Improving Documentation Using a Real-Time Location System in a Pediatric Emergency Department

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Abstract

Background Appropriate documentation of critical care services, including key time-based parameters, is critical to accurate severity of illness metrics and proper reimbursement. Documentation of time-based elements for critical care services performed in emergency departments (ED) remains inconsistent. We integrated electronic medical record and real-time location system (RTLS)-derived data to augment quality improvement methodology.

Objective We aimed to increase the proportion of patient encounters with critical care services performed at a pediatric ED that had appropriate documentation from a baseline of 76 to 90% within 6 weeks.

Methods The team formulated a framework of improvement and performed multiple plan-do-study-act cycles focused on key drivers. We integrated the capabilities of an RTLS for precise location tracking to identify patient encounters in which critical care services were performed and to minimize unnecessary audits and feedback. We developed an intervention using iterative revisions to address key drivers and improve documentation. The primary outcome was the proportion of patient encounters for which critical care services were performed for which a time-based attestation was documented in the medical record.

Results We analyzed 92 encounters between March 2020 and April 2020. While the proportion of eligible patient encounters with critical care documentation improved from 76 to 85%, this change was unable to be directly attributed to improvement efforts. Patients with respiratory complaints encompassed the majority of eligible encounters without appropriate documentation.

Conclusion Utilizing improvement methodology and a novel application of RTLS, we successfully identified the co-location of physicians with patients receiving critical care services and designed interventions to improve documentation of critical care services provided in a pediatric ED. While changes were not able to be attributed to improvement efforts in this project, this project demonstrates the utility of RTLS to augment and inform systematic improvement efforts.

Keywords

- geographical information systems
- clinical documentation
- billing
- emergency

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Background and Significance

Accurate and detailed physician documentation is required for key stakeholders to characterize patient acuity and ensure appropriate reimbursement.[1,2] All services provided by physicians during an emergency department (ED) visit, including procedures and cognitive work, are described by common procedural terminology (CPT) codes. These codes must be translated by trained medical coders into professional charges.[3] However, physician descriptions of patient care vary widely and may omit essential verbiage for appropriate coding and billing, leading to inaccurate reimbursement for services and incomplete severity of illness metrics.[4]

For patients who require critical care services, physician documentation must reflect the aggregate time spent on such care, in addition to medical necessity. CPT coding depends on multiple factors, including time increments as documented by physicians (e.g., less than 30 and 30–74 minutes).[5] This allows the coder to decide whether an emergency department CPT code (e.g., 99285) or a critical care code (99291) is appropriate. Such codes alter the relative value unit (RVU) assigned to the provided care and to financial reimbursement.

However, estimating the passage of time is difficult, especially in stressful situations with varying stimuli.[6,7] This difficulty accurately perceiving the passage of time compounds the potential for the inadvertent omission of key components of critical care documentation, namely time-based care estimates. Prior work has demonstrated discrepancies between documented elements of clinical care and those which were observed by third parties, highlighting an opportunity to improve documentation by accurately tracking physician time at the bedside during critical care encounters.[8] Real-time location systems (RTLS) have become common in clinical environments for asset tracking. While RTLS applications to augment clinical quality improvement methods have been described less commonly, efforts to apply situational analytics to health care information technology implementation have resulted in insights into context-specific activities and related outcomes.[9] As part of an ongoing initiative at our institution to explore the value of RTLS in various operational and academic applications, we piloted this project to provide insight into how co-locating patients and staff could enhance audit and feedback of clinician documentation.

Our objective was to augment traditional feedback and audit quality improvement methodology with the strategic integration of RTLS geolocation data. We sought to integrate RTLS capabilities with QI methodology to precisely identify encounters in which critical care services were provided and offer clinicians personalized, timely and specific documentation support. This QI project was evaluated by Cincinnati Children's Hospital institutional review board and did not meet the definition of human subjects research.

Methods

Setting and Context

This project was conducted at a pediatric tertiary care emergency department with a volume of approximately 80,000 patients. This institution houses the regions only pediatric intensive care unit and admits 85 to 90% of pediatric patients from a catchment area of approximately 2,000,000 people. We formed an improvement team to strategically integrate RTLS, evaluate baseline documentation patterns, form a framework of improvement, and develop interventions based on key drivers to improve critical care documentation for patients treated in our pediatric ED and admitted to an intensive care unit (ICU). Our goal was to increase the proportion of physician documentation with accurate critical care attestations for critically ill children from a baseline of 76% to a goal of 90% over a 6-week period and to gain insight into how co-location data could be incorporated into documentation auditing. We incorporated multiple iterative process revisions into the primary plan-do-study-act cycle of the project to refine our data collection methods and intervention development.

Emergency Department Workflow

The ED is staffed by pediatric emergency medicine (PEM) faculty and fellows, staff pediatricians, nurse practitioners, and resident physicians. All patients who are determined to be critically ill, likely to become critically ill, or require intensive resource use are evaluated and treated in the Shock Trauma Suite (STS), a designated critical care area adjacent to regular rooms. To make this determination, triage nurses apply criteria to patients who self-present, arrive via emergency medical services or via transport from outside facilities. These criteria incorporate vital sign abnormalities, physical exam findings, past medical history, and mechanism of injury to estimate the risk of critical illness and need for high-resource utilization. Additionally, patients whose medical status declines during the ED stay are moved from their ED room to the STS for the duration of their need for critical care. Therefore, nearly all critically ill patients are treated in this area for the duration of their ED visit. Additionally, physicians at our site typically perform most critical care tasks (consultant phone calls, chart review, and leading the care team) in the STS, allowing us to capture these components of critical care time.

