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PATIENT SAFETY AND QUALITY IN TRAUMA (H KAAFARANI, SECTION EDITOR)

Equal Access Is Quality: an Update on the State of Disparities Research in Trauma

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Abstract

Purpose of Review Over the past 5 years, disparities in the access to and quality of trauma care have expanded on the relatively nascent body of literature.

Recent Findings This review summarizes the newest findings in trauma disparities research, identifying 47 original research articles that either illuminate disparities that had not been previously described or augment our understanding of a known disparity. Furthermore, the current literature on trauma disparities establishes the importance of investigating disparities in pre- and post-hospital quality metrics and refining the approach to quality measurement for trauma care in pediatric and geriatric populations in particular. A new development on the study of trauma disparities is the effort to establish the mechanisms by which racial/ethnic and socioeconomic disparities occur.

Summary The authors conclude from this evidence-based review that, as new disparities in trauma care continue to emerge, novel approaches to measuring and eliminating these disparities are needed.

Keywords Trauma disparities · Disparities research · Trauma care quality · Racial disparities · Pediatric trauma · Geriatric trauma

Introduction

Racial disparities in the quality of and access to health care have been revealed in almost all areas of medicine. There is conflicting evidence on whether fewer racial disparities exist in emergency care as compared to elective and preventive care [1–17]. The management of injured patients, which accounts for a substantial component of emergency care and affects patients from all racial/ethnic and socioeconomic backgrounds, has become increasingly protocolized over the last three decades. While mortality rates for severely injured patients have decreased in recent years [18], evidence of racial disparities in trauma care continues to emerge. It was recently estimated that, over a 4-year period, approximately 5% of trauma deaths were attributable to racial disparities in trauma care [19••].

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Previous reviews of the literature have shown that race/ethnicity and insurance are associated with disparate outcomes following trauma [20–22]. Several studies have illustrated that Black patients have higher mortality rates than comparably injured White patients, partially due to the fact that Black patients are more likely to have penetrating mechanisms of injury [23–29]. Mortality rates differed when grouping all non-White patients together; some studies found that non-White race was a predictor of mortality in trauma [23, 30], while others showed no difference. With regard to long-term functional outcomes after traumatic injury, however, it is apparent that all racial minority groups fare worse than White patients [5, 31–35].

Studies have also shown that lack of insurance is a predictor for adverse outcomes in trauma surgery [26, 36–42]. Haider et al. demonstrated that insured patients had lower crude mortality rates than similarly injured uninsured patients, but Black and Hispanic patients had worse outcomes than White patients, regardless of insurance status [9]. When comparing blunt and penetrating trauma, lack of insurance is a predictor of mortality among similarly injured patients [28]. The deleterious effect of being uninsured on outcomes in trauma have been emphasized in the pediatric trauma literature, with numerous studies demonstrating that uninsured and

publicly insured children have higher mortality after sustaining trauma [27, 43]. As the Centers for Disease Control (CDC) has identified expansion of access to trauma care as a Healthy People priority [44], a thorough examination of these disparate outcomes is necessary to improve short-term and long-term outcomes for patients of color/racial minority patients following traumatic injury.

The literature on quality measurement and performance improvement in trauma care has also expanded in parallel with the literature on trauma disparities. In 2008, the American College of Surgeons (ACS) established the Trauma Quality Improvement Program (TQIP) to benchmark trauma centers. Several studies have since demonstrated a large degree of variability in hospital-level performance on both process and outcome measures [45–47]. There is evidence that patient selection and case mix, including racial and socioeconomic characteristics, contribute in part to this variability [20, 48, 49]. This evidence, which is summarized in detail in this review, is of critical importance to the development of an understanding of the current state of healthcare disparities and quality measurement in trauma surgery.

Objective

The objective of this review is to critically assess and summarize racial disparities in trauma outcomes, both short term and long term, described in the current body of literature (encompassing the last 5 years), in the context of recent developments in trauma system organization, health policy, economic infrastructure, and surgical education.

Methods

We searched the electronic database PubMed and the Cochrane Library. The search criteria, which were restricted to primary research articles published from 2012 to 2017, included the keywords "health disparities," "emergency," "surgery," "quality improvement," and "ethnic groups," with "trauma" included as a "title/abstract" search filter term. A total of 47 articles met the search criteria for this review, as shown in Table 1. Studies in which surgical patients of all ages were included, including pediatric and geriatric populations, and the outcomes in the studies varied from short-term outcomes such as in-hospital mortality to longer term outcomes, such as discharge to rehabilitation facilities. Studies examining process measures were sought by adding "process" to the search as a title/abstract filter term. In the absence of randomized controlled trials, our review focused primarily on retrospective and prospective cohort studies. The review was performed in a systematic manner, beginning with the broadest search and progressively adding search and filter terms to allow the development of a comprehensive analysis of the most current literature in trauma disparities.

