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An assessment of existing surge capacity of tertiary healthcare system of Khyber Pakhtunkhwa Province of Pakistan using workload indicators for staffing need method

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Abstract

Background: Globally the occurrence of disasters has increased more than fourfold during the last three decades. The main concern for the healthcare system responding to a disaster is its ability to deal with the sudden influx of patients and maintaining a certain level of surge capacity. Health workers are considered to be the major driving force behind any health system. Their role gets even more prominent during disasters or public health emergencies. With the lack of information on the health workforce in the tertiary healthcare system of Khyber Pakhtunkhwa, where most of the disaster surge is diverted, it is difficult to plan and respond to accommodate the sudden surge of patients.

Methods: This was a mixed method cross-sectional survey conducted in all the tertiary care hospitals of Khyber Pakhtunkhwa province of Pakistan to assess the current staffing situation and surge capacity based on the current workload. Annual service statistics of 2018 were collected from all the tertiary care hospitals of the province. WISN was piloted with only one healthcare staff category, i.e., for doctors in Ayub Teaching Hospital before assessment in all the tertiary care hospitals was undertaken.

Results: Overall, there were 1215 surplus doctors in medical and allied specialties and 861 doctors in surgical and allied specialties in the tertiary healthcare system. The health care system has an acute shortage of 565 emergency department doctors. The tertiary healthcare system of KP has an overall shortage of 1099 nurses. Based on the WISN generated numbers for doctors, the tertiary care system of KP has a combined healthcare staff (doctors and nurses) that can manage an additional surge of 6.3% of patients with the current patient workload.

Conclusion: The tertiary health care system of the Khyber Pakhtunkhwa Province of Pakistan does not possess the required $\geq 20\%$ HR surge capacity indicating that the tertiary healthcare system is poorly prepared for disasters or public health emergencies. The lack of nursing staff, more than the doctors, is the major reason behind the lack of HR surge capacity of the tertiary health care system.

Keywords: Surge capacity, WISN, Healthcare system, Disasters, Emergencies

Background

Disasters are catastrophic events that cause widespread death and misery. Globally the occurrence of disasters has increased from 120 per year in the 1980s to around 500 in the twenty-first century [1]. They have far-reaching social and economic effects on communities. They

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jeopardize the health of local communities in terms of the number of dead or injured and disrupt local health services due to loss of health staff, structural damage to healthcare facilities, and overburdening of healthcare services [2]. A healthcare system can easily be overwhelmed during disasters by a large and sudden influx of individuals in need of immediate healthcare.

Pakistan is one of the few countries in the world that are extensively affected by both natural and man-made disasters [3]. In the last two decades, Pakistan has seen an unprecedented number of disasters whether natural or manmade. During this period, the disasters have cost Pakistan around US\$126.79 billion in direct and indirect costs [4]. The province of KP has especially been affected by the man-made disaster in the form of suicide attacks, mass shootings, and armed conflicts in addition to natural disasters. Pakistan was at one point, ranked third after Iraq and Afghanistan in terms of suicide bombings [5]. Till June 2018, a total of 479 incidents of suicide bombings occurred resulting in 7291 deaths and more than 15,400 injuries [6]. Most of the burden of these conflicts has been borne by the tertiary healthcare facilities of Khyber Pakhtunkhwa. The main concern for the healthcare system and hospitals responding to a disaster is their ability to deal with the sudden and rapid influx of disaster victims or patients and maintaining a certain level of preparation for disaster that improves surge capacity.

Surge capacity is an essential component of all the elements covering disaster preparedness. It represents the ability of the healthcare system to handle an explosive patient inflow. There is no standardized or uniform definition of surge capacity. However, broadly surge capacity can be described as an ability of a healthcare system to scale up swiftly beyond its regular norms to provide for the increased patient load during disasters or public health emergencies [7].

Although, there is no consensus on the single definition of surge capacity, yet literature shows a considerable consensus on the elements of surge capacity. During the evolution of this concept, bed availability was considered as the sole indicator of surge capacity [8, 9]. However, as the concept evolved, academics became critical of relying solely on the bed numbers as an indicator of surge capacity and identified Staff, Staff, System, and Structure as the components determining surge capacity [10–12]. Studies have identified that instead of bed occupancy, the availability of the staffed beds can be the major limiting factor of the surge capacity in accommodating and providing treatment patients during disasters. Several surge need assessment studies have shown that hospitals must have the ability to augment 20% of the staffed beds to ensure meeting the health needs of disaster victims [13–15]. These studies highlight the need and importance of

adequate human resources in addition to physical logistics for effective disaster response by the health system.

The health workforce is considered to be the major driving force behind any health system. Their role gets even more prominent and important during disasters or public health emergencies that require surge capacity by building the resilience of the health systems [2]. Despite the importance of human resources in the effective functioning of health systems, there is a significant shortage of appropriate health workers. It is estimated that due to a shortage of 17.4 million health workers globally, between 1 and 3 billion people have no access to health care services [2, 16, 17]. Pakistan is one of the 57 countries identified by WHO that are facing a health workforce crisis [18]. The HRH situation in Khyber Pakhtunkhwa (KP) province is no different from the overall country's HRH situation. According to a report published by Govt. of the KP, only 56.6% sanctioned posts of doctors and 68.1% sanctioned posts of nurses are filled in primary and secondary health care system [19]. No HRH data are available for the tertiary healthcare system of the province.

