

## Special Article – Trauma System

# Needs-based Assessment of Trauma Systems: A Survey of the Membership of the Western Trauma Association

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## Abstract

**Background:** Widespread proliferation of Trauma Centers (TC) in many regions of the United States currently threatens several state trauma systems. Following a 2015 consensus conference, the American College of Surgeons Committee on Trauma published a Needs-Based Assessment of Trauma Systems (NBATS) tool to assist trauma systems in determining the number of trauma centers needed within a region. Acceptance of NBATS has not been widespread and some have opined that NBATS criteria were not appropriate.

**Methods:** A 16-question Lickert scale survey instrument, based on major components of NBATS, was made available electronically to the membership of the Western Trauma Association (WTA). If an item received 75% support (agree, strongly agree), an item was considered a consensus opinion. If 51% agreed or strongly agreed, the component was judged majority support.

**Results:** 167 members (71%) responded. 9 questions received consensus support: (1) an assessment tool is needed (2) TC designation should be based on need (3) needs of patients should be held above the interests of stakeholders (4) justification for a new TC should be mandatory before designation (5-6) too many or too few TCs will adversely affect trauma care (7) distance between TCs should be considered (8) the role of academic level 1 TCs should be preserved (9) the minimum TSA population to support a Level 2 TC is 600,000. Two questions received majority support: (1) designation of a new TC should be deferred if a functioning TC is present in a TSA of 1.5 million (2) a new TC should decrease transport times by 15 minutes.

**Conclusion:** There is broad support for a trauma system assessment tool, but the composition of the tool remains controversial. The expert opinion of the WTA membership should be considered in the future development of trauma system assessment tools.

**Keywords:** Trauma center; Trauma system; Trauma designation; Needs based assessment for trauma systems

## Introduction

In many regions of the United States, proliferation of Trauma Centers (TC) has occurred [1-11]. For example, the Florida trauma system expanded from 22 trauma centers in 2010 to 32 in 2016 while population of the state increased by 9.6% during the same period. Historically, trauma centers have most frequently been associated with busy public hospitals in urban settings. The injured patients cared for in these urban centers have whimsically been referred to as “the knife and gun club”, although vehicular related injuries usually represented the leading mechanism of injury. Of note, these centers concentrated a large number of severely injured patients that was important to meeting their commitment to education, resident training and research. University affiliation was, and is, the norm. Trauma care has not been considered as a profitable service line in many trauma centers, but instead, trauma services were viewed as a valuable resource to the community and region akin to police, fire and pre-hospital medical services. Changing national demographics over the past 2 decades have dramatically changed the patient populations at the majority of trauma centers. Penetrating injuries

from gunshot and stab wounds, while still a major public health problem have actually decreased in number since the 1990s. Road traffic safety initiatives, such as increased utilization of seat belts, air bags and intense efforts to reduce drunk driving, have stabilized the incidence of motor vehicle crash injuries. Falls in the geriatric population have increased dramatically and in many trauma centers represent the most frequently encountered mechanism of injury that results in admission [3-6]. The change in the types and number of patients admitted to trauma centers has also changed the financial fundamentals of trauma care. Geriatric patients and occupants of motor vehicles are much more likely to have insurance coverage. This dramatic change in payer mix has made trauma care profitable or at least budget neutral, in many trauma centers [4-6].

Due to many factors, a proliferation of trauma centers has been noted in many regions. The majority of “new” trauma centers have been Level 2 or 3 trauma centers established at existing community hospitals. Many of these facilities are in metropolitan areas already served by one or more Level 1 trauma centers. The increase in the number of trauma centers has been disruptive to some trauma systems

**Table 1:** Consensus Opinions (greater than 75% agree or strongly agree).

The minimum TSA population to support a Level 2 Trauma Center is equal to or greater than 600,000 (93%)
Trauma Center designation should be based on the needs of patients within a region or trauma system (92%)
The needs of the patient population should be held above the interests of stakeholder groups such as hospital or hospital systems (90%)
An assessment tool is needed to assist trauma systems in determining the appropriate number of trauma centers in a region (89%)
The role of academic level 1 Trauma Centers should be preserved (86%)
Too few Trauma Centers will adversely affect trauma care (84%)
Justification for the need of a new Trauma Center should be mandatory before designation of new Trauma Centers occurs (82%)
Too many Trauma Centers within a trauma system will adversely affect trauma care (80%)
The distance between existing Trauma Centers and proposed additional Trauma Centers should be considered (75%)

and threatens the ongoing organization and oversight functions of several state trauma systems. There has been dilution of the volume of seriously injured patients that has threatened their education and research missions.

