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Multi-country Implementation Study Rapid Deployment of Mobile Pharmacy Units in Disaster Zones

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Abstract
Healthcare delivery that involves the access of essential medicines during disasters has a very serious role to play but it is often disrupted in a crisis environment. This paper assesses the implementation of mobile pharmacy units (MPUs) in three countries affected by disasters- Pakistan (floods), Sweden (wildfires) and the Philippines (typhoon recovery) as a scalable option in disruption of pharmaceutical services. Every MPU was fitted with essential medicines that were recommended by WHO, cold-chain storage as well as real-time soft digital inventory. Within 6 months duration, the MPU handling 18,500 patients were able to provide reach to 92 percent of the essential drugs and took an average of 48 hours to get deployed. High rates of patient satisfaction were observed as 88 percent of them evaluated services as affordable and trustful. Cross-country outcomes confirm that MPUs are a fast-deployed system, culturally responsive, and that they become assimilated in national emergency systems. The research gives credence to the view that MPUs is a strong and efficient strategy in maintaining pharmaceutical services in areas faced with disaster.
Keywords: ***Disaster response, emergency health logistics, disaster medicine, humanitarian pharmacy, mobile pharmacy, pharmaceutical service, essential drugs, cold-chain management, pharmacy, public health in emergencies, multi-country application, health system resilience.***

1. Introduction
1.1 Background
Recent years are marked by an increasing number and severity of natural disasters, which is further enhanced by climate change and urban vulnerability that has posed a relevant problem to global health systems. Ranging between floods, earthquakes, wildfire and, typhoons, disasters usually lead to the older infrastructure being crashed, a displacement in the population and a critical loss in the availability of medical care, especially pharmaceutical services. In this case, the availability of essential medicines is required not only to address acute illnesses but also necessary to ensure treatment continuity that can easily worsen in chronic ailments like diabetes, hypertension, and asthma should drugs become unavailable.

Any effective healthcare response to emergencies cannot be functional without pharmaceutical services. Nevertheless, they tend to be under-prioritized in the disaster response and preparedness systems. Residual supply chains, damaged storage areas, shortage of trained pharmacists, weak integration within emergency medical teams and oxygen infrastructure often leaves the affected populations on the underserved side. Preventable morbidity and mortality are not the only result, but also a further degradation of faith in public health systems in the face of maximum need.(1)

Although mobile medical units have extensively been applied in humanitarian settings, the application of mobile pharmacy-specific units has not gained greater coverage in terms of study and integration. The time lag between medical emergency pharmaceutical demand and supply is increasing, which indicates that there is a strong need to develop the context-sensitive and technology-enabled flexible, rapid-response pharmaceutical models.

1.2 Disaster-Responsive Pharmaceutical Care Gaps
Although a number of achievements have been made in the context of emergency health logistics, there are still severe limitations related to provision of consistent access to medications during and after disasters. Fixed healthcare facilities easily fall short and the centrally distributed systems of pharmaceuticals are less responsive and reachable. In the country or other inaccessible regions, particularly in low resource nations, communities can be totally isolated in the supply lines days or possibly weeks.

Additionally, the traditional pharmaceutical response systems are often generic, reactive, and have very low flexibility to respond to local prescription trends and disease burden or language and cultural factors. Humanitarian pharmacy is a rather young specialty, but even today it has no proper mobile infrastructure that can autonomously run cold-chain protection, inventory overview, and contact central authorities in real-time.

The current technological innovations including solar powered vaccination, phone inventories, and module deployment typologies provide fresh horizons to redesign how pharmacy care may be delivered to a broken emergency. Nonetheless, studies related to implementation are scant and look into practical adoption of such systems in several geographical and disaster scenarios. This has left evidence to inform policymaking, scale-up, and adoption as part of disaster preparedness programs scarce.(2)

1.3 Study Goals

To fill this research gap, this multi-country prospective implementation research sought to determine the application of Mobile Pharmacy Units (MPUs) in three countries ravaged by disasters:

- In response to disastrous floods by monsoons in Pakistan;
- Sweden, as a save haven in mass wild fire evacuation in rural municipalities;
- The Philippines, after a mass destruction caused by typhoons in coastal settlements.

