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# EMCON: A Comprehensive Emergency Response System for Low- and Middle-Income Countries

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**Brief Report**

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## Abstract

**Background:** Emergency medical care in Pakistan remains uncoordinated due to the absence of a platform to connect hospitals, patients, and ambulances. Consequently, during periods of resource shortage and crowding of the emergency department at hospitals, patients and ambulances are unable to select the best site for patient management or transfer of patients, resulting in suboptimal care and poor outcomes.
**Objectives:** We developed a digital platform called EMCON (Emergency Connection) application, which can be used for inter-hospital and hospital-to-patient/ambulance communication to coordinate patient care. The platform offers real-time information on resource availability, facilitates interhospital patient transfers, coordinates ambulance responses, and assists patients in making decisions about seeking emergency care.
**Implementation:** The platform offers real-time information on resource availability, facilitates interhospital patient transfers, coordinates ambulance responses, and assists patients in making decisions about seeking emergency care. It has a range of features that allow hospitals to control the data that they share to maintain hospital buy-in, incorporates both electronic and manual data entry for real-time updates in low-resource settings or during electronic medical record disruption, and provides visual content and appointment scheduling services to keep patients engaged.
**Results:** The pilot testing of the EMCON platform yielded promising outcomes, highlighting its adaptability and effectiveness in diverse health care settings. Integration with an electronic medical record (EMR)-equipped tertiary hospital demonstrated seamless real-time data updates, ensuring efficient resource management and coordination. Meanwhile, the successful implementation at a resource-reliant blood bank underscored EMCON's versatility, allowing manual data entry for hospitals without EMR systems. These results emphasize the platform's practicality and potential to revolutionize emergency health care access in low- and middle-income countries (LMICs). EMCON's ability to bridge coordination gaps and enhance resource allocation holds great promise for improving patient outcomes, particularly in resource-constrained settings.
**Conclusion:** EMCON serves as a promising solution to address critical coordination issues in emergency care, bridging the gap between hospitals, patients, and ambulances to improve emergency health care access in low-resource settings.

## Background

Hospitals in Pakistan operate in silos due to the absence of robust platforms for inter-hospital and hospital-to-patient/ambulance communication regarding resource availability. During periods of Emergency Department (ED) crowding and resource shortage, hospitals, patients, and ambulances are unable to identify facilities with available resources for patient management or transfer in a timely manner. This results in significant patient distress, higher morbidity, and mortality. These limitations have become particularly evident during large-scale crises such as the Coronavirus disease 2019 (COVID-19) pandemic, devastating floods, and terrorist attacks, all of which underscore Pakistan's vulnerability to mass-casualty incidents (MCIs) and disasters.[1,2]

In such contexts, the ability to coordinate resources across institutions becomes critical. Studies on resource coordination and emergency response management in low- and middle-income countries (LMICs) highlight persistent gaps in efficiency and equity, often stemming from high financial costs, fragmented communication systems, and limited knowledge of resource distribution.[3,4] These challenges reduce the capacity of health systems to mount a timely and organized response during emergencies.

Currently, Pakistan lacks a central platform to connect the multiple ambulance providers that operate in isolation, impeding the deployment of a unified and organized emergency response. Previous surveys in Pakistan have shown that most patients rely on a private car, taxi, or local transport system to reach the ED due to the cumbersome and lengthy process of arranging an

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ambulance.[5,6] This absence of coordination is especially dangerous during disasters, when delays in mobilizing transport can translate into avoidable loss of life.

Finally, the lack of a centralized triaging and referral mechanism forces patients to rely primarily on their own judgment to seek emergency care and select an institution. In a setting of constrained resources and low patient literacy, this results in high rates of inappropriate emergency-seeking behavior (such as delayed or unnecessary emergency visits), which further overwhelms EDs and compromises disaster preparedness.[7]

### *Objectives*

We aimed to develop a digital platform that operates in low-resource settings and comprehensively facilitates emergency patient care (Figure 1), including the following:

1. Inter-hospital and hospital-to-patient/ambulance communication for resource availability.
2. Interhospital patient transfer.
3. Ambulance response coordination.
4. Patient assistance with the decision to seek emergency care.

