INTRODUCTION

Fractures of the small finger metacarpal neck, or “boxer’s” fractures, account for 20% of all hand fractures.1–3 These injuries are often sustained by young males striking an object with a closed fist.4 Classically, these fractures are treated nonoperatively with closed reduction and immobilization if angulation is <30 degrees without rotational deformity or shortening.5,6 The concern is that residual angulation at the fifth metacarpal may leave patients with discomfort and aesthetic complaints.7,8 A recent review by Dunn et al9 debunked this theory; the authors contend that given acceptable short- and long-term outcomes, it is reasonable to pursue nonoperative treatment for up to 70 degrees apex dorsal angulation without a rotational deformity. These authors also demonstrated that the evidence suggests a soft wrap with buddy taping the fourth and fifth digit without reduction yields equivalent results to closed reduction and splint treatment.9 Therefore, this approach to small metacarpal neck fracture management presents an opportunity to improve healthcare efficiency and expenditures. Efforts to minimize healthcare costs while providing quality care are at the forefront of many healthcare organizations. The purpose of our study was to implement a quality improvement (QI) intervention to shift the paradigm of management toward Velcro ulnar gutter brace treatment for pediatric metacarpal neck fractures resulted in a shift away from cast immobilization in >65% of patients, reducing risks and expenses of cast immobilization. (Pediatr Qual Saf 2019;4:e212; doi: 10.1097/pq9.0000000000000212; Published online 30 August, 2019.)

MATERIALS AND METHODS

Context

We applied a QI intervention in a large, urban, academic pediatric hospital with a high-volume orthopedic department, dedicated orthopedic trauma block, and a Level 1 trauma center. The intervention employed methods...
described by the Institute for Healthcare Improvement, including Failure Mode and Effects Analysis,11 Key Driver Diagram, and Plan-Do-Study-Act cycles12 to increase rates of bracing pediatric metacarpal neck fractures. The QI team was comprised of multiple different roles: the QI project lead (who also serves as the director of QI for the department of orthopedic surgery); the department of emergency medicine physician leadership; orthopedic staff managing patients in the emergency department; the lead cast technician for the orthopedic department; and 1 rotating PGY-4 orthopedic resident. Previous studies and literature were used to build this project of updating our practice to match current evidence-based practice and save healthcare costs.9,10,13–16

As this was a QI project that implemented evidence-based interventions and did not involve patient randomization or the sharing of patient data outside of the institution, it did not require institutional review board review and approval per policy. As part of the root cause analysis, we surveyed providers to determine why clinicians were not yet utilizing bracing. Their greatest concern was primarily that of patient compliance. Through discussion in educational sessions, some providers revealed they were reluctant to discontinue casting because casts are more difficult to remove, and therefore ensured adherence to treatment. We addressed these concerns primarily through education of both providers and families, as the literature suggests that fracture immobilization itself is an unnecessary intervention for these injuries.9,10,13–16 The literature also supports the notion that a removable soft wrap (comparable to our Velcro brace) offered greater comfort, so we believed that nonadherence would be a low concern.

Intervention
Review of our electronic medical records identified patients who had been diagnosed with a small finger metacarpal neck fracture. We then investigated whether they received a reduction/cast, reduction/splint, cast, brace, or “other” as their primary intervention. Our SMART (Specific, Measurable, Actionable, Relevant, Time-bound) aim was to increase the percentage of patients with these injuries treated with a removable Velcro ulnar gutter brace presenting to the orthopedic outpatient clinics from a baseline of 0% to >50% by December 2017 and to sustain this increase through December 2018. Our global aim was to establish a change in practice by applying evidence-based medicine to decrease unnecessary costs to patients and families while not sacrificing clinical outcomes. We identified 4 key drivers in the Key Driver Diagram needed to achieve our SMART Aim (Fig. 1). Finally, we employed Failure Mode and Effects Analysis to ascertain potential areas of process failure, consequences of failures, and ways to avoid these avenues of failure during implementation.

Intervention Measures:

**Outcome Measure:** Increase the percent of patients with small metacarpal neck fractures treated with a removable Velcro ulnar gutter brace presenting to the orthopedic clinics from a baseline of 0% to >50% by December 2017 and sustain until December 2018.

**Process Measure:** Increase provider compliance with the new bracing protocol from 0% to >50% by December 2017 and sustain through December 2018. (This measure was based on the number of providers who followed the new protocol for these patients and was evaluated by a retrospective review of encounter data. These charts are not included in this article as they were nonblinded so they would not be appropriate to publish.)

