ORIGINAL RESEARCH

Breaking Through the Bottleneck: Acuity Adaptability in Noncritical Trauma Care

An innovative model improves efficiency while preserving care quality.

For years, the U.S. health care system has been reporting inefficient patient throughput, or flow. Contributing factors include nursing shortages, overcrowded EDs, and high surgical volumes.[1, 2] Once admitted, patients often experience multiple intrahospital transfers necessitated by changes in their clinical status, leading to ever-changing available bed capacities across multiple units.[3] The downstream effects include treatment delays, increased safety risks, lower quality of care, increased costs, and decreased patient satisfaction.[3] When patients require specialty care, such as following a traumatic injury, impeded throughput can result in prolonged boarding times in undesignated areas, creating significant safety concerns, misuse of resources, and economic waste.[4, 5] To address these problems, alternative patient throughput models that optimize safety, patient experience, and stewardship of hospital resources should be considered.

Throughput can be defined as the amount of time it takes a patient to move through a course of hospitalization, from admission to discharge.[6] Many facilities use a traditional *fixed acuity model*. In such models, the severity of patient condition, nursing skill levels, nurse–patient ratios, and outfitting of rooms must be weighed in determining which patients are assigned to specific locations.[3] For example, under this model, postsurgical trauma patients would be transferred or "downgraded" from the ICU to a progressive care (step-down) unit and then to a general medical–surgical unit as their condition improves. The progressive care unit houses patients needing intermediate-level care, those ready to leave the ICU but not yet ready for a general medical–surgical unit.[7, 8] A scarcity of beds at this stage can cause bottlenecking, resulting in patients enduring prolonged boarding times or being admitted to inappropriate areas like the ED or the postanesthesia care unit (PACU).[8]

Adopting an *acuity-adaptable model* may be an effective approach to address these issues. In this model, the patient typically remains in one specially equipped room from admission to discharge, with the appropriate care delivered on site.[9] This allows for flexibility when adjusting to anticipated and unanticipated changes in the patient's clinical needs, ensures timely and seamless delivery of care, and reduces the logistical issues inherent in multiple transfers.

There is sufficient evidence that multiple intrahospital transfers adversely affect patient care and hospital efficiency.[10] Although the acuity-adaptable model offers a means to reduce or eliminate such transfers, institutions can face challenges in adopting it, such as its impact on staff resources, financial constraints, and the complexity of patient populations.[11] Despite these challenges, the acuity-adaptable model has been successfully implemented in various settings, including rural hospitals, hospital ICUs, and other specialty areas such as transplant and oncology units.[12-15] But to our knowledge, the acuity-adaptable model's use in trauma care has been investigated only recently,[16] as most studies have been conducted in areas where the course of patient progression is more predictable.[11]

Project purpose. The purpose of this quality improvement project was to evaluate the implementation of an acuity-adaptable model on a noncritical trauma unit. Specific aims were twofold:

- to examine and compare the metrics for throughput efficiency, resource utilization, and care quality indicators before and after implementation of the acuity-adaptable model

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ABSTRACT

Background: Achieving efficient throughput of patients is a challenge faced by many hospital systems. Factors that can impede efficient throughput include increased ED use, high surgical volumes, lack of available beds, and the complexities of coordinating multiple patient transfers in response to changing care needs. Traditionally, many hospital inpatient units operate via a fixed acuity model, relying on multiple intrahospital transfers to move patients along the care continuum. In contrast, the acuity-adaptable model allows care to occur in the same room despite fluctuations in clinical condition, removing the need for transfer. This model has been shown to be a safe and cost-effective approach to improving throughput in populations with predictable courses of hospitalization, but has been minimally evaluated in other populations, such as patients hospitalized for traumatic injury.

Purpose: This quality improvement project aimed to evaluate implementation of an acuity-adaptable model on a 20-bed noncritical trauma unit. Specifically, we sought to examine and compare the pre- and postimplementation metrics for throughput efficiency, resource utilization, and nursing quality indicators; and to determine the model's impact on patient transfers for changes in level of care.

Methods: This was a retrospective, comparative analysis of 1,371 noncritical trauma patients admitted to a level 1 trauma center before and after the implementation of an acuity-adaptable model. Outcomes of interest included throughput efficiency, resource utilization, and quality of nursing care. Inferential statistics were used to compare patients pre- and postimplementation, and logistic regression analyses were performed to determine the impact of the acuity-adaptable model on patient transfers.

Results: Postimplementation, the median ED boarding time was reduced by 6.2 hours, patients more often remained in their assigned room following a change in level of care, more progressive care patient days occurred, fall and hospital-acquired pressure injury index rates decreased respectively by 0.9 and 0.3 occurrences per 1,000 patient days, and patients were more often discharged to home. Logistic regression analyses revealed that under the new model, patients were more than nine times more likely to remain in the same room for care after a change in acuity and 81.6% less likely to change rooms after a change in acuity. An increase of over $11,000 in average daily bed charges occurred postimplementation as a result of increased progressive care–level bed capacity.

