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INJURY PREVENTION *and* CONTROL

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On the cover: The Rhode Island Hospital Injury Control COBRE supports the development of independent researchers to lead rigorous, innovative injury control research that changes practice and improves health. [LIFESPAN INJURY CONTROL COBRE: HTTPS://WWW.LIFESPAN.ORG/CENTERS-SERVICES/INJURY-CONTROL-COBRE]

Injury Prevention and Control: Mitigating Risk, Adopting Protective Strategies

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GUEST EDITOR

Injury has a dominant role in our nation's health. It is the leading cause of death in ages 1–44 and is one of the top ten causes of death in all age groups. In 2021, the Centers for Disease Control and Prevention (CDC) reported there were 306,086 fatal injuries nationally, but the scope of the injury problem is much greater, with approximately 40 million emergency department visits for injury and additionally over 57 million physician office visits. In 2019, the cost of caring for injury was estimated to be 4.2 trillion dollars. The CDC reports that our small state had 1,044 fatal injuries and the Rhode Island Department of Health reported 62,845 injury-related emergency department visits in 2022.

Injuries are frequently referred to as accidents, but that gives the impression that they are random events or bad luck that cannot be managed. Instead, like other diseases, injury has risk and protective factors to its occurrence. Although difficult to be immune from any injury, it can be controlled with mitigation of risk and adopting protective strategies that can stop its occurrence or minimize the resultant injury. For over 25 years, the Injury Prevention Center at Rhode Island Hospital has utilized community outreach, education, and research to control injury in Rhode Island. In April 2022, we were awarded NIH funding to create the Rhode Island Hospital Injury Control Center of Biomedical Research Excellence (COBRE). This augmented our ongoing research in allowing us to develop early career faculty researchers across the spectrum of injury control research that includes prevention, optimal treatment of injury, and rehabilitation and post-injury sequalae.

This issue of the *Rhode Island Medical Journal* addresses several topics of injury-control research across the lifecycle. **DR. DANIEL ANTONSON** et al examine using a frailty tool for older fall trauma patients in predicting inpatient mortality. **DR. JILLIAN E BEVERIDGE** et al discuss a new procedure for repair of anterior cruciate ligament (ACL) injury, and novel tools for the measuring of neurovascular function that could aid clinical decision-making. **DR. MARTHA ORMANOSKI** and **DR. SUSAN DUFFY** discuss the importance of safe sleep practices in preventing sudden infant death syndrome with the youngest members of the community. Unfortunately, some injuries are intentionally inflicted and **ALEKSA M. KAYE** et al reports on emergency department nursing screening for potential child abuse. **DR. MARY KATHRYN CANCILLIERE** et al explore the acceptability and feasibility of a navigator program with text messages in connecting self-injurious youths discharged from the emergency department to outpatient mental health care. **DR. J. AUSTIN LEE**'s team research takes us to Kenya and presents data on interpersonal violence among those seeking emergency care.

The burden of injury is substantial but through research we will continue to seek improved strategies for prevention, treatment, and rehabilitation to control injury's impact on us.

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The Modified Five-Item Frailty Index, Mortality, and Hospital Length of Stay in Geriatric Traumatic Fall Injuries

DANIEL ANTONSON, MD, MSc; JULIE BROMBERG, MPH; STEPHANIE LUECKEL, MD; MICHAEL J. MELLO, MD, MPH

ABSTRACT

This study investigates the association between frailty, measured by the modified five-item frailty index (mFI-5), with inpatient mortality and hospital length of stay for geriatric patients with fall-related injuries. Despite falls being major contributors to morbidity and mortality in those over 65, the interaction between frailty and post-fall outcomes remains underexplored. Data for patients aged 65 and above, admitted between 2014–2020 to Rhode Island Hospital's trauma service for fall-related injuries, were extracted from its Trauma Registry. Frailty scores were retrospectively assigned using mFI-5. Logistic- and linear-regression analyses examined the relationship between mFI-5 scores, mortality, and hospital length-of-stay. Among 6,782 patients (mean age: 81.7 ± 8.66 years), higher frailty scores correlated with increased inpatient mortality (OR: 1.259; 95% CI: 1.14–1.39; $P<0.000$) and longer hospital stays (Coeff.: 0.460; 95% CI: 0.35–0.57, $P<0.000$). Notably, age showed a negative association with hospital length of stay but no significant association with inpatient mortality.

KEYWORDS: frailty, geriatrics, falls, modified five-item frailty index (mFI-5)

INTRODUCTION

Geriatric adults, defined here as individuals aged 65 years and older, constitute an increasingly significant segment of the United States population. Traumatic falls represent a critical public health concern due to their association with significant morbidity and mortality in this population.[1,2] In 2020 alone, falls resulted in more than 36,000 fatalities, triggered over 3 million emergency department visits, and incurred medical costs exceeding $50 billion.[1] Beyond the immediate physical injury consequences, falls can precipitate a decline in functional independence, increasing the risk for institutionalization, especially among frail patients.[3]

Given the prevalence of poor outcomes after fall-related injuries, methods to risk-stratify geriatric patients admitted with these injuries is of particular interest. While there is no standard for risk stratification, the concept of frailty has emerged as an important consideration and has shown to be associated with adverse postoperative outcomes across several surgical domains, including geriatric trauma.[4-6]

Frailty can be conceptualized as a decrease in physiological reserve that results from impairments in multiple organ systems leading to increased vulnerability.[7] Several methods can quantify frailty, but the modified five-item frailty index score (mFI-5) (**Table 1**) has gained traction due to its simplicity and strong predictive value.[7]

Despite its simplicity, the mFI-5 has proven to be equally predictive as compared to other frailty index scores, such as the longer 11-item index score.[7] The mFI-5 could potentially be a simple tool to help surgeons, patients, and family members on discussion regarding treatment decisions and goals of care. Previous studies have investigated the relationship between mFI-5 and outcomes in various surgical domains, but no research has directly evaluated its predictive value in traumatic falls in geriatric patients.[4] This study seeks to meet this gap in knowledge.

Table 1. Components of the mFI-5

Modified Five-Item Frailty Index Score (mFI-5)
Congestive Heart Failure
Diabetes Mellitus
Chronic Obstructive Pulmonary Disease (COPD)
Dependent functional status
Hypertension

METHODS

We conducted a retrospective analysis using data from the Trauma Registry at Rhode Island Hospital that encompassed all adult trauma patients admitted between January 1, 2014, and December 31, 2019, who met specific inclusion criteria. Inclusion criteria required patients to be over the age of 65 at the time of admission and to have presented for evaluation and treatment of fall-related injuries. Lifespan IRB reviewed and provided approval of the study protocol.

The trauma registry provided the data in the form of an Excel spreadsheet. The dataset included demographic and clinical variables including age, gender, race, ethnicity, ICD-10 diagnosis codes, e-codes for injury mechanisms, injury severity scores (ISS), preexisting comorbidities, indication for surgical intervention, hospital length of stay in days (LOS), discharge disposition, functional status upon admission, and patient medical record numbers (MRN). The primary outcomes of interest were in-hospital mortality and hospital length of stay in days.

After receiving the data set, the modified five-item frailty index was used to retrospectively determine each patient's frailty level. Patients were assigned a score based on the presence of five predefined conditions within the preexisting comorbidities category of the data set: documented history of congestive heart failure, diabetes mellitus, chronic obstructive pulmonary disease, hypertension, and partial or total dependency in functional health status at the time of admission.

Each condition, if present, was assigned a score of '1'. The total mFI-5 score was calculated by summing the individual scores using Microsoft Excel (Microsoft Corporation 2019), with a potential range from 0 (least frail) to 5 (most frail).

R-studio was used for statistical analysis of the data set.[8] Logistic regression models were employed to assess the relationship between the mFI-5 scores and mortality. For evaluating the correlation between mFI-5 scores and hospital LOS, we utilized linear regression. All analyses were adjusted for potential confounders, including age, race, and gender. Results were presented with odds ratios (ORs), coefficients, and 95% confidence intervals (CIs). We set our significance value to 0.05.

Additionally, the association of ISS and mFI-5 was investigated using the Kruskal-Wallis Test. Post-hoc comparisons with pairwise Wilcoxon rank sum tests were conducted to identify specific group differences following a significant Kruskal-Wallis test result. Bonferroni correction was applied to adjust the p-values for multiple comparisons to control the family-wise error rate. Results are presented with a chi-squared value, degrees of freedom (df), and p-values. The significance value was similarly set to 0.05.

RESULTS

Out of the 6,749 patients' data reviewed, all met the inclusion criteria. The mean age of the cohort was 81.7 years with a standard deviation of 8.66 years. Demographics shown in **Table 2** demonstrate a homogeneous study population with more than 90% of patients identified as non-Hispanic White and 62.43% identified as female.

The distribution of the mFI-5 scores among the study population are shown in **Table 3**, with most patients scoring 1 or 2. There was a significant association between increasing mFI-5 scores and rising rates of mortality (OR: 1.259; 95% CI: 1.14–1.39; P<0.000). Notably, age was not a significant predictor of mortality (OR: 1.000; 95% CI: 0.99–1.01; P=0.888) in the study sample. A higher mFI-5 score was significantly associated with a prolonged hospital stay (Coeff: 0.460; 95% CI: 0.35–0.57; P<0.000). Conversely, increasing age was negatively associated with hospital length of stay (Coeff: –0.044; 95% CI: –0.06 to -0.03; P<0.000).

Table 2. Patient Demographics

Gender	**Count**	**Percent**
Female	4234	62.43%
Male	2548	37.57%
Race		
Not Disclosed	6	0.09%
American Indian/Alaskan	2	0.03%
Asian	53	0.78%
Black/African American	127	1.87%
Hawaiian/Pacific Islander	3	0.04%
Other Race	258	3.80%
White	6333	93.38%
Ethnicity		
Not Disclosed	6	0.09%
Hispanic or Latino	231	3.41%
Not Hispanic or Latino	6545	96.51%

Table 3. mFI-5, Age, and Primary Study Outcomes

mFI-5 Score: Mean = 1.61	**0** 12.8%	**1** 36.6%	**2** 32.2%	**3** 14.6%	**4** 3.2%	**5** 0.6%
Average Age: Mean = 81.7	78.64	81.43	82.66	82.74	81.44	79.10
Average Injury Severity Score: Mean = 9.71	10.55	9.70	9.61	9.31	9.11	10.41
Average Length of Stay: Mean = 5.81	5.33	5.49	5.94	6.48	6.79	6.56
Percent Inpatient Mortality Total = 5.30%	5.86%	3.83%	4.75%	8.08%	12.84%	5.82%

The Kruskal-Wallis test revealed that there were overall differences in ISS scores across the different levels of mFI5 (chi-squared = [12.513], df = [5], p-value = [0.0284]). Post-hoc pairwise comparisons using Wilcoxon rank sum tests with Bonferroni correction revealed significant differences in ISS scores between an mFI5 of 0 compared with an mFI-5 of 2 and 3. This suggests, when comparing the mean ISS score for mFI-5 scores, excluding 0, there's no significant difference. ISS was not significantly associated with age on linear regression (Coeff: –0.005; 95% CI: –0.02 to 0.01; P=0.544).

DISCUSSION

The findings suggest an association between an increased mFI-5 score and elevated inpatient mortality, along with prolonged hospital stays for older adults with traumatic fall injuries. Such outcomes accentuate the critical role of frailty in jeopardizing the life, health, and independence of geriatric individuals. Given these consequences, frailty assessments may have the potential to play a larger role in health evaluations, especially in light of the aging United States population. They may be incorporated at different levels of patient care, including during a primary care provider's visit for health maintenance, to assist with future goals of care and treatment discussions.

Interestingly, while age is often viewed as a marker of vulnerability after injury, our results spotlight the potential of mFI-5 as a possible superior predictor.[9] Notably, age alone did not demonstrate a significant correlation with increased mortality and was even negatively correlated with hospital length of stay. Since age did not correlate with a significant difference in ISS score, it is unlikely that this observed effect is due to differences in injuries.

It is unclear why age may be negatively associated; however, the relatively low R-squared value indicates that age is not a strong predictor of hospital stay length by itself, and there are likely other factors not included in our model that influence the length of stay, such as insurance status or prior living situation. Another potential explanation would be that older patients may already have significant resources in place at the time of their injury which could facilitate discharge. Further, given the small size of the effect, the relationship is likely not clinically significant. However, these observations further distinguish frailty from aging, bolstering the assertion that the former provides a more nuanced understanding of patient vulnerability.

Another compelling observation was the non-association between ISS and frailty. While more frail patients suffered worse outcomes than less frail patients, they did not suffer from more severe initial injury. This revelation further supports the idea that frailty may be a predictor of adverse outcomes regardless of what the initial injury may be.

While this study provides data on one crucial aspect of geriatric trauma care, it comes with certain limitations. The study's focus was confined to patients registered with the trauma registry service and therefore excluded patients who were not admitted or may have died prior to admission. The outcomes assessed were limited, and future studies might consider a broader spectrum of post-fall complications or longer-term outcomes. The retrospective nature of our study could introduce biases related to missing or incomplete data. The study did not adjust for all potential confounders, such as alternative pre-existing health conditions not accounted for by the mFI-5, which could influence outcomes. Although the study sample was large with 6,749 participants, all data was extracted from a single site. Furthermore, the study population was overwhelmingly identified as non-Hispanic, female White individuals. Repetition of this study at multiple locations with a more diverse patient population is needed to generalize the results to a wider population.

Other frailty indices such as the TSFI, FS, and RFS are similarly being evaluated for their predictive value in trauma patients. One study suggests that the TSFI and RFS are better predictors of outcomes for geriatric trauma patients compared with the mFI-5 and the FS; however, additional studies may be necessary to definitely conclude the superiority of one index of another.[10]

The mFI-5, given its simplicity and efficacy, could become a tool in clinical settings, helping physicians risk-stratify geriatric fall patients more effectively. This could aid in tailoring interventions, discussions about care goals, and optimizing resource allocation. Other future investigations might investigate the utility of prospectively integrating mFI-5 into clinical care, as most studies to date have focused on retrospective analysis.

CONCLUSIONS

Our study provides supporting evidence that the mFI-5 may serve as a predictor for both inpatient mortality and hospital length of stay in geriatric patients presenting with traumatic falls. Further, more expansive studies should investigate this relationship to better understand the predictive value of the mFI-5. Notably, in our study the mFI-5 emerged as a more reliable indicator than age, suggesting that frailty, rather than chronological age, could play a pivotal role in determining patient outcomes.

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Structure and Function Are Not the Same: The Case for Restoring Mechanoreceptor Continuity Following Anterior Cruciate Ligament Injury

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ABSTRACT

Anterior cruciate ligament (ACL) injury, particularly in increasingly young and active adolescents, continues to pose a clinical challenge with re-injury rates reported as high as 30%. Evidence also suggests that current standard-of-care ACL reconstruction (ACLR) does not mitigate post-traumatic osteoarthritis (PTOA) risk. Bridge-enhanced ACL restoration (BEAR) is a recently developed and tested ACL surgery that promotes primary healing of the native ACL with excellent early results. BEAR has shown to reduce signs of early PTOA compared to ACLR in an animal model. Here, we describe a theoretical framework related to re-innervation that can clarify why the outcomes of ACLR and BEAR surgeries differ. We also discuss how ongoing and new challenges in determining return-to-sport readiness following the competing surgeries may differ, and how emerging imaging tools and measures of neuromuscular function may aid in clinical decision-making to decrease the likelihood of re-injury and PTOA risk.

