Multicenter evaluation of financial toxicity and long-term health outcomes after injury

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BACKGROUND: Despite the growing awareness of the negative financial impact of traumatic injury on patients' lives, the association between financial toxicity and long-term health-related quality of life (hrQoL) among trauma survivors remains poorly understood.

METHODS: Patients from nine trauma centers participating in a statewide trauma quality collaborative had responses from longitudinal survey data linked to inpatient trauma registry data. Financial toxicity was defined based on patient-reported survey responses regarding medical debt, work or income loss, nonmedical financial strain, and forgone care due to costs. A financial toxicity score ranging from 0 to 4 was calculated. Health-related quality of life was assessed using the EuroQol 5 Domain tool. Multivariable regression models evaluated the association between financial toxicity and hrQoL outcomes while adjusting for patient demographics, injury severity and inpatient treatment intensity, and health systems variables.

RESULTS: Among the 403 patients providing 510 completed surveys, rates of individual financial toxicity elements ranged from 21% to 46%, with 65% of patients experiencing at least one element of financial toxicity. Patients with any financial toxicity had worse summary measures of hrQoL and higher rates of problems in all five EuroQol 5 Domain domains ($p < 0.05$ for all). Younger age, lower household income, lack of insurance, more comorbidities, discharge to a facility, and air ambulance transportation were independently associated with higher odds of financial toxicity ($p < 0.05$ for all). Injury traits and inpatient treatment intensity were not independently associated with financial toxicity.

CONCLUSION: A majority of trauma survivors in this study experienced some level of financial toxicity, which was independently associated with worse risk-adjusted health outcomes across all hrQoL measures. Risk factors for financial toxicity are not related to injury severity or treatment intensity but rather to sociodemographic variables and measures of prehospital and posthospital health care resource utilization. Targeted interventions and policies are needed to address financial toxicity and ensure optimal recovery for trauma survivors. (*J Trauma Acute Care Surg.* 2024;96: 54–61. Copyright © 2023 American Association for the Surgery of Trauma.)

LEVEL OF EVIDENCE: Prognostic and Epidemiological; Level III.

KEY WORDS: Financial toxicity; patient-reported outcomes; long-term outcomes; functional status.

Despite major advances in inpatient survival after major traumatic injury, the long-term outcomes of trauma survivors remain a critical blind spot for clinicians and health systems. Increased attention is being placed on the long-term outcomes of trauma survivors across multiple domains of well-being including physical health, mental health, functional status, social health, and financial risk protection. Because traumatic injury is a leading cause of death and disability among working-age adults in the United States, trauma survivors are at high risk for negative financial outcomes after injury. Lifesaving care for traumatic injuries can result in high out-of-pocket costs or medical debt for many US adults, even among patients with employer-sponsored health insurance.[1–4] Given the high rate of poor long-term physical and mental health outcomes after injury, trauma survivors may experience work and income loss[5,6] (for themselves or caregivers in their household), which further compounds their financial well-being. Furthermore, poor long-term physical and mental health may be compounded by inadequate treatment among those experiencing financial strain, as a previous national survey found that nearly one in four working-age trauma survivors reported delaying or foregoing care due to an inability to pay.[6]

However, despite the growing awareness of the negative financial impact of traumatic injury on patients' lives, little is known regarding the association between financial toxicity and long-term health-related quality of life (hrQoL) among trauma survivors. While much of the literature to date has described the financial burden facing trauma survivors in terms of potential out-of-pocket medical expenses based on claims data,[1–4]

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"financial toxicity" is a more inclusive concept that encompasses objective and subjective aspects of financial well-being and also accounts for both medical and nonmedical expenses.[7] A recent review by the American Association for the Surgery of Trauma (AAST) Health Economics Committee[7] highlighted multiple domains of financial toxicity including (1) medical bills and medical debt, (2) work loss and income loss, (3) burdensome nonmedical expenses, and (4) delayed or foregone care due to an inability to pay. While analysis from a single center has previously found financial toxicity to be associated with worse functional status and mental health at 4 and 12 months after injury,[5,8] multicenter studies incorporating more-robust clinical and health-system risk factors are lacking.

