

Assessing trauma readiness costs in level III and level IV trauma centers

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BACKGROUND:	Readiness costs are expenses incurred by trauma centers to maintain essential infrastructure. Although the components for readiness are described in the American College of Surgeons' <i>Resources for Optimal Care of the Injured Patient</i> , the cost associated with each component is not well defined. Previous studies describe readiness costs for levels I and II trauma centers based on these criteria. The purpose of this study was to quantify the cost of levels III and IV trauma center readiness.
METHODS:	The state trauma commission, along with trauma medical directors, program managers, and trauma center financial staff, standardized definitions for each component of trauma center readiness costs and developed a survey tool for reporting. Readiness costs were grouped into four categories: Administrative/Program Support Staff, Clinical Medical Staff, and Education/Outreach. A financial auditor analyzed all data to verify consistent cost reporting. Trauma center outliers were evaluated to validate variances. All levels III and IV trauma centers (n = 14) completed the survey on 2019 data.
RESULTS:	Average annual readiness cost is \$1,715,025 for a level III trauma center and \$81,620 for level IV centers. Among the costliest components were clinical medical staff for level IIIs and administrative costs for level IVs, representing 54% and 97% of costs, respectively. Although education/outreach is mandated, levels III and IV trauma centers only spend approximately \$8,000 annually on this category (0.8–3%).
CONCLUSION:	This study defines the cost associated with each readiness component outlined in the <i>Resources for Optimal Care of the Injured Patient</i> manual. The average readiness cost for a level III trauma center is \$1,715,025 and \$81,620 for a level IV, underscoring the need for additional trauma center funding to meet the requirements set forth by the American College of Surgeons. (<i>J Trauma Acute Care Surg.</i> 2023;94: 258–263. Copyright © 2022 American Association for the Surgery of Trauma.)
LEVEL OF EVIDENCE:	Economic and Value-Based Evaluations; Level III.
KEY WORDS:	Readiness costs; trauma center; rural trauma; survey.

The Centers for Disease Control and Prevention estimates that the total cost of injury in the United States in 2020 was a staggering \$4.2 trillion.¹ Overall costs include medical costs, lost work productivity, and costs associated with mortality and quality of life.¹ Trauma continues to be the leading cause of death for people between the ages of 1 and 45 years.² With the high incidence of death, health care costs, and the loss of productivity, traumatically injured patients continue to be a population requiring study and focus.

Trauma centers must meet requirements aimed at improving outcomes for traumatically injured patients. These organiza-

tions have readiness costs and treatment costs for providing this care. Reimbursement rates and contractual agreements have changed over the years, and organizations must consider the monetary impact of trauma patients on their overall bottom line. Readiness costs are the costs incurred by the trauma center to maintain essential infrastructure and availability as defined by the American College of Surgeons' *2014 Resources for Optimal Care of the Injured Patient*.³ These costs cannot be allocated as patient care costs because they are the operational costs to maintain a state of readiness for trauma patients to arrive at any time.⁴ In 2019, Ashley et al.⁵ created a tool as a method for defining the readiness costs for level I and level II trauma centers, with level I average costs noted to be \$10,078,506 and level II average costs \$4,925,103. However, there has been no review of the overall readiness costs for the level III and level IV trauma centers.

To capture these readiness costs, one must understand that levels III and IV trauma centers vary from levels I and II trauma centers in that they are typically nonteaching centers and have lower acuity and lower overall volume of injured patients.⁶ However, some resources remain the same regardless of trauma center level. Level III trauma centers must have trauma surgeons, orthopedists, anesthesiologists, radiologists, emergency medicine physicians, and medical subspecialty providers.³ Additional resource requirements include laboratory, radiology, respiratory, surgery, and trauma department staff.³ These resources are a large cost to organizations and, until now, have not been captured.

