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Changes in payer mix of new and established trauma centers: the new trauma center money grab?

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ABSTRACT

Background Although timely access to trauma center (TC) care for injured patients is essential, the proliferation of new TCs does not always improve outcomes. Hospitals may seek TC accreditation for financial reasons, rather than to address community or geographic need. Introducing new TCs risks degrading case and payer mix at established TCs. We hypothesized that newly accredited TCs would see a disproportionate share of commercially insured patients.

Study design We collected data from all accredited adult TCs in Pennsylvania using the state trauma registry from 1999 to 2018. As state policy regarding supplemental reimbursement for underinsured patients changed in 2004, we compared patient characteristics and payer mix between TCs established before and after 2004. We used multivariable logistic regression to assess the relationship between payer and presentation to a new versus established TC in recent years.

Results Over time, there was a 40% increase in the number of TCs from 23 to 38. Of 326 204 patients from 2010 to 2018, a total of 43 621 (13.4%) were treated at 15 new TCs. New TCs treated more blunt trauma and less severely injured patients (p<0.001). In multivariable analysis, patients presenting to new TCs were more likely to have Medicare (OR 2.0, 95% CI 1.9 to 2.1) and commercial insurance (OR 1.6, 95% CI 1.5 to 1.6) compared with Medicaid. Over time, fewer patients at established TCs and more patients at new TCs had private insurance.

Conclusions With the opening of new centers, payer mix changed unfavorably at established TCs. Trauma system development should consider community and regional needs, as well as impact on existing centers to ensure financial sustainability of TCs caring for vulnerable patients.

Level of evidence Level III, prognostic/epidemiological.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The number of trauma centers across the country has increased significantly, yet the financial motivators and impacts have not been fully explored.

WHAT THIS STUDY ADDS

⇒ New trauma centers care for a more financially profitable and less severely injured patient population and may be impacting the payer mix at established trauma centers.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The accreditation of new trauma centers may threaten the financial viability of established centers. State reimbursement models should support trauma centers caring for highest risk patients with complex socioeconomic needs.

INTRODUCTION

Access to efficient, high-quality trauma care after traumatic injury has improved outcomes for traumatically injured patients in the USA, specifically for those with high injury severity.[1] As the USA lacks a national trauma system, states are responsible for the structure and design of trauma systems.[2 3] There has been a substantial increase in the number of new trauma centers established across the country in the past decade.[4–7] Although there are areas of the country that still lack adequate access to trauma care, many new level I and II trauma centers have opened in communities already served by an existing trauma center.[4 7] The redundancy of these trauma centers does not improve injury-related mortality and may even lead to an increase in injury-related mortality, as additional trauma center designation dilutes the trauma volume seen and the expertise developed by each center.[6–8] For example, in Florida and New York City, new trauma centers designated close to an established level I trauma center led to a redistribution of more severely injured patients to the newer centers.[9 10]

National changes in reimbursement for trauma may have incentivized pursuit of trauma center designation independent of demonstrated regional need in many states. Traumatically injured patients have high rates of uninsurance and underinsurance[11 12] and trauma center designation can help hospitals recover additional reimbursement for otherwise uncompensated care.[13 14] Additionally, trauma center designation allows health systems to charge higher fees for trauma 'activations' or trauma team evaluations.[5 13] A recently published study reported the median charge for the highest level of trauma team activation to be $9500 per activation (IQR $5601–$17 805) across established healthcare systems.[15]

Given the increase in prevalence of trauma centers, we sought to further understand the alterations in care delivery and reimbursement that occurred at existing trauma centers when new trauma centers were founded. In this study, we aim to evaluate differences in patient characteristics and payer mix between new and established trauma centers in a state trauma system. We hypothesize