Conclusions: The implementation of an acuity-adaptable model on a dedicated noncritical trauma unit improved throughput efficiency and resource utilization without sacrificing quality of care. As hospitals continue to face increasing demand for services as well as numerous barriers to meeting such demand, leaders remain challenged to find innovative ways to optimize operational efficiency and resource utilization while ensuring delivery of high-quality care. The findings of this study demonstrate the value of the acuity-adaptable model in achieving these goals in a noncritical trauma care population.

Keywords: acuity-adaptable model, efficiency, nursing care, patient transfer, throughput, trauma

- to determine the impact of the acuity-adaptable model on patient transfers prompted by changes in clinical status

METHODS

Design and setting. A retrospective, comparative design was used to evaluate pre- and postimplementation data for an acuity-adaptable model on a noncritical trauma unit at a Magnet-designated academic medical center, which is also a level 1 trauma center. Our trauma service admits approximately 3,000 patients each year from a wide geographic catchment area in the southeastern United States; about 25% of these patients are transported in from rural areas.[17]

Preimplementation, the institution used a fixed acuity model of care, with patients transferring from higher levels of care to a six-bed progressive care unit and a 14-bed general medical–surgical unit. These units had decentralized nursing stations, and staff from both units reported to the same nurse manager (see Figure 1). The institution's standard staffing ratios were used: on the progressive care unit, two assignments of one RN to three patients, requiring two RNs per 12-hour shift; on the general medical–surgical unit, two assignments of one RN to five patients and one assignment of one RN to four patients, requiring three RNs per 12-hour shift.

For the postimplementation period, the progressive care and medical–surgical units were reconfigured as a single 20-bed noncritical trauma unit (see Figure 2). Prior to data collection, the study was approved by the facility's institutional review board.

Sample. Convenience sampling was used to identify patients who were 16 years of age or older, had incurred traumatic injury, and either had direct admission orders for progressive or general medical–surgical care or had transfer orders from the ICU to a progressive care or general medical–surgical unit. An initial 1,407 patients were identified. Patients were then excluded if they were on hospice care or if care was withdrawn during hospitalization. After removing excluded cases, a total of 1,371 remained for analysis. Two independent subsamples were identified from the total sample. The preimplementation sample consisted of 689 patients admitted to either the progressive care or medical–surgical unit between May 1, 2018, and March 31, 2019. We did not include data from April 2019, to allow for the transition from the fixed acuity model to the acuity-adaptable model. The postimplementation sample consisted of 682 admitted to the noncritical trauma unit between May 1, 2019, and March 31, 2020.

Measures. *Demographic and clinical characteristics.* Demographic and clinical data were collected from the electronic health record (EHR) to describe and compare the samples. Demographic data included age and gender. Clinical data included the patient's Injury Severity Score (ISS)[18] and the mechanism of injury, be it blunt, penetrating, or other (such as burn, drowning, or electrocution).

Throughput efficiency. Pre- and postimplementation, we assessed throughput in terms of boarding hours in the ED, ICU, and PACU, as well as total hospital length of stay in days. Boarding hours were defined as the time elapsed from when a given patient's admission or transfer orders had been placed to when the patient arrived at the assigned location.[19] Hospital length of stay was defined as the number of days elapsed from when admission orders had been placed to when discharge orders were completed. Both boarding and hospital length of stay durations were obtained through the institution's trauma program office, which provided the

Figure 1. Preimplementation: Fixed Acuity Layout with Six Dedicated Progressive Care Beds and 14 General Medical–Surgical Beds