**Balancing Measure:** Number of patients who return to the orthopedic clinic, emergency department, or urgent care with a brace or injury-related concerns within 30 days of brace application.

Education
An important aspect of the intervention was education for the rotating orthopedic residents, emergency medicine providers, radiology colleagues, and orthopedic attendings. We reinforced the recognition of small finger metacarpal neck fractures and sought to change the perception that reduction and casting must be performed for these injuries. We disseminated the available evidence suggesting that these fractures have good outcomes with minimal intervention, and we discussed our aim to manage these patients with a removable Velcro ulnar gutter brace without any reduction, and eliminate the repeat follow-up radiographs.

Equipment and Supplies
Availability of the Velcro ulnar gutter brace was paramount. These braces were previously never utilized in our institution, and we had to obtain approval for their use and purchase. Our lead cast technician also worked with a new vendor and determined which sizes we should use and purchase. Our lead cast technician also worked with a new vendor and determined which sizes we should obtain. We reviewed stocking procedures and policies to verify that there was a process in place to stock and maintain an adequate supply of braces to minimize barriers to care.

Throughout this process, we adapted and modified our method of distribution. We also continued to provide education and reminders regarding our intervention.

Intervention Analysis
A 40-month period of data collection began in October 2015. We tracked the total number of patients presenting each month with a small metacarpal neck fracture, as well as the number treated with the Velcro ulnar gutter brace. Monthly percentages of those treated by the brace are illustrated using a p-chart (Fig. 2) comparing the percent of mean noncast immobilizations with the total number of patients with small metacarpal neck fractures over time. Starting December 2016, our department initiated the campaign to use the Velcro ulnar gutter brace as definitive treatment for small metacarpal neck fractures. The
**Key Drivers**

- Availability of Velcro ulnar gutter brace in the clinical setting
- Improved recognition of boxer’s fractures as a fifth metacarpal neck fracture by providers
- Evolution of dogma that reduction and casting must be performed for these injuries
- Assessment of degrees of angulation and rotational deformity to identify patients meeting inclusion criteria

**Interventions**

- Stocking procedures and policies reviewed to confirm established process to stock and maintain a sufficient supply of braces
- Education for orthopaedic residents, emergency medicine providers, and radiology staff
- Dissemination of existing literature supporting the notion that these injuries achieve good outcomes with minimal intervention
- Implement site specific reminders to increase adherence of protocol among providers involved

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**Fig. 1.** Key driver diagram.

**Fig. 2.** Control chart/P-chart.
Reducing Healthcare Costs

campaign and literature supporting this treatment protocol were reiterated multiple times throughout our intervention to remind orthopedic faculty and house staff, emergency medicine physicians, and other providers. We held training sessions for each new group of residents who joined the orthopedic service. We also spent time throughout the project seeking feedback from providers on any barriers to implementation, and any reservations they might have to the adoption of the new protocol.

The Velcro ulnar gutter brace offers advantages such as:

1. Ease in implementation, as the straightforward nature of their application did not require extensive training for providers or parents.
2. Standardization, as this ensured minimal variability in use between patients.

More importantly, the emphasis of the intervention was the absence of closed reduction and cast immobilization, as well as repeat radiographs. The literature strongly supports the notion that metacarpal neck fractures do not require casting.

The balancing measure used in this effort was the number of patients who returned to the orthopedic clinic, emergency department, or urgent care with a concern related to their injury or the Velcro ulnar gutter brace.

Ethical Implications

Because multiple studies have demonstrated equivalent results with splinting, casting, or no immobilization,9,10,13–16 our multidisciplinary team felt that brace immobilization was an acceptable treatment option, and should not negatively impact patient outcomes. While we do not provide strong evidence that the clinical outcomes are equivalent in this particular study, this intervention relies on previous randomized clinical trials demonstrating that the alternative treatments are noninferior. And the emphasis of our study was that through education, it was possible to create a shift in practice and therefore, decrease costs.

RESULTS

Between October 2015 and January 2019, 312 pediatric patients presenting with a small metacarpal neck fracture met the guidelines for bracing without reduction. Most patients were adolescents and were approaching skeletal maturity (Fig. 3). Before this intervention, patients were reduced, cast immobilized, and followed radiographically for a minimum of 2 orthopedic follow-up visits, generating $916.25 per our institutional charges and billing department. These charges excluded the initial evaluation, as both of these factors were equal for the Velcro ulnar gutter brace group and cast group.

