

Implementation of an Orthopedic Trauma Program to Safely Promote Resident Autonomy

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ABSTRACT

Background There is ongoing tension in graduate medical education between progressive resident autonomy with entrustable professional activities and the need for supervision to ensure patient safety.

Objective We implemented a pediatric orthopedic surgical trauma safety program that utilized a postcall review conference to provide residents graduated responsibility learning opportunities during overnight trauma call without compromising patient safety.

Methods In the program, all orthopedic trauma cases seen in our main tertiary hospital emergency department by the overnight orthopedic resident were reviewed in a case conference. For 1 year, we performed an analysis of all fracture patients who were treated in the emergency department by our orthopedic surgery residents. From June 1, 2016, through June 30, 2017, all care delivery encounters were reviewed for decision-making errors, technical errors, and complication rates. Two resident groups rotated through our institution over the course of the study.

Results During the year of analysis, all 1298 fracture patients seen overnight in the main tertiary hospital emergency department were reviewed. From the first to the second halves of their rotations, the rate of resident decision-making errors (3.1% [12 of 385] to 2.3% [9 of 399]) and technical errors (9.1% [35 of 395] to 7.3% [29 of 399]) decreased. Excluding decision-making and technical errors, the complication rate for patients discharged home was 3.4% (27 of 784).

Conclusions Residents demonstrated decreased decision-making and technical error rates on overnight call while maintaining low complication rates.

Introduction

In graduate medical education, there is a need to balance resident independence with necessary supervision.^{1–4} While supervision is critical to ensure patient safety, excessive supervision may hinder a resident's ability to develop the independent decision-making and technical skills necessary for competent care.

According to studies, surgical providers have been associated with more than half of technical errors (60%) in medicine.^{5–8} Decision-making errors, such as judgment decisions regarding operative versus nonoperative management, discharge planning, and postprocedural care, have been shown to cause more adverse events than errors in surgical technique.⁹ Currently, there is little research addressing effective interventions that promote orthopedic resident learning and autonomy while maintaining patient safety.

In order to balance the conflicting demands of resident education and patient safety, we developed a pediatric orthopedic surgical trauma safety program that utilized a postcall review conference for all trauma cases seen by the overnight orthopedic resident in our tertiary hospital emergency department (ED), which is a certified level 1 trauma center. Our goal was to create

a system in which the 2 attributes were not mutually exclusive, with resident autonomy in orthopedic trauma scenarios covered by an ever-present, reliable postcall case review safety net to ensure patient safety.

Methods

Setting and Participants

Postgraduate year 3 orthopedic surgery residents at our institution rotate weekday night call duties (7 PM–7 AM) for 1 month at a time during their 6-month rotation in pediatric orthopedic surgery. There is an orientation to the hospital, ED, floors, and operating rooms before the residents begin on-call duties. This includes a review of all clinical activities, the distribution of independent work versus need for attending notification, and the cases that must be reviewed the following day. Residents are assisted by a physician's assistant in the hospital until 11 PM. In addition, residents are supervised remotely by an attending board-certified orthopedic surgeon with fellowship training in pediatric orthopedic surgery. The attending surgeon has access to the electronic health records, picture archiving and communication system radiology imaging, Health Insurance Portability and Accountability Act (HIPAA)–compliant texting, and multimedia HIPAA-compliant patient imaging. Attending physicians are available on short

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notice for any overnight emergency surgery. Pediatric emergency medicine and radiology physician attending staff, residents, and fellows are available to assist orthopedic residents as needed in decision-making and patient care. This network of support and consultation provides an in-house safety net. The onus is on the resident to seek advice and technical assistance. The residents formulate plans of care and execute the management plan they have devised. Families of patients who do not need immediate attending surgeon supervision are informed by the residents upon discharge that their child's care plan and management will be reviewed the following morning, and they will be notified if there are any changes. The expectation is that the orthopedic surgery residents will have progressive responsibility of care while seeking supervision as needed for the best patient outcomes.

