

Decreasing Ghost Scanning in Point-of-Care Ultrasound: Impact of a Visual Prompt to Save Images

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ABSTRACT

BACKGROUND: Ghost scanning, performance of point-of-care ultrasound without image archival, can adversely affect patient care, billing, quality assurance, and result in medicolegal concerns. This study evaluated the Extended Focused Assessment with Sonography in Trauma (eFAST) ghost-scanning rate during trauma activations after placement of a low-cost visual reminder.

METHODS: This single-center study was conducted from December 1, 2022 to November 30, 2023. Patients were included if they were the highest level of emergency department trauma activation. A ghost scan was classified as a documented eFAST examination in the electronic medical record nursing documentation without archived eFAST images in the picture-archiving and communication system. Six months of EMR review established a baseline ghost-scanning rate. Subsequently, a large label reminding clinicians to save images was placed prominently on the ultrasound machines for a six-month period with prospective chart review. The primary outcome was the absolute and relative difference in ghost-scanning rates after the label intervention. Differences between periods were analyzed using a two-tailed Mann–Whitney U test.

RESULTS: A total of 325 trauma encounters were included. In the pre-intervention period, 66 eFAST examinations were identified among 143 encounters, of which 74.2% (49) were ghost scans. In the post-intervention period, 86 eFAST examinations were identified among 182 encounters, of which 54.7% (47) were ghost scans, representing a 19.5% absolute reduction ($p = 0.013$).

CONCLUSION: The low-cost visual reminder was associated with a meaningful reduction in ghost scanning during eFAST examinations. Further investigation into similar interventions and their generalizability to other institutions is warranted.

KEYWORDS: POCUS; phantom scanning; ghost scanning; ultrasound; trauma

BACKGROUND

Ghost scanning, when a point-of-care ultrasound (POCUS) is performed without images being archived, is a known problem in emergency medicine and has patient care, billing, quality improvement and quality assurance (QA/QI) and medicolegal implications.¹⁻⁵ Guidelines from the Centers for Medicare and Medicaid, the American Institute of Ultrasound in Medicine, as well as the American College of Emergency Physicians recommend that all POCUS examinations should include a representative image saved with clinically relevant anatomy and pathology.^{6,7}

The highest level of trauma activations at a hospital often includes unstable patients, and the POCUS operator may prioritize other tasks over image archival.⁸ POCUS workflow may also be a barrier to saving images, as patients may not be registered or be registered under a temporary identification in the electronic medical record (EMR). Physicians may use POCUS to make immediate clinical decisions in trauma resuscitations, such as a positive Extended Focused Assessment with Sonography in Trauma (eFAST), resulting in prompt transfer to the operating room, without recognizing the benefit of saving images. Institutional culture may also prevent images from being saved if there is a lack of understanding about the dangers of ghost scanning, if images are not archived, or if POCUS examinations are not billed, resulting in a high rate of ghost scanning.

Some strategies to reduce the incidence of ghost scanning include locked ultrasound machines, personalized email reminders, implementation of barcode scanners, and didactic teaching about the value of saving images. These strategies are often time-consuming for ultrasound faculty, increase costs, and fail to reach a broad audience. One strategy that the authors propose as an effective reminder is a non-obstructive visual cue to save an image while performing a POCUS, offering a low-cost investment with minimal time investment. However, the magnitude of the effect is unclear. Therefore, our study aim was to assess the change in ghost-scanning rates when a label was placed on the ultrasound machine reminding the operator to save images as part of an emergency department (ED) QA/QI project for eFAST examinations. Trauma activations were chosen due to the ease of which they can be tracked in the EMR, the nursing documentation that occurs, and the previously seen high rates of ghost scanning.^{3,4}

METHODS

Study Design

This was a single-center, prospective QA/QI project that took place between December 1, 2022 and November 30, 2023. Patients were included if they were at least 18 years of age, arrived as the highest level of trauma activation, and had a POCUS documented by a nurse in the resuscitation run sheet within the EMR. Patients were excluded if there was insufficient EMR data, if their trauma designation was downgraded, if the trauma was without injury to the chest or torso, or if the mechanism of trauma was a burn. Institutional Review Board approval was obtained at the study institution.