Table 1 Characteristics of level I–III trauma centers in Pennsylvania, 2010–2018

	Total	Established trauma centers	New trauma centers	P value
Number of centers (%)	38 (100.0)	23 (60.5)	15 (39.5)	
Patients (%)	326 204 (100.0)	282 581 (86.6)	43 623 (13.4)	
Female gender (%)	136 516 (41.9)	116 484 (41.2)	20 032 (45.9)	<0.001
Age (%)				<0.001
16–39	88 477 (27.1)	78 818 (27.9)	9659 (22.1)	
40–64	101 179 (31.0)	88 906 (31.5)	12 273 (28.1)	
≥65	136 548 (41.9)	114 857 (40.6)	21 691 (49.7)	
Race (%)				<0.001
White	276 363 (84.7)	236 801 (83.8)	39 562 (90.7)	
Black	41 107 (12.6)	38 316 (13.6)	2791 (6.4)	
AAPI/other	8734 (2.7)	7464 (2.6)	1270 (2.9)	
ISS (%)				<0.001
<9	136 010 (41.7)	117 761 (41.7)	18 249 (41.8)	
9–15	119 061 (36.5)	101 943 (36.1)	17 118 (39.2)	
16–24	41 508 (12.7)	36 343 (12.9)	5165 (11.8)	
≥25	29 625 (9.1)	26 534 (9.4)	3091 (7.1)	
Penetrating injury (%)	24 673 (7.6)	22 649 (8.0)	2024 (4.6)	<0.001
Insurance (%)				<0.001
Private	137 544 (42.2)	119 055 (42.1)	18 489 (42.4)	
Medicare	118 973 (36.5)	100 321 (35.5)	18 652 (42.8)	
Medicaid	51 458 (15.8)	47 461 (16.9)	3997 (9.2)	
Self-pay	16 888 (5.2)	14 572 (5.2)	2316 (5.3)	
Missing	1341 (0.4)	1172 (0.4)	169 (0.4)	
Rural (%)	76 655 (45.0)	67 549 (43.8)	9106 (56.1)	<0.001
Comorbidities (%)				<0.001
None	72 680 (22.3)	63 556 (22.5)	9124 (20.9)	
1	75 307 (23.1)	65 227 (23.1)	10 080 (23.1)	
2	62 228 (19.1)	53 526 (18.9)	8702 (19.9)	
3 or more	115 989 (35.6)	100 272 (35.5)	15 717 (36.0)	

AAPI, Asian American and Pacific Islander; ISS, Injury Severity Score.

that newer trauma centers are more likely to have a more favorable payer mix with a higher proportion of privately insured patients, putting established centers at financial risk.

METHODS

We obtained state-level data from the Pennsylvania Trauma Outcomes Study (PTOS), a state-wide trauma registry that includes all accredited trauma centers in the state. We included adult patients presenting to accredited level I, II and III adult trauma centers across the state during a 20-year period, from 1999 to 2018. In Pennsylvania, trauma centers are accredited by the Pennsylvania Trauma Systems Foundation (PTSF), which accredits eligible trauma centers across the state using standards from the American College of Surgeons Committee on Trauma. We excluded patients evaluated at pediatric trauma centers, patients less that 16 years of age or patients with burn injuries as guidelines mandate transfer to specialized levels of care. Trauma centers that were present throughout the study period were included, as were trauma centers that joined the trauma system at any point during the study period. We excluded trauma centers that were only accredited transiently during the study period or centers with interrupted trauma certification. Level IV trauma centers were established in Pennsylvania in 2014 and exist mainly in rural areas. These centers lack surgical backup and possess existing relationships with existing trauma centers for definitive management, and as a result were excluded from our study.

Center-level analysis

Centers are identified in the data source by a deidentified center number. No information regarding center identity or location was evaluated, and no effort was made to identify specific centers. Center entry date was defined based on the first year they contributed data to PTOS. In 2004, trauma center reimbursement changed by policy: the Pennsylvania Trauma Systems Stabilization Act established additional Disproportionate Share Hospital payment for level I–III trauma centers across the state for each traumatically injured patient with Medicaid or no insurance. Therefore, we defined 'established' trauma centers as those recognized by the state trauma foundation before or during 2004, while 'new' centers were approved after 2004.

Center-level volume was determined by evaluating the number of patients submitted to PTOS each year. We tabulated annual trauma center payer mix, a categorical variable defining the proportion of patients at each hospital with the following primary insurance: private or commercial insurance, including workman's compensation, Medicare, and Medicaid or uninsured (self-pay) in a given calendar year.

