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Burns to the genitalia, perineum, and buttocks increase the risk of death among U.S. service members sustaining combat-related burns in Iraq and Afghanistan

Michael S. Clemens [a,b], *Judson C. Janak* [a], *Julie A. Rizzo* [a,c], *John C. Graybill* [b], *Michelle F. Buehner* [a,b], *Steven J. Hudak* [b], *Charles K. Thompson* [a], *Kevin K. Chung* [a,c,*]

[a] *United States Army Institute of Surgical Research, Fort Sam Houston, TX, United States*
[b] *San Antonio Military Medical Center, San Antonio, TX, United States*
[c] *Uniformed Services University of the Health Sciences, Bethesda, MD, United States*

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ABSTRACT

Purpose: Among service members injured in Iraq and Afghanistan, to determine the risk of mortality associated with combat-related burns to the genitalia, perineum, and buttocks.
Materials and methods: The prospectively maintained burn registry from the United States Army Institute of Surgical Research was retrospectively reviewed to identify all service members with combat-related burns sustained in Iraq and Afghanistan from March 2003 to October 2013. The two primary risk factors of interest were (1) any burn to the genitals, perineum, and/or buttocks (PB) and (2) burns involving the entire perineal, genital, and buttock region (complete PB). Cox proportional hazard models were used to estimate the risk of mortality for both primary risk factors, and adjusted for severe non-burn-related trauma, percent of burn over total body surface area (TBSA), inhalational injury, time to urinary tract infection, and time to bacteremia. A post-hoc analysis was performed to explore the potential effect modification of TBSA burned on the relationship between PB and mortality.
Results: Among the 902 U.S. service members with combat-related burns sustained during the study period, 226 (25.0%) had involvement of the genitalia, perineum, and/or buttocks. Complete PB was associated with a crude risk of mortality (HR: 5.3; 2.9–9.7), but not an adjusted risk (HR = 1.8; 0.8–4.0). However, TBSA burned was identified as a potential negative effect modifier. Among patients with burns <60% TBSA, sustaining a complete PB conferred an adjusted risk of death (HR = 2.7; 1.1–6.8). Further, patients with a perineal burn had a five-fold increased incidence of bacteremia. In adjusted models, each event of bacteremia increased the risk of mortality by 92% (HR 1.92; 1.39–2.65). Perineal burns were associated with a two-fold increased incidence of severe non-burn related trauma that also doubled mortality risk in adjusted models (HR 2.29; 1.23–4.27).
Conclusions: Among those with relatively survivable combat-related burns (<60% TBSA), genital/perineal/buttock involvement increases the risk of death. Bacteremia may account

* *Corresponding author at*: United States Army Institute of Surgical Research, 3698 Chambers Pass Drive, JBSA Fort Sam Houston, TX 78234, United States.
E-mail address: kevin.k.chung.mil@mail.mil (K.K. Chung).
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for part of this increased risk, but does not fully explain the independent risk associated with perineal burns.

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1. Introduction

Overall, nearly half a million patients receive medical treatment for burns in the United States annually, with an estimated 40,000 hospital admissions [1]. The relationship between burn size and morbidity and mortality is well documented with larger burn size generally increasing the risk of in-hospital death. Patients who sustain burns involving the perineal region, anatomically defined as external genitalia, perineum, and/or buttocks, present with unique challenges regardless of the total burn size: propensity for infection; difficulty in obtaining definitive wound coverage; and the risk of pressure induced ischemia [2–6]. The estimated incidence of burns to the perineum is 1.7–13% [2–4,7,8]. Due to the well-protected nature of the external genitalia, 96% of genital burns occur in the context of a larger burn [7]. In fact, because the reported median Percent Total Body Surface Area (TBSA) burned ranges from 21 to 56%, burns to the perineal region often serve as a marker for larger overall burns [3]. Regardless, analysis of the National Burn Repository demonstrated that genital burns independently contribute to a 54% increase in overall mortality [2]. Not surprisingly, they noted an increased risk of urinary tract infections (UTI) and sepsis as a potential culprit for this increased mortality [2]. Similar concerns have been hypothesized for peri-anal and buttock burns, noting a high incidence of enteric flora contaminating these wounds [6]. Management strategies involving artificial constipation, fecal management systems, or colostomy formation have been proposed, but large observational studies or clinical trials are lacking [4–6,9].

Specific to combat-related burns, McDougal and colleagues reported on their experience treating 197 perineal burns (PB) in a military cohort during Vietnam [10]. PB constituted 13% of all burn admissions during that time and the authors described an average 56% TBSA with 67% mortality. Further, combat-related PB offer their own unique challenges due to tissue destruction from concomitant blast-related trauma [11]. The relationship between PB, concomitant trauma and mortality in this unique cohort has never been reported.

Further, the current literature relies on either large database studies with generalized results or small case series without robust analyses. We sought to further refine the proposed mechanisms of mortality associated with perineal burns in a granular database. Among patients injured during combat operations in Iraq and Afghanistan, the objective of this study was to assess the relationship between perineal burns and mortality. We hypothesized combat-related PB were a risk factor for mortality.

2. Methods

2.1. Study design and population

We conducted a retrospective cohort study of U.S. casualties sustaining burns during combat operations in Iraq and Afghanistan from March 2003 to October 2013. Inclusion criteria included adult service members with burns who survived evacuation to the United States (US). This study received approval from the US Army Medical Research and Materiel Command Institutional Review Board (H-14-019).

2.2. Data extraction

Service members sustaining burns in Iraq and Afghanistan return to the US Army Institute of Surgical Research (USAISR) burn center for definitive care. The USAISR prospectively maintains a burn registry on all admissions. This database was validated with the Department of Defense Trauma Registry (DoDTR), a separate prospectively maintained database of all patients treated in a surgical treatment facility during combat operations. Outliers were defined and manually reviewed through patients' medical records to ensure accuracy. Microbiologic data was obtained from inpatient medical records, including organisms in all blood and urinary cultures.

2.3. Dependent and independent variables

The primary outcome of interest was mortality. The two primary independent variables were (1) any perineal regional burn and (2) complete perineal burns. Any PB was defined as a partial- or full-thickness burn to the external genitalia, perineum, and/or buttocks on the Lund–Browder chart, consistent with consensus definitions [4]. Complete PB was defined as a partial- or full-thickness burn to the external genitalia, perineum, *and* buttocks on the Lund–Browder chart.

The five confounders of interest were (1) percent TBSA, (2) severe non-burn-related comorbid injury (yes vs. no), (3) inhalation injury (yes vs. no), (4) time to urinary tract infection, and (5) time to total number of bacteremic events. Recognizing the severity of large burns, the patients were further divided into those sustaining large burns ($\geq$60%TBSA) or smaller ($<$60% TBSA) to explore the effect modification of TBSA on our analysis of perineal burns and mortality. In order to create an independent variable for severe non-burn-related injury, we first calculated a Non-Burn Injury Severity Score (ISS) similar to Hawkins et al. [12] (see eMethods1 in the Supplement).

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