# Trauma Patient Transitions From Critical Care: A Survey of U.S. Trauma Centers

NCPD 2.5 ANCC Contact Hours

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**BACKGROUND:** Transitions between clinical units are vulnerable periods for patients. A significant body of evidence describes the importance of structured transitions, but there is limited reporting of what happens. Describing transitions within a conceptual model will characterize the salient forces that interact during a patient transition and, perhaps, lead to improved outcomes.

**OBJECTIVE:** To describe the processes and resources that trauma centers use to transition patients from critical care to nonintensive care units.

**METHODS:** This cross-sectional study surveyed all Level I and II trauma centers listed in the American Trauma Society database from September 2020 to November 2020. Data were merged from the American Hospital Association 2018 Hospital Survey.

**RESULTS:** A total of 567 surveys were distributed, of which 152 responded for a (27%) response rate. Results were organized in categories: capital input, organizational facets, employee behavior, employee terms/scope, and labor inputs. Resources and processes varied; the most important opportunities for transition improvement included: (1) handoff instruments were only reported at 36% ($n = 27$) of trauma centers, (2) mandatory resident education about transitions was only reported at 70% ($n = 16$) of trauma centers, and (3) only 6% ($n = 4$) of trauma centers reported electronic medical record applications that enact features to influence employee behavior.

**CONCLUSIONS:** After years of focusing on transitions as a high-stake period, there remain many opportunities to develop resources and enact effective processes to address the variability in transition practice across trauma centers.

**KEY WORDS:** Critical care transitions, Handoffs, Transfer checklists, Trauma center processes, Trauma center resources, Trauma patient transitions

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## BACKGROUND

Patients are vulnerable during unit transitions and handoffs. The Institute of Medicine identified transitions as a safety concern more than 20 years ago (Institute of Medicine, 2000). The Agency for Healthcare Research and Quality currently recommends interventions to improve transition outcomes including communication techniques (TeamSTEPPS: Team Strategies & Tools to Enhance Performance & Patient Safety), coordinated handoffs (I-PASS: Illness severity–Patient summary, Action list, Situation awareness and contingency planning, Synthesis by receiver) (Skaret et al., 2019), and information technology (Megahed & Ahmed, 2018). The Agency for Healthcare Research and Quality has also organized a variety of recommendations that have led to impactful transition interventions, such as in heart failure, but there is a paucity of similar recommendations regarding interhospital transitions for trauma care (Hall et al., 2020; Oh et al., 2021).

A few trauma transition studies focus on handoff interventions and have produced clinically and statistically meaningful outcome improvements. They highlighted unique trauma population characteristics such as a pretransfer respiratory assessment, but they are single-center studies (Hoffman et al., 2017; Rosen et al., 2022). Transitions involve a collection of resources and processes enacted by clinicians; studying these variables together may advance trauma care. An in-depth description of current trauma patient transition practices and

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**KEY POINTS**

- Transition processes and resources vary across U.S. Level I & II trauma centers.
- Patient transition education is important for all clinicians and a requirement of residency programs.
- A systematic transition instrument is an encouraged process for clinicians to provide a quality care transition.
- Technology integration with transition processes demonstrates an opportunity for nurses to impact patient safety.

resources will not only inform whether and to what extent currently recommended transition processes are being used in trauma centers but also could lead to better informed and more targeted process-oriented recommendations and interventions.

Transition processes are actions or procedures that lead to a successful patient transition. Transition resources are the capital (material and human) or supply means available to accomplish this goal. Processes and resources are dependent upon each other to produce a transition outcome. Their relationship within health care organizations is complex but can be guided by a conceptual model.

The Administratively Mediated Variable (AMV) model, originally described by Minnick et al. (1997) and then revised by Minnick (2017), was used to organize the key elements of a trauma patient transition and to inform the development of a survey instrument (Figure 1). The AMV model describes the salient health services variables that interact to produce patient outcomes and organizes them into five broad categories: capital input (variables that entail significant financial investments), organizational facets (variables that affect autonomy and work environment), employee behavior, (clinician actions directed at patients), employee terms/scope (clinician behavior expectations associated with transfer duties), and labor inputs (quantity of clinicians and quality of actions). Based on a review of the trauma literature, the principal investigator selected AMVs amenable to capture by survey methodology. These included process AMVs: organizational facets, labor input (quality), provider behavior, and the resource AMVs: capital input, employment scope/terms, and labor input (quantity). Applying the Minnick model to trauma patient transitions advances organizational-level resource and process modeling. Note that the model has been updated since this study was completed; see Minnick (2022) for further information.

## OBJECTIVE

To describe and organize processes and resources that trauma centers use to transition patients from critical care to nonintensive care units.