Several tools have been developed by WHO and partners to assess the HR needs in health systems [20–22]. Most of these tools employ simple approaches like using health workforce-to-bed or population ratio to generate the required numbers. However, for accurate estimation of HR surge capacity, the mere availability of the number of healthcare providers (HCPs) will not suffice. To ensure and prepare for an HR surge capacity of $\geq 20\%$, hospitals and health systems must take into consideration both numbers and workload of HR. Workload Indicators of Staffing Needs (WISN) which estimates staffing needs based on the actual workload of the healthcare staff may prove to be an ideal tool to assess the existing HR surge capacity of the tertiary healthcare system and its constituent hospitals. This research aims to estimate the existing HR surge capacity of the tertiary healthcare system of Khyber Pakhtunkhwa using WISN by taking into account both existing numbers and staffing needs based on actual workload. Accurate estimation of HR surge capacity will enable the tertiary healthcare system and its constituent hospitals to plan, allocate, and re-appropriate resources to manage victims during disasters and public health emergencies.

Methods

This was a mixed method cross-sectional survey conducted in all the tertiary care hospitals of KP province of Pakistan namely Khyber Teaching Hospital (KTH), Lady Reading Hospital (LRH), Ayub Teaching Hospital (ATH), Hayatabad Medical Complex (HMC), Medical Teaching Institute Dera Ismail Khan (MTI DI Khan), Mardan Medical Complex (MMC), Medical Teaching

Institute Bannu (MTI Bannu) and Saidu Group of Teaching Hospitals (SGTH) to assess the current staffing needs and situation based on the workload of the patients and HR surge capacity. This study was conducted between March and October of 2019. The methodology to conduct this assessment was explicitly based on the directions provided in the WHO's "Workload Indicators of Staffing Need; User's Manual" [23]. Ethical approvals were obtained from the relevant ethical review committees and data collection permission was obtained from the Hospital Directors/Medical Directors of the surveyed hospitals.

As per the WISN guidelines, two committees, Technical Task Force and Expert Working Group were formed. Technical Task Force was responsible for the implementation of WISN in KP. This team comprised WISN country resource person, national and internationally trained experts of WISN, health systems experts, and statistician. The Expert Working Group was constituted to define the main workload components and subsequent determination of activity standards for the identified workload components. The expert working group consisted of a wide range of experts from nurses and doctors belonging to every clinical specialty present in the teaching hospitals of Khyber Pakhtunkhwa. The following steps were carried out in chronological order:

1. Determination of priority cadres.
2. Estimation of available working time.
3. Defining workload components.
4. Setting activity standards.
5. Establishing standard workloads.
6. Calculating allowance factors.
7. Determination of staff requirements based on WISN.
8. Analysis and interpretation of WISN results.

It was decided to choose doctors and nurses for estimation of staffing need and surge capacity after consulting with the technical task force. The rationale for choosing doctors and nurses for this assessment is related to their role in managing the surge of patients in tertiary care hospitals during disasters. Disaster literature highlights the importance of doctors and nurses during disaster response and designates them as an essential component in healthcare delivery during routine and disaster scenarios [24–29]. Additionally, the workload components for doctors and nurses are well defined in the tertiary care system of KP.

The HCPs of KP are entitled to 25 casual leaves as per the Govt. of Khyber Pakhtunkhwa Leave rules [30]. Under the same rules, they are also entitled to other leaves which include earned leave, ex-Pakistan leave, maternity leave, recreation leave, leave prior to

retirement, extraordinary leave, medical leave, special leave, quarantine leave, study leave, and leave for Hajj/Umrah. The HCPs also avail national holidays in addition to above mentioned categories of leave and in case they are on duty on the designated holidays, they are compensated with time off on a regular day.

Personal leave records were obtained from the HR department and duty registers of the eight tertiary care hospitals. Confidentiality was ensured by only obtaining leave records by designation and categories of HCPs. Total leaves under all the categories were calculated for both doctors and nurses which were then divided by the number of staff of each cadre in that hospital to get an average leaves per cadre per year. Average annual leaves for doctors and nurses were calculated to be 55 and 50 leaves, respectively.

Both doctors and nurses are required to work 6 days a week in all the tertiary care hospitals except LRH, where the nurses are working 5 days a week. The working hours for doctors are 36 h a week and for nurses, it is 48 h a week except for LRH, where nurses are required to work 40 h a week. Based on the possible available days and working hours/day, the available working time (AWT) for doctors was calculated as 1542 h in a year; whereas, the AWT for nurses was calculated as 2096 for all the tertiary care hospitals except LRH, where AWT for nurses was 1680 annual hours.

The workload components were defined by inviting the expert working groups from both nurses and doctors for focus group discussions (FGDs). On the advice of the technical task force, the expert working groups of doctors and nurses were further subdivided into the expert groups of medical and allied specialties (General Medicine, Pulmonology, Gastroenterology, Oncology, Cardiology, Pediatrics, Neurology, Psychiatry, Dermatology, etc.), surgical and allied specialties (General Surgery, Neuro Surgery, Orthopedics, Otolaryngology, Ophthalmology, Thoracic Surgery, Gynecology, Urology, etc.), and emergency department (ED) expert working group. This decision was taken based on the assumption that the workload components of surgical specialties, medical specialties, and ED differ from each other, and workload components can be grouped for similar specialties.