WHOs Model List Each MPU was to be fitted with vital medicines, cold-chain storage (temperature sensitive), and movable digital inventory systems. The MPUs were to be modular, easily erectable (in 48 hours or less), and staffed by trained pharmacy personnel.

The purpose of study was to:

- Evaluate the suitability and reactivity of the MPUs in three different disaster related scenarios;
- Compare outreach to patients, drug access and use;
- Determine the level of patient satisfaction and perceived accessibility;
- Locate contextual enablers and operation bottlenecks in environments.

Learning from the experience of implementation in low-, middle- and high-income countries, the study aims at providing the evidence-based conclusions on effectiveness of the MPUs and contribute to policy-oriented recommendations on introducing the pharmaceutical delivery systems into national preparedness plans on disasters.

2. Mobile Pharmacy Units (MPUs) concept

2.1 Developments & Usage Arising in the Past

The concept of mobile healthcare provision has been in use many years to increase access to health services to the underserved population, rural, or those crisis affected. Sacrificial clinics moving through the Texas countryside and makeshift tents in war-torn areas, mobility has made up much of humanitarian medicine. But the slower and even piecemeal evolution of mobile pharmaceutical care as a specific operational and professional entity has occurred.

The very first manifestations of mobile pharmacy services found their place in mobile health clinics, and medicines were distributed out of an improvised setup e.g. backpacks, tents, or trucks. These models were not autonomous, standardized, or with cold chains; they were also frequently attended by the availability of a supervisor physician to prescribe and dispense. Therefore, their effectiveness was low and irregularly recorded.

Formalized: In the last decade, the concept of dedicated Mobile Pharmacy Units (MPUs) has appeared in the literature as part of a (still on-going) attempt to professionalize humanitarian pharmacy practice and increase the resilience of pharmaceutical supply chains during emergencies. Initial designs of the MPU were based on the uses of a modular field hospital system and designed on a pharmacy application level, which includes secure storage, refrigeration, and transportable inventory control systems

Recent years have seen the extension of MPUs to be self-sufficient, rapidly deployable and matched to the pharmaceutical permissibility at the national level which changes at varying rates. This has been made possible by the development of compact refrigeration technology, solar power technology and digital supply chain management. These units can be pre-loaded with key medicines, vaccines, and medical supplies and specialized based on disaster specific requirements (e.g., trauma care, waterborne disease care, or chronic care continuation supplies).(3)

2.2 Inherent Praises and Designs Characteristics

A good MPU has to be capable of being more than merely a mobile vessel of drugs it ought to be a pharmacy-level operational centre that is capable of dispensing, storing, tracking, and reporting pharmaceutical information

and also do all these activities in real time. The main parts of MPU model as considered in this research paper were:
Stock Essential Medicines: Preloaded according to WHO Model List and modified in accordance with epidemiology and local cultural norms.
Cold Chain Infrastructure Refrigerators (refrigerators or even solar-powered refrigerators) with capacity to store the vaccine and temperature sensitive medicines at 2-8 o C.
Inventory Management System: Systems that can log incoming/outgoing stock, usage rates and low-supply alerts using tablets or cloud linking.
Prescriber-Pharmacist Interface: ePrescription or paper prescription support, which allows distanced prescribing when this is needed.
Patient access design: layout; design to enable walk-in consultation, queuing systems and privacy of data.
Notably, the MPU would all be built in a modular way, with each capable of being transported by truck, trailer or even air via containers, and would be either stand-alone or be part of a larger emergency health mission. Units staff members were licensed pharmacists, pharmacy technicians, and trained logistical support personnel either on a local or national basis of the health services.

