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# Optimizing mass casualty burns intensive care organization and treatment using evidence-based outcome predictors

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## ABSTRACT

**Background:** Majority of current research focuses on pre-hospital care in mass casualty incidents (MCI) whereas this study is the first to examine multifactorial aspects of intensive care unit (ICU) resource management during a surge in massive burn injury (MBI) patients whilst identifying key outcome predictors that resulted in successful disaster managements. **Methods:** Both critical care, surgical parameters and cost-effectiveness are investigated in patients admitted with severe burns resulting from the explosion. A fully integrated trauma response and expansion of critical care resources in Linkou Chang Gung Memorial Hospital (CGMH) in this incident is analyzed.

**Results:** 52 burn patients were treated in CGMH and 27 patients (51.9%) had TBSA greater than 45% with the mean TBSA of  $44.6 \pm 20.3\%$ . ICU based management of MBI including early debridement and resource strategizing.

The overall mortality rate was 2/52 (3.85%). Patients had an average of 14.8 days on mechanical ventilation and 43 days as an inpatient in total. Operative treatment wise, 44.2% of patients received escharotomies and each patient received an average of 2 skin grafting procedures. The initial TBSA was a significant predictor for burn wound infection (OR 1.107, 95% CI 1.023-1.298;  $p=0.011$ ). Each patient cost an average of USD 1035 per TBSA% with an average total cost of USD 50415.

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*Conclusion:* With ever increasing chances of terrorist activity in urban areas, hospitals can hopefully increase their preparedness using outcome-predictors presented in this study.

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## 1. Introduction

With increasing unrest in the world, trauma as a disease is an increasingly common entity [1]. Mass burns injuries (MBI) can place an extreme burden on the healthcare system of a country due to its high demand for nursing and medical care [2]. Much of the literature at present focuses on pre-hospital management of mass casualty events in recent history. There is a paucity of literature focusing on strategizing the use of intensive care units (ICU) in available in hospitals for mass casualty incidents (MCI) especially with regards to MBI. We present a detailed analysis of the in-hospital reorganization of critical care resources as well as clinical and non-clinical factors which led to an overall successful outcome of a MCI.

The 2015 Taiwan color dust explosion is a recent urban disaster involving a young age group where aerosolized colored powder was released and ignited into a crowd at an outdoor party. As a result of the massive fireball, 499 people were burn injured simultaneously [3]. The resulting management of the disaster was deemed a success by the European Commission where representatives from the hospital were invited to share their experiences in dealing with an immediate surge in demand for burns care.

The Joint Commission International (JCI) accredited Linkou Chang Gung Memorial Hospital (CGMH) is the nation's largest hospital with 3704 beds serving 10,357 inpatients a month [3]. It also has the largest number of dedicated burns intensive care beds in the country and hence received the bulk or one-fifth of the total number of burns patients serious enough to be admitted to hospital. A total of 52 patients with serious burns injuries were admitted to our ICU. 27 patients had more than 45% total body surface area (TBSA) burns and 25 had less than 45% TBSA. All patients survived except for 2 patients after receiving treatment.

MBI results in hemodynamic instability mostly from the loss of large volumes of fluids from injured skin. Logistics, organization of manpower, resources and communication between various specialties are crucial for a seamless transition of care from pre-hospital to the emergency department and eventually to the ICU [4,5]. The outcome predictors based on our model of care employed in this recent disaster in the hope that other medical units, when faced with this unfortunate tragedy, may better identify key parameters that improve the care and outcome of patients with MBI.

## 2. Methods

### 2.1. Study overview

This retrospective cohort study focuses on the integrated management of patients with MBI requiring admission for treatment within the largest burns unit in the country with the capability for 28 beds in burns ICU and another 24 beds in the microsurgical ICU. Being a tertiary trauma and medical center

with more than 3700 beds and 90 operating theatres, the department also has 37 attending burns physicians which were mobilized during the event. We sought to determine the logistical, treatment, ICU management burden this episode had on our institution. Patient consent was not required as this was a retrospective, anonymized study. This study received institutional board review (IRB) permission from Chang Gung Memorial Hospital Ethics Committee case number: 201600146B0.

### 2.2. Patients

A cohort included patients admitted to Linkou CGMH intensive care units (burns and general surgical) from the mass casualty burns event related to the dust explosion in 2015. The treatment process and operative details including debridement and skin graft episodes were analyzed.

### 2.3. Outcomes

The main outcomes examined were treatment parameters received in the ICU including resuscitation volume and any complications especially in the form of burn wound infections (BWI) and acute kidney injury (AKI) [6]. We classified AKI patients according to the KDIGO guidelines during hospitalization using serum creatinine criteria [7]. If multiple episodes of AKI occurred, we recorded all episodes according to their consecutive severity. Cost analysis was also obtained from the hospital with regards to total spending from treatment to staffing and occupation of ICU beds.

### 2.4. Statistical analysis

Chi-square test, Fisher's exact test, and Wilcoxon test were used for analysis where appropriate. The factors examined included gender, age, and other clinical factors. The statistical analysis was performed with SAS software version 9.1 (SAS Institute Inc., Cary, NC, USA). Logistic regression models were used to define the risk factors for postoperative morbidity, including AKI and BWI. A univariate analysis was performed for all clinical factors to determine crude odds ratios, and multivariate analysis was performed to estimate the adjusted odds ratio for prediction of postoperative morbidity. The level of significance for all P values was set at  $p < 0.05$ .

## 3. Results

### 3.1. Logistics, communication, increasing capacity and chain of command

Coordination and distribution of patients were determined by the government led by the Ministry of Health and Welfare. Linkou CGMH having the largest number of burns critical care beds in the country, was referred 49 burns patients within 6h with the larger

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