



Workload Indicators of Staffing Need as a tool to determine nurse staffing for a high volume academic Emergency Department: An observational study

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ABSTRACT

Introduction: Determination of staffing requirement for an Emergency

Department (ED) is often difficult due to random arrivals of a complex mix of cases, fluctuating volumes and lengths of stay. Most staffing strategies are based on patient census, lengths of stay, patient dependency or patient classification systems. However, the actual quantity of workload is seldom employed as a basis to calculate staffing.

Aim: The aim of this study was to determine the requirement of nurses for a high volume academic ED and to suggest measures to optimally schedule them.

Methodology: Structured interviews were held with ED nurses to list their health service activities, support and additional activities. Time taken for the activities was calculated based on observations and interviews. Records were perused to obtain annual service statistics. Workload Indicators of Staffing Need (WISN) described by World Health Organization was utilized to analyze and determine staffing need.

Results: The study identified 34 health service activities, 21 support activities and 3 additional activities to be performed by 125 nurses with a total available working time of 187,250 h for an annual volume of 105,103 patients. The WISN ratio was 0.90 which indicates that the current staff strength was inadequate. The Emergency Department requires 13 more full time staff nurses for it to function optimally. In case of reallocation of certain relevant duties to phlebotomists or nursing assistants, the requirement of staff nurses is 102. Consequently, a skill mix ratio of 82% nurses to 18% nursing assistants and phlebotomists is suggested.

Discussion: The Workload Indicators of Staffing Need is a simple, easy to use method that can prospectively measure direct and indirect nursing activities and translate workload into nursing full time equivalents for the ED. This method is also useful to identify activities that do not require nursing professional skills and prescribe the skill mix of staff.

1. Introduction

Despite demonstrated evidence of an association between increased nurse staffing and a lower rate of hospital related mortality, adverse patient events [1] and burn out rates [2], there is no universal agreement about a tool to measure and model ward staffing requirements. There is no consensus about nationally set mandatory nurse staffing levels [3]. Determination of staffing for Emergency Departments (ED) is even more difficult due to random arrivals of a complex mix of cases, fluctuating volumes and lengths of stays. ED staff are required to multi task in an atmosphere of high tension, noise and activity [4]. Emergency Departments, therefore, need to be appropriately staffed in order to assure satisfaction and improve outcomes for both patients and nurses. Though sufficient staffing is a cost factor, inadequate staffing may lead to very high patient care costs [5,6].

Emergency care literature describes staffing approaches based on professional judgement, patient census, hours per patient visit, patient acuity or dependency, patient classification systems, nursing productivity, and workforce mix [7–9]. Professional judgement is

subjective and unreliable. Patient census, hours per patient visit and length of stay provide no indication of patient dependency or case mix across departments. Patient acuity or dependence can capture the complexity of each individual case, but it can also fluctuate across the patient's ED stay, which can be difficult to capture with some tools. The time period of dependency of the patient is undefined by patient classification systems. For some patients this may change rapidly with medical intervention or the level of dependency could increase over time. In a systematic review of 12 ED patient classification systems, there was no single tool that was comprehensively ED relevant, simple, easy to use, valid, reliable, prospectively able to measure both direct and indirect nursing activities and capable of translating workload into nursing full time equivalents (FTE) [9]. This study demonstrates a tool that may address these deficiencies.

The aim of this study was to determine the nursing staff requirement for a high volume academic Emergency Department of a tertiary care academic hospital and to suggest measures to optimally schedule it.

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2. Methodology

2.1. Study design, setting and sample

This descriptive and quantitative study was conducted from May to October 2016 in the ED of a tertiary care academic hospital. There has been a very significant increase in bed occupancy and patient throughput in the ED over the years. Bed occupancy was persistently above 100% due to additional utilization of patient trolleys. The annual patient volume for the year 2015-16 at this ED was 105,103. There was a 26% increase in patient volume compared to the preceding year's volume. Ambulance diversion was a daily event at this ED, a proxy marker for crowding. However, the ED staffing has not been commensurate with the patient volumes. Therefore, the ED was chosen as the unit of study to determine nursing requirement.

This ED catered to patients needing only emergency care. These patients were either relocated to their respective wards after provision of emergency care within forty eight hours or discharged based on patient's status. Admitted patients who have not yet been assigned an inpatient bed were not boarded in this ED.

