

## Policy Forum



## Comprehensive Level One Trauma Center Could Lower In-hospital Mortality of Severe Trauma in China\*

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Trauma is a major health and social problem in the US and China. It constitutes the main cause of death in people aged 45 or under in both countries<sup>[1-2]</sup>. There is clear evidence from clinical studies that a large percentage of these deaths are needless and preventable if better treatment and prevention programs are available<sup>[2-3]</sup>.

There is evidence from US studies that well-organized level one trauma centers reduce mortality in severe trauma patients<sup>[3-4]</sup>. But in China, there is still no trauma center accreditation system like American College of Surgeon Committee for Trauma (ACS-COT). Various initiatives have been undertaken to improve trauma care in China, but a comprehensive trauma network made up of accredited trauma centers is still under development<sup>[1]</sup>.

Sichuan Provincial People's Hospital of Sichuan Academy of Medical Sciences (SAMS) established its trauma service in 1992 and has since become one of the largest trauma centers in China. It currently operates an integrated, comprehensive trauma service system in its East Branch. There are similarities between the SAMS trauma service and level one trauma centers designated by ACS-COT in US, such as having a multidisciplinary, integrated medical team, a special intensive care unit (ICU) facility for severe trauma patients and a data management system which could be used for continuing analysis and quality improvement. But the environments of two countries (China and US) also have many differences, in areas such as medical regulations for trauma service, financial support, and infrastructure for pre-hospital emergency medical service.

A comparison based on data from US and China trauma services is valuable for both sides for the following reasons: 1) Verifying the efficacy of an international recognized trauma service standard in China and providing evidence-based recommendation for the development of relevant policies for the designation of trauma centers in China; 2) Providing an international aspect on the role of leading trauma centers for relevant regions. For these reasons, we conducted a comparison study that compares outcomes following major traumas managed by UCLA, UCSF, and SAMS trauma services.

Chengdu is one of the biggest cities in southwest China with a population of 11.49 million and is that approximately 7 million people lives in metropolitan area (at the end of year 2010)<sup>[5]</sup>. SAMS trauma service is the only designated trauma center in Chengdu and its East Branch is operating according to level one trauma center standard established by ACS-COT. Local emergency medical service system has been established since the end of 1990s. The transportation of trauma patients followed 'closest first' principle, but for those who are evaluated as severe or complicated poly-injury will be sent to nearest advanced comprehensive hospital (grade 3A hospital). The East Branch of SAMS serves two major urban districts: Jin Jiang District and Long Quan-yi District, where has a combined population of approximately 1.02 million<sup>[4]</sup>. It established a trauma registry database for collecting information on all trauma patients admitted since December of 2009.

Los Angeles (LA) is the second-most populous city in the United States with a population of 3.79 million. It has an area of 1 215 km<sup>2</sup>, and is located in Southern California. There are five ACS-COT verified

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Level One trauma centers in LA region. Each Level one trauma center is a comprehensive regional resource that is a tertiary care facility central to the trauma system. And it is capable of providing total care for every aspect of injury, from prevention through rehabilitation. UCLA Trauma Center is a major trauma center in state of California and US; the number of trauma patients receiving treatment from this center is around 1 000 per year.

San Francisco (SF) is the biggest city of Northern California with a population of 0.82 million. It has an area of 121 km<sup>2</sup>. Trauma Center of San Francisco General Hospital (SFGH) is affiliated to UCSF. It is the only ACS-COT verified Level One trauma center in SF. It is serving around 3 900 patients each year. SFGH and its trauma center is also a major trauma service provider in US.

The study cohorts were retrospectively identified and the data extracted from the SAMS, UCLA, and UCSF trauma registries for the one year period from January 1st to December 31st 2010. All three databases contain all primary (transported directly to trauma center from trauma scene) and secondary admitted (transported to trauma center after admission to other hospitals) trauma patients, with an Injury Severity Score (ISS)  $\geq 16$  and positive signs of life on arrival at the trauma center. No burn patients or patients <15 years are included in this study.

Demographic data included gender and age. Mechanism of injury, ISS, blood transfusion, physiological biochemical and blood cell test at admission were used to determine injury patterns at each center. ISS-adjusted mortality was used as major outcome.

The research protocol was approved by medical ethical committee at SAMS and institutional research board at UCLA and UCSF.

Data was described as mean $\pm$ standard deviation ( $x\pm s$ ) or as median and inter quartile range (IQR) in the case of a skewed distribution. Differences between groups were analyzed with the *t*-test for data presented as means or used ANOVA for data presented as medians, respectively. Differences in counts or percentages were evaluated with the chi-square test. Differences were considered significant if a two-tailed *P* value is <0.05.

Multivariate logistic regression was used to identify independent mortality related factors. To improve the accurate of mortality related risk factor estimation, we introduced partial least square (PLS)<sup>[5-6]</sup>, an advanced statistic tool and generated a

statistic variable called Variable importance in the Project (VIP) scores (Formula 1).

$$VIP_j = \sqrt{\frac{p}{Rd(Y; t_1, \dots, t_m)} \sum_{h=1}^m Rd(Y; t_h) w_{hj}^2}$$

$$Rd(y_k; u_h) = r(y_k; u_h)$$

$$w_{hj} = \text{weighting}(h, j)$$

**Formula 1.** Variable importance in the Project (VIP).

VIP scores measure the correlation between variables and the result, the larger VIP scores the stronger the correlation. We set VIP scores >1 as the threshold. We used PLS to screen candidate variables that could be used for multivariate logistic regression<sup>[7]</sup>.

The *t*-test or Mann-Whitney *U* test, chi-square test, multivariate logistic regression and PLS are performed by using the R (version 2.15.2). All computation process has operated at a high performance computing platform (HPC, CPU Xeon E7-8848 \*4, 512GB DDR3 1333Mhz; Environment: Unbutu 12.04).

In total 829 cases were enrolled for analysis (SAMS=78, UCLA=200, UCSF=551). Table 1 showed demographics of patients in three centers. Patients' age and gender distribution were similar in three centers; most of them were male (72.6%).

Although all cases were severe traumas, the severity of injuries was different between three centers. Two US centers have significantly more patients with higher ISS scores (Percentage of Patients whose ISS>25: SAMS=24.4%, UCLA=39%, UCSF=46.5%, *P*=0.004).

ISS adjusted mortality was not significantly different between the three centers (SAMS=12.1%, UCLA=19.9%, and UCSF=12.8%, respectively; *P*=0.065).

The mechanisms of injury (MOI) are significantly different between SAMS, UCLA, and UCSF (Table 2, Figure 1). In Chengdu, the most common causes of trauma were fall (FA, 28.2%), motorcycle (MM, 21.8%), and enclosed vehicle (EV, 17.9%). In Los Angeles, the most common causes of trauma were pedestrian/bike vs. vehicle (42.6%), FA (23.1%), and EV (18.5%). In San Francisco, the most common causes of trauma were FA (37.9%), EV (29.8%), and assault (AS, 19.9%).

A multivariate logistic regression analysis (Table 3) showed that the risk of injury related death in SAMS is not significantly higher than UCLA (*OR* 0.933, *P*=0.141) or UCSF (*OR* 0.978, *P*=0.599).

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