Intervention

Due to the complexity of communication and transitions of care, we instituted a postcall trauma safety case review program in the pediatric orthopedic surgery department of our institution. Every morning at 6 AM, the overnight resident e-mails all orthopedic surgery department attending surgeons, residents, fellows, advanced care practitioners, and nursing case coordinators summarizing the orthopedic trauma cases seen during the overnight shift in the main tertiary hospital ED. Patients included in this e-mail are divided into 3 sections: (1) patients who received definitive treatment (usually conscious sedation fracture reduction and casting) and were discharged home; (2) patients admitted directly to the hospital for complex multitrauma care, orthopedic surgery, musculoskeletal infection, or other clinical issue requiring immediate hospitalization; and (3) discharged patients who met criteria for our Satellite Trauma Orthopedic Program Operating Room (STOP OR), in which less-acute, stable, operative fracture cases receive surgical intervention at a dedicated satellite location trauma operating room that week (TABLE).¹⁰

This patient list is preliminarily reviewed by the chief of orthopedics and on-call surgeons daily at 6 AM. Any immediate concerns are addressed at that time with the overnight resident. A detailed review is performed at 7 AM daily morning case review trauma rounds, in which plans of care, surgical planning, and dispositions are finalized. The trauma case conference is attended by the orthopedic residents, the attending pediatric orthopedic surgeon on call at the main tertiary hospital, the STOP OR attending orthopedic surgeon via teleconference, and all available orthopedic surgery

What was known and gap

Residency programs must balance the need for progressing resident autonomy with patient care concerns.

What is new

A pediatric orthopedic surgical trauma safety program that uses a review conference to provide residents graduated responsibility without compromising patient safety.

Limitations

Single site and single specialty program limit generalizability.

Bottom line

Residents participating in an overnight pediatric orthopedic surgical trauma safety program demonstrated decreased rates of decision-making and technical errors as they progressed through the rotation.

attendings, fellows, residents, and advanced care practitioners. Transparent discussion occurs for every case, with the goal of achieving optimal patient care and resident education. Consensus regarding patient care is reached. Following this trauma case review, care coordinators contact patients to verify the plan of care with their families, notify them of any changes, and confirm that there have been no new issues.

Faculty meet monthly during the 6-month resident rotation to review each resident's performance. In addition, each resident meets with the orthopedic surgeon in chief at the end of the first month, at the 3-month mark, and at the end of the rotation to review clinical and educational summative performance. Any resident performing at a low level by qualitative and narrative assessments is placed in the "a resident at risk" program with frequent mentoring sessions to enhance performance. None of the residents in this cohort were placed in this program.

Outcomes

All fracture patients presenting to the main tertiary hospital ED and processed through our trauma safety program from June 1, 2016, through June 30, 2017, were identified. Patient medical records were reviewed to determine diagnoses, complications, and treatment received for each of the 3 discharge/admit possibilities (definitive ED care and discharge, admit directly for in-hospital care, or delay urgent surgical care to satellite operating room). Decision-making errors, in which the orthopedic resident's discharge planning differed from the one decided in the morning case review, were recorded. Technical errors, in which an orthopedic resident's overnight discharged fracture reduction was inadequate or a patient returned within 2 weeks for repeat reduction, were recorded.

The Boston Children's Hospital Institutional Review Board deemed this project exempt from review.

TABLE

Sample Case Review Summary List Delivered to Orthopedic Surgery Care Team

Category	Summary
OR overnight	None
ED admit to orthopedics	[Patient Name/MRN]: 6M, otherwise healthy, s/p fall while rollerblading with significantly displaced and shortened left midshaft femur fracture. Closed and isolated injury, NVI, no concern for compartment syndrome. Booked for OR today with [attending physician].
ED admit to other service	None
Still in ED	None
ED discharged home	[Patient Name/MRN]: 18M LHD with base of 1st metacarpal fracture. Closed, NVI. S/p attempted closed reduction in ED w/ slight improvement in angulation. Plan for trial of nonoperative treatment. F/u in 1 week. Parents are aware that angulation is borderline and fracture may require surgical fixation depending on appearance at follow-up. Mother: [mother's name and cell phone].
	[Patient Name/MRN]: 14M with right ankle fracture after falling skateboarding. Closed isolated injury. NVI. S/p closed reduction in ED and bivalved long leg casting. F/u in 1 week. Mother: [mother's name and cell phone].
	[Patient Name/MRN]: 2F RHD who sustained fall from couch. Isolated injury, closed, NVI. XRs show nondisplaced supracondylar humerus fracture. Plan for nonoperative management in bivalved long arm cast. Follow up in 1 week. Mother: [mother's name and cell phone].
ED discharged home for STOP OR	[Patient Name]: 4M, RHD, otherwise healthy, presents for evaluation of a left elbow injury after falling off a bench. XR shows displaced type 2 extension type supracondylar humerus fracture. Closed and isolated injury, NVI, no concern for compartment syndrome. Placed in a well-padded posterior long arm splint. They live in [city] and agreed with plan for OR in [the STOP OR] today for closed reduction and percutaneous pinning. Mother is keeping the patient NPO and awaiting our call this morning. Mother: [mother's name and cell phone]. Father: [father's name and cell phone].
Inpatient consults	None
Curbside	None
Inpatient updates	None
Phone calls	None