Internal analysis of our ED workflow prior to this project has shown that patients who receive treatment in this area spend an average of 68 minutes (standard deviation [SD]: 32 minutes) in the STS, while physicians spend an average of 35 minutes (SD: 18 minutes). Therefore, simply using patient-based location time metrics would result in a large denominator upon which to base our interventions and an unacceptably large number of "false positives." We sought to utilize RTLS-derived data to inform our improvement project to increase the precision of our interventions.

Critical Care Documentation

The Centers for Medicare & Medicaid Services (CMS) define critical care as a physician's direct delivery of medical care for a critically ill or injured patient. A critical illness acutely impairs one or more vital organ systems such that there is a high probability of imminent or life-threatening deterioration. Critical care is time based and involves complex decision-making, and must be reasonable and medically necessary.[5] Our institution embedded a "smart phrase" in the electronic medical record (Epic Systems, Madison, Wisconsin, United States) to facilitate the documentation of required elements of critical care, both to aid coding and to improve communication among providers. This specifies critical care time that does not include separately reported billable procedures. Addition of this smart phrase to the medical record requires the documenter to take multiple steps and is not required for chart completion.

Real-Time Location System

RTLS refers to various technologies that automatically track the geolocation of objects, equipment, or people within a defined physical space in real time.[10] Various communication methods, such as radiofrequency identification (RFID) and infrared (IR), are used to locate transmitters on the objects of interest in relation to installed sensors, allowing precise locations to be displayed and analyzed over time. The virtual environment can be mapped to the physical environment and standard workflow patterns to allow for robust analysis of movement data.[10] There are myriad applications of RTLS in healthcare, including operational, clinical, safety and quality improvement initiatives.[11–14] In anticipation of a large scale RTLS installation in a new critical care tower, our institution implemented an RTLS pilot program in the ED to troubleshoot installation, streamline implementation, and test its operational functionality. An RFID-based RTLS (CenTrak, Newtown, Pennsylvania, United States) was installed in the ED in October 2018 and all staff badging was operational by February 2019. The RTLS-derived data were internally validated with accuracy to within 2 feet with a 3-second delay (range = 1–9 seconds delay). Data transfer to internal servers was also validated and reliable. An operational test was conducted from February to April 2020 in which all patients who arrived in our ED had an RTLS badge immediately attached and were tracked throughout their encounter. This test was designed to refine and solidify the operational choreography required to quickly attach RTLS badges to patients upon arrival and remove the badges upon discharge or admission. We conducted our project in conjunction with this test to take advance of the unique opportunity to precisely co-locate patients with specific physicians throughout their time in the ED. Consent for RTLS tracking was obtained from patients as part of the general consent to treat process.

Our improvement team included three PEM physicians, a coding specialist, a patient registration manager, a nurse manager, and an office administrator. We constructed a key driver diagram to make explicit our framework of improvement (►Fig. 1). Each of these drivers was identified as a component of the care process which may reduce critical