## METHODS

### Study Design

This study used a cross-sectional design and survey method. From September 2020 to November 2020, surveys were sent to the center administrator at every state-designated Level I and II trauma center in the United States ($n$ = 567). After an introductory postcard, three separate survey mailings were sent at 1-week intervals via the U.S. postal service addressed to the "Trauma

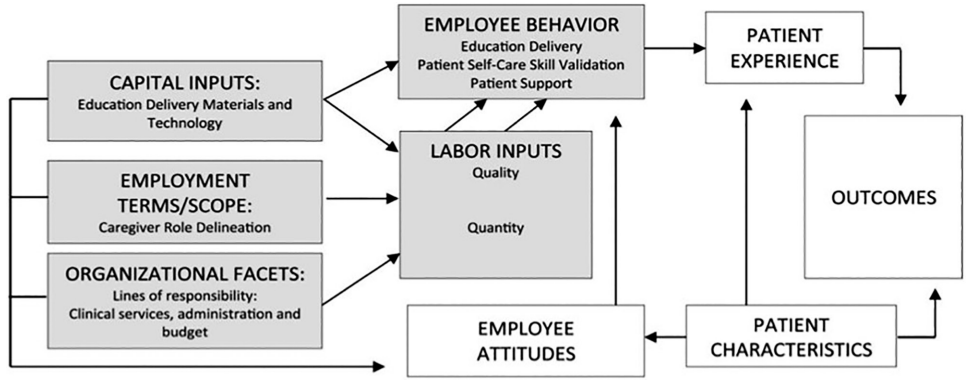


**Figure 1.** The Administratively Mediated Variable (AMV) model from Minnick (2017). *Notes.* Shaded categories were identified as salient to patient transitions with available variable data from trauma center administrators and measured in this study. Transition variables that operationalize the AMV model include: *Capital input:* Computer-software systems, RN communication hardware, EMR, EMR utilization, and functionality toward transitions. *Employee behavior:* Education providers to patients and families, provider handoff method. *Employment terms/scope:* Physician team model, transfer order responsibility, RN shift change overlap time. *Labor inputs: Quantity & quality:* Patient-to-provider ratios, trauma ICU leadership, MD daytime vs. nighttime ratios, temporary staff, transition education delivery and type by role-type. *Organizational facets:* Structure of the ICU; budget and occupancy. Processes expected; handoff tools, frequency of transitions at shift change.

Program Director or Manager." Administrator respondents also had the option to complete the survey by REDCap, Version 9.8.2 (Vanderbilt University). All U.S. Level I and II trauma center addresses obtained from the American Trauma Society Trauma Information Exchange Program, which maintains an up-to-date listing of trauma centers throughout the U.S. and institutional statistics (e.g., annual admissions) from the 2018 American Hospital Association dataset, were merged with respondent data to reduce the survey burden.



### Setting

All U.S. Level I and II trauma centers were identified in the American Trauma Society database.

### Instrument

A survey was developed using techniques that Dillman et al. (2014) recommended to reduce the risk of a measurement error. Items were conceptually validated (universal-CVI) (Almanasreh et al., 2019) with the Minnick AMV model by a panel of four experts in trauma care, an intensivist attending, a fellow physician, a nurse practitioner, and an intensive care unit (ICU) registered nurse. The panelists placed each item into the following major concept categories: capital input, organizational facets, employee behavior, employee terms/scope, and labor inputs. Refinement of the items continued until an 80% agreement was reached among the panelists. Further refinement of the survey included asking four hospital administrators to evaluate the understandability of the questions and the ease with which administrators could access the information. The principal investigator interviewed the panelists using a line-by-line technique, including word clarity, conceptual understanding, data availability, and survey burden. The final survey was produced in paper and electronic format and is available as Supplemental Digital Content 1 (available at: http://links.lww.com/JTN/A121, The Trauma Patient Transitions: Administrator Survey). Survey development, production, and administration were approved by the Vanderbilt University Internal Review Board (IRB #200923).

### Analysis

Frequency distributions were created using SPSS Version 27 (IBM, Armonk, NY). Nominal and ordinal categorical data were summarized. Continuously scaled data were severely skewed; thus, median and interquartile range (IQR) were used to summarize those distributions. Randomly missing item responses within the survey sample were noted. Due to the descriptive nature of this work and the desire to use all available data, no imputation of missing values was conducted and response sample sizes are clearly noted with each summary in the table. The generalizability of our respondent hospital characteristics to those available in the American Hospital Association data (assumed population) was assessed using one-sample $\chi^2$ and Wilcoxon tests.