Patient-level analysis

Because new centers could not see patients before they came into existence, we analyzed a subset of our data from 2010 to 2018 to compare patient-level trends in trauma care at new versus established centers. We compared patient demographic, injury, and

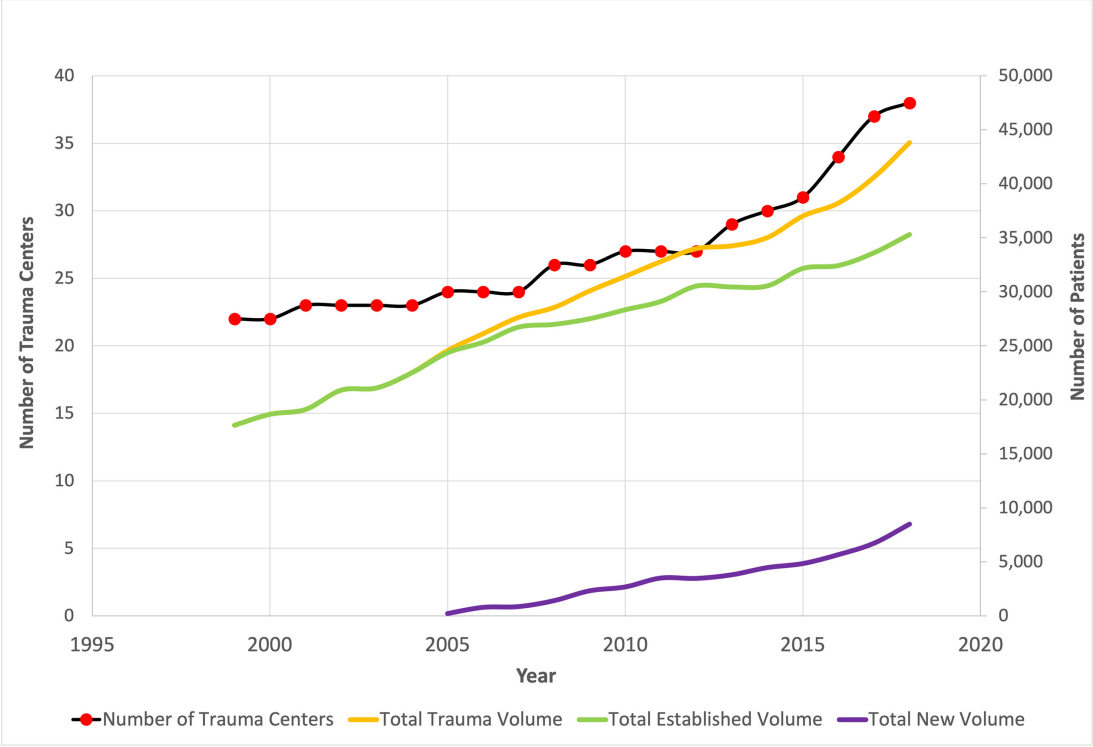

Figure 1 Adult trauma centers and trauma volume in Pennsylvania over time, 1999–2018. The black line with red dots represents the number of trauma centers over our period of observation, as depicted by the first y-axis. The yellow line represents the corresponding increase in the number of patients reported to the state trauma registry as measured by the secondary y-axis. The green line represents the trauma volume at established trauma centers, while the purple line represents corresponding trauma volume at new trauma centers over our period of observation. Source: Pennsylvania Trauma Outcomes Study.

clinical characteristics between patients presenting to established versus new trauma centers. As the number of new centers and the number of patients seen at these centers increased over time, we subsequently performed a subset analysis of more recent years, from 2015 to 2018 and in 2018 to confirm that our findings remained consistent over time.

We compared patient-level characteristics between each center including gender, race, age, comorbidities, mechanism of injury (blunt vs. penetrating), and Injury Severity Score (ISS). We assessed for patient rural versus urban status using patient county codes linked to Office of Management and Budget rural urban continuum codes.[16]

To identify characteristics associated with presentation to a new versus established trauma center, we conducted a multivariable logistic regression analysis with trauma center type as the outcome and patient insurance as the exposure of interest. This analysis incorporated additional patient demographics, comorbidities, and injury characteristics. This analysis used data from 2010 to 2018 because 27 of 38 included trauma centers were already in place by 2010. Pearson correlation test was used to test for collinearity for linear variables and Spearman correlation was used for non-parametric variables, and interaction terms were created to assess the effect of these complex collinearities. Specifically, due to high correlation between increasing age and comorbidities, these were assessed together as an interaction term for complexity. We performed our analysis using patient-level data from 2010 to 2018. We performed sensitivity analysis comparing identified trends to those in more recent years: 2015–2018 (when 31 of 38 trauma centers were in place) and 2018 (when all trauma centers were present). This research was determined to be exempt by an institutional review board. Data were collected in accordance with the STROBE case–control checklist (see online supplemental material).

