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ORIGINAL ARTICLE

Multi-professional education reduces surgical resident messaging volume

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Abstract

Introduction Mobile messaging devices (MMD) have become common for communication in healthcare with the hope of improving accessibility of clinicians, efficiency, and response time. However, MMDs tend to increase messaging volume, contribute to clinician fatigue, and raise safety concerns. Our hypothesis was that targeted multi-professional education will reduce messaging volume and subjective burden on clinicians.

Methods Data for messages sent and received for PGY 1–5 general surgery residents from April to December 2021 were obtained. A multi-professional group was created, and nursing-led education was delivered to surgical nurses from July to September 2021. Baseline messaging data from April to June 2021 were compared to post-education data obtained from October to December 2021. A two-sample *t* test was performed with a statistical significance at $p \leq .05$. Surgical residents were surveyed for messaging burden, and data were compared between baseline and post-education.

Results Comparing baseline to post-education messaging data, PGY 1 surgical residents received an average of seven fewer messages per day (22 vs 15, $p = .019$). Similarly, PGY 1–3 surgical residents received an average of six fewer messages per day (18 vs 13, $p = .007$). Survey data showed a similar burden perceived between baseline survey in July 2021 (25 residents) and post-education survey in March 2022 (9 residents).

Conclusion Targeted multi-professional education decreases the volume of messages received by surgical residents, but not a reduction in a subjective burden. Additional solutions are required to realize a meaningful improvement in use from MMDs.

Keywords Multi-professional education · Surgery resident · Messaging volume · Mobile messaging device

Introduction

Burnout and stress leading to depression and suicidal ideation have been shown extensively throughout the literature within general surgery training. Specifically, burnout among said residents has been connected to workload burden along with other issues including discrimination, abuse, and harassment [1, 2]. While great efforts have been employed throughout residency programs across the nation to combat discrimination, abuse, and harassment, it is difficult for programs to target decreasing workload due to the 80-h work week restriction [3]. Therefore, targeting unnecessary workload for surgery residents while at the workplace is a feasible means to decrease overall workload and, in turn, burnout, alongside the other methods for burnout reduction previously mentioned. When considering unnecessary workload, recent literature shows that general surgery residents receive an upper average of 89 messages via mobile messaging devices (MMDs) per shift after transitioning away from traditional pagers [4]. MMDs are becoming more common for clinical communication within healthcare to improve accessibility, efficiency, and response time between clinicians and nurses. However, MMDs tend to increase messaging volume, contribute to clinician fatigue, and raise safety concerns [5]. Furthermore, they add significantly to surgery resident workload and burnout [6, 7].

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When further exploring the evolution of paging and its burden to surgical residents, it must be noted that paging as a form of urgent and emergent communication has become a fundamental part of medicine. This technology has evolved from previous overhead paging to most recently an alphanumeric two-way messaging system via MMDs in which physicians receive a text message via a cellular phone application and can respond back with a text message [8, 9]. While this new technology has allowed for easier targeted communication, an unfortunate effect of this new technology has been increased distraction among surgical practices [10, 11]. Furthermore, multiple studies have shown that a large portion of these studies are not urgent [12–16]. While benefits exist in this messaging system including quick clinician response time, messaging volume and frequency of non-urgent messaging have been shown to increase, specifically during critical patient care times, serving as distractions [17, 18].

At academic medical centers, postgraduate year (PGY) 1 residents often carry the primary pager responsibility for surgical services and may be the most affected by the increased message volume. In many institutions, PGY 1 residents are part of a night float system which involves detailed patient handoff. Several studies have shown that patient handoff is crucial for patient care, especially in surgical specialties when managing postoperative patients [16, 19–21]. Just like all clinical responsibilities, patient handoffs are not immune to distractions. Medical errors can often be traced back to flawed handoff, thus highlighting the importance of limiting unnecessary interruptions during these designated times [16, 19]. Since the advent of mobile phone application-based messaging, the effect of increased volume of messages and distractions has not been objectively described for PGY 1 surgery residents. Our institution has previously reported that PGY 1 general surgery residents have a large messaging burden with significant distraction from messages during crucial handoff times [4].