Twenty-four focus group discussions were carried out in four locations across the province. Six FGDs were arranged at each site. One FGD was arranged for professorial staff/consultant doctors related to medical and allied specialties and the emergency department. Another FGD was arranged for training medical officers (residents) and medical officers of medical and allied specialties and ED. Similar FGDs were arranged for surgical and allied specialties. For nurses, FGD was arranged for nurses working in medical and allied and ED specialties

and another for nurses working in surgical and allied specialties.

The participants for FGDs were selected using non-probability purposive sampling. They were selected based on their knowledge and expertise in the related field. Before the start of the FGDs, based on the WISN user manual, an interview guide was made which included 12 discussion points related to workload indicators. The FGDs were carried out by the researcher and the two trained assistant moderators. Participants were briefed on the WISN in detail and the objectives of FGD were highlighted. The participants were asked to free list the activities they thought a well-motivated and qualified health care worker belonging to their specialty should perform at a locally acceptable professional standard of care. Participants were asked to identify Support Activities, Health Service Activities, and Additional Activities. For additional activities, participants were asked to identify workload components and the number of members from respective cadres of HCPs that should perform the identified workload component. The health service activities were not divided any further for which statistics were not available. Similarly, the participants were asked to reflect on activity standards. Activity standards were further bifurcated into service standards and allowance standards as per the methods highlighted in the manual. For support and additional activities, the participants were engaged in determining the allowance standard. The FGDs were transcribed, coded, and interpreted. For every cadre, subgroups, and specialties, health services activities, support activities, and additional activities were determined along with activity and allowance standards.

The validity of the FGD findings was assured by triangulation/cross-validation and respondent validation techniques [31, 32]. Nurses and doctors were observed in their respective settings by the researcher to verify the workload components and to check if some workload components whether any services activities, support activities, and additional activities were missed during FGDs. An extensive literature review of previously conducted WISN assessments in different settings was carried out before and after the FGDs to identify any missing workload components. The final report was presented to the HCPs of different cadres and specialties during a seminar to determine whether the participants felt the identified workload components and the allotted time were accurate. The opportunity was provided to them to comment on the finding, which could be later incorporated into the final calculations.

The tertiary healthcare hospitals of KP provide almost similar clinical services through their medical and allied specialties, surgical and allied specialties, and EDs.

Therefore, health services activities and their activity standards had no significant difference. However, due to some differences in academic services related to undergraduate and postgraduate teachings and associated some clinical procedures, differences were observed in support and additional activities and their activity standards in three tertiary care hospitals, namely SGTH, LRH, and MTI Bannu. Based on the technical task force recommendations and agreement of the expert working group during the seminar, the health services activities and their activity standards were set similar for all the 8 tertiary care hospitals and support and additional activities and their activity standards were set individually for the hospitals due to the differences as shown in Tables 1, 2, 3, 4, 5 and 6.

Annual service statistics of 2018 were collected from all the tertiary care hospitals of KP. Service statistics were collected from hospital HMIS for health services activities of both doctors and nurses working in medical and allied specialties, surgical and allied specialties, and ED. These collected statistics included department/specialty-wise and month-wise admissions, discharges, the daily number of patients in wards, OPD statistics (general and causality/ED), surgeries both major and minor, the average length of stay, bed occupancy, inpatient days among others. To ensure the accuracy of the data, the data generated from the HMIS system were cross-checked with individual ward's daily statistics and OT and OPD records of every tertiary care hospital. The workload statistics and WISN calculations were recorded and analyzed using Microsoft Excel. The WISN software was not used for the final calculation due to challenges reported in the literature [33]. WISN was piloted with only one health staff cadre/category, i.e., for doctors in Ayub Teaching Hospital before the assessment was undertaken in all the tertiary care hospitals of the province. No results or estimates were generalized to other hospitals.

Results

Staff requirements were calculated separately for doctors and nurses working in medical and allied specialties, surgical and allied specialties, and ED in all the eighth tertiary care hospitals of the province by initially estimating the annual workload of patients presenting to these hospitals and calculating their relative components as shown in Table 7

The WISN results were analyzed by two methods. Firstly, the difference between the current and required number of staff was compared which indicated whether the hospital was understaffed or over staffed concerning specific cadre and specialty. WISN and its analysis were performed individually for each teaching hospital and the total health staff (doctors and nurses) needed in each

Table 1 Health service activities and activity standards for doctors

| Activity | Number of staff performing the work | Activity standard | Workload data |
|---|-------------------------------------|--------------------|----------------------|
| <i>Medical and allied and surgical and allied specialties</i> | | | |
| Ward round | All doctors | 7 min/patient | Inpatient days |
| Admission | All doctors | 15 min/patient | Number of admissions |
| OPD | All doctors | 10 min/patient | Number of OPD |
| Death | All doctors | 10 mints/death | Number of deaths |
| Discharge | All doctors | 10 min/patient | Number of discharges |
| Pre- and post-round examination (DPR, order carryout, counseling, etc.) | All doctors | 30 min/patient/day | Inpatient days |
| Major surgeries* | All doctors | 150 min/operation | OT data |
| Minor surgeries* | All doctors | 50 min/surgery | OT data |
| <i>Emergency department</i> | | | |
| ED consultation | All doctors | 10 min/patient | ED OPD |