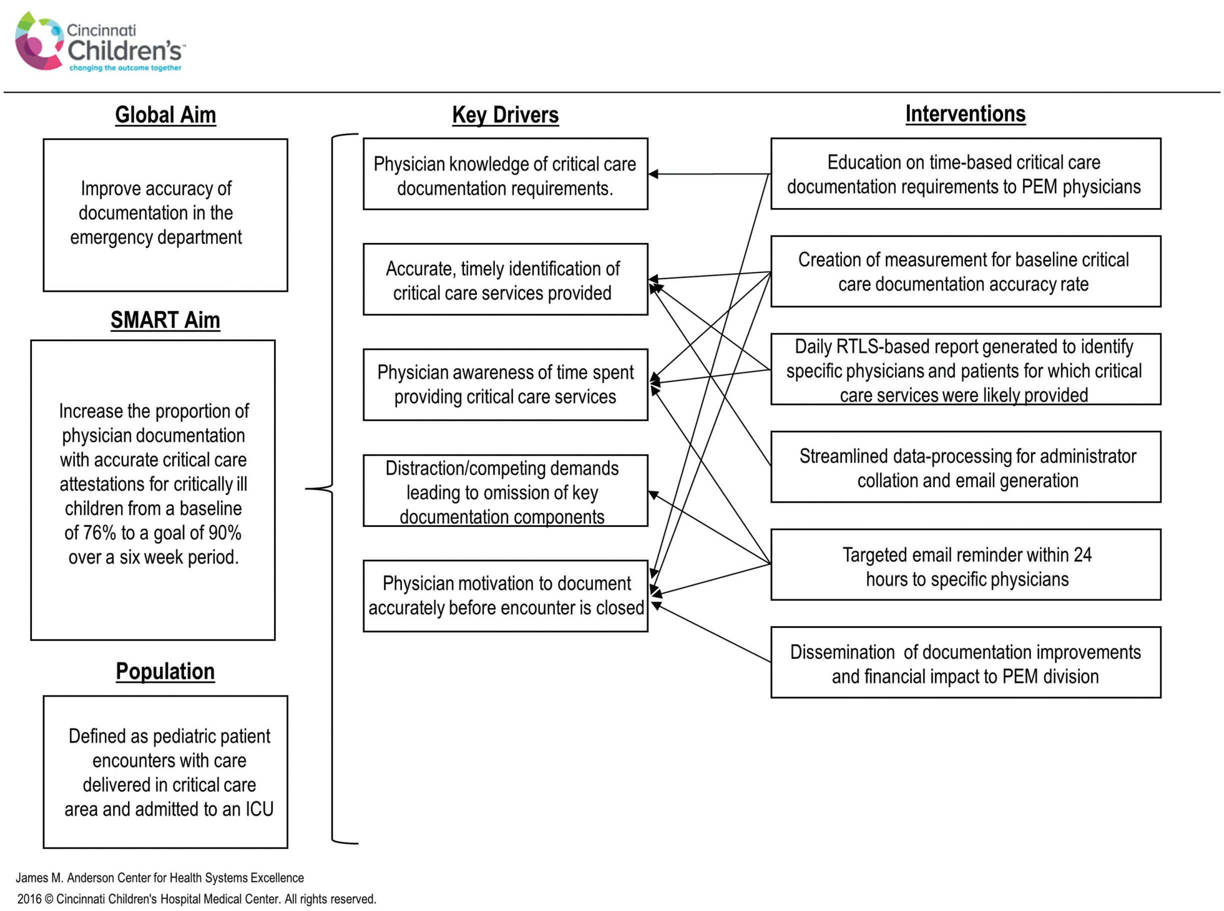

Fig. 1 Key driver diagram of inaccurate critical care documentation. ICU, intensive care unit; PEM, pediatric emergency medicine; RTLS, real-time location system.

care documentation. We used multiple iterative process revisions to design and refine our definitions, data collection, and processes to address these drivers, ultimately resulting in our final email intervention. We collected data during the operational test during which patient geolocation was available to precisely characterize patient encounters, which likely included critical care services and to evaluate our interventions.

We posited that, for patients who were ultimately admitted to an intensive care unit (pediatric ICU, cardiac ICU, or neonatal ICU), physician time spent in close physical proximity to a patient located in the critical care area of our ED would likely represent the minimum amount of time providing CMS-defined critical care. Therefore, we sought to determine the baseline rate of encounters in which physicians spent more than 25 minutes in proximity to critically ill patients in the STS and included a critical care attestation in the EMR. From February 2019 to February 2020, our RTLS capabilities included physician and staff locations but not exact patient location. Therefore, we used the location of the physician in the specific STS room where the patient was located based on EMR and audited charts to determine rates of appropriate documentation. This baseline determination occurred prior to implementation of interventions for this project.

Determination of Critical Care Encounters

Physicians in our division are educated on CMS documentation requirements upon hiring. Reinforcement occurs during routine divisional staff meetings, but review of documentation for critical care encounters was not routinely performed prior to this project. We utilized the expertise of each team member to strategically integrate RTLS capabilities to enhance the process to identify patients who were most likely to have received critical care services. We used iterative process revisions to determine the criteria for time and location, which would capture all the patients who were most likely to receive critical care services while limiting "false positives." We then identified the physicians who were primarily involved in the care provided in the STS, and characterized their RTLS-derived locations were compared with these patients' locations. Most of the critical care for these patients was provided at the bedside but that portions may occur at a separate location (phone calls with consultants, chart review, etc.). Therefore, a 25-minute cutoff captured a portion of encounters with up to 5 minutes of care occurring elsewhere in the ED, thus fulfilling CMS critical care criteria. This strategy under-represented all critical care services provided (patients who expired were not admitted to the ICU, etc). However, given the specific workflow patterns in our ED, the strategy allowed for the most efficient and targeted testing of this RTLS-based project.

Report Generation and Streamlining

The team created an operational process to streamline data collection from multiple sources, including RTLS, scheduling software, and medical records. This process was iteratively refined until we were able to generate a comprehensive daily report outlining all the patients who met the aforementioned criteria and the physicians who likely provided their critical care services for the previous 24 hours.

Email Intervention

For 6 weeks, an administrator reviewed the daily location report and sent a single email to each physician who met the project criteria for critical care services for specified patients. The email was sent only to the identified physicians and included the date of care, names, and medical record numbers of the critical patients, and the duration of time spent in the STS with those patients from the RTLS. The text of the message reminded the physicians to consider if their care constituted critical care as defined by CMS and, if applicable, to ensure their note was documented accurately. To minimize "false-positive" documentation, the email was sent within 1 day of the encounter and explicitly reminded physicians that, ultimately, documentation was at their discretion in accordance with CMS regulations for separately billable procedures (i.e., intubation).

Measures

Our operational definition for our primary process measure is the proportion of patient encounters in which a critical care attestation was appropriately documented by the attending physician. The denominator for this measure was all encounters of patients were treated in the STS and admitted to an ICU and in which the attending physician was co-located with the patient for >25 minutes. The numerator for this measure was encounters in which a specific critical care attestation was documented, which included critical care time spent on patient care, specific functions performed, and patient complexity and risk of morbidity.

Analysis

A P-chart was constructed to analyze the proportion of eligible patient encounters in which critical care was accurately documented. The identified process measure was measured over time on a statistical process control chart to evaluate the impact of the defined intervention. The rules for interpretation of a Shewhart chart were applied to the P-chart to identify special cause variation.[15] We identified characteristics of encounters in which a critical care attestation was likely warranted but not documented.

Results

We evaluated a total of 92 patient encounters during an operational phase in which all patients had their location tracked via RTLS between February 3, 2020 and April 7, 2020. The median proportions of patient encounters meeting inclusion criteria with critical care attestations changed from 76.0 to 84.9% in the postimplementation period, but a change in centerline was not demonstrated (►Fig. 2). In total, 22% of these patients spent more than 30 minutes in the STS, but physicians did not spend more than 25 minutes co-located with them and did not document a critical care attestation.

