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Long term mortality in a population-based cohort of adolescents, and young and middle-aged adults with burn injury in Western Australia: A 33-year study

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ABSTRACT

Background: Advances in the treatment and management of burn patients over the past decades have resulted in a decline of in-hospital mortality rates. Current estimates of burn-related mortality are usually in the context of deaths occurring during the admission or within a short time period after the incident burn. Limited data are available that examine long term mortality after burn injury. This study aimed to assess the impact of burn injury on long-term mortality and quantify any increased risk of death attributable to burn injury.
Methods: A population-based cohort study of persons 15–44 years of age hospitalised for burn injury (n = 14,559) in Western Australia (1980–2012) and a matched non-injured comparison group (n = 56,822) using linked health administrative data was used. Hospital morbidity and death data were obtained from the Western Australian Hospital Morbidity Data System and Death Register. De-identified extraction of all linked hospital morbidity and death records for the period 1980–2012 were provided by the Western Australian Data Linkage System. Survival analysis was conducted using the Kaplan–Meier method and Cox proportional hazards modelling.
Results: The adjusted all-cause Mortality Rate Ratio (MRR) for burn injury was 1.8 (95%CI: 1.7–2.0); those with burn injury had a 1.8 times greater rate of mortality than those with no injury. The index burn injury was estimated to account for 44% of all recorded deaths in the burn injury cohort during the study period after discharge. Increased risk of mortality was observed for both severe (MRR, 95%CI: 1.9, 1.3–2.9) and minor (MRR, 95%CI: 2.5, 2.2–3.0) burns.
Conclusions: An increased risk of long-term all-cause mortality is associated with both minor and severe burn injury. Estimates of total mortality burden based on the early in-patient period alone, significantly underestimates the true burden of burn injury in adolescents, and young and middle aged adults. These results have significant implications for burn injury prevention.

1. Introduction

Burn injury is an important cause of morbidity and mortality worldwide (Peck, 2011). Survivors of burn injury can experience a broad spectrum of physical and psychological outcomes dependent on the burn severity (Esselman, 2007; Fauerbach et al., 2007). Advances in the treatment and management of burn patients over the past decades have resulted in a decline of in-hospital mortality rates (Akerlund et al., 2007; Duke et al., 2011a). Mortality is considered to be an accurate clinical outcome measure (McDowell and Newell, 1996) and is an objective health measure often reported in burn injury assessments. Current estimates of mortality related to burn injury are usually in the context of deaths occurring during burn admission or within a relatively short time period after the incident burn (Duke et al., 2011a; Brewster et al., 2013; Mandell et al., 2013). A large volume of burn injury literature examines the impacts of burn severity, increasing age, gender and presence of comorbid conditions on increased mortality risk during the inpatient period (Bessey et al., 2006; Kerby et al., 2006; O'Keefe et al., 2001). However, limited data are available that examine long term mortality after burn injury.

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Many studies that have described long term mortality after general trauma have been limited by methodological issues associated with small sample sizes (Brenneman et al., 1995), non-population sampling (Baguley et al., 2000; Frutiger et al., 1991), absence of comparison groups (Harris et al., 2003) and inadequate follow up time (Harris et al., 2003; Leibson et al., 2002). Linked population health administrative data provided the means to overcome these limitations and to examine long-term impacts of injury (Cameron et al., 2005); however, burn injury constituted a small proportion of the included cases of injury in this study.

This study used linked state-wide health administrative data of persons aged between 15 and 45 years of age at hospital admission for a burn injury in Western Australia during the period 1980–2012 and a matched population-based non-injured cohort. The study aimed firstly, to assess the influence of burn injury on long-term all-cause mortality; and secondly, to estimate any increased risk of death attributable to burn injury.

2. Methods

The Western Australian Population-based Burn Injury Project (WAPBIP) is a population-based retrospective cohort study using linked health administrative data from the Western Australian Data Linkage System (WADLS). The WADLS is a validated record linkage system that routinely links administrative health data from core datasets (including Hospital Morbidity Data System (HMDS), Western Australia Death Register) for the entire population of Western Australia of 2.5 million (Holman et al., 1999). Project approvals were obtained from the Western Australian Department of Health and the University of Western Australia Human Research Ethics Committees.

A de-identified extraction of all linked hospital morbidity (Hospital Morbidity Data System (HMDS)) records for all persons aged 15–44 years admitted to a Western Australian hospital with an index or first burn injury within the period 1 January 1980–30 June 2012, was undertaken by the WADLS. The index burn injury was defined as the first hospital admission in a patient record set with a burn injury as the principal and/or additional diagnosis using the International Classification of Diseases (ICD) codes Version 9 (ICD9-CM) 940–949 and Version 10 (ICD10-AM) T20–T31. A population-based comparison cohort was randomly selected from the Western Australian Birth Registrations (<18 years) and Electoral Roll (≥18 years); any person with an injury hospitalisation during the study period was excluded from the population-based non-injury cohort by WADLS. The resultant comparison cohort (i.e. no injury hospitalisations) was frequency-matched 4:1 on birth year, gender and year of index burn discharge for the period 1980–2012.