*Specific for surgical and allied specialties

Table 2 Support activities and activity standards for doctors

| Activity | Appropriate cadre | Activity standard |
|--|-------------------|--|
| Post-graduate teaching (for all except MTI Bannu) | All doctors | 180 min/week |
| Clinico-pathological conference | All doctors | 60 min/week |
| Journal club | All doctors | 60 min/week |
| Documentation | All doctors | 60 min/week (For ED 180 min/week) |
| Tea break | All doctors | 30 min/day |
| Minor medical procedures (for medical and allied units only) | All doctors | 180 min per week (for all hospitals except SGTH where it was 120 min/week) |
| Resuscitations and emergency patient care | All doctors | 20 min/day (for ED 90 min/day) |

Table 3 Additional activities and activity standards for doctors

| Activity | Appropriate cadre | Activity standard |
|--|--------------------|-----------------------------------|
| Undergrad teaching (except LRH) | Professorial staff | 20 h /year |
| Committee/boards | Professorial staff | 30 h/year |
| Performance appraisal | Professorial staff | 2 h/year |
| Attending to call | 2 doctors | 60 min per day = 360 min per week |
| Administrative work (for ED only) | Shift in charge | 3 h/day |
| Daily non-clinical round (for ED only) | In charge | 6 h/week |

Table 4 Health service activities and activity standards for nurses

| Activity | Number of staff performing the work | Activity standard | Workload data |
|--|-------------------------------------|-------------------|------------------|
| Medicine and allied and surgical and allied specialties | | | |
| Receiving, registering and admitting a patient | All nurses | 15 min/patient | Admissions |
| Ward round | All nurses | 7 min/patient | Inpatient days |
| Pre-ward and post-ward round orders (chart vital medication) | All nurses | 30 min/patient | Inpatient days |
| Bedding | All nurses | 5 min/patients | Inpatient days |
| Death care | All nurses | 10 min/death | Number of deaths |
| Preoperative preparation* | All nurses | 10 min/patient | OT data |
| Post-operative receiving/care* | All nurses | 15 min/patient | OT data |
| Emergency department | | | |
| ED patient care | All nurses | 5 min/patient | ED OPD |

*Specific for surgical and allied specialties

Table 5 Support activities and activity standards for nurses

| Activity | Appropriate cadre | Activity standard |
|----------------------------------|-------------------|---|
| Handing over taking over | All nurses | 120 min/day (for ED 60 min/day) |
| Daily cleaning | All nurses | 60 min/day |
| Detailed cleaning | All nurses | 120 min/week |
| Ward meeting | All nurses | 60 min/week |
| Tea break | All nurses | 30 min/day |
| Assistance in medical procedures | All nurses | 180 min per week (except SGTH where it was 60 min per week) |

Table 6 Additional activities and activity standards for nurses

| Activity | Appropriate cadre | Activity standard (medical and allied and surgical and allied) | Activity standard emergency department |
|---|------------------------|--|--|
| Weekly medicine indent creation receiving and arranging | 1 Charge nurse | 120 min/week | 60 min/week |
| Indent article daily | 1 Charge nurse | 60 min/day | 60 min/day |
| Daily expanse | 1 Charge nurse | 60 min/day | 60 min/day |
| Bedside teaching | 1 Charge nurse | 60 min/week | NA |
| Ward report | 1 Charge nurse | 90 min/day | NA |
| Administrative work | 1 Charge nurse | 60 min/day | 30 min/day |
| Record keeping | 1 Charge nurse | 30 min/day | 30 min/day |
| Resuscitation/emergency and on demand care | 1 Charge nurse | 60 min/week | 180 min/day |
| Appraisals | Nursing superintendent | 60 min/month | 60 min/month |
| Duty roster | Nursing superintendent | 120 min/month | NA |

teaching hospital was added to get the estimated health staff situation and work pressure in the tertiary care system of KP.

The results as shown in Table 8 indicate that individually all the hospitals showed a surplus of doctors except MTI DI Khan and MTI Bannu where there was a shortage of 55 and 181, respectively. However, the overall status of the tertiary healthcare system shows that there is a surplus of 1511 doctors in the tertiary health care system of the province.

Specialty-wise, medical and allied and surgical and allied specialties showed a surplus of doctors in all the hospitals except MTI DI Khan, where there was a shortage of 48 doctors in medical and allied specialties, and MTI Bannu where every allied specialty showed a shortage of doctors.

Overall, there were 1215 surplus doctors in medical and allied specialties and 861 doctors in surgical and allied specialties in the tertiary healthcare system. However, the data analysis showed that the health care system had an acute shortage of 565 doctors in emergency departments. The same trend was observed in all the tertiary care hospitals of KP indicating an acute shortage of doctors in emergency departments.

In the second method of analysis, the WISN ratio was calculated by dividing the current number of staff by the required staff of specific cadre and specialty. This ratio is a proxy measure for work pressure the health worker will feel during his daily work. The lowest workload pressure based on the WISN ratio was observed in Khyber Teaching Hospital based on 2018 workload data where workload pressure was 1.92. Results show that the highest workload pressure was recorded in MTI Bannu where the WISN ratio was 0.43. For emergency departments of the tertiary hospitals, where

every hospital's data analysis showed acute shortage, the WISN ratio also indicated high workload pressure, and the highest workload pressure was recorded in the emergency department of KTH which was 0.16 followed by in LRH with 0.18 WISN ratio as shown in Table 8. The current number of doctors shown in Table 8 includes faculty of attached medical colleges, consultants, trainee registrars, medical officers, and residents.