Nursing activity was the unit of sampling in this study. In other words, the patient was not the unit of sampling. If the same activity was performed on the same patient multiple times in a day, the number of times of performance of that particular activity was taken to calculate workload even if it was done on the same patient. The list of template tables provided in the Workload Indicators of Staffing Need (WISN) described by World Health Organization [10] was used as the tool to guide each step of the study.

2.2. Data collection

Structured individual and group interviews with ED nurses were conducted by trained hospital administrators to list health service activities, support and additional activities. Nurses with less than three months of experience in the ED and new recruits were excluded from the study. The time taken by a nurse to perform each enlisted health service activity was calculated by direct observation in the ED by a hospital administrator. The time taken for each activity was observed again randomly twice a week for a total period of eight weeks. The mean time of 16 observations for each activity performed by nurses in the ED was taken as the unit time for each health service activity. The purpose of taking a mean time of 16 observations was due to the assumption that nursing activities cannot be merely understood as a series of tasks since there may be variability in the task time for each task due to issues such as the age of the patient, the level of cooperation, language barriers, etc. Since it was not possible to directly observe support and additional activities, the time taken to perform each such activity was calculated based on approximations given by the nurses during interviews. Departmental records were perused to obtain annual service statistics.

2.3. Data analysis

Analysis of the workload and the staffing requirement was done based on the steps of the WISN.

2.4. Ethical considerations

Approval was obtained from the medical institution prior to the conduct of the study. Participants were informed verbally about the study and written informed consent was obtained from them. Participant anonymity was maintained. No personal information of any participant was collected during the study. The study did not involve any bio medical research per se.

3. Results

Each step of the WISN tool is described in detail as the manner of calculation at each step would ultimately predict the number of nurses required.

3.1. STEP 1: Determining priority cadre

The first step involved identifying the strength of nursing cadre and determining priority cadre. In this ED, there were 104 staff nurses, 8 nurses-in-charge, 2 Assistant Nursing Superintendents and 1 Deputy Nursing Superintendent. Staff nurses are involved in direct patient care. Nurses-in-charge have additional non patient care duties and the Assistant and Deputy Nursing Superintendents have a supervisory role with purely administrative duties. In another study, the ED nurses of this hospital under study perceived stress in the domains of work demands and relationships which were both in the bottom 10 percentile when compared to the international benchmark as per the Health and Safety Executive, UK [11]. The mean score of burnout among ED nurses was significantly higher (26.72 ± 3.82) compared to the nurses of ICUs in this hospital [12]. These findings were considered as indirect indicators of staff shortage. The highest priority was, therefore, assigned to staff nurses as they are directly involved in patient care.

3.2. STEP 2: Calculating estimated available working time (AWT)

The second step calculated the total number of working hours available for each category of nurse after deducting the total number of leaves and days not worked in a year from the total number of possible working days in a year as per the formula: $AWT = [A - (B + C + D + E)] * F$. (Table 1). One hour of rest was considered for each nurse per shift. Based on the formula, the estimated available working time for staff nurses was 1498 h or 89,880 min in one year.

3.3. STEP 3: Defining workload components

This step listed all the current workload components in the ED which were classified based on whether the activity was a health service activity, additional activity or a support activity, performed by either all the staff nurses or only a few staff nurses (Table 2).

3.4. STEP 4: Setting activity standards

An Activity Standard is a unit time (or rate) for a health care activity – how much time, on average, performing an examination, filling a prescription, taking an X ray etc it should take to complete by qualified staff who are working to acceptable professional standards. Two types of activity standards are defined. Standards for the services and activities which are reported in the annual service statistics are called Service Standards. Allowance Standards apply to those activities which are not reported in the annual service statistics. This may be because the activities cannot easily be measured. An allowance is made in the

Table 1
Possible annual working days (A) and non working days.

Possible annual working days (A) and non working days	Staff category
	staff nurse
Possible working days in one year (A)	365
Public holidays (B)	5
Annual leave (C) (earned leaves, casual leaves and entitled offs)	136
Sick leave (D)	10
Other leave (training, Personal leave, etc.) (E)	0
Number of working hours in one day (F)	7

Table 2
Workload components of a staff nurse.