KEYWORDS: ACL, neuromuscular, kinematics, surgery, post-traumatic osteoarthritis

THE ONGOING CLINICAL CHALLENGE OF TREATING ACL INJURY

The anterior cruciate ligament (ACL) is one of the most frequently injured knee ligaments with up to 400,000 ACL tears occurring in the US annually.[1,2] Of these occurrences, teenagers are the most at-risk population.[3,4] This adolescent demographic presents a particularly challenging clinical problem as ACL tear increases the risk of post-traumatic osteoarthritis (PTOA), with up to 50–80% of these young patients developing symptomatic OA within 10 to 20 years of their injury.[5-7] Given there are no known disease-modifying therapies for PTOA, the injury leaves these typically young adults to manage their condition over most of their lifespan. Further, ACL re-injury is not uncommon and has been reported to be as high as nearly 30% in athletes under the age of 20[8] with subsequent inferior patient outcomes after graft failure.[9] These observations underscore the need to identify mechanisms that modulate re-injury and PTOA risk following ACL tear and to augment current treatment strategies to improve patient outcomes.

PRIMARY REPAIR AS AN EMERGING TREATMENT FOR ACL INJURY

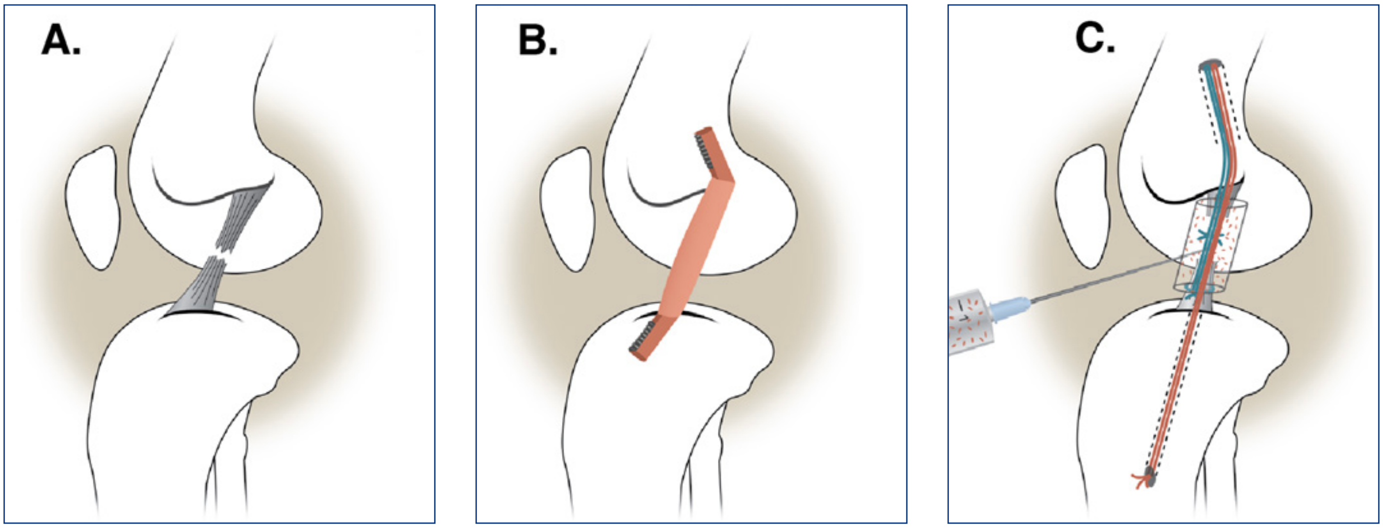
Spontaneous healing of the ACL is rare and if left untreated, the knee is unstable with many patients unable to perform activities of daily living, let alone resume sports. ACL reconstruction (ACLR) is the current standard of care and involves drilling bone tunnels through the footprints of the ACL and replacing the torn ligament with a tissue graft harvested from elsewhere in the body. ACLR grossly restores knee stability and allows many patients to resume pre-injury activities, but the procedure does not mitigate PTOA risk[10] or fully restore clinical, functional, and patient-reported outcomes (PROs).[11-13] Reasons for these shortcomings remain elusive with measures of knee laxity, patient demographics, societal factors, surgical treatment and the need for subsequent revision surgery explaining only 10–20% of the variation in PROs in a multivariable regression analysis of nearly 1600 ACLR patients followed prospectively for 10 years (NCT00478894).[9] Thus, factors not yet fully captured by these clinical trials may be important modulators of long-term patient outcomes and joint health. Bridge-enhanced ACL restoration (BEAR), is a surgery that involves use of an FDA-cleared extracellular matrix sponge to create a stable blood clot that allows the torn ACL ends to reconnect through primary wound healing[14] (**Figure 1 A,B,C**).

BEAR has several advantages over conventional ACLR, including the elimination of graft donor site morbidity associated with autograft procedures (e.g., patellar tendon, hamstring, and quadriceps tendon),[16] and as we speculate here, the potential to preserve ACL mechanoreceptor machinery. Alongside restoration of the double bundle morphology of the native ACL, these distinguishing features may explain the more rapid and complete recovery of knee extensor and flexor strength and functional hop test performance following BEAR compared to ACLR patients within the first two years after surgery.[17,18] These differential responses were noted despite the presence of similar magnitudes of residual joint laxity between the competing surgeries. We believe that this observation points to the presence of mechanisms other than graft biomechanical function that modulate early patient outcomes.

INNERVATION AND PTOA RISK

In developing the BEAR procedure, one of the exciting outcomes observed in the animals that underwent BEAR was

Figure 1. [**A**] Following ACL tear, [**B**] ACLR involves removing the ACL and replacing it with a tendon graft by drilling bone tunnels through the footprints of the ACL so that the graft can be introduced into the joint. [**C**] BEAR is an alternative approach that uses a suture bridge through small bone tunnels drilled adjacent to ACL footprints to provide initial stability while the extracellular matrix sponge soaked with autologous blood creates a stable blood clot that promotes primary wound healing. [FIGURE IS USED WITH PERMISSION FROM MURRAY AND FLEMING[15]]



that they had less cartilage damage – a hallmark of PTOA – compared to animals that underwent ACLR.[15,19] Meanwhile, the biomechanical properties of the grafts and repaired ACLs were similar.[15,19] Several subsequent pre-clinical studies have failed to identify biological modulators that might explain the differential cartilage outcomes observed by 12 months in the animal models.[20-22] Interestingly, hind limb loading was similar between the competing surgeries up to six months after surgery, but it diverged between 6–12 months.[23] This leads us to hypothesize that the functional divergence might reflect a different neuromuscular strategy conferred by the preservation of the mechanoreceptor anatomy that would occur with BEAR, but may not be present following ACLR because of the bone tunnel drilling required for graft placement and removal of the injured ligament. Evidence from small animal models adds further support to this working hypothesis, whereby severe osteoarthritis develops when the mechanoreceptor signaling pathway in the knee is surgically ablated without disturbance to the intra-articular connective tissues.[24] With respect to the ACL specifically, the native ACL contains mechanoreceptors[25] with the majority located in the epiligament and bony insertions.[26,27] ACL mechanoreceptors – Ruffini corpuscules, Pacinian corpuscules, and Golgi-like tendon organs – relay afferent communication about joint position and ligament tension to the central nervous system,[28-30] whereas free nerve endings are believed to contribute primarily to nociception.[31] However, debate remains as to which tissues (e.g., synovium, capsule, menisci)[32] contribute to proprioceptive and nociceptive information.[31] Nevertheless, a reflex arc exists between the ACL and hamstring muscles, that when elicited by direct mechanical tensioning[33] or electrical stimulation of the ACL,[34] hamstring contraction is triggered. Because hamstrings are antagonists to anterior tibial translation[35] – the direction of motion constrained primarily by the ACL[36] – their activation under excessive ACL tension would off-load the ACL.[37] This protective reflex arc is either absent[38] or significantly diminished following ACLR.[34,39] Thus the inability of the central nervous system to accurately detect changes in ligament tension and respond would result in joint proprioception deficits. Conversely, if BEAR restores the neural connectivity between the two torn ends of the ACL, its sensory function may also be restored and would promote more normal neuromuscular and kinematic function.

PERSISTENT ABNORMAL NEUROMUSCULAR FUNCTION AND KNEE KINEMATICS

When faced with reduced afferent proprioceptive input and compromised spatial awareness of a limb due to ACL injury, individuals may experience challenges in actively constraining joint orientation through coordinated muscular contractions. This hypothesis builds on the longstanding observations that ACLR patients demonstrate residual abnormal knee kinematics after surgery.[40,41] Our recent work has shown that ACLR subjects land from a hop with their tibia positioned more anteriorly[42-44] and that their neuromuscular function remains different from that of controls' more than a decade after surgery.[45-47] Greater anterior tibial translation and more rapid sliding between contacting tibiofemoral surfaces have shown a direct and linear correlative relationship to the amount of cartilage damage observed in a large animal model of ACL transection.[48,49] Thus, if neuromuscular function does not adequately constrain this motion, PTOA onset could result. What is known from the animal models in terms of damaging contact mechanics and their relationship to PTOA dovetails the variable rate of PTOA onset observed clinically, with some ACLR patients remaining asymptomatic for decades while others develop early degenerative changes.[5-7,9] ACLR and post-operative rehabilitation aim to target these structural and functional mechanisms thought to be mechanical drivers of PTOA risk, though they fail to do so in many patients.[10]

REHABILITATION AND RETURN-TO-SPORT (RTS) READINESS

Following either ACLR or BEAR surgery, the primary goal of rehabilitation is to diminish pain and swelling and to regain lower limb flexor and extensor muscle strength and function by implementing a progressive program that sequentially targets knee range of motion, lower limb strength, and dynamic plyometrics.[50,51] Despite following best practices and careful clinical oversight, evidence suggests that few patients pass all functional test criteria designed to inform RTS readiness.[52] Alarmingly, re-injury rates as high as 30% within the first five years of injury have been reported.[8] Of note, this statistic includes the risk of contralateral injury, which appears to be highest within the first year of index ACL injury.[8] There is mounting evidence that peripheral and cortical processing changes indicative of central nervous system reprogramming[41] also occur during this two-year post-injury time frame.[53,54] Why these systemic changes occur is speculative, but because nature favors symmetry[55] we posit that the central nervous system may undergo a degree of reorganization to re-establish lower limb symmetry. If the nervous system is undergoing a rapid state of flux by adapting both injured and contralateral limb function, it may heighten ACL injury risk already present because of underlying factors (e.g., posterior tibial slope, narrow notch width, ACL size, genetic susceptibility).[56,57] To this point, our data demonstrate that neuromuscular[47] and kinematic[44] function of the contralateral limb appear more similar to the ACL-injured limb of ACLR patients than those of healthy controls 10+ years after injury. The cross-sectional nature of that work precludes us from ascertaining whether these neuromuscular and kinematic differences were inherent to these patients and could reflect why they were injured to begin with; however, longitudinal studies by others suggest contralateral kinematics gradually change over time, dovetailing the movement patterns of the ACLR limb.[58,59] In a similar vein, PROs likewise change rapidly over the first two years after ACLR before plateauing.[9,11] Taken together, there appears to be a rapid period of local, systemic, and psychological adaptation before reaching a steady state at two years post-surgery.

SPECIAL CONSIDERATIONS FOR BEAR PATIENT REHABILITATION AND RTS READINESS

Preliminary clinical studies have demonstrated that BEAR patients are passing functional benchmarks earlier, have a more rapid and complete restoration of knee flexor and extensor strength, and report greater psychological readiness to RTS.[17,18] This accelerated recovery following BEAR poses a new set of challenges for the rehabilitation team, whereby the patient may feel ready to engage in more dynamic activity, but the healing ACL may not be sufficiently remodelled to withstand the magnitude of tensile loading it may undergo, as preclinical studies suggest the healing ACL continues to gain tensile strength and stiffness up to 12 months after repair.[19] Further, there are temporal differences between the biological remodelling of an implanted tendinous graft and primary healing of the native ACL. The ACL graft undergoes "ligamentization", during which it gets progressively weaker as it is revascularized before regaining ultimate tensile strength and stiffness as the collagen is remodelled; however, graft structural properties never fully recapitulate those of the native ACL with inferior graft stiffness and diminished tensile strength.[60] In the case of BEAR, the repair is weakest in the immediate postoperative period followed by a gradual increase in structural properties as the provisional synovial scaffold is remodelled into organized collagen.[61] Work in animal models suggests that the functional end point is ultimately the same between the competing surgeries,[15,19] but there is currently no consensus on how best to promote optimal functional healing following BEAR, neither tools or metrics capable of probing the structural properties of the ACL directly to monitor how they may respond to mechanical cues. There is thus an opportunity to address these clinical gaps with novel metrics that capture the underlying biological healing processes and their relationship to neuromuscular function more directly.

EMERGING TOOLS TO GAUGE RTS READINESS

Clinical exams, functional tests, and PROs are staples of clinical and research toolboxes used to judge the integrity of the implanted ACL graft and a patient's overall physical and psychological readiness to RTS; however, they are poor predictors of re-injury risk.[52] Using magnetic resonance imaging (MRI) to predict when the tissue would be able to withstand tensile forces associated with sport participation would be a valuable tool. Our research group has made progress towards this end,[62-65] where we have shown its promise in predicting graft/ACL failure.[62,66] Nevertheless, the imaging approach does not capture the role that the neuromuscular system may play in graft/ACL remodelling or contralateral injury risk.

Using conventional motion capture (MoCap) to determine joint kinematics and kinetics has provided insight into the functional recovery following ACLR,[59] but has yet to identify the "smoking gun" between biomechanical abnormalities and PTOA pathogenesis, possibly due to limitations associated with the accuracy[67] required to record dynamic movements that are most likely to be associated with greater re-injury risk, such as jump landings and cutting maneuvers.[67] Common to all kinematic measures is that they are largely the result of neuromuscular function; capturing how muscles are activated, the quality of their contraction, and their coordination may be a more direct measure of neuromuscular changes and their potential differential response to ACLR versus BEAR, as well as contralateral injury risk.

The most common and least invasive way to acquire measures of muscular activation entails using surface electrodes placed over the muscle bellies of interest to record electromyography (EMG) signals. We have recently demonstrated that analysis of the frequency content of signals acquired from EMG provides rich information capable of distinguishing subtle differences in muscle activation patterns between ACLR patients and healthy control subjects.[46] Importantly, these differences were not detected in the same subjects using conventional EMG approaches that analyzed only the timing of muscle activation.[45] Another important finding was that our approach additionally identified contralateral limb differences in ACLR patients,[47] which could prove to be a useful metric for tracking systemic changes in neuromuscular function after ACL injury. With support from the Injury Control Center of Biomedical Research Excellence (COBRE) at Rhode Island Hospital, work is ongoing to determine the extent ACLR and BEAR neuromuscular activation patterns are different after two years of healing, and how they relate to knee kinematics and PROs. As the work matures and we learn more about the neuromuscular features that distinguish the two surgeries, we hope to develop a framework that uses lower limb EMG-based machine learning to identify rehabilitation milestones that would have utility in determining RTS criteria.