Summary of Recent Findings in the Trauma Disparities Literature

As process measures are increasingly used to measure clinical performance in trauma, disparities in the adherence to evidence-based protocols represent an important variable in the study of trauma disparities. Efforts to improve quality of care for geriatric trauma patients, for instance, have focused on several process-oriented quality indicators [96–98]. At the moment, no such metrics exist for benchmarking trauma centers according to racially disparate outcomes and processes. Synthesizing the data from the trauma quality improvement literature with the disparities literature to establish methodologies for measuring disparities as a quality indicator is an essential future direction to pursue if the discipline of trauma care is to continue to move forward.

Recent investigations into disparities in trauma have expanded upon the existing body of knowledge by not only revealing disparities that had not been previously characterized but also reflecting the shift in focus from immediate outcomes to longer term functional outcomes and systems interventions. Post-injury patient-reported quality of life has emerged in parallel to this trend as an outcome measure of care quality. Additionally, a number of studies described age-specific trends in racial disparities among injured patients, particularly in older age groups. As process measures evolve to track quality of care for geriatric trauma patients, racial disparities among this vulnerable population take on a new dimension of significance. Finally, a recurring theme in the updated body of trauma disparities literature is the effort to understand the complex mechanisms underlying racial and socioeconomic disparities in quality of trauma care. These findings are described in detail below.

New Disparities in Trauma Surgery

The early 2000s saw a wave of studies that defined disparities in various aspects of trauma care. This trend continued over the past 5 years, during which numerous studies have emerged detailing disparities in the management of injured patients that had not been previously described. Black patients, especially those without insurance, are more likely to die following an intentional injury, with uninsured Blacks comprising 76% of all excess trauma center deaths due to assault [55]. Traumatic brain injury (TBI) among veterans, both combat and non-combat, was found to differentially affect patients based on their race; one study found that Hispanic ethnicity was a predictor of mortality

Table 1 Annotated table of references

Lead author/publication year	Title	Study design	Years studied	Study characteristics
Haider/2012 [50•]	Association Between Hospitals Caring for a Disproportionately High Percentage of Minority Trauma Patients and Increased Mortality	Retrospective cross-sectional	2007–2008	Outcome of interest: crude mortality and adjusted odds of in-hospital mortality Data source: National Trauma Data Bank Adjusted variables: age, sex, insurance status, injury severity, presence of hypotension at admission, presence of severe head and/or extremity injury, mechanism of injury
Egede/2012 [51]	Racial/Ethnic Disparities in Mortality Risk Among US Veterans With Traumatic Brain Injury	Retrospective cross-sectional	2006	Outcome of interest: mortality Data source: linked VA databases Adjusted variables: age, marital status, gender, service connectedness, urban residence, VA region of residence, insurance status, comorbidities.
Taghavi/2012 [52]	Does Payer Status Matter in Predicting Penetrating Trauma Outcomes?	Retrospective cohort	2005–2009	Outcome of interest: ICU length of stay, total hospital length of stay, discharge to rehab facility, in-hospital complications, in-hospital mortality Data source: single institutional data Adjusted variables: age, sex, ethnicity, payer status, socioeconomic status, ISS, GCS
Cassidy/2012 [53]	Health Disparities Analysis of Critically Ill Pediatric Trauma Patients in Milwaukee, Wisconsin	Retrospective cohort	2005–2009	Outcome of interest: mortality Data source: institutional data Adjusted variables: age, race, GCS, injury severity, insurance, mechanism, comorbidities
Martin/2012 [54]	Race Disparities in Firearm Injuries and Outcomes Among Tennessee Children	Retrospective cohort	1998–2010	Outcome of interest: mortality Data source: institutional trauma registry Adjusted variables: age, race, sex, whether the injury was intentional, zip code, median income by zip code
Harris/2012 [55]	Homicide as a medical outcome: Racial disparity in deaths from assault in us level I and II trauma centers	Retrospective cohort	2005–2008	Outcome of interest: mortality following intentional injury Data source: NTDB Adjusted variables: race, insurance, age, sex, mechanism of injury, head injury, ISS < GCS, year, trauma center level, hospital bed size, hospital case volumes
Lee/2012 [56••]	Are there racial disparities in the use of restraints and outcomes in children after motor vehicle crashes?	Retrospective cohort	2002–2007	Outcome of interest: emergency surgery, morbidity, mortality, length of stay Data source: NTDB Adjusted variables: age, sex, GCS, ISS, use of restraints
Young/2013 [57]	Racial differences in receiving morphine among prehospital patients with blunt trauma	Retrospective cohort	2009	Outcome of interest: analgesia administration in the pre-hospital setting Data source: single urban Emergency Medical Services registry Adjusted variables: sex, race, age, pain score on a pain scale, time under pre-hospital care
Glance/2013 [58]	Trends in Racial Disparities for Injured Patients Admitted to Trauma Centers	Retrospective cross-sectional	2000–2009	Outcome of interest: death, major complication, failure to rescue Data source: Pennsylvania Trauma Outcome Study Adjusted variables: age, gender, comorbidities, mechanism of injury, transfer status, GCS motor component
Haskins/2013	Racial Disparities in Survival Among Injured Drivers	Retrospective cohort	2000–2008	Outcome of interest: mortality Data source: National Automotive Sample System Crashworthiness Data System Adjusted variables: age sex, body mass index, time of crash, whether the vehicle rolled over, whether the occupant was ejected from the vehicle, seat belt use, travel speed, adverse weather, type of medical facility, LOS, alcohol use, occupant injury severity, injured body region