RESULTS

In 2004, there were 23 state accredited level I–III trauma centers that met our definition for established trauma centers. This number increased to 27 in 2010 and 31 in 2015 (table 1). By 2018, the total number of trauma centers had increased by 39.5% to 38, for a total of 15 new trauma centers. During our 20-year period of observation, trauma volume at verified level I–III trauma centers increased across the state from a total of 17 653 patients in 1999 to 43 808 in 2018 (figure 1).

Patient characteristics

From 2010 to 2018, there were 326 204 included patient encounters across the state. The majority (86.6%) were evaluated at established trauma centers, while the remaining 43 623 (13.4%) were seen at new trauma centers established after 2004. From 2010 to 2018, patients evaluated at new trauma centers were more likely to be female, older than 65 and white (table 1). Patients at new trauma centers were less likely to have suffered penetrating injuries (4.6% vs. 8.0%, $p<0.001$) and less likely to be severely injured with ISS≥25 (7.1% vs. 9.4%, $p<0.001$). New trauma centers were also more likely to serve patients in rural communities (table 1). The same trends in patient and trauma center characteristics persisted in sensitivity analysis from 2015 to 2018 and in 2018 (online supplemental table 1A,B). While total state trauma volume increased over time, the proportion of patients seen at new trauma centers also increased.

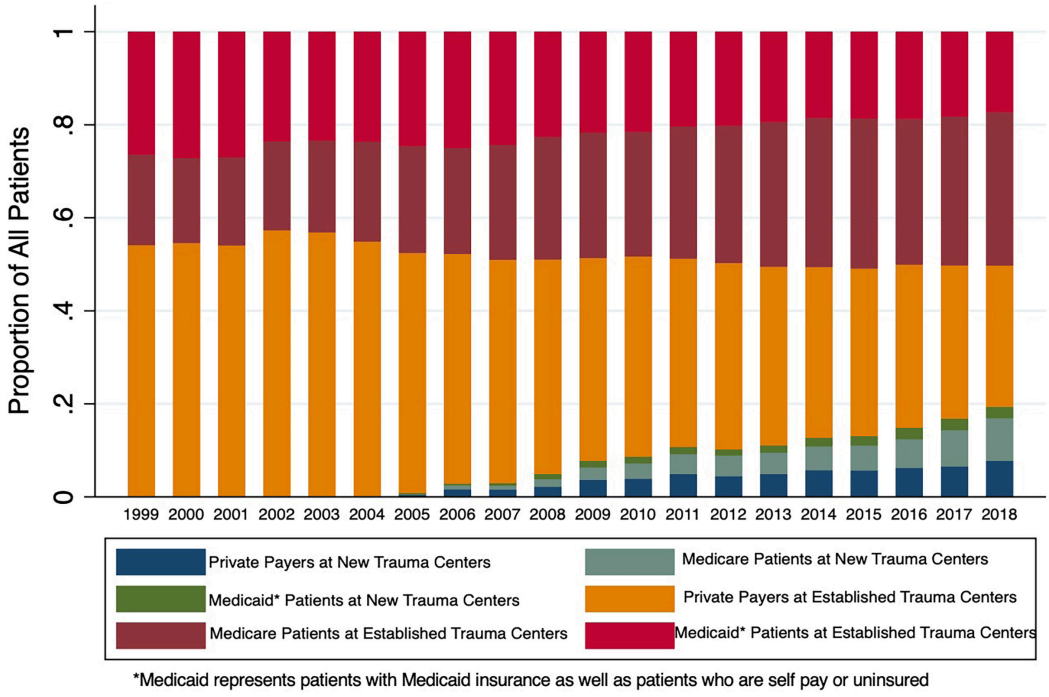

Figure 2 New versus established trauma center payer mix over time, 1999–2018. This graph represents the changes in payer mix (private, Medicare, and Medicaid/uninsured) between established trauma centers (the warm red-orange colors) and new trauma centers (the cool blue-green colors) over time. Source: Pennsylvania Trauma Outcomes Study.

In 2018, 19.4% of the state trauma volume was seen at new trauma centers.