Hospital and death data from the Western Australia HMDS and Death Register were linked to each cohort (burn, non-injury) for the period 1980–2012. Hospital admissions data included principal and additional diagnoses, age and gender, Aboriginal status, index admission and separation dates, burn injury characteristics (total burns surface area percent (TBSA%), burn depth), geographic location (collectors district, postcode). Indices of social disadvantage (Socio-economic Indices for Areas (SEIFA) (Trewin, 2003)) and remoteness index (Accessibility Remoteness Index of Australia (ARIA+) (Glover and Tennant, 2003)) were supplied by WADLS for the burn and non-injured cohorts. The death data included cause of death and date of death. Cause of death was classified using ICD9-CM and ICD10-AM disease and external cause codes.

Age was classified into 5-year age groups and Aboriginal status was classified by record of Aboriginal or Torres Strait Islander status on any admission record. TBSA% was classified by ICD supplementary codes (948 ICD9CM; T31 ICD10AM) and used to categorise burn severity: minor (TBSA < 20%), severe (TBSA ≥ 20%), and burns for which no TBSA% was coded. For each person a Charlson Comorbidity Index (CCI) (Charlson et al., 1987) was generated using principal and additional diagnosis fields with a 5-year look back period in the hospital morbidity data (Preen et al., 2006). The CCI value was used to generate a comorbidity variable (CCI = 0; CCI = = 1; CCI = 2: CCI ≥ 3) for inclusion in the analyses. Record of existing congenital anomaly was identified using principal diagnosis ICD codes 740–759 (ICD9-CM) and Q00-G99 (ICD10-AM) and a 5-year look back period. A variable was generated to represent any hospitalisation in the year prior to study start (prior hospitalisation). Social disadvantage and remoteness indices supplied by WADLS were based on geocoded place of residence (i.e. census collector district (~200 households), postcode). SEIFA scores were partitioned into quintiles to generate five ordinal categories from most disadvantaged to least disadvantaged. The Accessibility and Remoteness Index of Australia (ARIA+) was used to classify geographical disadvantage and access in terms of physical distance from services by five remoteness categories: major cities, inner regional, outer regional, remote, and very remote Australia. Person-years of risk (PY) were calculated from the final discharge date of the index admission burn cases to study end date (death or censored at 30 June 2012).

Chi squared tests for categorical and Kruskal–Wallis tests for non-parametric continuous variables were performed with the level of significance set at 0.05. Survival analysis was conducted using the Kaplan–Meier method and Cox proportional hazards model. Kaplan–Meier plots of survival estimates for burn vs. non-injury and for burn severity (minor, severe, burns-no TBSA coded vs. non-injury) were generated and log rank tests were used to compare the survival distributions of burn and no injury cohorts. Cox proportional hazard regression was used to estimate the effects of burn injury on long-term survival while adjusting for potential confounders (index age, gender, Aboriginal status, comorbidity, social disadvantage and remoteness, prior hospital use, record of congenital anomaly, and index year). The hazard ratios (95% confidence intervals (CI)) estimated from the Cox proportional hazards model were used as measures of Mortality Rate Ratios (MRR). Preliminary analyses revealed no evidence of non-proportionality (Hosmer and Lemeshow, 1999; Cleves et al., 2008). Attributable Risk Percent (AR%) was used to estimate the proportion of long-term mortality where burn injury was an attributable cause. The AR% was calculated as the adjusted rate ratio minus one, divided by the adjusted rate ratio, multiplied by 100 ($AR\% = ((adjMRR - 1)/adjMRR) \times 100$) (Gordis, 2000). The percentage of deaths in the burn injury cohort that was attributable to burn injury was estimated after adjusting for known potential confounders. All statistical analyses were performed using Stata V12 statistical software (StataCorp LP, College Station, TX).

3. Results

During the period January 1980–June 2012, there were 14,559 persons aged between 15 and 45 years hospitalised for a first burn injury. In addition, 56,822 persons were included in the non-injured cohort that was randomly selected and matched on age and gender. Of those in the burn cohort with a TBSA% supplementary code, 7% had severe burns of 20% TBSA or greater and 93% had minor burns with TBSA less than 20% TBSA. Sixteen percent of the burn cohort had sustained full thickness burns, 37% partial thickness, 20% erythema and for 29% burn depth was unspecified.

The median (IQR) age at index for both cohorts was 27 (21–34) years and 75% of each cohort was male. The burn injury cohort had significantly higher proportions of Aboriginal people, socially disadvantaged and those that lived in regions outside of major cities and were more likely to have records of prior hospitalisation,