Preliminary analysis at our institution showed that nursing was the primary contributor to messaging volume. Nursing turnover has been at an all-time high during the COVID-19 pandemic [22], so nursing onboarding regarding training and communicating via MMDs was explored. New nurses receive 1:1 communication with their preceptors. They also attend a skills day with case scenarios and communication simulation. However, human factors can lead to variation in how new nurses are trained in MMDs. The cognitive load is minimal in the simple user-friendly interface. The ergonomics and usability of the software are easy and clear. Nurses can use the interface on the workstation or their mobile device in various high-stress and dynamic situations. There is fair workflow integration of the messaging system aligning well with their existing workflow. There is minimal training in communication skills, specifically including patient information or the use of concise communication. Furthermore, there is minimal training on cultural and language factors where nurses from different background and training levels may face challenges. Hence, there may be a lack of standardization in the use of MMDs. Therefore, this study hypothesized that standardized multi-professional education targeted at surgical nurses would reduce messaging volume and subjective burden on surgical residents. While other clinicians contribute to messaging volume, nurses have the highest and most clinically relevant impact on patient care, further supporting our decision to target nursing education to achieve the greatest impact.

Methods

Institutional assurances, collaboration, and overview

The Institutional Review Board evaluated this project and approved it as a quality improvement study. Baseline data analyzed from April to June 2021 revealed the primary contributor to messaging volume was nursing. A multi-professional group was created that included surgeons, surgery residents, and surgical nursing leaders. Surveys were sent to all surgical residents (Table 1) and surgical nurses (Table 2) at the beginning of the study to assess overall attitude and target specific issues for both groups. With this information, our multi-professional team collaborated extensively to create a required educational nursing video, an informational poster displayed at each surgical nursing station, weekly nursing huddle reminders, and feedback for residents regarding best practice guidelines for MMDs. Surgical residents were educated and prohibited from using secure messaging for patient orders per Centers for Medicare and Medicaid Services (CMS) [23]. The educational period lasted from July to September 2021. The post-educational period was from October to December 2021, when the same survey was sent to surgical residents to assess subjective burnout improvement.

Education material

The surgical nursing educational video was 8 min long and focused on building our MMD community by formatting appropriate messages, describing appropriate process, identifying potential patient safety issues, identifying correct groups for patient needs, and describing methods of reducing fatigue related to MMDs. Table 3 is a breakdown of the components within the educational video. The educational video had simulations with interactive knowledge checks. This educational video was delivered to 205 out of 268 surgical nurses via nursing leadership as a requirement

Table 1 Survey sent to all surgical residents in July 2021 regarding their overall attitude toward MMDs

Question	Options
What is your role?	PGY 1, 2, 3, 4, 5, or 6
What is your overall attitude toward MMD?	Positive, negative, neutral
How many times per day do you SEND a message on MMD?	< 10, 10–30, or > 30
How many times per day do you RECEIVE a message on MMD?	< 10, 10–30, or > 30
Is there a noticeable difference in the number of messages you send/receive on NIGHT shift compared to day shift?	Yes, no
Do you feel fatigued from the number of messages you respond to each day?	5-point Likert scale[a]
Do you feel as if you miss information due to the number of messages you receive?	5-point Likert scale[a]
Do you feel the amount of information you receive via simultaneous messages all at once, is dangerous?	5-point Likert scale[a]
Has a patient ever been harmed or received lack of care due to messages overload?	5-point Likert scale[a]
How often do you receive messages that are not meant for your team?	5-point Likert scale[a]
What are your general problems with MMDs?	Free text

[a]Likert scale scoring: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree

Table 2 Survey sent to all surgical nurses in July 2021 regarding their overall attitude toward MMDs