Payer mix

There was an increase in all payers at both new and established trauma centers over time (online supplemental figure). Figure 2 shows payer mix over time at new and established trauma centers. New trauma centers cared for a growing share of total trauma patients, but a disproportionately low share of Medicaid and uninsured patients. In 2018, Medicaid and uninsured patients made up 12.7% of patients treated at new centers designated after 2004 versus 21.3% of pre-existing centers. Correspondingly, new trauma centers disproportionately care for an increasing proportion of patients with private insurance (figure 3).

There were significant differences identified between traumatically injured patients from rural versus urban areas. Patients in rural areas were more likely to have private insurance than patients in urban areas (42.8% vs. 36.0%, p<0.001). Rural trauma patients were more likely to be older than 65 years of age (46.8% vs. 35.7%, p<0.001) and to have Medicare insurance (40.8% vs. 32.7%, p<0.001) than patients in urban areas. Therefore, we compared the patient populations in urban and rural areas separately (online supplemental table 2A,B). Patients from urban communities evaluated at new trauma centers were more likely to be older than 65 years of age (50.3% vs. 34.5%, p<0.001), have private insurance (39.7% vs. 35.6%, p<0.001) and Medicare (46.3% vs. 31.5%) than urban patients treated at established trauma centers. New trauma centers in urban areas were also less likely to care for patients with Medicaid (7.9% vs 24.7%, p<0.001) and those who were uninsured (5.5% vs 7.8%, p<0.001). Similar findings were observed when looking at patients in rural communities (online supplemental table 2B).

Multivariable regression results

In a multivariable logistic regression model, patients seen at new trauma centers between 2010 and 2018 were more likely to be commercially insured or Medicare beneficiaries than to be uninsured or have Medicaid when compared with patients at established trauma centers, despite adjusting for clinical and demographic characteristics (table 2). There was no difference between adjusted rates of uninsured patients between new and old centers when these were examined separately (online supplemental table 3). However, significant differences between patients at new versus established centers persisted. Patients at new centers were less likely to be non-white (OR 0.53, 95% CI 0.50 to 0.57) and less likely to have penetrating injuries (OR 0.62, 95% CI 0.56 to 0.68). Patients at new trauma centers were more likely to live in rural versus urban areas (OR 1.37, 95% CI 1.32 to 1.42). Even after adjusting for rurality, new centers were also less likely to care for older, comorbid patients as complexity increased. These results were confirmed with sensitivity analyses for adults aged 16-64 (online supplemental table 4) and for the more recent years (online supplemental table 5A,B).

DISCUSSION

The number of designated level I–III trauma centers in Pennsylvania has risen during the past 20 years. New trauma centers may help to care for the overall increase in injuries associated with a growing and aging state population, but their contribution is not distributed evenly over the population in need. Patients