From October 2015 to November 2016, we treated <1% (1/142) of patients with metacarpal neck fractures without casting. With the transition of protocol from December 2016 to January 2019, we observed special cause variation in the primary outcome measure, which was the percentage of patients treated with a Velcro ulnar gutter brace instead of reduction and cast immobilization. This measure increased to 54.5% (90/165 patients), with a process mean shift to >65%. Analysis of the statistical process control chart used for the outcome measure in this study indicated significant process shifts related directly to the annotated interventions (Fig. 2). There is some inherent variation attributed to relatively small patient volumes, but all points remained within control limits.17

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![Age Group Percentages of Small Finger Metacarpal Fracture Patient Population October 2015 – January 2019](image)

Fig. 3. Age groups of QI initiative patients
The basis of this study is that prior studies supported quality and care components of the intervention, allowing our providers to reasonably expect that they did not compromise care despite not following up with the patient—which were central to cost reduction. These patients undergoing bracing also did not have a scheduled orthopedic follow-up or further radiographic evaluation. As a balancing measure, we reviewed all of the patients in the 5 months with the highest bracing compliance and discovered only 1 patient had returned to an urgent care, albeit for syncope not related to his injury.

After the initial evaluation, the only cost billed to the patient’s family or insurance was for the Velcro ulnar gutter brace. In the first 26 months of implementation, this QI saved a total of 261,846 healthcare dollars.

DISCUSSION
As rising healthcare costs become an ever-present challenge, efforts should be taken to seek avenues to decrease costs while not compromising quality patient care. One such avenue is the management of small metacarpal neck fractures, as they are common injuries to the hand. Management of these injuries has evolved over the last several decades. In 1957, Lord detailed intramedullary fixation without mention of angulation or rotational deformity. In 1964, Butler described operative management for every displaced fracture.

In contrast, Arafa et al concluded that these fractures could achieve good outcomes without the need for reduction or immobilization as long as rotational alignment is maintained. It is generally accepted that any amount of rotational deformity should be corrected, but the degree of angulation for which repositioning is required is more controversial, ranging anywhere from 20 to 70 degrees.

A biomechanical study concluded that 30 degrees is the upper limit for acceptable final angulation, as it resulted in a satisfactory flexor digiti minimi grip strength and digital range of motion. More recently, Dunn and colleagues, systematic review of clinical studies randomizing cast immobilization versus soft wrap without reduction concluded that angulation up to 70 degrees is acceptable for conservative treatment without reduction and cast immobilization. Moreover, the authors concluded that these treatments (cast immobilization versus soft wrap without reduction) are equivalent. With robust literature suggesting opportunities for cost reduction in this area, we investigated the practices employed at our institution and launched a QI intervention.

Before our intervention, bracing was rarely used to manage small metacarpal neck fractures at our institution despite compelling evidence suggesting its efficacy and cost-effectiveness. This practice may be due, in part, to the lack of awareness of recent literature among our providers and/or the reluctance to shift from an established management modality. Some providers were reluctant to transition, as they did not think patients with these injuries would wear the brace and viewed the cast as a safer option.

By identifying these barriers, we may help address them appropriately, and consequently increase rates of bracing, further decreasing the overall healthcare cost burden. By educating the orthopedic surgery and emergency medicine staff, the rates of brace treatment did increase to >65%. We were able to avoid charges of $839 and decrease overall healthcare spending by $261,846. This analysis did not include cost savings from time off employment and transportation. We should note that the cost of the brace used in these interventions increased between 2017 and 2018, but even with this increase, this method of treatment still avoided $766 in charges per patient.

There are notable limitations to this QI study. Although our intervention eliminated the need for follow-up appointments in the clinic, there was no standardized method to assess patient satisfaction with the brace. Based on substantial evidence in existing literature, both short- and long-term outcomes are equivalent between the treatments in terms of the range of motion, perception of pain, and patient satisfaction. However, we did not confirm these variables in our specific patient population, given the format of the intervention. No patients returned for repeat evaluation or change in treatment management. It may have been possible that patients presented to their primary care physician or clinics outside of our institution's network for reinjury or complications from management. We did not call patients or their families to investigate.

Additionally, a proportion of the patients who received casting in place of the Velcro ulnar gutter brace treatment did so for a few reasons, including family preference or the requirements of a juvenile-detention facility or group therapy home. This fact lowers our ratio, as we could not include these patients in the Velcro ulnar gutter brace compliance volumes.

In conclusion, a QI initiative emphasizing Velcro ulnar gutter brace treatment for pediatric metacarpal neck fractures with <70 degrees angulation and without significant rotational deformity resulted in a shift away from cast immobilization in the majority of patients. This practice can significantly reduce costs not only to patients but also decrease the overall healthcare cost burden.

DISCLOSURE
The authors have no financial interest to declare in relation to the content of this article.

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