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Improving care and equity in the American trauma system: past, present and future

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SUMMARY

Trauma care in the USA is fragmented, unequal, and millions of people lack adequate access to a trauma center. These inequities are the result of historic precedent, racial and socioeconomic discrimination, and the economics of trauma care. The fixed location of trauma centers may also fail to meet the needs of moving and changing populations.

Further, the current methods of trauma center formation perpetuate existing inequity by leaving the pursuit of trauma center creation up to hospitals, resulting in verification and designation processes that are mostly reliant on financial capability rather than community need. This particularly impacts those who are socioeconomically vulnerable, as existing trauma centers may not be accessible to their communities and new centers may not seek to serve them. On the contrary, already well-resourced communities increasingly receive duplicative care.

A thorough understanding of the interplay between trauma center designation, socioeconomic and geographic disparities in trauma care—and potential levers for change—is crucial in trauma systems planning for more equitable trauma care.

THE ORIGINS, IMPACT, AND STRUCTURE OF TRAUMA SYSTEMS

Civilian trauma care in the USA initially developed as a byproduct of casualty management during the American Civil War.[1] Wartime efforts became the early model for what later evolved into the current civilian trauma system, spurred further by the development of interstate highways and a subsequent focus on injury prevention and management. Trauma care accelerated in the 1960s, but the modern concept of American College of Surgeons (ACS)-designated trauma centers began in the 1980s, with large academic medical centers representing early adopters.[1] A fragmented evolution has been ongoing since.

The development of our trauma system and of these specialty hospitals has unequivocally provided a survival benefit compared with care at non-trauma hospitals.[2–4] Logically, any delay in reaching these centers and the interventions they confer allows ongoing progression to death and, as a result, time to such care remains the single most important factor predicting survival after injury.[5–9] This is particularly true for severely injured patients, where a lack of early intervention accounts for 25% of preventable deaths.[10] Standard measures for time to trauma center care have previously evaluated the ability to obtain care within 1 hour of injury, the so-called "golden hour". However, particularly for penetrating trauma, each minute of prehospital time reduces the likelihood of survival, making the "golden hour" a relatively poor metric of access across differing injury mechanisms.[11–13] Beyond the "golden hour", standard metrics for timely access to trauma care are lacking. Defining the appropriate time to care is challenging in a heterogeneous patient population and varies by injury mechanism and severity of patient condition. Despite the lack of standard criteria, timely access to trauma care represents an important quality marker for designation of trauma centers.[14] Surprisingly, time to care has remained markedly unequal—even in small geographies—as the trauma system has expanded.

Although a need for change is recognized, often in the form of calls for federal oversight, the American trauma system remains decentralized.[1] Trauma center *verification* of hospital capability is left to the ACS, or an equally stringent state agency, whereas final trauma center *designation* is the responsibility of individual states, with no federal supervision. Reflective of the overall state of healthcare in the USA, financial incentives, rather than patient need, are often the determining factor in the survival of existing centers and hospitals seeking out a new designation as a trauma center, resulting in an oversaturation of facilities serving wealthier clientele in urban areas with large academic medical centers. Simultaneously, access to trauma care for socioeconomically and geographically disadvantaged populationshas been reduced, as hospitals in these areas are less able to tolerate the financial burden of trauma center designationwhile caring for uninsured or underinsured patients and have increasingly shuttered.[15 16] Even using the outdated "golden hour", which is far too long to allow the survival of many trauma victims, more than 30 million Americans lack timely access to a trauma center.[17]

THE CURRENT LANDSCAPE OF THE AMERICAN TRAUMA SYSTEM

The recent history of the American trauma system is reflective of the current disparities impacting all aspects of healthcare. In the early 2000s, trauma centers closed across the country, primarily impacting access to care for already underserved populations.[18] These groups, including rural communities and non-white, uninsured, and economically disadvantaged individuals, suffered an increase in time and distance to trauma care.[18 19] Additionally, the redistribution of care from closed hospitals had a negative financial impact on surviving centers, as the payor mix at these facilities

increasingly included underinsured or uninsured patients and those with government insurance, for which trauma care reimbursement is significantly lower.[19]

The loss of trauma centers was followed by a re-expansion of trauma systems across the country during the past 10–15 years with the designation of large numbers of new centers, largely level three through five facilities.[20] Although in theory the designation of new centers should improve care, trauma care access has only increased by 3.4%, indicating that new centers are providing redundant coverage to those surviving earlier waves of closures.[20] Paradoxically, the opening of many new trauma centers has not improved access to care for disadvantaged patients.[18 20] This is due, at least in part, to the prioritization of economic viability, rather than patient need, in seeking trauma center verification. As with the redistribution that was seen in the setting of trauma center closures, a new pattern of patient redistribution may occur with the designation of redundant centers, impacting payor mix, injury patterns, and between-facility transfers, largely driven by financial incentives and economic survival considerations. These changes have contributed to persistent inequity in the American trauma system.