Currently, 2517 nurses are working in the tertiary healthcare system of the KP province. The staffing assessment of nurses, as shown in Table 9, revealed that every tertiary care hospital in the province has an acute shortage of nurses. The highest shortage in terms of numbers was recorded in MMC with a shortage of 271 nurses based on the workload it received in 2018. LRH on the other hand had the highest number of nurses working among the tertiary care hospitals of the province and reported a shortage of only 29 nurses. The tertiary healthcare system of KP has an overall shortage of 1099 nurses which requires around 3616 nurses based on the workload of patients presenting to the tertiary healthcare system in 2018.

Further analysis of the departmental requirement of nurses was not carried out as the hospital data showed that the strength of various units changed during the year and there were very few specialized nurses working in the tertiary healthcare system and almost all of the nurses are general pool nurses which are rotated among various allied specialties and between specialties. Secondly, unlike doctors where the specialty matters for patient care, depending upon the public health emergency or disaster requiring a specific type of care, the principles of nursing care remain almost the same apart from exceptional circumstances.

Table 7 Workload of the patients in the tertiary health care system

| Hospital statistics | KTH | LRH | ATH | MMC | HMC | MTIDI Khan | MTI Bannu | SGTH |
|---|---------|-----------|---------|---------|---------|------------|-----------|---------|
| <i>Medical and allied specialties</i> | | | | | | | | |
| Number of patients during ward rounds | 150,956 | 194,767 | 172,339 | 150,100 | 165,537 | 160,520 | 101,119 | 210,369 |
| Admission | 35,106 | 51,535 | 44,324 | 38,886 | 43,911 | 57,534 | 36,114 | 61,332 |
| OPD | 332,911 | 445,788 | 412,944 | 175,622 | 290,058 | 131,582 | 281,844 | 220,701 |
| Death | 1653 | 6122 | 3621 | 2715 | 1885 | 2501 | 975 | 3139 |
| Discharge | 34,364 | 40,434 | 39,939 | 35,949 | 40,685 | 51,688 | 34,201 | 53,007 |
| Number of patients during pre/post-round examination | 150,956 | 194,767 | 172,339 | 150,100 | 165,537 | 160,520 | 101,119 | 210,369 |
| <i>Surgical and allied specialties</i> | | | | | | | | |
| Number of patients during ward rounds | 186,180 | 239,496 | 188,702 | 165,916 | 193,133 | 95,154 | 112,221 | 229,433 |
| Admission | 40,474 | 88,876 | 51,455 | 36,707 | 41,996 | 24,336 | 33,006 | 52,382 |
| OPD | 336,471 | 511,385 | 276,690 | 216,150 | 277,357 | 124,713 | 192,361 | 285,022 |
| Death | 813 | 1888 | 489 | 97 | 1074 | 702 | 102 | 214 |
| Discharge | 38,294 | 69,646 | 49,867 | 34,952 | 39,699 | 21,441 | 31,892 | 45,676 |
| Major surgeries | 28,104 | 48,650 | 20,292 | 12,842 | 20,847 | 10,890 | 12,043 | 15,593 |
| Minor surgeries | 8267 | 60,017 | 30,168 | 8022 | 27,071 | 14,197 | 22,995 | 16,758 |
| Number of patients during pre- and post-round examination | 186,180 | 239,496 | 188,702 | 165,916 | 193,133 | 95,154 | 112,221 | 229,433 |
| ED visits | 673,998 | 1,189,663 | 323,964 | 226,601 | 590,091 | 212,650 | 248,770 | 409,835 |

Table 8 Healthcare staffing situation: doctors in tertiary healthcare system of KP