The following challenges were anticipated and had to be addressed when designing the platform:

- **Local buy-in and ownership:** Hospitals were hesitant to disclose the availability of resources since they wanted to maintain emergency reserves of resources (ventilators, blood, etc.). There were also concerns that bureaucratic influence would be used if the public was aware of available reserves to pressure them to use resources for non-critical patients. The platform required participation from multiple hospitals to be effective, so these concerns needed to be addressed.
- **Real-time up-to-date information:** The platform depended on having up-to-date information about the availability of resources. Information about a change in resource availability needed to be communicated to the patient/ambulance when they were en route to the hospital.
- **Lack of electronic records:** Most hospitals in Pakistan do not have an EMR system. They rely on tracking the availability of resources through manual entry in registers.
- **Digital outreach and usability:** Patients had to be informed about the application and be familiar with it so they could rely on it during emergencies. The web platform and mobile application had to be easy to navigate. There are several languages commonly spoken in Pakistan, and the application had to be available in those, namely: Urdu, English, Punjabi, Pashto, and Sindhi.
- **Liability:** There were concerns regarding liability if the information on the platform was incorrect and resulted in an adverse patient outcome.
- **Finances:** The intervention had to be low-cost and follow a sustainable financial model.
- **Data protection:** Accessing patient information by integrating with the hospital EMR raised substantial safety and privacy risks, which required careful consideration. These concerns were addressed by ensuring end-to-end encryption of data and using a strict user authentication and restricted access system. It is important to note that EMCON is not designed to directly update or replace existing hospital EMRs. Instead, it functions as a communication and coordination layer,

