

Effectiveness of digital consultation in reducing emergency department length of stay

Natan Mulubrhan Alemseged^{1*}, Melaku Getachew¹, Dereje Woldasilase², Fenta Wondimneh³, Ellen J Weber⁴

1. Department of Emergency and Critical Care Medicine, School of Medicine, College of Health and Medical Sciences, Haramaya University, Harar, Ethiopia.

2. Department of Radiology, School of Medicine, Haramaya University, Harar, Ethiopia.

3. School of Nursing, Haramaya University, Harar, Ethiopia.

4. Department of Emergency Medicine, University of California San Francisco, San Francisco, California, USA.

*Corresponding author: Natan Mulubrhan Alemseged; Email: natanxy@gmail.com

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Abstract: **Objective:** Emergency department length of stay (EDLOS) is a critical measure of healthcare efficiency and quality, and prolonged stays are associated with worse outcomes, particularly for patients requiring intensive care unit (ICU) admission. This study evaluates the impact of a digital consultation management system implemented at Hiwot Fana Comprehensive University Hospital in Ethiopia between May 2020 and May 2024.

Methods: A pre–post quasi-experimental design was utilized to compare EDLOS for ICU patients before and after the implementation of the new consultation system. The traditional consultation process was characterized by multi-step verbal communication among healthcare providers. The new system employed a secure Telegram channel to facilitate real-time communication, whereby all physicians in the consulting service were simultaneously notified of the patient requiring ICU care. We determined the proportion of patients admitted to the ICU staying more than 24 hours in the emergency department (ED) between pre- and post-implementation of the Telegram system using chi-squared tests and mean difference in LOS using Mann Whitney U.

Results: This study included 415 patients with 202 patients in the pre-implementation period (May 01, 2020, to May 31, 2022) and 213 in the post-implementation period (June 01, 2022, to May 31, 2024). The mean age was 43.3 years (SD: 18.75 years), and no significant demographic or clinical differences were observed between the pre- and post-intervention groups, except for payment method. Before implementation, 32.6% of patients stayed in the ED > 24 hours while after the implementation 28.8% stayed > 24 hours (P=0.03). The mean EDLOS decreased from 2.83 (SD: 2.5) days to 2.27 (SD: 1.64) days following implementation (P=0.04), with a reduction of approximately 13.2 hours in EDLOS. Overall ICU mortality decreased from 31.4% to 25.8%, though this was not statistically significant.

Conclusion: A digital consultation system can reduce EDLOS in a limited-income country, consistent with findings from similar studies. Further research is needed to explore long-term impacts and scalability, especially in low-resource settings.

Keywords: Crowding; Digital Consultation; Emergency Department; Information Technology; Length of Stay; Patient Outcomes

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1. Introduction

Emergency department length of stay (EDLOS) refers to the total time patients spend in the emergency department (ED), from arrival to departure (1). Research has demonstrated that prolonged ED stays are associated with a 15%–30% increase in mortality rates, reflecting poor hospital performance and patient care (2,3). Despite the implementation of various interventions, such as team triage and enhanced staffing, prolonged EDLOS continues to be a persistent challenge worldwide (2).

EDLOS serves as an important indicator of healthcare system efficiency and quality, reflecting not only patient care

but also organizational management and overall health system performance (4). Several factors contribute to increased EDLOS, including delays in consultations, radiology and laboratory services, and general ED crowding. Patient-related factors such as higher acuity, specific presenting symptoms, greater complexity, and delays in pain management can also exacerbate EDLOS (2,5,6). However, the primary cause of prolonged EDLOS and crowding is the inability to transfer admitted patients from the ED to available inpatient beds (7). The consultation process within the ED is a critical aspect of patient management that significantly impacts both the quality of care and the efficiency of emergency services (8).

EDs heavily rely on interdisciplinary consultation to obtain specialist opinion on management and whether or not a patient should be admitted. Timely consultations are essential; however, studies have shown that response times for urgent consultations often exceed recommended limits, leading to extended ED stays and increased patient morbidity (9,10). Therefore, establishing protocols that ensure rapid response times for consultations is vital for optimizing patient flow and reducing EDLOS.

