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Diversity and Disparities in Orthopaedic Surgery (Guest Editors Alice Chu MD, Selina Poon MD, MPH)

Does Universal Insurance and Access to Care Influence Disparities in Outcomes for Pediatric Patients with Osteomyelitis?

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Abstract

Background Healthcare disparities are an issue in the surgical management of orthopaedic conditions in children. Although insurance expansion efforts may mitigate racial disparities in surgical outcomes, prior studies have not examined these effects on differences in pediatric orthopaedic care. To assess for racial disparities in pediatric orthopaedic care that may persist despite insurance expansion, we performed a case-control study of the outcomes of children treated for osteomyelitis in the TRICARE system, the healthcare program of the United States Department of Defense and a model of universal insurance and healthcare access.

Questions/purposes We asked whether (1) the rates of surgical intervention and (2) 90-day outcomes (defined as emergency department visits, readmission, and complications) were different among TRICARE-insured pediatric patients with osteomyelitis when analyzed based on black versus white race and military rank-defined socioeconomic status.

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Each author certifies that his or her institution waived approval for the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.
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Methods We analyzed TRICARE claims from 2005 to 2016. We identified 2906 pediatric patients, of whom 62% (1810) were white and 18% (520) were black. A surgical intervention was performed in 9% of the patients (253 of 2906 patients). The primary outcome was receipt of surgical intervention for osteomyelitis. Secondary outcomes included 90-day complications, readmissions, and returns to the emergency department. The primary predictor variables were race and sponsor rank. Military rank has been used as an indicator of socioeconomic status before and during enlistment, and enlisted service members, particularly junior enlisted service members, may be at risk of having the same medical conditions that affect civilian members of lower socioeconomic strata. Patient demographic information (age, sex, race, sponsor rank, beneficiary category [whether the patient is an insurance beneficiary from an active-duty or retired service member], and geographic region) and clinical information (prior comorbidities, environment of care [whether clinical care was provided in a civilian or military facility], treatment setting, and length of stay) were used as covariates in multivariable logistic regression analyses.

Results After controlling for demographic and clinical factors including age, sex, sponsor rank, beneficiary category, geographic region, Charlson comorbidity index (as a measure of baseline health), environment of care, and treatment setting (inpatient versus outpatient), we found that black children were more likely to undergo surgical interventions for osteomyelitis than white children (odds ratio 1.78; 95% confidence interval, 1.26-2.50; p = 0.001). When stratified by environment of care, this finding persisted only in the civilian healthcare setting (OR 1.85; 95% CI, 1.26-2.74; p = 0.002). Additionally, after controlling for demographic and clinical factors, lower socioeconomic status (junior enlisted personnel) was associated with a higher likelihood of 90-day emergency department use overall (OR 1.60; 95% CI, 1.02-2.51; p = 0.040).

Conclusions We found that for pediatric patients with osteomyelitis in the universally insured TRICARE system, many of the historically reported disparities in care were absent, suggesting these patients benefitted from improved access to healthcare. However, despite universal coverage, racial disparities persisted in the civilian care environment, suggesting that no single intervention such as universal insurance sufficiently addresses differences in racial disparities in care. Future studies can address the pervasiveness of these disparities in other patient populations and the various mechanisms through which they exert their effects, as well as potential interventions to mitigate these disparities.

Level of Evidence Level III, prognostic study.

Introduction

In the United States, healthcare disparities persist among racial and ethnic minorities [3, 15, 16, 21, 26]. The causes of these differences in health care are multifactorial [41]. Contributing elements likely include conscious or unconscious differences in perception [30] or treatment [2] based on insurance status, socioeconomic status, or race or ethnicity. Other factors may include healthcare segregation, inadequate access to insurance, and/or inappropriate clinical care [8, 16]. Disparities in pediatric healthcare have also been documented in several different contexts [14, 17, 34, 37], including orthopaedics [12, 23, 24]. Specifically, disparities attributed to race or ethnicity have been documented in the care of children with acute osteomyelitis [24].