Question	Options
What is your role?	Day or night shift
What is your overall attitude toward MMD?	Positive, negative, neutral
How many times per day do you SEND a message on MMD?	< 10, 10–30, or > 30
How many times per day do you RECEIVE a message on MMD?	< 10, 10–30, or > 30
Please select the group/department you feel you receive the MOST MMD messages from	Dietary, PT/OT, lab, phlebotomy, providers, other
Prior to messaging the provider using MMD, do you review the chart for relevant information or discuss the clinical situation with your charge nurse or another experienced nurse for guidance?	5-point Likert scale[a]
Do you feel fatigued from the amount you use MMD per day? Please consider calls/messages from the provider, not alerts from medical devices and communications from other members of the interdisciplinary team	5-point Likert scale[a]
Do you get frustrated with how long it takes providers to respond to MMD?	5-point Likert scale[a]
Has a patient ever been harmed or received lack of care due to a slow response to your MMD?	5-point Likert scale[a]
Which statement best describes you? (choose one)	(a) I respond with "thank you" and "okay" after I receive messages, or (b) I use the read-receipt option of MMD
What statement(s) best describe you? (select all that apply)	(a) I review the EMR for relevant information that may answer my question before messaging (b) I consider the urgency of my message and only send messages that require prompt response (c) I provide 2 identifiers in each message (d) I accept orders sent in messages (e) I include a full set of vital signs if messaging regards vital changes (f) I start a new message thread for each patient
What are your general problems with MMDs?	Free text

[a]Likert scale scoring: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree

and had a 76% completion rate of all surgical nurses. Even though the videos were required, many nurses could not complete this training because of night shifts, paid time off, part time status, and non-compliance. Although they were required, there was no administrative punitive consequence for not completing the training. Figure 1 shows the poster displayed at all surgical nursing stations with reminders on how to appropriately format and send MMD messages. An additional poster (not displayed for privacy) listed individual attending surgeon names and the correct services to contact.

Table 3 Components of the 8-min educational video required for surgical nurses

General guidelines	• Do not respond "thank you" or "okay" or send emojis within messaging threads. Instead, use the read-receipt function to confirm delivery • Orders should not be sent or accepted via messages • If messaging about a change in vital signs, include a complete set of newest vital signs • Always send messages via the service-line group rather than a direct message to an individual provider • The day team reviews labs and replaces electrolytes every morning. There is no need for the call team or night team to be notified unless lab values are critical
Messaging format	• Always include a patient's first and last name, medical record number, and room number when sending a message • Use a new message thread for each patient • If messaging regarding a change in vital signs, include a complete list of newest vital signs • If requesting a phone call, specify if the matter is non-urgent, urgent, or emergent, and provide the number in which you can be reached
Troubleshooting	• Check the medication administration record and orders sections of the electronic medical record before messaging as many questions regarding pain medications, nausea medications, Foley catheter removal, etc., are already there • Ensure order sets are initiated before messaging • If unsure regarding a nursing management issue, refer to your charge nurse or co-workers first to discuss appropriate trouble shooting methods • Refer to daily progress notes for information about care plans

Fig. 1 Poster displayed on all surgical nursing units to provide visual reminders about building our messaging community

Resident-led education was also delivered to surgical residents in July 2021 and included a review of the education the surgical nurses were receiving along with reminders to include your service line's MMD handle on every note, to refrain from messaging "thank you" or "okay" or sending emojis when messaging, and to refrain from sending orders via secure messaging.

Outcomes

The primary outcome of this study was the number of messages sent and received per surgery resident following multi-professional education on our institution's MMD. Secondary outcomes included subjective stress and burnout response per surgery resident following multi-professional education on MMDs.

Data collection

We collaborated with our MMD system (Halo Health, Cincinnati, OH) to collect data on messaging information which included number of messages per department, per individual, information on message's senders and receivers, and timestamps of all messages. Individual message content was not available for patient privacy. Reports on messaging volume data were exported monthly, collated, and reorganized for analysis. Surgical nursing surveys were distributed by nursing leadership and results were anonymously obtained. Similarly, surgery resident surveys were distributed by the study authors and results were anonymously obtained.

Data analysis and statistical considerations

MMD data were obtained from April to December 2021. The data included a record of every message sent and received. Each record included details on the sender's name, role, and department. Each message had a date and time stamp recorded. These data were collated and organized then generated into a dashboard. This dashboard was then used to analyze surgical resident messaging volume. The educational period was between July and September 2021. The pre-education period was defined as April to June 2021. The post-education period was defined as October to December 2021. The same surveys were sent to surgical residents after the post-education period. The primary measure to evaluate messaging volume was average messages received per workday. A two-sample *t* test was performed on the same groups (PGY classes) to determine a difference in the means. The level of statistical significance was set at $p \leq 0.05$, and p values were two tailed.