Table 1 (continued)

Lead author/publication year	Title	Study design	Years studied	Study characteristics
Haider/2013 [59••]	Minority Trauma Patients Tend To Cluster at Trauma Centers With Worse-Than-Expected Mortality	Retrospective cross-sectional	2007–2010	Outcome of interest: death, observed/expected mortality ratios Data source: National Trauma Data Bank Adjusted variables: age, gender, comorbidities, mechanism of injury, presence of hypotension at admission, pulse rate at admission, total GCS, injury severity, presence of severe head injury, need for ventilator use
Asemota/2013 [60]	Race and Insurance Disparities in Discharge to Rehabilitation for Patients with Traumatic Brain Injury	Retrospective cross-sectional	2005–2010	Outcome of interest: discharge to inpatient rehabilitation Data source: nationwide inpatient sample Adjusted variables: insurance, mechanism of injury, injury severity, age
Singer/2013 [61]	Insurance- and Race-related Disparities Decrease in Elderly Trauma Patients	Retrospective cross-sectional	2002–2006	Outcomes of interest: in-hospital mortality Data source: National Trauma Data Bank Adjusted variables: age, sex, head injury severity, GCS, injury severity, hypotension on admission, insurance type
Schoenfeld/2013 [62•]	Patient Demographics, Insurance Status, Race, and Ethnicity as Predictors of Morbidity and Mortality After Spine Trauma: A Study Using the National Trauma Data Bank	Retrospective cross-sectional	2008	Outcome of interest: mortality, complications, length of stay, ICU days, time on vent Data source: National Trauma Data Bank Adjusted variables: insurance, comorbidities, injury severity, length of stay, ICU days, ventilator time
Short/2013 [63•]	Insurance Type, Not Race, Predicts Mortality After Pediatric Trauma	Retrospective cohort	2007–2008	Outcome of interest: in-hospital mortality Data source: NTDB Adjusted variables: race, insurance, age, gender, ISS, GCS, Head AIS, admission SBP
Bell/2013 [64•]	Insurance status is a predictor of failure to rescue in trauma patients at both safety net and non-safety net hospitals	Retrospective cohort	2008–2010	Outcome of interest: complications, failure to rescue, mortality Data source: NTDB Adjusted variables: injury severity, mechanism of trauma, age, sex, race, comorbidities, head injury, hypotension, hospital clustering
Bolorunduro/2013 [65]	Disparities in Trauma care: Are Fewer Diagnostic Tests Conducted for Uninsured Patients with Pelvic Fracture?	Retrospective cohort	2002–2006	Outcome of interest: mortality, receipt of indicated diagnostic and treatment modalities Data source: NTDB Adjusted variables: age, sex, race, ISS, presence of shock, GCS motor score, injury mechanism
Ali/2013 [66]	Socioeconomic Disparity in Inpatient Mortality After Traumatic Injury in Adults	Retrospective cohort	2003–2009	Outcome of interest: inpatient mortality Data source: NIS Adjusted variables: ISS, mechanism of injury, comorbidities, race, insurance status
Ramirez/2013 [67]	Pediatric Injury Outcomes in Racial/Ethnic Minorities in California	Retrospective cohort	1999–2010	Outcome of interest: inpatient mortality Data source: California Office of Statewide Health Planning and Development hospital discharge database Adjusted variables: age, sex, injury severity, comorbidities, insurance status, admission year, teaching hospital status, mechanism of injury
Kisat/2013 [68]	Predictors of Sepsis in Moderately Severely Injured Patients: An Analysis of the National Trauma Data Bank	Retrospective cohort	2007–2008	Outcome of interest: development of post-traumatic sepsis Data source: NTDB Adjusted variables: age, gender, ethnicity, insurance status, mechanism of injury, injury severity, presence of hypotension, major surgical procedure, ICU admission
Shashaty/2013 [69]	African American Race, Obesity, and Blood Product Transfusion Are Risk Factors for Acute	Prospective cohort	2005–2009	Outcome of interest: development of acute kidney injury Data source: single institution enrollment