2.3 Operational Logistics in Emergencies

The implementation of MPUs in the emergency environment needs to find a compromise between the expediency and security and coordination. In the current research, the standardization of deployment protocols was uniform in the context of the three countries but localized. The deployment protocol of each MPU was four-phased:
Activation mechanism: The mechanisms are sparked by disaster notification, request of the local health authority, or appeal of the humanitarian partner.
Assembly & Preloading: Items inventoried with equipment, medications, and connectivity checked and stored. Time target: lower than 24 hours.(4)
Transporting & installation: Product shipped to field location, deployed (including cold-chain verification and electricity). Time target: 24H to 48H after activation.
Operations & Monitoring: Additional conditions under which the full service will be provided have been started, such as prescription processing, stock recording, interaction with the patients, and collecting feedback.
To make sure that the placement of MPU correspond with the priority needs, integration with national or humanitarian health clusters was essential to prevent duplication with either mobile clinics or fixed facilities. Linkage with logistic and cold-chain professionals thus provided transport safety and integrity of the temperature sensitive medicines.
MPUs under this study work on a 6-8 hours rotation basis according to the demand and security situation. Daily data upload, emergency requests of resupply, and reporting Incidents were all featured in all units.

3. Methods

3.1 Learning locations and setting

The study was a prospective implementation study spread across disaster situations in three geographically and socioeconomically different countries:
Pakistan: Devastating floods in the provinces of Sindh and Punjab as a result of monsoonal rains (August- October) exposed more than 1.2 million residents to displacement and immersed hundreds of health facilities.
Sweden: Vastomanland wildfires (JulyAugustSeptember 2014), evacuation of the rural districts of the province of Vastomanland due to fires, and a shortage of pharmacies in this area during crisis situations.
Philippines: The effect of Typhoon Narda in the Luzon and the surrounding islands (September- November) which caused damage to the infrastructure and remote accessibility to coastal communities.
These locations were selected to reflect low-, middle- and high-income conditions, and differing typologies of disaster (flood, fire and storm) delivering a wide comparative view on the viability and workability of MPUs in dissimilar working requirements.
The deployment of MPU in the country was coordinated with the local partner in each country: Ministry of Health (Pakistan), the Swedish Civil Contingencies Agency, and the Philippine Department of Health working with the NGOs and the pharmacy associations.(5)

3.2 The Deployment Procedures

The activation and operation of MPU in the three countries were standardized so that there was uniformity in evaluation but with the possibility of adaptation depending on the context.

Pre-deployment and activation

- The introduction of deployment became startled by official emergency declarations as issued by the local authorities.
- The pre-foundation of MPUs was done according to the list of essential medicines in countries along with chronic and acute medicines.

A team, headed by a pharmacist, examined units on completeness, refrigeration stability and digital connectivity.

Field Setup

- The MPU was positioned to support one high need location per country based on accessibility, displacement of population and destruction of local health facilities.
- Setup included power supply (diesel generator or solar backup, etc), checking cold-chain, and trying digital inventories.

Service Provision

- Duties of MPUs extended to six working days with an average of 8 hours each.
- The number of licensed pharmacist (1 2), pharmacy technician (1), and logistics assistant as a part of the team was determined.
- The medications were given in line with prescriptions done by local clinics or by the local medical units doing prescribing on the ground.
- All services services had been free, and recorded the consultations with the patient by the patient, but not the identifying information, to perform aggregate analysis.

Supply Chain: Resupply

- Central depots were used to supply cold-chain supplies at an interval of 7 10 days.
- The mobile reporting tools were used to activate emergency restocking procedures.
- The inventories were being audited on weekly basis, and wastage reports were made on a monthly basis.

3.3 Data collection and data analysis

The analysis in the study stratified three key groups of data that were collected in the study period:

Service Utilization Metric

- Cumulative patients treated
- Age, gender of the patient
- Groups of dispensed medication (e.g., antibiotics, antipyretics, insulin, antihypertensives)

Operational Metrics

- A timeline or schedule of deployment since activation and being ready to operate
- The availability rates of essential medicine (of the items in stock divided by those planned)
- The performance in maintaining cold-chain (Temperature records)

Patient Satisfaction and Input

- The structured surveys were conducted after dispensation and sampled 10 percent of the patients
- The questions addressed areas of accessibility, perception of the quality of the service and general satisfaction
- Ratings at 5-point Likert scales and in free comment fields

Analysis of the quantitative data was carried out using descriptive statistics (mean, median, standard deviation) by country. An idea of comparative metrics across sites was visualized to match and make use of such cross-learning. Field reports and patient survey qualitative responses were coded thematically to find trends, issues, problems and the preference of the user.(6)

All the three countries had their relevant authorities to provide ethical approval. The surveys that involved the feedback were voluntary and anonymous.