Results

The pre-education baseline period was from April to June 2021. The education period was from July to September 2021. The post-education period was from October to December 2021. During the baseline period, PGY 1–5 received 102,394 messages. Nursing contributed the highest (30.5%) to the total, with Surgery (26.9%), Emergency Medicine (6.7%), Critical Care (3%), Trauma (3%), other residents (3.9%), and Pediatrics (2.7%) being the next level contributors. After 3 months of education intervention and during the post-education period, PGY 1–5 received 82,443 messages. Again, Nursing contributed the highest (26.1%) to the total, with Surgery (24.7%), Emergency Medicine (7.9%), Critical Care (4.9%), Trauma (4%), other residents (3.8%), and Pediatrics (3.5%) having a similar level of contribution. These data are demonstrated in Table 4.

We evaluated the average number of nursing messages received per resident by PGY level as categorized into PGY 1–3 and PGY 4–5 groups. A total of 26 categorical surgery residents were evaluated with 20 PGY 1–3 and 6 PGY 4–5. We combined junior residents and senior residents because their workflow is similar. Nurses tend to message junior residents first, maintaining the hierarchy and training paradigm of residency. Different services have variable combination of residents, but typically the PGY 1–3 are the "first call" for most services, and we wanted to determine if there was a change in messaging for both those groups. PGY 1–5 residents received 31,221 messages for an average of 1,201 messages per resident in the baseline pre-education period, compared to 21,498 in the post-education period for an average of 827 messages per resident. On average, residents received 374 fewer messages each in the post-education period. PGY 1–3 residents received 24,503 messages for an average of 1,225 messages per resident in the baseline pre-education period, compared to 17,397 in the post-education period for an average of 870 messages per resident. On average, PGY 1–3 residents received 355 fewer messages each in the post-education period. PGY 4–5 residents received 6,718 messages for an average of 1,120 messages per resident in the baseline pre-education period, compared to 4,101 in the post-education period for an average of 684 messages per resident. On average, PGY 4–5 residents received 436 fewer messages each in the post-education period. These data are demonstrated in Table 5.

Table 4 Number and percentage of messages to PGY 1–5 Surgery Residents

Number and percentage of messages to PGY 1–5 surgery residents	Pre-education (Apr–Jun 2021) [*n*]	Post-education (Oct–Dec 2021) [*n*]
Total messages	102,394	82,443
Percentage breakdown		
Nursing	30.50% [31230]	26.10% [21518]
Surgery	26.90% [27544]	24.70% [20363]
Emergency medicine	6.70% [6860]	7.90% [6513]
Critical care	3.00% [3072]	4.90% [4040]
Trauma	3.00% [3072]	4.00% [3298]
Other residents	3.90% [3993]	3.80% [3133]
Pediatrics	2.70% [2765]	3.50% [2886]
p value	0.81	

Education period (Jul–Sep 2021)

We further evaluated the number of nursing messages received per day by individual residents and then calculated the average number of messages per level. PGY 1–5 residents received the same number of messages during the pre-education and post-education period (16 vs. 16 messages/day, $p = 0.83$). PGY 4–5 received the same number of messages during the pre-education and post-education period (11 vs. 15 messages/day, $p = 0.22$). PGY 1–3 residents received five fewer messages per day between the pre-education and post-education period (18 vs. 13 messages/day, $p = 0.01$). PGY 1 residents received seven fewer messages per day between the pre-education and post-education period (22 vs. 15 messages/day, $p = 0.02$). These data are demonstrated in Table 6.

During the pre-education period, surgical nurses were surveyed to assess their overall attitude toward messaging and to identify areas for multidisciplinary intervention. There was only an 18% response rate out of 340 nurses surveyed. Nursing overall attitude toward MMD was 92% positive or neutral and only 8% negative. Nurses self-reported that they sent more messages than they received per day. 48% of nurses reported sending fewer than 10 messages/day, 48%

Table 5 Number of nursing messages to surgery residents

PGY level	Pre-education messages	Post-education messages	Pre-education messages per resident	Post-education messages per resident
PGY 1–5 ($n=26$)	31,221	21,498	1,200	827
PGY 1–3 ($n=20$)	24,503	17,397	1,225	870
PGY 4–5 ($n=6$)	6,718	4,101	1,119	683