Table 1 (continued)

Lead author/publication year	Title	Study design	Years studied	Study characteristics
	Kidney Injury in Critically Ill Trauma Patients			Adjusted variables: race, comorbidities, injury severity (abdomen), BMI, receipt of PRBC transfusion
Lad/2013 [70]	Racial Disparities in Outcomes After Spinal Cord Injury	Retrospective cohort	2000–2009	Outcome of interest: mortality, ICU length of stay, total hospital length of stay, in-hospital complications, disposition Data source: NTDB Adjusted variables: race, comorbidities, mechanism, injury severity, presence of hypotension
Hazlitt/2013 [71]	Disparities in Trauma: The Impact of Socioeconomic Factors on Outcomes Following Traumatic Hollow Viscus Injury	Retrospective cohort	2000–2009	Outcome of interest: mortality, complications Data source: Trauma Registry for the American College of Surgeons Adjusted variables: age, gender, income, insurance payer, mechanism of injury, injury severity, comorbidities, ICU length of stay, overall length of stay, discharge disposition
Scott/2013 [19••]	Counting the lives lost: How many Black trauma deaths are attributable to disparities?	Retrospective cohort	2007–2010	Outcome of interest: mortality Data source: NTDB Adjusted variables: age, sex, ISS, hypotension at presentation, mechanism of injury, GCS, ventilator use,]injury intentionality, insurance status
Haider/2014 [72]	Unconscious Race and Class Bias: Its Association with Decision-Making By Trauma and Acute Care Surgeons	Survey-based	2013	Outcome of interest: responses to clinical vignettes Data source: trauma and acute care surgeon participants Adjusted variables: participant age, sex, explicit race or social class preference
Hicks/2014 [73•]	Association Between Race and Age in Survival After Trauma	Retrospective cross-sectional	2003–2010	Outcome of interest: in-hospital mortality Data source: nationwide inpatient sample Adjusted variables: age, sex, insurance, mechanism of injury, injury severity, head injury severity, comorbidities
Meagher/2015 [74]	Racial and Ethnic Disparities in Discharge to Rehabilitation Following Traumatic Brain Injury	Retrospective cross-sectional	2007–2010	Outcome of interest: discharge destination Data source: National Trauma Data Bank Adjusted variables: age, sex, insurance status, mechanism of injury, injury severity, GCS motor score, length of stay, days in the intensive care unit, days on the ventilator
Hicks/2015 [75]	Explaining the Paradoxical Age-Based Racial Disparities in Survival After Trauma: The Role of the Treating Facility	Retrospective cross-sectional	2003–2009	Outcome of interest: death, observed/expected mortality ratios Data source: nationwide inpatient sample Adjusted variables: age, sex, insurance, mechanism of injury, injury severity, head injury severity, comorbidities
Kane/2014 [76]	Racial/Ethnic and Insurance Status Disparities in Discharge to Post-hospitalization Care for Patients With Traumatic Brain Injury	Retrospective cohort	2008–2011	Outcome of interest: discharge disposition Data source: Oregon State Inpatient Database Adjusted variables: age, sex, race, insurance, ISS, comorbidities, LOS
Falor/2014 [77]	Insurance status predicts survival for trauma patients undergoing urgent intervention	Retrospective cohort	All years in the NTDB	Outcome of interest: survival after urgent thoracotomy/laparotomy Data source: NTDB Adjusted variables: age, sex, ethnicity, mechanism of injury, ISS, comorbidities, pre-hospital intravenous fluids, p-rehospital CPR, pre-hospital placement of thoracostomy tube
Dismuke/2015 [78]	Racial/Ethnic Differences in Combat and Non-Combat-Associated Traumatic Brain Injury Severity in the Veterans	Retrospective cohort	2004–2010	Outcome of interest: TBI severity Data source: linked VA databases Adjusted variables: combat exposure, race/ethnicity, urban versus rural residence,

Table 1 (continued)