In this study, we used data from a statewide quality initiative that links trauma registry data to patient-reported outcome measures to evaluate the risk-adjusted association between financial toxicity and multiple validated measures of hrQoL. This study had the following three objectives: (1) to evaluate the rate of financial toxicity among trauma survivors; (2) to evaluate the independent association of increased severity of financial toxicity with worse long-term hrQoL after adjusting for relevant patient, injury, treatment, and health-systems factors; and (3) to identify the independent drivers of financial toxicity, which may inform future efforts to mitigate financial toxicity among trauma survivors.

PATIENTS AND METHODS

Data Source and Analytic Cohort

This study uses data from the Michigan Trauma Quality Improvement Program (MTQIP), a statewide collaborative comprising all 35 American College of Surgeons' Committee on Trauma–verified Levels 1 and 2 trauma centers in Michigan. The MTQIP maintains a robust clinical trauma registry aligned with the National Trauma Data Standard. Participating centers receive risk-adjusted benchmark reports leveraging registry data as a component of its quality improvement efforts.[9] In 2021, MTQIP began a voluntary quality improvement initiative to expand outcome reporting beyond those captured in the trauma registry before patient discharge. To do so, MTQIP created a survey to collect long-term patient-reported outcomes on topics including hrQoL, opioid use, financial outcomes, and caregiver burden to evaluate patients' recovery journey and to help assess the care delivered. Six questions used the EuroQol Research Foundation EuroQol 5-Dimension 5-Level (EQ-5D-5L) survey instrument, as described hereinafter.[10] Patients from participating centers were contacted by MTQIP staff on behalf of their treating trauma center via phone, email, or short message service; were informed of this quality initiative's purpose; and elected to complete surveys documenting their outcomes and recovery voluntarily. The MTQIP attempts to contact patients at 3- to 6-month intervals between month 3 and month 24 after hospital discharge; however, because of variable enrollment by different centers, patients were contacted as soon as 1 month after discharge to as late as 18 months after discharge. Patient survey results are coupled with their trauma registry information and delivered back to the treating trauma center in list form every 2 months for quality improvement efforts. Aggregate data are presented and discussed at MTQIP collaborative meetings. A deidentified participant use file containing clinical trauma registry information and patient-reported survey responses was used. The University of Michigan Institutional Review Board deemed this study exempt because it represents the secondary use of deidentified data obtained for MTQIP quality efforts.

Inclusion criteria for our analytic cohort consist of all adult trauma patients admitted between July 1, 2021, and December 31, 2022, with an Injury Severity Score of >4 and with at least one completed survey. Survey responses were excluded if less than 75% of the survey questions were completed. During this period, 403 unique patients completed 510 surveys meeting these criteria (Supplemental Digital Content, Supplementary eFig. 1, http://links.lww.com/TA/D308). In addition to these 510 completed surveys, 214 surveys were declined after patient contact was made (70.4% participation rate). See Supplemental Digital Content (Supplementary eTable 1, http://links.lww.com/TA/D308) for details regarding demographics of contacted patients who did and did not complete surveys. For this observational study, the STROBE guideline was used to ensure proper reporting of methods, results, and discussion (Supplemental Digital Content, Supplementary Data 1, http://links.lww.com/TA/D308).

Outcome Variables — Financial Toxicity

Although there is not yet a consensus measurement tool for financial toxicity tailored to trauma patients, our definition is derived from the conceptual overview of financial toxicity outlined in a recent review published by the AAST Health Economics Committee.[7] We defined four elements of financial toxicity as patient-reported survey responses indicating (1) new medical debt, inability to pay medical bills, or medical bills being paid off over time; (2) income loss for patient or household, loss of employment by a patient or a caregiver, or employment change by a patient or caregiver; (3) difficulty with nonmedical expenses such as paying for food, housing, utilities, or credit card bills; and (4) delayed or forgone care due to an inability to pay. Patients with an affirmative response in any of these four domains were considered to have experienced financial toxicity, and we then added each of these elements to create a financial toxicity score that ranged from 0 elements (no financial toxicity) to 4 elements (most severe financial toxicity).

Outcome Variables — hrQoL

To evaluate the association between financial toxicity and long-term hrQoL, we used the EQ-5D-5L instrument, which is a validated tool to evaluate hrQoL that is used in many countries for clinical and economic evaluation.[10] The EQ-5D-5L has been validated in trauma patients,[11] and it was one of the tools recommended by the American College of Surgeons' Consensus Conference on Trauma Patient-Reported Outcome Measures in 2020.[12] The five dimensions of the EQ-5D-5L include (1) mobility, (2) self-care, (3) usual activities, (4) pain/discomfort, and (5) anxiety/depression. Survey respondents are asked to report on problems in each of these five dimensions ranging from a score of 1 to 5 (no problems, slight problems, moderate problems, severe problems, extreme problems). For this study and in accordance with guidance from the EQ-5D-5L, we defined a score of 2 or greater as having any problems in that dimension.