Insurance expansion has been proposed as a means of mitigating racial disparities [15, 18, 34]. The TRICARE insurance plan has been used to model the impact of insurance expansion on Americans under the age of 65 years [29, 43]. TRICARE is an insurance program of the United States Department of Defense and provides healthcare coverage to all active-duty and retired military personnel and their dependents, irrespective of educational, vocational, or occupational status [29, 43]. Prior studies have used TRICARE data to examine the anticipated effects of universal health insurance and equal access on racial disparities in adult surgery [8, 29], because the insurance plan is a natural model of universal insurance and healthcare access. However, pediatric orthopaedic care has not been considered. In this study, osteomyelitis was selected as the clinical context through which to examine disparities in pediatric care, given previously reported disparities for this condition [20, 21], as well as relatively high rates of post-treatment morbidity and use of healthcare resources.

Consequently, to clarify the effects of universal health coverage on the mitigation of disparities in access to and outcomes of pediatric orthopaedic care, we sought to determine whether (1) the rates of surgical intervention and (2) 90-day outcomes (defined as emergency department visits, readmission, and complications) were different among TRICARE-insured pediatric patients with osteomyelitis when analyzed based on black versus white race and military rank-defined socioeconomic status.

Patients and Methods

This study was conducted using TRICARE insurance claims. The characteristics of the TRICARE insurance program have been described in prior studies [8, 29, 34]. Briefly, TRICARE is managed by the Department of Defense and provides universal healthcare coverage and access to more than 9 million uniformed service personnel

and their families in military and civilian healthcare settings [30]. As such, it served as a model of universal insurance and healthcare access in our study. Treatment provided through Department of Defense healthcare facilities is termed direct care, while that contracted by TRICARE with civilian healthcare organizations is termed purchased care. Because TRICARE is a closed system, it is unlikely that any patient in this study would have received care without it being billed to TRICARE.

We queried insurance claims data from October 1, 2005 to September 30, 2016 using diagnosis codes from the International Classification of Disease (ICD)-Ninth Revision or Tenth Revision to identify pediatric patients (0 to 17 years old) treated for osteomyelitis. We included all non-Medicare-eligible pediatric patients with a diagnosis of osteomyelitis in either the ICD-9 (see Appendix, Supplemental Digital Content 1, http://links.lww.com/CORR/A237) or 10 (see Appendix, Supplemental Digital Content 2, http://links.lww.com/CORR/A238) during our study time period (n = 4415). Medicare-eligible patients were not included to ensure we captured complete care billed exclusively to TRICARE. We excluded all patients with a diagnosis of cranial or maxillofacial osteomyelitis or septic arthritis (n = 1993). To ensure all patients had at least 90 days of follow-up, we excluded all patients with fewer than 90 days of TRICARE enrollment or those receiving a procedure for osteomyelitis after June 30, 2016 (n = 222). Because we sought to compare sponsors who were enlisted personnel or commissioned officers, sponsors who identified as cadets or pediatric beneficiaries listed as active-duty were also excluded (n = 4). Finally, patients with missing sex (n = 1) and region (n = 9) in their TRICARE claims data were also excluded from the analysis.

Patient demographic information (age, sex, race, sponsor rank, beneficiary category [whether the patient was an insurance beneficiary of an active-duty or retired service member], and geographic region) and clinical information (Charlson comorbidity index, environment of care [comparing whether clinical care was provided to the patient in a civilian or military facility], treatment setting [inpatient versus outpatient], and length of stay) were extracted from TRICARE claims. We categorized race based on the patient's self-report as white or black, with all other races classified as other. Because the group of patients in this study whose race was classified as other was heterogenous, we focused primarily on comparisons between black pediatric patients and white counterparts. When race data for the patient were missing (n = 1298), we imputed race from the sponsor's race, a method previously validated in other studies [34, 36, 40]. Sponsor rank (a proxy for socioeconomic status [8, 10, 29, 39, 43]) refers to the recorded rank of the primary TRICARE beneficiary, which was categorized as junior enlisted, senior enlisted, and officer. In this paradigm, given that primary TRICARE beneficiaries are predominantly from the military [5], dependents of junior enlisted personnel are considered to belong to the lower socioeconomic group, consistent with prior studies indicating junior-enlisted ranks represent a lower socioeconomic status based on education levels, prevalence of medical conditions associated with lower socioeconomic strata, and military pay grades [28, 31]. To assess the impact of sponsor employment status on our outcomes, we divided beneficiary category into dependents of active-duty or guard personnel, dependent of retiree, or other. Comorbidities were classified as none, one, or at least two comorbidities.