The American College of Surgeons Committee on Trauma (ACSCOT) has recognized the real and potential problems associated with the proliferation of trauma centers, which include increased health care costs, destabilization of existing trauma systems and degradation of the research and educational missions of long standing trauma centers. Conversely, the COT has recognized that too few trauma centers in a region is also quite problematic. To begin to address these issues, the ACSCOT sponsored a consensus conference in 2015 with the goal of developing methods of assessment that could be used by trauma systems to determine the appropriate number of trauma centers in a region. Following the consensus conference, the ACSCOT published a Needs-Based Assessment of Trauma Systems (NBATS) tool to assist trauma systems in determining the appropriate number of trauma centers needed within a region. The NBATS tool developed by the ACSCOT was quite similar to an assessment tool previously used by the Florida Department of Health [7]. Acceptance of NBATS has not been widespread and some have opined that specific NBATS criteria were not appropriate. As a result, the ACSCOT has scaled back implementation of NBATS until additional opinions and data are considered. To assist the ACSCOT in developing a subsequent, and hopefully, more widely accepted version of NBATS, a survey instrument based on the original version of the NBATS assessment tool was developed. Since it is well recognized that the membership of the multidisciplinary Western Trauma Association (WTA) are experts in trauma care and trauma systems, the opinions of this Association represent a significant body of expert opinion.

## Methods

A 16 question Lickert scale survey instrument, based on the major components of NBATS, was developed by the authors with input from a number of additional trauma medical directors, trauma surgeons and emergency medicine physicians and other healthcare providers actively involved in trauma care. An initial test of the survey instrument was conducted by offering the survey to the trauma medical directors in Florida. Additional survey items were added to provide additional clarity of opinion based on the feedback provided by this group. The survey was made available electronically to the membership of the WTA by emailing an internet link to the survey. Additionally, the survey link was announced at the 2017 Western

Trauma Association meeting. If an item received 75% support (agree, strongly agree), an item was considered a consensus opinion. If 51% agreed or strongly agreed, the component was judged to have majority support. If a survey item did not receive support from greater than 50% of the respondents, this item was determined to lack consensus. Anonymity of the respondents was maintained by the electronic survey platform. The authors did not have access to the identities of the survey respondents. Respondents were prevented from taking the survey more than once by the electronic survey instrument. This survey was performed to summarize the opinions of experts in trauma care, and as such, dealt with subjective responses. Therefore, a statistical analysis was felt to be unnecessary and inappropriate.

## Results

167 members (71%) responded to the survey. Nine questions received consensus support: (1) an assessment tool is needed to assist trauma systems in determining the appropriate number of trauma centers, (2) trauma center designation should be based on the needs of patients within a region or trauma system, (3) the needs of the patient population should be held above the interests of stakeholder groups such as a hospital or hospital system, (4) justification for the need of a new trauma center should be mandatory before designation of a new trauma center occurs (5) too many trauma centers within a trauma system will adversely affect trauma care, (6) too few trauma centers will adversely affect trauma care, (7) the distance between existing trauma centers and proposed additional trauma centers should be considered, (8) the role of academic level 1 trauma centers should be preserved (9) the minimum TSA population to support a Level 2 trauma Center is 600,000 (Table 1). Two survey items received majority support: (1) designation of a new trauma center should be deferred if a functioning trauma center is present in a TSA of 1.5 million, (2) a new trauma center should decrease medianpatient transport times by 15 minutes (Table 2). Majority support was not reached for the following survey items: (1) using a quantitative formula to determine the number of trauma centers for a trauma system (2) community support as a valid indication for a new trauma center, (3) median transport times greater than 30 minutes is a valid indication for a new trauma center, (4) the minimum TSA population for a Level 1 trauma center, and (5) the number of patients with an Injury Severity Score (ISS) greater than 15 patients needed to support a Level 1 TC (Table 3).