Abbreviations: OR, operating room; ED, emergency department; MRN, medical record number; s/p, status post; NVI, neurovascularly intact; LHD, left hand dominant; f/u, follow-up; RHD, right hand dominant; XR, x-ray; STOP OR, Satellite Trauma Orthopedic Program Operating Room; NPO, nil per os (nothing by mouth).

Analysis

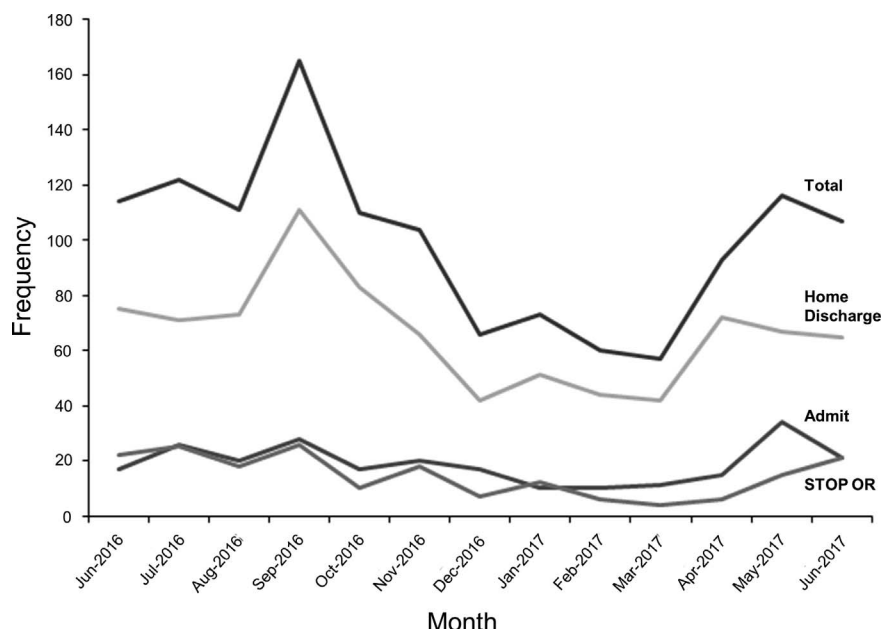
Over the course of the study, 2 orthopedic surgery residency groups rotated through our institution, and each group contained 6 residents. Group 1 rotated from mid-June 2016 through mid-December 2016. Group 2, which had already completed a 6-month trauma rotation, rotated from mid-December 2016 through mid-June 2017. Each group's rotation was divided into 2 time periods: the first half of the rotation and the second half of the rotation. The rates of resident decision-making errors, technical errors, and other complications were analyzed for the 2 time periods within each resident group to assess if the orthopedic resident achieved improved clinical aptitude without endangering patient safety.

The rates of technical and decision-making errors in this sample size were underpowered for resident-level (correlation across individual residents) and time-level correlation. Initially, the first half of the 6-month rotation was viewed as the pretest and the second half as the posttest in a quasi-experiment

analysis, but there was too much variation in injury and patient types in this cohort study to allow for this form of statistical analysis. Testing at the patient level would have inappropriately provided statistical significance ($P < .05$) for most patient-level comparisons. As a result, P values are not presented. Future prospective studies are being planned to address these sample size and cohort design limitations.