## RESULTS

### Participants

Of the 567 U.S. Level I and II trauma centers in 2020, 152 center administrators returned a paper survey ($n = 109$) or completed the REDCap web survey version ($n = 43$), resulting in a 27% ($N = 152$) response rate. Characteristics of all U.S. Level I and II trauma centers and those represented by the survey respondents are summarized in Table 1. There were no significant differences between the respondent sample and populations except for teaching activity. Trauma centers with teaching activity (e.g., medical and nursing students) were underrepresented in the sample (only 29% vs. 68% in the assumed population, $p < .001$).

A subsample of administrators ($n = 54$) responded to a question about what patient acuity measures they use to characterize their populations. The highest percentage reported using the acute physiology and chronic health evaluation (APACHE) (56%, $n = 30$), the sequential organ failure assessment (SOFA) (50%, $n = 27$), and the trauma and injury severity score (TRISS) (41%, $n = 22$). The reported use of other measures was considerably smaller—case mix index (CMI), 9%, $n = 5$; severe acute respiratory syndrome (SARS), 6%, $n = 3$; trauma symptom inventory (TSI), 2%, $n = 1$; and some other measure, 11%, $n = 6$—half of these respondents reported the use of multiple acuity scores; thus, the sum equals more than 100%. The patient racial groups with the highest representation at respondent trauma centers ($n = 40$) were White (74%, IQR 55, 86) and Black, African American (13%, IQR 5, 35). Other racial categories comprised less than 5% of patients in responding centers; all are reported in Table 2.

### Outcome Data and Main Results

#### *Processes*

**Organizational Facets.** Fifty-seven percent ($n = 77$) of respondents indicated that trauma patients were assigned to a designated ICU. Twenty-three percent of trauma ICUs were reported to include step-down beds ($n = 17$). Within those step-down units, 65% ($n = 11$) of administrators reported that those beds were dedicated to trauma patients.

Forty percent ($n = 30$) of respondents reported using a policy or guideline to evaluate whether patients are ready to transfer to the ward. Of those, three reported that those guidelines were computerized.

**Table 1.** Characteristics of Level I and II U.S. Trauma Centers and Survey Responders

| | State-Designated Level I and II Trauma Centers | Responders | |
|---|---|---|---|
| **Trauma Center Characteristic** | ***n* = 567**<br>***n* (%)** | ***n* = 152**<br>***n* (%)** | $\chi^2$ |
| Trauma center level | | | $p = .13$ |
| State-designated Level I | 219 (39) | 50 (33) | |
| State-designated Level II | 347 (61) | 102 (67) | |
| ACS verified | 347 (61) | 97 (64) | $p = .51$ |
| Ownership | $n = 558$ | $n = 151$ | $p = .83$ |
| Government, nonfederal | 85 (15) | 26 (17) | |
| Government, federal | 2 (<1) | 1 (<1) | |
| Nongovernment, not-for-profit | 411 (74) | 109 (72) | |
| Investor-owned, for-profit | 60 (11) | 15 (10) | |
| | ***Mdn* (IQR)** | ***Mdn* (IQR)** | **Wilcoxon** |
| Hospital capacity | | | |
| Total licensed beds | $n = 510$ | $n = 136$ | $p = .34$ |
| | 470 (325, 696) | 453 (311, 679) | |
| Trauma ICU beds | $n = 378$ | $n = 102$ | $p = .32$ |
| | 21 (15, 32) | 20 (15, 28) | |
| Total facility inpatient days | $n = 558$ | $n = 151$ | $p = .53$ |
| | 104,133 (66,513, 164,418) | 99,276 (57, 741, 164,545) | |
| Financial variables | $n = 558$ | $n = 151$ | $p = .24$ |
| Medicare certification | 555 (98) | 150 (99) | |
| Organizational facets | $n = 488$ | $n = 129$ | |
| ICU intensivist model | 464 (95) | 119 (92) | $p = .10$ |
| Closed intensivist ICU model | 123 (22) | 24 (16) | $p = .39$ |
| Labor inputs | | | |
| APRN/PA employed by hospital | $n = 483$ | $n = 129$ | $p = .94$ |
| | 462 (96) | 124 (96) | |
| Teaching status | $n = 454$ | $n = 147$ | |
| Report hospital trainees | 307 (68) | 42 (29) | $p < .001$ |
| COTH member | $n = 558$ | $n = 151$ | $p = .49$ |
| | 180 (32) | 44 (29) | |
| Nonteaching | $n = 558$ | $n = 151$ | $p = .49$ |
| | 378 (68) | 107 (71) | |
| Location by ACS regions[a] | $n = 566$ | $n = 152$ | $p = .27$ |
| Region 1 | 29 (5) | 5 (3) | |
| Region 2 | 44 (8) | 13 (9) | |
| Region 3 | 55 (10) | 13 (9) | |
| Region 4 | 86 (15) | 19 (13) | |
| Region 5 | 143 (25) | 45 (30) | |
| Region 6 | 48 (9) | 8 (5) | |