In addition to the individual scores for each of the five dimension, the EQ-5D-5L provides two additional summary scores. The first, which we defined as *self-reported health*, is measured using the EuroQol Visual Analog Scale where the respondents are asked "mark an X on the scale to indicate your health today" with a score of 0 being the best health they can imagine and a score of 100 being the worst health they can imagine.[10] The second, known as the *EQ-5D health index*, uses the responses from these questions to reflect how good or bad a health state is according to the preferences of the general population of a country/region.[10] The EQ-5D health index scores generally range from less than 0 (where 0 is the value of a health state equivalent to dead; negative values representing values as worse than dead) to 1 (the value of full health), with higher scores indicating higher health utility. While the self-reported health value measured by the EuroQol Visual Analog Scale represents the patient's perspective of their overall health, the EQ-5D health index is designed to represent the societal perspective of good or poor health specific to a country or region and, therefore, often used in economic analyses.

Other Variables of Interest

Given the complex causal pathway between injury and both financial toxicity and hrQoL, we evaluated variables across the following four domains: patient demographics, injury severity and inpatient treatment intensity, health systems variables, and additional control variables. Patient demographics included age, sex, race/ethnicity, baseline comorbidities, health insurance coverage, and household income. Injury and treatment variables included injury mechanism, Injury Severity Score, severe traumatic brain injury, severe extremity injury, intensive care unit stay, operative surgical intervention, length of hospital stay, and discharge disposition. Health system variables included trauma center level, transfer between hospitals, and any transportation by ground or air emergency medical services. Because of the risk of time-varying effects on financial toxicity, all models also included terms for year and elapsed time since discharge as well as facility-level fixed effects (please see Supplemental Digital Content, http://links.lww.com/TA/D308, for more detailed definitions of these variables).

Statistical Analyses

Univariate analyses were performed using *t* tests, χ^2 tests, and analysis of variance, as indicated. To determine the rate of financial toxicity, we determined each patient's highest financial toxicity score. To evaluate the independent association between financial toxicity score and hrQoL outcomes of interest, we performed response-level multivariable logistic and linear regressions, also using the covariates described previously. To evaluate the risk factors for any financial toxicity, we performed a response-level multivariable logistic regression using the covariates described previously. Because some patients had more than one response at different times during their recovery, we clustered standard errors at the patient level for each of these models. *p* Values of <0.05 were considered statistically significant. Analyses were performed using Stata statistical software, version 18.0 (StataCorp, College Station, TX).

Sensitivity Analyses

We performed a sensitivity analysis that used a univariate screen to select covariates for our model to evaluate the relationship between patient, injury, treatment, and system traits and financial toxicity (Supplemental Digital Content, http://links.lww.com/TA/D308).

RESULTS

We identified 403 patients who provided 510 completed surveys during the study period (Supplemental Digital Content, Supplementary eFig. 1, http://links.lww.com/TA/D308). The median elapsed time from hospital discharge to time of survey was 6 months (interquartile range [IQR], 4–9 months). The median age was 65 years (IQR, 49–74 years), 52.8% of respondents were female, 2.6% were uninsured, and the median household income of respondents was $65,000 (IQR, $45,000–$95,000). Regarding race and ethnicity, 1.4% of respondents were Hispanic, 3.3% were non-Hispanic Black, 93.1% were non-Hispanic White, and 2.2% were categorized as another race or ethnicity. The median Injury Severity Score was 10 (IQR, 9–14), 58% underwent an operative or angiographic intervention, and 27.3% were admitted to the intensive care unit. Additional summary demographics, injury and treatment details, and health system traits are shown in Supplemental Digital Content (Supplementary eTable 2, http://links.lww.com/TA/D308).

Rates of individual financial toxicity elements ranged from 21% to 46% (Table 1). Among 403 patients, 263 (65%) reported at least 1 element of financial toxicity (Table 1). In multivariable analyses, patients with any element of financial toxicity had lower EuroQol index scores and worse self-reported health (Fig. 1; Supplemental Digital Content, Supplementary eTable 3, http://links.lww.com/TA/D308).