Staff category: staff nurse	
Workload group	Workload component
Health service activities of all staff nurses	Triage of patients Admission of patients Discharge of patients Bed making Administration of medicines Following Doctors' instructions Injection of antibiotics Observing, recording and reporting of vital signs eg TPR and BP. Input output charting Collecting, labeling and dispatch of laboratory samples. Insertion of CVP line Intubation Care of intubated patient Initial care of patient on ventilator Hourly suction of patient on ventilator Gastric lavage Insertion of nasogastric tube Enema Chest tube insertion Writing of diet sheet, supervision and distribution of diets. Nebulisation Tracheostomy assistance Securing IV access Usage of infusion pump Infusion pump refill Counseling patients and their attendants. Care of the dying and dead. Assisting administration of infusion and blood Transfusion. Foley's catheterisation Starting IV line for thrombolysed patients Canulisation Assisting oxygen delivery Preparation for and assistance in clinical tests and medical/surgical procedures. Urine testing for sugar and albumin. Observation, recording and reporting of all procedures and tests. Work related to protocol for victims of sexual assault.
Support activities of all staff nurses	Hand offs of patients on observation Hand offs of other patients, and ward inventory in each shift. Maintenance of therapeutic environment. Keeping the ED clean and tidy. Routine care and cleaning of dressing trolleys, cupboards apparatus, mackintosh etc. Care of clean and soiled linen. Disinfection of linen, beds, floor and bed pans, and fumigation of rooms etc. Preparation of room, trolleys, and sets for procedures. Preparation of surgical supplies Maintaining interpersonal relationship with patients, relatives and health team members. Orientation of new staff/students. Demonstration and guidance to nursing students Participation in staff education and staff meetings. Participation in professional activities. Demonstration of tasks and supervision of domestic staff. To report incidents of absconded patients, thefts, fire safety issues etc to the senior nursing officials. Miscellaneous communication/counselling Record keeping and registers Inventory and instruments checking CME and Workshops In-service training

Table 2 (continued)

Staff category: staff nurse	
Workload group	Workload component
Additional activities of certain staff nurses	Ambulance check Maintenance of supplies related to disaster management Maintenance of area for VIPs including stock taking

calculations for these activities according to the amount of working time they should absorb [10].

The unit time for each health service activity was calculated by taking the average of 16 observations for each activity performed by nurses in the ED on different occasions for a period of eight weeks to define the activity standards. (Table 5, column 3).

3.5. STEP 5: Establishing standard workloads

The service standards were translated into the equivalent volumes of work per year per employee which are known as the standard workloads. Standard workload is the amount of work which one health worker can do in a year. This was calculated by dividing the Available Working Time (AWT) in a year by the unit time for the activity [10]. For a staff nurse, the AWT was calculated as 89,880 min as shown in Step 2. Therefore, standard workload of one staff nurse with respect to one activity, say, triaging of patients is 14,980 at the rate of 6 min for this activity per patient (Table 5, column 4).

3.6. STEP 6: Calculating allowance factors

There are two types of allowance standards. Category allowance standards (CAS) are determined for support activities that all staff nurses perform. Individual allowance standards (IAS) are for those activities that are performed by only certain staff nurses [10].

Category Allowance Standard (CAS) was calculated in the form of percentage of working time spent on an activity as observed or noted by the staff (Table 3). Thereafter, Category Allowance Factor (CAF) was calculated using the formula: $CAF = 1 \text{ divided by } [1 \text{ minus } (\text{Total CAS percentage divided by } 100)] = 1 \div 1 - (28.92/100) = 1.4$.

The time required to perform each additional activity by certain staff nurses is calculated which is multiplied by the number of staff nurses required to perform that activity in one year. The time required for all activities are then added to calculate the total Individual Allowance Standard (IAS) in a year. Individual allowance factor is then calculated by dividing the total Individual Allowance Standard with total Available Working Time (AWT) of a staff nurse (Table 4).

3.7. STEP 7: Determining staff requirements

The total number of staff nurses required was calculated by multiplying the total number of staff obtained (Table 5) above with the category allowance factor and then adding the individual allowance factor to the result. Total number of staff required was thus obtained as 125.

3.8. STEP 8: Analysis of results by difference or ratio

The current actual strength of staff nurses is 104. As per the WISN method, the total number of staff nurses required is 125. The WISN difference is 21 staff nurses. In terms of ratio, it is 0.83 which indicates that the current staff strength is inadequate. The Emergency Department requires 21 more full time staff nurses for it to function optimally. When the nurses-in-charge are included, the existing strength of nurses is 112. Consequently, the WISN ratio is 0.90 and the

Table 3
Calculation of Category Allowance Standard (CAS).

	Activity	Time spent	CAS (%age of working time)
Support activities done by all staff nurses	1 Hand offs of patients on observation	30 min per 24 h	2.38
	2 Hand offs of other patients and ward inventory in each shift	180 min per 24 h	14.28
	3 Miscellaneous communication	10 min per shift	2.38
	4 Record keeping and registers	15 min per shift	3.57
	5 Inventory and instruments checking	20 min per shift	4.71
	6 CME/Workshop	12 h in 1 year	0.8
	7 In-service training	2 h in 2 months	0.89
	Total		28.92

WISN difference is 13 nurses.