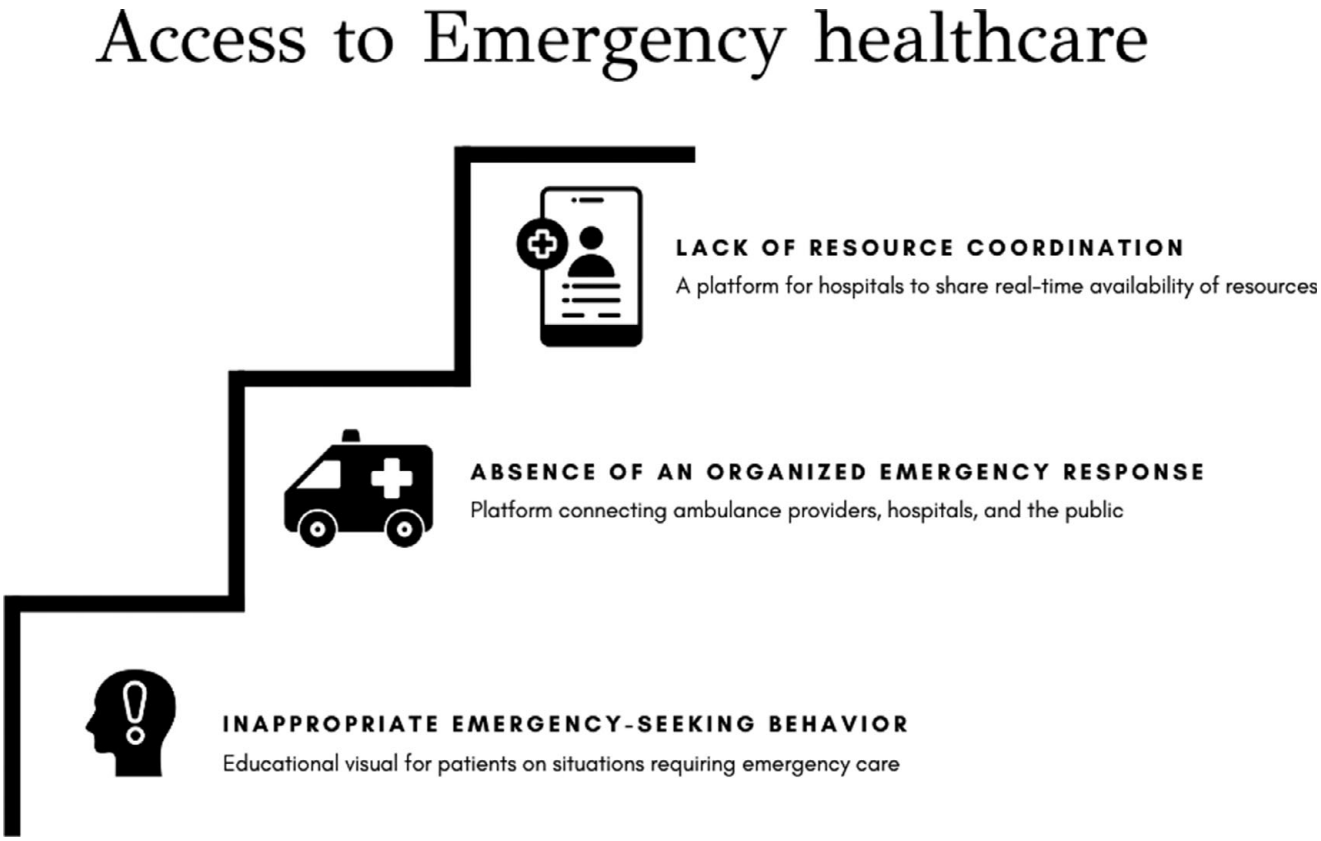



**Figure 1.** Features within the EMCON system to overcome challenges in the emergency medical system.

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facilitating real-time exchange of critical patient information between hospitals and ambulances while each hospital maintains its own EMR. Patient confidentiality is protected through end-to-end encryption, role-based access control, secure server storage, and audit trails, ensuring compliance with data protection standards.

- **Co-creation with end-users:** In addition, the design process prioritized co-creation with end-users. Hospital administrators, emergency physicians, ambulance providers, and patients were involved at every stage of development to ensure that the platform addressed real-world needs, was user-friendly, and fostered a sense of ownership that is critical for adoption.

## Methods

We implemented a three-phase process when developing the platform (Figure 2):

### *Phase 1: Platform Development*

The Emergency Connection (EMCON) platform was designed as an open-access system to facilitate public access to emergency services. EMCON is not a registered trademark and currently has no patent or licensing; it is a non-commercial initiative intended solely for public health benefit.




**Figure 2.** Phases for implementation of the EMCON intervention.

EMCON comprises a web platform and mobile application. The web platform is used by hospitals, and the mobile application is used by patients and ambulances (currently, both platforms are offline for further development and public relaunch). The platform performed the following four functions:

1. The web platform allowed hospitals to enter and view information about existing resources and their current availability. When transferring a patient, hospitals could share patient details, including the medical history and reason for transfer, with the receiving hospital.
2. The ambulance availability section provided real-time information about the current location of ambulances for all providers on the platform, enabling patients to select an ambulance based on their preference.
3. The news and information section in the mobile application had figures and diagrams to assist patients with the decision to seek emergency care. It was built after consulting ED physicians about common presenting complaints for which a delay in receipt of care could result in worse outcomes. It was also a reliable source of information about the development of events during disasters.
4. The appointment scheduling service in the mobile application was integrated with the hospital's EMR and allowed patients to request and keep track of outpatient appointments. This increased patient interaction with the app and also improved compliance with relevant care after discharge from the ED.