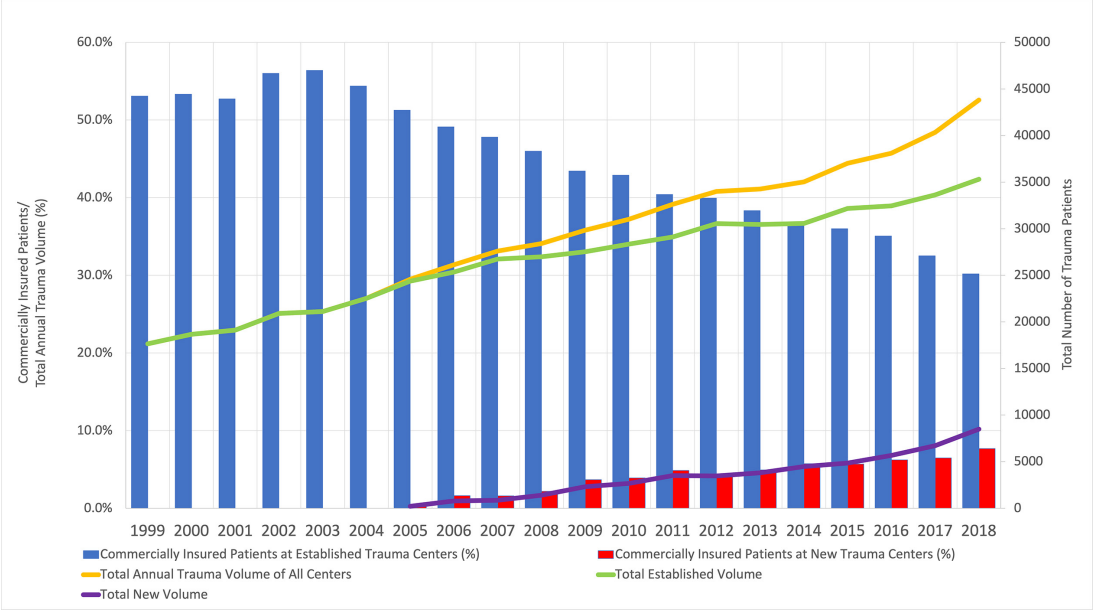

Figure 3 Commercially insured patients at new versus established trauma centers over time, 1999–2018. The blue bars represent the proportion of privately insured patients at established trauma centers over time, while the red bars represent the proportion of privately insured patients at new trauma centers over the same time period, both reflected on the primary y-axis. The yellow line represents the coinciding increase in trauma volume during this time period, as depicted on the secondary y-axis. The green line represents the coinciding trend in trauma volume at established trauma centers, while the purple line represents the increase in volume at new trauma centers. Source: Pennsylvania Trauma Outcomes Study.

at new trauma centers were more likely to be white, older, less severely injured and live in rural areas. New trauma centers saw patients with higher rates of Medicare and private insurance versus Medicaid when compared with patients at established trauma centers over time. This discrepancy may indicate that the more socially and medically complicated patients—those with Medicaid, the highest injury severity and older age with comorbidities—were least likely to be cared for at new trauma centers. While overall increasing access to trauma care, our data suggest that the arrival of new trauma centers has the potential to adversely affect financial stability of established centers that continue to care for the patients least able to pay.

Table 2 Association of patient characteristics of new vs. established trauma centers in Pennsylvania, 2010–2018

Characteristic	OR (95% CI)	P value
Payer status		
Private	1.56 (1.47 to 1.65)	<0.001
Medicare	2.01 (1.88 to 2.14)	<0.001
Medicaid/self-pay	Ref	
Gender		
Female	1.11 (1.08 to 1.15)	<0.001
Male	Ref	
Non-white race	0.53 (0.50 to 0.57)	<0.001
Injury Severity Score		
<9	Ref	
9–15	1.02 (0.99 to 1.06)	0.19
16–24	0.86 (0.82 to 0.91)	<0.001
≥25	0.79 (0.74 to 0.85)	<0.001
Mechanism of injury		
Penetrating	0.60 (0.55 to 0.66)	<0.001
Blunt	Ref	
Area		
Rural	1.37 (1.33 to 1.42)	<0.001
Urban	Ref	
Age with comorbidities		
16–39 without comorbidities	Ref	
16–39	0.82 (0.79 to 0.85)	<0.001
40–64	0.86 (0.85 to 0.88)	<0.001
≥65	0.89 (0.88 to 0.90)	<0.001

Although timely access to trauma center care is an essential determinant of outcomes, prior studies have generally not found that adding centers to a trauma system improves system-level outcomes. This disconnect may be explained by the fact that trauma center designation is rarely determined by any objective measure of local population need. Indeed, one study demonstrated that census tracts where new trauma centers were established between 2014 and 2019 had lower community rates of poverty than census tracts where trauma centers ceased to exist.[4] We were limited in our ability to analyze the geography of new trauma centers, and instead focused on the results in terms of patient and payer mix. We cannot assess hospital motivations for seeking trauma center designations, but financial benefit may play a role. Indeed, a recent study found that for-profit health systems were more likely to seek trauma center verification in financially beneficial, low-need locations than non-profit systems.[17] In order for our systems to have the greatest impact, we must incentivize both equitable geographic and socioeconomic distribution of trauma centers.

During our 20-year period of observation, the number of trauma centers in Pennsylvania increased by almost 40%, significantly outpacing the increase in the population of 4.6% from 12.2 to 12.8 million Pennsylvania residents. Providing high-quality trauma care benefits population health and is cost-effective in terms of quality-adjusted life years gained.[1 18] However, nearly one-quarter of trauma patients are uninsured[11] and 70% of uninsured traumatically injured patients are at risk for catastrophic health expenditures.[19] Similarly, hospitals are at risk for financial losses when caring for uninsured or underinsured traumatically

injured patients, in contrast to significant profits realized when caring for their commercially insured counterparts.[20 21] State-sponsored trauma subsidies for underinsured patients, such as the Pennsylvania Trauma Systems Stabilization Act of 2004, help provide additional financial coverage to cover the gap. However, if new centers treat more patients with private insurance, the financial viability of established trauma centers may be threatened. Recognizing the potential harms of geographic redundancy and to address the rise in the number of trauma centers, the Pennsylvania state legislature amended the trauma center accreditation standards in 2019 requiring that any new level I–III trauma center be located more than 25 miles from an existing center.[22] These geographic requirements that followed our study may help ensure that future trauma center designation represent true geographic need.