4. Results

4.1 Reach and Service utilization to Patients

The three Mobile Pharmacy Units (MPUs) offered services to a total of 18,500 patients in total over the six months implementation process:

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- Pakistan: 8,200 patients (44 percent)
- Philippines: 6,100 patients (33%)
- Sweden results: 4,200 patients (23 percent)

Usage of services was context specific. In Pakistan and the Philippines, demand was highest during the first 3 to 4 weeks following deployment since the deployment upended the fixed health facilities and displaced a large population. In Sweden, health infrastructure was largely intact but inaccessible when evacuation was initiated and also key to the MPU was care to the chronically ill who were unable to access their local pharmacies.(7)

The leading three classes of medication distributed at sites were:

- Paracetamol, ibuprofen (analgesics and antipyretics)
- Antibiotics (amoxicillin, azithromycin)
- Insulin analogs, antihypertensives (chronic disease drugs)

The proportion of patients under 12 was 28% and, therefore, the rate of adults over 60 was 22% which means that a significant number of vulnerable populations use it. The mean drugs retailing per patient were 1.8.

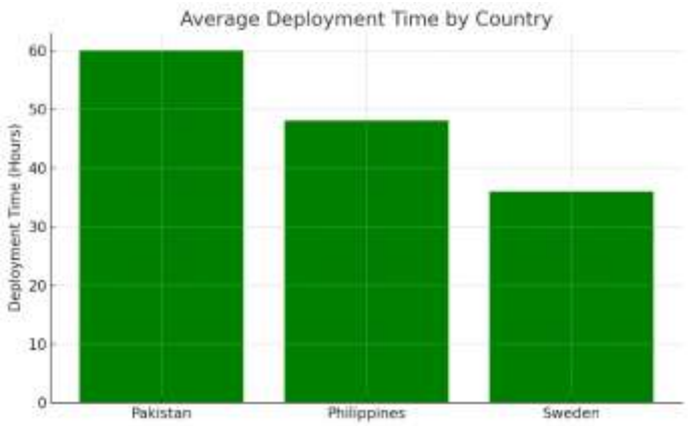

Figure 1: Average Deployment Time By Country

4.2 Supply continuity and availability of medicine

The critical MPU indicator measure was the provision of essential medicines. In the three countries, the average availability rate of the WHO-classified essential medicines in MPUs was 92 percent at the end of the six months monitored period.

- Pakistan: 89 pct available
- Sweden 95% avail.
- Philippines: 93 percent availability

The main causes of stock-outs were delays on transportation (serious weather or insufficient road access). The digital inventory system was also found to be vital in causing automated resupply orders and this involvement served to stabilize eventual shortages. The medication in the cold-chain (insulin, vaccines) met temperature regulations 97 percent of time as measured by daily logs.(8)

Less than 1 percent of the wastage was because of expiry or spoilage and there was no found security breach and no medication diversion at any location.

4.3 Efficiency and deployment timelines

All sites had achieved the desired value with a mean time between activation and full operational readiness being 48 hours:

Sweden: 36 hours (it is shorter because of improved road infrastructure and access to supply chain)

Philippines: 48 hours

Pakistan: 60 hrs (road conditions and clearing of the donated goods through customs)

Checklists of setup, personnel deployment kits were very useful in minimizing downtime. The MPU was capable of full connectivity with local health systems in Sweden in just 12 hours enabling real-time validation of prescriptions and retrieval of Victoria-wide medication history in patients with digitised records.