Table 6 Number of nursing messages to individual surgery residents per workday

PGY level	Pre-education average	Post-education average	*p* value
PGY 1 ($n=6$)	22	15	0.02
PGY 1–3 ($n=20$)	18	13	0.01
PGY 4–5 ($n=6$)	11	15	0.22
PGY 1–5 ($n=26$)	16	16	0.83

Table 7 Nursing survey of attitude and volume of messages

Aspect	Percentage	
Overall attitude toward messaging		
	Positive or neutral	92%
	Negative	8%
Self-reported volume of messages		
Messages sent per day		
	Less than 10 messages/day	48%
	10–30 messages/day	48%
	Greater than 30 messages/day	3%
Messages received per day		
	Less than 10 messages/day	60%
	10–30 messages/day	28%
	Greater than 30 messages/day	12%

Table 8 Nursing survey of actions and perceptions

Action	Percentage	
Actions before messaging a clinician		
	Always	43%
	Often	33%
	Sometimes	7%
Nursing fatigue from messages and alerts		
	Sometimes	35%
	Rarely	37%
	Never	17%
Nursing frustration with clinician's response time		
	Often	13%
	Sometimes	55%
	Rarely	27%
Nursing perception of patient harm due to slow response		
	Sometimes	27%
	Rarely	37%
	Never	55%

10–30 messages/day, 3% greater than 30 messages/day. 60% of nurses reported receiving fewer than 10 messages/day, 28% 10–30 messages/day, 12% greater than 30 messages/day. These data are demonstrated in Table 7. Most nurses either reviewed the chart or discussed with another nurse or charge nurse before messaging a clinician (43% always, 33% often, sometimes 7%). Nursing fatigue from messages and alerts was varied (35% sometimes, 37% rarely, 17% never). Nursing frustration with clinician's response time was also varied (13% often, 55% sometimes, 27% rarely). Nursing felt patient harm due to slow clinician response to be minimal (27% sometimes, 37% rarely, 55% never). These data are demonstrated in Table 8. The use of read receipts was prevalent in 57% of respondents, with 43% using "okay" and "thank you" to conclude a message thread. Questions regarding a culture of patient safety in messaging displayed a heterogeneity of responses. The percentage of nurses who reviewed the chart for relevant patient information to their question prior to sending a message was 90%, considered the urgency of the message and only sent urgent messages was 67%, provided two patient identifiers in each message was 73%, accepted orders via the messaging app was 65%, included a full set of vitals when there was a change in vitals was 75%, and started a new message thread for each new patient was 80%. These data are demonstrated in Table 9.

Surgical residents were surveyed during the pre-education and post-education periods to assess change in their overall attitude, messaging burden, and to identify areas for multidisciplinary intervention. Response rate during the pre-education period was much higher than the post-education period (96% vs. 35%). Residents felt fatigued and missed information due to the overwhelming number of messages they received, finding it dangerous to receive simultaneous messages all at once. However, they did not believe patients were harmed or received inadequate care due to message overload. Residents' overall attitude toward the MMD

Table 9 Nursing survey of practices in messaging

Practice	Percentage	
Use of read receipts		
	Yes	57%
	Conclusion of message thread (responses used: "Okay," "Thank you")	43%
Culture of patient safety in messaging		
	Review EHR for relevant information prior to sending message	90%
	Consider urgency of message before sending	67%
	Provide two patient identifiers in each message	73%
	Accept orders via messaging app	65%
	Include full set of vitals with changes	75%
	Start new message thread for each new patient	80%

messaging app was slightly negative. Residents' subjective assessment of message volume (10–30 messages/day) was accurate to objective measurements of actual messages received. Despite the reduction in messaging volume, there was no reduction in perception of most questions in the survey. In fact, PGY 1–5 residents felt an increase of fatigue and missed information due to the number of messages from the pre-education period to the post-education period (3.96 vs. 4.67, $p = 0.012$). PGY 1–3 felt an increase in missed information due to volume of messages as well (3.35 vs. 4.00, $p = 0.047$). These data are demonstrated in Table 10.