Results

Twelve residents were analyzed over the course of the study, with 6 residents per group. All residents attended the postcall conference every weekday morning. Residents in off-site locations attended via teleconference. All attending pediatric orthopedic surgeons in the department rotated staffing the postcall review conference weekly, with no lapses in attendance. The meeting was also regularly attended by medical students, fellows, advanced care practitioners, nursing care coordinators, and 1 to 2 additional attending physicians. Although we have

**FIGURE 1**

Number of Cases Screened Through the Trauma Safety Program (June 2016–June 2017), Stratified by Discharge Category

not yet performed a formal resident satisfaction survey, feedback from one-on-one meetings with residents at the beginning, halfway point, and end of the rotation has been overwhelmingly positive.

The postcall review conference lasted for 30 minutes each morning. Additional time requirements included (1) an attending surgeon briefly reviewed the overnight resident summary e-mail before the conference began; (2) an advanced practice provider organized change-of-care interventions after each conference (up to 30 minutes if surgical intervention required); and (3) a resident prepared the morning e-mail (up to 20 minutes).

From June 1, 2016, through June 30, 2017, all 1298 patients seen overnight in our main tertiary hospital ED and screened through our trauma safety program were analyzed. Of these, 862 (66%) received definitive treatment in the ED and were discharged home, 246 cases (19%) were admitted inpatient, and 190 (15%) met criteria for our STOP OR (FIGURE 1). The most common cases encountered were distal radius fractures ($n = 263$) and both bone forearm fractures ($n = 163$). On average, residents saw 3.56 patients per night. Group 1 residents saw a total of 759 patients (58%) over their rotation (average 4.12 cases per night; range, 0–10), while group 2 residents saw a total of 539 cases (42%; average 2.98 cases per night; range, 0–7). Of note, summer typically has more orthopedic surgery trauma care (group 1) than winter (group 2), with fall and spring usually equivalent.

Decision-Making Errors

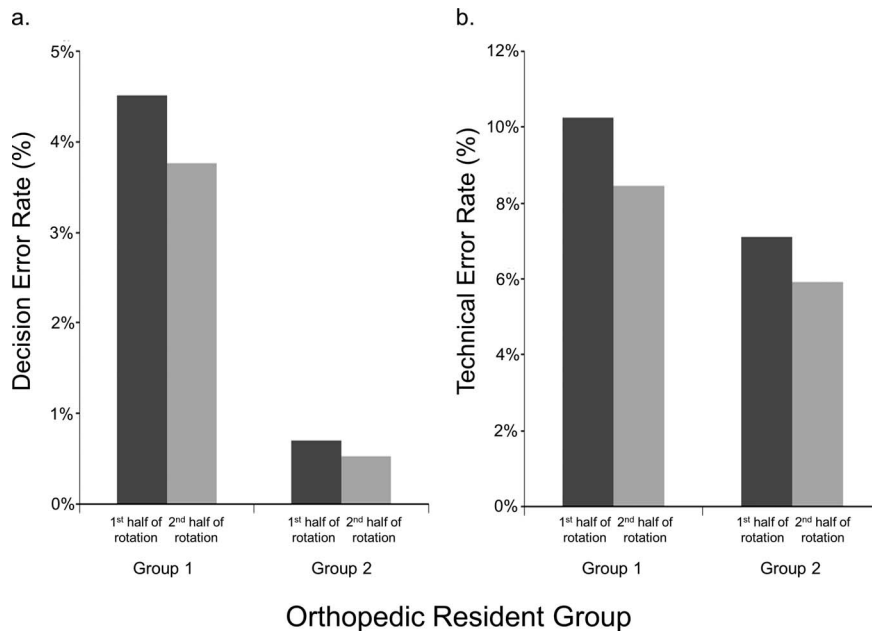
All 21 decision-making errors (2.4% of all entrustable professional activities by overnight residents during the year of analysis), in which the orthopedic resident's overnight management plan was changed during the course of the morning case review rounds, occurred with patients who were discharged home for nonoperative management. In all of these cases, patients were contacted after case review rounds and asked to return for surgical intervention. The diagnoses most often requiring a change in management were medial epicondyle fractures (27%, 3 of 11) and femur fractures (17%, 2 of 12).

Technical Errors

There were 64 total technical errors (7.4% of all reductions performed by residents during the analysis time frame), in which an orthopedic resident's discharged reduction required repeat reduction within 2 weeks for lost alignment. Forty-seven of the technical errors (70%) required surgery, while 27 (30%) required cast wedging. All of these patients had their problems resolved in a timely fashion through our system.