THE ROLE OF INFLAMMATION

It is worth noting that although we have focused on the structural and functional differences between ACLR and BEAR, it is possible that the molecular environment also plays an important role in the long-term risk of PTOA.[68] As we eluded to earlier, several subsequent studies in the porcine model of ACLR and BEAR investigated whether pro-inflammatory cytokine concentrations and RNA expression in the synovium, synovial fluid, and articular cartilage differed between the competing surgeries.[21,22,69-74] Two notable findings emerged: 1) there are no differences in the RNA transcriptome within the first four weeks post-op between the competing surgeries;[22,69] 2) inflammatory mediators and metabolic markers detectible in the synovial fluid are upregulated following only BEAR,[70] and only by 12 months are differences in synovial fluid proteome detectible[21] with a greater abundance of cytokines being chondroprotective.[72] It is also worth reiterating that the temporal emergence of the differential molecular outcomes parallels the emergence of a different gait strategy,[23,72] which provides additional evidence that neuromuscular control may play an important chondroprotective role and may even influence the molecular environment. These are ongoing topics of investigation.

SUMMARY

Whereas ACLR continues to be a successful surgery insofar as it restores gross knee structure and stability following ACL tear, it may not restore the native ligament's neural connectivity and the more fine-tuned neuromuscular control necessary to fully recapitulate pre-injury function. BEAR is an emerging surgical approach that may preserve mechanoreceptor function and in-turn promote a more complete neuromuscular and kinematic recovery that mitigates PTOA risk. Emerging tools being developed in the research setting offer promise towards providing insight into the functional status of the healing ACL and the neuromuscular system with the goal of reducing re-injury risk and augmenting the clinician's ability to guide RTS decision-making following ACL surgery.

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Preventing Sleep-Related Deaths in Infants

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INTRODUCTION

It is early morning in the emergency department when EMS arrives with a previously healthy infant who was found unresponsive and lifeless in bed by the family upon awakening. The infant was last seen well during a feed at 3 a.m., after which the parents fell asleep with the infant in their bed surrounded by blankets and pillows. This is unfortunately an all-too-familiar occurrence for emergency medical teams. In most cases, immediate resuscitative measures at the scene and hospital are unsuccessful, and comforting a devastated family, gathering historical information, and arranging medical examiner investigations become the only interventions that medical teams can provide. The tragedy of such loss is compounded by historical information that suggests that the infant was sleeping in an unsafe environment, making the death preventable.[1,2] Despite widespread public health campaigns that promote evidence-based safe sleep practices, infants continue to die from unsafe sleep environments.

IMPORTANCE

In the United States, approximately 3,500 infants die of sleep-related deaths each year.[3] Furthermore, a recent examination of 7,595 sudden infant deaths in the US between 2011 and 2020 found that 76% of the infant deaths were associated with multiple unsafe sleep practices.[4] In addition, the leading cause of injury-related deaths in infants in the US is unintentional suffocation, with 82% of these categorized as accidental suffocation and strangulation in bed (ASSB).[1] In 2020, approximately 25 infants out of 100,000 live births died of ASSB in the United States.[5]

Rhode Island is not immune. In 2022, six children under the age of one died in this state, increasing to 12 in 2023. In an average year, 50% of these Rhode Island infant deaths are shown to be due to unsafe sleep practices.[6]

RISK FACTORS

Certain practices significantly increase the risk of infant suffocation while sleeping. Accidental infant suffocation is most often caused by airway obstruction from **loose, soft objects** such as pillows and blankets.[1-3] Specifically, the use of soft-bedding is associated with a 16-fold increase in the odds of suffocation.[7]

Infants placed in **non-supine positions** (e.g., not on their backs) have approximately two times the odds of sleep-related suffocation.[7]

Infants **sharing a sleep surface** with another person are 2.5 times more likely to die of suffocation, most commonly from overlaying of a caregiver.[1,7] Surface sharing becomes five to ten times riskier if the caregiver is using sedating medications or substances (such as alcohol), if there is prenatal or postnatal exposure to tobacco smoke, or if the infant is less than four months old.[3,4]

In contrast to surface sharing, room sharing (i.e., having the infant in the same room as the caregiver, but on a different surface) is protective against sudden infant death syndrome (SIDS).[3] Specifically, infants who do not room share with their caregiver are 19 times more likely to die of sleep-related suffocation.[7]

There is also a four-fold increase in the odds of suffocation if a **non-approved sleep surface** is used, as wedging can occur.[2,7] The key characteristics of an approved sleep surface are firm, flat, and non-inclined.[3]

Additional risk factors for ASSB include male infant, low gestational age, low infant birth weight, multiple birth, high birth order, lack of prenatal care, young maternal age, and mothers with low educational attainment.[8]

DISPARITIES

There are notable racial and ethnic disparities associated with sleep-related deaths. Specifically, non-Hispanic Black and American Indian/Alaska Native infants are disproportionately affected, both having a five-fold increase in the odds of sleep-related suffocation.[3,5,7] These disparities often reflect socioeconomic inequities that may limit families' choices in sleep surfaces and environments.[3] It is important to remember that race and ethnicity have intersectionality with socioeconomic status, housing stability, employment status, and domestic violence, all of which are also documented risk factors for sleep-related infant deaths.[3,9,10] Recognizing and addressing these disparities during routine maternal and pediatric care is essential to design the most effective, sustainable interventions to reduce sleep-related infant mortality.

BARRIERS

Most caregivers are aware of the American Academy of Pediatrics (AAP) safe sleep recommendations.[11] However, prior studies have shown that knowledge of the safe sleep guidelines does not always correlate with adherence to them.[11-13] For example, one study found that even though 85% of parents believed that the back was the safest sleeping position, only 69% had their infant sleep on their back.[11] Another study found that parents made "deliberate decisions to violate recommendations," especially bedsharing.[13] Previously cited reasons for the discrepancy between knowledge and practice include concerns about infant comfort, convenience, and parent-infant bonding.[13] Parents' willingness to deviate from recommended practices may also be related to their perceived immunity to Sudden Unexpected Infant Death (SUID), as has been found in prior studies.[10,14]

SAFE SLEEP RECOMMENDATIONS

Among the strongest safe sleep recommendations in the updated 2022 AAP guidelines are the following: (a) place the infant in the supine position (i.e., on their back), (b) use a firm, flat, non-inclined sleep surface, (c) keep soft objects (such as blankets, pillows, stuffed toys, and bumper pads) away from the infant's sleep area, and (d) room share without surface sharing. Instead of using blankets to keep infants warm, infant sleep clothing and/or non-weighted wearable blankets are recommended. Additional recommendations encourage breastfeeding, pacifier use, and routine immunizations and discourage smoke and nicotine exposure, as well as parental substance use.[3]

Local and national initiatives led by the Centers for Disease Control, the National Institute of Child Health and Development, HRSA Maternal and Child Health Bureau, and the Consumer Product Safety Council support research, education, and strategies to prevent infant sleep-related deaths. Programs providing no cost or low-cost safe sleep surfaces and education to families directly addresses disparities in access to safe sleep surfaces are available across the country including Rhode Island. [22,23]

TIPS FOR PEDIATRIC PROVIDERS

According to the 2022 AAP recommendations, it is essential for healthcare providers to "endorse and model safe infant sleep guidelines."[3] Parents consider healthcare providers to be trusted sources of information.[14-17] Studies have shown that parents are likely to model practices their child's healthcare provider engages in, whether or not it is consistent with the AAP guidelines.[10,18] In fact, "seeing or hearing of a healthcare professional not following the AAP recommendations [has been shown to send] a clear message to mothers that these recommendations were unimportant."[10] Healthcare providers therefore play an integral role in reducing sleep-related infant mortality.

Accompanying these recommendations, the AAP has developed the Sudden Unexpected Infant Death (SUID) Prevention Program. This includes evidence-based counseling and educational resources for infant caregivers and providers. Its goal is to reduce disparities in SUID and decrease the overall SUID rates.[19] In the most recent "Safe Sleep Initiatives Newsletter," various tips for providers were emphasized including (a) applying an equity lens to safe sleep efforts, (b) forming multidisciplinary, diverse partnerships between physicians, other healthcare workers, and parents, and (c) engaging in frequent community outreach and education.[19-21]

Overall, healthcare providers must work collaboratively with families to explain and promote the AAP guidelines, model safe practices, and have thoughtful conversations with caregivers about the challenges they are experiencing in relation to infant sleep. Asking about what barriers they may be facing and normalizing that infant sleep is challenging can lessen parents' fears and allow for more honest, productive conversations. These conversations must always be nonjudgmental, especially when discussing breastfeeding and surface sharing, and focus on risk reduction. Finally, pediatric providers must communicate that they have the same goals as caregivers – to make sure the infant is healthy and safe. Aligning themselves on the same team as the parents helps break down the communication barriers and establish trust.

CONCLUSIONS

Infants continue to die from unsafe sleep environments. These deaths can largely be prevented by encouraging caregivers to follow the AAP guidelines and helping them overcome barriers. Pediatric providers must work collaboratively with families to reduce ASSB and other causes of sleep-related infant mortality.

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Evaluation of a Child Abuse Screen Performed by Nurses Among Young Children with Fractures Seen in a Pediatric Emergency Department

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ABSTRACT

AIMS: To assess institutional compliance with, and test characteristics of, a child abuse screen performed by emergency department (ED) nurses for children <5 years old who were diagnosed with fractures.

METHODS: A secondary analysis of a retrospective observational study of children 0–5 years old with fractures seen at a pediatric ED between January 2018 and April 2023 was performed. We analyzed demographics, ED visit data, and results of the nurse-completed abuse screen. Screen results were compared to ED clinician concern for abuse to calculate test characteristics.

RESULTS: The mean age of the 2,705 children identified was 38.4 months (SD 19.8). Out of the total patient cohort, 2,449 (90.5%) had a nurse-completed screen. Among these, 65 patients (2.4%) screened positive for possible abuse. We found no statistically significant difference in screen completion by age group, race, ethnicity, language, or insurance type. Of 312 (11.5%) encounters with clinician concern for abuse, 17.6% screened positive, 76.0% screened negative, and 6.4% had an incomplete screen. The sensitivity and specificity among screened children aged 0–5 were 19.2% [95% CI 14.7–23.8%] and 99.5% [95% CI 99.3–99.8%]. The PPV and NPV were 84.6% [95% CI 75.8–93.4%] and 90.3% [95% CI 89.1–91.5%]. Comparatively, among children <12 months, the sensitivity was 24.4% [95% CI 18.0–30.8%], specificity was 98.1% [95% CI 95.4–100%], PPV was 95.5% [95% CI 89.3–100%], and NPV was 43.7% [95% CI 37.3–50.1%].

CONCLUSIONS: Although there was high compliance with this nurse-completed abuse screen, it is an inadequate sole modality for screening young children with fractures, with a low probability of a positive screen given clinician concern for potential abuse for the entire cohort *and* among high-risk infants.

KEYWORDS: Child abuse screen, electronic health record, pediatric emergency department

INTRODUCTION

Child abuse is a public health issue with severe short- and long-term consequences. Approximately 25% of children are abused or neglected in their lifetimes, with an estimated 18% experiencing physical child abuse.[1,2] After bruising, fractures are the most common childhood injury from physical abuse.[3] It is estimated that 25–56% of abusive fractures occur among children <12 months,[4] up to 80% among children <18 months,[5] and the vast majority among children <5 years,[4] underscoring the importance of optimizing screening for this high-risk group.

The emergency department (ED) is an entry point into the healthcare system for many abused children. Children who have been abused are known to visit the ED more often than non-abused children, and ED providers may be their first and only medical contact.[6-8] While early detection presents ED providers with a critical opportunity to reduce morbidity and mortality, healthcare providers either miss or misdiagnose abusive fractures in young children up to 20% of the time.[9] Although the American Academy of Pediatrics (AAP) has developed evidence-based guidelines for evaluating physical child abuse, validated and universal child abuse screening tools remain lacking.[10]

To date, several screening tools have been published and validated, including injury-specific clinical decision rules and more general screens.[11-15] However, because no comprehensive gold standard to screen for all forms of child abuse exists, many hospitals implement their own screens, which can be active (provider-completed), passive (utilize information embedded in the electronic health record (EHR)), universal (for all children irrespective of presenting complaint) and/or targeted (limited to certain age groups and/or complaints).[4,16] Inconsistent screening compliance, insufficient clinician knowledge, and clinician biases, among other barriers, remain significant obstacles to accurate detection.[8,13,17] As such, hospitals must critically review their screening protocols to ensure that there is high compliance, identify potential institution-based barriers, and evaluate screening test characteristics.

In 2018, the study site, Hasbro Children's Hospital, implemented a mandatory abuse screen performed by ED nurses, similar to previously published screening questions.[13] To date, no formal evaluation of this screen has been completed.

The aims of our study were to assess institutional screening compliance and test characteristics (sensitivity, specificity, negative and positive predictive values) compared to ED clinician concern for abuse and discussion with a child abuse pediatrician (CAP), among children <5 years who were diagnosed with a fracture.

METHODS

Study design and population

A secondary analysis of a larger retrospective observational study of children aged 0–5 years old who visited a regional tertiary pediatric ED between March 2015 and April 2023 was performed. All patients included in the primary study had at least one diagnosed fracture, identified by the International Classification of Disease 10th revision (ICD-10) codes (See **Box**). Full-text ED encounter notes and discrete data were provided by research information services in Microsoft Excel™ (Microsoft, Redmond, WA, USA). The institutional abuse screen became embedded in the EHR in January 2018; as such, encounters between January 2018 and April 2023 were included. The study was approved by the institutional review board.

Box. ICD10 Codes for Fractures

Skull: S02.0*, S02.1*, S02.7*, S02.8*, S02.9*
Nasal bone, orbital floor, maxilla, mandible: S02.2, S02.3*, S02.4*, S02.6*; dental fractures (S02.5) were excluded
Pelvis and spine: S12*, S32*
Rib: S22.3*, S22.4*, S22.5*
Shoulder and humerus: S42*
Radius and ulna: S52*
Wrist, hand, and fingers: S62*
Femur: S72*
Tibia and fibula: S82*
Ankle, foot, and toes: S92*

Hasbro Children's Hospital is the only level-one pediatric trauma center in Rhode Island with a catchment area also including parts of Connecticut and Massachusetts. Annually, an average of 55–60,000 patients are seen in this pediatric ED, of which approximately 52% are male, 47% White, and 14% Black. Nearly 40% of patients identify as Hispanic. More than 45% of patients have public insurance. Any ED clinician concern about potential abuse and/or neglect can be reviewed directly with a consultant child abuse pediatrician (CAP) 24 hours a day, 7 days a week.

Measures

Demographic features including sex, age, race, ethnicity, insurance payor, and primary language were collected. Sex, race, and ethnicity categories were self-reported by the patient/caregiver or assigned by hospital registration in accordance with the institution's practices. We included race and ethnicity data because of previously described disparities in the screening and reporting of potential child abuse.[10,18-20]

Encounter-level characteristics included date and time of visit and ED disposition (e.g., admit, discharge). Derived variables based on the date and time of ED presentation were day of the week, month of the year, and shift. The three shift periods corresponded to the institution's standard nursing shifts (07:00–14:59, 15:00–22:59, and 23:00–06:59).

Child Abuse Screen

The four-question universal screen was to be completed by registered nurses for all children, regardless of age or chief complaint, to identify those who may have experienced abuse/neglect and potentially needed additional evaluation. Education regarding child abuse was provided in a lecture given by nurse educators or by an online educational module at the time of nursing onboarding. Education regarding the screening questions was provided during triage training by nurse educators.