## Discussion

In recent decades, there has been an intense debate regarding

**Table 2:** Majority opinions (Between 50% and 74%).

Designation of a new Trauma Center should be deferred if a functioning Level 1 or Level Trauma Center is present in a TSA of 1.5 million (54%)
A new Trauma Center should decrease transport times by 15 minutes (53%)

**Table 3:** No majority opinion (less than 50%).

A quantitative formula instead of general principles to determine the number of trauma centers for a trauma system should be used
Community support is a valid indication for a new Trauma Center
Median transport time greater than 30 minutes is an indication for a new Trauma Center
The minimum TSA population for a Level 1 Trauma Center
The number of patients with an Injury Severity Score (ISS) greater than 15 patients needed to support a Level 1 TC

the number of trauma centers needed in a variety of trauma systems [1,2]. The nature of the debate has varied from region to region and from state to state, but has consistently involved several issues. The desire to provide optimal care to injured patients is at the core of the discussion in most areas, but other factors such as hospital and health care system finances and profitability, cost of care, education and training and politics have occupied prominent positions in the ongoing discussion [8]. Debates regarding the appropriate number of trauma centers are frequently the topic of news reporting [1-2]. Additionally, changing demographics of the trauma patient population have fueled the discussion. The trauma patient of the current decade is more likely to be older, injured due to a fall and have health coverage compared to the “average” trauma patient of the 1980s and 1990s. Due to many factors, many regions of the United States have observed the proliferation of trauma centers despite rules and regulations designed to provide the correct number of centers in a system. The American College of Surgeons Committee on Trauma recognized this problematic situation and attempted to assist in resolving the problem *via* two new initiatives: 1) releasing a position statement regarding trauma center designation and 2) developing an instrument to assess trauma center needs within a system, the ACS Needs Based Assessment of Trauma Systems (NBATS). The NBATS tool was published after development at a multidisciplinary consensus conference and is based on 6 components: 1) population within a TSA, 2) median transport times, 3) local support, 4) the number of patients with an ISS greater than 15 that received care at a hospital not designated as a trauma center, 5) the number of Level 1 Trauma Centers present in the system and 6) the number of patients with an ISS greater than 15 treated in existing trauma centers. The ACS NBATS instrument was modeled after an instrument used by the Florida. Unfortunately, the Florida experience was less than uniformly successful. Analyses of the trauma system in Florida, a state that has experienced the rapid proliferation of trauma centers, have demonstrated increased cost and dilution of patient volumes at Level 1 trauma centers without an improvement in outcomes [9-11]. Therefore, the Florida assessment tool that served as the model for ACS NBATS appears seriously flawed.

The development of a functional and accurate trauma assessment tool is a complicated process that must incorporate conflicting data and opinions. One of the pillars of the original ACS NBATS instrument used TSA population as a factor in calculating the need for trauma centers. This concept is not as simple as it may seem. For example, a TSA of 1 million in a densely populated urban center is obviously dissimilar to the TSA of a sparsely populated state on

the Great Plains or Mountain West with the same population. Durham et al, in a 2006 assessment of the “mature” Florida trauma found that the population was well served with improved mortality rate and decreased costs when there were 1.23 trauma centers per million population [12]. The number of trauma centers in Florida has increased dramatically since this document was published. Conversely, Carr, et al, in an analysis of the United States population found that 29.7 million of 309 million residents were more than 60 minutes distant from a Level 1 or Level 2 Trauma Center. This group identified the most underserved populations were located in a rural setting and were less likely to have insurance. This finding would seem to direct future trauma center designations to serve these areas [13]. Our survey found somewhat conflicting opinions regarding TSA population required for trauma center designation. There was strong agreement that a minimum population of 600,000 was needed to support a level 2 trauma center, but the majority of the group did not agree that the minimum TSA population for a level 1 trauma center should be greater than a million. Interestingly, the majority of the respondents agreed that the presence of a functioning level 1 or level 2 trauma center in a TSA of 1.5 million is reason to defer designation of additional trauma centers.