The distribution of financial toxicity scores (range, 0–4) among the 510 completed surveys was as follows: 0 elements in 38% of responses, 1 element in 28.%, 2 elements in 18%, 3 elements in 10%, and 4 elements in 5% (Table 1). The distribution of demographics, injury and treatment details, and health systems details across various levels of financial toxicity is shown in Supplemental Digital Content (Supplementary eTable 2, http://links.lww.com/TA/D308). In multivariable analyses, higher financial toxicity scores were associated with a higher rate of reporting problems in all five of the EQ-5D health dimensions (Fig. 2; Supplemental Digital Content, Supplementary eTable 4, http://links.lww.com/TA/D308) as well as lower EuroQol index scores and worse self-reported health (Fig. 3; Supplemental Digital Content, Supplementary eTable 5, http://links.lww.com/TA/D308).

Univariate associations between covariates of interest and financial toxicity are available in Supplemental Digital Content (Supplementary eTable 6, http://links.lww.com/TA/D308). In our final multivariable logistic regression analysis, we found that younger age, lower household income, more baseline comorbidities, discharge to an inpatient rehabilitation or skilled nursing facility, and transport by air ambulance services were independently associated with higher odds of financial toxicity (Table 2). Regarding health insurance, 100% of uninsured patients without health insurance experienced financial toxicity, so an odds ratio is not estimated. Notably, no injury traits or inpatient treatment

TABLE 1. Summary of Patient-Reported Measures of Financial Toxicity

	Affected, n	Responding, n	Rate, %
Elements of potential financial toxicity (patient level)			
Medical debt or difficulty with medical bills	107	387	28
Income loss or job loss	184	401	46
Nonmedical financial strain	129	402	32
Delayed or forgone care due to cost	83	403	21
Maximum no. financial toxicity elements (patient level)			
No financial toxicity	140	403	35
1 or more	263	403	65
2 or more	143	403	35
3 or more	68	403	17
All 4 elements of financial toxicity	24	384	6
Financial toxicity score (response level)			
Financial toxicity score 0	195	510	38
Financial toxicity score 1	145	510	28
Financial toxicity score 2	94	510	18
Financial toxicity score 3	51	510	10
Financial toxicity score 4	25	510	5

A total of 403 unique patients provided 510 survey responses during the study period. A total of 18 of 403 patients (4.4%) (and 19 of 510 responses [3.7%]) did not answer questions for one element of financial toxicity. No patients failed to answer at least three questions. Sensitivity analyses excluding these 19 responses did not alter the distribution of financial toxicity scores.

intensity details were independently associated with financial toxicity in this adjusted analysis (Table 2). In addition, elapsed time was not significant association with financial toxicity (Supplemental Digital Content, Supplementary eTable 7, http://links.lww.com/TA/D308). The results of our sensitivity analyses revealed nearly identical results (Supplemental Digital Content, Supplementary eTable 8, http://links.lww.com/TA/D308).

DISCUSSION

In one of the first multi-institutional analyses of patient-reported financial outcomes among trauma survivors, we have three principal findings. First, financial toxicity is common, with more than 60% of our cohort reporting one or more elements of financial toxicity. Second, higher degrees of financial toxicity were independently associated with worse long-term outcomes across every dimension of hrQoL evaluated. Third, patient-level risk factors for financial toxicity were not related to injury traits or inpatient treatment intensity. Rather, financial toxicity was associated with demographic traits suggestive of inadequate financial risk protection (e.g., younger age, lack of health insurance, lower income, more chronic conditions) and utilization of prehospital and posthospital health care resources such as air ambulance transport and postdischarge rehabilitation or nursing facility. Taken together, these findings highlight the need for specific policies and programs to ensure that all trauma survivors can achieve optimal recovery.