We used ICD-9 and ICD-10 procedure codes to identify patients who underwent a surgical intervention for osteomyelitis (see Appendix, Supplemental Digital Content 3, http://links.lww.com/CORR/A239). The rates of surgical intervention for osteomyelitis and outcomes at 90 days (including emergency department visits, readmissions, and clinical complications) were recorded. Complications were defined using a previously published ICD-9 algorithm that includes infectious, venous thromboembolic, cardiac, and pulmonary complications, as well as shock [7, 29]. Additionally, the list of complications was adapted to the ICD-10 (available from the authors by request) to enable complete analysis of the data.

Demographics

During the study period, 2906 patients met the inclusion criteria, 44% of whom (1272) were female. Among the 2906 patients, 62% (1810) were white, 18% (520) were black, 19% (557) were of another race, and 1% (19) lacked race data (Table 1). In terms of age, 36% of the patients (1042 of 2906 patients) were 0 to 5 years old, 20% (592) were 6 to 10 years old, and 44% (1272) were 11 to 17 years old. Of the 2906 patients, 28% (808) were inpatients and 72% (2098) were outpatients.

Primary and Secondary Outcome Variables

Our primary outcome was receipt of surgical intervention for osteomyelitis. Secondary outcomes included 90-day complications, readmissions, and returns to the emergency department.

The primary predictor variables in our analysis were race and sponsor rank as a proxy for socioeconomic status. Because the group of patients in this study whose race was classified as other was heterogenous, we focused primarily on comparisons between black pediatric patients and their white counterparts. Similarly, in terms of socioeconomic status, we focused on the outcomes of dependents of junior and senior enlisted personnel compared with those of the dependents of officers as the referent.

Given that length of stay does not affect osteomyelitis as a disease state, it was excluded a priori as a predictor variable in our analyses. All other clinical and demographic variables were included as covariates in multivariable logistic regression analyses to determine the independent effect of race and sponsor rank on the outcomes of interest.

We found that 11% of the patients (314 of 2906 patients) returned to the emergency department within 90 days of discharge (Table 2). Additionally, 13% (375) were readmitted during this same time period. Complications were documented in 9% of the patients (263). Surgical intervention was performed in 9% of the patients (253).

Statistical Analysis

All statistical analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC, USA). Statistical significance was set a priori for variables with odds ratios and 95% confidence intervals exclusive of 1.0. The data analysis was performed between December 17, 2018 and March 30, 2019. This study was exempt from institutional review board approval, and all data were deidentified.

Results

Disparities in the Rates of Surgical Intervention

After controlling for potential confounding variables such as age, sex, sponsor rank, beneficiary category, geographic region, Charlson comorbidity index, environment of care, and treatment setting, we found black children with osteomyelitis were more likely to undergo surgical interventions than white patients were (OR 1.78; 95% CI, 1.26-2.50) (Table 3). There were no differences in surgical intervention between children of junior enlisted sponsors (OR 0.79; 95% CI, 0.46-1.36) and senior enlisted sponsors (OR 0.92; 95% CI, 0.67-1.28) and the children of officers. When stratified by environment of care, black children with purchased care had a higher rate of surgical intervention than white children (OR 1.85; 95% CI, 1.26-2.74) (Table 4). No differences in direct care were apparent (OR 1.55; 95% CI, 0.75-3.21) (Table 5).