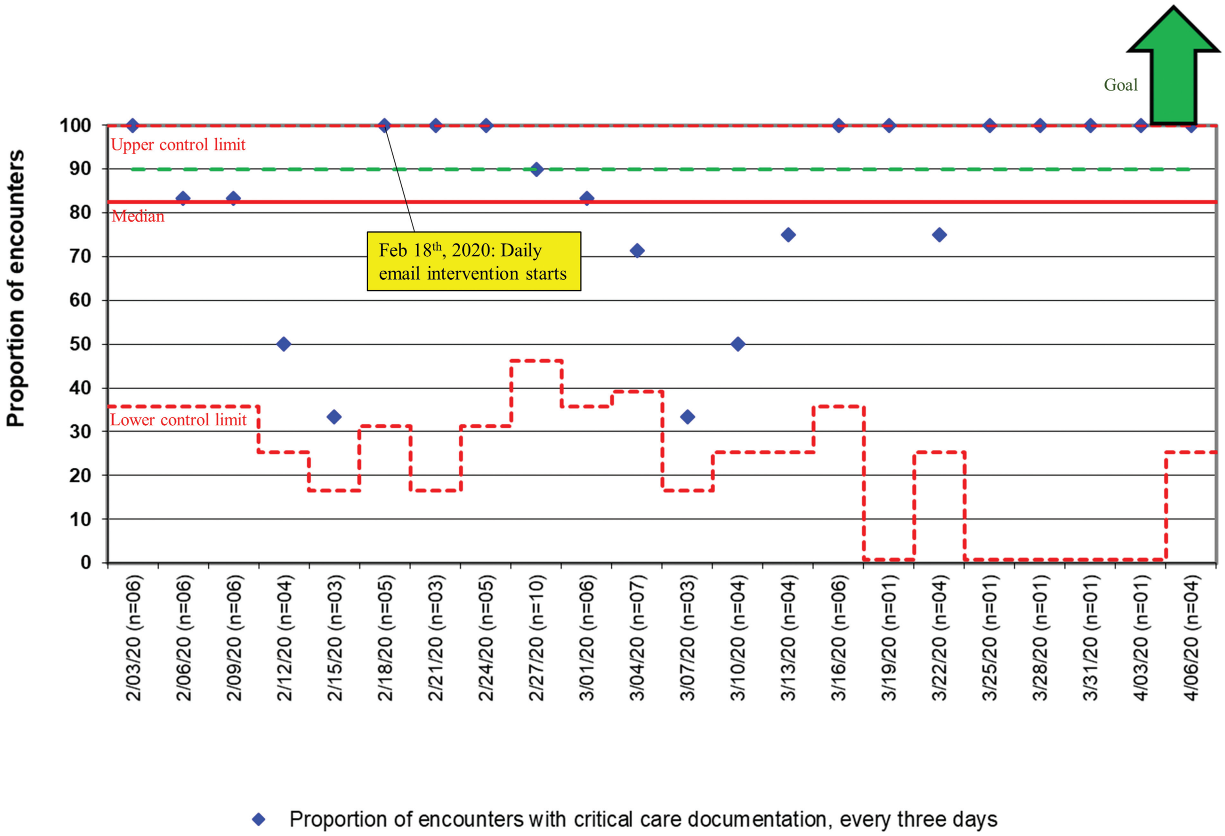

Fig. 2 Proportion of encounters of patients treated in the Shock-Trauma Suite and admitted to a pediatric intensive care unit who had a critical care attestation documented in the medical record (February 2020–April 2020).

Plan-Do-Check-Act Cycle and Iterative Process Revisions

Throughout the project, we performed multiple iterative process revisions to refine RTLS and data management processes (►Fig. 3). The initial revisions focused on configuring RTLS settings to accurately determine the co-location times of critically ill patients and physicians. To efficiently use resources, we initially placed RTLS badges only on patients who received care in the STS in September 30, 2019 to November 7, 2019. This became problematic for registration staff workflow as some patients arrived by car, some arrived by EMS, and some did not immediately require critical care services, creating situations with inconsistent badging. We ultimately utilized a comprehensive workflow for registration staff to place badges on all patients in the ED. Coupled with a standard process to reclaim badges upon patient departure, we were able to increase badges available for cleaning and reuse.

Subsequent revisions were used to refine the criteria to identify patient encounters that likely included critical care services and to efficiently produce the daily report and email intervention. A cutoff time of 25 minutes of identified co-location was used after multiple revisions to broadly capture relevant patient encounters accounting for some critical care time outside of the STS without too many "false positives." Similarly, the email intervention was refined to effectively target relevant physicians while reducing administrator workload. We initially created individual emails to each physician for each patient encounter. However, due to the relative few daily patient encounters, the email was consolidated into one reminder to each specific physician which included all their relevant patients.

A Pareto chart was constructed to display the types of patient encounters in which documentation was most commonly recorded inaccurately. Patients with primary respiratory complaints accounted for the most common type of encounter with inaccurate critical care documentation (►Fig. 4).

Discussion

Summary and Interpretation

We integrated RTLS with improvement methodology to design, refine, and evaluate the effect of interventions on critical care documentation. The inadvertent omission of key components of time-based documentation for critical care services in the ED may lead to inaccurate CPT coding and reduced reimbursement. Maximizing appropriate reimbursement for patient care is paramount to the fiscal sustainability of health care facilities nationwide, especially in economically challenging times. While we did not show a change in the centerline of the proportion of encounters with critical care documentation, we successfully developed, defined, and integrated an RTLS-based system to efficiently identify applicable encounters and remind physicians to evaluate that encounter for critical care services performed.