The following features were incorporated to address the aforementioned challenges:

- **Local buy-in and ownership:** Hospitals were allowed to select a reserve quantity for each resource so that the platform would show the resource as unavailable when the reserve was reached. They could also select which other institutions were allowed access to information about available resources. An additional feature allowed them to share exact numbers or availability status (available/unavailable) for resources. Hospitals could select resources that were shared with the public and Emergency Medical Services (EMS) providers on the mobile application. Hospitals could activate a disaster response, during which they could share a preselected set of resources with additional stakeholders.
- **Up-to-date information and lack of EMR:** Information had to be updated in real-time in the platform. For a hospital using EMR, the platform was linked to the EMR system and was updated with the EMR system. For hospitals not using EMR, a feature that allowed manual data entry into the platform was designed. This feature allowed the system to operate in low-resource settings. In our experience, minimal resources were required at these institutions, and some of the existing personnel were repurposed to support the platform. Patients and ambulances were allowed to select a route to the hospital and received notifications if there was a change in the availability of the resource they required at their en-route hospital. They were also redirected to a different hospital.
- **Digital outreach and usability:** A feature that allowed patients to schedule appointments ensured that they developed familiarity with the application and downloaded it for routine appointments, increasing the probability of the application

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being present during an emergency. The mobile application was available in the four common languages in Pakistan.

- **Liability:** A pop-up was displayed when the patient utilized the application, stating that while the platform aimed to provide accurate information, patients had to use it at their own risk.
- **Finances:** To promote long-term sustainability, the development team adopted a hybrid financial model. Hospitals contribute a modest annual subscription fee of $1,800 (PKR 512,640) to the EMCON development team to cover maintenance and expansion costs, while external partnerships are being explored for technical support, disaster-readiness upgrades, and potential integration with governmental systems. This approach balances affordability with sustainability, ensuring the platform remains functional and adaptable in low-resource settings.

## Implementation

### *Phase 2: Pilot Testing*

The EMCON platform was conceptualized in mid-2020 and developed throughout 2021. Pilot testing was carried out at selected hospitals and blood bank between January and June 2023. EMCON represents a voluntary initiative led by medical students and faculty, independent of governmental or private sector ownership, though supported by hospital subscriptions to sustain its maintenance and growth.

The implementation of the EMCON platform involved a pilot phase conducted at two distinct sites, each presenting its unique challenges and opportunities. The first site, a large tertiary-care, teaching hospital equipped with an EMR system, saw a seamless integration of the platform. During the pilot testing, the EMCON platform was successfully linked to the hospital's EMR, ensuring real-time updates without any notable delays when there were changes in the hospital's electronic record. This integration provided a highly efficient resource management system, facilitating streamlined coordination between hospital departments and offering a valuable model for EMR-connected institutions.

In contrast, the second site, a blood bank reliant on manual records of resources, necessitated a different approach. The pilot testing at the blood bank primarily involved training the staff to enter data into the EMCON platform manually. This process addressed the challenges posed by the absence of an EMR system, showcasing the platform's adaptability to low-resource settings and offering a practical solution for institutions that rely on manual record-keeping.

A key strength of the pilot phase was the collaborative involvement of end-users in real-time troubleshooting and refinement. Their direct feedback led to iterative improvements in usability, data entry processes, and patient-facing functions, demonstrating the importance of participatory design for long-term uptake.

The pilot runs received great feedback, EMCON integrated well into both sites, and this underscores the versatility of the EMCON platform, capable of accommodating varying health care infrastructures to enhance resource management and coordination in emergency medical care. It also demonstrated that the health care sites in Pakistan were open toward accepting the platform. EMCON helped in displaying the real-time update of information from the hospital's databases and communicating it with other parties.

### *Phase 3: Launch*

This phase consisted of two parts.

