemed unworthy of long-distance evacuation. Noting the high incidence of waste-burning injuries, the burn center personnel took on the task of intervening in an attempt to reduce such injuries, and their intervention was followed by a significant reduction in the incidence of burns from waste incinera-

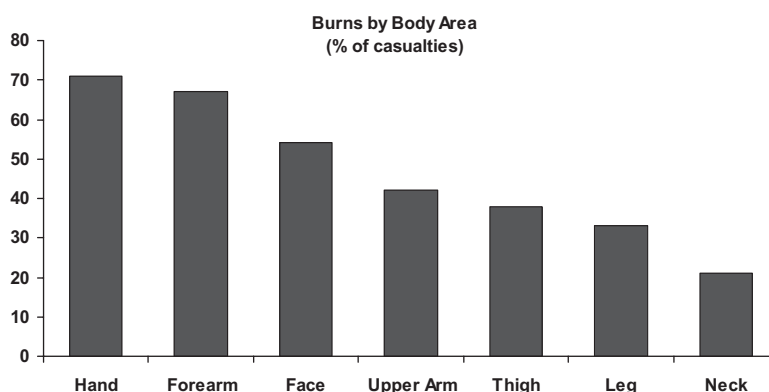


Figure 2. Anatomic distribution of burns in the study population. The areas least likely to be protected by clothing and equipment (hands, forearms, and face) were the most frequently burned.

tion. The data presented also suggest that the severity of the injuries sustained decreased following the intervention as well. The decrease in incidence is even more striking given the fact that the intervention was principally deployed through the Army chains of command and that all four of the postintervention casualties were from the Marine Corps. In essence, the incidence of waste burning casualties from military units who would have had direct access to the intervention was zero in the year following the intervention. Although no prevention initiative as comprehensive as the one reported here has been repeated focusing on any of the other armed services participating in active combat theaters, burn prevention has become a theater-wide force protection focus of the Department of Defense. The joint service nature of medical operations in the current mature combat theaters in Iraq and Afghanistan makes the burden of noncombat injury prevention shared by all of the armed services.

The reasons for the observed decreases in burn incidence and severity are likely to be several. The targeted intervention likely played a central role in the improvements seen. The intervention was aimed at changing the behavior of individuals in the combat theater, and although it cannot be proven from these retrospective data, these behavioral changes likely did occur. The various commanders to whom the memoranda were distributed have large stakes in preserving the health of their fighting forces. They, thus, play a significant role in setting boundaries for potentially dangerous tasks such as waste incineration, so when new procedures (ie, safer burning methods, and wearing of protective equipment and clothing) are ordered by commanders, these orders are generally followed. The use of increased protective measures also likely contributed to a decrease in the severity of such injuries when they did occur.

With the data and resources available to the authors, we cannot prove conclusively that the measures outlined in the targeted intervention were implemented, and we recognize this as a significant limitation of this study. One of the authors (D.K., November 2008) is currently deployed in the Iraq theater of operations and has discussed the dangers of waste burning with local commanders. These individuals appreciate the dangers posed by waste burning and though they were not privy to the initial initiative, they have kept in place measures implemented by their predecessors. Throughout the current combat theaters, burn prevention and fire safety have become heavily emphasized force protection measures.

Another contributor to the decreased incidence of waste-burning injuries after March 2004 is the overall

maturation of facilities in the combat theater. As a theater matures, more sophisticated methods are implemented to dispose of waste. The use of new and existing resources, such as buildings and sanitary facilities, reduces the overall need for the field-expedient task of incinerating waste. This leads to a reduction in the amount of service members at risk for injury and is likely reflected in our data as well.

The anatomic distribution of burns seen in this cohort is typical of both military^{4,6} and civilian⁷ burn cohorts. This concentration of injuries represents those body parts most likely to be uncovered at the time of injury and thus exposed to thermal insult. The hands, forearms, and face were the most commonly affected areas in this study. Burns to these areas are highly morbid, and they carry significant cosmetic and functional consequences for the casualty. The treatment of such burns is consequently resource intensive, and many of the service members in this cohort of casualties were unable to return to military duty secondary to their preventable injuries. These factors combine to make prevention of such burns a military imperative. The use of fire-resistant gloves, such as those made of Nomex or other similar materials, during military operations has been identified as effective in reducing burns to the hands,⁸ and given that more than two-thirds of our cohort sustained these highly morbid injuries, we continue to recommend them.⁹

This study has limitations that bear mentioning. Principally, our ability to generate conclusions based on the available data is limited by the retrospective nature of the study. Addressing our primary hypothesis, though a significant decrease in waste burning-related burn incidence was seen following the implementation of the education initiative, a cause-and-effect relationship between these variables can only be inferred, but not concluded. Another limitation here is that we cannot be certain of the exact incidence of waste-burning burns because of the potential for missed injuries as noted earlier and that we do not know the exact number of service members "at risk" (ie, involved in ground operations in the combat theater) during the evolution of the study period.

To conclude, the distribution of an education program produced by the U.S. Army Burn Center attempting to address the problem of burns sustained while burning waste was followed over the next year by a significant decline in the incidence of waste burning injuries. Although probably multifactorial, the education program likely played a role in this decrease in incidence.

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