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Georgia is fortunate to have a dedicated funding mechanism that supports trauma system development. State code provides directives for the funding encompassing the entire system, of which the trauma centers are one component.⁷ While trauma center funding is not intended to support trauma readiness costs in their entirety, a methodology to determine cost data can be used to ensure funding is distributed equitably. The goal of this study was to collect data from the level III and level IV trauma centers to determine readiness costs for trauma patient care as defined in the American College of Surgeons' 2014 *Resources for Optimal Care of the Injured Patient*.³

PATIENTS AND METHODS

In June of 2021, the newly formed levels III and IV Rural Trauma Committee of the Georgia Trauma Commission established a readiness cost workgroup charged with creating the process to collect readiness cost data from Georgia's 14 designated levels III and IV trauma centers. None of the level III trauma centers were American College of Surgeons-verified during the data collection year. Over a 6-month period, from June 2021 through December 2021, a five-phase process was used:

Phase I: (survey tool deployment) focused on optimizing the existing levels I and II trauma readiness cost survey tool for levels III and IV trauma centers

Phase II: (stakeholders communication) included two readiness cost informational webinars for participants, refinement of the tool, and development of a frequently asked questions document

Phase III: (data collection) submission of the completed survey tool

Phase IV: (sample selection and data validation) — cost validation process by a third-party auditing firm through random cost component testing using sampling techniques and submission of supporting documentation as indicated

Phase V: (data analysis) — review of aggregate survey results by workgroup.

Inclusion criteria were state-designated or American College of Surgeons-verified level III trauma centers and state-designated level IV trauma centers in Georgia during the readiness costs analysis year. Similar to Mabry et al.,⁶ eligible centers were incentivized to participate through the annual contract funding and grant award process. A total of 14 centers, 8 level III and 6 level IV trauma centers, participated in the readiness cost survey, representing 100% of the levels III and IV centers in our state. For the calendar year the survey data were collected, 2019, the total number of patients reported by participating centers was 4,868. By trauma center level, 4,401 patients were from level IIIs, and 467 were from level IVs. The Consolidated Health Economic Evaluation Reporting Standards guideline was used to ensure proper reporting of methods, results, and discussion as required by Equator-Network guidelines. The Consolidated Health Economic Evaluation Reporting Standards checklist is available as digital supplement material for this article (Supplemental Digital Content, Supplementary Data 1, <http://links.lww.com/TA/C787>).

Procedures to produce consistency and validity were developed by a workgroup of the committee and a third-party firm. In November 2021, the third-party firm conducted virtual follow-up

sessions with centers where data were either incomplete or unusually inconsistent with data from other centers of the same level. By December of 2021, the third-party firm began testing the various cost components of each center's survey results to validate consistent and accurate reporting in the following way:

Level III: selected 66 cost components for all III trauma centers,
Level IV: selected 24 cost components for all level IV trauma centers.

Trauma centers were asked to submit supporting documentation (payroll records, contracts, invoices, etc.) for the selected cost components. Overall, 57% of the total reported original cost of the levels III and IV trauma centers were tested. Results are reported in US dollars. The original report of all eight level III trauma centers was \$13,819,321. Using the testing process noted previously, \$7,797,871 (56%) of the total original reported costs were tested. Of the \$7,797,871 tested, \$5,760,157 (74%) were noted to have appropriate documentation without exception. The original cost of all six level IV trauma centers was \$426,777. Using the same testing process, \$342,863 (80%) of the total original reported costs were tested. Of the \$342,863 tested, \$185,083 (54%) were noted to have appropriate documentation without exception. Overall, of the total dollars requested to test for all levels III and IV trauma centers, 73% were noted to have appropriate documentation and were tested without exception. For centers with exceptions, the third-party firm collaborated with the trauma centers to adjust the cost components accordingly for any differences. The most common reasons for adjustments were owing to the misinterpretation of the survey instructions, accounting for nontrauma patients in specific categorical costs, the inability to find the data requested, and not understanding what information was being asked.