Lead author/publication year	Title	Study design	Years studied	Study characteristics
	Health Administration: 2004–2010			age, gender, marital status, service connectedness
Scott/2015 [79••]	Racial and Regional Disparities in the Effect of the Affordable Care Act's Dependent Coverage Provision on Young Adult Trauma Patients	Retrospective cohort	2007–2012	Outcome of interest: insurance coverage expansion or reduction Data source: NTDB Adjusted variables: race/ethnicity, census region
Osler/2015 [80]	Trauma care does not discriminate	Retrospective cohort	2010	Outcome of interest: mortality Data source: NIS Adjusted variables: age, sex, traumatic shock, extent of anatomic injury using the trauma mortality prediction model (TMPM), mechanism of injury, comorbidities, insurance
Piatt/2015 [81]	Pediatric spinal injury in the US: epidemiology and disparities	Retrospective cohort	2009	Outcome of interest: patterns of injury, mortality, spinal fusion Data source: Kids' Inpatient Database, NTDB Adjusted variables: age, race, payor, ISS, mechanism of injury, type of injury, spinal level of injury, systolic blood pressure at admission
Hicks/2016 [82]	Racial disparities after vascular trauma are age-dependent.	Retrospective cohort	2005–2012	Outcome of interest: in-hospital mortality, amputation Data source: nationwide inpatient sample Adjusted variables: age, gender, injury type, injury severity, insurance status, comorbidities, injury intent, and extremity injury severity.
Natale/2016 [83]	Relationship of Physician-identified Patient Race and Ethnicity to Use of Computed Tomography in Pediatric Blunt Torso Trauma	Prospective cohort	2007–2010	Outcome of interest: receipt of abdominal CT scan Data source: institutional data from 20 North American Emergency Departments Adjusted variables: age, sex, use of abdominal ultrasound, injury severity
Strong/2016 [84]	Outcomes of Trauma Admission for Falls: Influence of Race and Age on In-hospital and Post-Discharge Mortality	Retrospective cohort	1997–2008	Outcome of interest: in-hospital mortality, disease-specific death within 1 year post--discharge Data source: single institution trauma registry Adjusted variables: age, sex, median annual household income by zip code, previous trauma admissions, injury severity, blood alcohol content at admission, mechanism of fall, associated hip fracture, comorbidities.
Mahmoudi/2016 [85]	Racial Variation in Treatment of Traumatic Finger/Thumb Amputation: A National Comparative Study of Replantation and Revision Amputation	Retrospective cohort	2007–2012	Outcome of interest: probability of undergoing replantation after traumatic finger or thumb amputation Data source: NTDB Adjusted variables: age, sex, race, ISS, the presence of multiple-digit amputation injuries, insurance status
Jarman/2016 [86]	Rural risk: geographic disparities in trauma mortality	Retrospective cohort	2009–2010	Outcome of interest: mortality Data source: Nationwide Emergency Department Sample (NEDS) Adjusted variables: age, sex, injury type and severity, comorbidities, trauma designation, and Census region
Moore/2016 [87]	Availability of Outpatient Rehabilitation Services for Children After Traumatic Brain Injury: Differences by Language and Insurance Status	Cross-sectional	N/A	Outcome of interest: availability of and travel time to services Data source: single institution Adjusted variables: English proficiency, insurance status, education level
McQuistion/2016 [88]	Insurance status and race affect treatment and	Retrospective cohort	2002–2012	Outcome of interest: LOS, procedures, mortality, discharge disposition Data source: NTDB

Table 1 (continued)