| Health center | Doctors | Current number | Required number, based on WISN | Shortage or excess | Workforce problem | WISN ratio |
|---|---------------------|----------------|--------------------------------|--------------------|-------------------|------------|
| Khyber Teaching Hospital | Medical and Allied | 527 | 175 | 352 | Surplus | 3.01 |
| | Surgical and Allied | 537 | 249 | 288 | Surplus | 2.16 |
| | Emergency | 20 | 126 | -106 | Shortage | 0.16 |
| | Total | 1084 | 550 | 534 | Surplus | 1.97 |
| Lady Reading Hospital | Medical and Allied | 499 | 229 | 270 | Surplus | 2.18 |
| | Surgical and Allied | 536 | 411 | 125 | Surplus | 1.30 |
| | Emergency | 39 | 222 | -183 | Shortage | 0.18 |
| | Total | 1074 | 862 | 212 | Surplus | 1.25 |
| Ayub Teaching Hospital | Medical and Allied | 355 | 207 | 148 | Surplus | 1.71 |
| | Surgical and Allied | 351 | 244 | 107 | Surplus | 1.44 |
| | Emergency | 15 | 61 | -46 | Shortage | 0.25 |
| | Total | 721 | 512 | 209 | Surplus | 1.41 |
| Mardan Medical Complex | Medical and Allied | 178 | 147 | 31 | Surplus | 1.21 |
| | Surgical and Allied | 215 | 181 | 35 | Surplus | 1.19 |
| | Emergency | 18 | 43 | -25 | Shortage | 0.42 |
| | Total | 411 | 371 | 41 | Surplus | 1.11 |
| Hayatabad Medical Complex | Medical and Allied | 476 | 181 | 295 | Surplus | 2.63 |
| | Surgical and Allied | 518 | 242 | 276 | Surplus | 2.14 |
| | Emergency | 22 | 109 | -87 | Shortage | 0.20 |
| | Total | 1016 | 532 | 484 | Surplus | 1.91 |
| MTI DI Khan | Medical and Allied | 106 | 154 | -48 | Shortage | 0.69 |
| | Surgical and Allied | 138 | 121 | 17 | Surplus | 1.14 |
| | Emergency | 17 | 41 | -24 | Shortage | 0.41 |
| | Total | 261 | 316 | -55 | Shortage | 0.83 |
| MTI Bannu | Medical and Allied | 71 | 117 | -46 | Shortage | 0.61 |
| | Surgical and Allied | 52 | 154 | -102 | Shortage | 0.34 |
| | Emergency | 14 | 47 | -33 | Shortage | 0.30 |
| | Total | 137 | 318 | -181 | Shortage | 0.43 |
| Saidu Teaching Hospital | Medical and Allied | 408 | 195 | 213 | Surplus | 2.09 |
| | Surgical and Allied | 361 | 246 | 115 | Surplus | 1.47 |
| | Emergency | 16 | 77 | -61 | Shortage | 0.21 |
| | Total | 785 | 518 | 267 | Surplus | 1.52 |
| Total across tertiary healthcare system | | 5490 | 3979 | 1511 | Surplus | 1.38 |

Table 9 Healthcare staffing situation: nurses in tertiary healthcare system of KP

| Health center | Cadre | Current number | Required number, based on WISN | Shortage or excess | Workforce problem | WISN ratio |
|---|--------|----------------|--------------------------------|--------------------|-------------------|------------|
| Khyber Teaching Hospital | Nurses | 325 | 436 | -111 | Shortage | 0.74 |
| Lady Reading Hospital | Nurses | 773 | 802 | -29 | Shortage | 0.96 |
| Ayub Teaching Hospital | Nurses | 342 | 465 | -123 | Shortage | 0.73 |
| Mardan Medical Complex | Nurses | 109 | 380 | -271 | Shortage | 0.28 |
| Hayatabad Medical Complex | Nurses | 398 | 448 | -50 | Shortage | 0.88 |
| Mufti Mehmood Teaching Hospital | Nurses | 128 | 336 | -208 | Shortage | 0.38 |
| Khalifa Gul Nawaz Teaching Hospital | Nurses | 150 | 268 | -118 | Shortage | 0.55 |
| Saidu Teaching Hospital | Nurses | 292 | 391 | -99 | Shortage | 0.74 |
| Total across tertiary healthcare system | Nurses | 2517 | 3562 | -1099 | Shortage | 0.71 |

Based on the WISN generated numbers for doctors, the estimated surge capacity of the tertiary health care system and its constituents tertiary care hospitals was calculated by the percentage difference between excess and required numbers of HCPs as highlighted in Tables 8 and 9. The HR surge capacity assessment as shown in Table 10 indicates that only four hospitals that are KTH, ATH, HMC, and SGTH have an adequate number of doctors to receive and manage a surge of $\geq 20\%$ of patients in addition to their usual workload. However, the data show that if the surge capacity is estimated for individual specialties, none of the tertiary care hospitals' EDs have any surge capacity in terms of the number of doctors to manage additional workload which is expected in the disaster scenarios. The tertiary healthcare system as a unit has the

surge capacity to manage the additional patient workload of up to 27.5% with the current number of doctors. However, if the level of nursing care has to be maintained up to the locally acceptable standard of care and keeping in view the current workload, worryingly nor the tertiary healthcare system or any of its constituent tertiary care hospitals are prepared to manage any percentage of surge of additional of patients.

Nevertheless, the results show that if the total number of nurses and doctors are added and considered for joint surge response to a disaster, as shown in Table 11 and highlighted in the literature, only two hospitals in the province, i.e., KTH and HMC have adequate HCPs to manage a surge of $\geq 20\%$ of patients. The provincial capital Peshawar has three tertiary care hospitals, i.e., KTH, LRH, and HMC. If the conglomerated surge capacity based on the combined number HCPs and their workload is considered in these three hospitals, the surge capacity is estimated to be 22.2% indicating that the provincial capital hospitals can jointly manage a sudden surge of patients and has the recommended surge capacity. The tertiary healthcare system of KP as a whole has a combined health workforce that can manage an additional surge of 6.3% of patients with the current patient workload.