Through the validation process, the original costs reported for the eight level IIIs of \$13,819,321 were reduced by \$99,114 for an adjusted total of \$13,720,207. The original costs for the six-level IVs of \$426,777 were increased to \$489,722 for an adjusted total of \$489,722. Overall, the total costs for all level III and level IV trauma centers were decreased by \$36,169 (−0.3%) for an adjusted total of \$14,209,929.

The Survey Tool

Administrative/Program Support Staff

The administrative section included costs for various staff members, such as senior administrator and trauma program manager (or equivalent role), and participation costs for state, regional, and national activities. Program support staff included collaborative services (case management, discharge planning, social services, physical therapy, occupational therapy, and speech therapy), outreach, injury prevention, performance improvement (PI), and trauma registry. The standard calculation for these staff positions was salary and benefits multiplied by the percent of time dedicated to trauma.

In addition to the positions listed previously, trauma medical directors (TMDs), emergency department liaisons, surgical intensive care unit (ICU) liaisons, orthopedic liaisons, and neurosurgical liaisons were included, where applicable. The formula to calculate their associated cost was administrative stipend if contracted, or if employed, salary and benefits multiplied by the

percent of time spent on the trauma center's administrative functions. The final piece included in the administrative section was the cost associated with hardware and software for registry activities as well as screening, brief intervention, and referral to treatment for alcohol.

Clinical Medical Staff

This section covers trauma medical staff compensation for all required medical and surgical subspecialties. All specialties listed in the American College of Surgeons' 2014 *Resources for Optimal Care of the Injured Patient*,³ along with stipends or other payments, that is, for trauma call pay, were included. For employed physicians, the net cost was determined by salary plus benefits minus professional fee reimbursement and then estimating the portion attributable to trauma. This methodology was used to ensure that only costs associated with trauma were reported.

Education and Outreach

This survey section included costs for community outreach, injury prevention, professional education, and outlying hospital education. It also included costs for up to 16 hours of trauma continuing medical education for the following personnel: TMD, trauma program manager (or equivalent role), trauma PI coordi-

nator, trauma registrars, emergency department liaison, surgical ICU liaison, neurosurgical liaison, and orthopedic liaison. The final piece of this section included specific costs associated with trauma-related hospital staff education involving the emergency department, ICU, operative, and postanesthesia care units. The trauma center readiness survey tool is available as digital supplement material for this article (Supplemental Digital Content, Supplementary Data 2, <http://links.lww.com/TA/C810>).

RESULTS

Table 1 shows levels III and IV trauma centers' total and mean costs, the number of trauma centers reporting costs, and the range in each category for administrative/program support staff. Total costs for this category for all levels III and IV trauma centers were \$6,719,428, with a level III mean cost of \$780,674 and a level IV mean cost of \$79,005. The highest total cost component in the administrative and support staff category was respiratory therapy at \$949,887. The next highest total cost was speech therapy at \$918,333, followed by occupational therapy at \$873,715. Of the level III centers reporting costs for the required subspecialty liaisons, the emergency medicine liaison was the highest cost at \$50,144.

Table 2 shows levels III and IV trauma centers' total and mean costs, the number of centers reporting costs, and the range