In developed countries, a prolonged ED length of stay (EDLOS) is typically defined as over four to six hours, while in low- and middle-income countries (LMICs), stays are often much longer. A recent systematic review in Ethiopia defined prolonged EDLOS as > 24 hours, finding that 64% of patients experienced this (11). While the study from Hiwot Fana comprehensive specialized hospital (HFCSH) reports a delay for 42% of all patients (6). To address this, we implemented a digital consultation system to reduce EDLOS for ICU admissions at HFCSH from May 2020 to May 2024 and assessed its impact.

2. Methods

2.1. Study design

This was a pre–post quasi-experimental study designed to assess the effect of a change in the consultation process on ED length of stay for ICU patients. The study was granted ethical approval from Haramaya University, College of Health and Medical Sciences, the Institutional Review Board.

2.2. Study setting

The study was conducted at the ED of Hiwot Fana Comprehensive University Hospital, which includes an Emergency Medicine and Critical Care residency program. As the largest tertiary care hospital in Eastern Ethiopia, it has more than 500 inpatient beds, which are occupied approximately 90% of the time. The ED serves around 12,000 patients annually, with an average LOS of 2.78 days. The hospital relies on a paper-based medical record system.

2.3. Participants

The study included adult patients presenting to the ED and requiring admission to the ICU between May 2020 and May 2024. The study excludes patients discharged home, admitted to the regular wards, those who died while awaiting admission, surgical cases, and pediatric cases.

2.4. Study protocol

In the ED, junior ED residents evaluate patients and report their findings to senior residents and attending consultants to determine the need for ICU admission. This process was not changed as it is essential to the teaching mission of our hospital.

Before the implementation of the new system, consultations followed a traditional multi-step process. The junior ED res-

ident would first assess the patient and gather the necessary clinical information before presenting their findings to a senior ED resident and the attending consultant in the ED. If ICU admission was required, a consultation form or phone call would be sent to the duty junior or senior ICU resident. The ICU resident, in turn, would communicate with the ICU consultant to finalize the admission decision. This process often led to delays in decision-making, as it depended on the availability of multiple team members to relay information and reach a consensus.

The digital consultation management system introduced in this study streamlines this process by utilizing a secure Telegram channel. Telegram is a cloud-based messaging app founded by Pavel Durov in 2013, developed by Telegram FZ-LLC, and headquartered in Dubai, United Arab Emirates (UAE). It offers secure communication with end-to-end encryption for "secret chats" and MTProto encryption for standard chats. To ensure patient privacy and data security, sensitive information such as patient names, hospital card numbers, and other personally identifiable details are not displayed in the Telegram channel.

With the new system, all physicians working in the ED and ICU are added to a dedicated Telegram channel. When a patient in the ED requires ICU admission, the ED resident (junior or senior) posts the patient's diagnosis, medical history, and physical examination findings in the channel. Once the admission request is posted, the ICU duty consultant physician or department head reviews the case and responds in real-time about the ICU admission decision. This direct line of communication eliminates the need for phone calls, intermediaries or physical handoffs, reducing delays. In addition to admission decisions, the Telegram channel allows for immediate back-and-forth discussions regarding patient management, clarification of findings, and updates on bed availability. Physicians can also attach images, lab results, or ECG tracings, further streamlining decision-making and enhancing collaboration between teams.