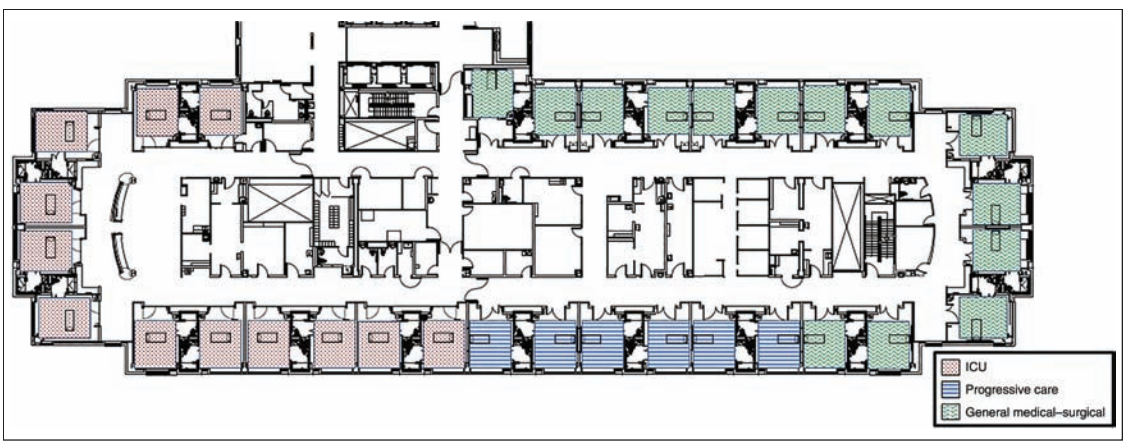
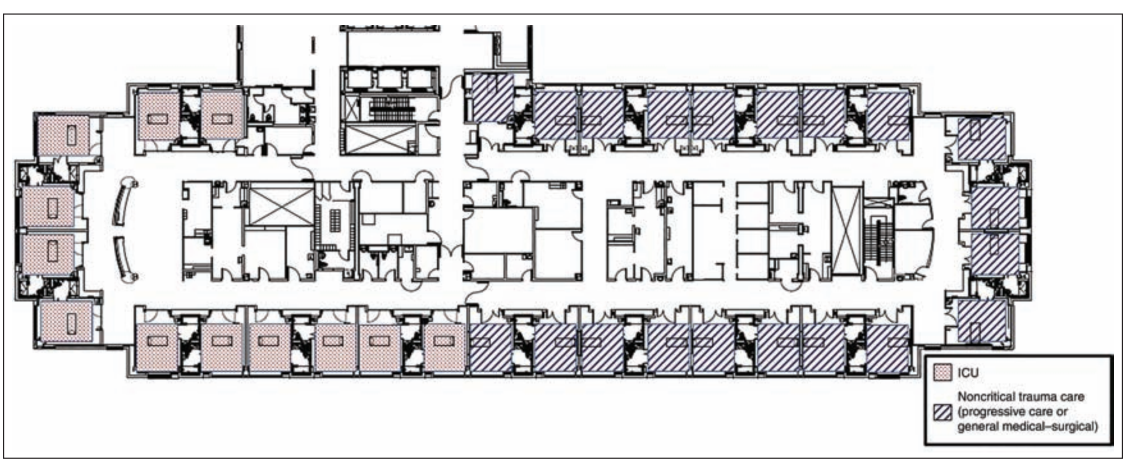


Figure 2. Postimplementation: Acuity-Adaptable Layout for 20 Noncritical Trauma Patients



initial list of trauma patients' medical record numbers (MRNs).

Resource utilization. For both the pre- and postimplementation periods, physical resource utilization was measured in patient transfers, assuming one of three conditions: a patient had a change in level of care and remained in the same room; a patient had a change in level of care and was relocated to another room; or a patient was relocated but had no change in level of care. Nursing staff utilization was assessed in terms of full-time equivalent (FTE) data, collected from hospital productivity reports. This included the units' average weekly worked FTE, the average weekly benchmark FTE, and the variance between the two. Worked FTE represents nursing hours worked with consideration for patient census and complexity, whereas benchmark FTE is a comparator metric derived from workforce data provided by similar institutions. FTE variance was calculated by subtracting worked FTE from benchmark FTE. A variance of zero indicates ideal staffing, a negative variance indicates overstaffing, and a positive variance indicates understaffing. For more context, weekly totals of patient days (general medical–surgical, progressive, and adjusted patient) were also collected. (Adjusted patient days is a metric that depicts inpatient resource allocation and use with consideration for the complexity of care and the use of outpatient resources.) Lastly, financial resources were assessed using a unit's average daily bed charges; these data were obtained from the institution's finance department.

Nursing quality indicators. Fall and hospital-acquired pressure injury (HAPI) rates per 1,000 patient days were calculated for both the pre- and postimplementation periods. Falls and HAPIs are important nursing-sensitive indicators of care quality,[20] and present well-known challenges in trauma nursing.[21, 22] A fall was defined as any unplanned descent to the floor with or without injury; a HAPI was defined as any localized injury to the skin or underlying tissue (or both) acquired during hospitalization. To calculate rates, monthly occurrences of each were collected from institutional incident reports and summed; each sum was then divided by the total number of patient days and multiplied by 1,000 to produce the rate. Patient discharge dispositions were collected from the EHR as a proxy measure of quality. Patient discharge disposition is influenced by multiple factors, including the course of hospitalization and quality of nursing care received.[16, 23] Discharge dispositions were categorized as follows: routine to home; home with additional services (including home health care); another inpatient facility (such as long-term care, skilled nursing facility, or rehabilitation facility); or other (such as psychiatric service, prison, or left against medical advice).