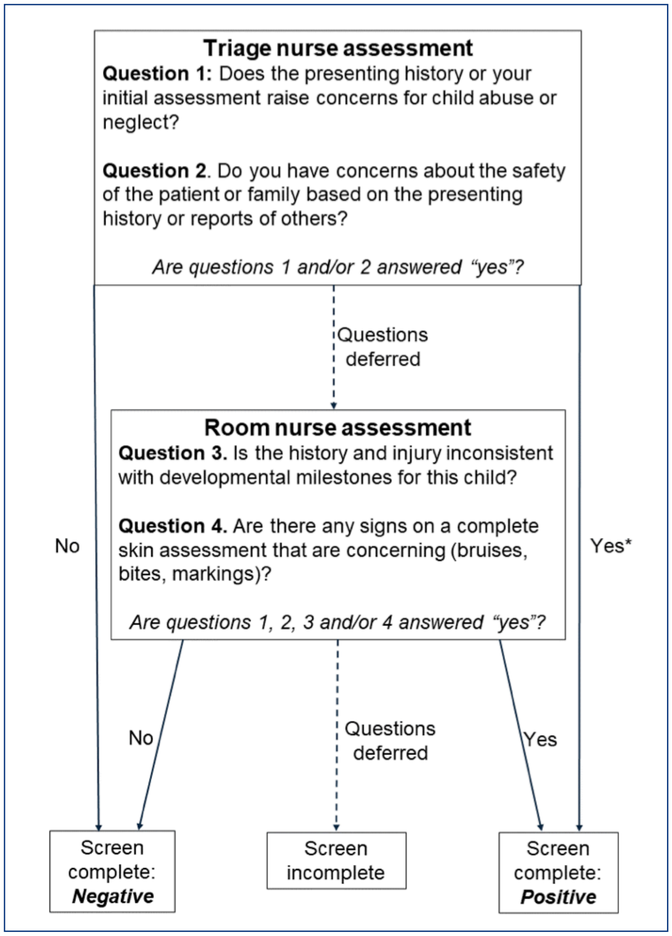
Figure 1 shows the intended workflow of the screen. The screening questions are similar to the previously published Escape questionnaire.[13] A screen was considered positive for potential abuse if any of the four questions were answered "yes." A screen was considered negative if the first two questions were completed by the triage nurse and were answered "no" or if all four questions were completed by the room nurse and answered "no." Although screening was intended to be mandatory and universal, nurses were able to defer the questions in the EHR; a screen was considered incomplete if questions were left unanswered.

Emergency Department Clinician Concern for Abuse

If the ED clinician had concerns for potential abuse/neglect, independent of or based on the nursing screen, a CAP was called to review the case. Encounters reviewed with a CAP were identified in two ways. The first was the presence of a CAP consultation or plan of care note associated with the ED encounter. Second, keyword identification from the clinicians' notes for all encounters were identified through manual review of the dataset. Search terms included the child abuse pediatrics center eponym ("Aubin Center"), "child protect-" (-ion, -ive), "child safe," "abuse," "non-accidental," "DCYF" and "DCF" (the local states' acronyms for departments of children (youth) and families), and "skeletal survey." Encounters with these terms were included if a clinician documented that there was a discussion with

Figure 1. Child Abuse Screen Workflow

- Nurses are prompted to answer questions 1 and 2 during the triage process.
- If the first two questions are answered "no" in triage, the screen is considered complete and negative.
- If at least one question is answered "yes" in triage, the screen is considered complete and positive, and the nurse is required to alert the attending physician. *Room nurses may additionally complete questions 3 and 4 at their discretion.
- Triage nurses can defer the initial two questions to room nurses, who are then prompted to answer all four questions. Questions may be deferred again, leaving the screen incomplete.
- If any one of the four questions is answered "yes" by the room nurse, the screen is positive; if all four questions are answered "no" by the room nurse, the screen is negative.



a CAP due to concerns of potential abuse/neglect related to the current encounter. Documentation of prior but not current abuse evaluation(s) or concerns, documentation of placement in child protective services custody prior to the time of the encounter but no concerns related to the current fracture visit, or explicit documentation of *lack* of concern, were coded as no concern.

Statistical Analysis

All data were exported into Microsoft Excel™ for coding and analyzed using SAS™ (version 9.4, SAS Institute, Inc., Cary, NC, USA). Descriptive analyses were performed to describe the study population and ED encounter characteristics, reporting results as frequencies and proportions, with mean and standard deviation when applicable. Bivariate analyses were conducted to determine associations between the patient and ED encounter characteristics by screening completion and results, with 95% confidence intervals reported. Chi-square tests were calculated for comparative analyses.

To calculate the test characteristics for the nursing screen, results were compared to the reference standard of ED clinician concern and discussion with a CAP. This reference standard was chosen rather than cases of confirmed abuse, as previously described,[3,13] given that the purpose of the screen is to recognize *potential or suspected* abuse/neglect, and not to diagnoses cases. Furthermore, the diagnosis of abuse is not commonly made in the ED setting, and concern for abuse is essential to its potential identification. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for the entire sample and stratified among children <12 months, 12 to <24 months, and 24 to <36 months, as younger children are at higher risk of sustaining and having missed abusive fractures.[9,20-22] Children with incomplete screens (N=256) were excluded from these analyses. There was a small proportion of patients with more than one encounter during the 8-year study period; because the screen was to be completed at every encounter and the opportunity for child maltreatment could arise between visits, all encounters were included in the analysis.

RESULTS

There were 2,705 children who presented to the ED with fractures during the study period. The mean age was 38.4 months (SD 19.8) and 45.7% were <3 years old. Most patients were female (55.3%), White (59.7%), non-Hispanic (72.2%), and publicly insured (35.4%) (**Table 1**). 69.6% of encounters occurred between Monday and Friday, 60.1% during the 15:00–22:59 shift, and 14.3% were admitted (**Table 2**). A combined 86.7% presented with a chief complaint related to an injury or pain. The most common fractures were radius and/or ulna (24.1%), humerus (23.3%), and tibia and/or fibula (17.0%) (**Table 2**).

Overall, 90.5% (N=2,449) of patients were screened, of which 65 (2.4%) screened positive for nursing concern for potential abuse/neglect, and 88.1% screened negative. There were 256 (9.4%) encounters with an incomplete screen. We found no statistically significant differences in screening completion by age group (p=0.14), race (p=0.66), ethnicity (p=0.89), primary language (p=0.92), or insurance type (p=0.56). Furthermore, screen completion was not

Table 1. Patient Demographics, N=2,705

	N (%)
Sex	
Male	1,497 (55.3%)
Female	1,208 (44.7%)
Mean age, months (SD)	38.42 (19.8)
Age group	
0 to <12 months	293 (10.8%)
12 months to <24 months	436 (16.1%)
24 to <36 months	506 (18.7%)
36 to <48 months	464 (17.2%)
48 to <60 months	480 (17.7%)
>60 months	526 (19.5%)
Race	
White or Caucasian	1,614 (59.7%)
Black or African American	211 (7.8%)
Other	859 (31.7%)
Unknown/patient refused	21 (0.8%)
Ethnicity	
Not Hispanic or Latino	1,953 (72.2%)
Hispanic or Latino	736 (27.2%)
Unknown/Patient Refused	16 (0.6%)
Language	
English	2,407 (89.0%)
Spanish	260 (9.6%)
Other	37 (1.4%)
Unknown	1 (0.0%)
Insurance	
Public	957 (35.4%)
Private	1686 (62.3%)
Self-pay	62 (2.3%)

statistically significant according to the day of the week (p=0.46), nursing shift (p=0.42), or triage acuity (p=0.36). The proportion of completed screens by sex was statistically significant (p=0.04), with a higher proportion of screens among males (54.7%). Screening by ED disposition was also statistically significant: 89.4% of discharged children were screened, versus 96.9% of admitted children (p<0.001). There was a significant difference in positive, negative, and incomplete screens by age group, with 15.0% of children <12 months screening positive compared to <2% positive in each of the other age groups (p<0.001).

There were 312 (11.5%) encounters that had ED clinician concern for abuse and/or neglect. Of those with clinician concern, 55 (17.6%) had a positive screen, 237 (76.0%) had a negative screen, and 20 (6.4%) had an incomplete screen. Among encounters with negative or incomplete screens and clinician concern, 139 (54.1%%) were <12 months, 44 (17.1%) were 12 to <24 months, and 31 (12.1%%) were 24 to <36 months. The racial distribution of patients for whom there was a positive screen and ED clinician concern (45.5% White, 12.7% Black) was similar to that of the general ED population (47% White, 14% Black), however there was an

Table 2. Emergency Department (ED) Encounter Characteristics, N=2,705

	N (%)
Day of week	
Monday	376 (13.9%)
Tuesday	360 (13.3%)
Wednesday	356 (13.2%)
Thursday	388 (14.3%)
Friday	401 (14.8%)
Saturday	401 (14.8%)
Sunday	423 (15.6%)
Shift[a]	
07:00-14:59	710 (26.3%)
15:00-22:59	1,625 (60.1%)
23:00-06:59	370 (13.7%)
Emergency Severity Index (ESI)	
1	3 (0.1%)
2	862 (31.8%)
3	1,441 (53.3%)
4	391 (14.5%)
5	3 (0.1%)
Missing	5 (0.2%)
ED disposition	
Discharge	2,311 (85.4%)
Admit	387 (14.3%)
Other/Unknown	7 (0.3%)
Mode of arrival	
Car/Walk-in	2,508 (92.8%)
Ambulance/Emergency Medical Services	182 (6.7%)
Helicopter/Other	13 (0.5%)
Missing	2 (0.1%)
Chief complaint[b]	
Injury	2,081 (76.9%)
Pain	265 (9.8%)
Medical	17 (0.6%)
Fussy	7 (0.3%)
Concern for abuse	1 (0.0%)
Other	323 (11.9%)
Missing	11 (0.4%)
Fracture type	
Forearm (radius and/or ulna)	653 (24.1%)
Humerus	629 (23.3%)
Tibia and/or fibula	459 (17.0%)
Clavicle	265 (9.8%)
Skull	198 (7.3%)
Fingers, metacarpals, and/or carpal bones	183 (6.8%)
Toes, metatarsals and/or tarsal bones	170 (6.3%)
Femur	79 (2.9%)
Orbital and/or nasal	31 (1.2%)
Multiple bones in disparate body regions	24 (0.9%)
Spine (cervical, thoracic, lumbar)	12 (0.4%)
Rib	2 (0.1%)

a Based on standard nursing shifts.
b Chief complaints categorized as "injury" specifically included the following terms: fall, "injury," known fracture, laceration, motor vehicle crash, trauma. Those categorized as "medical" included the terms: abdominal pain, cough, emesis, fever, hematemesis, joint swelling, "medical," mouth lesions, otalgia, seizures, shortness of breath, sore throat. Those categorized as "other" had a chief complaint specifically of "other."

Table 3. Test characteristics of nursing-completed abuse screen for the entire cohort ages 0–5 years, and stratified by age group[a]

	% [95 % CI]
1–5 years	
Sensitivity	19.2% [14.7%–23.8%]
Specificity	99.5% [99.3%–99.8%]
Positive predictive value	84.6% [75.8%–93.4%]
Negative predictive value	90.3% [89.1%–91.5%]
0–<12 months	
Sensitivity	24.4% [18%–30.8%]
Specificity	98.1% [95.4%–100%]
Positive predictive value	95.5% [89.3%–100%]
Negative predictive value	43.7% [37.3%–50.1%]
12–<24 months	
Sensitivity	11.1% [1.9%–20.3%]
Specificity	99.1% [98.2%–100%]
Positive predictive value	62.5% [29%–96.1%]
Negative predictive value	89.5% [86.4%–92.6%]
24–<36 months	
Sensitivity	12.1% [1%–23.3%]
Specificity	99.5% [98.9%–100%]
Positive predictive value	66.7% [29%–100%]
Negative predictive value	93.6% [91.3%–95.8%]

a Age was stratified up to age 36 months given the higher risk of abuse among infants and toddlers, and the estimate that up to one in five abusive fractures are missed among children under the age of 3 years.[9]

overrepresentation of White children (70%) compared to Black children (0%) for whom there was a positive screen and the ED clinician was *not* concerned.

The overall cohort admission rate was 14.3%. Over three-quarters (76.9%) of the 65 children with a positive screen were admitted, while 54.3% of the 312 children with ED clinician concerns were admitted. Clinicians raised concern for 56.1% of patients ultimately diagnosed with skull fractures and 32.9% with femur fractures who screened negative.

The test characteristics of the nursing screen among children <5 with completed screens as well as among children when stratified by age can be seen in **Table 3.** Overall, the sensitivity of the nurse-completed screen is poor (19.2%, 95% CI 14.7–23.8%), with a specificity of 99.5% (95% CI 99.3–99.8), PPV of 84.6% (95% CI 75.8–93.4%), and NPV of 90.3% (95% CI 89.1–91.5%). When stratified by age, there are notable differences in test characteristics. Among the highest risk children < 12 months, the sensitivity is slightly higher at 24.4% (95% CI 18–30.8%), with a specificity of 98.1% (95% CI 95.4–100%), and PPV of 95.5% (95% CI 89.3–100%), however the NPV is markedly lower at 43.7% (95% CI 37.3–50.1%).

DISCUSSION

We sought to assess compliance with and test characteristics of an institution-specific child abuse screening among children aged 0–5 diagnosed with a fracture(s). The overall compliance rate of 90.5% was comparable to other findings on universal child abuse screening in EDs.[23-24] Moreover, the proportion of children who screened positive (2.4%) is also comparable to other studies of universal screening.[13,25-26] We found no differences in the proportion of patients screened based on sociodemographics, with the exception of sex. While this may be due to the expectation of universal rather than targeted screening, evidence regarding the relationship between universal screening and human biases is still inconclusive.[16] We found the screen's overall sensitivity to be poor among children <5 who ultimately were diagnosed with fractures, markedly lower than that of previously published screens,[12,13,28-30] and signifying that few encounters raising clinician concern for potential abuse would be identified with a positive screen.

This institutional screen has similar questions to the Escape questionnaire,[13] yet the specific language and complete set of questions were not used. Studies assessing the diagnostic accuracy of Escape found its sensitivity, specificity, PPV, and NPV to be 80–100%, 98.3–99%, 10–25.5%, and 99–100% respectively when using reference standards of confirmed[12] and suspected[13] child abuse. However, these study populations included children who were up to age 18 years[12,13] and overall, at lower risk of abuse than just infants and toddlers, possibly impacting the test characteristics. As previously described,[3,13] clinician concern for potential abuse was intentionally chosen as the reference standard over confirmed abuse, as the goal of the screen is to identify high-risk cases that warrant further consideration, and not to diagnose abuse. The prevalence of abusive fractures among infants and toddlers is high,[4-5] and fracture identification should prompt consideration of abuse, particularly among infants <1 year. Thus, we chose to err on the side of including encounters that ultimately may not have been determined to be abuse as to minimize the potential for missed cases.

Our findings revealed a large discrepancy between clinician and nurse concerns, as 76.0% of children for whom clinicians were concerned for abuse had a negative screen. There were notable differences in test characteristics when stratified by the youngest and highest-risk patients. One possible explanation for these findings is that nurses may have suspected abuse to be more likely among children <12 months, thus increasing sensitivity and PPV compared to the entire cohort of children 0–5 years; however, 54.1% of cases with clinician concern but a negative nurse screen occurred in this age group. Although screening nurses were not aware of the final diagnosis, 86.7% of chief complaints were related to pain and/or injury, which should have prompted consideration of abuse, particularly among infants. Conversely, potential abuse among ambulatory children 12 to <36 months could have been misinterpreted as a developmentally appropriate unintentional injury, resulting in lower screening sensitivity in this age group.[27,28] These discrepancies were likely influenced, at least in part, by a combination of limited child abuse training for nurses at the study institution, the use of a modified screen that has not been validated, and a suboptimal workflow. Questions 1 and 2 of the screen, typically completed in triage, relied on nurse assessment when 1) the history and exam were brief and limited; 2) the child was typically dressed and in the presence of a caregiver; and 3) multiple other assessments were required, which may have reduced screening accuracy.