4. Discussion

Our study identified 34 health service activities, 21 support activities and 3 additional activities to be performed by 125 nurses with a total available working time of 187,250 h for an annual volume of 105,103 ED patients. The estimated time required for each of the 34 health service activities was also recorded.

According to the 2001 Emergency Nurses Association Benchmark Guide, the average ED patient requires 1.57 h of direct nursing care [13]. As per this guide, with the current annual load of 105,103 patients, 110 staff nurses are required with 7 nursing hours per nurse per shift. Indirect patient care activities and non patient care activities are still not accounted in this estimation. As per our study, 89 nurses are required for direct patient care activities and 36 nurses are required for the additional and support activities.

California was the first state in the USA to enact legislation regulating nurse-to-patient ratios at 1:4 for all ED patients except trauma/resuscitation patients and critical patients [14]. Standards in India recommend a similar ratio [15]. As per this norm, 72 nurses would be required for an annual volume of 105,103 patients. Norms based estimations do not take into account the actual workload involved and may not accurately reflect the actual requirement.

As per Templin [16], there are typically four components to a staffing standard or staffing equation: i) Variable component ii) Fixed or constant component iii) Target utilization percentage or performance goal, and iv) Paid time off add-on factor. The variable component is the equivalent of direct nursing care and ancillary or indirect care. The fixed or constant component includes activities that do not vary directly with the change in daily visits of patients such as change of shift report, supplies, trips to other departments (not patient transport), new staff orientation, and general management. Target utilisation percentage is the percentage of the ED nursing staff's utilization of working hours in productive activities and is recommended to be between 65% and 85% depending on total volume, shift, and day-to-day volume fluctuation. To achieve 75% staff utilization, the average staff member should spend 6 h of their 8-hour shift performing productive activities. Productive time typically includes a personal, fatigue and delay (PFD) factor. The fourth component is adding a factor for paid time off. The first and second components are equivalent to the health service activities and support activities of all staff nurses and additional activities of certain

nurses as per the WISN method. The third and fourth components were accounted for in step 2 of WISN. Due to high volumes of patients, our study fixed a target utilization percentage of 87.5%.

The model proposed by Gaidzinski [17] uses a complex equation to calculate staff requirement using criteria such as the classification level of care required by patients according to a validated patient classification system such as the Fugulin Patient Classification System, which classifies the level of nursing care into five levels: intensive care, semi-intensive care, high dependency care, intermediate care and minimal care; obtaining time of assistance and ratio of registered nurses and non-registered nurses assistants according to the level of care; calculation of the technical security index that covers planned and unplanned absences; and finally, determining the staff productivity index to calculate nursing requirement and triage risk classification protocol for emergency admission triage. This method requires a special data collection exercise from each patient by direct observation and from medical records and does not consider activities that are not related to patient care.

This WISN based calculation did not take into account unplanned absences of nurses in step 2 which may be practically relevant. However, in this study, it was not recognised as an important factor as nurses are provided from the pool of relief nurses who are assigned duties in ED to perform the duties of those ED nurses absent on duty.

The Nursing Hours Per Patient Day (NHPPD) model [18], developed using the Western Australia's Nursing Workload Monitoring System – User Manual, calculates nursing hours based on bed occupancy, number of service hours, number of working days and bed categories. The drivers of nursing workload in the ED are volume of attendance, Australasian Triage Score, Length of Stay in the department, size of the department and size of the observation Ward (if any). However, this model could not be used to calculate nursing hours and staff for this ED as it was not feasible to classify the beds of this ED into categories as specified in the model. The staff would require training in Australasian Triage Score. Due to high volumes and high turnover, an unspecified number of trolleys were utilised in a dynamic manner every day which was difficult to quantify.

The Emergency Nursing Association (ENA) staffing guidelines [8] calculates the full-time equivalent positions needed for patient care based on patient census, patient acuity, patient length of stay, nursing time for interventions and activities by patient acuity, skill mix for providing patient care based on nursing interventions that can be delegated to a non-RN and adjustment factor for the non-patient care time

Table 4
Individual Allowance Standard.