Another component of the ACS NBATS tool used to determine the need for trauma centers is median transport time. It is unlikely that a single scale of transport times, as was published in the initial ACS NBATS instrument, will be applicable to all regions of the country. Urban, suburban and rural trauma systems face different challenges. For example, a 30 minute transport time in western Kansas is in all likelihood expeditious and optimal. An identical transport time in a metropolitan area would be considered excessive. As described above, Carr et al documented that approximately 30 million Americans live greater than 60 minutes for a trauma center [13]. Jarman, et al, found that residents of rural areas have a higher mortality rate following injury. This finding is most pronounced in the Midwest and South and appears to be related, at least in part, to prolonged mean transport times [14]. Our survey found that a majority of respondents believed that designation of a new trauma center should reduce transport times by at least 15 minutes. Improving the median transport time for patients injured in a rural setting may be improved more by enhancing prehospital transportation resources instead of establishing a trauma center in a remote area where patient volumes are low. Importantly, the ACS NBATS tool did not address the distance of a proposed trauma center from an existing trauma center. Our survey found a consensus opinion that the distance between trauma centers should be strongly considered in this assessment. It makes little sense to

establish a new trauma center adjacent to an existing trauma center for the sole purpose of reducing transport times by a trivial amount of time. Additionally, trauma centers that are in geographic proximity are more likely to be closed by a natural disaster or terrorist attack. It is better to have a regional distribution of trauma resources.

Inherent in the concept of a contemporary trauma system is the presence of a robust lead agency that provides the vision for trauma system development and improvement, as well as overseeing regulatory compliance from the major stakeholders in the trauma system, i.e. trauma centers, other hospitals and prehospital providers. The ACS NBATS instrument includes support from both the lead agency as well as local community support as a heavily weighted component of the assessment tool. Interestingly, while it is assumed that a lead agency is important in a trauma system, very little literature is available to analyze the importance of lead agency support for the designation of individual trauma centers within a TSA. Similarly, the impact of supportive letters from local governmental agencies and community stakeholder organizations on trauma center designation remains obscure. Unfortunately, governmental agencies that could serve as trauma system lead agencies are by their nature, influenced by politics. This is perhaps even more true for local governmental officials and community stakeholder groups. It is difficult to imagine the circumstances that would lead an elected local official to voice opposition to a new trauma center in the community. Using Florida as an example, this component of ACS NBATS is the most subjective area of assessment as well as being the most volatile. Therefore, many have opined that inclusion of this component into the ACS NBATS tool is inappropriate and unnecessarily politicizes the trauma center designation process [1,2]. The majority of the respondents to our survey did not support this aspect of ACS NBATS.

Another component of the ACS NBATS instrument involves assessment of the number of seriously injured patients (ISS>15) within a TSA that are treated and discharged from facilities not designated as a Level 1, 2 or 3 trauma center. The current concept of an inclusive trauma system recognizes the fact that the majority of injured patients do not require admission to a trauma center, but instead, receive acceptable care at "nontrauma" centers. All hospitals in an inclusive trauma system are important participants regardless of trauma center designation. The inclusive trauma system utilizes the full spectrum of acute care hospitals to deliver trauma care. Patients with minor injuries may be treated at any acute care facility. Level 3 or Level 4 trauma centers are capable of caring for a broad spectrum of minor and moderate injuries. Patients with severe are treated at Level 1 and high functioning Level 2 trauma centers. The intent of an inclusive trauma system has never been to transport all injured patients to Level 1 or Level 2 trauma centers. Durham, et al, found that only 38% of injured patients in a mature trauma system were treated at a trauma center [11]. Pracht, et al, found that 68% of injured geriatric patients were treated at acute care facilities without trauma center designation and that the survival advantage of trauma centers was greater for children and adults rather than the elderly [15]. Subsequently, Pracht, et al, found that only 37% of elderly injured patients in Florida were treated at designated trauma centers and the survival advantage of trauma centers diminished with increasing age [16]. Ciesla, et al, in a recent evaluation of the Florida Trauma System found that 93% of severely injured children and 85% of injured

adults were treated at designated trauma centers, but only 41% of the injured elderly were treated at designated trauma centers. This group concluded that access to trauma centers was essentially complete and that other factors, such as patient and family preferences and provider decision making, were responsible for lower utilization of trauma centers [17]. In summary, it appears that the general concept of an inclusive trauma system achieves the transport of injured patients to the appropriate facility. Respondents to our survey supported the use of general principals rather than a rigid quantitative approach trauma center designation within a trauma system.