Despite the lack of a gold standard screen, hospitals have been increasingly integrating clinical decision support systems into their EHRs to comply with AAP guidelines.[16,31,32] Child abuse pediatricians and researchers have agreed that these systems should layer active and passive approaches, incorporate real-time data on clinical characteristics, integrate into the clinical workflow, mitigate disparities, and be accompanied by ED staff training.[16,33,34] Although the screen in this study was brief and integrated into the EHR, workarounds allowed for nearly 10% of screens to remain incomplete, undermining the goal of universal screening. The sole reliance on nursing assessment as well as verbal communication of results to the responsible clinician limits its impact and value, and it is clear that this screen is not optimal for identifying the most vulnerable patients presenting with fractures. While our findings are not generalizable to hospitals with different screening tools, these findings support the need for institutions to assess their screens and utilize evidence-based validated methods, when possible, rather than institution-specific tools.

Limitations

Although a keyword search for common terms and phrases related to concern for child abuse, cases with ED clinician concern may have been overlooked if documentation did not include the identified keyword terms. Additionally, we designated clinician concern for abuse as the reference standard in lieu of having confirmed child abuse cases. This could have introduced misclassification bias into our test characteristics and limits comparability to other validated screens. Finally, we did not review all cases *without* the presence of the keywords, which may have introduced partial verification bias.

CONCLUSION

This study corroborates existing evidence on child abuse screening limitations and further emphasizes the need for institutions to perform ongoing assessment and validation of screening tools used to identify children who may have been abused across the pediatric age spectrum *and* in high-risk subgroups. Although the screen used in this study demonstrated high compliance, test characteristics varied by age, and there were notable differences compared to clinician concerns, highlighting potential knowledge gaps, biases, and opportunities for screening improvements. Based on our findings, we recommend implementation of automated multidimensional screening systems that incorporate evidence-based, objective, and discrete data elements and validated tools (e.g., TEN-4 FACESp),[15] and more robust nursing education about child maltreatment. Universal screening with special attention to high-risk groups (e.g., an infant presenting with an injury) is critical to improve the identification of potentially abused patients.

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Development of an Emergency Department Family Navigator and Text Message Intervention for Caregivers to Reduce Youth Risk of Suicide and Self-injurious Behavior

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ABSTRACT

BACKGROUND: Suicide and self-injurious behavior (SSIB) in youth 10 to 14 years old has rapidly increased, with suicide rates for youth 10 to 18 years being the second leading cause of death. Youth with SSIB seen in the Emergency Department (ED) are often discharged to the community, yet less than 40% receive subsequent mental health (MH) care within 30 days. This open pilot study examined the feasibility, acceptability, and sample characteristics of a two-component Family Navigator with text messaging intervention, ED REaCH, for caregivers of youth with SSIB discharged from the ED.

METHODS: Sixteen dyads of youth (*M*=12.67; *SD*=1.09) seeking emergency care for SSIB and their caregivers were enrolled from the ED of a pediatric hospital in the northeast US from November 2023 to March 2024. Dyads were enrolled in the ED REaCH intervention consisting of navigation procedures to promote linkage to care, engagement in community-based MH care for youth with SSIB, and a digital platform to extend purported mechanisms underlying the intervention's efficacy (MH literacy, MH communication, and MH engagement). Data was collected on measures of social identities, demographics, functioning, MH services, and intervention satisfaction.

RESULTS: All (100%) caregivers accepted the text messages. Most (75%) utilized the Family Navigator and completed the intervention feedback interviews. Overall, caregivers endorsed positive experiences and satisfaction with the two-component intervention. All caregivers who utilized the Family Navigator reported that 100% of youth attended MH care.

CONCLUSION: Preliminary findings suggest that the content and delivery methods of this intervention are perceived by caregivers as feasible and acceptable. As such, next steps include the evaluation of the ED REaCH intervention in a randomized clinical trial design. Future directions need to focus on intervention scalability, adaptability, personalization, and sustainability.

KEYWORDS: Youth, Suicide, Emergency Department, Family Navigator, Text Messages

INTRODUCTION

Suicide is the second leading cause of death for youth aged 10–18 years in the United States (US), and rates of suicidal and non-suicidal self-injurious behavior (SSIB) in youth 10 to 14 years have been rapidly increasing.[1-3] This surge in SSIB coincides with a 60% increase in Emergency Department (ED) visits related to mental health (MH) disorders and a 329% increase in visits related to SSIB in individuals under 18 years.[4]

A prior suicide attempt is the single most potent predictor of youth suicide,[5] and up to 50% of youth who die by suicide present to the ED within the year preceding death.[6] Even more prevalent is nonfatal suicidal behavior, as it results in significant morbidity and increased risk of death by suicide.[5-7] Most youth with SSIB are discharged from the ED to the community (73%), yet less than 40% receive subsequent MH care within 30 days.[8] This delay in receiving MH care is concerning given these are the same youth at high risk for suicide reattempts, especially within the first six months.[5]

For youth with SSIB, underlying MH disorders, such as depression and anxiety are relevant remediable risk factors to target in the context of interventions, given their association with suicidal behavior.[5,9] Depression and anxiety are often treatable with consistent attendance and engagement in MH care.[10,11] Notably, EDs have become an essential and often routine MH service for youth and are frequently the first point of entry for youth into the MH system.[12]

Despite high rates of youth seen in the ED for SSIB, effective ED interventions to increase linkage to subsequent community-based MH care are lacking. Over 20 years of evidence[13] highlights the need for youth with SSIB to be linked to community-based MH care after an ED admission. Still, there is limited evidence detailing effective ED interventions to bridge this gap.[14-16] To further compound this problem, structural barriers (e.g., long waitlists, availability) limit access to care, which is frequently accompanied by reduced motivation to seek services due to the expectation of long wait periods.[14]

Even when a referral is made from the ED to a community-based MH service, there is often a considerable "referral-to-service gap" when attempting to connect youth and families to care.[17,18] In a recent review of the literature, pediatric patient navigation models for pediatric illness were denoted efficacious in facilitating patient engagement and the linkage to community-based services (time spent and services completed).[18] Navigation models can provide a "warm handoff" for youth and their families who have experienced a hospital admission and are discharged with referrals to community-based care.[17,18] Research demonstrates effective navigation models in pediatric specialty clinics, and adherence to complicated and life-dependent treatments.[18] The literature also showcases the effectiveness of navigation models in community settings and in adult populations.[19] However, to our knowledge, there is no evidence regarding navigation models for youth with SSIB in pediatric EDs, particularly integrated protocols that seek to both promote linkage to care and the extension of information, support, and encouragement for families in their natural environment.

Digital platforms, such as text messaging, have been shown effective in providing information, support, and encouragement to individuals within their natural environments.[20] Text-based platforms are highlighted in the literature due to their effects promoting healthy behavior change.[21-23] For example, in a pediatric ED study, sending educational text messages to infant caregivers was effective in reducing the number of visits to the ED.[24] Given the accessibility and small expense of sending text messages, the results have direct implications on the cost of health care, in addition to improving continuity and quality of care for pediatric patients.[25] Studies suggest that text messaging with caregivers is feasible and acceptable.[26] However, to our knowledge, the integration of navigation models and text messaging to extend and help promote greater ED intervention reach and access does not exist.

The present study examines feasibility, acceptability, and qualitative outcomes of a navigation- and text message-based intervention that employs an ecological model within a socio-cultural theoretic framework of MH service disparities and barriers to treatment that is grounded in motivation enhancement theory.[27,28] Foundational data for this intervention was derived from key stakeholder interviews (*n*=40; youth with SSIB utilizing the ED, their caregivers, ED psychiatric emergency service clinicians, and community-based MH clinicians) from 2022 to 2023 that support this intervention development by identifying barriers and facilitators to youth linkage to MH service after an ED admission.[29,30] Specifically, stakeholders' highlighted information included gaps in securing community-based MH care (with long wait times, little availability); limited youth and caregiver MH literacy (i.e., MH symptoms, coping/tolerance of distress, normative youth development, reasons for care, and levels of care/types of treatment), limitations in youth and caregiver MH communication (i.e., symptom severity, how to ask for help, how to discuss concerns, and language used to talk about MH and distress); and the engagement and navigation of the MH system (i.e., system structure, barriers to care). The intervention described here combines navigation procedures to promote linkage to care, engagement in and adherence to community-based MH care for youth with SSIB, as well as a digital platform to extend purported mechanisms underlying the intervention's efficacy (MH literacy, MH communication, and MH engagement). An open pilot trial of the intervention was conducted with caregivers of youth with SSIB after discharge from a pediatric ED acute care admission. The primary objective of this pilot intervention was to examine preliminary indices of feasibility, acceptability, and qualitative outcomes of the developed intervention (ED REaCH).

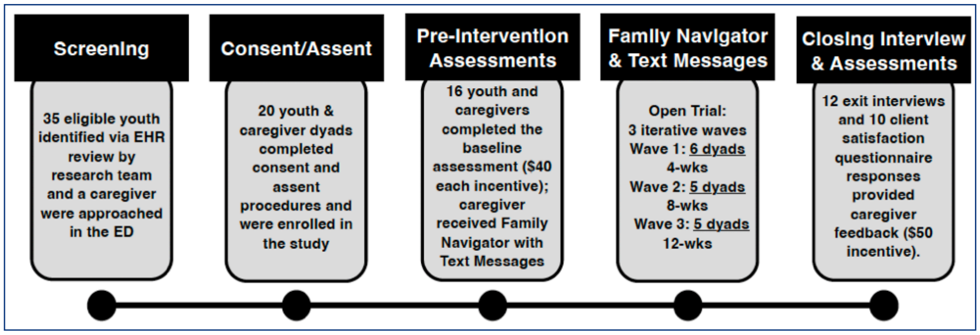
METHODS

Participants and Procedures

An open pilot trial of the ED REaCH intervention was conducted in the ED of a pediatric hospital in the northeast US. Youth met study eligibility criteria if they were 10 to 14 years old, living at home with a legal guardian/caregiver, presenting to the ED with SSIB, and had a discharge plan home. Youth were excluded from the study if they had a presentation of psychosis, sexual assault, or child abuse, were in police custody, unable to assent due to severity of symptoms, illness, or developmental disabilities, referred to inpatient psychiatric care, not fluent in English, or if no caregiver/legal guardian was able to provide consent and participate. Caregivers were eligible for the study if they were the youth's legal guardian and lived with the youth. Institutional Review Board (IRB) approval was obtained prior to study implementation. The study was registered at ClinicalTrials.gov: NCT05954585.

Sixteen dyads of youth (M_{age}=13.00, *SD*=0.73) seeking emergency care for SSIB and a caregiver were approached and enrolled into this study via three waves of recruitment from November 2023 to March 2024. All electronic health records (EHR) of youth presenting to the ED during a convenience sample of daytime shifts were screened for eligibility. If found eligible, caregivers and youth were approached by study staff to determine interest. Study procedures and time commitments were explained to interested youth and caregivers. Written caregiver consent and youth assent were obtained. Directly after consent/assent, each youth and caregiver completed a battery of self-report measures while in the ED. Caregivers who consented to the study agreed to share specific data within their youth's EHR with the study: Reason for admission, SSIB evaluation information, and disposition. Study procedures were completed in the ED with families during the youth's ED admission wait times (frequently greater than 60 minutes). Once the battery of assessments was complete, caregiver participants scheduled their first appointment with the study Family Navigator. At the end of the study, each caregiver completed exit interviews to provide feedback about the study intervention. Youth and caregivers were each compensated for their time completing

Figure 1. Overview of Study Procedures



the study assessments ($40) and caregivers for completing the exit interview ($50).

This theory-driven study was conducted to further develop and refine the intervention.[27,28] **See Figure 1** for an overview of the trial. This iterative process involved three waves: The 1st wave over four weeks with six dyads, the 2nd wave over eight weeks with five dyads, and the 3rd wave over 12 weeks with five dyads. Feedback after each wave informed the next wave of modifications to the intervention to maximize acceptability and usefulness. Queries on intervention satisfaction, usability, and acceptability were collected via a qualitative exit interview with caregivers to explore attitudes and opinions regarding intervention content, conditions, and delivery. The primary questions were related to the two-component (Navigator and text messaging) intervention's feasibility, acceptability, burden, engagement, helpfulness, usability, and satisfaction. Target enrollment for this study was between 16 to 20 youth and caregiver dyads.

External Advisory Board

An External Advisory Board was established for this study and made up of four nationally recognized experts (psychologists, research physicians, and research scientists within academic medical centers) in the field of ED injury control and suicide prevention. The Board met twice annually with the Primary Investigator (MKC) and provided feedback that was integrated in the intervention's scalability, sustainability, acceptability, and translation.

ED REaCH (RESILIENCE EDUCATION AND CAREGIVER HELP)

ED REaCH emphasizes the importance of resilience, education, and caregiver support via the two-component family navigation and text messaging intervention to reduce youth SSIB risk.

Family Navigator

The Family Navigator was a research staff member trained in motivational interviewing principles.[31] The Navigator protocol was not designed to provide SSIB crisis intervention. The protocol (~20 mins) was based on prior navigator models and designed for caregivers, not youth.[17,18] Contact was made biweekly with caregivers during the 1st wave. Following caregiver feedback requesting more frequent contact, Navigator contact was increased to weekly in the 2nd and 3rd waves. Caregivers were contacted for their bi/weekly Navigator appointment for four weeks (wave-1), eight weeks (wave-2), or 12 weeks (wave-3) or until their youth attended community-based MH services, whichever came first. If families did not follow up with MH services after a 12-week period, they were able to remain in the study until services were obtained (though, this did not occur during this trial). During the bi/weekly communications, the Navigator spoke with caregivers and provided education, support, and assistance on youth MH symptoms and severity, MH communication, and MH service(s); discussed the ED discharge plan including the youth's safety plan (and facilitated another copy of the plan when needed) and referral to MH care; discussed SSIB safety procedures and the restriction of lethal means; addressed barriers to MH care and coordinated MH services; provided other requested resources (i.e., education on gender-affirming care, LGBTQ+ peer groups) for families and youth.

Text Messages

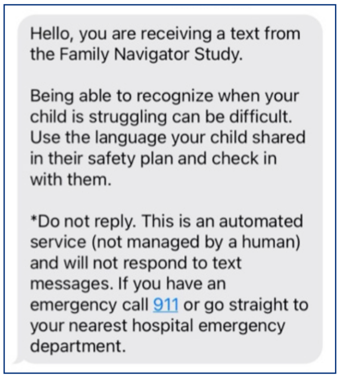
Automated text messages were delivered via Qualtrics[32] online survey platform and based on the intervention putative mechanisms (i.e., MH literacy, MH communication, and MH engagement). The text messages were sent to caregivers three times per week until the end of the study. Youth did not receive text messages. Text message content included two to three sentences on caregiver communication strategies, MH literacy, encouragement, support, the importance for youth MH services, and SSIB safety procedures including lethal means restriction. See **Figure 2** for an example text message.

