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Does the type of skin replacement surgery influence the rate of infection in acute burn injured patients?

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ABSTRACT

Introduction: Infection is a major cause of morbidity and mortality following burn. Early debridement and wound closure minimize the risk of infection. This study aimed to examine the association of surgical modalities with burn wound infection (BWI) rate, graft loss and length of stay (LOS) outcome.

Method: This study is a retrospective analysis of all patients undergoing surgical intervention at the Royal Perth Hospital between 2004 and 2011. Multivariable regression analyses were used to predict the impact of burn and patient factors on the outcomes.

Results: Seven hundred seventy patients were eligible for inclusion with 74.8% males and a mean total body surface area (TBSA) burnt of 7.9% (range 1.0–75). Sixty-seven patients (8.7%) had positive post-operative swabs indicating potential wound infection. Age and TBSA significantly increased the risk of BWI (confirmed by quantitative swab). Positive microbiology was not associated with surgery type. Age, TBSA, diabetes and surgical modalities had significant influence on LOS in hospital. Only TBSA was an independent predictor of graft loss.

Conclusion: Age, TBSA and diabetes were associated with poorer outcomes after burn. Surgery type was not associated independently with the risk of infection.

1. Introduction

Infection remains a leading cause of morbidity and mortality following burn [1]. Burn wound infection (BWI) leads to poor wound healing and increased risk of scarring which may have a negative psychological and functional impact on the patient [2].

Survival following burn has improved over the last two decades with the widespread use of early wound debridement surgery and skin replacement provided to remove the source of wound infection and restore skin integrity [3].

Critical factors previously identified to influence the risk of developing BWI include age, percentage of total body surface area (TBSA), presence of full-thickness burns and presence of an inhalation injury [4]. Inhalation injury contributes to tissue hypoxia [5]. Reduced tissue oxygen tension increases the risk of BWI [6] and reduces wound strength after healing [7].

BWI is linked to graft loss and additional surgical procedures and an increased length of stay (LOS) [1]. With respect to BWI, the species of infectious organism influences outcome. *Pseudomonas aeruginosa* retards the speed of wound healing [8]. Gram-negative organisms are associated with a 50% increase in predicted mortality for patients [9].

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While the patient demographics and burn factors associated with poorer outcomes including the development of BWI, are well established, it has not been determined if infection rate is independently associated with different surgical modalities.

This study aims to examine if surgical modalities are associated independently with post-operative BWI rate, and related outcomes: graft loss and LOS.

2. Materials and methods

2.1. Patient inclusion

All acute burn patients admitted to the RPH undergoing a surgical procedure for their injury between January 1st 2004 and December 31st 2011 were identified retrospectively from the RPH Burns Minimum Dataset (BMDS). Patients were included if they had skin grafting or a skin replacement procedure during admission. As in other burn centers, the type of skin closure procedure at Royal Perth Hospital (RPH) is determined by the size, depth and site of the wound [3]. At RPH, current practice involves split skin grafting (SSG), and aerosolized point-of-service cell suspension in the form of Recell® in isolation, and in combination, as the mainstay of surgical treatment for burn wound closure. The SSG is the most common technique and utilized for wounds assessed to require repair extending to the deep reticular dermis. The SSG is meshed routinely at 1.5:1 or occasionally, applied in sheets for small wounds. Cell suspension is applied in isolation to 'deeper' mid-dermal injuries or in combination with SSG in deep reticular dermal wounds. While no longer routine practice, prior to 2007, Cellspray® (aerosolized cultured pre-confluent keratinocytes) was used to facilitate the coverage of a larger surface area wounds with reduced donor area. Integra® is used at RPH acutely for patients receiving replacement of deep reticular or complete dermal destruction and, or limited donor skin [10].

2.2. Identifying BWI

At RPH, all patients are swabbed routinely on admission which involves cavity screening to identify multi-resistant *Staphylococcus aureus* (MRSA) and vancomycin resistant enterococcus (VRE). Patients are isolated immediately if the swabs are positive upon microscopy or prophylactically until cleared, if the patient has been admitted to a hospital outside the state of Western Australia within the last 12 months. Further, wound swabs are routinely sent for quantitative analysis at the first dressing change. The criteria used to confirm suspicion of a BWI at the RPH Burn Center was described by Silla et al. [11] based on Peck et al's definitions [12]. During the admission, burn surgeons and burn unit nurses regularly monitored the burn wound for early signs of infection. When more than one of the following clinical signs of: increased pain; redness (lymphangitis); temperature; and, white cell count were present, the wound was swabbed and analyzed by microscopy and culture and for sensitivity. Diagnosis of BWI was defined as $>10^5$ bacteria from the wound swab [14]. In principle, antibiotic therapy was not started without BWI confirmed by quantitative swab and sensitivities. For the study, the BWI rate was defined as the frequency of confirmed new BWI in the post-surgical period that was not present prior to surgery.

2.3. Exclusion criteria

Patients confirmed to have BWI or community acquired infections on admission or in the pre-surgical period were excluded from the study analysis. Patient episodes were excluded if they were admitted subsequent to their acute episode for reconstructive or scar release surgery including soft tissue flaps. However, the patient data and outcomes during their acute episode of care was not removed from the analysis. Patients with a positive sputum, urine or blood microbiology culture were excluded to isolate patients with a positive microbiology for BWI only.

2.4. BMDS data and linkages: study variables

The data extracted from the BMDS described: demographics (age, gender, presence of co-morbidities); the severity of the burn (TBSA, burn depth, inhalation injury); infectious complications (confirmed in wound and, or other sources); interventions (surgical technique, anti-biotic therapy); and, short-term outcomes (LOS and graft loss).

At RPH, the depth of burn is assessed *upon admission* by the Attending Surgeon or the Nurse Director (and coded and recorded into the BMDS as such). Subsequent to the initial assessment, patients who do not respond to dressings may have areas of their burn that benefit from surgery. The graft loss variable was defined as a dichotomous outcome which indicates if the patient graft failure was greater than ~0.25% TBSA or was deemed to benefit from further acute surgical intervention by the Attending Burn Surgeon. This decision was made at day five to seven post operation or at the first ambulatory clinic attendance if discharged prior.

These data were linked to detailed laboratory records including: time of wound swab(s); location of wound swab(s); and, organism(s) cultured. The latter information was obtained from the 'iSoft' digital repository prior to linking with the individual data from each episode of acute care extracted from the BMDS.

2.5. Data analysis

Analysis of the data was conducted using SPSS Version 20.0, using descriptive statistics, Chi-square two-tailed test, Fisher exact tests and a multivariate logistic regression model. Univariate analysis of variance was used to determine the influence of each variable (surgical techniques, age, TBSA, depth of burn, inhalational injuries and diabetes) on the outcomes of interest (infection rate graft loss, and LOS). Surgical modalities included in the study were SSG, ReCell®, SSG with ReCell®, and SSG with CellSpray®. Patients with CellSpray® alone were excluded due to low numbers ($n = 3$) as were Integra patients ($n = 8$). Diabetes was the most frequently identified co-morbidity in this cohort. All other comorbidities were too rare (underpowered) to include in the analyses as co-variates.