Unlike many components of the ACS NBATS, a significant body of literature exists regarding the relationship between trauma center volume and patient outcomes. Nathans, et al, analyzed data from thirty-one academic level 1 or level 2 trauma centers participating in the University Health system Consortium Trauma Benchmarking Study. This group found that seriously injured patients with either penetrating abdominal trauma or blunt multisystem trauma had improved outcomes if the case volume exceeded 650 patients per year. Improved outcomes were evidenced by decreased mortality and decreased length of stay. However, Nathans noted that the evident only in patients with high risk for adverse outcomes [18]. Bennet, et al, analyzed severely injured patients treated at level 1 trauma centers between 2001-2006. Furthermore, they compared outcomes at ACS Verified and Non-Verified centers. They found that mortality was lower at medium volume centers compared to low volume centers. This group identified improved outcomes at high-volume level 1 trauma centers that were verified by the American College of Surgeons. They concluded that the minimum volume requirements for level 1 trauma centers propagated by the ACSCOT were valid and that level 1 ACS Verification enabled level 1 centers to effectively manage a high volume of severely injured patients [19]. Bell, et al, performed a retrospective cohort review of the National Trauma Data Bank to determine if mortality, failure to rescue and complications were influenced by trauma center volume. They found that higher trauma center volumes were associated with decreased mortality. They concluded that further research should attempt to determine optimal trauma center volumes [20]. More recently, Brown, et al, evaluated the association of trauma center volume changes with mortality rates. This was a retrospective cohort study of severely injured (ISS > 15) patients from the National Trauma Data Bank. The analysis used a standardized mortality ratio (ratio of observed to expected deaths). Importantly, this group found that each 1% increase in trauma volume was associated with improved outcomes and that for each that each 1% decrease in volume there was a twofold increase in the odds of a worsening standardized mortality ratio. The concluded that increasing volume was associated with improved outcomes and, conversely, decreases in volume were associated with worse outcomes. Furthermore, this group noted that trauma center verification seemed to facilitate the benefits of increased volume. Finally, they stated that "these results also have implications for trauma system planning, particularly in ensuring that excess trauma centers do not dilute volumes and degrade system outcomes over time" [21]. The respondents to our survey agreed that maintaining trauma center volume must play an important role in future needs based assessment tools. Greater than 75% of respondents agreed that the traditional role of academic trauma centers must be maintained and that too many trauma centers in a trauma system will adversely

affect care. However, our survey found that the opinions of our respondents regarding the number of severely injured patients to needed to sustain the functions of a level 1 trauma center were quite varied.

Application of the ACS NBATS instrument to actual regions or states is limited. Uribe – Reitz, et al, used data from California to test NBATS assessment of trauma centers in that state. NBATS estimates were 70% lower than the current number trauma centers in urban areas, but 90% higher than the current situation in rural areas [22]. This paper demonstrates the complexity and difficulty of determining the need for trauma centers in a variety of geographic and demographic settings. The difference in estimates between rural and urban areas noted in this analysis is striking. It seems unlikely that a single assessment tool will be applicable to disparate regions [22].

## Conclusion

Our survey found that there is broad support for a trauma system assessment tool that will assist trauma systems to determine the appropriate number of trauma centers within a region. However, the composition of a trauma system survey tool remains controversial. Unfortunately, objective data are limited and outnumbered by subjective opinions found in previously published survey documents. Many other factors such as financial interests and politics appear to have significantly influenced the trauma designation process in many regions. Future needs based assessment tools should focus on areas with support in the literature and avoid excessive political influence. Additionally, local factors such as population density and transport distance should be considered. The experience and commitment of the multidisciplinary Western Trauma Association is substantial. The opinions of the WTA membership should be considered in the future development of trauma system assessment tools.

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