Measures

Sample Characteristics

All participant dyads completed pretreatment quantitative self-report measures to assess youth social identities, SSIB,

Figure 2. Text Message Example


Hello, you are receiving a text from the Family Navigator Study.

Being able to recognize when your child is struggling can be difficult. Use the language your child shared in their safety plan and check in with them.

*Do not reply. This is an automated service (not managed by a human) and will not respond to text messages. If you have an emergency call 911 or go straight to your nearest hospital emergency department.

psychological symptoms, MH services to date, family demographics, communication, MH literacy, and motivation for youth MH care, and caregiver life stressors and sources of support. See **Table 1** for questionnaire details.

Feasibility, Acceptability, and Safety

Feasibility was evaluated through (a) recruitment rate of four to six dyads per month, (b) 80% retention rate across the study period, including percent of participants who completed assessments, (c) 70% completion rate of Family Navigator protocol, and (d) 70% engagement with the text messages including participant reports of reading messages.

Acceptability was derived from (a) the perceived usability of the intervention reported during the Qualitative Exit Interview with mostly positive/few negative comments, (b) mostly positive/few negative comments from the feedback, and (c) average score of 24 on the Client Satisfaction Questionnaire (CSQ-8). Safety was evaluated via (a) no report of serious adverse events and (b) chart review of youth patient readmission to the ED for SSIB.

Qualitative Interviews

Research staff conducted semi-structured interviews (~30-minutes) with caregivers over the phone at the end of the intervention protocol for each wave of the study. The purpose of these interviews was to elicit feedback on perceived acceptability and usability of the intervention, as well as ways to improve/refine intervention content and delivery for the subsequent phase of the study involving a randomized clinical trial.

Data Analysis

The iterative development and initial acceptability and feasibility results presented below are based on youth and caregiver dyads. Descriptive statistics (via SAS version 9.4, Cary, NC) were utilized to describe the study population and explore responses. Qualitative data analysis was conducted to learn and understand caregiver feedback about the intervention using the Framework Matrix approach.[43] Interviews were independently coded by two research staff, who met to establish code concordance. The Principal Investigator resolved any discrepancies. Framework Matrix is a structured process to categorize qualitative data by *topic/a priori* (deductive) and *data driven* (inductive) codes.

Table 1. Study Measures

Suicidal Ideation Questionnaire (SIQ-JR):[33] is a 15-item measure covering youth distress and suicidal intent. Each item is on a 5-point Likert Scale and a sum score was obtained for all items. Greater scores correspond to higher levels of suicidal ideation; clinical cutoff score is 15.
Pediatric Symptom Checklist (PSC):[34] is a 35-item measure that assesses youth psychological impairment via 5 subscales (Attention, Internalizing, Externalizing, School and Other), with 3-category responses (0-Never, 1-Sometimes, 2-Often). The total score is derived from the sum of the attention, internalizing, externalizing and school subscales. Clinical cut score is 28 or above.
McMaster Family Assessment Device (FAD):[35] is a 60-item measure with seven subscales (problem solving, communication, roles, affective responsiveness, affective involvement, behavior control and general functioning). Subscales are scored by taking the average.
Motivation for Youth Treatment (MYTS):[36] is an 8-item scale that assesses youth treatment motivation of youth and caregivers. MYTS has two subscales – recognition the youth has a problem; readiness to participate in treatment. MYTS has a total score and subscale scores. Higher scores correspond to higher motivation for treatment.
Mental Health Literacy Scale (MHLS):[37] (adapted for this study) is used to explore the participant's understanding of mental health. Caregivers received a 33-item measure: 13 items used a 4-point Likert Scale and 20 items on a 5-point Likert Scale (maximum score of 152). Youth received a 24-item measure: four items on a 4-point Likert Scale and 20 items on a 5-point Likert Scale (maximum score of 116). A composite score was derived from summing all the items; higher scores corresponding to greater mental health literacy.
Child and Adolescent Services Assessment (CASA):[38] is a 36-item measure adapted for study use and administered to caregivers regarding youth healthcare utilization. Response options include "Yes," "No," and "Don't Know." The CASA is scored as a sum score of the responses of "Yes." Higher scores indicate greater utilization of healthcare services.
Life Stress scale: [39] is an 18-item measure that assesses experienced stressors by the caregiver over the past month. Life stress items had response options including "Didn't happen", "No negative impact", "Little negative impact", "Negative impact", and "Very negative impact." Endorsed responses were scored as a sum score. Higher scores indicate higher stress impact.
Life Support scale: [39] is a 12-item measure that assesses caregiver support received from others, outside of the family, over the past month. Life support response options included "Not at all," "Once," "Twice," and "3 or more times". Responses aside from "Not at all" were scored as a sum score. Higher scores indicate higher caregiver support impact.
Client Satisfaction Questionnaire (CSQ-8):[40] is an 8-item measure assessing quality of service, relevance of service, satisfaction with service received and likelihood of referring others to the service. Utilizing a 4-point Likert Scale, a composite score was derived by summing all 8 items with higher scores corresponding to greater satisfaction with services received.
Barriers to Treatment: [41] is a 44-item rating of how much caregivers agree with statements about their expectancies of barriers to treatment for their child, using a 5-point Likert scale (1=totally disagree, 5=totally agree). Higher scores indicate increased barriers to care. This measure was adapted for study use and contained 38 items.
Social Determinants of Health (SDOH):[42] is a 14-item measure is used to help identify specific needs of an individual/family. It screens for five core health-related social needs, which include housing, food, transportation, utilities, and personal safety, as well as employment, education, childcare, and financial strain.
Navigator Session Feedback Survey: is a 3-item survey developed to assess caregiver satisfaction of the Navigator session including the overall session, pace, and Navigators' knowledge, support, and engagement.

RESULTS

Sample Characteristics

Social Identities and Demographic Data

A diverse sample of youth (M_{age}=13.00, *SD*=0.73) identified as 31.25% Hispanic/Latinx, 25% as Black/African American, and 56.25% as White. While youth sex assigned at birth was reported as 93.73% female, gender identity represented a significant range: 50% identified as male, 18.75% as female, and 12.50% as non-binary. A proportion of youth identified their sexual orientation as pansexual/asexual (31.25%) and homosexual (25%). Most caregivers (M_{age}=41.87, *SD*=6.37) identified both sex assigned at birth and gender identity as female (68.75%), as well as 81.25% identified as non-Hispanic, 25% as Black/African American, and 75% as White. Caregivers were biological (93.75%) or adoptive (6.25%) parents, with annual income varied across the sample, with the most frequently reported ranges being $26–49K (18.75%), $75–99K (18.75%), $100–149K (18.75%) and $150K+ (18.75%). See **Table 2** for greater detail.

Youth MH Symptoms

Youth suicidal ideation on the Suicidal Ideation Questionnaire-Jr (SIQ-Jr; *M*=33.56, *SD*=14.88) was more than double the scale's clinically significant cutoff score of 15. However, only 25% of youth and 12.5% of caregivers indicated on the Pediatric Symptom Checklist (PSC) that youth MH symptoms were in the psychologically impaired range. Youth and caregivers did, however, endorse youth clinically elevated Internalizing Subscales scores *M*=7.56 and *M*=6.75, respectively, on the PSC.

Family Communication and MH Literacy

When compared to their caregivers, youth indicated fewer problems with communication (*M*=2.38, *SD*=0.21 versus *M*=2.42, *SD*=0.15), affective involvement (*M*=2.5, *SD*=0.42 versus *M*=2.8, *SD*=0.37), and behavior control (*M*=2.59, *SD*=0.2 versus *M*=2.64, *SD*=0.23) on the McMaster Family Assessment Device (FAD). Youth demonstrated lower MH literacy on the Mental Health Literacy Scale (MHLS; *M*=89.13, *SD*=11.18 out of a maximum score of 116) than their caregivers (*M*=127.06, *SD*=12.78 out of a maximum score of 152).

Table 2. Sample Characteristics

	Youth (n=16) *N* (%) or mean (SD)	Caregivers (n=16) *N* (%) or mean (SD)
Sex at Birth		
Male	0 (0%)	5 (31.25%)
Female	15 (93.75%)	11 (68.75)
Do not want to answer	1 (6.25%)	0 (0%)
Gender Identity (> one can be selected)		
Male	8 (50%)	5 (31.25%)
Female	3 (18.75%)	11 (68.75)
Non-binary	2 (12.5%)	
Genderqueer	0 (0%)	
Agender	1 (6.25%)	
Gender non-confirming	1 (6.25%)	
Not listed (Indicated: Gender-fluid)	2 (12.5%)	
Do not want to answer	0 (0%)	
Ethnicity		
Hispanic or Latino	5 (31.25%)	3 (18.75%)
Non-Hispanic or Latino	10 (62.5%)	13 (81.25%)
Do not want to answer	1 (6.25%)	0 (0%)
Race (more than one can be selected)		
American Indian/Alaskan Native	1 (6.25%)	0 (0%)
Asian	2 (12.5%)	1 (6.25%)
Black or African American	4 (25%)	4 (25%)
Native Hawaiian/Other Pacific Islander	1 (6.25%)	1 (6.25%)
White	9 (56.25%)	12 (75%)
Not listed	0 (0%)	1 (6.25%)
Prefer not to answer	1 (6.25%)	0 (0%)
Sexual Orientation		
Heterosexual	3 (18.75%)	
Homosexual	4 (25%)	
Bisexual	1 (6.25%)	
Undecided	1 (6.25%)	
Other (Indicated: Pansexual & Asexual)	5 (31.25%)	
Do not want to answer	2 (12.5%)	
Caretaker Highest level of Education		
Some high school		2 (12.5%)
High school degree		1 (6.25%)
Some college		3 (18.75%)
2-year degree		3 (18.75%)
4-year degree		5 (31.25%)
Master's level degree		2 (12.5%)
Marital Status		
Single, never married		4 (25%)
Living with partner, unmarried		1 (6.25%)
Married		7 (43.75%)
Separated/divorced		4 (25%)
Annual Income		
$5,000–$49,999		5 (31.25%)
$50,000–$74,999		1 (6.25%)
$75,000–$99,999		3 (18.75%)
$100,000–$149,000		3 (18.75%)
Greater than/equal to $150,000		3 (18.75%)
Prefer not to answer		1 (6.25%)

MH Treatment and Barriers to Care

Youths' overall motivation for treatment total score indicated lower motivation for treatment than their caregivers (*M*=29.44, *SD*=4.11 versus *M*=32.94, *SD*=3.49) on the Motivation for Youth Treatment (MYTS). Interestingly, youth demonstrated higher scores than caregivers on the "recognition that the youth has a problem" subscale, (*M*=14.75, *SD*=3.45 versus *M*=9.69, *SD*=2.02) but slower "readiness to participate in treatment" subscale scores than their caregivers (*M*=14.69, *SD*=2.44 versus *M*=23.25, *SD*=2.41). On the Child and Adolescent Services Assessment (CASA), caregivers endorsed a modest level of healthcare service utilization for their youth (*M=10.13, SD*=5.14; Min: 2; Max: 19*)*. On the Barrier to Treatment scale, caregivers indicated several factors that might compromised their child's MH care, namely, "scheduling appointment times…" (33%), "…too tired after work…" (33%), "treatment will be more work than I think" (33%), and "bad weather…" (42%) being the greatest concerns. Similarly, on the Social Determinants of Health (SDOH) measure, caregivers endorsed numerous barriers including "eating less than you felt you should…wasn't enough money for food" (42%), "…challenges with attending school" (50%), "…child education needs" (42%), and "…previous contact with DCYF" (58%).

Caregiver Stressors and Support

While most caregivers (81.25%) indicated a high level of challenges with life stressors on the Life Stress scale (four or more life stressors; *M*=12.31, *SD*=8.54, Min: 3, Max: 36), 93.75% of caregivers endorsed two or more sources of support (*M*=11.75, *SD*=6.98, Min: 3, Max 30) on the Life Support scale.

Feasibility

Recruitment

Electronic health records were screened and 58 youth 10- to 14-years-old were identified in the ED as meeting study criteria. Out of those 58, 13 were discharged and left the hospital prior to being approached about the study; 45 dyads were approached, but 10 youth who initially met study criteria were discharged to inpatient psychiatric care and no longer met study criteria; 18 dyads declined study participation (reasons included: "too tired," "too busy," "too stressed," "not interested," "too much going on," "too frustrated," and "we just want to go home"); one dyad was approached and signed a 'consent to contact' form (to be contacted after their ED discharge) but later did not return study calls; and 16 dyads met full study criteria and enrolled into the study.

Table 3. Caregiver Report on the Two-component Navigator and Text Message Intervention

Client Satisfaction Questionnaire (CSQ-8; n=8)		
Question	Response option	End of study
How would you rate the quality of service you received?	Excellent	7 (88%)
	Good	1 (12%)
	Fair	0
	Poor	0
Did you get the kind of service you wanted?	No, definitely	
	No, not really	
	Yes, generally	4 (50%)
	Yes, definitely	4 (50%)
To what extent has our care met your needs?	Almost all of my needs have been met	4 (50%)
	Most of my needs have been met	3 (38%)
	Only a few of my needs have been met	1 (12%)
	None of my needs have been met	0
If a friend were in need of similar help, would you recommend our services to them?	No, definitely no	0
	No, I don't think so	0
	Yes, I think so	0
	Yes, definitely	8 (100%)
How satisfied are you with the amount of help you received?	Quite dissatisfied	0
	Indifferent or mildly dissatisfied	0
	Mostly satisfied	3 (38%)
	Very satisfied	5 (63%)
Have the services you received helped you to deal more effectively with your problems?	Yes, they helped a great deal	4 (50%)
	Yes, they helped	4 (50%)
	No, they really didn't help	0
	No, they seemed to make things worse	0
In an overall, general sense, how satisfied are you with the services you have received?	Very satisfied	5 (63%)
	Mostly satisfied	3 (38%)
	Indifferent or mildly dissatisfied	0
	Quite dissatisfied	0
If you were to seek help again, would you come back to our services here?	Yes, they helped a great deal	5 (63%)
	Yes, they helped	3 (38%)
	No, they really didn't help	0
	No, they seemed to make things worse	0
Caregiver Satisfaction on Navigator Session (n = 10)		
Please rate your satisfaction with this navigator session/ guidance provided by the family navigator.	Quite dissatisfied	0
	Indifferent or mildly dissatisfied	0
	Mostly satisfied	4 (40%)
	Very satisfied	6 (60%)
Was the session at a comfortable pace?	Yes	10 (100%)
	No	0
Was the navigator engaging, supportive, and knowledgeable?	Yes	10 (100%)
	No	0

Family Navigator: Caregiver Attendance and Retention

Family Navigator initial appointments were scheduled while youth were still in the ED. A total of 12 out of 16 caregivers (75%) attended their first Navigator appointment. For Wave 1, five out of six (83.33%) caregivers attended their first appointment, for Wave 2, three out of five (60%) attended, and for Wave 3 four out of five (80%) attended.

Youth Attendance in Community-based MH Care

At the first Navigator call (within three to seven days from the ED admission), most caregivers (83%) reported that their youth had attended the ED recommended community-based MH care (i.e., partial program, treatment with new therapist, treatment with original therapist, home-based family therapy). One caregiver (from Wave 1) continued to work with the Navigator for a second appointment, and then reported the youth had attended a new therapist session. Another caregiver (from Wave 1) worked with the Navigator for a total of five appointments to secure services. This caregiver was a single parent, attending college, while also working full-time. They reported that they had difficulty receiving and making phone calls during office hours to secure services. With support, coaching and assistance, this caregiver was able to secure a therapist for the youth for remote telehealth MH care.