In our study, 8% of white children (142 of 1810) and 12% of black children (63 of 520) underwent surgical interventions (Table 3). Of the 666 patients whose sponsors were officers, 10% (64) underwent a surgical intervention, while 7% (24 of 342) of beneficiaries who had junior enlisted personnel as sponsors and 19% (64 of 1879) of patients with senior enlisted personnel as sponsors underwent a surgical intervention.

Disparities in 90-day Emergency Department Visits, Readmission, and Complications

After controlling for potential confounding variables such as age, sex, sponsor rank, beneficiary category, geographic region, Charlson comorbidity index, environment of care, and treatment setting, we found there were no differences between black and white children in terms of 90-day emergency department use (OR 0.89; 95% CI, 0.64-1.23), readmissions (OR 0.87; 95% CI, 0.64-1.19), and complications (OR 1.16; 95% CI, 0.81-1.67). Children with junior enlisted sponsors had a higher likelihood of emergency department use at 90 days than beneficiaries with sponsors who were officers (OR 1.6; 95% CI, 1.02-2.51) but demonstrated no differences in readmissions (OR 1.27; 95% CI, 0.84-1.91) and complications (OR 0.79; 95% CI, 0.46-1.36). No disparities were seen in the direct care setting (Table 5).

Among the 1810 white children, 12% (209) returned to the emergency department, 13% (243) were readmitted, and 8% (152) had a complication by 90 days (Table 3). Among the 520 black patients, 10% (54) returned to the emergency department, 12% (63) were readmitted, and 9% (48) had a complication. Of the 666 patients whose sponsors were officers, 9% (57) returned to the emergency department, 12% (81) were readmitted, and 9% (60) had a complication. Of the 342 beneficiaries who had junior enlisted sponsors, 13% (43) returned to the emergency department, 14% (49) were readmitted, and 7% (23) had a complication. Among the 1879 children with a senior enlisted sponsor, 11% (212) returned to the emergency department, 13% (242) were readmitted, and 9% (177) had a complication.

Discussion

Healthcare disparities persist among racial minorities [3, 15, 16, 21, 26], including among pediatric patients receiving orthopaedic care [12, 23, 24]. Although insurance expansion has been studied as a means of addressing these disparities [15, 18, 34], pediatric orthopaedic care has not been considered. In this study, we examined claims from TRICARE, a military insurance program that serves as a model of universal insurance and healthcare access, to clarify how universal health coverage may mitigate disparities in the outcomes of pediatric orthopaedic care. In our study of 2906 universally insured pediatric patients with osteomyelitis, racial disparities were persistent in the civilian care environment for black patients and children with sponsors of lower military ranks, our proxy for lower socioeconomic backgrounds. Although differences in care for these at-risk groups were absent when care was administered through Department of Defense healthcare

facilities (direct care), in the setting of care delivered through the civilian health system (purchased care), black children had a higher odds of surgical intervention than white children. Likewise, patients who were dependents of junior enlisted personnel (our proxy for low socioeconomic status) had increased odds of emergency department use overall. These data suggest that although universal access to healthcare may mitigate disparities in some settings, it is an incomplete solution, warranting further study of other mechanisms through which disparities are mediated and can be addressed.

Limitations

We recognize several limitations to this work. First, our analysis was conducted using insurance claims from TRICARE, and it is unclear whether universal healthcare insurance and access in this predominantly military population generalizes to non-military settings of universal healthcare. Prior studies have demonstrated that the sociodemographic characteristics of the population covered by TRICARE as a whole approximates that of individuals in the United States under the age of 65 years [7, 29, 32]. However, another prior study identified clinically relevant differences in healthcare use between TRICARE patients and non-military populations, such as longer hospital length of stay and higher emergency department use in the former group [6]. Additionally, this sociodemographic similarity does not necessarily translate to generalizability of clinical findings and may not specifically apply to children treated for osteomyelitis. These limitations may consequently limit the generalizability of our findings to non-military populations and to patients with other clinical conditions. Although we believe these limitations do not challenge the internal validity of our findings or the need to explore their implications for healthcare expansion, a further study of the external validity of our results, especially in pediatric patients with other orthopaedic conditions, is warranted.