Transitioning to the acuity-adaptable model. Before implementation of the acuity-adaptable model, all medical–surgical nurses received training in progressive care through the nursing staff development department. The training included web-based modules, certifications in advanced cardiac life support and trauma nursing (the Emergency Nurses Association's Trauma Nursing Core Course), code blue simulation classes, and four weeks of one-on-one orientation with progressive care unit nurses. The total cost of training for the medical–surgical nurses, including nonproductive time, was $31,892. Mixed focus groups comprising progressive care and medical–surgical staff were also conducted to ensure that everyone had the resources and support needed for a successful transition. These discussions followed the institution's shared governance model and addressed the planning of appropriate patient assignments and the development of action plans for anticipated challenges.

Multiple intrahospital transfers adversely affect patient care and hospital efficiency.

The postimplementation period of the study would be conducted in the reconfigured 20-bed noncritical trauma unit. To this end, a capital expenditure request of $230,000 was approved for the installation of necessary monitoring equipment in the 14 medical–surgical rooms that weren't already so equipped. This allowed staff to monitor changes in acuity, and the institution's central monitoring unit was made aware of the additional telemetry-monitored beds. An evaluation of communication devices was completed to ensure that staff would continue to receive alerts to call lights and alarms.

The new unit's initial staffing plan retained the same weekly benchmark FTE; thus, five RNs were scheduled per 12-hour shift. With patient acuity and safety in mind, the number of progressive care–level patients was capped at 10. House officers and bed assignment personnel were notified of the go-live date and of the progressive care patient limit. Shift assignments were adjusted with consideration for patient acuity, location on the 20-bed unit, continuity of care, and workload, such that on average, each nurse was assigned a mix of two general medical–surgical and two progressive care patients. Lastly, the two units were merged into one cost center to ensure accurate postimplementation data capture.

Data collection. The institution's internal trauma database was queried for patient records that met study criteria. Once the sample population was identified by MRNs, demographic and clinical data were extracted from the EHR, as noted above. Throughput indicators and patient dispositions throughout hospitalization were collected by tracking each patient's MRN in the bed assignment dashboard. Resource utilization data, including FTE values, progressive and general medical–surgical patient days, and costs, were collected from unit productivity reports and financial data tagged to the MRNs. Nursing quality indicators were captured by querying the institution's internal incident reporting system.

Data analysis. Descriptive statistics were used to characterize the sample and subsamples. Independent *t* tests, Mood median tests, and chi-square (χ^2) analyses were used for group comparison, and fall and HAPI rates were qualitatively compared. Binary logistic regression was used to determine the impact of the acuity-adaptable model on the three conditions of patient transfer. The independent variable was the unit acuity model (fixed or acuity-adaptable), and covariates included age, ISS, and hospital length of stay. Significance was set at $P < 0.05$. All analyses were performed using IBM SPSS, version 27.

RESULTS

Sample. A total of 1,371 patients met the criteria and were included in our analysis. The mean age of the sample was 52 years and 63% were male. The majority (86%) were admitted following blunt trauma. The mean ISS was 14, indicating a high moderate level of injury.[18, 24] Across the total sample, median boarding times in the ED, ICU, and PACU were 5.8, zero, and zero hours, respectively, and the median length of hospital stay was seven days. Over one-third (35%) of patients were routinely discharged to home. For a more detailed description of the sample and subsamples, see Table 1.

Table 1. Demographic and Clinical Characteristics of the Sample by Acuity Model

Characteristic	Total Sample (N = 1,371)	Fixed Acuity Model (n = 689)	Acuity-Adaptable Model (n = 682)	*P*
Age in years, mean (SD)	52 (21)	52 (20)	53 (22)	0.28
Gender, n (%)				0.42
Male	864 (63)	427 (62)	437 (64.1)	
Female	507 (37)	262 (38	245 (35.9)	
ISS, mean (SD)	14 (9)	14 (9)	14 (9)	0.92
Mechanism of injury, n (%)				0.31
Blunt	1,184 (86.4)	602 (87.4)	582 (85.3)	
Penetrating	113 (8.2)	49 (7.1)	64 (9.4)	
Other	74 (5.4)	38 (5.5)	36 (5.3)	
Boarding hours, median (IQR)				
ED	5.8 (21.2)	9.8 (23.1)	3.6 (18.5)	< 0.001
ICU	0 (3)	0 (3.3)	0 (2.9)	0.68
PACU	0 (0)	0 (0)	0 (1.7)	0.07
Hospital LOS in days, median (IQR)	7 (8)	7 (7.5)	7 (9)	0.73
Discharge disposition, n (%)				< 0.001
Routine home	477 (34.8)	206 (29.9)	271 (39.7)	
Home with services	279 (20.4)	164 (23.8)	115 (16.9)	
Another inpatient facility	582 (42.5)	306 (44.4)	276 (40.5)	
Other	33 (2.4)	13 (1.9)	20 (2.9)	

IQR = interquartile range; ISS = Injury Severity Score; LOS = length of stay; PACU = postanesthesia care unit.