Table 10 Surge capacity of tertiary care hospitals

| Health center | Cadre | Surge capacity % |
|--------------------------------|----------------------|-------------------|
| Khyber Teaching Hospital | Medical and Allied | 66.8 |
| | Surgical and Allied | 53.6 |
| | Emergency Department | No surge capacity |
| | Total | 49.3 |
| Lady Reading Hospital | Medical and Allied | 54.1 |
| | Surgical and Allied | 23.3 |
| | Emergency | No surge capacity |
| | Total | 19.7 |
| Ayub Teaching Hospital | Medical and Allied | 41.7 |
| | Surgical and Allied | 30.5 |
| | Emergency | No surge capacity |
| | Total | 29.0 |
| Mardan Medical Complex | Medical and Allied | 17.4 |
| | Surgical and Allied | 16.3 |
| | Emergency | No surge capacity |
| | Total | 10.0 |
| Hayatabad Medical Complex | Medical and Allied | 62.0 |
| | Surgical and Allied | 53.3 |
| | Emergency | No surge capacity |
| | Total | 47.6 |
| MTI DI Khan | Medical and Allied | No surge capacity |
| | Surgical and Allied | 12.3 |
| | Emergency | No surge capacity |
| | Total | No surge capacity |
| MTI Bannu | Medical and Allied | No surge capacity |
| | Surgical and Allied | No surge capacity |
| | Emergency | No surge capacity |
| | Total | No surge capacity |
| Saidu Group Teaching Hospitals | Medical and Allied | 52.2 |
| | Surgical and Allied | 31.9 |
| | Emergency | No surge capacity |
| | Total | 34.0 |

Discussion

The phenomenon of the surge and its related capacity is not unidirectional or static. It has multiple components that intricately interact with each other to generate adequate surge capacity. The availability of appropriate numbers and a mix of HCPs are pivotal for the adequate surge capacity of the health system. This study was conducted to estimate the surge capacity of the tertiary healthcare system based on the actual workload of patients presenting to the tertiary care hospitals in the KP province.

Table 11 Surge capacity based on total numbers of health care providers

| Hospital | Surge capacity (total healthcare providers) |
|---------------------------------|---|
| KTH | 30.0% |
| LRH | 9.9% |
| ATH | 8.1% |
| MMC | No (deficient HCP) |
| HMC | 30.7% |
| MTI DI Khan | No (deficient HCP) |
| MTI Bannu | No (deficient HCP) |
| SGTH | 15.6% |
| Conglomerated HMC, KTH, and LRH | 22.2% |
| Tertiary healthcare system KP | 6.3% |

Published literature on WISN seldom elaborates on the workload components and their activity standards and that makes it difficult to compare. Nevertheless, our workload components and activity standards were similar to what is reported in the literature. The results of our study show that the activity standard set for ward rounds was 7 min/patient which is similar to a study conducted in Uganda where ward round was set between 5 and 8 min [34]. Similarly, the activity standard for pre- and post-round patient care by nurses was set at 30 min which is similar to the routine nursing care activity standard (30 min) set for general hospitals in Namibia [33]. Available working days for doctors and nurses were recorded at 257 and 262 days, respectively, which far exceeds what has been reported in studies conducted in Asian and African hospitals that have reported between 199 and 246 available working days for various cadres of HCPs [34–37].

The study results show that individually all the hospitals have an excess of doctors except MTI DI Khan and MTI Bannu where there was a shortage of 55 and 181 doctors, respectively. However, the overall status of the tertiary health care system of the province shows that there is a surplus of 1511 doctors. This finding complements the results of the staffing need assessment conducted in Uganda which indicated that the clinical staff was adequate in their general hospitals [37]. However, very few studies have indicated an excess of doctors in hospitals [38]. Unlike the findings of our assessment, most of the studies have indicated a shortage of doctors in hospitals where WISN was conducted [33, 36, 39, 40].

Although WISN shows an overall surplus of doctors, yet all the tertiary care hospitals showed insufficient doctors in their EDs. The EDs everywhere are busy and the shortage of doctors and nurses based on the WISN calculations has been evident in other teaching hospitals as well. A study conducted in a teaching hospital in Iran showed a shortage and high work pressure of health care staff working in emergency departments [41]. Literature also suggests that emergency departments are usually understaffed whether assessed by WISN or otherwise [41–43]. In the context of Pakistan and KP particularly, these EDs work as evening OPDs and the patients usually present with minor ailment and complaints which causes an unnecessary workload in the EDs. This situation, however, is not exclusive to Pakistan or KP alone. Literature shows that even in advanced health systems like NHS in England, where there is a strong network of GPs, the patients still seek primary care in emergency departments of teaching hospitals/trust hospitals [44].

The results of this study show that all the tertiary care hospitals had an acute shortage of nurses with high

workload pressure. Nurses more than any other cadre of health care providers are affected by the size, skills, and mix [34, 43]. Complementing the result of our survey, several studies both in developing and developed countries have reported an acute shortage of nurses working at every level of the healthcare delivery system [34, 36–39, 41–43, 45]. Studies have shown that nurses have higher workload pressure as compared to doctors which indicates relatively fewer nurses as compared to doctors in the many healthcare delivery systems [36–38]. The result of this survey further strengthens these findings showing high workload pressure was more common in nurses as compared to doctors. The major reason for the shortage of nurses in the province is the lack of adequate nursing institutions and cultural barriers for the women to join this profession.

Several researchers have proposed role re-definition to overcome the shortage of healthcare providers during disasters where junior doctors or even medical and nursing students can provide necessary nursing care. Some studies have taken this interesting approach of role redefinition/re-designation towards filling the human resource gap and studied staffing assessment with combined healthcare staff. A study conducted in a large Turkish hospital that involved multiple cadres of staff, calculated the total staffing needs of the hospital and assessed the work pressure of the hospital instead of the individual cadre [36]. Sharing of roles between HCPs has been highlighted in other published literature as well, suggesting that the roles can be interchanged if a sudden surge in the number of patients is experienced [33]. Based on this approach, the results show that only three tertiary care hospitals, i.e., MMC, MTI DI Khan, and MTI Bannu have an overall shortage of healthcare workers. However, the tertiary healthcare system as a whole will still have surplus health care workers which can be deputed if the need arises to other hospitals as a measure of contingency and crisis surge capacity.