TABLE 1. Administrative and Program Support Staff Costs

Administrative and Program Support Staff	LIII TC Mean,			LIV TC Mean,			Totals, US \$
	US \$	No.	Range (US\$000s)	US \$	No.	Range (US\$000s)	
Senior administrator support	17,332	7	6–36	6,245	5	1–30	176,131
Program administrator: trauma director	51,147	5	19–127	8,750	1	53–53	461,677
Trauma program manager/coordinator	67,694	5	78–144	46,456	6	14–91	820,287
Participation costs for state, regional, and national activities	2,999	7	0–8	2,131	4	2–8	36,779
Education/outreach coordinator	1,325	2	5–5	—	—	—	10,597
Respiratory therapy	109,891	8	28–231	11,793	5	3–34	949,887
Case management, discharge, planning, and social services	87,283	8	28–158	—	—	—	698,261
Physical therapy	99,686	8	39–198	—	—	—	797,486
Occupational therapy	109,214	8	36–198	—	—	—	873,715
Speech therapy	114,792	8	31–220	—	—	—	918,333
Injury prevention coordinator	7,214	3	2–43	—	—	—	57,708
Research coordinator	—	—	—	—	—	—	—
PI coordinator	23,271	5	0–75	—	—	—	186,171
Trauma registrar — employed	31,956	7	5–70	—	—	—	255,651
Trauma registrar — contract	—	—	—	—	—	—	—
Trauma program secretary	7,061	2	1–56	—	—	—	56,488
TMD	23,722	6	4–84	468	2	1–2	192,587
TMD participation costs	3,039	6	3–6	242	2	0–1	25,760
ED liaison	6,268	2	3–47	—	—	—	50,144
ICU surgical liaison	2,247	3	5–8	—	—	—	17,979
Orthopedic liaison	2,559	2	2–18	—	—	—	20,476
Neurosurgeon liaison	1,143	1	9–9	—	—	—	9,144
Anesthesia liaison	291	1	2–2	—	—	—	2,325
Registry hardware and software	10,292	7	6–17	2,920	6	2–4	99,862
SBIRT	248	1	2–2	—	—	—	1,980
TEG	—	—	—	—	—	—	—
Total	780,674			79,005			6,719,428

ED, emergency department; LIII, level III; LIV, level IV; SBIRT, screening, brief intervention, and referral to treatment; TC, trauma center; TEG, thromboelastography.

TABLE 2. Clinical Medical Staff

Clinical Medical Staff	LIII TC Mean, US \$	No.	Range (US\$000s)	LIV TC Mean, US \$	No.	Range (US\$000s)	Totals, US \$
Trauma surgery	326,941	8	5–1,388	—	—	—	2,615,528
Trauma physician extender	—	—	—	—	—	—	—
Orthopedics	166,534	7	5–548	—	—	—	1,332,274
Neurosurgery	80,818	4	8–344	—	—	—	646,548
Anesthesia	56,518	5	4–307	—	—	—	452,145
Radiology	57,146	1	457–457	—	—	—	457,167
Urology	19,886	4	2–120	—	—	—	159,089
Vascular	5,062	2	2–38	—	—	—	40,495
Emergency medicine	—	—	—	—	—	—	—
Physician coverage	45,830	4	11–206	—	—	—	366,642
Emergency medicine physician/APP	—	—	—	—	—	—	—
Internal medicine	38,687	3	67–137	—	—	—	309,496
Cardiology	36,453	3	5–280	—	—	—	291,628
Gastroenterology	24,147	2	2–192	—	—	—	193,174
Infectious disease	—	—	—	—	—	—	—
Pulmonary medicine	7,606	2	4–57	—	—	—	60,846
Nephrology	918	2	1–7	—	—	—	7,337
Surgical resident support	—	—	—	—	—	—	—
Payment for uninsured	54,110	1	433–433	—	—	—	432,882
Total	920,656	—	—	—	—	—	7,365,251

APP, advanced practice provider; LIII, level III; LIV, level IV; TC, trauma center.

in each category for trauma clinical medical staff support by specialty. As expected, there were no clinical medical staff costs reported for level IV trauma centers. The total costs for all levels III and IV trauma centers were \$7,365,251, with a level III mean cost per center of \$920,656. The highest surgical specialty costs reported by the level IIIs were trauma surgery at \$2,615,528. This was followed by orthopedics at \$1,332,274 and neurosurgery at \$646,548. These were among the most significant categor-

ical costs overall. For nonsurgical required medical specialties, radiology was the highest cost reported at \$457,167, followed by emergency medicine at \$366,642.

Table 3 shows levels III and IV trauma centers' total and mean costs, the number of trauma centers reporting costs, and the range in each category for education and outreach. The total costs for all levels III and IV trauma centers were \$125,250, with a level III mean cost of \$13,695 and a level IV mean cost of \$2,615.