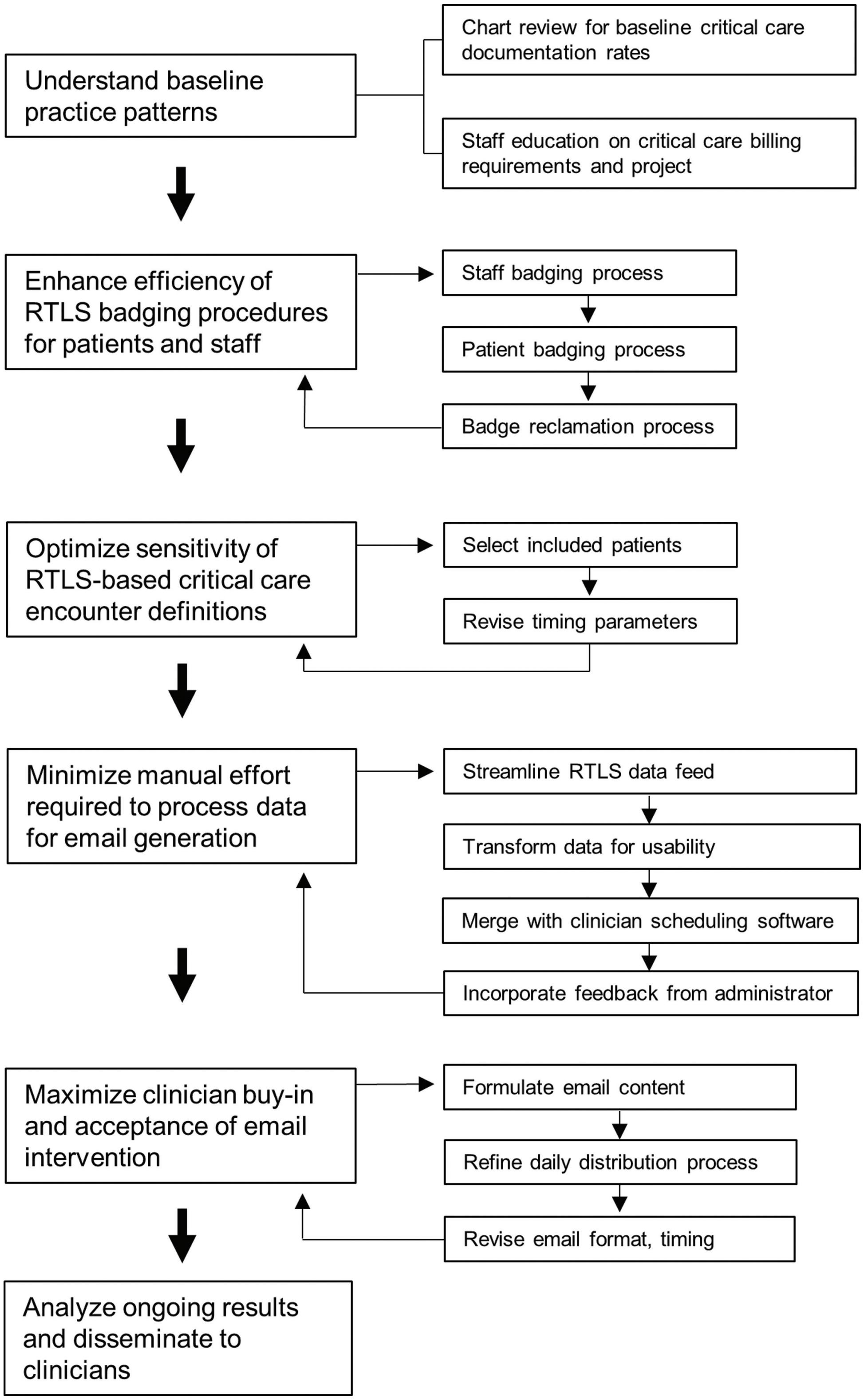

Fig. 3 Flow chart of iterative process revisions.

During the postintervention period, the COVID-19 pandemic dramatically decreased patient volumes, changed ED workflow, and ultimately ended our project. While we did not show special cause variation in our primary outcome, we are encouraged by the operational success of the project, positive feedback from clinicians, and the trajectory of our results. In a short-time period, we demonstrated the potential for effective interventions and the implications for similar RTLS applications in various healthcare environments.

In addition to a growing volume of critically ill patients, EM physicians are also providing more critical care services in the ED.[16,17] There is increasing emphasis on appropriate