Changes Over Time

Because all decision-making and technical errors occurred for visits in which the patients were initially discharged home, we compared decision-making errors, technical errors, and other complication rates

**FIGURE 2**

Changes in Decision Error Rate and Technical Error Rate for Group 1 and Group 2 Residents Between First and Second Halves of Rotations

for these patients over time within and between resident groups.

There was a decrease in decision-making errors between resident groups 1 and 2, with a 4% (19 of 457) rate of decision-making errors in group 1 and only 0.6% (2 of 327) of errors in group 2. The overall rate of decision-making errors decreased from 3.1% (12 of 385) to 2.3% (9 of 399) between the first and second halves of the resident rotations. When stratified over time within each group, the rate of decision-making errors decreased by 17% within group 1 residents from the first half (4.5%, 11 of 244) to the second half (3.8%, 8 of 213) of their rotation and by 24% for group 2 from the first half (0.71%, 1 of 141) to the second half (0.54%, 1 of 186; FIGURE 2).

There was a decrease in technical error rates from group 1 (9.4%, 43 of 457) to group 2 (6.4%, 21 of 327) residents. The overall rate of technical errors decreased from 9.1% (35 of 395) to 7.3% (29 of 399) between the first and second halves of the resident rotations. When stratified over time, the number of technical errors decreased by 18% within group 1 residents from the first half (10.2%, 25 of 244) to the second half (8.5%, 18 of 213) of their rotation as well as by 17% for group 2 from the first half (7.1%, 10 of 141) to the second half (5.9%, 11 of 186) of their rotation (FIGURE 2).

Not including decision-making and technical errors, the fracture complication rate for patients discharged home was low at 3.4% (27 of 784),

stratifying to 3.6% (14 of 385) across all residents during the first half of their rotations and 3.3% (13 of 399) during the second half.

Discussion

Our findings suggest that this pediatric orthopedic surgical trauma safety program provided residents the opportunity to gain clinical experience through the relative autonomy of overnight orthopedic trauma call without compromising patient safety. From the first to the second halves of their respective rotations, the rate of decision-making errors and technical errors decreased for both group 1 and group 2 residents while maintaining a low overall complication rate of 3.4%, comparable to rates described for other pediatric orthopedic trauma scenarios (2.4%–5.1%).¹¹

To the best of our knowledge, our study is the first orthopedic surgery-specific report to assess methods to ensure patient safety while promoting resident learning and autonomy. Previous projects aiming to promote resident autonomy have been described in general surgery. The majority of projects focus on accurate, feasible ways to measure a resident's proficiency in order to guide faculty into providing appropriate levels of resident autonomy.

The Zwisch scale was developed in order to facilitate reliable, valid measurement of resident operative performance, with the goal of creating a common gauge with which to allow residents to

progress to autonomous practice.¹² The American College of Surgeons and the Association of Program Directors in Surgery developed a verification of proficiency tool to determine a resident's qualification to progress to independent surgical practice, with incorporation of the scale throughout residency.¹³ While these studies focus on ensuring patient safety using accurate measures of trainee proficiency, assessment occurs while the resident is being supervised. Our program approaches patient safety using a safety net of next-day case review and immediate overnight backup in order to ensure that potential errors are identified and remedied.

Our study has limitations. Our single institution study may not be generalizable to other programs with differing levels of coverage, support staff, and resources. In particular, acceptability may decrease for smaller practice settings that demand a higher level of time commitment for the rotating attending physician on call for morning case reviews. In addition, programs with limited teleconference capabilities may have more issues with adherence to conference attendance.

We plan to implement a formal review of our trauma safety program by both the residents and attending surgeons on staff in order to improve our program.

Conclusion

An overnight pediatric orthopedic surgical trauma safety program, utilizing a postcall review conference to provide residents graduated responsibility learning opportunities during overnight trauma call, demonstrated decreased resident decision-making and technical error rates while maintaining low complication rates. Residents demonstrated decreased rates of decision-making and technical errors as they progressed through their rotation in the program, while preserving a low level of overall complications. This program provides a feasible method to safely promote resident autonomy in pediatric orthopedic trauma.

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