In this study, we used sponsor rank as a proxy for a patient's socioeconomic status and self-reported race as predictors of outcomes, which are imperfect measures of these metrics. One challenge to interpreting sponsor rank lies in its impact on the generalizability of the study findings in a civilian context, because no such metric exists outside the military. However, this limitation is unavoidable when using proxy markers for socioeconomic status; indeed, other commonly accepted markers, such as employment status, remain untested in the TRICARE dataset [5]. The use of sponsor rank as a proxy measure has been well-substantiated in previous studies [8, 10, 29, 39, 43] and is consistent with prior studies indicating junior-enlisted ranks represent a lower socioeconomic status based on soldier background and military pay grades [28, 31]. Separately, prior work has brought to light the problematic aspects of using race in orthopaedic research; this is a flawed genetic and social concept and racial self-reporting is deeply inaccurate [20]. However, the goal of this study was not to assess the biology or genetics of race as it pertains to pediatric patients with osteomyelitis, and we make no claims regarding a biologic explanation of the relationship between race or socioeconomic status and the outcomes of interest. Instead, the analysis presented is predicated on an acceptance of the capacity of large-scale data and the unique aspects of the TRICARE system to meaningfully examine the sociodemographics that underlie our findings. The analysis also rests on the precedent of prior work [3, 15, 16, 21, 26] demonstrating that such disparities exist and can be measured. Ultimately, the limitations presented by our choice of sponsor rank and self-reported race as predictor variables do not obscure the implication that there are still disparities in clinical outcomes despite universal insurance and access to care.

Because patients were not randomized in the clinical environment in which care was delivered, selection and indication bias may have influenced our determinations regarding patient experiences with direct and purchased care. The lack of randomization may have missed any potential effects of factors that bias patients towards seeking purchased as opposed to direct care, such as the severity of illness, geographic proximity, and patient preferences. Our exclusion criteria (craniofacial osteomyelitis, septic arthritis, cadet sponsors, pediatric patients with active-duty sponsors, and patients with missing data) may have also introduced the possibility of additional selection bias and potentially limits the generalizability of our results. Although the exclusion of patients with missing predictor variable data was a statistical necessity given our logistic regression models, it introduces the possibility of selection bias. However, it is unclear how these missing data might bias this study or whether there are any clinically substantial differences in patients with data missing from the insurance claims analyzed in this study. Furthermore, we believe our exclusion of pediatric patients with active-duty sponsors and cadets is warranted given the unique characteristics of this subset of patients. Our decision may help strengthen our study population's resemblance (and therefore our findings' generalizability) to the general United States pediatric population. Altogether, however, these potential biases do not eliminate the value of the finding that disparities still exist despite universal healthcare in the TRICARE system, and that certain environments of care seem to demonstrate these disparities more than others. In addition, although patients in our study may have accessed care outside of the TRICARE system, thereby introducing the potential for transfer bias, based on our study design, we excluded patients we

believed were the most liable to access care outside the TRICARE system (non-continuous TRICARE enrollment or dual Medicare-eligible). Additionally, TRICARE is a closed system, and it is unlikely any patient included in this study would have received care without it being billed to TRICARE.

An additional limitation is our dependence on claims data, which limited our ability to capture clinical nuances that clarify important parameters, such as the severity of illness or indications for surgery. The absence of these details may have confounded our estimates regarding the effect of race. For example, if black children had more severe osteomyelitis as a group because of factors extraneous to race, such as delayed access to care, they may have had stronger indications for surgery. We were also unable to evaluate the appropriateness of surgical intervention, readmission, or returns to the emergency department, given the variations in criteria for these metrics. Despite our reliance on claims data, however, any potential confounders because of the limitations of these data are likely to be present in both environments of care by which the study was stratified, lending weight to our finding that disparities were present in purchased but not direct care settings. Finally, in pediatric patients with osteomyelitis, indications for surgery are not always clear and can vary among institutions and providers. The receipt of surgery, therefore, may not directly translate to the need for surgery, presenting a limitation of our primary outcome metric of the receipt of surgery. This variability in the decision to operate may present a means by which disparities in care persist, requiring further investigation into disparities in the indications for surgery.