(*continues*)

**Table 1.** Characteristics of Level I and II U.S. Trauma Centers and Survey Responders (*Continued*)

| Trauma Center Characteristic | *Mdn* (IQR) | *Mdn* (IQR) | Wilcoxon |
|---|---|---|---|
| Region 7 | 35 (6) | 14 (9) | |
| Region 8 | 38 (7) | 14 (9) | |
| Region 9 | 68 (12) | 15 (10) | |
| Region 10 | 20 (4) | 6 (4) | |

*Note.* Data obtained from the American Hospital Associated (AHA) Annual Survey (2018) and the American Trauma Society (ATS) TIEP report (2020) and the American College of Surgeons (ACS) verification and regional organization (2020). ACS verified = American College of Surgeons verifies the presence of resources for the optimal care of the injured patient; APRN = advanced practice registered nurse; COTH = Council of Teaching Hospitals and Health Systems organized by the Association of American Medical Colleges; ICU = intensive care unit; IQR = interquartile range; PA = physician assistant.

[a]ACS regions: Region 1 = RI, CT, MA, ME, NH, VT. Region 2 = NJ, NY. Region 3 = DE, MD, PA, DC, VA, WV. Region 4 = GA, AL, FL, GA, KY, MS, NC, SC, TN. Region 5 = IL, IN, MI, MN, OH, WI. Region 6 = LA, AR, LA, NM, OK, TX. Region 7 = IA, KS, MO, NE. Region 8 = CO, MT, ND, SD, UT, WY. Region 9 = CA, AZ, HI, NV. Region 10 = WA, AK, ID, OR.



Less than 1% ($n$ = 3) of administrators reported that patients must have a mandatory stay in the step-down unit when transitioning from the trauma ICU. Only 36% ($n$ = 27) of respondents reported the use of a systematic handoff tool, and that transfers mostly happen sometimes (43%, $n$ = 31), frequently (23%, $n$ = 17), or always (4%, $n$ = 3) during a nursing shift change. The transition process associated with AMVs is described in Table 3.

**Employee Behavior.** Almost all (90%) administrators ($n$ = 56 of 62 respondents) reported that health care providers were expected to educate patients about the unit environment when patients leave the ICU. A slightly smaller percentage (86%) reported education to families was also expected. This study did not explore the extent to which this behavior happens.

**Labor Input: Quality.** Labor input quality may be described as the educational attainment of the workforce. Administrators ($n$ = 49) reported that a median 80% IQR (74.5, 93.2) of their registered nurse (RN) workforce held a baccalaureate degree or higher. Education regarding patient transitions for unit leaders, RNs, and physicians is described in Table 3; and was notably low for physicians ($n$ = 55, 40%), nurse practitioners (NPs), and physician assistants (PAs) ($n$ = 54, 35%). Another measure of labor quality is the stability of the workforce. Trauma center respondents reported stable nurse staffing with temporary agency or float pool nurses covering 10% or less of trauma ICU shifts at 72% ($n$ = 73) trauma centers.

**Table 2.** Demographic Characteristics of Patients in the Trauma Center Sample

| Patient Characteristic | *M* (*SD*), % | *Mdn* (IQR), % |
|---|---|---|
| Patients >65 years ($n$ = 57) | 46.6 (18.9) | |
| Patient racial makeup ($n$ = 40) | | |
| American Indian, Alaskan Native | | <1 (0, 1) |
| Asian | | 1 (<1, 5) |
| Black, African American | | 13 (5, 35) |
| Native Hawaiian or other Pacific Islander | | <1 (0, <1) |
| White | | 74 (55, 86) |
| More than one of these | | 2 (0, 5) |
| Ethnicity ($n$ = 44) | | |
| Identify as Hispanic or Latino/a | | 10 (5, 20) |

*Note.* IQR = interquartile range.

### *Resources*

**Capital Input.** Capital input for transitions included computer hardware and software programming to facilitate patient transitions. Electronic medical records (EMRs) were reported to be used during transitions at most trauma centers (99%, $n$ = 72), and 78% ($n$ = 53) of administrators reported the use of software systems to navigate hospital bed flow. Patient-specific physiologic readiness programs were reported at 6% ($n$ = 4) trauma centers. Transition resources organized by the AMV model are described in Table 4.