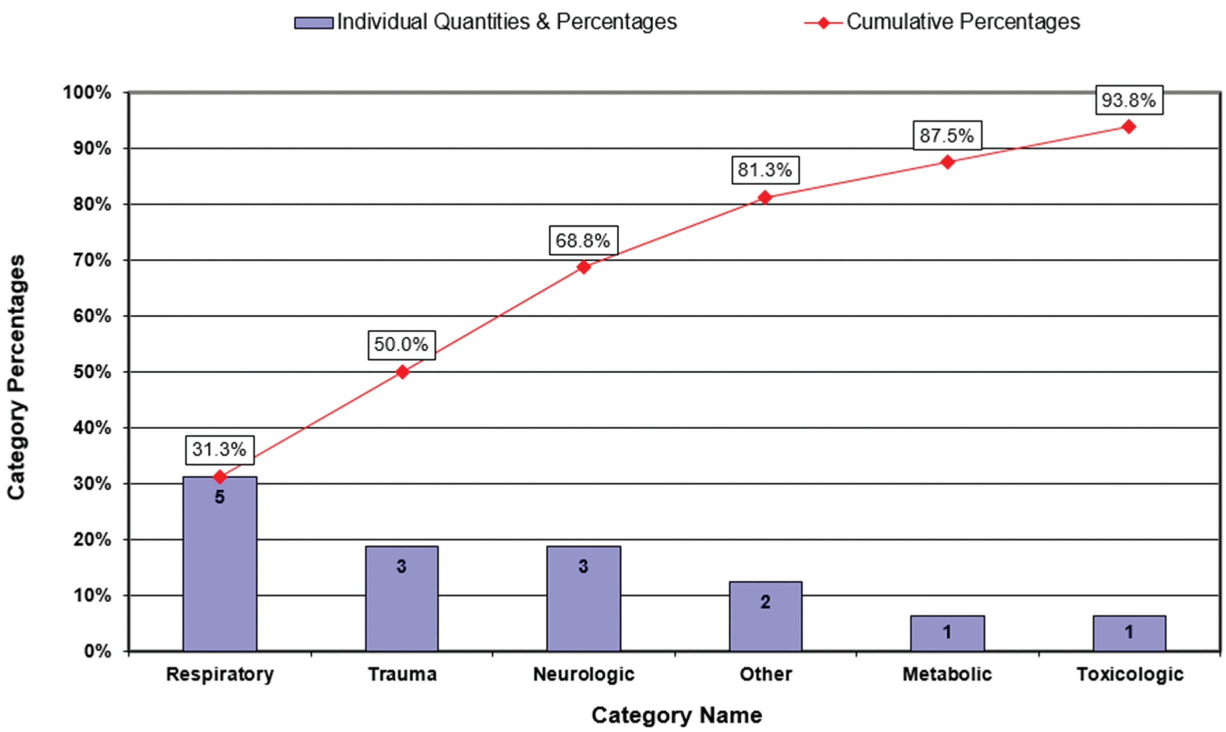

Fig. 4 Pareto chart of patient category for inaccurate critical care documentation (February 2020–April 2020, $n = 15$).

documentation to capture these services and accurately describe mortality and morbidity characteristics of these populations. Prior clinical documentation improvement programs have focused on standardizing documentation, physician education, and auditing.[18] Elkbuli et al found improved accuracy in mortality, case mix index, and severity of illness after program implementation in a trauma service.[19] Kittinger et al showed desirable results after a similar improvement effort in a plastic surgery practice. Other improvement projects focused on intensive documentation education and concurrent auditing for trauma and critical care physicians.[20,21]

While these projects successfully achieved their improvement goals, they required expensive and time-consuming educational sessions and retrospective team auditing. We were able to perform a focused intervention utilizing a novel technology to augment usual coding education and practices.

Improvement projects focusing on the electronic medical record have improved documentation efficiency, coding completion, and improved reimbursement.[22,23] Utilizing the benefits of automation through electronic data capture can remove some of the cognitive burden from physicians.[24,25] King et al demonstrated the utility of an RTLS-equipped EMR to improve performance in locating patients and increase physician efficiency interacting with the EMR.[26] Our project demonstrated an effective method to automate components of critical care documentation, which usually falls to the individual physician: the perception of time and proactively documenting that time in the chart.

We used a Pareto chart to display the patient categories in which the proportion of inaccurate documentation was most common. While not directly related to our stated outcomes, these data demonstrate that patients treated for critical abnormalities of the respiratory system were most commonly inadequately documented. This is expected, as disorders of the respiratory system are a frequent reason to treatment in the pediatric ED. Our findings may inform further targeted efforts and highlight the need to help physicians accurately identify the critical care time they spend on services for common conditions with a wide range of severity. Additionally, the RTLS-based processes developed in this project have the potential to augment traditional process related analyses. While this study was not powered for more detailed analysis, future investigation of the patient–physician dyad, predictors of documentation errors and patient experience with RTLS-based processes may be warranted.

Strengths

In this focused quality improvement initiative, we utilized a novel application of RTLS to provide targeted, timely, and specific documentation support to EM physicians in a tertiary care pediatric ED. Multiple iterations of intervention refinement resulted in an automated report, requiring minimal staff efforts to create daily emails to physicians. We reduced "false positive" emails by 22% utilizing patient–physician co-location metrics compared with patient-only metrics. Ultimately, we postulate that intervention provided specific feedback to individual physicians regarding patients they had recently treated, allowing them to easily adjust their documentation as appropriate. While our results did not result in a centerline shift to demonstrate special cause variation, this pilot work demonstrates the feasibility of RTLS-based interventions. With additional data collection after workflow "normalization" postpandemic, we expect centerline shift.

This work has significant financial implications. For critical care services provided, the targeted intervention described would increase the coded work relative value unit from 3.80 to 4.50 (99285–99291). For emergency departments providing 5 to 8% of patients with critical care services with annual volumes of 100,000 patients per year, this intervention would result in $120 000 to $202 000 of additional professional billable services.[27] These cost savings must be balanced against the significant financial investment in RTLS installation and maintenance. The costs to install and maintain widespread RTLS in clinical setting vary widely. These costs can be significant and include setup (hardwired equipment costs, and installation work) and maintenance (ongoing RFID tag purchasing, software licensing, and system updates, personnel management) costs. To provide adequate coverage, reliability, and precision in our ED of 42 patient rooms, four critical care bays, and three staff work areas, RTLS installation costs totaled over $270,000. Hardware installation and wiring cost $114,000, software setup cost $70,000 and badges, parts and equipment cost $84,000. While these systems can also assist in asset management, inventory management, and supply chain logistics, operational leaders must incorporate large initial investment with expected long-term cost savings. This project demonstrates potential return on investment when thoughtfully applying RTLS to clinical operations.