1. Patient outreach: Patients were informed about the platform at the hospital, and the application's use for routine appointments and services such as vaccinations was promoted. The mobile application was made available in two commonly spoken languages in Pakistan, Urdu and English. EMCON will be expanded further to include other regional languages to cater to a diverse patient population.
2. Hospital outreach: Hospital administration leaders were approached about the platform, and its benefits were conveyed. In the first phase of implementation, we added only tertiary care hospitals in Karachi, a metropolitan city in Pakistan, with well-established EMR systems. We updated information regarding only the availability of resources at hospitals. Additional hospitals and further features were implemented in subsequent iterations. This work is currently being performed with the hope that more institutions will be added to make the network more robust.

Future plans include expansion to additional settings, improved integration with EMR, application of artificial intelligence to build predictive algorithms based on practice patterns, an extension of language support, and development of disaster response protocols. Beyond technical scaling, EMCON's long-term sustainability depends on continued stakeholder engagement, cross-sector partnerships, and policy alignment. Building shared ownership among hospitals, prehospital providers, and patients will remain central to ensuring that EMCON evolves into a resilient, sustainable platform for emergency and disaster response.

## Hurdles

We experienced our greatest hurdles in Phase 3 of the implementation process. We made several attempts to collaborate with the Ministry of Health to implement the platform. However, there would be long delays between meetings. In addition, there were frequent leadership changes due to government personnel transfers. Each newly appointed official would have their own agenda. We would have to restart attempts to bring the government official on board and continue implementation. Health care was decentralized in 2010 and came under the provincial government's jurisdiction. The political parties that form the provincial government often fail to work well together. They would hesitate to implement the project since it was viewed as promoting a rival party's project. Due to these challenges and to remain apolitical, we approached each hospital's administrative leadership instead.

The majority of patients in Pakistan pay out-of-pocket for health care, with limited financial risk protection mechanisms available, WHO reported USD 18.36 out-of-pocket expenditure (OOP) per capita in 2022.[8] Some hospitals offer subsidized treatment for patients with financial limitations; however, due to the high prevalence of poverty, many patients are compelled to seek care from these hospitals despite prolonged delays due to ED crowding. Conversely, some private hospitals accommodate patients in suboptimal conditions despite ED crowding in order to maximize revenue. The platform's utility was limited in these situations, making it challenging to secure hospital buy-in from such institutions.

It is important to acknowledge that the use of this platform requires patients to have smartphone access and internet connectivity.

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Patients without smartphones or internet access, particularly in remote areas, may face challenges in utilizing the platform. This could potentially disadvantage certain segments of the population. However, the patients can utilize the application from their nearest hospital/medical center that is onboard with EMCON.

## Where to Start

To establish a similar platform for connecting hospitals, ambulances, and patients, we recommend the following key steps, considering various aspects such as implementation barriers, funding, planning, stakeholder buy-in, and patient engagement:

1. Partnering with hospital and prehospital system leadership: In addition to working with local government and health officials, it is essential to engage directly with hospital and prehospital care providers' leadership. They play a pivotal role in the successful adoption and implementation of the platform, given their direct involvement in emergency medical care.
2. Conducting an in-depth analysis of challenges and roadblocks: Prioritize a comprehensive analysis of the challenges that hospitals and prehospital care providers face when sharing data about resources. Identifying potential hurdles during platform development and implementation will help devise targeted strategies to overcome them effectively.
3. Collaborating with dedicated local organizations: Forge partnerships with local organizations already committed to similar missions. Creating opportunities for piloting the platform in a controlled environment with these organizations will provide valuable feedback and insights for improvement.
4. Designing a tailored platform with specific features: Customize the platform to address the specific concerns and needs of hospitals, ambulances, and patients. Ensuring secure and seamless data exchange among all stakeholders is critical to successful implementation.
5. Engaging stakeholders extensively: Involve hospital administrators, prehospital system leaders, health care providers, and patient representatives throughout the development process. Actively seek their feedback and address their concerns to foster buy-in and cultivate a sense of ownership over the platform's success.
6. Forming strategic partnerships with relevant stakeholders: While government collaboration is important, it is equally vital to build strategic partnerships with hospital and prehospital care providers, health care organizations, and other relevant stakeholders. These collaborations will facilitate effective implementation on a larger scale and ensure long-term sustainability.