### *Employment Terms Scope*

***Physician, Nurse Practitioner, and Physician Assistant Scope.*** Trauma physician team models reported by administrators varied significantly: 41% ($n$ = 31) reported that the physician team model was a "closed" model, 13% ($n$ = 10) reported a "simple mixed model," 18% ($n$ = 14) reported a "semi-mixed model," 25% ($n$ = 19) reported a "matrix mixed model," and 3% ($n$ = 2) reported an "open unit" model.

The following ICU role types were reported to be involved in trauma patient transfers: 47% ($n$ = 36) reported nurse practitioners, 36% ($n$ = 27) reported physician assistants, 55% ($n$ = 42) reported resident/fellow physicians, 55% ($n$ = 42) reported attending physicians, and 8% ($n$ = 6) reported "others." The 8% of "other role types" answers included "RNs" and "the multidisciplinary team." More precisely described than involvement, the roles reported to be essential in trauma patient transitions included nursing leader networks 66% ($n$ = 49), nonclinical bed managers 69% ($n$ = 51),

**Table 3.** Transition Processes: Organizational Facets, Labor Input Quality, and Employee Behavior

| Organizational Facet | *n* (%) | *Mdn* (IQR) |
|---|---|---|
| *Structure* | | |
| Designated trauma ICU (*n* = 152) | 77 (57) | |
| Standardized method for staff nursing budget (*n* = 69) | | |
| Yes | 36 (52) | |
| No | 6 (9) | |
| Do not know | 27 (39) | |
| *Process* | | |
| Standardized handoff tool (*n* = 75) | 27 (36) | |
| Trauma ICU unique transfer tool (*n* = 73) | 3 (5) | |
| Transfer during nursing shift change (*n* = 73) | | 3 (2, 4) |
| Always = 1 | 9 (12) | |
| Frequently = 2 | 13 (18) | |
| Sometimes = 3 | 31 (43) | |
| Rarely = 4 | 17 (23) | |
| Never = 5 | 3 (4) | |
| **Labor Input Quality** | | |
| Temporary nursing agency or float pool use (*n* = 73) | | |
| 0% of shifts | 26 (36) | |
| >0% or ≤10% of shifts | 26 (36) | |
| >10% or ≤20% of shifts | 8 (11) | |
| >20% or ≤50% of shifts | 5 (7) | |
| >50% of shifts | 8 (11) | |
| Transition associated education in last 2 years | | |
| Unit leadership (*n* = 62) | 42 (68) | |
| Type of education | | |
| Unit based | 23 (37) | |
| Hospital based | 25 (40) | |
| Outside agency based | 3 (2) | |
| Is required (*n* = 37) | 28 (76) | |
| Registered nurse (*n* = 63) | 44 (70) | |
| Type of education | | |
| Unit based | 29 (46) | |
| Hospital based | 29 (46) | |
| Outside agency based | 5 (8) | |
| Is required (*n* = 39) | 27 (70) | |
| Physician/Intensivist (*n* =55) | 22 (40) | |
| Type of education | | |
| Unit based | 10 (18) | |
| Hospital based | 13 (24) | |
| Outside agency based | 4 (7) | |
| Is required (*n* = 20) | 14 (70) | |
| NP/PA (*n* = 54) | 19 (35) | |
| Type of education | | |
| Unit based | 10 (19) | |
| Hospital based | 12 (22) | |
| Outside agency based | 4 (7) | |
| Is required (*n* = 18) | 12 (67) | |
| **Employee Behavior** | | |
| Provider education | | |
| To patients (*n* = 62) | | |
| Education about floor environment | 56 (90) | |
| Education about the floor staff expectations | 35 (57) | |
| Education about the transfer process | 54 (87) | |
| An opportunity to preview the floor | 3 (5) | |
| A visit from floor representative | 7 (11) | |
| To families (*n* = 64) | | |
| Education about floor environment | 55 (86) | |
| Education about the floor staff expectations | 33 (52) | |
| Education about the transfer process | 50 (78) | |
| An opportunity to preview the floor | 8 (13) | |
| A visit from floor representative | 7 (11) | |
| Provider handoff method (*n* = 75) | | |
| Tape recordings | 0 | |
| By phone call communication | 45 (60) | |
| Review patient information without face-to-face report | 8 (11) | |
| Face-to-face report | 5 (7) | |
| Walking rounds with the patient included | 17 (23) | |

*Notes.* ICU = intensive care unit; IQR = interquartile range; NP = nurse practitioner; PA = Physician assistant

nurse practitioners 35% (*n* = 27), physician assistants 55% (*n* = 42), and physicians 87% (*n* = 54).

Although most respondents (97%, *n* = 74) reported that attending physicians may write transfer orders, only 45% (*n* = 34) reported that those attending physicians were most responsible for transfer duties. Most transition work was conducted by physicians in training (fellow, resident, or intern) (55%, *n* = 41), nurse practitioners 35% (*n* = 27), or physician assistants 55% (*n* = 42).