Note: Significance was set at $P < 0.05$. Comparisons were performed with independent *t* tests, Mood median tests for independent sample, or χ^2 tests, depending on the level of measurement and distribution of data.

Table 2. Comparison of Resource Utilization by Acuity Model

Item	Fixed Acuity Model	Acuity-Adaptable Model	*P*
Stayed in room after change in level of care, n	33	217	< 0.001
Relocated after change in level of care, n	88	24	< 0.001
Relocated without change in level of care, n	13	23	0.09
Weekly RN worked FTE, mean (SD)	22.1 (1)	22.1 (1)	0.52
Weekly RN benchmark FTE, mean (SD)	23.7 (1.5)	30.8 (7.9)	< 0.001
Weekly RN FTE variance,[a] mean (SD)	1.6 (1.8)	8.7 (7.9)	< 0.001
Weekly total medical–surgical patient days, mean (SD)	92.8 (6.3)	78.6 (11.7)	< 0.001
Weekly total progressive care patient days, mean (SD)	37.8 (4.3)	55.5 (10.7)	< 0.001
Weekly total adjusted patient days,[b] mean (SD)	140.9 (18.1)	154.3 (26.5)	0.004

FTE = full-time equivalent.

[a] FTE variance = benchmark FTE – worked FTE. A variance of zero indicates ideal staffing, a negative variance indicates overstaffing, and a positive variance indicates understaffing.

[b] Adjusted patient days is a metric that depicts inpatient resource allocation and use with consideration for the complexity of care and the use of outpatient resources.

Note: Significance was set at $P < 0.05$. Comparisons were performed with independent *t* tests or χ^2 tests, depending on the level of measurement and distribution of data.

Pre- and postimplementation comparison of the acuity-adaptable model. *Throughput efficiency.* Throughput, assessed as boarding hours in the ED, ICU, and PACU and hospital length of stay in days, was compared pre- and postimplementation to examine the impact of the acuity-adaptable model. After implementation, median ED boarding time was reduced by 6.2 hours (9.8 hours preimplementation to 3.6 postimplementation), a significant finding (χ^2 [1 *df*] = 26.1, $P < 0.001$). There were no differences in median ICU or PACU boarding hours or hospital length of stay.

Resource utilization. Regarding physical resources and patient transfers, after implementation, there were significantly more instances of patients remaining in the same room despite a change in level of care (33 preimplementation to 217 postimplementation; χ^2[1 *df*] = 167.9, $P < 0.001$). There were also significantly fewer instances of patients transferring to a new room following a change in level of care (88 preimplementation to 24 postimplementation; χ^2[1 *df*] = 39.1, $P < 0.001$). There were no significant differences in instances of patients who changed rooms but stayed at the same level of care.

Regarding nurse staffing, there was no difference in average weekly worked FTE between the pre- and postimplementation periods, as additional staff weren't added. But the average weekly benchmark FTE was significantly higher postimplementation than preimplementation (30.8 and 23.7, respectively). Unsurprisingly, there was a wider degree of variance between the average weekly worked FTE and the average weekly benchmark FTE during postimplementation compared with preimplementation (8.7 and 1.6, respectively). In terms of patient days, on average there were significantly more medical–surgical patient days per week preimplementation than postimplementation (92.8 and 78.6, respectively). But in the postimplementation period compared with the preimplementation period, on average there were significantly more progressive care patient days per week (55.5 and 37.8, respectively) and total adjusted patient days per week (154.3 and 140.9, respectively).

In terms of financial resources, average daily bed charges for the noncritical trauma unit were $64,067 whereas those in the progressive care and medical–surgical units combined were $52,458. In other words, postimplementation, the average daily bed charges increased by $11,609, reflecting the noncritical trauma unit's increased capacity for progressive-level care patients. For more details comparing resource utilization by acuity model, see Table 2.

Nursing quality indicators. In the preimplementation period, there were 16 falls and 11 HAPIs, which can be restated as index rates of 2.2 and 1.5 occurrences per 1,000 patient days, respectively. In contrast, in the postimplementation period, there were 10 falls and nine HAPIs, which can be restated as index rates of 1.3 and 1.2 occurrences per 1,000 patient days. Between the pre- and postimplementation periods, fall and HAPI index rates decreased respectively by 0.9 and 0.3 occurrences per 1,000 patient days. (While clinically meaningful, these findings weren't analyzed for statistical significance because of low incidence and risk of type II error.) We also determined that there was a significant association between the pre- and postimplementation periods and discharge disposition (χ^2[3 *df*] = 20.46, $P < 0.001$). Notably, nearly 40% of patients in the postimplementation period were routinely discharged to home compared with 30% in the preimplementation period. And fewer patients in the postimplementation period compared with the preimplementation period were discharged to home with services (16.9% and 23.8%, respectively) or to another inpatient facility (40.5% and 44.4%, respectively).