2.5. Sampling technique

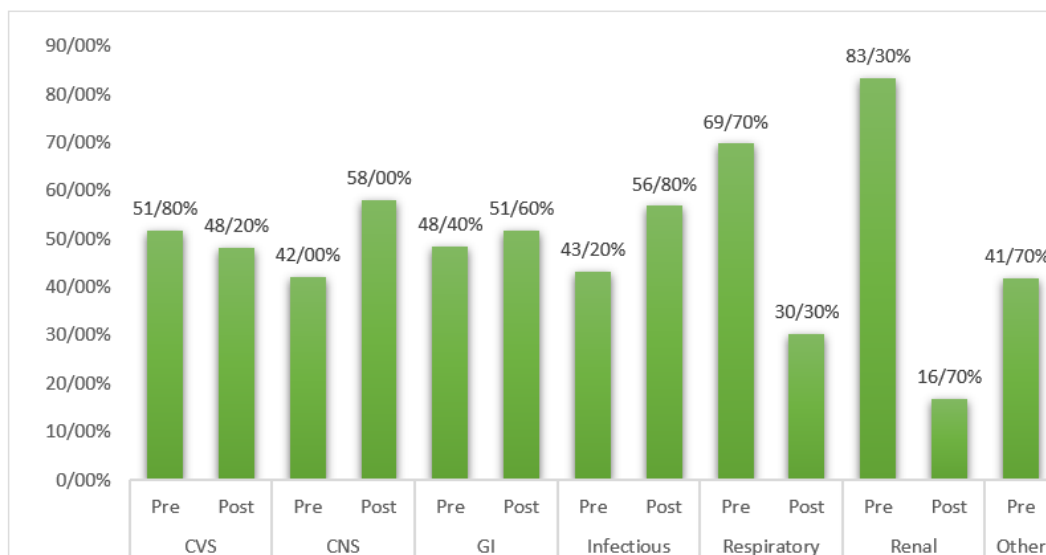
Given the frequency of ICU admissions in our ED, a four-year pre- and post-study was conducted based on the feasibility of reviewing all available charts. The pre-intervention period spanned from May 1, 2020, to May 31, 2022, coinciding with the establishment of the ED in May 2020. The post-intervention period extended from June 1, 2022, to May 31, 2024.

The dataset comprised variables such as patient age, sex, place of residence, modified early triage warning score (MEWS) (12), diagnosis, and duration of ICU stay. These data were obtained from patient paper charts and the hospital's registration system. Trained data collectors, including ED and ICU physicians, manually extracted the relevant information using a standardized data collection form.

Table 1 Baseline characteristics of patients in the pre- and post-consultation periods

Baseline characteristics		Pre-intervention (202)	Post-intervention (213)
Age (mean+SD)		43.56 (19.3)	43.12 (18.3)
Sex	Male	115 (56.9%)	132 (61.9%)
	Female	87 (43.1%)	81 (38.1%)
Date of arrival	Weekdays*	147 (72.7%)	156 (73.2%)
	Weekend**	55 (27.3%)	57(26.8%)
Time of arrival	Working Hours	108 (53.4%)	124 (58.2%)
	Duty Hours	94 (46.5%)	89 (41.8%)
Residence	Rural	141 (69.8%)	118 (55.3%)
	Urban	61 (30.1%)	95 (44.7%)
Early warning score £ (median (IQR))(12)		6 (-7)	6 (5 -7)
Payment method	Insurance	36 (17.8 %)	123 (57.7 %)
	Out of pocket	157 (77.7 %)	86 (40.3 %)
	Free	9 (4.4 %)	4 (1.8 %)
Diagnosis	CVS	57 (28.2%)	53 (24.8%)
	CNS	47 (23.2%)	65 (30.5%)
	GI	31 (15.3%)	33 (15.4%)
	Infectious	16 (7.9%)	21 (9.8%)
	Respiratory	19 (9.4%)	10 (4.7%)
	Renal	10 (4.9%)	3 (1.4%)
	Others	22 (10.8%)	28 (13.1%)

* From 8:01 am to 5:00 pm; ** From 5:00 pm to 7:59 am; CVS: Cardiovascular system; CNS: Central nervous system; GI: Gastrointestinal
£: Early warning score

**Figure 1** Bar graph of ICU admitted cases with in pre and post intervention time at HFCSH from

2.6. Study outcome

The primary outcome of interest was the proportion of prolonged length of stay in the ED. Secondary outcomes included patient outcomes in the ICU and factors associated with these outcomes.

2.7. Statistical analysis

The data analysis included means with standard deviations (Z-tests for skewness showed no significant differences between the two groups, indicating that the mean difference reflects the intervention's effect), as well as medians with in-

terquartile ranges (IQRs). Mann-Whitney U test was used to compare the numeric data. The Pearson chi-squared test was used to compare frequencies of the categorical data. The PASW software, version 18 (SPSS Inc., Chicago, IL), was used for statistical analyses. A P-value < 0.05 was deemed to indicate statistical significance.