A trauma resuscitation was defined as a patient with a life-threatening traumatic injury or meeting specific trauma criteria defined by the institution.⁴ An ED nurse trained in critical care was responsible for real-time EMR documentation of trauma resuscitation events, including the performance of an eFAST examination. This run sheet documentation was found to be accurate in prior studies with a similar methodology and served as an indicator for eFAST performance during the trauma resuscitation.^{3,4}

The time from December 1, 2022 to May 31, 2023 served as a baseline for ghost scanning. A previous study at the institution showed a ghost-scanning rate of 86.5% for eFAST examinations from July 1, 2019 to July 1, 2021.⁴ Because this previous data was presented at the study institution, it was important to establish a new baseline to accurately assess the benefit of the visual reminder to save images. Starting June 1, 2023 through November 30, 2023, a label reading, "Please save all ultrasound clips even if not ordered," was placed prominently on the screen of the Sonosite LX (FUJIFILM Sonosite, Inc., Bothell, WA) ultrasound machine [Figure 1] that is dedicated to the department's critical care area where trauma resuscitations are managed. This visual

reminder was placed without informing the emergency medicine or trauma teams, and only the study team was aware ghost scanning was being evaluated for a QA/QI project.

Setting

The study was performed at a Level 1 trauma center with over 115,000 annual patient visits and an active ED POCUS program with approximately 7,500 POCUS examinations performed annually and global ultrasound privileging for attendings.⁹ The ED is staffed by approximately 60 emergency medicine attendings and has a three-year emergency medicine residency program with 54 residents. ED residents participate in 16 hours of dedicated ultrasound training during their first month, at least four weeks of dedicated POCUS training by the end of their second year, and are required to perform a minimum of 500 POCUS examinations, with 50 of them being eFAST examinations prior to graduation. The hospital uses an order-based POCUS workflow, with the intended workflow requiring an order to first be placed in the EMR prior to starting a POCUS examination, selection of the correct patient on the ultrasound machines, and for the images to be saved by the operator. Saved images upload to the picture archival and communication system (PACS) with interpretation occurring in the EMR; there is no POCUS manager or middleware system. There is an option to save images without a patient identification on the ultrasound machine where the images are uploaded to the PACS under a temporary identification, and remain searchable by both time and date. These anonymous images can later be linked with a patient's chart, but only remain available for viewing on PACS and not the EMR itself.

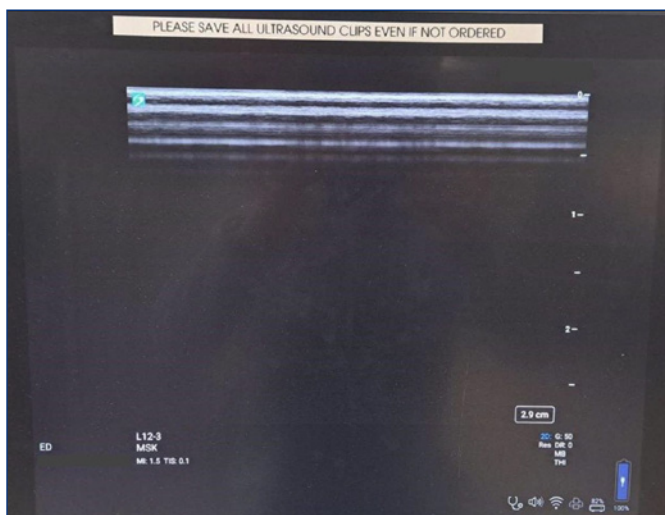
Trauma resuscitations at the study institution are managed in a six-bed critical care area staffed by a care team, including an attending emergency medicine physician and a resident, fellow, or both. For the highest level of trauma responses, the trauma surgery team and trauma surgery attending are present throughout the duration of the patient's initial care.

All ED attendings are globally credentialed to perform POCUS and receive training in POCUS as a condition for their board certification. Quality assurance of 10% of POCUS examinations was performed by clinical ultrasound fellowship trained faculty members. Although the ED nurse practitioners and physician assistants as well as the trauma service may also perform eFAST examinations, there was no formal credentialing guidelines in place for these personnel in our ED at the time of the study. The ED care team is primarily responsible for the eFAST performance and saving of images.

Chart Review

Trauma resuscitations were identified utilizing a pre-existing trauma registry in the EMR documenting all trauma team activations. Manual chart review and abstraction was

Figure 1. Visual prompt placed on an ultrasound machine



completed by three investigators (RB, CX, DC) unblinded to the research question, and a fourth investigator (TS) randomly selected 10% of cases to review for accuracy. A one-hour meeting was held for all investigators to develop a consistent review process for all EMR variables.