***Nursing Scope.*** Most administrators reported using one of two nursing shift change strategies: either oncoming shift overlap or staggered shifts (Table 4). More than half of respondents (65%, *n* = 49) reported a 30-min overlap of nursing shifts. Five (6%) administrator respondents reported staggering RN shifts by more

**Table 4.** Transition Resources: Capital Input, Employment Terms/Scope, and Labor Input Quantity

| **Capital Input** | ***n* (%)** |
|---|---|
| Computer-software programs used for transfers ($n = 68$) | |
| Electric bed flow programs | 53 (78) |
| Software text platforms | 15 (22) |
| Patient physiologic readiness programs | 4 (6) |
| Decision support software | 8 (12) |
| Identification to receiving team prior to transfer | 28 (42) |
| Other | 7 (11) |
| Registered nurse communication hardware ($n = 75$) | |
| Phones/two-way mobile communication ($n = 75$) | 60 (80) |
| Pagers/other communication device ($n = 73$) | 9 (12) |
| EMR use ($n = 71$) | 71 (100) |
| EMR utilization ($n = 73$) | |
| Physician order entry ($n = 73$) | 72 (99) |
| Admission/transfer functions ($n = 73$) | 73 (100) |
| In- and out-of-hospital records ($n = 73$) | 66 (90) |
| Primary care office records ($n = 73$) | 47 (64) |
| Skilled nursing facility records ($n = 72$) | 13 (19) |
| EMR function for transition work ($n = 71$) | |
| Physician order entry ($n = 68$) | 66 (97) |
| Admission/transfer functions ($n = 67$) | 65 (97) |
| In- and out-of-hospital records ($n = 62$) | 46 (74) |
| Primary care office records ($n = 43$) | 28 (65) |
| Skilled nursing facility records ($n = 12$) | 7 (58) |
| **Employment Scope/Terms** | ***n* (%)** |
| Physician team model[a] in ICU ($n = 76$) | |
| Closed model | 31 (41) |
| Simple mixed model | 10 (13) |
| Semi-closed model | 14 (18) |
| Matrix mixed model | 19 (25) |
| Open unit | 2 (3) |
| May write a transfer order ($n = 76$) | |
| First-year resident | 23 (30) |
| Resident | 54 (71) |
| Fellow | 41 (54) |
| Attending | 74 (97) |
| Physician role most responsible for the transfer ($n = 75$) | |
| First-year resident | 3 (4) |
| Resident | 33 (44) |
| Fellow | 5 (7) |
| Attending | 34 (45) |

(*continues*)

**Table 4.** Transition Resources: Capital Input, Employment Terms/Scope, and Labor Input Quantity (*Continued*)

| **Employment Scope/Terms** | ***n* (%)** | |
|---|---|---|
| Dedicated bed management role facilitating resources ($n = 75$) | 70 (93) | |
| Registered nurse shift scheduled overlap time ($n = 75$) | | |
| Not at all | 8 (11) | |
| 1–15 min | 8 (11) | |
| 16–29 min | 10 (13) | |
| 30 min | 49 (65) | |
| 31–59 min | 0 | |
| 60 min | 0 | |
| **Labor Inputs Quantity** | ***n* (%)** | ***Mdn* (IQR)** |
| Trauma ICU monthly patient budgeted occupancy (# of patients) ($n = 43$) | | 15 (10, 19) |
| Trauma ICU actual monthly patient occupancy (# of patients) ($n = 45$) | | 15 (11, 22) |
| Monthly # of assigned residents in trauma ICU ($n = 69$) | | 2 (1, 4) |
| Monthly # of assigned intensivists in trauma ICU ($n = 68$) | | 4 (4, 6) |
| Trauma ICU with a medical director ($n = 75$) | 75 (15) | |
| Trauma ICU with multiple medical directors ($n = 66$) | 18 (27) | |
| Nurse practitioner daytime patient ratios ($n = 69$) | | |
| 1:≤5 | 13 (19) | |
| 1:6–8 | 8 (12) | |
| 1:9–11 | 17 (25) | |
| 1:12–21 | 9 (13) | |
| >21 | 2 (3) | |
| Does not employ nurse practitioners | 20 (29) | |
| Physician assistant daytime patient ratios ($n = 67$) | | |
| 1:≤5 | 12 (18) | |
| 1:6–8 | 11 (16) | |
| 1:9–11 | 10 (15) | |
| 1:12–21 | 7 (11) | |
| >21 | 0 | |
| Does not employ physician assistants | 27 (40) | |
| Intensivist daytime patient ratios ($n = 65$) | | |
| 1:≤5 | 4 (6) | |
| 1:6–8 | 8 (12) | |
| 1:9–11 | 13 (20) | |
| 1:12–14 | 14 (22) | |
| 1:15–18 | 13 (20) | |
| 1:19–21 | 4 (6) | |
| >21 | 5 (8) | |
| Does not employ intensivists | 4 (6) | |