Looking ahead, EMCON holds promise for scalability beyond urban tertiary hospitals. In underserved and rural regions, the platform could be adapted to integrate with primary health care facilities, local ambulance networks, and telecommunication-based triage services, thereby addressing the disproportionate challenges of resource scarcity and delays in emergency care access in these settings.

Considering the challenges faced during the implementation of the initial platform, it is essential to prioritize engaging with hospital and prehospital care providers' leadership to gain a comprehensive understanding of their needs and concerns. Collaborating closely with these stakeholders will help tailor the platform to meet their specific requirements and increase the likelihood of successful adoption and implementation.

## Conclusion

The development and implementation of the EMCON platform represent a significant step forward in addressing critical coordination challenges within emergency medical care in LMIs, particularly in Pakistan. EMCON offers a promising solution to bridge the gap between hospitals, patients, and ambulances, thereby improving access to emergency health care in resource-limited settings. While the path to establishing this system has not been without obstacles, such as political complexities and financial considerations, the successful pilot testing of EMCON underscores its potential to revolutionize emergency health care access. Looking ahead, the key to its success lies in extensive stakeholder engagement, the customization of the platform to meet specific needs, and the formation of strategic partnerships. These steps are crucial for ensuring the sustained growth and impact of EMCON, ultimately enhancing emergency health care delivery in regions facing resource constraints.

**Data availability statement.** The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

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**Author contribution.** WR and SMAA conceived and designed the intervention and implemented it in the country. AS provided supervision for the design and implementation of the intervention. WR and SMAA wrote the manuscript. AM, JL, and AAJ critically reviewed the manuscript. All authors have reviewed and approved the manuscript.

**Funding statement.** EMCON was developed as a student-led, non-profit innovation under academic mentorship, without external funding or a financial foundation. The company is owned by the authors WR and SMAA; however, it has not yet been registered, and a patent has not been filed. The initiative was designed and implemented voluntarily for academic and humanitarian purposes.

**Competing interests.** The authors WR and SMAA were involved in both the development and implementation of the EMCON platform described in this manuscript. While this dual role may represent a potential conflict of interest, steps were taken to maintain objectivity in the design, evaluation, and reporting of the study. EMCON is a student-led initiative, not a registered company, and the authors have no stock ownership, financial benefit, or commercial affiliation related to the platform. The work was conducted as part of an academic and humanitarian effort rather than a commercial venture. The authors also gratefully acknowledge the volunteer programmers and technical collaborators who contributed to the platform's development, independent of the evaluative process.

**Note.** The term "EMCON" in this manuscript specifically refers to the "Emergency Connect," a digital health platform conceptualized and piloted by the authors. It is distinct from other unrelated entities or events that may use the same acronym. At present, EMCON, as described here, is not a registered trademark.

**Ethical standard.** As this paper involved the design, testing, and deployment of software, rather than conducting research involving human or animal subjects, it did not require approval from an Institutional Review Board (IRB) or Ethics Committee.

### Key Messages

- A comprehensive platform that connects hospitals, patients, and ambulances to facilitate timely triaging to appropriate sites was developed for patients seeking emergency care.

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- Program developers should consider features that allow hospitals to have control over the data being shared to gain hospital buy-in.
- Program developers should consider contingency plans that allow the platform to operate during periods of EMR destruction or in low-resource settings without electronic medical record availability.
- Local buy-in through government or local organization partnership is essential to implement such a platform.

**Teaser Key Message.** We developed a digital platform that offers real-time information on resource availability, facilitates interhospital patient transfers, coordinates ambulance responses, and assists patients in making decisions about seeking emergency care. It has features that maintain hospital buy-in, engage patients, and operate in low-resource settings or during infrastructure disruption.

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