Financial toxicity was common in our cohort, with approximately two thirds of patients reporting one or more elements of financial toxicity after discharge. Although 97.5% of our respondents had health insurance at the time of their injuries, nearly one in three patients reported medical debt or difficulty paying medical bills. Although the low percentage of uninsured patients in our population (given the national uninsured rate is approximately 8% among US adults) may underestimate the rates of financial toxicity nationally, our findings are in line with a recent study of working-age, commercially insured adult survivors of injury, which found that nearly 25% of patients had medical debt in collections on their credit reports in the year after injury.[4] In our study, over two in five patients reported job loss or income loss affecting their household after their injuries. In a previous study by Murphy et al.,[5] which evaluated financial toxicity at a single level 1 trauma center, found similar rates of injury-related unemployment or income loss at approximately 60%. Notably, one in five patients reported delaying or forgoing needed health care entirely because of an inability to afford it. These findings are consistent with a previous analysis of the National Health Interview Survey, which found that patients hospitalized for injury in the preceding year had approximately 2.5 times greater odds of reporting medical debt or forgoing care due to cost than a matched control group.[6] Taken together, these findings demonstrate the pervasive nature of financial toxicity after injury and highlight the need to better understand both

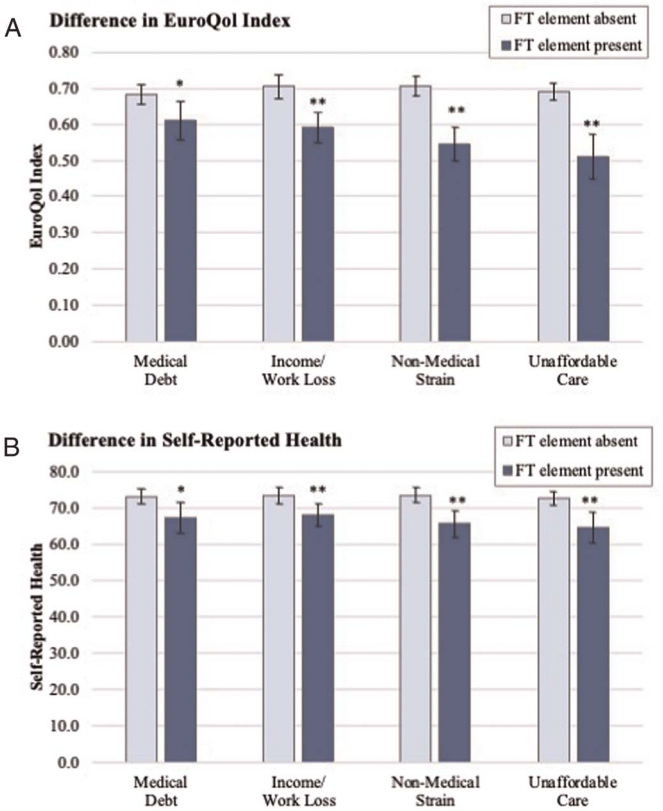

Figure 1. Error bars represent 95% confidence intervals for adjusted marginal averages by group from multivariable linear regression models for each outcome. *$p < 0.05$ for the risk-adjusted difference between respondents with and without each of four elements of financial toxicity. **$p < 0.01$. See *Patients and Methods* for variables included in risk adjustment and Supplemental Digital Content (http://links.lww.com/TA/D308) for data in tabular form. FT, financial toxicity.

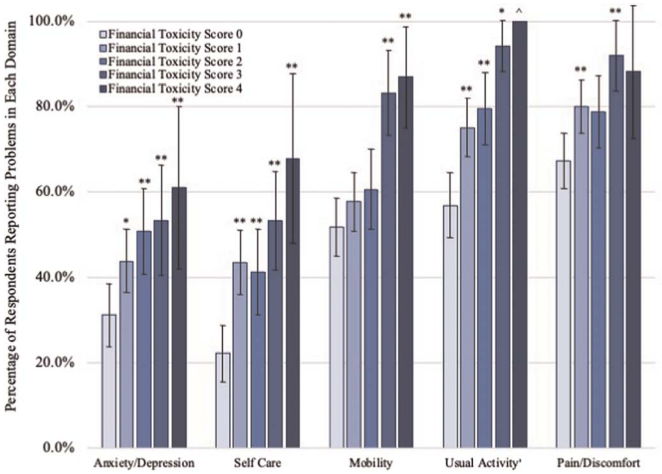

Figure 2. Error bars represent 95% confidence intervals for adjusted marginal averages by group from multivariable logistic regression models for each outcome. Reference group is financial toxicity score 0. *$p < 0.05$ for the risk-adjusted difference between respondents stratified by financial toxicity score. **$p < 0.01$. ^One hundred percent of patients with a financial toxicity score of 4 had problems with usual activities and thus were omitted from adjusted models. See *Patients and Methods* for variables included in risk adjustment and Supplemental Digital Content (http://links.lww.com/TA/D308) for data in tabular form including adjusted odds ratios. EQ-SD-5L, EuroQol 5 Dimensions, 5 Levels.

who is at greatest risk and the impact of financial toxicity on patients' long-term recovery.