(*continues*)

**Table 4.** Transition Resources: Capital Input, Employment Terms/Scope, and Labor Input Quantity (*Continued*)

| Labor Inputs Quantity | *n* (%) | *Mdn* (IQR) |
|---|---|---|
| Attending physician daytime patient ratios ($n = 65$) | | |
| 1:≤5 | 6 (9) | |
| 1:6–8 | 5 (8) | |
| 1:9–11 | 14 (22) | |
| 1:12–14 | 11 (17) | |
| 1:15–18 | 7 (11) | |
| 1:19–21 | 3 (5) | |
| >21 | 9 (14) | |
| Defers to the intensivist for ICU responsibilities | 10 (15) | |

*Note.* EMR = electronic medical record; ICU = intensive care unit; IQR = interquartile range.

[a]Physician team model definitions: *Closed models:* Only intensivists manage patients.

*Simple mixed models:* Some patients are managed by intensivist(s), and some are managed by attending physicians on primary teams. *Semi-closed model:* Patients are managed jointly by an intensivist and the attending physician from a primary team with defined roles. *Matrix mixed models:* Some patients are managed by an intensivist, some are managed by attending physicians, and some are jointly managed by both intensivists and attending physicians. *Open unit:* There are no intensivists, attending physicians manage their own patients.



than 1 hr; eight (10%) respondents reported that RNs were staggered to specifically update the oncoming shift.

**Labor Input: Quantity.** Nurse practitioners and physician assistants are on the trauma team in most trauma centers (Table 4). Eighty-seven percent ($n = 65$) of administrators reported NPs. Sixty percent ($n = 39$) reported that the hospital employed NPs, whereas the other 40% ($n = 26$) reported they were employed by physician groups. A median of four NPs were included on the trauma teams reported on in this study (IQR 2, 6; $n = 52$).

Seventy-five percent ($n = 56$) of administrators reported that PAs were on their trauma team. Of those, sixty-three% ($n = 35$) reported that the hospital employed PAs and the other 37% ($n = 21$) by physician groups. Administrators ($n = 42$) reported that trauma teams included a median of six PAs (IQR 2, 9).

Of the 73 responding administrators, daytime RN nurse-to-patient ratios of 1:2 were most common (70%, $n = 51$) and ratios of 1:1 or 2:1 were less frequent (25%, $n = 18$). Five percent ($n = 4$) of administrators reported a ratio of one RN to three or more patients in the ICU.

## DISCUSSION

The processes and resources associated with trauma patient transitions demonstrated variation in all variable categories, suggesting that a one-size-fits-all approach to improving transitions is unlikely to succeed. Individual trauma centers may find some variables to be static and not easily modifiable, such as teaching hospital designation with resident physicians. Some variable recommendations, such as waiting to transfer a patient during shift changes, may go against organizational efficiency metrics. Other variables, such as using a standardized handoff instrument for patient transitions, may be more applicable to all. Only by organizing the variables into categories and measuring their interactions can future quality improvement studies be effective. The first step on this journey is to organize and describe the variables; therefore, the most important findings from this study are discussed by the model's categories.

### Processes

#### *Organizational Facets*

Structural and process variability was found in many organizational facets. Many centers do not have a dedicated trauma unit; and only 27 (36%) of respondent trauma centers reported using a standardized transition instrument as patients leave the ICU. Transition instruments are important, particularly during shift changes, and have been associated with reducing ICU readmissions (Methangkool et al., 2019; Niven et al., 2014; Pucher et al., 2015). One such instrument recommended by the Accreditation Council for Graduate Medical Education (ACGME) includes the use and education of transitional care through curriculum learning and a standardized approach (e.g., I-PASS) (Rosenbluth et al., 2018). This best practice has been recommended for many years, but has not been a common practice at trauma centers.

In addition to the poorly ascribed practice of a standardized handoff, many transitions were reported as happening sometimes (43%, $n = 31$), frequently (23%, $n = 17$), or always (4%, $n = 3$) during a shift change. Shift changes often result in multiple handoffs and may contribute to poor patient transition outcomes (Bukoh & Siah, 2020). The frequency of change-of-shift transitions and the lack of an organized handoff instrument at most Level I and II trauma centers is an opportunity for practice improvement.