3. Results

During the time periods of the study, 415 patients were admitted to the ICU from the ED, 202 patients in the

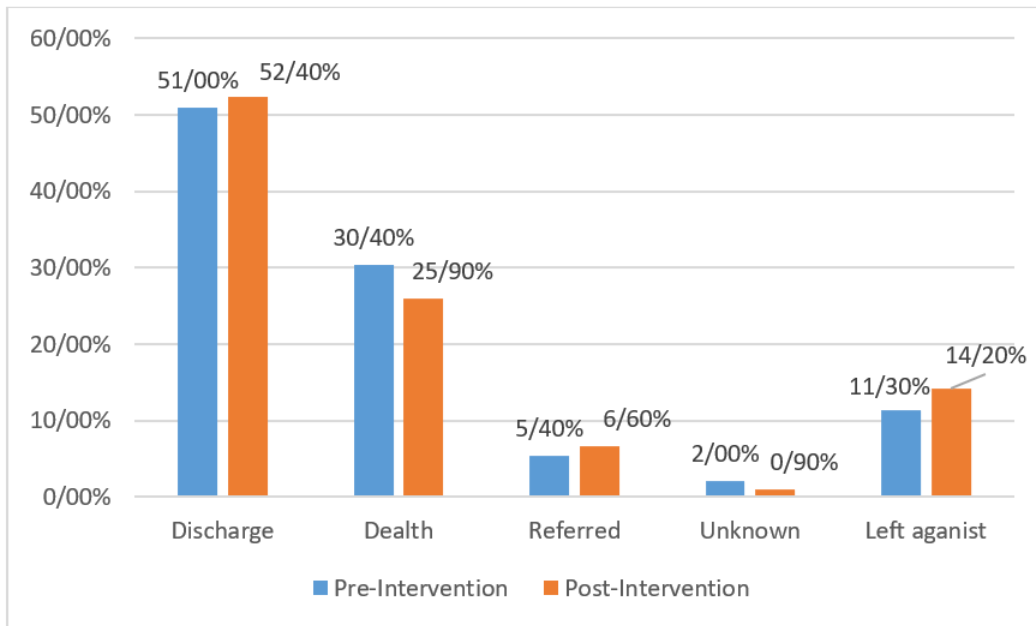


Figure 2 The bar graph of the outcome of ICU-admitted patients in pre and post-intervention at HFCSH from May 2020 to May 2024

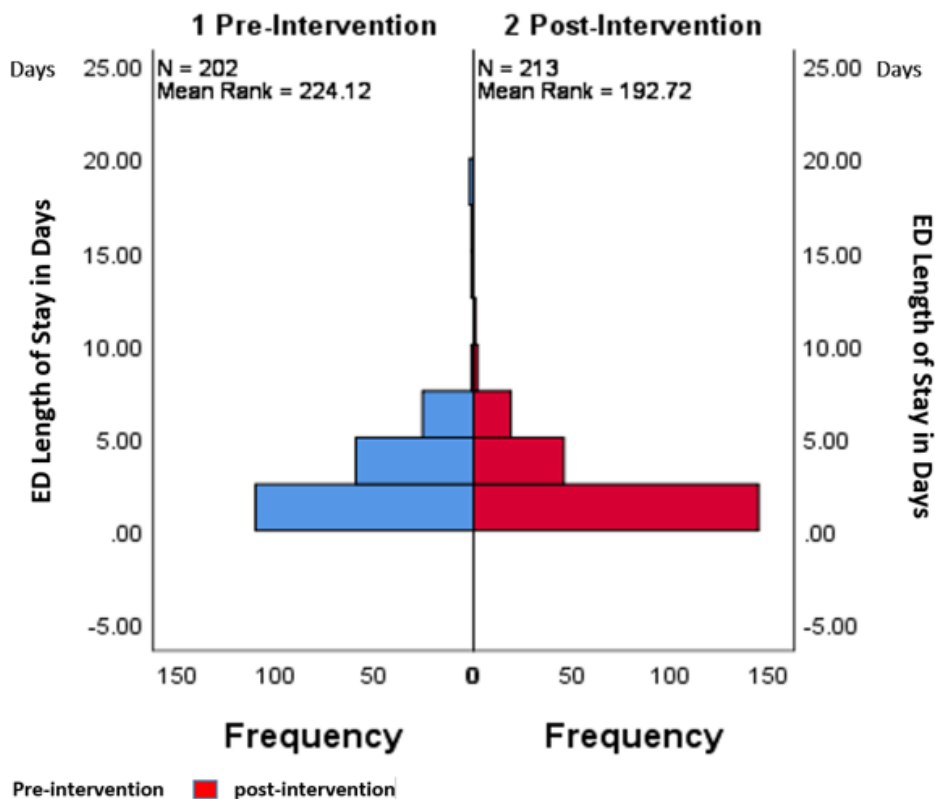


Figure 3 Mann-Whitney U test to compare the mean ED length of stay in the pre- and post-intervention period. (Mann-Whitney U =24768.5 with P-value 0.006)