The responsibility of the trauma system is first and foremost to its patients. Trauma center creation should prioritize community need while holding both new and established centers to the highest quality standards. While our goal here is not to assess quality of care or patient outcomes (these are monitored closely by the PTSF), there may be trade-offs if center density reduces either overall volume or volume of key patient pathologies, attenuating experience and expertise. Prior work by our group has demonstrated no significant difference in mortality between high and low-volume centers for operative trauma in the PTOS database, however, has demonstrated a mortality difference between high and low-volume centers for patients presenting in shock.[23 24] Assessing value in trauma care requires assessing essential patient quality metrics, and the added financial costs for the individual and the overall trauma system. Future efforts to understand the population benefit of new centers—including survival, failure to rescue and triage metrics—will allow us to apply even more rigor to our accreditation standards.

Important health insurance expansion also occurred during our study period. In 2014, the Affordable Care Act (ACA) expanded health insurance coverage and Pennsylvania was one of the early adopters of Medicaid expansion on January 1, 2015. From 2010 to 2017, rates of uninsurance for adults under age 65 in Pennsylvania dropped from 12.1% to 6.6% during our study period.[25] The ACA was successful in expanding insurance coverage primarily through Medicaid expansion, granting Medicaid coverage to those previously uninsured.[26] Medicaid insurance provides hospitals with some reimbursement compared with entirely uninsured patients; however, this reimbursement is still undesirable to hospitals as it often does not recoup health system costs. Our multivariable logistic regression analysis combined Medicaid and uninsured patients into the same reference group to adjust for any potential shifts due to the ACA during this time.

Limitations

Our study has several limitations. First and foremost, confidentiality measures precluded us from identifying the locations of individual centers; therefore, we could not determine where new centers were located compared with established centers. It may be that new centers opened in areas of true geographic need as suggested by geospatial analysis[27 28] and that these trauma catchment areas also happened to have a favorable payer mix. Our patient-level analysis demonstrated that patients in rural areas were more likely to be treated at new trauma centers. These rural areas could possess more favorable, private or Medicare insurance compared with patients seeking care at urban, established centers. Our findings do not fully account for the geographic motivations. However, our findings are consistent when separately evaluating rural and urban patients, suggesting that geography is not the whole story (online supplemental table 7A,Band 6A,B). Even if new trauma centers are serving true need, the system-wide clinical and financial implications of trauma center designation decisions deserve appropriate consideration.

Additional limitations include the lack of evaluation of non-trauma centers (even if they subsequently became trauma centers) which may play a variable role in trauma care over time. During the 20-year period of observation, there were significant national shifts in the health insurance landscape, and the vertical integration of large health systems and unemployment rates, which are not addressed due to the retrospective nature of this cohort study. Our dataset only included trauma patients captured in the PTOS, which excluded patients with short interval admissions and minor traumatic injury, such as isolated hip fracture. Additionally, we excluded patients transferred to another hospital, as we could not track their destination or outcomes. An evaluation of transfer patterns between new and established trauma centers may further reveal the financial practices of new centers. Finally, our state-level analysis may not be generalizable to other states or geographic regions.

CONCLUSIONS

As new trauma centers are approved across states, the financial impact on existing trauma centers must be considered. Incentivizing equitable access to high-quality trauma care is essential to improve the health of the population and eliminate disparities seen in trauma care. The designation of trauma centers should be determined by community need while weighing the resources available to the population. Trauma centers caring for a larger proportion of patients with complex socioeconomic needs should be appropriately supported in this mission. A national trauma system would need to consider both equitable distribution of resources as well as reimbursement. Trauma systems will need to expand to meet the needs of the growing population; however, this should be done intentionally and equitably with awareness of the unintended consequences of expansion. Future efforts should include evaluating state-level subsidies for trauma care through the Pennsylvania Trauma Systems Stabilization Act and the subsequent impact on established trauma centers after the approval of geographically adjacent trauma centers.

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