Our second principal finding of our study was the strong independent association between financial toxicity and essentially every dimension of hrQoL we evaluated. Increasing financial toxicity was associated with worse self-reported health and worse EuroQol index scores in a dose-dependent fashion. Similarly, all five dimensions of the EQ-5D-5L showed a nearly monotonic association with financial toxicity after adjusting for patient demographics, injury traits, treatment intensity, and health systems variables. The mechanisms underlying the association of financial toxicity and worse physical health, mental health, and functional status merit further study. Data from a single center have shown higher rates of depression and posttraumatic stress disorder as well as worse 36-item short form survey mental and physical scores among patients with worse financial toxicity.[5,8] Our study extends these findings by incorporating more robust clinical data and expanding the definition of financial toxicity, including delayed or forgone care, which may be a key driver of the link between financial toxicity and worse long-term outcomes.

The third principal finding is that, although financial toxicity is common, not all patients are at the same risk for financial toxicity after injury. In our risk-adjusted analyses, financial toxicity was associated with demographic traits suggestive of inadequate financial risk protection, including younger age, lower income, lack of health insurance, and multiple baseline comorbidities. Younger adults have less wealth and are more reliant on weekly or monthly income, which places them at significant risk after an injury that impairs their ability to work. Similarly, the fundament purpose of health insurance is to protect against unanticipated medical expenses.[13] In addition, our findings are aligned with prior work, which has demonstrated higher rates of medical debt among adults with more chronic medical conditions.[14] For these individuals, traumatic injuries may represent an acute-on-chronic financial stressor that is further compounded by work or income loss and may exacerbate the risk of forgoing care due to an inability to pay.

By combing trauma-registry data with long patient-reported outcome measures, we were able to evaluate risk factors for financial toxicity across various potential causal mechanisms beyond patient demographics. One of the most notable findings of our study is that financial toxicity was not independently associated with injury severity, injury mechanism, use of the intensive care unit, receipt of a surgical operation, or hospital length of stay. This is somewhat surprising because injury severity might be expected to predict work loss or income loss, and factors related to inpatient treatment intensity might be expected to drive up the cost of an inpatient stay. Future studies with higher proportions of severely injured patients are needed to confirm these findings. However, these findings suggest that cost-reduction strategies that save money and improve the value of care for payers and hospitals might not reduce patients' risk of developing financial toxicity.

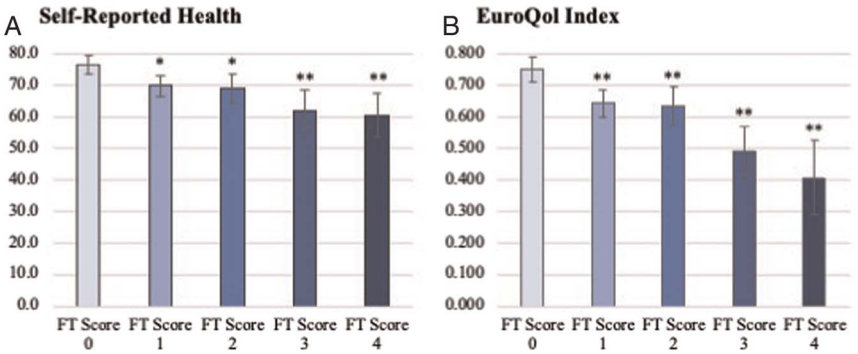

Figure 3. Error bars represent 95% confidence intervals for adjusted marginal averages by group from multivariable linear regression models for each outcome. Reference group is financial toxicity score 0. *$p < 0.05$ for the risk-adjusted difference between respondents stratified by financial toxicity score. **$p < 0.01$. See *Patients and Methods* for variables included in risk adjustment and Supplemental Digital Content (http://links.lww.com/TA/D308) for data in tabular form including adjusted odds ratios. FT, financial toxicity.