The figure presents the distribution of ED length of stay (in days) during the pre-intervention (May 1, 2020 – May 31, 2022) and post-intervention (June 1, 2022 – May 31, 2024) periods. The histogram illustrates the frequency of patients within different lengths of stay, with pre-intervention cases represented in blue and post-intervention cases in red. The mean rank for the pre-intervention group (n = 202) was 224.12, while for the post-intervention group (n = 213), it was 192.72. The reduction in ED length of stay in the post-intervention period suggests a potential improvement in patient flow and efficiency.

pre-intervention period, and 213 patients in the post-intervention period. Overall, 57% of the patients were male, and the mean age of the enrolled patients was 43.3 years (SD, 18.75 years) (Table 1). In both periods, most patients arrived on weekdays, with a slight majority presenting between 8:01 AM and 5:00 PM. 58.8% of the patients were paying out of their pocket and 31.8% of the patients were covered by insurance (Table 1).

3.1. Patient characteristics

The mean early triage warning score of the patients was 6 (± 1.95) (12). The most common reasons for ICU admission were neurological disorders, followed by cardiovascular disorders (Figure 1). In this review, both neurological and cardiovascular disorders were found to be associated with high case fatality (Figure 1).

As shown in Figure 2, among all 415 patients, the mortality was 28.1%. The mortality rate for patients in the pre-digital consultation group was 30.4% ($n = 202$) and 25.9% ($n = 213$) in the post-digital consultation group. The Pearson Chi-square test indicated no statistically significant difference in mortality before and after the intervention 0.299. (Figure 2)

3.2. Effect of digital consultation on ED length of stay

On average, patients spent 2.52 days ($SD=2.15$) in the ED, with the minimum length of stay recorded at 1 day and the maximum reaching 24 days. In the pre-intervention group, the proportion of patients with prolonged EDLOS was 32.6%, while in the post-intervention group it was 28.8%, (P -value of 0.03). The mean ED length of stay for ICU patients decreased significantly after the introduction of digital consultation, from 2.86 days ($SD=2.5$) to 2.27 days ($SD1.64$) (P -value of 0.04). This intervention resulted in a mean reduction of 13.2 hours in ED length of stay, with a 95% CI: 3.24, 23.2 hours (Figure 3).

4. Discussion

This study reports on a digital consultation system that was implemented in a low resource setting to improve the ED LOS of ICU patients. While in high-income countries, it is considered appropriate for admitted patients to stay in the ED no more than 6 hours, LMICs have much longer times to admission, and in Ethiopia, more than 24 hours is considered a delay (12). In the pre-intervention period in our study, 32.6% of patients had prolonged EDLOS, while in the post-intervention group, this proportion decreased to 28.8% ($P=0.03$). The introduction of digital consultation significantly reduced the EDLOS for ICU patients in our hospital, with the mean duration decreasing from 2.78 to 2.27 days. This reduction aligns with existing literature that highlights the benefits of digital consultation systems in improving ED workflows. For instance, Cho et al. conducted a study in a tertiary care teaching hospital in South Korea, where the implementation of a computerized consultation management sys-