Impact of unit acuity model on patient transfers due to a change in status. Binary logistic regression models were performed to ascertain the impact of the acuity-adaptable model on the likelihood of patient transfer, while controlling for age, ISS, and hospital length of stay. First, we assessed the impact of the acuity-adaptable model on the likelihood of patients having a change in level of care but remaining in the same room. The acuity-adaptable model had a significant effect (χ^2[4 *df*] = 227.4, $P < 0.001$) and explained 25% of the variance. We found that in this model, patients were nine times more likely to stay in the same room after a change in level of care than they were in the fixed acuity model, holding all else constant.

Secondly, we assessed the impact of the acuity-adaptable model on the likelihood of patients being relocated after a change in level of care. The model had a significant effect (χ^2[4 *df*] = 107.8, $P < 0.001$) and explained 17.5% of the variance. In this model, patients were 81.6% less likely to move to a new room after a change in level of care than they were in the fixed acuity model, holding all else constant.

Lastly, we assessed the impact of the acuity-adaptable model on the likelihood of patients being relocated without having a change in level of care. This model had a significant effect (χ^2[4 *df*] = 51.8, $P < 0.001$) and explained 10.1% of the variance, but it had no impact on the likelihood of this type of transfer. For more details on these findings, see Table 3.

DISCUSSION

This investigation focused on the effect of an acuity-adaptable model in a noncritical trauma patient population on throughput efficiency, resource utilization, and nursing quality. Our findings showed that the acuity-adaptable model had several favorable effects, including significantly reduced ED boarding times and fewer patient transfers for changes in level of care. Furthermore, because the new model increased unit capacity for progressive care patient days, unit-level average daily bed charges increased, with a potential for increased unit profits. And although the noncritical trauma unit was initially understaffed, as FTE remained unchanged, after the study ended more nursing staff were added. Care delivery was improved with no decrease in care quality.

The boarding of patients in undesignated areas has been associated with patient harm, and can result from bed shortages and inefficient patient

Table 3. Logistic Regression Models Demonstrating Predictors for the Three Conditions of Patient Transfer

	Model 1: Remaining in same room following a change in level of care			Model 2: Relocating following a change in level of care			Model 3: Relocating without a change in level of care		
	β	OR (95% CI)	*P*	β	OR (95% CI)	*P*	β	OR (95% CI)	*P*
Acuity-adaptable model	2.25	9.47 (6.4-13.96)	< 0.001	–1.69	0.184 (0.11-0.31)	< 0.001	0.46	1.56 (0.74-3.62)	0.22
ISS	0.04	1.036 (1.02-1.05)	< 0.001	0.03	1.03 (1.01-1.05)	0.009	–0.04	0.96 (0.92-1.01)	0.10
Age, years	0.003	1.004 (0.99-1.01)	0.41	0.01	1.01 (1.00-1.03)	0.009	–0.006	0.997 (0.98-1.02)	0.49
Hospital LOS, days	0.02	1.03 (1.01-1.04)	< 0.001	0.05	1.05 (1.04-1.07)	< 0.001	0.067	1.07 (1.05-1.09)	< 0.001
χ^2 tests	χ^2 (4 *df*) = 227.4, $P < 0.001$			χ^2 (4 *df*) = 107.8, $P < 0.001$			χ^2 (4 *df*) = 51.8, $P < 0.001$		
Hosmer-Lemeshow test[a]	0.292			0.540			0.723		
Nagelkerke R^2 test[a]	0.250			0.175			0.101		

χ^2 = chi square; ISS = Injury Severity Score; LOS = length of stay; OR = odds ratio.
[a] Hosmer-Lemeshow and Nagelkerke R^2 tests are used in binary logistic regression to test how well the data fits the model. The Hosmer-Lemeshow test is a measure of how well the observed event rate matches the expected event rate. $P < 0.05$ indicates a poor fit. The Nagelkerke R^2 is a measure of variation in the dependent variable as explained by the model. Values range from 0 to 1, with those closer to 1 representing a better fit.
Note: Significance was set at $P < 0.05$.

throughput.[25, 26] Following our implementation of an acuity-adaptable model, we found that the median ED boarding time was reduced by over 60%. Matukaitis and colleagues reported similar results after implementing the acuity-adaptable model on two units, redesigning them for noncritical cardiac care and intermediate care patients admitted from the ED.[27] Following implementation, there was a 55% reduction in ED boarding time. More recently, Thacker and colleagues reported that using the acuity-adaptable approach in creating a single noncritical care trauma unit led to significantly reduced ED boarding times; notably, before implementation of that approach, nearly 73% of patients who boarded in the ED were waiting for intermediate care beds.[16] These findings are congruent with ours and support the notion that increasing a facility's capacity to provide progressive care has a positive impact on ED throughput.

After implementation, median ED boarding time was reduced by 6.2 hours.