RESULTANT INEQUITY AND THE ADVENT OF TRAUMA DESERTS

Areas without appropriate access to trauma care are termed "trauma deserts". Classically, trauma deserts are thought of as a problem of rural areas, in which large geographic distances between patients and the nearest trauma center result in longer transport times and disparate outcomes. By this definition, approximately 30 million people in the USA live in trauma deserts, defined as no access to a level I or II trauma center within 1 hour.[17]

As would be expected given the geographic areas served by rural hospitals, rural populations are at high risk of living in a trauma desert by the standard definition, with 31% of rural individuals impacted.[17 21] Rural areas are less likely to have large, centralized academic medical centers able to shoulder the financial burden of maintaining trauma center designation. These areas are additionally plagued by under-triage, in which trauma patients are transported first to inappropriate levels of care. This is likely intertwined with lack of timely access to trauma centers, despite their survival benefit.[22] Lack of timely access to trauma care in rural areas results in a higher mortality rate for severely injured patients, who may die in the field or prior to arrival at a hospital. Though socioeconomic disparities are present in rural areas, geographic distance to trauma care appears to be a significant driver of higher mortality rates in these locales.[23]

Despite the concentrated geographic conditions and frequency of multiple trauma centers with overlapping catchment areas, individuals in urban areas are also at risk of poor access to trauma care. In comparison to almost one third of rural patients living in a trauma desert, estimates place the corresponding rate at nearly 12% for urban populations.[21]

However, the "golden hour" by which trauma deserts are historically defined is a poor metric due to the minute-by-minute relationship between time to care and outcomes for some severe injuries—especially gunshot wounds. Instead, small temporal differences in access to care can yield disparate outcomes across even small geographies. Urban trauma deserts have been variably described as a location five miles or 15 min from a trauma center.[24] By this metric, trauma deserts are a problem for both rural and urban populations, through somewhat disparate mechanisms and with different definitions.

Urban trauma deserts exist at least partly due to inequity, with areas with a high concentration of minority and socioeconomically disadvantaged residents at higher risk for inadequate access to trauma care, representing the lasting impact of historic racial and economic segregation and structural determinants of health.[11 17 21 25 26] In addition to the disadvantage posed by the placement of trauma centers in wealthier urban areas, individuals themselves also suffer from displacement through complex sociopolitical dynamics, further reducing access to care.[18 27]

In urban areas, injury patterns provide important context to the discussion of access to care. Trauma patients in urban areas tend to have more severe injuries than their rural counterparts, resulting in time-critical need for trauma center access impacting outcomes, even in areas with relatively short transport times compared with those encountered in rural areas.[28] For these gravely injured patients, access to definitive intervention is the most significant lifesaving measure, underscoring the importance of timely access to a trauma center.[5 11–13] In particular, firearm assaults, an especially lethal mechanism of injury, are more concentrated in urban areas (although most deaths occur in rural counties overall), and are more prevalent among young, non-white individuals, who are among those least likely to have timely access to trauma care, resulting in higher fatality rates.[11 29 30]

Although the specifics of disparate access vary between urban and rural areas, lack of access to trauma care remains prevalent throughout the USA. Compounding geographic disadvantage are the impacts of socioeconomic disparity. Sociodemographic disparities have been identified throughout all aspects of trauma care, and are directly associated with mortality after injury.[31]

Minority racial groups, uninsured, and underinsured patients have worse outcomes than their white, wealthier counterparts.[26 29] Consistent with historical disadvantage secondary to inequitable economic and social policies, trauma patients experiencing the highest levels of socioeconomic disadvantage tend to be those at high risk of poor access to trauma care.[32 33] The intersectionality between geographic and socioeconomic disadvantage in trauma patients is relatively understudied and should be a focus of data-driven trauma systems planning. The calculus of financial solvency for trauma centers is complex and highly variable, but understanding it is central to any effort to improve care and equity.