The criteria for surge capacity have been extensively discussed. It has been proposed by academics that the adequate level of surge capacity is the availability of 20% of total staffed beds for immediate management of patients during a public health emergency or disaster [13–15]. This number of 20% surge capacity in terms of availability of staffed beds is generated based on the US Health Resources and Services Administration advised capacity [14].

The current study shows that, based on the number of doctors, only four hospitals (KTH, ATH, HMC, and SGTH) can manage a sudden surge of $\geq 20\%$ of patient workload and the tertiary healthcare system as a unit can manage an additional patient workload of up to 27.5%. Neither the tertiary healthcare system nor its

constituent hospitals have a sufficient number of nurses that can manage any additional surge of patients.

However, for disaster response, if work pressure of the hospital instead of the individual cadre is taken as discussed earlier [36], only two hospitals in the province, i.e., KTH and HMC have adequate healthcare providers which may use role redefinition to manage a surge of $\geq 20\%$ of patients if adequate beds and logistics are available. However, KP tertiary healthcare system's HR as a whole can only manage an additional 6.3% of surge of patients. The results shows an insufficient surge capacity which stems from the shortage of doctors and nurses and is a major cause for concern for the health system decision-makers and hospital managers. Our study further augments the finding of the study conducted by Zia et al. that showed that the secondary health care system of KP province has poor preparedness for disaster management [46]. This highlights a critical fault in the overall health system of the province. In case of disaster, the tertiary healthcare system cannot rely on the secondary healthcare facilities to accommodate overflow surge of patients during disaster owing to the lack of preparedness and resources. The tertiary health care system and its constituent tertiary care hospitals have no option but to accommodate and manage whatever surge of patients they receive during disasters which will result in compromised quality of care. Having a sufficient HR surge capacity provides an opportunity and evidence for the health system to improve other surge capacity elements like beds, logistics, and finances to match HR capacity and achieve an adequate overall system surge capacity.

Some researchers argue that WISN uses previous year's statistics to estimate staffing needs and it estimates staffing needs that should have been for the last year. However, the facility workload relatively changes slowly and the difference is usually non-significant from one year to another unless some special situation arises [23]. Thus, the estimate from the previous year may be true of the current year as well. As far as special situations, one can always apply percentage correction that can be factored in to calculate the estimate. As per the national disaster management authority and national counter-terrorism authority of Pakistan, KP experienced 2 natural and 310 terrorist activities during 2018. These disasters resulted in 275 deaths and 541 people presenting to various public sector hospitals with injuries. However, no disaster resulted in either a large influx of patients or a declaration of emergency by the hospitals or the provincial disaster management authority [47, 48]. Therefore, the estimates made using WISN fairly accurately represent the workload experienced during non-disaster situations in the tertiary healthcare system of KP.

Conclusion

WISN assessment indicates that with the current workload, six out of eight tertiary care hospitals and the tertiary healthcare system as a unit have a surplus of doctors. However, the same cannot be said for nursing staff. None of the constituent hospitals of the tertiary healthcare system of KP have the required number of nurses to manage the current workload of patients.

Although, the conventional use of WISN assessment provides a robust workload based staffing situation and needs, yet, there is an untapped potential of the WISN technique to assess the staffing situation in certain scenarios where the hospitals might face a sudden surge of patients. WISN provides a novel approach to assess the surge capacity and resulting disaster preparedness of the tertiary healthcare system.

The HR surge capacity based on WISN indicates that the tertiary health care system of the Khyber Pakhtunkhwa Province of Pakistan does not possess the required $\geq 20\%$ HR surge capacity indicating that the tertiary healthcare system is poorly prepared for disasters or public health emergencies even if other resources like beds and supplies are available. This lack of preparedness will compromise the quality and standards of care received by the disaster victims.

To improve the current HR situation and surge capacity, the tertiary healthcare system and its constituent hospitals need to hire and manage the current strength of HCPs by allocating them according to patient workload. To improve the surge capacity, it will not be cost effective to hire more HCPs preemptively to manage disasters. Instead, the health system must develop a provincial registry of nurses, volunteer and retired doctors, and allied staff that can be called if the need arises. Moreover, HCPs may be trained to adapt to role re-definition during disasters to manage the initial surge of patients before pre-identified HCPs from the pool can be deputed to the hospitals in need.

Abbreviations

WHO: World Health Organization; HMIS: Health Management Information System; HCP: Healthcare Provider; HRH: Human Resources in Health; KP: Khyber Pakhtunkhwa; WISN: Workload Indicators of Staffing Needs; KTH: Khyber Teaching Hospital; LRH: Lady Reading Hospital; ATH: Ayub Teaching Hospital; HMC: Hayatabad Medical Complex; MTI DI Khan: Medical Teaching Institute Dera Ismail Khan; MMC: Mardan Medical Complex; MTI Bannu: Medical Teaching Institute Bannu; SGTH: Saidu Group of Teaching Hospitals; AWT: Available working time; ED: Emergency department; FGD: Focus group discussion.

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