TABLE 2. Adjusted Odds Ratios of Experiencing Financial Toxicity

	Adjusted Odds Ratio	95% Confidence Interval		Adjusted *P* Value
Patient demographics				
Age groups				
≥80 y	Reference	—	—	Reference
65–79 y	0.90	0.45	1.81	0.766
40–64 y	4.16	1.54	11.24	0.005**
18–39 y	5.53	1.57	19.40	0.008**
Female	1.51	0.91	2.50	0.108
Race/ethnicity				
White, non-Hispanic	Reference	—	—	Reference
Black, non-Hispanic	1.86	0.47	7.35	0.373
Hispanic or other	3.38	0.49	23.37	0.217
Health insurance				
Private/commercial	Reference	—	—	Reference
Medicare	0.82	0.39	1.71	0.592
NFA/workers comp	0.76	0.34	1.73	0.516
Medicaid	4.27	0.59	31.08	0.152
Uninsured	†	†	†	†
Household income				
Greater than $95,000	Reference	—	—	Reference
$45,000 to $95,000	1.07	0.65	1.78	0.780
Less than $45,000	2.55	1.31	4.97	0.006**
Baseline comorbidities				
None	Reference	—	—	Reference
1	1.25	0.66	2.37	0.493
2 or more	2.24	1.19	4.22	0.013*
Injury and treatment details				
ISS				
ISS 4–8	Reference	—	—	Reference
ISS 9–15	1.24	0.58	2.62	0.580
ISS 16–24	2.57	0.95	7.00	0.064
ISS ≥25	1.61	0.45	5.85	0.466
Injury mechanism				
Fall	Reference	—	—	Reference
Motor vehicle collision	1.48	0.74	2.94	0.267
Firearm/stab/cut	1.08	0.05	22.27	0.962
Other	1.25	0.45	3.44	0.670
Extremity injury with AIS ≥3	1.19	0.58	2.42	0.639
Severe traumatic brain injury	1.29	0.23	7.07	0.770
Any operative procedure	0.99	0.56	1.75	0.968
Any ICU stay	0.87	0.42	1.80	0.713
Hospital length of stay				
0–2 d	Reference	—	—	Reference
3–6 d	1.28	0.72	2.25	0.399
7–13 d	1.56	0.67	3.65	0.304
≥14 d	1.83	0.48	7.01	0.377
Hospital discharge disposition				
Home	Reference	—	—	Reference
Inpatient rehabilitation	2.17	1.03	4.54	0.041*
Skilled nursing facility	2.48	1.05	5.85	0.039*
Other	1.83	0.65	5.13	0.253
Health system traits				
Transferred between hospitals	1.69	0.94	3.03	0.081
Level 2 center	1.17	0.41	3.35	0.769
Transport type				
Self	Reference	—	—	Reference
EMS ground	1.02	0.54	1.94	0.942
EMS air	7.30	1.19	44.71	0.032*

Continued next page

TABLE 2. *(Continued)*

Adjusted odds of reporting any financial toxicity elements. Multivariable logistic regression model included all variables in this table as well as year of injury, elapsed time from injury to survey, and facility-level fixed effects.

*$p < 0.05$.

**$p < 0.01$.

†One hundred percent of uninsured patients experienced financial toxicity; thus, odds ratio is not available.

AIS, Abbreviated Injury Scale; EMS, emergency medical services; ICU, intensive care unit; ISS, Injury Severity Score; NFA, no-fault automobile insurance; Workers Comp, workers compensation insurance.

Instead of injury severity and inpatient treatment intensity, financial toxicity was associated with the utilization of prehospital and posthospital health care resources such as air ambulance transport and postdischarge rehabilitation or nursing facility. It is possible that these variables are markers for particularly devastating injuries. However, our multivariable models included many clinical measures of injury severity and treatment intensity. It is also possible that air ambulance transport increases financial strain in multiple ways. First, prior studies have demonstrated that air ambulances are associated with very high out-of-pocket costs for patients.[15–17] Second, families of patients flown from their homes to a hospital many miles away may experience financial strain due to nonmedical expenses such as travel, food, and housing. Relatedly, nonhome discharge may drive financial toxicity through multiple mechanisms as well. This finding is corroborated by the findings of Nishtala et al.,[8] which found nonhome discharge to be associated with financial frailty on univariate analysis. The majority of health care spending for injured Medicare beneficiaries is related to postdischarge care, and thus, patients may struggle with significant medical expenses.[18] Greater rehabilitation needs are also likely to drive work loss and/or income loss and increase the risk of needing care that the patient cannot afford.