TABLE 3. Education and Outreach Cost

Education and Outreach	LIII TC Mean, US \$	No.	Range (US\$000s)	LIV TC Mean, US \$	No.	Range (US\$000s)	Totals, US \$
Injury prevention	87	2	0–1	444	2	1–2	3,355
Community outreach	1,183	4	0–8	314	3	1–1	11,350
Professional education	1,952	3	1–10	369	3	0–1	17,827
Outlying hospital education	—	—	—	—	—	—	—
Trauma medical director	1,197	3	1–4	—	—	—	9,579
Trauma program manager	1,176	3	1–6	398	3	0–1	11,795
Trauma program coordinator	—	—	—	—	—	—	—
Trauma registrar	428	2	1–2	—	—	—	3,423
ED liaison	—	—	—	449	3	0–1	2,695
ICU liaison	—	—	—	—	—	—	—
Neurosurgical liaison	—	—	—	—	—	—	—
Orthopedic liaison	—	—	—	—	—	—	—
Emergency department	7,138	6	3–21	—	—	—	57,100
ICU	242	2	0–2	—	—	—	1,933
Surgery/PACU	292	1	2–2	—	—	—	2,346
Prehospital and hospital-based provider training	—	—	—	641	2	1–3	3,847
Total	13,695	—	—	2,615	—	—	125,250

LIII, level III; LIV, level IV; PACU, postanesthesia care unit; TC, trauma center.

Education and outreach costs were the lowest reported costs, categorically, by level IV trauma centers. The highest reported cost in this category was emergency department education at \$57,000 by level III trauma centers with no level IVs reporting costs in this category. The costs reported for trauma-related hospital staff (TMD, trauma program manager, registrar, and clinical staff caring for trauma patients in the emergency department, ICU, and perioperative care areas) exceeded the combined reported costs for injury prevention, community outreach, and professional outreach education by more than double.

Table 4 shows levels III and IV trauma centers' total readiness costs and their mean. The total readiness costs for all Georgia levels III and IV trauma centers were \$14,209,929, with a level III mean cost of \$1,715,025 and level IV mean cost of \$81,620. For each of the 4,868 patients admitted to Georgia's levels III and IV trauma centers in 2019, the total readiness cost amounted to \$2,919.

DISCUSSION

This study defines the costs associated with trauma readiness for levels III and IV trauma centers as defined in the American College of Surgeons' 2014 *Resources for Optimal Care of the Injured Patient*.³ Through a standardized survey tool, the average readiness cost for a Georgia level III and level IV trauma center is \$1,715,025 and \$81,620, respectively. As expected, the overall cost of readiness for levels III and IV trauma centers is significantly less than the costs of levels I and II trauma centers reported by Ashley et al.^{5,8} Little or no costs were reported in several categories, particularly with respect to the level IV centers. For example, in the clinical medical staff category, there are few costs to report for level III centers and even less for level IV trauma centers.

Education and outreach were among the lowest reported costs. Larger centers are frequently resourced better with assets and technology to provide trauma education and outreach as part of their mission. A level III or IV trauma center is often a rural community's only access to trauma education. Highest reported cost category for level III trauma centers was the clinical medical staff. Level IV centers' highest costs reported were administrative; not surprisingly, level IV centers had no clinical medical staff costs reported. The advent of "level III-N" in the newest edition of the American College of Surgeons' 2022 *Resources for Optimal Care of the Injured Patient*⁵ underscores the costs associated with providing neurosurgical services. The absence or presence of neurosurgical services accounted for the largest cost variation among level III centers. The Verification Review

Committee of the American College of Surgeons Committee on Trauma was wise to develop an enhanced designation for level III trauma centers that incorporate neurosurgery.