tem resulted in a reduction of 106.5 minutes in EDLOS (13). Similarly, Razavi et al. reported improved shorter EDLOS and increased healthcare provider satisfaction after the integration of a consult order system, which streamlined workflows and reduced the time required to initiate consultations (14). These studies demonstrate how digital tools can optimize consultation processes and enhance patient care efficiency. The overall mortality rate of the ICU patients in the study was 28.1%, with a decrease from 30.4% in the pre-intervention period to 25.8% in the post-intervention period. Although not statistically significant, this reduction in mortality following the implementation of digital consultations suggests a positive effect on patient outcomes. Research has consistently demonstrated that delays in ICU admission from the ED are associated with higher mortality rates and adverse patient outcomes, such as requiring invasive ventilation and longer ventilation days (15–19). Groenland et al. conducted a comprehensive registry analysis involving 14,788 patients and found that prolonged time from the ED to ICU correlates with increased hospital mortality (15). The study emphasized the need for effective triage systems that can identify severely ill patients promptly, thereby preventing delays that could compromise patient safety. However, while the reduction in mortality rates is promising, it is important to contextualize these findings within the broader scope of digital health interventions. Digital consultations are part of a larger spectrum of healthcare improvements, and their effects on mortality rates can be influenced by various factors, including the overall quality of care, the efficiency of emergency services, and the specific conditions being treated.

There is evidence of the benefit of other digital innovations in health care. The implementation of digital scribe systems offers a promising avenue for enhancing clinical documentation and consultation efficiency in the ED. These systems provide a digital platform for summarizing clinical conversations, thereby improving communication, documentation accuracy, and overall operational efficiency (20). Digital scribe systems in LMIC have improved health professionals' work efficiency (21). Razavi et al. highlighted the positive impact of video consultations on communication among healthcare providers and patients, as well as on workflow within health facilities (14). While the digital system itself plays a significant role, it is essential to note that the real benefit lies in how these systems enable real-time communication between parties. This facilitates the development of more optimized patient care plans and follow-up, ultimately improving the quality of care delivered.

Despite the advantages of digital consultations, several challenges remain. The integration of digital solutions into existing workflows requires careful consideration of organizational factors, including staff training, technology infrastructure, and the establishment of clear protocols for use (22,23). Additionally, privacy and data security must be addressed. When consultations occur via personal phones, there is a risk that sensitive patient information could leave the hos-

pital with its users. Implementing encryption and access controls is crucial to ensure compliance with data protection standards. Furthermore, the potential for increased workload on healthcare providers must be considered to prevent burnout and ensure the sustainability of digital consultation practices.

5. Limitations

The limitations of this study include its single-center design, which may restrict the generalizability of the findings to other healthcare settings. Additionally, as the study focuses exclusively on ICU patients, it does not provide insights into broader ED operations or outcomes for non-ICU patients. As a pre- and post-intervention study, it is subject to potential confounding. However, no significant changes in patient characteristics or hospital staffing occurred between the two periods, minimizing this concern. To confirm the generalizability of these findings, similar studies should be conducted in different settings.

6. Conclusion

Implementation of digital consultation system in a low-income country resulted in reduced EDLOS for ICU patients. Further research is needed to explore the long-term impacts and scalability of digital consultation systems, as well as to address any infrastructural and training challenges that may influence their effectiveness in various settings.

7. Declarations

7.1. Acknowledgement

We are grateful to the Royal College of Emergency Medicine for funding and the College of Health and Medical Sciences at Haramaya University for funding and ethical approval of this study. To wrap off this study, we would also want to send our warmest gratitude to the study participants, data collectors, and supervisors of the data collectors.

7.2. Authors' contribution

NM conceived the study, and NM, MG, FM, DW, and EW contributed to the design of study. NM, MG, FM, and DW contributed to data collection, analysis, and interpretation, and wrote the manuscript. NM, MG, FM, DW, and EW critically revised the manuscript, and all authors read and approved the final manuscript for submission.

7.3. Conflict of interest

The authors declare that they have no competing interests.

7.4. Funding

This study was financially supported by the Royal College of Emergency Medicine. The funder had no role in the study selection, data collection, analysis, or interpretation.

7.5. Ethics approval and consent to participate

The research was conducted according to the recommendations of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Health Research Ethics Review Committee of Haramaya University College of Health and Medical Sciences. A formal letter of ethical approval received from the IHRERC was sent to Hiwot Fana Comprehensive University Hospital to get administrative permission. Informed verbal and written consent was obtained from study participants. The participant's identity was kept secret during data collection and dissemination processes.

7.6. Availability of data and materials

All the data supporting the study findings are within the manuscript. Additional detailed information and raw data are available from the corresponding author on reasonable request.

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