Discussion

Mobile messaging devices (MMDs) have revolutionized communication in healthcare, presenting both benefits and obstacles. While easy access and accurate communication are advantageous, the increased fatigue, burnout, and high message volume pose challenges, particularly for surgical residents who spend significant time in the operating room. There is limited understanding regarding the exact messaging volume and subjective burden experienced by surgical residents. This study highlights that surgical residents encounter substantial fatigue and feel as if they miss important information due to the overwhelming and simultaneous number of messages they receive. Consequently, MMD technology may significantly contribute to resident burnout. This study stands out by objectively demonstrating the average daily and 3-month messaging volumes for surgical residents, enabling comparisons with other programs, and establishing a benchmark for future interventions targeting messaging volume improvement.

When evaluating nursing messages received by surgical residents, an average overall decrease in message volume from all nurses to all surgical residents was observed. However, an analysis of individual resident data revealed only a modest clinically relevant reduction in messages (5–7 messages per resident/day). The study specifically focused on daily message volume, as it was suspected to have the greatest impact on individual perception of messaging volume-related fatigue. Furthermore, a reduction in messaging volume was primarily observed in junior residents (PGY 1–3), which aligns with the fact that nursing messages are often directed to them. Since the reduction in daily messages was modest, there was no improvement in survey results concerning fatigue, attitude, and messaging burden among most surgery residents. In addition, considering nursing contributed to only approximately 25% of the messages, the lack of improvement in subjective surveys is understandable, as other contributors to messaging volume were not addressed through education or intervention. MMD education was delivered to only 76% of nurses, and a higher impact in reduction of messaging may have been observed with 100% delivery of education. It is possible that a few outliers contributed to most of the high-volume messaging behavior, however, without a deeper analysis of the messaging data, it is not possible to confirm such a statement. Interestingly, all residents (PGY 1–5) reported increased fatigue and missed information due to message volume in the post-education period, while junior residents (PGY 1–3) specifically experienced an increase in missed information. Certainly, greater awareness of MMD education/observer effect can change responses on the survey. It may also be a factor of ongoing frustration being additive because no relevant change in messaging volume occurred despite education and surveying. It is worth noting that the survey response rate was low, with 25 residents responding pre-education and only 9 residents responding post-education. This low responder rate may introduce selection bias, with residents who have a more significant problem with MMDs and their burden being more likely to respond. Therefore, interpreting the results of all questions should be approached with caution due to the low response rate during the post-education period. One possibility of this low response rate may be because the post-education survey

Table 10 Surgery resident survey of messaging burden and messaging application attitude

Question	PGY 1–5 Pre-education ($n=25$)	PGY 1–5 Post-education ($n=9$)	p value	PGY 1–3 Pre-education ($n=17$)	PGY 1–3 Post-education ($n=8$)	p value	PGY 4–5 Pre-education ($n=8$)	PGY 4–5 Post-education ($n=1$)	p value[d]
Do you feel fatigued from the amount of messages you respond to each day?[a]	3.96	4.67	***0.012***	4.06	4.63	0.067	3.67	5.00	N/A
Do you feel as if you miss information due to the amount of messages you receive?[a]	3.16	3.78	***0.047***	3.35	4.00	***0.047***	2.83	2.00	N/A
Do you feel the amount of information you receive via simultaneous messages all at once, is dangerous?[a]	3.44	4.00	0.107	3.65	4.13	0.204	2.83	3.00	N/A
Has a patient ever been harmed or received lack of care due to messages overload?[a]	2.32	2.33	0.973	2.53	2.50	0.949	1.83	1.00	N/A
How often do you receive messages that are not meant for your team?[a]	3.60	3.78	0.517	3.65	3.88	0.483	3.50	3.00	N/A
What is your overall attitude toward MMD?[b]	2.08	2.56	0.150	2.24	2.50	0.453	1.83	3	N/A
How many times per day do you SEND a message on MMD?[c]	2.16	2.44	0.155	2.29	2.50	0.504	1.67	2	N/A
How many times per day do you RECEIVE a message on MMD?[c]	2.56	2.78	0.317	2.71	2.75	0.828	2.00	3	N/A

[a]Scale: 1 = never to 5 = always

[b]Scale: 1 = positive to 3 = negative

[c]Scale: 1 = less than 10, 2 = 10 to 30, 3 = more than 30

[d]Unable to calculate p value since post-survey $n=1$

was delivered in December and January, when residents' focus was on studying for the American Board of Surgery In-Training Examination.