Lead author/publication year	Title	Study design	Years studied	Study characteristics
	outcome of traumatic brain injury			Adjusted variables: race/ethnicity, age, gender, insurance status, injury type, head AIS, ISS, year of discharge, hospital region, mechanism of injury
Gerry/2016 [89]	Uninsured status may be more predictive of outcomes among the severely injured than minority race	Retrospective cohort	2010–2012	Outcome of interest: in-hospital mortality, post-hospital discharge disposition Data source: NTDB Adjusted variables: age, sex, race, number of comorbidities, insurance, mechanism of injury, ISS, GCS, trauma center level, hospital bed size
Missios/2016 [90]	The association of insurance status and race with the procedural volume of traumatic brain injury patients	Retrospective cohort	2009–2011	Outcome of interest: in-hospital procedural volume Data source: NTDB Adjusted variables: age, vital signs at presentation, gender, race, insurance, mechanism of injury, ISS, GCS, number of neurosurgeons per hospital, number of trauma surgeons per hospital, hospital region, hospital teaching status, hospital bed size
Schoenfeld/2016 [91]	The influence of race and hospital environment on the care of patients with cervical spine fractures	Cohort control	2003–2010	Outcome of interest: surgical rate, postoperative morbidity, mortality, and LOS Data source: Massachusetts State Inpatient Database Adjusted variables: receipt of a surgical intervention, age, sex, insurance status, number of medical comorbidities
Metcalfe/2016 [89]	Unplanned 30-day readmissions in orthopedic trauma	Retrospective cohort	2007–2011	Outcome of interest: unplanned 30-day readmission Data source: California State Inpatient Database Adjusted variables: age, sex, race, insurance, comorbidities, injury type, ISS, procedural complications, discharge against medical advice
Irizarry/2017 [92]	Prevalence and ethnic/racial disparities in the distribution of pediatric injuries in South Florida: implications for the development of community prevention programs	Retrospective cohort	2011–2017	Outcome of interest: injury pattern, mortality Data source: single institution trauma registry Adjusted variables: race, age, geographic region, injury severity, ICU LOS, hospital LOS
Driesman/2017 [93]	Racial disparities in outcomes of operatively treated lower extremity fractures	Prospective cohort	1 year	Outcome of interest: long-term functional outcome as measured by the SMFA (short musculoskeletal function assessment) and pain scores Data source: single institution Adjusted variables: age, sex, mechanism of injury, ISS, insurance
Budnick/2017 [94]	Ethnic disparities in traumatic brain injury care referral in a Hispanic-majority population	Retrospective cohort	2005–2015	Outcome of interest: discharge disposition to rehabilitation facilities Data source: single institution trauma registry Adjusted variables: age, sex, race, residence, admission GCS, GCS motor, ISS, hospital and ICU LOS, mechanism of injury, insurance status, residence
Leibl/2017 [95]	Disparities in the Surgical Treatment of Facial Fractures: Results from the National Trauma Data Bank	Retrospective cohort	2002–2014	Outcome of interest: receipt of surgical intervention Data source: NTDB Adjusted variables: age, sex, race, insurance, ISS, hospital teaching status, hospital trauma center status

following TBI [51] while another found that both Black race and Hispanic ethnicity were associated with more severe TBI [78]. The authors postulated the differences in adherence to numerous processes of care that inform outcomes in TBI as potential contributors to these disparities.

Poor outcomes among injured patients are associated with non-White race, according to several recent studies. Adult patients with traumatic spinal cord injuries experience different outcomes depending on their race, with Black and Hispanic patients demonstrating longer risk-adjusted length of stay than White and Asian patients. Interestingly, the same study also found that Black and Native American patients have higher odds of complications than White, Hispanic, or Asian patients [70]. Similarly, Schoenfeld et al. found that non-White patients have an increased mortality risk following spine trauma, a relationship that is amplified by lack of insurance [62•, 91]. These disparities persist among children as well; in a nationwide sample of pediatric patients with spinal injuries, Black children were more severely injured and were less likely to undergo definitive operative intervention [81]. Black patients who suffer traumatic amputation of the digits, an injury associated with devastating consequences to quality of life and vocational performance, are less likely than White patients to undergo replantation, despite advancements in microsurgical techniques [85]. They are also less likely to receive surgical intervention for facial fractures [95]. Among patients requiring emergency laparotomy and fecal diversion due to hollow viscus injury, Black and Hispanic patients were less likely to ultimately undergo stoma reversal procedures than their White counterparts [99]. The authors speculated that this was due to the increased likelihood of Black and Hispanic patients lacking insurance, rather than any hospital-level quality indicators, but acknowledged that this conclusion is difficult to defend in the absence of validated process measures for this condition. Black race is also a strong predictor of developing sepsis [68] and acute kidney injury [69] among severely injured patients, which others have attributed to the fact that Black patients tend to cluster at poorer-quality hospitals [59••].

Insurance disparities, which are distinct from but closely related to racial disparities, have also been evaluated and defined in the context of trauma in recent years. Uninsured patients who sustained penetrating trauma are more likely to have shorter ICU lengths of stay and longer overall hospital lengths of stay [52] and less likely to receive inpatient procedures while hospitalized for TBI [90]. Those with pelvic fractures are less likely to receive clinically indicated diagnostic tests and therapeutic interventions, such as embolization, and even have higher mortality rates [65]. Serious complications, such as anastomotic leaks and fascial dehiscence, are more common in uninsured patients who sustain traumatic hollow viscus injuries [71]. Another nationwide study demonstrated that inpatient mortality following traumatic injury is higher among lower income patients, even after risk adjustment, and uninsured trauma patients who present without vital signs and undergo urgent thoracotomy/laparotomy are less likely to survive than insured patients [66, 77]. Insurance disparities in a relatively new quality metric known as failure to rescue have also been identified, with uninsured patients being more likely to experience failure to rescue than publicly or privately insured patients [64•]. Many of the authors of these studies have sought to explain these associations by theorizing that uninsured patients tend to cluster at trauma centers that perform below average on both process and outcome measures.