Despite these limitations, we found that although many of the historically reported disparities in care were absent in our study population, disparities according to race were demonstrated in the purchased care (civilian) environment, but not in the direct care (military) environment. Specifically, many of the historically reported disparities in care [1, 9, 12, 13, 42] (for example, higher rates of complications, readmissions, and emergency department use by black patients and those from lower socioeconomic backgrounds) were absent, especially in treatment at military healthcare facilities. However, we were able to identify differences in care provided in the civilian setting (purchased care). Our results support the role of universal insurance in decreasing healthcare disparities among children [11, 34, 35, 38], but we suggest no single intervention would sufficiently address the issue of differences in care for patients from disadvantaged backgrounds. Prior research using TRICARE data found no evidence of racial disparities in access to care and 90-day outcomes for adult patients with a traumatic injury or for patients who underwent emergency general surgery in the direct and purchased care settings [8, 34, 43]. However, the presence of disparities in the purchased care setting in the present study suggests that universal insurance coverage is not completely protective across all care environments for pediatric patients; universal coverage improves but does not eliminate the problem. Our finding that black children had higher operative rates for osteomyelitis in civilian hospitals is consistent with the work of Okubo et al. [24], who reported higher rates of inpatient care among black children with osteomyelitis than among white children. Although it is unclear why higher operative rates were seen for black children in this context, potential causes include barriers to communication, provider bias, and healthcare segregation [16, 18, 27]. These characteristics have been described in civilian healthcare, whereas they are largely thought to be absent in military healthcare facilities [15, 16, 18, 27, 29] and were absent from military care settings (direct care environment) in our analysis. Although the precise reason for this is unclear, a prior study postulated that reduced or absent healthcare segregation and provider bias may be contributing factors [29].

Disparities in emergency department use, one of our secondary endpoints, were also demonstrated. After controlling for demographic and clinical factors, greater emergency department use was documented for pediatric dependents of junior enlisted personnel, a proxy of lower socioeconomic status [10, 28], compared with pediatric dependents of officers. In a prior study, high rates of emergency department use were attributed to a lack of access to outpatient and follow-up care [4]. Other studies in the civilian sector have shown that commercially insured patients were more likely than those insured through Medicaid (another proxy for socioeconomic status) to have timely access to orthopaedic care, even after widespread insurance expansion through the Affordable Care Act [19, 22, 33]. In the military health system specifically, orthopaedic outpatient care reduced the likelihood of unnecessary emergency department visits in adults who underwent spine surgery and total joint arthroplasty [6, 25]. This may be a function of better follow-up and coordination of care at military healthcare facilities, which could further mitigate health disparities that would otherwise be due to a lower socioeconomic status. Additional research is warranted to clarify why the children of enlisted personnel have higher emergency department use. This is probably best accomplished through prospective, clinically granular, or mixed-methods research and is unlikely to be further characterized by efforts that rely on claims-based data.

Our findings highlight disparities that may have key implications for clinicians, patients, and policymakers. Foremost, consistent with prior work examining racial surgical disparities in adults [29], our study demonstrated that the provision of universal insurance combined with improved access to healthcare resources resulted in

substantial improvement in outcomes after treatment of osteomyelitis in pediatric patients, compared with a historical report [24]. Although no disparities in care were seen at military healthcare facilities, differences in the frequency of use of surgical intervention and the likelihood of emergency department use in the civilian setting were present among black patients and those from lower socioeconomic backgrounds, respectively. The presence of disparities in the purchased care environment suggests that providing universal insurance alone will not sufficiently address the issue of differences in care for patients from disadvantaged backgrounds. Further research into the practice patterns, approaches to care, and social and clinical drivers of decision making that render the military healthcare context distinct from civilian centers is necessary to better understand the observed differences in the care of underserved populations between the military and civilian healthcare systems.

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