The readiness costs survey tool used for level III and level IV trauma centers was based on the original level I and level II survey tool.⁸ Revisions were made to include the standards required by the American College of Surgeons' 2014 *Resources for Optimal Care of the Injured Patient*,³ based on the trauma center level. Although the survey process was initiated in 2021, the requested data year was 2019 to control for pandemic-related financial aberrancies. Because of the 2-year lapse in the requested data year and survey process, there were challenges to address. The first challenge was the acquisition of some centers by larger health care organizations during the data year. The transitioning of data, electronic processing of financial information, and the change in reporting structures made some information unavailable to those attempting to complete the survey tool. The movement of hospitals in and out of the trauma system between the data collection year and the survey timing presented an additional challenge. The sample was limited to centers designated as level III or IV trauma centers during the data collection year, calendar year 2019. A total of four centers, two designated after 2019 and two voluntarily withdrawing from designation after 2019, were excluded.

The halo effect of this project was immeasurable, beginning with the creation of the levels III and IV Rural Trauma Committee. This project engaged and empowered members of the level III and level IV trauma center community to assume ownership of a project that was uniquely their own. Prior readiness cost surveys in the state focused on the level I and level II trauma centers; this project represented an opportunity to highlight rural trauma center readiness costs that have never been assessed. This important work will transcend the operational and clinical realms by leveraging the group to optimize multidisciplinary trauma care in the rural environment.

Previous studies suggest that readiness cost results may be used to determine trauma activation fees.⁵ Applying this methodology, dividing the total readiness costs by the number of trauma patients yielded an average readiness cost for each patient of \$2,919. The survey also has utility in support of a potential start-up grant process to recruit additional centers into the trauma system in areas of need. This information can be a powerful tool to illustrate the cost of trauma care to state legislators who can impact trauma centers and overall system funding.

Despite the 100% participation rate of all 14 levels III and IV trauma centers, this survey's small sample size is a study

TABLE 4. 2019 Trauma Center Readiness Costs

Cost Category	Level III	Level III	Level IV	Level IV	Levels III and IV Totals, US \$
	Total, US \$	Mean, US \$	Total, US \$	Mean, US \$	
Administrative	6,245,395	780,674	474,033	79,005	6,719,428
Clinical medical staff	7,365,251	920,656	—	—	7,365,251
In house OR availability	—	—	—	—	—
Education and outreach	109,561	13,695	15,689	2,615	125,250
Totals	13,720,207	1,715,025	489,722	81,620	14,209,929

OR, operating room.

limitation. The effort to assess readiness costs for levels III and IV trauma centers was a grassroots attempt and a first for centers that historically have fewer financial resources than their larger levels I and II counterparts. Readiness cost estimates are conservative numbers, as some costs may have been inadvertently omitted or underreported. However, because of the potential existing capacity within various roles that can dedicate time to the trauma program, an overestimation effect of some costs components of readiness is possible. Since completing this study, the American College of Surgeons has released new trauma center criteria. Although costs associated with the new criteria may have changed, the methodology and process to assess readiness costs can be replicated using the new criteria. Continued efforts are needed in assessing readiness costs to understand how to support start-up and sustainability funding for the levels III and IV trauma centers.

CONCLUSION

This study, which aimed to define the readiness costs of level III and level IV trauma centers, was a first attempt at establishing a method to determine the monetary impact trauma center designation or verification has on the operational costs of an organization. Conservatively, the average readiness costs for levels III and IV trauma centers are \$1,715,025 and \$81,620, respectively. While serving as a baseline cost estimate for financial sustainability as a trauma center, this study emphasizes the need for additional funding for levels III and IV trauma centers. In addition, cost data may be used to develop a trauma center start-up grant process to support the recruitment of additional levels III and IV trauma centers in areas of need. Performing this survey on a statewide level built an infrastructure of collaboration among the centers that will go beyond this project into other initiatives impacting trauma patient care across the state.

AUTHORSHIP

E.V.A. and K.A.V. participated in study design, data collection, analysis, interpretation of data, and drafting of the manuscript. R.S.M. participated in

the study design and critical revision of the manuscript. E.V.A., K.A.V., and D.W.A. participated in the analysis and interpretation of data. D.W.A., G.K.P., and A.R.R. participated in critical revisions of the manuscript.

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DISCLOSURE

The authors declare no conflicts of interest.

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