Examining the number of messages residents receive per day (11–22) may seem insignificant. However, this metric does not account for the frequency per hour, untimely delivery, or disruption during critical clinical moments, such as procedures or emergencies. Even though this MMD platform allows for forwarding or "gatekeeping" by a surgical nurse while in the operating room, the messages still come through while operating and have to be addressed. If messages are forwarded to a colleague, it increases their workload, and if residents are inundated with multiple messages for patients on their service under their care, they tend to scrub out to address the issues. There is not enough resident redundancy built into the system to allow multiple residents to be scrubbed in at the same time without addressing service needs. Moreover, this low number of messages fails to consider the impact on time spent on consults, new admissions, operating, and addressing floor or ICU emergencies. Despite the seemingly low quantity, the subjective burden resulting from this volume significantly affects residents, to the extent that they feel patient safety is compromised. Therefore, this number should be taken seriously. Notably, when comparing these numbers to our previous institution's messaging results (4), the present data are over 3 months, 2 years prior to the current study. The number of residents, rotations schedule, time of the year, nursing experience, and familiarity with the MMD may all have significantly changed. We did not expect the number of messages to remain the same between the two studies.

An interesting observation from the resident and nursing surveys is that despite residents feeling fatigued, missing information, and considering simultaneous messages dangerous, they did not believe that patients experienced harm or received inadequate care because of message overload. Furthermore, residents' subjective assessment of message volume (10–30 messages/day) aligns quite accurately with the recorded number of messages they received. Notably, nurses displayed a positive attitude toward MMDs, and their message volume was relatively low. They generally adhered to best practices in messaging clinicians, with minor room for improvement in checking the medical record and conferring with another experienced nurse before messaging a clinician. Nurses also reported minimal frustration with clinician response time. Even though nursing response rate to the survey was only 18%, we were able to get education training to 76% of surgical nurses. During the training, it was noted that even though the survey was anonymous, nurses felt reluctant to complete the survey out of fear of consequences associated with their answers. Despite repeat reassurances, the response rate did not significantly improve and is a weakness in the study.

It may be speculated that nursing messaging volume is higher because they perceive a slow response rate from clinicians. However, survey results showed that nursing frustration with clinician response time was low (sometimes 55% and rare 27%). Nursing also felt that low response time leading to patient harm was minimal (rarely 37% and never 55%). In addition, nursing messaging practices were better than anticipated, with a majority utilizing read receipts, reviewing the medical record, checking message urgency, and avoiding multiple patient questions on the same thread. Notably, in free text surveys and discussion sessions with nursing, a significant number thought they could accept orders via secure messaging. It is difficult to confirm if any nurses accept orders via secure messaging since our study design did not plan to collect these data. While education interventions modestly improved messaging volume by reinforcing existing nursing practices, the most significant impact of the study was educating residents and nurses about CMS policy to strictly avoid orders via secure messaging. This policy clarification to their workflow led to increased frustration and burden perception among residents (observed via in person discussions during residency town-hall meetings), as it required them to give verbal orders via phone call or directly enter orders into the medical record.

Limitations of this study include its focus primarily on nursing as a high contributor to messaging volume, while other significant contributors remain unaddressed. Further interventions targeting other medical specialties could be explored. Another limitation is the low response rate in the surveys, as mentioned earlier. We suspect that resident frustration and fatigue during the post-education period may be attributed to the change in order entry policy, no longer allowing orders via secure messaging. The observer effect on taking surveys with no palpable change in messaging volume may also increase frustration on post-education surveys. Furthermore, the limited time available for the post-education survey was due to our institution's transition to a different medical record MMD, necessitating closure of the survey before the new MMD's initiation to avoid introducing different functionality that could affect the results. Future direction for improvement may require improved targeted surveys and education initiatives focusing on other groups (Table 4) with high message volumes. In addition, better operationalization and delivery of surveys should be pursued to improve response rates.

Conclusion

Targeted multi-professional education decreases the volume of messages received by surgical residents. Some targeted education practice changes may increase perceived messaging fatigue despite a reduction in messaging volume. Further

targeted study is required to see if reduction in messaging volume results in improved perception of MMDs. Additional solutions are required to realize a meaningful improvement in the use of MMDs.

Declarations

Conflicts of interest None declared.

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