Information via Text Message

Caregivers (100%) accepted (i.e., did not stop or refuse) each of the text messages throughout the duration of the study. During the end-of-study interviews, caregivers reported reading the text messages and finding them "actionable," "relevant," and "new" or "a good reminder."

Acceptability

Satisfaction

Out of this two-component intervention, 75% of caregivers participated in the Navigator component and 100% completed the text message component. Caregiver satisfaction on Navigator sessions (n=10) revealed a high rate of satisfaction, with 60% Very Satisfied and 40% Mostly Satisfied. Caregivers expressed high support, satisfaction, and usability of the Navigator and text message intervention during the qualitative interviews. Among caregivers responding to the CSQ-8 (n=8), the average score was 31.75, suggesting a high level of satisfaction with the program. See **Table 3** for Navigator session and intervention feedback.

Table 4. Intervention Feedback and Iterative Modifications

Content	Caregivers Exit Interview Quotes:
1. Review Safety Plan A Safety Plans is a brainstorm of ways for youth to stay safe and have a plan on what to do to reduce risk and self-harm when experiencing SSIB symptoms. It can include planning for a future crisis, considering your options, and making decisions about your next steps.	"It is great to have the [safety] plan, but it is also challenging because now that we are home and she is back to school, some of the coping skills she listed now do not work. What do we do?" "We have used Safety Plans before and found what worked for them last month, is not working for them now." "I need more information about safety plans/coping skills; how to operationalize them; how to have them grow with my child developmentally and situationally."
2. Review Lethal Means Restriction An approach to suicide prevention that reduces access to a fatal method of suicide (e.g., firearms, medications, sharps)	
3. Mental Health Literacy When a family utilizes the ED for youth acute SSIB, youth and caregivers alike are often acutely distressed and may have difficulty remembering the details of their youth's ED encounter and disposition. This can often be explained as a function of their distress tolerance.	"I have no idea how the mental health system works. We went to the ED, and the providers were speaking gibberish to us. We need more information about all of the different types of service." "It would be helpful if their PCP had more information and resource on MH, maybe it would not have gotten to this extreme" "I don't let it happen, but I can see how stigma and embarrassment can get in the way."
4. Youth Adherence/Attendance to ED Recommended level of Community-based Care	"While we are on the waitlist, we are going to wait to see if my child really needs that level of care. It is a lot of time out of school."
5. Review of MH Communication	"The text messages remind me how to approach him [youth] in a positive way."
6. Mental Health Engagement	"We need to know we are not alone." "We are sitting in the dark and do not know what to do with our youth – they have a therapist and a psychiatrist – but what do we do to support them at home?" "We need to be a unified group – caregiver(s) and youth."
7. Caregiver Anxiety and Support	"We [Caregivers] need to know how to help ourselves." "I need more info to manage my own anxiety." "I feel fully responsible for my youth's problems." "I feel overwhelmed and completely stressed out."
8. How to parent a child after an ED visit for SSIB.	"I need more information and support while I support my child."

Exit Interviews' Feedback

Exit Interviews' feedback and intervention modifications are outlined in **Table 4**. Overall, caregivers reported feeling satisfied with the ED REaCH intervention. When asked what else they would like to have in the intervention, they reported wanting: 1) more information about the safety plan and "how to use it" once they were "home" in their own environment, 2) more "education and scaffolding" on youth distress tolerance, MH symptoms and symptom severity, 3) a "road map" of youth MH services and resource, 4) more caregiver "support" and ways to "manage [their] own anxiety" including the development of "peer support" platforms, and 5) more information and education about "how to parent [their] child after an ED admission for SSIB," including "how to set limits."

The External Advisory Board was satisfied with the iterative intervention development, study timeline, and preliminary outcomes reported in this open trial.

Safety

Throughout this open trial, there were no reports of serious adverse events. There were also no reports via the EHR documentation of youth participant ED re-admissions during this open trial's time frame.

DISCUSSION

The present study was conducted to further develop and refine, ED REaCH, a two-component navigation and text messaging intervention for caregivers of a diverse sample of youth with SSIB discharged from the ED. ED REaCH is grounded in the literature, derived from key stakeholder feedback, and based on three putative mechanisms of change: MH literacy, MH communication, and MH engagement. Findings from this open pilot development trial suggest that this two-component intervention for ED discharged youth with SSIB is, in general, feasible to administer and acceptable to caregivers.

ED REaCH is an important treatment for diverse youth with SSIB linkage to care, as it (a) focuses on caregivers/legal guardians as a conduit for youth MH care, (b) employs an ecological model within a socio-cultural theoretic framework of MH service disparities and barriers to treatment, (c) is grounded in both the evidenced-based practice of pediatric navigation and text-based digital health, and (d) is delivered by a highly accessible digital health platform with support from a Family Navigator. This unique combination of intervention content and delivery methods offers caregivers of diverse youth with SSIB support, encouragement, and motivation for youth linkage to MH care, as well as increased MH literacy, MH communication, and MH engagement strategies. The ED REaCH intervention was not only feasible to administer, but also was conducted at a comfortable pace, where caregivers were "very" and "completely" satisfied with the timing and amount of Navigator phone calls and text messages. Twelve out of 16 (75%) participants were retained in the navigation portion of the study and 100% in the text messaging throughout the entire 3-waves. Additionally, 10 out of 12 caregivers who completed the Family Navigator survey (83%) indicated that the Navigator was engaging, supportive, and knowledgeable. All caregivers also said that they accepted, read, and found utility and actionability in the weekly text messages. This is important, as studies indicate that one-way communications are effective in facilitating behavior change.[20]

While dyads reported a low level of overall youth MH symptomatology, they endorsed a high, clinical level of youth internalizing symptoms. These differences could be due to the lack of MH symptom identification and/or misunderstanding of symptom severity and is in line with stakeholder interviews which suggested the need for greater information on MH literacy, particularly symptom and severity recognition.[29,30] This was also highlighted in the caregiver end-of-study interviews, where caregivers indicated wanting more of this same information.

Further, youth report indicated better family communication than their caregivers; however, youth reported lower MH literacy and motivation for treatment. While discrepancies in youth and caregiver report are widely documented,[44] patterns of discrepancy may predict treatment outcomes and provide insight into which youth and families may need more intensive engagement and services.[45] This information can then be utilized via the Navigator to provide greater education and individualize engagement strategies.

Most caregivers indicated four or more life stressors, multiple barriers to treatment, and endorsed many items on the Social Determinants of Health, as well as identified limited supports and resources. These preliminary results highlight the significant need for this two-component intervention that leverages digital health and navigation procedures while employing an ecological model within a socio-cultural theoretic framework of MH service disparities and barriers to treatment.[17,18,27,28] Research that develops intervention without stakeholder feedback, addressing systemic barriers to care, or including Social Determinants of Health, will not be able to support and meet the needs of this diverse population of youth with SSIB and their caregivers who utilize the ED.

The feasibility of the current ED REaCH intervention was enhanced by its text messaging component. Text messaging-based interventions often have high digital literacy, are cost-effective, and are considered standard and easily accessible across all types of cellphones.[20] Additionally, incorporating this intervention into the ED setting so that it is available to youth with SSIB in an acute situation provides an opportunity for human touch points, which then bolstered the Family Navigation intervention and retention.

Further, caregivers' input and feedback about ED REaCH's putative mechanisms and content: MH literacy (symptoms, service, safety plans, lethal means restriction), MH communication, MH engagement, provided the iteratively modified and newly added content on: caregiver anxiety and support and how to parent a child after an ED visit for SSIB. Using stakeholder feedback via the process of gathering, processing, and responding[43] provides actionable impact to intervention development, and thus enhanced this interventions' acceptability, useability, and caregiver satisfaction.

Limitations

There are several limitations to the current study. First, the current sample of youth was limited regarding age, sex assigned at birth, and ethnic diversity, as well as overall sample size. As such, the generalizability of study finds may be limited. Future trials, with larger sample sizes and adequate representation of youth characteristics, including a broader age range, are needed to determine whether this intervention is feasible and acceptable across families utilizing the ED. Second, given that this was an open development pilot trial, the present study did not employ a control group or follow-up assessments to examine outcomes. Thus, it is difficult to determine whether clinical improvements will be observed throughout the study period. However, considering that caregivers reported over 80% of youth attended MH care, the preliminary data is promising. To fully evaluate the effectiveness of this intervention, future research will employ a randomized controlled trial design. Thirdly, we were unable to assess baseline demographic differences among those who agreed to enroll in the study versus those that did not. These differences would be important to investigate in future studies so that improvements in the intervention could be made. Fourth, the study employed a convenient sample of youth that utilized the ED from 8 a.m. to about 8 p.m. Monday through Friday. The characteristics of youth who utilize the ED outside of this window of time may differ on youth and family characteristic, whereby limiting the generalizability of study findings. However, due to limited ED provider staffing in the evening hours and on weekends, many youth with SSIB who utilized the ED after hours or on weekends obtain their final disposition after reevaluation during the daytime shift. Another limitation is that multiple study measures were evaluated via self-report and may include recall bias or halo effects. Finally, this was a single-site study, and navigation was inherently tied to the MH resources in the community. As such, it is unclear whether the success of this project is due to the navigation itself, or the community resources. Future studies will need to include a multisite design.

CONCLUSION

The findings from this open pilot development study suggest promising results on the feasibility, acceptability, and safety of this two-component navigation and text message-delivered intervention, ED REaCH. The intervention benefits from employing an ecological model within a socio-cultural theoretic framework of MH service disparities and barriers to treatment and addresses systemic barriers to care. While preliminary, our data suggests that this intervention may hold promise in improving MH treatment outcomes for youth with SSIB. Next steps include the evaluation of this intervention using a randomized controlled clinical trial design. Additionally, future directions need to focus on enhancing the reach, automation, and personalization of this caregiver intervention to augment its scalability, feasibility, and acceptability, and provide youth with SSIB discharged from the ED the MH support and care they need.

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Characteristics of Interpersonal Violence and Intimate Partner Violence Among Injured Adults Seeking Emergency Care in Nairobi, Kenya

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ABSTRACT

BACKGROUND: Interpersonal violence is a significant contributor to global morbidity, and affects young adults, particularly males. In Kenya, injuries, including those from interpersonal violence, are a leading cause of emergency department (ED) visits.

OBJECTIVE: This study aims to evaluate the frequency, demographics, and types of injuries caused by interpersonal and intimate partner violence among patients presenting to the Kenyatta National Hospital (KNH) ED in Nairobi, Kenya.

METHODS: This was a prospective cross-sectional study among injured adult patients presenting to the KNH ED.

RESULTS: Of 665 enrolled patients, 82% identified as male and the median age was 30 years. Among enrollees, 257 (39%) reported ever having experienced physical, sexual, and/or emotional violence. Seventy-one patients reported a history of intimate partner violence; more than half had experienced intimate partner violence within the past 12 months.

CONCLUSIONS: Research on interpersonal injuries in ED settings is lacking, but data from a single Kenyan ED reveals a significant portion of injured patients with a history of interpersonal and intimate partner violence.

KEYWORDS: Injury, Interpersonal Violence, Intimate Partner Violence, Emergency Medicine, Kenya

INTRODUCTION

Intentional injuries resulting from interpersonal violence is a leading cause of morbidity among all age groups, causing an estimated 1.1% of all disability adjusted life years (DALYs) lost in 2019, and is the fifth leading cause of DALYs lost among 10–24 year olds globally.[1] Interpersonal violence is an injury inflicted by another individual, and "the nature or mode of violence may be physical, sexual, or psychological."[2] Intimate partner violence occurs when such interpersonal injury occurs between romantic partners.[3] Prior work in Kenya has evaluated both interpersonal and intimate partner injuries, but little work has been done in emergency departments (EDs) where patients frequently seek unscheduled medical care for injuries.

Injuries are a leading cause of seeking unscheduled medical attention in Africa and in Kenya.[4-7] Injury is also a leading cause of mortality in Nairobi, Kenya, accounting for 10.6% of all recorded deaths.[8] Within Kenya, one in eight adults experiences an injury annually, and the nation's largest hospital, Kenyatta National Hospital (KNH) is a tertiary care center; a quarter of all patients in the KNH ED are seen due to injuries.[8-12] Among injured Kenyans, a number of studies have found a higher burden of injury morbidity and mortality among males.[13-16] Limited work has been done previously in Kenya to evaluate the epidemiology and burden of injuries that are due to interpersonal and intimate partner violence among persons seeking emergency care.[6,17-20]

This study aims to evaluate the frequency, demographics, and types of injuries caused by interpersonal violence and intimate partner violence from among a population of patients presenting to the KNH ED.

METHODS

Study design and Setting

Study data were collected from March 6 to June 23, 2023. This study was an *a priori*, cross sectional secondary analysis of prospective data from patients presenting with injuries to the KNH ED; the data were derived from a prospective study assessing HIV care delivery in the study setting. KNH is the largest hospital in Kenya, the main public hospital serving the nation's capital, and it is also an important receiving center for referrals from across the country. The ED functions 24-hours a day and has continually available medical and nursing staff as well diagnostic and treatment resources. The KNH ED is the primary center for injuries in Nairobi; approximately 60 injured patients are seen daily in the ED, with around 30–40% of injured patients admitted to the hospital wards.[21-23]

Selection of Participants

Patients with injuries were screened and recruited from among all persons seeking ED care at KNH. Physical injuries were defined based on the standard triage process that is currently used in the ED, which is a modified version of the South African Triage Scale (SATS) as well as the standard World Health Organization guideline references for the case definition of injury.[24,25] Patients were included who are at least 18 years of age, seeking care in the KNH ED for an injury, and were willing and able to provide informed consent. The exclusion criteria included those: seeking care for non-injury medical or surgical needs, legal prisoners of the state, those known to be pregnant, and patients triaged as critically ill. Critical illness was used as an exclusion criteria due to high unlikelihood to provide informed consent; prior work in the KNH ED demonstrated <3% of patients were triaged as critical.[24] For injured, non-critical patients, the mental status was assessed by study personnel and required the participant to be alert and oriented to time, place and self, as has been done previously in this setting.[26]

All enrolled participants provided informed consent. Study information and consents were available in the two main languages used in the study setting (Kiswahili and English), and all research personnel enrolling patients were fluent in the both languages. Participants were provided appropriate reimbursement for their time spent completing research assessments. The study was approved by both the KNH Ethics and Research Committee and the Institutional Review Board of Rhode Island Hospital.

Data Collection and Management

All participants enrolled in the study received standard care for injuries at the discretion of their treating providers in the ED, who were not members of the research team. Patient interactions with study personnel for screening and consent took place in a distinct space from where clinical care occurs or other patients are present to ensure confidentiality. Enrollment and patient data was captured as close to the post-triage period, after ED arrival, as possible. The enrollment data included demographic data, medical history, as well as information on injuries and interpersonal violence. The primary mechanism(s) of injury was recorded based on participant report. At the time of ED disposition, data was collected on the outcomes of their ED care. All data were maintained in electronic formats on password-protected computing devices and were only accessible by study staff. Collected data was stored and managed using REDCap.[27,28]

Outcomes and Analysis

Data on patient demographics (age, gender, etc.), education experience, current employment, and chronic health history were recorded at enrollment. The primary descriptive aims around an individual's primary injury (mechanism and intention), as well as secondary data regarding interpersonal violence and intimate partner violence from both the index visit as well as whether the individual had any historical exposure prior to the index visit (both ever occurring and occurring in the last 12 months) were all collected during the patient's ED care. Types of interpersonal violence was defined as the following: emotional violence was defined as "being scared or intimidated or threatened with harm," physical violence was defined as being "hit, slapped, kicked or otherwise physically hurt," and sexual violence was determined to be performance of "sexual acts against your wishes."[29] Survey instruments utilized validated questions from the World Health Organization multi-country Study on Women's Health and Domestic Violence against Women.[29]

Data analysis was completed using Stata v.14.0.[30] Descriptive analysis was performed for the population stratified based on those who had and had not experienced intimate partner violence. Comparisons were made using chi-squared, Fisher's exact nonparametric testing or Wilcoxon rank sum as appropriate, based on observation frequency and conformity with normality of distribution.