Prior researchers have found that, for patients leaving the ICU or the PACU, a lack of available beds on general medical–surgical units was a major contributor to delayed transfer and subsequent boarding.[4, 28] Yet in our study, implementing the acuity-adaptable model led to no significant changes to ICU or PACU boarding times. In a study by Mathews and Long, simulated reconfigurations were used to estimate patient transfer times from the ICU to a step-down unit, using various numbers of each bed type.[29] They found that, as the number of allocated step-down beds increased, the estimated average boarding time decreased, suggesting that having increased capacity to care for noncritical patients would theoretically decrease boarding time in the ICU. Although inadequate capacity also contributes to PACU boarding, we could find no studies exploring the impact of an acuity-adaptable model on PACU boarding. Further research in this area is warranted.

Notably, the most common implementation of the acuity-adaptable model has used a single-stay room approach.[3, 13, 30] In this configuration, patients stay in the same room from admission to discharge, which convolutes comparison of our findings to others based on boarding times across different inpatient areas. One reason that, in our study, the new model impacted ED, but not ICU or PACU, boarding times might be that most trauma patients are admitted through the ED. Those who don't need intensive care or surgical intervention may bypass the ICU or the operating room and be assigned to and occupy a noncritical care bed sooner than patients transferring from the ICU or the PACU.

We found no change in hospital length of stay after implementing an acuity-adaptable model, in contrast to previous studies which have found that such implementation significantly decreased hospital length of stay.[12, 13, 16, 30] Of interest, one study found that when patients were first admitted to a general medical–surgical unit and then transferred to intermediate care, length of stay was significantly longer, even when controlling for demographics and acuity.[31] This adds context to our finding that being able to avoid transfers by managing patients' changing care needs in one room didn't increase their length of stay. It's also possible that the lack of change we observed in hospital length of stay could be related to discharge disposition. The pre- and postimplementation samples were clinically similar; yet, compared to patients in the preimplementation period, more patients postimplementation were routinely discharged to home rather than to home with services or to another inpatient facility. (These last two discharge dispositions tend to increase length of stay because of the need to coordinate patient education across nursing and other disciplines such as physical and occupational therapy.[16, 32]) Further investigation is warranted to better understand this finding.

Multiple intrahospital transfers can lead to inefficient use of both physical and human resources. In one study, Hendrich and Lee explored transfer process efficiency by assessing transfer events in terms of actual value-added and "waste" times.[33] They found that the average transfer event took 306 minutes, of which 264 minutes were nonproductive; thus average transfer process efficiency was just 13.7%. Adoption of an acuity-adaptable model can reduce or eliminate transfers, which in turn improves operational efficiency and optimizes resource use.[3, 9, 33] In our study, implementing this model reduced patient transfers due to change in clinical status by 72.7%, and when controlling for age, severity and mechanism of injury, and length of stay, by 81.6%. Reciprocally, significantly more noncritical trauma patients received care in the same room despite a change in level of care and, when controlling for the same covariates, such patients were more than nine times more likely to do so. These findings are congruent with those of a hallmark study by Hendrich and colleagues, which tested an acuity-adaptable model and subsequently reported a 90% reduction in patient transfers after a change in level of care.[3] Taken together, these findings indicate that an acuity-adaptable model can effectively reduce patient transfers while optimizing physical resources and preserving care quality.

Care delivery was improved with no decrease in care quality.

Regarding nursing staff resources, benchmark FTE, FTE variance, and number of progressive care patient days were each significantly higher postimplementation, despite maintaining actual worked FTE. Similarly, Sosebee and colleagues found that implementing an acuity-adaptable model did not significantly change actual worked FTE.[34] But neither did they report significant differences in other indicators of nursing resource utilization (patient days, demand for service). They acknowledged that, since only part of their study unit participated in evaluating the model, this may have influenced their findings. In our study, the number of progressive care patient days increased 46.8% postimplementation. There is evidence that an increase in patient acuity impacts benchmark FTE to reflect increased clinical demands.[35] Because our model increased progressive care capacity and patient days without altering the number of RNs, after the end of the study period we were able to justify adding another nurse to the noncritical trauma unit staff. This ensured that we could better meet our patients' clinical needs. After taking into account the initial capital investment, the cost of additional training for existing staff, and the cost of adding another nurse to standard staffing, we calculated that the unit's annual bed charges could potentially increase by more than $3.9 million.