One study argued that Black race and/or Hispanic ethnicity were not associated with worse outcomes in trauma patients. The authors extrapolated from a nationally representative sample that there was no difference in risk-adjusted survival among injured patients based on race or insurance status [80]. However, other investigators disputed these conclusions on the grounds that the data set used to perform this analysis lacked the clinical granularity needed to meaningfully interpret data on trauma outcomes. Therefore, adjusting for known confounders such as injury severity and trauma center level designation was rendered impossible by the inherent limitations of the selected data set. Furthermore, all the aforementioned studies that did find racial disparities restricted the sample to those with moderate to severe injuries, whereas this study alone included patients with mild injuries who are at low risk for mortality, resulting in attenuation of the observed effect [100] (Fig. 1).

Age-Related Disparities in Trauma Surgery

In the management of trauma, patient age is associated with differences in injury mechanism, injury severity, clinical outcomes, and functional outcomes; these differences are further influenced by patient race and insurance status. Hicks et al.

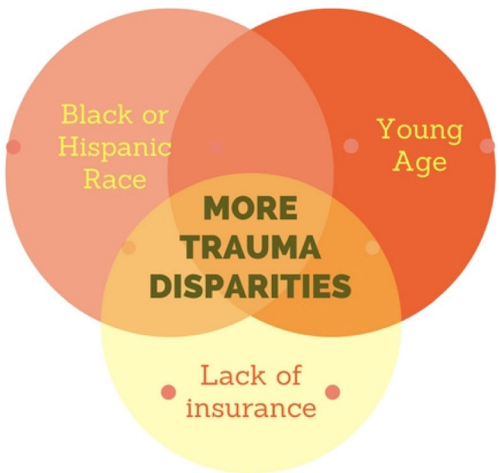

Fig. 1 The interaction among underrepresented minority race/ethnicity, young age, and lack of insurance coverage can potentiate disparities in trauma

described a paradoxical association between race and mortality among elderly trauma patients; in a large nationwide sample, older Black patients actually had reduced mortality compared to similarly injured older White patients, in contrast to the higher risk-adjusted mortality risk among young Black trauma patients [73•]. Further study by this group revealed that young Black trauma patients tend to receive care at lower performing trauma centers, whereas older Black patients were less likely to be treated at these poorer-quality facilities, suggesting an important age-related disparity in the management of injured patients [75]. Another study asserted that among elderly trauma patients, only Hispanic ethnicity is a predictor of increased mortality. Older patients in this cohort are also less likely to be uninsured than their younger counterparts [61]. Among patients with isolated vascular trauma, however, race is the single greatest predictor of adverse outcomes in the elderly, with older Black patients being five times more likely to experience death or amputation [82].

On the other end of the age spectrum, injured children also experience age-dependent disparities, although insurance appears to be an effect modifier for racial disparities in the pediatric population. Having insurance is associated with a reduction in mortality in a nationwide sample of injured children, as adjusting for insurance mitigates the racial disparities seen in this population [63•]. A similar phenomenon was described in a state database, which showed that outcomes differ according to race on unadjusted analysis, but adjusting for variables that determine access to care explains and eliminates these disparities [67]. Multiple studies using data from institutional trauma registries found that Black race was associated with lack of insurance, higher mortality rates, fewer diagnostic tests, and higher rates of penetrating injury in a cohort of critically ill pediatric trauma patients, which suggests that the disparities seen in this population are multifactorial in etiology [53, 54, 81, 83, 92, 101, 102]. As there are currently no validated quality metrics for access to trauma care, these new data indicate that there may be a fundamental difference in baseline health status for uninsured children, as well as children belonging to underrepresented minority groups, that puts them at increased risk for unfavorable outcomes following traumatic injury, but is not captured by current quality measurement techniques.

Pre-Hospital and Post-Hospitalization Disparities

Fortunately, despite the limitations of measuring quality as a function of access to care, our understanding of disparities in trauma care now extends beyond in-hospital outcome measures to those that occur before and after hospitalization. For instance, one study described a pre-hospital disparity in trauma that was previously unexplored: the use of restraints in motor vehicle collisions and its relationship to outcomes. The authors of this study found that Black, Hispanic, and Native American children are the least likely to use restraints and have more severe injuries [56••]. Another study found that among children who sustained injuries as a result of bicycle accidents, Black children were less likely than White children to be wearing a helmet at the time of the accident [103] White patients are more likely than Black or Hispanic patients to receive pre-hospital analgesia for blunt trauma injuries [57]. Research in pre-hospital disparities has also uncovered geographical disparities in trauma care; patients in rural areas, for example, are more likely than patients in non-rural areas to die after traumatic injury, thought to be the result of increased travel time for rural patients to receive treatment [86, 104]. While not a racial disparity per se, geographic disparities represent an important public health concern that is likely to disproportionately affect the most socioeconomically disadvantaged patients.