In the Philippines and Pakistan, the MPUs were used independently and had manual recordkeeping and synchronized with the databases of the NGO partners on a daily basis.

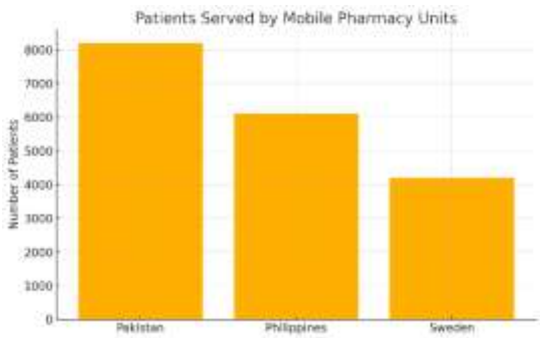

Figure 2: Patients Served By Mobile Pharmacy Units

4.4 Scores of Patient Satisfaction

One thousand and eight hundred patients (10 percent) were involved in satisfaction surveys. The next mean points were obtained in five major domains (on 5-point scale):

Domain	Avg. Score (All Countries)
Accessibility of Services	4.6
Friendliness of Staff	4.8
Clarity of Medication Instructions	4.5
Perceived Quality of Medicines	4.7
Overall Satisfaction	4.7

5. Discussion

5.1 Crucial Results and Cross-Comparison

This is a multi-country implementation study showing that Mobile Pharmacy Units (MPU) constitute a potentially scalable, viable solution to providing continuity of pharmaceutical care services in the wake of disasters. These systems (MPUs) have been deployed across Pakistan, Philippines and Sweden in less than 60 hours on average, treated more than 18,000 patients and maintained a stock level of vital medicines above 90 percent in six months. In extremely dissimilar locales churches-turned-MPUs (or remote villages escaped by the floodwaters in Sindh to evacuated wildfire areas in distant Scandinavia) these proved susceptible and efficient. The performance across the three settings shows consistency indicating robust operation and modular use in the settings. In particular, the quick deployment in Sweden (36 hours) indicated logistic effectiveness in the environment of high resources, and Pakistan and the Philippines exemplified it when used in extreme circumstances of poor infrastructure.(9)

High patient satisfaction rates (more than 4.5/5 in all spheres of service) contribute to the importance of the availability of pharmaceutical care in the case of a crisis. The high score of the friendliness of staff and clarity of medication instructions especially deserves mentioning, they also demonstrate the significance of the interaction of a pharmacist and a patient even in the emergency situation.

5.2 Policy and Operation Implications

There are various operational implications associated with the findings. First, the availability of key medicines (>92%) demonstrates that the model of needs-based medication kits preconfigured with responsive restocking policies is able to overpass the common supply chain problems which are created after the cataclysms.

Second, the maintenance of the cold-chain integrity observed in the majority of the sites proves that MPUs can send not only oral-related medications but also temperature-sensitive drugs such as insulin and vaccines provided that corresponding power sources can be utilized (i.e., solar or backup generators). This is essential in continuity of chronic diseases in cases of emergencies.

Third, it was critical to integrate mobile digital inventory systems. It enabled the actual recognition of inventory, resupply and avoided wastages. This implies that the emergency pharmacy framework of the future must have digital health solutions incorporated into them, not as an add-on.

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Policy-wise, MPUs are an unusual opportunity of health system resilience. Governments and humanitarian organizations can incorporate MPUs into the national disaster response strategies as either separate units of pharmacy services or as modules of the mobile clinics. There is, however, a critical need to adjust regulations that will enable pharmacist-initiated independent practice, fast procurement procedures, and adaptable licensure in emergencies.(10)

This paper further demonstrates that even within high income environments, situations will require a temporary fill even by MPUs, e.g.: populations evacuated to areas where their usual pharmacies are gone. In Sweden, as one example, many of the patients with chronic illnesses stated continuous access to antihypertensives and insulin during dislocation related to wildfire.