Regarding nursing quality indicators, both fall and HAPI rates improved postimplementation. Falls per 1,000 patient days were reduced by nearly 41% in our study, a finding congruent with Hendrich and colleagues' estimated postimplementation reduction of 67%.[3] Similarly, Venditti found that patients on a unit employing the acuity-adaptable model were 76.5% less likely to fall than those in a traditional cardiac ICU.[30] Known inpatient fall risk factors include older age, impaired cognition, decreased mobility, and opioid use, all of which are common among trauma patients. One study, conducted among hospitalized trauma patients, found that patients who had sustained blunt trauma were five times more likely to fall than those who had not.[36] And a study of within-unit falls on a short-stay acute medical unit found that each time a patient moved rooms, their fall risk rose 27%.[37]

As risk assessment and mitigation are imperative for fall prevention, it's also worth noting that increased nurse staffing and skill mix have been associated with lower fall rates.[38] Although postimplementation we did not add more nursing staff, the skill mix improved, and assignment logistics were adjusted such that each nurse cared for the same distribution of patients by acuity level, with their location on the 20-bed unit also taken into account. In other studies, clustering patients by acuity level and location resulted in fewer falls by improving communication and nursing response times.[39, 40] Our acuity-adaptable model reduced patient transfers, improved the nursing skill mix, and redistributed care assignments evenly by patient acuity with consideration for location, all of which likely contributed to the reduction in falls.

Postimplementation, we also observed a 20% decrease in the HAPI rate per 1,000 patient days. Although there is a paucity of evidence regarding the impact of an acuity-adaptable model on HAPI incidence, there is research associating increased skill mix and improved nurse–patient ratios with lower pressure injury rates.[35] In our study, during the transition period, all nurses were trained to progressive care standards, thus increasing the overall skill mix on the new unit. This training, along with the redistribution of assignments, may have contributed to the reduction in HAPIs. Further investigation is warranted to better understand the potential associations.

Regarding discharge disposition, patients were more often routinely discharged to home postimplementation than to home with services or to another inpatient facility. Advancements in trauma care have drastically reduced mortality for injured patients, and many patients now survive to discharge with the course of hospitalization having a significant impact on their discharge disposition.[41] Similarly, in the study by Thacker and colleagues, after implementation of an acuity-adaptable model, significantly more patients were discharged to home following hospitalization for traumatic injury.[16] Numerous factors inherently place trauma patients at higher risk for discharge to a location other than home.[42] In our study, even though the pre- and postimplementation samples were clinically similar, the improved postimplementation nursing skill mix probably enhanced care quality and led to more favorable discharge dispositions.

Relevance to clinical practice. This study has demonstrated that a unit based on the acuity-adaptable model is an efficient, resource-wise, and patient-centered alternative model of care delivery for noncritical trauma patients. Nurse leaders considering the acuity-adaptable model should have a clear understanding of any systemic constraints they may face in applying the model in their facility. For example, at our institution there was a high demand for progressive care–level beds. By understanding where the need was greatest, we were able to develop the acuity-adaptable noncritical trauma unit in the optimal preexisting space, thereby increasing our capacity for patients needing progressive care. We were also able to drastically reduce ED boarding times, which prior research has shown to benefit the efficiency of the entire facility.[25]

Patient throughput involves multiple types of hospital resources. When patient transfers decrease, bed availability becomes clearer in real time, allowing for better resource planning and utilization when capacity issues arise. And as other investigators have shown, inefficient transfer processes significantly contribute to nonproductive nursing time.[33] Improved resource utilization is another potential benefit of the acuity-adaptable model that nurse leaders should consider.

Staffing remains a high-priority challenge for many nurse leaders and institutions. In adopting an acuity-adaptable model, it's important that leaders consider the current nursing staff skill mix and any additional education and training needed and provide the appropriate resources to maximize staff skill sets—particularly if adding more staff is not an option. In our study, it took a collaborative, multifaceted effort to ensure that the nurses were adequately prepared for the launch of the noncritical trauma unit. This was vital to the successful implementation of the model, and to improved patient outcomes without adding worked FTE.

Limitations. This study had some limitations. First, the retrospective design meant that data collection was restricted to existing records. Second, the acuity-adaptable model was tested on a single unit at a single site. The characteristics of the study institution, unit, nursing staff, and trauma patients will not be representative of all trauma centers. The way trauma patients moved through hospitalization should also be acknowledged. Before this project, in 2012 our institution began using a rapid admission process for critical trauma patients.[43] Staff familiarity with this process could have promoted expeditious throughput of all trauma patients. Lastly, for trauma patients, the course of hospitalization can be complex and unpredictable, which can cloud understanding of outcomes. Although we sought to limit confounding influences on the model's effectiveness by selecting specific covariates for regression analyses, there may have been unknown variables that influenced our results.

CONCLUSIONS

Health care systems across the United States continue to be challenged by increasing demands for services while also facing numerous barriers to doing so efficiently and effectively. Leaders of health care organizations must embrace a strategic and innovative approach to navigating the constraints of the current system in order to optimize operational efficiency and resource utilization and ensure delivery of high-quality care. The findings of this study demonstrate the value of the acuity-adaptable model in achieving these goals in a noncritical trauma care population and can guide researchers and health care leaders seeking to implement and evaluate this approach in other populations and settings. ▼

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