Assessment of functional outcomes after trauma has also come to the forefront in recent years, and racial disparities exist in the post-hospitalization phase of care as well. For patients who sustain falls, the risk of post-discharge mortality appears to be higher among Blacks [84]. Black and Hispanic patients are less likely to be discharged to post-acute inpatient rehab after traumatic brain injury, even when insured [60, 74]. Racial minorities and patients with Medicaid as their primary insurance payer have poorer long-term functional outcomes following lower extremity fractures that are treated operatively [93]. Clinical decision-making surrounding end-of-life care also varies across trauma patients of different races, with Black patients receiving more escalation of care and Hispanic patients being less likely to have withdrawal-of-care orders, indicating the presence of heretofore unexplored cultural preferences and interactions with the healthcare system among different racial groups [105]. Furthermore, disparities in post-discharge rehabilitation referrals following traumatic brain injury have been observed for racial/ethnic minorities, as well as those without insurance [76, 87, 88, 94].

Finally, unplanned readmissions after receiving treatment for traumatic injuries represent another quality measure for which minority patients have inferior outcomes. Black race was found to be a predictor of unplanned 30-day readmission following trauma [89, 106].

Causal Pathways of Disparities in Trauma

Researchers have focused on elucidating the mechanisms underlying trauma disparities in recent years. Fundamental differences in the characteristics of the hospitals at which racial minority patients tend to receive their trauma care have been identified as an important contributor to disparate outcomes in this population. Patients treated at hospitals at which racial minority patients account for greater than 25% of the population have increased odds of death and major complications [50•, 58], and

Black patients are more likely than Hispanic or White patients to be treated at these high-mortality centers [59••].

Other theories to explain disparities in trauma include the relationship between minority race and lack of insurance or inadequate insurance. Recent studies have shown that patients without insurance or with Medicare have higher odds of death following blunt injury than patients with Medicaid [107]. Uninsured patients are also less likely to have diagnosed comorbid conditions at the time of injury, yet still have higher odds of mortality than their insured counterparts, suggesting that the burden of undiagnosed comorbidities in this population is an underlying factor in the observed mortality difference [108]. Policy initiatives aimed at expanding insurance coverage have disproportionately benefited White patients in South and West census regions, with young Black and Hispanic trauma patients experiencing similar uninsured rates before and after the introduction of legislation [79••].

One study sought to examine the provider-level behaviors that could influence disparities in trauma, namely, unconscious race and class bias. In the study sample, a large majority were found to have implicit biases towards upper socioeconomic classes and in favor of White patients, but these biases were not associated with vignette-based clinical decision-making. Whether unconscious bias affects clinical decision-making outside of simulated scenario has not yet been established, this area represents a new frontier of research in trauma disparities [72].

Study Limitations

This evidence-based review of the current literature on racial disparities in trauma surgery, while illustrative of the extant knowledge in the field, is limited by the absence of experimental studies. The preponderance of observational studies in the disparities literature is not a recent phenomenon; previous reviews on this topic have also yielded predominantly retrospective cohort studies that used administrative data sets. Research in healthcare disparities is challenging to accomplish within the constraints of a randomized controlled trial, for practical and ethical reasons, and there are few proposed interventions for reducing disparities that lend themselves to investigation in this format.

Conclusions

Understanding the scope of the problem of racial disparities in the management of injured patients is an imperative research objective in the overall effort to eliminate healthcare inequities. Investigations over the last 5 years have expanded upon this objective by defining disparities in populations at the extremes of the age spectrum and in the pre- and post-hospital phases of care and by exploring the underlying causes of previously defined disparities in trauma. Furthermore, there is a deficit in the ability of existing quality metrics to capture disparities in trauma processes and outcomes. Although the literature has yet to describe and test definitive interventions for reducing disparities in access to and quality of trauma care, this review indicates that research in racial disparities in trauma is evolving towards a more comprehensive understanding of these inequities and the approach that future investigators may ultimately take to mitigate their effect on vulnerable patients.

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Compliance with Ethical Standards

Conflict of Interest The authors declare no conflicts of interest relevant to this manuscript.

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- • Of importance
- •• Of major importance

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