RESULTS

From March 6 to June 23, 2023, 2596 patients presented to the KNH ED who were screened for participation. Among those, 1202 (46%) did not meet inclusion criteria and 729 (28%) declined participation. A total of 665 participants (26%) were enrolled (**Figure 1**).

Patient Characteristics

Of the 665 patients enrolled (**Figure 1, Table 1**), 545 (82%) identified as male and the median age was 30 years (IQR: 24–38 years). Of enrolled patients, 257 (39%) reported ever having experienced physical, sexual, and/or emotional violence. The rate of having one or more chronic medical conditions was not different between those with and without history of interpersonal violence (p=0.79). There was a statistically significant difference in employment and interpersonal violence (p=0.01), with higher rates of self-employment among injured patients who denied any history of interpersonal violence, and higher rates of unemployment among those reporting prior interpersonal violence. Education level and currently in school status were not statistically significantly different between the two groups (p=0.15). More often than not (n=416, 63%) enrolled patients were

Figure 1. Patient enrollment

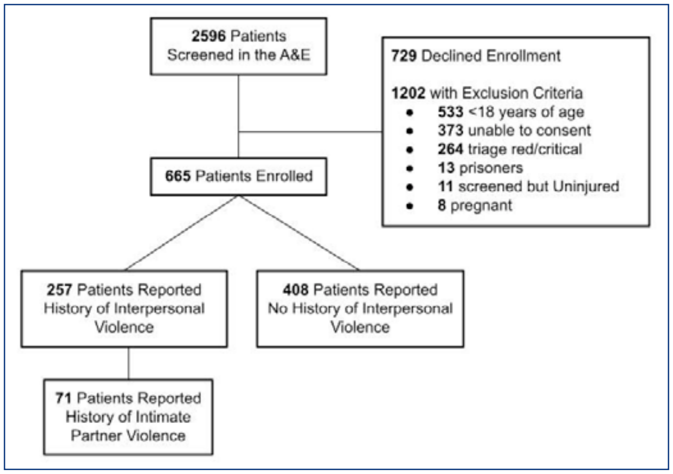

Table 1. Patient Characteristics, Stratified By Interpersonal Violence (IPV) History

	All n (%)	No-IPV n (%)	Yes-IPV n (%)	p =
	n = 665	n = 408	n =257	
Demographics				
Age, years: Median (IQR)	30 (24–38)	30 (25–39)	29 (24–36)	0.235
Preferred Gender Male	545 (82.0)	331 (81.1)	214 (83.3)	0.346
Vocation				0.011
Working Professional	65 (9.8)	38 (9.3)	27 (10.5)	
Working Laborer	306 (46.0)	181 (44.4)	125 (48.6)	
Self-Employed	145 (21.8)	106 (26.0)	39 (15.2)	
Unemployed/ Not Working	141 (21.2)	76 (18.6)	65 (25.3)	
Missing/Unknown	8 (1.2)	7 (1.7)	1 (0.4)	
Highest Education Level				0.149
Post Secondary	171 (25.7)	107 (26.2)	64 (24.9)	
Secondary	291 (43.8)	185 (45.3)	106 (41.2)	
Primary	187 (28.1)	106 (26.0)	81 (31.5)	
No Schooling	11 (1.7)	5 (1.2)	6 (2.3)	
Currently in School	58 (8.7)	31 (7.6)	27 (10.5)	0.148
Report 1+ Chronic Medical Condition	62 (9.3)	39 (9.6)	23 (9.0)	0.792
Referred/Transferred from Outside Facility	416 (62.6)	257 (63.0)	159 (61.9)	0.419

Table 2. Patient Injuries, Stratified By Never Interpersonal Violence (IPV) History

	All n (%)	No-IPV n (%)	Yes-IPV n (%)	p =
	n =669	n =409	n =260	
Injury Mechanism				
Road Traffic Injury	282 (42.4)	197 (48.3)	85 (33.1)	0.001
Gunshot wound	9 (1.4)	7 (1.7)	2 (0.8)	0.308
Fall	131 (19.7)	88 (21.6)	43 (16.7)	0.127
Burn	23 (3.5)	15 (2.7)	8 (3.1)	0.699
Stab or cut	76 (11.4)	38 (9.3)	38 (14.8)	0.031
Electrocution	6 (0.9)	3 (0.7)	3 (1.2)	0.566
Other blunt	52 (7.8)	31 (7.6)	21 (8.2)	0.789
Other penetrating	25 (3.8)	16 (3.9)	9 (3.5)	0.782
Other	62 (9.3)	14 (3.4)	48 (18.7)	0.001
Missing/Unknown	3 (0.6)	0 (0.0)	3 (1.2)	0.029
Injury Intention				**0.001**
Unintentional	552 (83.5)	369 (90.4)	183 (71.2)	
Intentional	94 (14.2)	30 (7.4)	64 (24.9)	
Unknown/Missing	15 (2.3)	9 (2.2)	10 (3.9)	

transferred from another healthcare facility (no difference in referral rates between those with or without interpersonal violence, p=0.419). Among the subset of enrollees reporting ever having had alcohol before in their lifetime (n=356), 29% (n=102), reported having used alcohol at the time of injury.

Female Participants

Of the 115 enrolled injured females (17% of enrollees), 43 (37% of enrolled females) identified as ever having prior history of interpersonal violence. Of these 43 females, 19 reported a history of physical violence, 19 reported a history of emotional violence, and five reported a history of sexual violence.

Injury Findings

There were a total of 669 primary mechanisms of injuries reported among the 665 enrollees for their index ED visits. Blunt mechanisms of injury (**Table 2**), including road traffic injuries, falls, and "other blunt" mechanisms accounted for 465 of the 669 injuries (70%) across all enrollees. There were fairly high rates of "other" and "missing/unknown" injury mechanisms among all patients (n=65, 10%), and these were more prevalent in those reporting a history of interpersonal violence (p=0.001 and 0.029, for "other" and "missing" respectively).

Intentional Injuries

For the specific injuries that brought an enrolled patient to the KNH ED, 84% were unintentional injuries; this was significantly different between those without (90%) and those with (71%) a history of interpersonal violence (p=0.001). In the population there were a total of 94 intentional injuries that resulted in the patient seeking ED care; these were from either someone completely unknown to the patient (n=43, 46%) or a non-family member that is also not a sexual partner (n=40, 43%).

There were no statistically significant differences across the types of perpetrators (**Table 3**) of intentional injury among those with or without history of interpersonal violence (p=0.328). Of note, 30 patients who had reported no prior history of interpersonal violence reported an intentional injury as the cause of that ED visit. The frequency of intentional injury among those without a history of interpersonal violence, were more common caused by persons unknown to the patient (17 of 30, 57%).

History of Interpersonal Violence

Of the 257 patients with a history of prior exposure to interpersonal violence, physical violence was the most commonly experienced domain of violence, with comparably higher rates of emotional violence (**Table 4**). Among those with experience of interpersonal violence in the past 12 months (n=162), there was a similar distribution of the domains of interpersonal violence exposure.

Table 3. Perpetrator of Intentional Injury, Stratified By Interpersonal Violence (IPV) History

	All n (%)	No-IPV n (%)	Yes-IPV n (%)	p =
	n = 94	n = 30	n = 64	0.328
Spouse	4 (4.3)	0 (0.0)	4 (6.3)	
Non-spouse family member	2 (2.1)	0 (0.0)	2 (3.1)	
Known Person (non-sex, non-family)	40 (42.6)	11 (36.7)	29 (45.3)	
Known Person (sex partner, non-spouse)	3 (3.2)	1 (3.3)	2 (3.1)	
Unknown Person	43 (45.7)	17 (56.7)	26 (40.6)	
Police Officer	1 (0.15)	0 (0.0)	1 (1.6)	
Other/Missing/ Wish not to disclose	1 (0.15)	1 (3.3)	0 (0.0)	

Table 4. Interpersonal Violence Exposure Matrix, for Enrolled Patients Previously Exposed to Interpersonal Violence

	Ever Exposed n (%)	Last 12 months n (%)
	n = 257	n = 162
Physical	118 (45.9)	82 (50.6)
Physical & Emotional	54 (21.0)	28 (17.3)
Emotional	32 (12.4)	28 (17.3)
Physical & Sexual & Emotional	17 (6.6)	7 (4.3)
Sexual	13 (5.1)	6 (3.7)
Physical & Sexual	12 (4.7)	4 (2.5)
Sexual & Emotional	11 (4.3)	7 (4.3)

Table 5. Intimate Partner Violence Typology

	Ever Exposed n (%)	Last 12 months n (%)
	n = 71	n = 38
Physical	17 (23.9)	8 (21.1)
Physical & Sexual & Emotional	15 (21.1)	6 (15.8)
Sexual & Emotional	10 (14.1)	6 (15.8)
Sexual	10 (14.1)	5 (13.2)
Physical & Sexual	9 (12.7)	4 (10.5)
Physical & Emotional	5 (7.0)	5 (13.2)
Emotional	5 (7.0)	4 (10.5)

Intimate Partner Violence

Seventy-one patients (28% of those with a history of interpersonal violence, and 11% of all enrollees) reported a history of intimate partner violence (**Table 5**); more than half of these (n=38, 54%) reported experiencing intimate partner violence within the past 12 months. For those who ever experienced Intimate partner violence, this was most frequently experienced as physical violence alone (n=17, 24%) or as a combination of physical, sexual, and emotional violence (n=15, 21%).

DISCUSSION

In this prospectively evaluated population of 665 injured patients treated in the KNH ED, 257 (39%) reported ever having experienced a form of interpersonal violence. A further 30 patients who had reported no prior history of interpersonal violence reported intentional injury as the cause for the injury that brought them to the ED. As noted in the methods, this is because one's "history of interpersonal violence" would have occurred prior to the index visit. This finding highlight that these 30 patients "without a history of interpersonal violence" have indeed now experienced interpersonal violence. Of those with a history of interpersonal violence, 71 individuals reported a history of intimate partner violence.

Among participants, 82% identified as male and the median age was 30 years. A prior national survey in Kenya found that approximately 15% of respondents had injuries in the prior 12 months, and 60% of those injured were males.[31] Work by Saidi et al in Nairobi found that among 237 trauma autopsies, the average age of the victims was 29.8 years and were predominantly males (90%).[32] Another study of injury mortality similarly found males accounted for 85% of the injured/dead.[8]

In this patient cohort, blunt injuries were the predominant mechanism (70%). Several different studies on injury leading to mortality have found similar patterns of injury mechanism. Gathecha et al found injuries from assault/blunt force (31%), blunt road traffic injuries (26%) and lower rates of firearm injury (15%).[8] Saidi et al found injuries were from road traffic (35%), gunshot wounds (26%) and blunt assault (20%).[32] Our present work found lower rates of gunshot injury (1%) but a bit higher rates of stabbing (11%) and other penetrating trauma (4%).

Of enrollees in the present work, 94 (14%) reported their injury was intentional; very few intentional injuries were perpetrated by a spouse, a non-spouse family member, or a non-spouse sexual partner. The preponderance of intentional injuries were from either someone completely unknown to the patient or a non-family member that is not a sexual partner. Ranney et al performed prior work in western Kenya and found that among a population of 562 injured patients at a health facility, the majority (71%) of violent injury was caused by an assailant known to the victim.[33] In that study, "women were more likely to be injured by a spouse/partner, whereas men were more likely to be injured by an acquaintance."[6] These differences in reported perpetrators could be due differences in the populations studies as the population from western Kenya was less urban than the current cohort.

Of patients enrolled in this study, more than a third reported ever having experienced physical, sexual, and/or emotional interpersonal violence. Our cohort found violence from physical alone, physical and emotional, and emotional alone as the most likely reported experiences of prior interpersonal violence. A demographic survey across Kenya has shown 34% of women, and 27% of men, have experienced physical violence since the age of 15 years.[34] Very little prior work has been done evaluating physical violence of both men and women, though work from Kenya did show that bidirectional violence may be present in many intimate partner relationships.[35]

In this population, 10% of participants were excluded due to being triaged as critical, while prior work in the same KNH ED showed a critical triage rate of 2.4% after a triage-related intervention.[23] It is unclear why there was such a difference, though one hypothesis would be that the first study took place during the early phase of the COVID-19 pandemic which may have impacted the severity of cases, with a possible role for lower rates of transfer/referral given the high rates of patients transferred to KNH for injury care in this study.

More research is necessary to explore injuries and interpersonal violence within emergency department settings among injured individuals. Future work should aim to inform the development of standardized treatments and potential targeted interventions for application in Kenya and potentially other comparable contexts.

Limitations

Many injured patients in Kenya may not be seen or evaluated in the ED setting; in a household survey on injury in Kenya, "only one out of 25 injuries were brought to a health facility for attention."[36] While this may try to account for all injuries, we do recognize that our cohort of enrolled patients is in a large tertiary referral hospital and nearly two-thirds of enrollees were transferred from other health facilities for which one could infer that these patients are more complex or ill in some way. Patients with the most severe outcome of injury, death, were not included in this cohort while prior work in fatal injuries in Nairobi found about half of patients (51.4%) experienced out-of-hospital death.[8] Additionally, the lack of data on anatomical regions of injuries precludes the ability to evaluated injury impacts and poly-trauma in the population.

One would also presume a level of both nonresponse (nonparticipation) and response (incompletely truthful response) bias, with a segment of eligible patients not wanting to discuss sensitive topics such as injury, HIV, and interpersonal/ intimate partner violence.

Research on interpersonal violence and emotional, physical and sexual violence can re-traumatize survivors and may have led some participants to decline participation or provide inaccurate response. Such response bias would likely result in under estimations of the frequency and burden.

One must also consider that much interpersonal violence is experienced by women and children while our cohort of enrollees is overwhelmingly male and excluded children. Prior work in Kenya noted that the majority (56% in their study) of women did not seek help after experiencing interpersonal violence.[37] Similarly, there is a large body of evidence that has been collected on the relationship between pregnancy and intimate partner violence; in our study all patients with known pregnancy were excluded. Much of the work on interpersonal violence in Kenya has focused on the experiences of women, and while our cohort of patients expands the body of evidence it does not fully represent the breadth of interpersonal violence and intimate partner violence.[38-40]

CONCLUSION

There is a gap in interpersonal injury research from high-risk emergency care settings in Africa such as Kenya. The current data demonstrate that there is a substantial segment of injured patients evaluated in the Kenyan ED setting with a history of interpersonal violence even among persons seeking care for non-interpersonal violence care. Further study is needed on injury and interpersonal violence in the ED setting among injured persons, in order to inform development and implementation of treatment and targeted interventions in Kenya and other similar settings.

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