Our findings regarding the high incidence of financial toxicity and the robust association between financial toxicity and worse long-term outcomes have important implications for researchers, health care providers, and policymakers. First, critical knowledge gaps regarding financial toxicity should be addressed by researchers interested in improving long-term outcomes for trauma survivors. In the recent review paper published by the AAST Healthcare Economics Committee, the committee highlighted four key knowledge gaps including (1) better characterizing financial toxicity after acute illness or injury, (2) identifying at-risk populations, (3) understanding the bidirectional relationship between financial health and other health outcomes, and (4) evaluating the impact of policies and programs to mitigate financial toxicity and optimize recovery.[7] Second, hospital-

based programs that target patients at the highest risk for financial toxicity are needed. As our understanding of the burden of financial toxicity increases, efforts to screen and refer at-risk patients to financial resources provided by the hospital or available in the community could be included in trauma survivor clinics, wrap-around clinics, and hospital-based violence intervention programs.[19,20] Many such programs routinely do this as a part of their holistic approach to care, and such interventions will only be strengthened by a concerted effort to measure and evaluate the impact of such interventions. Third, payers and policymakers can improve the long-term outcomes of trauma survivors by targeted interventions that reduce the risk of burdensome medical bills and improve the affordability of perinjury care. For example, insurance expansion policies, policies that limit "surprise" medical bills, limits on out-of-network billing, and policies that expand the scope of postinjury mental health and rehabilitation services may all serve to improve long-term outcomes after injury.[2,13,21–27] Lastly, any such interventions that improve functional recovery after injury and help patients return to work will not only benefit patients but also reduce the social and economic burden of nonfatal injuries nationwide, which the Centers for Disease Control and Prevention estimates to be approximately $69 billion.[28]

These findings should be interpreted in light of our study's limitations. First, although this is one of the first multi-institutional analyses of financial toxicity after injury, all institutions are from the same state, and external validity remains a limitation. It is possible that analyses from other states could differ from ours both regarding state-level policies that impact financial risk protection (e.g., Medicaid expansion) and regarding patient case mix. Notably, our patients were older, had few penetrating or high severity injuries, and <3% were uninsured. It is possible that our estimates are lower than the national average because a younger population with a higher uninsured rate may have higher rates of financial toxicity. On the other hand, the lower number of severely injured patients in our cohort may not be generalizable to other cohorts regarding the association of injury severity and financial toxicity. Second, our analyses rely on patients' self-report of financial toxicity and via survey completion. It is possible that the presence of financial toxicity may impact the likelihood of a patient responding to a voluntary survey on long-term outcomes. Third, these data may not directly compare with prior analyses regarding the financial burden of trauma care that focus on out-of-pocket spending. We did not include out-of-pocket spending in our definition of financial toxicity because we found the presence of medical debt or self-reported difficulty paying medical bills to better characterize strain associated with medical bills. Fourth, further work is needed to evaluate independent risk factors for the subelements of financial toxicity. Designing targeted interventions will require further analyses to better understand the mechanisms that underlie risk for different components of financial toxicity (e.g., employment status of all members of the household and sources of income). Lastly, causality cannot be determined by retrospective analyses of observational data that lack preinjury information on financial toxicity or a relevant comparison cohort. Future studies that have preinjury and postinjury information or, alternatively, more robust time trends based on serial observation are needed to provide better insight into the causal nature of injury on financial strain.

In this multi-institutional evaluation of long-term patient-reported outcomes among trauma survivors, we found that financial toxicity affects the majority of patients and that financial toxicity was independently associated with worse physical health, mental health, and functional status after adjustment for multiple confounders. Financial toxicity was not related to injury severity or treatment intensity, but rather it was related to sociodemographic markers of financial risk protection and health system markers of increased medical and nonmedical financial burden. To optimize recovery after injury, long-term financial outcomes should be incorporated into patient-report outcome measures, and targeted programs and policies are needed at the hospital, state, and federal levels. Only by understanding and addressing the root causes of financial toxicity will we be able to optimize recovery for all trauma survivors.

AUTHORSHIP

All authors took part in the design of this study. A.C., C.d.S., Z.G., J.L.J., J.K., I.M., J.M., and M.R.H. took part in data acquisition. All authors took part in the analysis and interpretation of data for this study.

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DISCLOSURE

Conflicts of Interest: Author Disclosure forms have been supplied and are provided as Supplemental Digital Content (http://links.lww.com/TA/D309).

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