5.3 Limitations

Although the study provides substantial evidence of the MPU feasibility, a number of limitations are also to be mentioned:

- The set of the health system infrastructure, the intensity of disasters and routes of access varied by sites, which influenced deployment progress and the degree of deployed services.
- Data related to patient satisfaction was voluntary and they may be prone to a positive response bias.
- The authors did not determine cost-effectiveness, the element that is crucial when implementing decisions on scaling up in resource-constrained environments.
- The design paid more attention to 6 months deployment; further sustainability and integration of the steps with recovery periods still needs to be researched.

Also, whereas all MPUs had digital systems, the level of connectivity, particularly in rural Pakistan and in island areas of the Philippines, posed a problem of real-time reporting.

6. Conclusion

6.1 Insights Conclusory

The study is used to show the possibility, flexibility, and efficiency in using Mobile Pharmacy Units (MPUs) in disastrous areas in various geographical and economic settings. Within a six-month deployment span, MPUs deployed to Pakistan, the Philippines, and Sweden offered essential pharmaceutical services to more than 18,500 patients, wherein floods, wildfires, and typhoons were the main disaster contexts in the three countries.

At all locations, MPUs recorded a median 92 percent availability rate of essential medicines, a strong sign of supply chain performance, even under stressful circumstances. The average deployment was 48 hours with activation to full service provision and compares with the international standard of accelerated health responses among countries. Both positive patient satisfaction and the fact that pharmacy services were not only logistical undertakings, but important aspects of caring and high quality care, remained solid throughout.

The same results received in the context of three hugely different healthcare systems confirm the MPU as a cross-contextual, modular solution. Integration of cold-chain infrastructure and computerized inventory tools also made it feasible to safely store sensitive drugs, such as insulin and vaccines, which are very important to the continuity of acute/chronic care during disaster response.

6.2 Disaster and Emergency Health Management Implications

Disaster policy and national health emergency preparedness have direct implications as far as the findings are concerned. The scalable ultra-fast deployment model of pharmaceutical care provided with the help of MPU can be both stand-alone and whenever access to mobile medical clinics is feasible. They have unique roles in the larger humanitarian logistics system due to this gap-filling ability either in destruction of infrastructure, remote displacement or overloaded clinic.

Notably, MPU is capable of maintaining continuity of care of chronic disorders, which is increasing to be a concern during humanitarian crises. Noncommunicable diseases have become more common in displaced people communities, and access to antihypertensive, antidiabetic, and psychotropic drugs becomes not an option any longer. This paper ascertains that MPUs have the capacity to ascertaining these requirements provided they are appropriately supplied and staffed.

In addition to the operational efficiency enhancement, the situation of integrating real-time digital monitoring of the stock, facilitated the foundation of transparent reporting, improved forecasting, and expediency of resupply. Such integration facilitates future national health information system interoperability that contributes to long-term preparedness and coordination.

The use of MPUs in emergency procedures can also be seen as fulfilling a concept of providing health equity, in the way that underserved peoples in rural or isolated regions are not locked out of access to vital medicines.

6.3 Prosuggestions to a Wider Implementation

In view of the current implementation study, we Suggest the following to achieve the wider adoption and institutionalization of MPUs:

- Incorporate MPUs into national preparedness plans especially in pharmaceutical supply-chains and emergency logistics planning models.
- Prepare ready-made and situation-specific deployment packages, such as cold-chain systems with mobile solutions, region-specific basic medicine lists, etc.
- Develop trainings on the pharmacists and technicians during emergency response procedures, specifically on electronic inventory management applications, field triage and mobile care processes.
- Collaborate across sectors with humanitarian organizations, logistics firms and telecom companies in order to help enable large-scale MPU operations.
- Undertake cost-effectiveness and impact studies in order to inform funding models and sustainability planning.

To sum up, MPUs can be deemed as a new, engaging, life-saving measure when it comes to disaster health management. The way they can deliver timely and quality pharmaceutical care in the face of emergencies is what makes them an indispensable asset to future-ready health systems, particularly in a global context where climate-related and humanitarian crises are increasingly becoming a problem.

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Conflicts of interest

The authors have no conflicts of interest to declare

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