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# Does the Institution of a Statewide Trauma System Reduce Preventable Mortality and Yield a Positive Return on Investment for Taxpayers?



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**BACKGROUND:** In July 2009, Arkansas began to annually fund \$20 million for a statewide trauma system (TS). We studied injury deaths both pre-TS (2009) and post-TS (2013 to 2014), with attention to causes of preventive mortality, societal cost of those preventable mortality deaths, and benefit to tax payers of the lives saved.

**STUDY DESIGN:** A multi-specialty trauma-expert panel met and reviewed records of 672 decedents (290 pre-TS and 382 post-TS) who met standardized inclusion criteria, were judged potentially salvageable, and were selected by a proportional sampling of the roughly 2,500 annual trauma deaths. Deaths were adjudicated into sub-categories of nonpreventable and preventable causes. The value of lives lost was calculated for those lives potentially saved in the post-TS period.

**RESULTS:** Total preventable mortality was reduced from 30% of cases pre-TS to 16% of cases studied post-TS, a reduction of 14%. Extrapolating a 14% reduction of preventable mortality to the post-TS study period, using the same inclusion criteria of the post-TS, we calculate that 79 lives were saved in 2013 to 2014 due to the institution of a TS. Using a minimal standard estimate of \$100,000 value for a life-year, a lifetime value of \$2,365,000 per person was saved. This equates to an economic impact of the lives saved of almost \$186 million annually, representing a 9-fold return on investment from the \$20 million of annual state funding invested in the TS.

**CONCLUSIONS:** The implementation of a TS in Arkansas during a 5-year period resulted in a reduction of the preventable death rate to 16% post-TS, and a 9-fold return on investment by the tax payer. Additional life-saving gains can be expected with ongoing financial support and additional system performance-improvement efforts. (J Am Coll Surg 2017;224:489–499. © 2017 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

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Trauma patients are best cared for in an organized trauma system (TS) that has adequate numbers of functioning trauma centers (TCs) to receive those injured patients. This has been shown repeatedly in both civilian

and military environments.<sup>1-9</sup> Similarly, the study of deaths and the mechanisms and events leading up to those deaths are an essential part of the quality-improvement infrastructure of a robust TS. A subset of deaths, those that are preventable or potentially preventable, represents a group of patients that are particularly important to study to improve the quality of care and reduce mortality for the entire TS. Preventable trauma mortality studies have served as the underlying basis for TS development and improvement dating back to 1970s. It is essential to learn lessons from those unfortunate deaths so that those lessons can then lead to improvements in the TS, reducing mortality and morbidity in the future.<sup>10-15</sup>

Those states that have implemented an inclusive TS have documented substantial reductions in rates of preventable trauma deaths. Arkansas remained the last state

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### Abbreviations and Acronyms

ADH	= Arkansas Department of Health
ALS	= Advanced Life Support
ATCC	= Arkansas Trauma Communications Center
ED	= emergency department
EMS	= emergency medical services
OFI	= opportunities for improvement
TAC	= Trauma Advisory Council
TC	= trauma center
TS	= trauma system
VLL	= value of life lost
VSL	= value of a statistical life

without an organized TS or designated TCs.<sup>16</sup> The need for Arkansas to have an inclusive TS was recognized and addressed by the Governor's Trauma Advisory Council (TAC), along with multiple other medical and healthcare associations and groups. Aided by roughly \$20 million per year funding from the state, the Arkansas TS was launched in 2010. Has this investment by the citizens into a statewide TS resulted in any demonstrable benefits? In 2015, a preventable mortality study comparing a sampling of trauma deaths from 2009 (pre-TS) with 2013 to 2014 (post-TS) was conducted. This study's aim was to determine the effect of the implementation of a statewide TS on mortality, patient care, and other system-related issues, as well as the return on investment into that system by the taxpayers.

## OVERVIEW OF TRAUMA RESOURCES

### Emergency medical services

Prehospital care included Advanced Life Support (ALS) ground units, Basic Life Support ground units, and air medical services (both fixed and rotor wing). The air medical services typically had capabilities that exceeded those of the ALS ground services, including the ability to perform rapid sequence intubation. The number of ambulance services (ALS and Basic Life Support) was not significantly different between phases of the study. The majority of the patients, when transported by ground, were transported by ALS services during both periods.

### Trauma center levels

In 2009 (pre-TS), no TCs had yet been designated. Best estimates of each hospital's future level of designation were used to classify each facility in that phase of the study, with Level I being the highest and Level IV representing the level with fewest resources. At the time the second cohort was being treated (2013 to 2014) 66 of 72 (92%) hospitals had been designated by the Arkansas

Department of Health (ADH). The remaining 6 facilities are noted as nondesignated. One facility had also achieved TC verification by the American College of Surgeons.

The designation level for the 58 in-state participating hospitals were: 2 Level I, 5 Level II, 20 Level III, and 31 Level IV. In addition to the state's hospitals, 4 bordering states with a total of 7 TCs receive and treat injured Arkansans. These TCs are verified in both their own state and by Arkansas using each TC's state standards. There were 4 Level I, 1 Level II, and 2 Level III out-of-state TCs that provided care to Arkansans during the project periods.

### Other system resources

The TS had other resources that helped in the proper functioning of the system. The Arkansas Trauma Communications Center (ATCC) was designed to receive calls using a statewide radio system from emergency medical services (EMS) units, and to then to help assist the EMS units using a uniform field triage scheme to transport the patient to the closest appropriate TC. This dispatch was aided by a web-based facility dashboard, updated by the TCs, that showed each center's capabilities (eg neurosurgery, general surgery, and orthopaedic surgery services), as well as capacity (whether or not those services were temporarily unavailable to accept new patients). In addition, there was a rapid acceptance protocol put into place, so that trauma patients could be rapidly accepted at appropriate TCs with little delay in decision making.<sup>17</sup>

## METHODS

### Background methodology and structure of study

This study was commissioned by the ADH to inform the agency of the impact of implementation of the trauma system, and to identify opportunities for additional improvement in the system of care and patient outcomes. The TS stakeholder advisory group (TAC) reviewed previous preventable mortality study results and agreed on the methodology and funding for the project. It was agreed that the study would be conducted as part of the system's ongoing quality-improvement process, thereby allowing the deliberation, working documents, and notes about specific aspects of patient care to be protected under the state laws governing quality improvement in general, and language protecting quality improvement specific to the TS. This protection allowed open, frank, and thorough discussion of issues that might not have occurred had the project not been conducted in this protected manner.

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