#### *Labor Input: Quality*

Physician and nursing education about transitions was not reported to occur at almost 30% of the responding trauma centers. Despite transitions ranking as a top safety priority by many regulatory bodies, trauma center administrators reported a scarcity of transition education. The Accreditation Council for Graduate Medical Education (Weiss et al., 2012) mandates resident education about transition practices, but many trauma centers reported that no formal transition education existed in their curriculum over the past year.

Although nurses' education about transitions is not mandated, they are essential to the process. Leveraging the nurse's essential role in the transition process

with a multidisciplinary transition instrument could facilitate unit education and safety for all role types; it should be pursued in a future study, as should its possible impact on outcomes.

#### *Employee Behavior*

Almost all the respondents reported that providers are expected to deliver transition education to patients and families as they leave the ICU. The content, quality, and efficacy of this education were not evaluated and are a topic for future study.

Variability in the handoff method between providers was also reported; most handoffs were reported by phone, some in person, and some at the bedside. Many studies have described handoffs since the 1980s, but most lack a theoretical framework or operational organization; this has contributed to implementation difficulty and explains some of the variability described in this process (Webster et al., 2022).

### Resources

#### *Capital Input*

Nearly all survey respondents reported basic EMR functions. EMR integration for decision support has demonstrated clinical effectiveness in patient safety, clinical management, diagnostic support, patient-facing decision support, cost containment, and administrative functions (Sutton et al., 2020). It continues to be refined for many clinical scenarios to improve patient safety, clinical management, and organizational efficiency (Gupta et al., 2020).

Although bed flow software and EMR are commonly used at trauma centers (99%), an integrated approach to evaluate outcomes does not exist. The paucity of this integration is not surprising given its complexity and limited (if not absent) application in any health care environment (Cifra et al., 2021). This is an important contribution nursing can develop. Future transition interventions should focus on EMR integration, particularly if they influence providers and nurses to do quality cognitive work of information transfer.

#### *Employment Terms, Scope*

Models of care and team makeup varied significantly. The multidisciplinary makeup of provider teams across the respondent trauma centers is evident from this survey, but very limited knowledge exists regarding the optimization of care team models. A single model of care is not likely to exist because of the complicated matrix that health care is delivered, but optimizing roles by matching best practices with role strengths will likely produce better transition outcomes. For example, a recent study examined the value of NPs at the hospital level and demonstrated overall favorable effects on patients, nurse staff satisfaction, and efficiency (Aiken et al., 2021), but it did not describe the type of unique contribution that NPs add to the organization or teams. Developing a body of evidence that identifies the unique contribution of every role (RN, NP, PA, pharmacy, residents, fellows, etc.), and how they synergistically impact patient outcomes would inform how to operationalize a multidisciplinary team resource.

#### *Labor Input: Quantity*

Most trauma centers employ NPs and PAs on their trauma team and most are hospital-based employees rather than employed by private physician groups. This structural business decision to modeling may have pros and cons, none of which are described in the literature for this setting. Most trauma center nurses hold baccalaureate degrees, have a stable 1:2 nurse-to-patient ratio, and have a low degree of agency nurse staffing. These factors likely contribute to better outcomes, particularly if these nurses have a high degree of satisfaction with their jobs, but this has yet to be verified.

## LIMITATIONS

Although additional responses would have improved generalizability, the response rate (27% of the U.S. universe) was acceptable for this methodology (Dillman et al., 2014). A well representative sample of trauma centers across American College of Surgeons regions was demonstrated. The survey respondents were limited to administrators. Administrators were hypothesized to be the most accessible and knowledgeable reporter for a study of this type. Some employee behavior variables were described, but a complete description of the fidelity to which providers complete their transition duties was not investigated in this study. A study comparing administrator and provider answers to the same items is recommended. Lastly, since the survey administration, provider-to-patient ratios may have been impacted by the COVID -19 pandemic, future assessment is recommended.

## CONCLUSIONS

Exploring the processes and resources used to transition trauma patients within U.S. Level I and II hospitals demonstrated significant heterogeneity and offers many opportunities for research and practice. The interdependent nature of resources and processes suggests that future interventions should incorporate both. Integrating known recommendations that engage technology to incorporate transition processes is a natural next step. Leveraging the EMR (resource) with a transition instrument (process) may facilitate outcomes that address the gaps identified by this survey. If designed properly it may

educate novice nurses and providers about safety and population best practices, track compliance, and associate patient outcomes. Given that the EMR was reported to be used by all units during transition work, it is imperative to establish what interventions actually improve transition work. Such a study may discover the characteristics of a high reliability trauma transfer. Until such an integrative resource is available, trauma programs should consider incorporating the use of a systematic transition instrument and invest in educating nurses and providers on high fidelity transition practices.

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