While this project was conducted in a pediatric ED, there are numerous lessons learned that are applicable to broader contexts. We confirmed that documentation of time-based care is difficult, and there is a need for objective time-based measurements and feedback. Specific, timely and targeted feedback is effective and well received when coupled with a demonstrable outcome measure. In a dynamic clinical environment, accurate measurement of co-location of patients and physicians via RTLS depends on precise tracking of both parties. We found that thoughtful planning was needed to strategically apply RTLS capabilities to clinical workflow, thereby maximizing benefit and adapting to system limitations.

This study provides proof of concept for the value of RTLS to objectively measure time-based clinical activities for quality improvement. Future work is needed to further refine these processes and create fully automated RTLS-based documentation support to accurately capture and communicate critical care services.

Limitations and Lessons Learned

Our work has several limitations. It was performed at a large tertiary pediatric ED with an operational RTLS that may limit generalizability. Physicians do not need to be physically proximate to patients to perform critical care services. Other tasks such as consultation with experts may take place away from the bedside. While this certainly has the potential to impact our results, aspects of our work blunt this limitation. We strategically chose a threshold of 25 minutes to reasonably include all patient who most likely had critical care services performed, based on local practice patterns and workflow. This threshold effectively serves as a minimum requirement for a patient encounter and thus would be included in our email intervention. Physicians could then decide after receiving feedback whether they performed critical care services and could adjust their documentation as needed. This threshold could easily be adjusted to account for various workflow patterns and optimize the sensitivity of the intervention.

We did not consider patients treated outside of the critical care area of the ED, and it is possible that some patients received critical care services in regular ED rooms. Thus, as our measurement of location serves as a proxy for our primary outcome, the scalability and generalizability of our work is limited. We did not follow up directly with physicians to determine their reasons for documentation decisions, as our objectives were primarily to test the effectiveness of a partially automated intervention with minimal staff efforts. While it is possible that our results could be skewed by a small group of physicians contributing to documentation inaccuracies due to their own style, our analysis showed only one instance of a single physician with two encounters with inaccurate documentation. We were unable to evaluate the long-term effects of our intervention due to drastic changes in the ED workflow due to the COVID-19 pandemic. However, our work has produced an RLTS-based process of identification of critical care services provided in an ED to be used in future QI work.

Key lessons learned may be applied to RTLS applications in other zone-based care environments, including EDs and ICUs. Intervention design requires intimate knowledge and consideration of local workflow patterns and physician practices. The completeness of RTLS linkage to services provided in various areas may be improved by considering clinical resources used, orders, and patient complaints and acuity. While documentation decisions are ultimately at the discretion of clinicians, thoughtful nonintrusive co-locating feedback can be helpful when provided in an efficient and timely manner. Finally, the costs associated with RTLS installation and operation can be significant. While the cost-effectiveness of any single RTLS application may not be sustainable, when developed in a concerted effort to complement an overall RTLS implementation plan, these applications may provide value for patients, clinicians, and hospital systems.

Conclusion

Implementation of a quality improvement initiative utilizing RTLS created timely, specific and targeted physician feedback for critical care services provided for pediatric ED patients who were admitted to an ICU.

Clinical Relevance Statement

This study describes a quality improvement project to improve critical care documentation in an emergency department by integrating quality improvement methodology with geolocation data from a real-time location system. This strategic integration improved the precision of an audit and feedback intervention to efficiently target physician reminders and minimize unnecessary interruptions. When thoughtfully applied, RTLS-derived data can augment quality improvement methods to successfully improve health care delivery.

Multiple Choice Questions

1. Real-time location systems can augment quality improvement methodology by:
   a. Providing objective geolocation information to inform specific targets for interventions and selected outcome measurement
   b. Replacing improvement team planning and plan-do-check-act (PDSA) cycles
   c. Reducing time requirements for data analysis
   d. Circumventing staff acceptance of time-based measurements

   Correct Answer: The correct answer is option a. RTLS-derived data can enhance quality improvement initiatives after carefully planning and application of relevant geolocation data to clinical workflows and human interactions. Successful application depends on this careful application, which requires an improvement team and PDSA cycles to optimize. Analysis of RTLS data can be time intensive and requires staff acceptance to smoothly integrate into operations and improvement work.

2. Barriers to accurate clinical care documentation include:
   a. Ambiguous definitions of critical care as outlined by CMS
   b. Perception of time spent accomplishing a task in a stressful environment
   c. Extensive physician knowledge of billing codes associated with critical care
   d. Extended time passage between service provision and completion of documentation

   Correct Answer: The correct answer is option b. Critical care documentation is dependent upon providers understanding the CMS definitions of critical care, recognizing the need for documentation of their services, and remembering to document the time spent providing services retrospectively. The CMS definitions of critical care are explicitly outlined within published billing and coding, and providers must be familiar with the definitions of "critical care" services to appropriately document. Though some institutions require providers to complete their own coding and billing, this is not a universal requirement, and most institutions provide coding and billing specialists to complete this task or consult if there are questions. Critical care is documented retrospectively in all cases, and evidence shows that stressful environments can alter a person's perception of the passage of time. Documentation of services must be completed "during, or as soon as practicable after it is provided in order to maintain an accurate medical record," per the 2019 update to CMS Medicare Claims Processing Manual Chapter 12 (physicians/nonphysician practitioners).

Protection of Human and Animal Subjects

Activities in this project conducted solely for quality improvement purposes were deemed QI and did not require further institutional review board review.