A ghost scan was defined as an eFAST examination, identified based on the EMR nursing run sheet, with no associated images saved to the PACS. If an eFAST was performed during the patient encounter, study investigators (RB, CX, DC) reviewed the PACS during the date and time of the patient visit to evaluate for any saved images attributable to the patient. If there were no images associated with the patient, investigators reviewed the PACS for eFAST studies that took place within 30 minutes of the eFAST time documented within the EMR. This iterative search was established so that any images obtained prior to patient registration were accounted for.

Outcomes

The primary study outcome was the absolute and relative difference in ghost-scanning rates from the initial six-month phase to the subsequent six-month phase, when a visual reminder was added to the ultrasound machine.

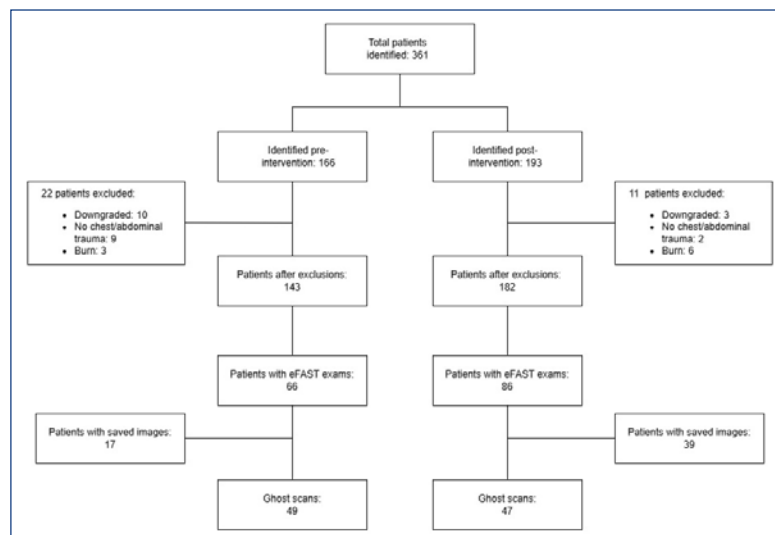
Data Analysis

The prevalence of ghost scanning was calculated in Microsoft Excel (Redmond, WA). Tests of normality on the data was performed using a Shapiro-Wilk test, and a two-tailed Mann-Whitney *U* test was performed to assess for differences in pre-intervention and post-intervention variables. Alpha <0.05 was used to determine statistical significance. This additional testing was conducted with IBM SPSS Version 27 (Armonk, NY).

RESULTS

There were 166 trauma activations in the pre-intervention period and 193 in the post-intervention period for a total of 359 patients reviewed. A total of 23 patients were excluded from the pre-intervention period, 10 due to being downgraded from a full trauma activation, 9 were determined to have an isolated head injury without associated thoracic or abdominal trauma, and 4 with a burn as their primary injury. During the post-intervention period, 11 patients were excluded, 3 due to downgrade, 2 with isolated head injuries without associated thoracic or abdominal trauma, and 6 with burns as their primary injury [Figure 2]. After exclusions, the pre- and post-intervention periods had 143 and 182 patients respectively, for a total of 325 patients. The total cohort included 229 (70.5%) male patients with an average age of 45.1 (SD 21.2). Demographically, the cohort was 52%

Figure 2. Flowchart of patients included for analysis



(172) Caucasian, 17.8% (58) African American, 19.7% (64) Hispanic, and 9.5% (31) other/unknown race.

Of the 143 patients in the pre-intervention period, 66 (46.2%) eFAST examinations were performed based on nursing run sheet review, with 49 (74.2%) identified as ghost scans due to lack of identified images within PACS. In the post-intervention period, a total of 86 (47.3%) documented eFAST examinations were identified from the 182 trauma activations, with 47 (54.7%) labeled as ghost scans. This represents an absolute reduction of 19.5%, and a relative reduction of 26.3%, of ghost eFAST examinations following the label intervention, which was statistically significant ($p = 0.013$). There was no statistically significant difference in the percentage of eFAST examinations performed post-intervention compared to pre-intervention ($p = 0.84$). There was also a similar number of positive eFAST examinations in the pre-intervention period ($n = 17$, 25.8%) compared to the post-intervention ($n = 22$, 25.6%) ($p = 0.98$).