FINANCIAL CONSIDERATIONS IN TRAUMA CARE

The financial side of trauma care represents a paradox, with some centers experiencing significant financial losses whereas others enjoy increasing profit margins and favorable patient and payor mix. Trauma centers are increasingly costly to operate; simply achieving the readiness standards for ACS verification in 2014 was estimated at more than US$10 million per year for a level one center—and care has undoubtedly become more expensive and the verification requirements of the "Grey Book" have become ever more expansive.[34] At the same time, a quarter of American level one and two centers and a full 60% of level three centers are considered financially vulnerable.[35]

Despite the associated costs, financial motivations are a prominent factor in hospitals seeking new trauma center verification and designation. This may be partly due to the more lucrative payor mix that tends to receive care at newly designated centers, which conversely results in an increased proportion of government insurance, with lower reimbursement, seen at existing trauma centers.[36 37] Furthermore, as for-profit hospitals, which are an increasing proportion of healthcare facilities

in this country, seek trauma center designation, costs increase to patients and payors, whereas hospital profits increase, without a corresponding improvement in patient outcomes.[38 39] Although this structure drives profits for investors, it does so at the detriment of an already financially vulnerable population.

For non-profit and existing trauma centers, the changes associated with the designation of new centers create a financial challenge. Lack of funding leaves trauma centers at risk for closure, with safety-net facilities often operating at a financial loss due to low reimbursement rates, uncompensated care, and high costs associated with trauma center readiness. In the absence of outside financial support, centers providing higher proportions of uncompensated care tend to be more financially vulnerable, impacting access for disadvantaged patient populations for whom access to care is already suboptimal.[35] Despite this, there is no standardized funding source for trauma centers. Federal funding, when promised, does not always materialize, and that funding present through congressional action is both decreasing and insufficient to cover trauma center operating costs. State funding is variable both in terms of amount and origin, though states with higher levels of trauma funding have lower trauma mortality, underscoring the importance of an adequately funded system.[40]

IMPROVING TRAUMA SYSTEMS

The ACS has made recommendations to consider population need as the primary driver of trauma center designation.[15] Methods of calculating need include analyzing existing and predicted access to care by both population and distance, with consideration of the use of geospatial modeling, though detailed metrics are not provided.[16] Additionally, consideration of socioeconomic characteristics of projected trauma center patient populations, and the real-world impacts of payor mix and patient population, are not discussed.[16] To promote the use of the need for care to analyze trauma center designation, the ACS introduced the Needs Based Assessment of Trauma Systems Tool (NBATS) in 2015, with the most recent version (NBATS-2) published in 2018. These tools provide a scoring system that can be used to analyze the number of trauma centers that should be allocated to a given geographic area.[41 42] However, there is no mandate to use these tools, and some important considerations, such as socioeconomic and geographic disparity, are not taken into account. Notably, the ability of these tools to accurately predict trauma volumes has been called into question, and NBATS may be more helpful in trauma center planning when combined with other relevant information, such as emergency medical service protocols.[43] Though these recommendations are laudable, there is currently no oversight to ensure that they are used in practice, resulting in a default to financial considerations in the designation of trauma centers.[15 20]

Financial considerations cannot be overstated and little progress in access can be made without addressing funding. Operating a trauma center is a costly endeavor, and without programs in place to provide funding, trauma center designations will continue to be a product of financial resources, concentrated in wealthy urban areas with large academic medical centers, irrespective of patient need. In addition to the use of real-world data and predictive modeling to analyze resource allocation for trauma center designation, programs are necessary to offset the high operating costs and relatively low margins of providing trauma care for underserved populations.[15]

Although reimbursement rates for trauma remain poor, targeting the high level of uncompensated care in trauma provides one avenue of savings. Programs such as Medicaid expansion may help to offset the financial burden of trauma center designation to some degree. At the government level, funding allocation is fragmented at best. Although federal oversight has been suggested for trauma centers, this would require a major overhaul of the current system that may not be a feasible initial step. As trauma center designations are under state purview, and states have the ability to allocate funding, state-level policies must promote equitable access to trauma care.

As of 2018, 29 states had mechanisms in place providing trauma system funding, including general appropriations, fines levied for offenses, and taxes.[44] However, the amount of funding provided by this legislation varies widely, and is not tied to patient need. Notably, this information is rarely publicly available, underscoring the complex drivers behind trauma center funding. Using modeling and NBATS-like tools to analyze the geographic allocation of trauma centers may also provide a framework to reduce spending on redundant trauma care, which could be reallocated to trauma center designations in areas of higher need.[45] Limiting state funding to trauma centers meeting documented needs will reduce waste and promote equity in access to care. Improving population trauma care, though costly from a payor perspective, will improve population health, reducing overall costs and improving equity in the healthcare system and society.

CONCLUSIONS

The American trauma system provides high quality and life-saving care, but is plagued by inequitable access to care driven by historic precedent and the need for financial solvency in a difficult environment. This has resulted in an oversaturation of trauma centers in wealthy areas, irrespective of patient need. Although efforts are underway to encourage the use of need, rather than financial motivations, to analyze trauma center allocation, incentives to do so are lacking. At the state level, reallocation of funds to promote the goal of equitable access to trauma centers represents a viable path forward toward improved care for all injured patients.

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