Author Contributions

K.M.O., L.B., and S.C.P. conceived the study and framework of improvement. L.B. developed data collection processes. K.M.O., L.B., and S.C.P. iteratively refined the quality improvement interventions. K.M.O. and L.B. collected data and analyzed results. K.M.O. drafted the manuscript and all authors contributed substantially to its revision. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Conflict of Interest

None declared.

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References

1 Yu AYX, Quan H, McRae AD, Wagner GO, Hill MD, Coutts SB. A cohort study on physician documentation and the accuracy of administrative data coding to improve passive surveillance of transient ischaemic attacks. BMJ Open 2017;7(06):e015234
2 Aiello FA, Judelson DR, Durgin JM, et al. A physician-led initiative to improve clinical documentation results in improved health care documentation, case mix index, and increased contribution margin. J Vasc Surg 2018;68(05):1524–1532
3 Wiler JL, Poirier RF, Farley H, Zirkin W, Griffey RT. Emergency severity index triage system correlation with emergency department evaluation and management billing codes and total professional charges. Acad Emerg Med 2011;18(11):1161–1166
4 Cohen GR, Friedman CP, Ryan AM, Richardson CR, Adler-Milstein J. Variation in physicians' electronic health record documentation and potential patient harm from that variation. J Gen Intern Med 2019;34(11):2355–2367
5 Medicare Claims Processing Manual CMS. 100–04, Chapter 12: section 30.6.12 H. CMS manual system 2019. Accessed June 19, 2020 at: https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/Downloads/clm104c12.pdf
6 Eagleman DM. Human time perception and its illusions. Curr Opin Neurobiol 2008;18(02):131–136
7 Grommet EK, Droit-Volet S, Gil S, Hemmes NS, Baker AH, Brown BL. Time estimation of fear cues in human observers. Behav Processes 2011;86(01):88–93
8 Berdahl CT, Moran GJ, McBride O, Santini AM, Verzhbinsky IA, Schriger DL. Concordance between electronic clinical documentation and physicians' observed behavior. JAMA Netw Open 2019; 2(09):e1911390–e1911390
9 Novak LL, Anders S, Unertl KM, France DJ, Weinger MB. Improving the effectiveness of health information technology: the case for situational analytics. Appl Clin Inform 2019;10(04):771–776

10 Kamel Boulos MN, Berry G. Real-time locating systems (RTLS) in healthcare: a condensed primer. Int J Health Geogr 2012;11 (01):25
11 Berg B, Longley G, Dunitz J. Improving clinic operational efficiency and utilization with RTLS. J Med Syst 2019;43(03):56
12 Conley K, Chambers C, Elnahal S, et al. Using a real-time location system to measure patient flow in a radiation oncology outpatient clinic. Pract Radiat Oncol 2018;8(05):317–323
13 Hornyak R, Lewis M, Sankaranarayan B. Radio frequency identification-enabled capabilities in a healthcare context: an exploratory study. Health Informatics J 2016;22(03):562–578
14 Martínez Pérez M, Cabrero-Canosa M, Vizoso Hermida J, et al. Application of RFID technology in patient tracking and medication traceability in emergency care. J Med Syst 2012;36(06): 3983–3993
15 Provost LP, Murray S. The Health Care Data Guide: Learning from Data for Improvement. Jossey-Bass; 2011
16 Herring AA, Ginde AA, Fahimi J, et al. Increasing critical care admissions from U.S. emergency departments, 2001-2009. Crit Care Med 2013;41(05):1197–1204
17 Mullins PM, Goyal M, Pines JM. National growth in intensive care unit admissions from emergency departments in the United States from 2002 to 2009. Acad Emerg Med 2013;20(05):479–486
18 Kulkarni D, Heath J, Kosack A, Jackson NJ, Crummey A. An educational intervention to improve inpatient documentation of high-risk diagnoses by pediatric residents. Hosp Pediatr 2018;8(07):430–435
19 Elkbuli A, Godelman S, Miller A, et al. Improved clinical documentation leads to superior reportable outcomes: an accurate representation of patient's clinical status. Int J Surg 2018; 53:288–291
20 Fox N, Swierczynski P, Willcutt R, Elberfeld A, Mazzarelli AJ. Lost in translation: Focused documentation improvement benefits trauma surgeons. Injury 2016;47(09):1919–1923
21 Frazee RC, Matejicka AV II, Abernathy SW, et al. Concurrent chart review provides more accurate documentation and increased calculated case mix index, severity of illness, and risk of mortality. J Am Coll Surg 2015;220(04):652–656
22 Parwaiz H, Perera R, Creamer J, Macdonald H, Hunter I. Improving documentation in surgical operation notes. Br J Hosp Med (Lond) 2017;78(02):104–107
23 Silfen E. Documentation and coding of ED patient encounters: an evaluation of the accuracy of an electronic medical record. Am J Emerg Med 2006;24(06):664–678
24 Pan HY, Shaitelman SF, Perkins GH, Schlembach PJ, Woodward WA, Smith BD. Implementing a real-time electronic data capture system to improve clinical documentation in radiation oncology. J Am Coll Radiol 2016;13(04):401–407
25 Pasalic D, Reddy JP, Edwards T, Pan HY, Smith BD. Implementing an electronic data capture system to improve clinical workflow in a large academic radiation oncology practice. JCO Clin Cancer Inform 2018;2:1–12
26 King K, Quarles J, Ravi V, et al. The impact of a location-sensing electronic health record on clinician efficiency and accuracy: a pilot simulation study. Appl Clin Inform 2018;9(04):841–848
27 CY 2020 Physician fee schedule final rule. CMS-1715-F 2020. Accessed June 19, 2020 at: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeeSched

