PATIENT FLOW AND WAITING TIME IN EMERGENCY DEPARTMENT OF TERTIARY HEALTH CARE HOSPITALS OF KHYBER PAKHTUNKHWA

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Abstract

**Background:** The sudden occurrence of a disaster leads to considerably high impact on population’s health and on the capacity of health system to respond to the sudden surge of affected population. Emergency departments EDs play an important role in managing patients and providing high quality care in complex situations. Pre existing bottle necks in the emergency service delivery reduces the existing surge capacity of system and renders ED inefficient in providing timely and quality care to patients affected by the disaster. The understanding of patient flow by the hospital can improve the overall efficiency of operations on day to day basis and emergency response. **Methodology:** This was a cross sectional survey involving all the tertiary care hospitals of Khyber Pakhtunkhwa province of Pakistan. 910 patients were selected using non probability sampling and patient’s progress through ED was mapped and timed from the entry to discharge or admission. **Results:** Major bottle necks identified during process mapping were overcrowding and long waiting times. Median processing time from entry to disposition was 50mins (IQR 28-72). The median service time experienced by the patients during their treatment in the ED was 15 mins (IQR 15-28.75 min). Overall median waiting time for all processes through which patients passes during their visit to ED was 26 mins (IQR 14-40 mins). The patients who required diagnostic tests (lab, radiology, EG etc) had significantly higher (p=0.00) median waiting time 41 (IQR 32-51) mins. **Conclusion:** When process mapping is conducted properly, it proves to be a valuable tool for service improvement by identifying flaws in flow of patients, potential bottle necks and duplicate processes. Improving flaws in patient flow can improve patient waiting time which in turn can improve hospital’s existing surge capacity.
Keywords : Patient Flow, Process Mapping, Emergency Department Waiting Times, Surge Capacity

I. Introduction

Disasters are unpredictable events that jeopardize systems, increases risk of injuries and illness and cause widespread loss of life, and economy XV. Almost all disaster, whether they are manmade or natural have similar medical and public health outcomes I. When these events occur, they result in mismatch between needs and resources and overwhelm the emergency medical care capacities. The sudden occurrence of a disaster leads to considerably high impact on population’s health and on the capacity of health system to respond to the sudden surge of affected population XXVII. During routine emergency service delivery, the hospitals in most instances are already stretched to their limits VIII and with sudden occurrences of complex emergencies and disasters, the health care systems gets severely strained. Recently the focus has been shifted to the principals of surge capacity, which dictates the provision of medical services simultaneously to both critical and non-critical causalities XXIX.

The most important aspect of health related disaster response is to reduce morbidity and mortality as much as possible. This is achieved by accommodating patients and providing quality medical and surgical care I. In order to effectively cater for the unusual surge of patients, the hospitals must be prepared for such events. Most of the hospitals have the disaster plan to mitigate such events but having a disaster plan does not mean the hospital is prepared for such events XIV.

Hospital readiness against disasters is strongly linked to a well-made hospital disaster preparedness plan. It must be a comprehensive and have an all hazard mitigation plan. It must address how to effectively manage sudden surge of patients, business continuity, secondary surge, referrals, coordination and linkages etc. XI.

However, to make a comprehensive disaster management plan encompassing above mentioned elements, the hospitals initially have to conduct an extensive all hazard risk and vulnerability assessment, assessment of their existing surge capacity and identify bottle necks in routine service delivery that can affect their existing surge capacity XIII. Inadequate preparedness by the hospital results in poor patient outcomes, and system disruptions XXIV.

ED has a pivotal place in response to disaster. This department has an important role in managing patients and providing high quality care in complex situations XXIII, XXV. In high volume hospitals, the daily surge of patients may be so large that health care delivery system rarely attains acceptable waiting times. This is caused either by increase number of patients with single service line depicted as single server model in which “patients from single line are served by single facility XVI or hospital wards that are not able to accommodate the referred patients quickly enough from ED or OPD creating phenomenon of bottle neck which is defined as “ any part of system where patient flow is obstructed causing waits and delays” XVIII
With departments not absorbing patients over long period of time, the situation leads to disequilibrium and perpetually long queues and ensuing long waiting times and inefficient patient flow XVIII. Preexisting bottle necks in the emergency service delivery system reduces the existing surge capacity and renders ED inefficient in providing timely and quality care to patients affected by the disaster.

The understanding of patient flow by the hospital can improve the overall efficiency of operations on day to day basis and emergency response VII, XVII. Hospitals since long have been struggling to gain the understanding and identify the bottle necks in routine service delivery and to reduce the queues and patient waiting times in order to improve their surge capacity. Recently the Hospitals have turned to operational research techniques used in manufacturing to assess and improve their service delivery like Lean management, Kizen, Six Sigma etc. All these methods try to improve services by improving efficiency and removing waste, streamlining processes or improving quality XXVIII. Hospitals are increasingly using these techniques and studies have shown that they have significantly improved the services and reduced waiting times XX.

Over the past two decades Pakistan and particularly province of Khyber Pakhtunkhwa, has seen a large number of manmade and natural disaster which has intensified the need and mandated the focus on adequate tertiary health care system’s surge capacity. With limited resources and frequent surges of patients, it is pertinent to identify the process and bottle necks in the routine services delivery especially at ED to improve the service delivery and surge capacity of the tertiary health care system.

This study was carried out to map the processes of service delivery for the patients entering the ED of the tertiary are hospital and to time these various processes to identify potential bottle necks.

II. Methodology

This was a cross sectional survey using principals of operational research. This study applied, one of the operation’s researches quantitative techniques, simulation to map the process of patient flow through the ER. Patient flow can be assessed and explained commonly and more frequently by operational perspective and, less commonly through clinical perspective VII. This study used process mapping to provides basic operational understanding and holistic visual outlines of all processes of the health service delivery.

This study was carried out in all the 8 major tertiary care hospitals of Khyber Pakhtunkhwa province of Pakistan. Sample size was calculated to be 910 using WHO software with the formula of estimating population mean with following assumption; anticipated mean of visit to disposition time of 5.1 hours, X anticipated SD of 1.6 hours, absolute precision of 10.4 and relative precision of 0.2.

140 patients each from Ayub Teaching Hospital, Mardan Medial Complex, Lardy Ready Hospital, Khyber Teaching Hospital and Hayatabad Medical Complex and 70 patients each from Mufti Mehmood Teaching Hospital, Saidu Teaching Hospital and Khilafat Gul Nawaz teaching hospital were selected from emergency departments based
on the average daily ER visits of these respective hospitals. These patients were selected using non probability consecutive sampling. These patients were followed through their stay in the hospital until they were discharged and process map with timing was constructed.

The process mapping was carefully planned and involved direct observation of the processes. Detailed preparations were carried out before implementation which included building and training a team of doctors for patient observation, and documentation. Emergency Departments of all the 8 tertiary care hospitals were visited to understand the individual operational systems of the hospitals. Similarities in the processes were grouped and coded and process measures were defined. Time intervals and type of patients that will be followed were also identified.

Three time-based elements were identified which were assessed using process mapping i. Patient entering into the system ii. Therapeutic decision and intervention iii. Patient moving out of the system after intervention. The team recorded the progress and time in and out of each patient passing through each area and process using synchronized watches and time logs.

Ethical approvals from all the relevant hospitals were taken and emergency department staff of the tertiary care hospitals was briefed on the processes and all the documentation of the project. Seventy five patients were followed in each hospital during all the three working shifts.

Processes were manually drawn. The process map was designed according to the principles for designing cognitive effective visual notations proposed by Moody. We also ensured semantic transparency and cognitive integration to depict processes belonging to same or different categories. Patient process were analyzed using SPSS v 21.

III. Results

Process Map

Three main types of patient present to ED. They are critically ill and require resuscitation, patients needing urgent care and need assistance in form of stretcher or wheel chair for accessing ED and walk-in patients without need of any assistance. The non critical patients are registered and wait for primary consultation in the main sitting area. Critical patients needing resuscitation are directly shifted to Procedure/Treatment room and treated accordingly without any delay.

For non critical patients, they are examined by the duty medical officer and a therapeutic decision is taken based on the condition and need. Patient is either referred to specialist/resident medial officer for second review, for diagnostic procedure (Radiological, Labs, ECG), referred to concern clinical/surgical department for admission, to treatment bay/procedure room for treatment or prescribe medicines and is discharged. Two different patient flow pathways for critical and non critical patients are shown in Fig-1 and 2 respectively.
Fig 1: Process map of non critical and walk-in patients

Fig 2: Process map of critical patients

Three main processes (waiting, service provision and transportation) shown in Table 1 are identified, in the process map as the patient passes through the ED.
### Table: 1 Emergency Department Processes

| S. No | Waiting Processes | Service Processes | Transportation |
|-------|-------------------|-------------------|----------------|
| 1     | Waiting for 1st Consultation | Immediate Care | To the Emergency Department after arrival |
| 2     | Waiting for Diagnosis | Consultation with Medical Officer | |
| 3     | Waiting for Results | Consultation with Specialty Registrar or TMO | |
| 4     | Waiting for 2nd Consultation | Diagnostic Procedure | To and from the Diagnostic Procedure |
| 5     | Waiting for Admission | Admission and start of treatment | To the treatment bay |
| 6     | Waiting for Treatment | Treatment | To the ward |

### Observational Findings

During the process mapping, various bottle necks were identified. One of the major issues was multiple parallel consultations and resulting in enhanced cumulative waiting time. In addition to that following observations were made which hindered the normal flow of patients and causing potential service choke points

i. Clear directions for patients were missing in majority of EDs. A large number of patients were uncertain where to present after registration and hence, adding to time that can be avoided before first consultation

ii. Number of patients exceeded the seating capacity of the ED causing overcrowding. Which lead to some patients getting delayed access to desired consultative areas

iii. Triage of patients that needed urgent care was missing in some EDs of Teaching hospitals causing unwarranted waiting times

iv. Some patients didn’t get assistance that they needed for transfer because of limited number of available wheelchair and stretchers

v. With the volume of patients, the number of causality medical officers and specialist residents are not sufficient

vi. An unnecessary waiting time which can be avoided is the waiting for the diagnostic report and taking it after a delay and then wait for second consultation.

### Waiting Times

Of the total 910 patients presenting to the emergency department, complete data of 796 (87.4%) patient’s flow through the 8 teaching hospitals was available. 114 (12.6%) patients had either missing or incorrect data. Highest average daily patient turnover was recorded in Lady Reading Hospital followed by Khyber Teaching Hospital as shown in Table-2 below

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Table 2: Average ED Beds and Number of Patients

| Emergency Department | Ayub Teaching Hospital | Lady Reading Hospital | Khyber Teaching Hospital | Hayatabad Medical Complex | Mardan Medical Complex | Khalifa Gul Nawaz Teaching Hospital | Mufti Mehmood Teaching Hospital | Saidu Teaching Hospital |
|----------------------|------------------------|-----------------------|--------------------------|---------------------------|-----------------------|-----------------------------------|-------------------------------|------------------------|
| Beds                 | 28                     | 138                   | 21                       | 60                        | 20                    | 15                                | 48                           | 30                     |
| Average Number of Patients/ days | 1300-1600 | 2800-3200 | 1600-2000 | 1500-1800 | 1000-1300 | 300-500 | 400-600 | 700-900 |

In each tertiary care hospital, the patients were observed in all three shifts; 8:00 am-2:00 pm, 2:00pm to 8:00 pm and 8:00pm to 8:00 am. Majority of the patients 379 (47.61%) presented to ED between 2 and 8 pm (Table-3)

Table 3: Shift Distribution of Patients

| Shift                  | Patient Presenting (n) | Percentage (%) |
|------------------------|------------------------|----------------|
| Morning 8:00 am - 2:00 pm | 191                    | 23.99%         |
| After noon 2:00 pm - 8:00 pm | 379                    | 47.61%         |
| Night 8:00 pm -8:00 am   | 226                    | 28.39%         |

The large majority of patients 541 (67.96%) patients were discharged after completion of their treatment in the ED of hospitals while 255(32.03%) were admitted in various wards for further evaluation and treatment.

Overall median visit time of patient between arrival and either discharge or admission was 50 mins (IQR 28-72 mins; mean 51.8 ± 29.3 min). However, these median times changed considerably if the patient required secondary consultation 60 min (IQR 35-82 mins; mean 61.9± 29.7 min), diagnostic procedures 69 min (IQR 55-86 mins; mean 72.4 ± 24.06 min) or admission 70 min (IQR 53-86 mins; mean 71.8 ± 25.87 min) as shown in Fig 3.
The highest overall median time from patient getting in the ED to disposition was observed in Saidu Teaching Hospital 69 mins (IQR 50-95 mins, mean 70.3 ± 32.1 mins) Table-4

Table 4: Process Times in Various Hospitals

| Hospital                        | Median (mins) | IQR (mins) | Mean (mins) | SD (mins) |
|---------------------------------|---------------|------------|-------------|-----------|
| Ayub Teaching Hospital          | 47            | 28-70      | 51.22       | 29.70     |
| Lady Reading Hospital           | 41            | 24-64      | 45.05       | 25.41     |
| Hayatabad Medical Complex       | 46            | 27-62      | 46.40       | 25.68     |
| Khyber Teaching Hospital        | 48            | 25-70.5    | 49.06       | 28.46     |
| Mardan Medical Complex          | 51            | 26.75-66   | 49.74       | 28.28     |
| Saidu Teaching Hospital         | 69            | 50-95      | 70.33       | 32.11     |
| KhalifaGul Nawaz Teaching Hospital | 63          | 34.5-85.5  | 61.91       | 32.76     |
| Mufti Mehmood Teaching Hospital | 60            | 33-82.75   | 59.09       | 31.81     |
With regards to types of patients, the lowest processing median time 40 mins (IQR 35.5-6.75, mean 46.9 ± 15.1 mins) was observed in critical patients needing resuscitation.

Median service time was 15 mins (IQR 15-28.75 min, mean 20.06 ± 1.54 mins). The highest median service time experienced by the patients during their treatment in the ED was 10 mins (IQR 6-27 mins, mean 16.2 ± 12.1 mins) followed by 9 mins (IQR 6-12 mins, mean 8.7 ± 4.1 mins) for initial processing and treatment in the ward for patients being admitted through ED Table -5

Table 5: Service Times

| Service Time                          | Median | IQR     | Mean   | SD    |
|---------------------------------------|--------|---------|--------|-------|
| Time during Consultation              | 4      | 3--4    | 3.8    | 1.8   |
| Time during consultation 2            | 5      | 4--7    | 5.6    | 1.9   |
| Time during Diagnostic Procedure     | 3      | 2--3    | 4.6    | 5.7   |
| Time during re consultation post diagnosis | 4    | 3--5    | 3.9    | 0.91  |
| Treatment Time                        | 10     | 6--27   | 16.2   | 12.1  |
| Processing and Initial Treatment      | 9      | 6--12   | 8.7    | 4.1   |

Overall median waiting time for all processes through which patients passes during their visit to ED was 26 mins (IQR 14-40 mins, mean 28.3 ± 16.98 mins). In comparison the median service time was 15 mins (IQR 9-28.75 mins, mean 20.06 ± 15.41 mins). The mean transportation time was 3.44 ±3.46 minute

The highest median waiting time was experienced by patients while they waited after registration for initial consultation with doctor in duty as shown in Table-6

Table 6: Waiting Times

| Waiting Time                          | Median (mins) | IQR (mins) | Mean (mins) | SD (mins) |
|---------------------------------------|---------------|------------|-------------|-----------|
| Waiting in the Main ED for First Consultation | 9             | 6-12       | 8.9         | 4.3       |
| Waiting for Specialist Registrar or TMO | 7             | 5-10       | 7.8         | 3.5       |
| Waiting Time for Diagnostic Procedure | 6.5           | 4-10       | 7.2         | 4.4       |
| Waiting for Report                     | 7             | 1-16       | 8.9         | 8.7       |
| Waiting for Consultation after Diagnostic Procedure | 8             | 5-11       | 7.8         | 3.8       |
| Waiting time for Treatment in ED       | 5             | 2-11       | 6.9         | 5.4       |
| Waiting Time for Admission             | 5             | 4-7        | 6.6         | 5.6       |

The median waiting times, and service times showed variation depending upon the patient presentation to ED. As shown in the table 7 below, most of the patients
presented during 2:00-8:00 pm and this shift had the highest median waiting and service time. However, there was difference in both median waiting and service times, statistically significant difference was only observed in overall median service time.

Table 7: Waiting Times based on Patient Presentation Time to ED

| Time of Arrival to Hospital | Total Waiting Time | Total Service Time |
|-----------------------------|-------------------|--------------------|
| 8:00 am - 2:00 pm (191)     | Median 23.0        | 13.0               |
|                             | IQR 15-36          | 7--20              |
|                             | Mean 27.1          | 16.1               |
|                             | Std. Deviation 16.4| 13.0               |
| 2:00 pm - 8:00 pm (379)     | Median 28.0        | 21.0               |
|                             | IQR 14-42          | 10--35             |
|                             | Mean 29.5          | 24.0               |
|                             | Std. Deviation 17.8| 16.6               |
| 8:00 pm - 8:00 am (226)     | Median 25.0        | 13.0               |
|                             | IQR 14-38.25       | 6.75-22            |
|                             | Mean 27.3          | 16.9               |
|                             | Std. Deviation 16.1| 13.6               |

It can be seen in the above tables that the bottle necks in the service delivery at ED are mostly waiting times. The median waiting time constitutes around 52% of total time spent by the patient from registration to disposition. The other bottle neck which can be identified is the multiple consultation processes and resultantly multiple waiting times. This is more pronounced while the patient is waiting for the reports of diagnostic tests.

The patients who required diagnostic tests (lab, radiology, EG etc) had significantly higher (p=0.00) median waiting time 41 (IQR 32-51) mins as compared to patients who didn’t require diagnostic procedures 15 (IQR 10-23) min. Most of this waiting time as shown in table 6 was waiting for report. Table 8.

Table 8 Waiting Times based on Need for Diagnostic Procedure

| Diagnostic Procedure Conducted | Total Waiting Time |
|--------------------------------|--------------------|
| Yes (364)                      | Median 41.0        |
|                                | IQR 32-51          |
|                                | Mean 41.9          |
|                                | Std. Deviation 14.0|
| No (432)                       | Median 15.0        |
IV. Discussion

Emergency departments in routine are one of the most important and most visited departments of any high-volume tertiary care hospital. These EDs gain a central role in any disaster situation and subsequent response as they have to accommodate abnormal surge of patients and provide quality services to reduce morbidity and mortality.

Emergency departments while managing routine surge of patients are frequently faced with the overcrowding as observed during the process flow mapping in this study of various Eds XII. This overcrowding results from mismatch between number of patients arriving and resources like number of doctors, treatment beds, isolation beds, nurses and paramedics etc.

In addition to the above limitations, as observed in our study, avoidable parallel processes and waiting times can distort patient flow and an inefficient flow has been recognized as one of the major contributors to the ED overcrowding, long queues and excessive waiting times V. This erratic patient flow and subsequent overcrowding is more prominent in high flow tertiary care hospital like the EDs of tertiary care hospitals included in the study where on average 1000 to 1200 patients visit ED each day. Similar findings of erratic patient flow and overcrowdings have also been reported from tertiary care hospitals in India XII.

This distorted flow is caused by the fact that over the years, the patient flow has increased IV. This increase can be attributed to increase in population, environmental changes leading to changes in communicable disease epidemiology, emergence and reemergence of diseases, accidents IX and more patients seeking health care at tertiary care hospitals rather than going to secondary or primary health care facilities for minor ailments. This high utilization of tertiary care hospitals is because of the patient have more trust in tertiary care hospitals providing adequate and quality care as compared to secondary health care facilities. This fact was highlighted by study conducted in tertiary care hospital in India where patients suggested that they will prefer tertiary care hospital over secondary care hospitals for their medical needs III.

Poor flow factors identified in this study such as lack of directions, lack of adequate sitting areas have also been identified in patient flow analysis in GhanaX Similarly prolonging waiting times due to insufficient staff was also noted in the study carried out in Iran in 2012 II.

Poor flow as discussed leads to overcrowding. This may also lead to poor quality of care and might lead to repeated visits V causing further burden on already resource constrained setting. Poor flow can also leads to impaired drainage of patient either in the form of discharge or admissions to the respective wards. This obstructed flow

|                | IQR  |
|----------------|------|
| Mean           | 16.8 |
| Std. Deviation | 8.9  |
cause backlog of patients in the ED, prolonging waiting times and drastically reducing surge capacity in the ED in the event of disaster VI.

The median waiting time noted during this study was 26 min which compiles to the Institute of Medicine standards of patient waiting time not exceeding 30 mins. This is an interesting finding as these standards could not be met by US hospitals when they were assessed during national hospital ambulatory medical care survey where median waiting time was 46.5 mins XXI. Having said this, the median first consultation time for each patient in this study was 4 mins which is significantly lower than 8.25 mins reported in multiple studies in developed countries XXVI Shorter consultation will lead to quick turnover and hence, reduced waiting time which is not necessarily an achievement as shorter consultation times may lead to missed or wrong diagnosis and poor clinical outcome for the patient XXX.

The highest median waiting times apart from waiting for consultation was observed for waiting for report of diagnostic procedure 7 min, waiting for diagnostic procedure 6.5 min and waiting for treatment in ED and waiting for admissions 5 mins each. All these bottle necks were identified in study conducted in Ayatolah Kashani hospital where apart from waiting times for various categories of doctor’s consultation, the highest mean waiting times were observed for diagnostic services II.

V. Conclusion

Process mapping is simple and cost-effective method that offer holistic view of the processes and provide visual representations of patient flow through the health care delivery system. When process mapping is conducted properly, it proves to be a valuable tool for service improvement by identifying flaws in flow of patients, potential bottle necks and duplicate processes. Improving flaws in patient flow can improve patient waiting time which in turn can improve hospital’s existing surge capacity.

Limitations

There were some limitations with regards to the timing of this study. Our study duration was limited to a period of three months during early spring. The surge of patients and resultant waiting times are largely dependent on patient flow which in turn is linked to seasonal trend of diseases. The highest surge of patient is observed during summers and lowest turnover is noted in winters. Hence, these waiting times and service times may change depending upon the season and disease trends. Secondly the study could have used staffing practices and estimation of staff idle times to identify processes for improvement.
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