DISCUSSION

Ghost scanning remains a significant barrier to patient care, medical billing, quality improvement and quality assurance, and poses a potential medicolegal risk.^{2,3} However, there is limited research on strategies to mitigate ghost scanning. The optimal strategy to reduce the prevalence of ghost scanning remains unclear and will likely require a broad, multi-step approach to address the numerous barriers to saving ultrasound examinations.^{10,11} The goal of this label intervention was to place a visual prompt within view of the POCUS operator, who may be more likely to archive images or prompt questioning about the image archival processes if they were unfamiliar. In this single-centered study, nearly 75% of eFAST examinations performed during the highest

level of trauma activations were ghost scans prior to the intervention, with the number dropping to approximately 55% following the intervention. The absolute reduction of approximately 20% is notable given that the intervention was low cost and easy to implement, resulting in continuation of the label intervention.

There have been limited studies evaluating strategies to reduce ghost scanning. A study by Kolbenson et al demonstrated a reduction in ghost scanning from 100% (no images archived) to 30% through implementation of a POCUS curriculum and resources for internal medicine residents.¹⁰ While our intervention saw less of an absolute reduction, it did not require ultrasound faculty oversight, email reminders, curriculum implementation, or other time intensive interventions. Additionally, given the high number of trauma activations per year, a 20% decrease in the ghost-scanning rate has the potential to impact many patients.

Our single-center study supports that simple, low-cost interventions may offer an affordable means of reducing the rate of ghost scans during high-acuity patient encounters. This intervention is likely to have variable results at different institutions; however, as the causes of ghost scanning are multifactorial and can result from differences in POCUS workflow, ED staffing, patient volumes, operator experience, and average patient acuity.^{3,11} Despite this, our intervention offers an essentially zero-cost investment with little to no perceivable risk to the patient, institution, or POCUS operator. This sticker intervention serves as a first step towards reducing ghost scanning, as part of a multi-step process, including improvements in overall infrastructure, POCUS machine technology, and programs designed to target POCUS operators who do not archive images. However, these strategies require a significant investment in faculty time and warrant further investigation to determine the extent of their impact and optimal implementation. Given the low cost and low-risk nature of our label intervention, and its substantial improvement in ghost-scanning rates, we suggest this be trialed at other institutions as a component of larger ghost-scanning interventions to assess its effectiveness to decrease ghost scanning across institutions.

One study drawback was that we cannot rule out the influence of the Hawthorne Effect on our study results, despite our efforts to reduce its effect. The previous study at our institution showing a high ghost-scanning rate was publicized to the hospital's ED and trauma team, which may have played a role in improving our ghost-scanning rate even after accounting for our study's washout period. If the emergency medicine or trauma teams were aware of our study taking place, it may have influenced their likelihood of saving images. There were no additional email reminders or educational sessions about eFAST image archival that took place during the study period. To our knowledge, the only individuals aware of this study taking place were the study team members; however, the study members were part of

the pool of potential providers that may have cared for these trauma patients.

There are several other limitations to this study that warrant mention. The retrospective EMR review is a proxy for eFAST performance, as direct video review was unavailable at our institution. There is a chance that eFAST images were saved and were not identified during review due either to incorrect archiving or POCUS machine upload failures, leading to an overestimation of ghost scanning. However, it would be expected that this effect would be equal before and after our intervention, as there were no major changes to the EMR review, image archival processes, or machine hardware. This study took place at a single institution with its own unique barriers to image acquisition and workflow practice patterns that may not be present at other institutions and limits the generalizability of this study. This study was not designed to evaluate the specific traumatic injuries suffered by patients and their clinical outcomes, which could have affected the prevalence of ghost scanning, as higher acuity patients may result in increased ghost scanning. We attempted to mitigate this limitation by selecting only patients with the highest level of trauma activation, and our results showed no difference in positive eFAST examinations between the pre- and post-intervention groups. Alternatively, there may have been a difference in ghost-scanning rates for positive and negative eFAST examinations, but the study was underpowered to detect any differences. The seasonality of trauma may have served as a confounder, as it is possible that certain injury or trauma patterns were more heavily represented in one of the intervention periods, influencing ghost-scan rates.

CONCLUSION

Prior to our intervention, ghost scans accounted for nearly three-quarters of eFAST exams taking place during the highest level of trauma activations at our institution. Our label-based intervention demonstrated a 19.5% absolute reduction and a 26.3% relative reduction in ghost scanning, showing promise as a low-cost intervention in reducing rates of ghost scanning. The post-intervention ghost-scanning rate of 54.7% suggests a need for further ghost scanning interventions. The label-based intervention is one part of a multi-step approach to decrease ghost scanning, and the generalizability of this intervention to other institutions and workflow structures warrants further investigation.

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