Workload group	Workload components	Number of staff performing the work	IAS (Actual working time per person)	Annual IAS (for all staff performing activity)
Additional activities of certain staff nurses	Ambulance checking	2	8 h in one month	192 h
	Maintenance of supplies related to disaster management	2	8 h in 2 months	96 h
	VIP area maintenance	2	8 h in 2 months	96 h
	Total IAS in a year			384 h
	Individual Allowance Factor (IAF)			0.26

Table 5
Determining staff requirement.

Sn	Health service activity	Unit time or rate of working (in minutes)	Standard workload	Annual workload	Staff required for the activity (Annual workload/Standard workload)
(1)	(2)	(3)	(4)	(5)	(6)
1	Triaging of a patient	6	14,980	105,103	7.02
2	Admission of a patient	15	5992	9490	1.58
3	Discharge/transfer of a patient	15	5992	57,305	9.56
4	Bed making	2	44,940	45,990	1.02
5	Administration of medicines	1	89,880	75,164	0.84
6	Following Doctors' instructions	1	89,880	75,164	0.84
7	Injection of antibiotics	1	89,880	300,656	3.35
8	Observing, recording and reporting of vital signs eg TPR and BP.	2	44,940	180,267	4.01
9	Input output charting	1	89,880	75,164	0.84
10	Collecting, labeling and dispatch of laboratory samples.	1	89,880	263,074	2.93
11	Insertion of CVP line	20	4494	4380	0.97
12	Intubation	10	8988	2555	0.28
13	Care of intubated patients	10	8988	2555	0.28
14	Initial care of patient on ventilator	40	2247	4380	1.95
15	Hourly suction of patient on ventilator	20	4494	4380	0.97
16	Gastric lavage	20	4494	1825	0.41
17	Insertion of Nasogastric tube	5	17976	1825	0.10
18	Chest tube insertion	25	3595.2	730	0.20
19	Tracheostomy assistance	50	1797.6	547.5	0.30
20	Securing IV access	10	8988	105103	11.69
21	Enema	7	12840	2920	0.23
22	Writing of diet sheet, supervision and distribution of diets	5	17976	19345	1.08
23	Nebulisation	2	44940	25,550	0.57
24	Initiating infusion pump	10	8988	58765	6.54
25	Infusion pump refill	5	17976	19589	1.09
26	Counseling patients and their attendants	10	8988	180267	20.06
27	Care of the dead patients.	40	2247	3650	1.62
28	Assisting administration of infusion and blood transfusion.	15	5992	29200	4.87
29	Foley's catheterisation	15	5992	7300	1.22
30	Securing IV access for thrombolysed patients	15	5992	4745	0.79
31	Canulisation	10	8988	8213	0.91
32	oxygen delivery	2	44940	25550	0.57
33	Urine testing for sugar and albumin	2	44940	5210	0.12
34	Work related to protocol for victims of sexual assault	20	4494	4	0.00
	Total				88.82

included in each full-time equivalent position. This method requires calculation of average nursing time in minutes by acuity level and the average length of stay in minutes by acuity level in addition compared to WISN. An approximate adjustment for non-patient care time is factored into the calculation.

Duffield suggested an approach of expanding the practical skills of unregulated workers which are directly applicable to their particular work context by 'learning on the job' as part of workforce strategies to improve performance in ED [19]. More importantly, their scope of work needs to be defined within set boundaries to ensure safety and quality. In our study, Table 5 [2] identifies tasks that may be allocated to non-nursing staff such as bed making, collection, labelling and dispatch of blood samples and securing IV access. In such case, number of nurses needed would be 102 instead of 125. In other words, the skill mix ratio of nurses and nursing assistants/phlebotomists suggested is 82–18%. This result is in consonance with the findings of the Center for Nursing Classification research which states that for 100% of all nursing interventions and activities involved in patient care, 86.1% must be performed by an RN, whereas the remaining 13.9% can be performed by a non-RN [20]. The British Association of Emergency Medicine also suggested a ratio of 80% to 20% for ED [7]. The Royal College of Nursing recommended a benchmark ward establishment skill mix ratio of 65% registered nurses to 35% healthcare assistants for a general acute ward [3]. A higher ratio of registered nurses was recommended for acute medical units [21]. In this study, the ratio of nurses may

further decrease if the assistants are also engaged in discharging patients and diet charting under guidance. The precise manpower attributable to this workload could not be measured in our study.

In this hospital, presently, there are no posts such as phlebotomists. However, it may be relatively easier to recruit contractual staff for the above activities in terms of operational and budgetary reasons than having to recruit full time equivalent regular staff nurses.

The greatest amount of workload was related to communication which required 20 FTE nurses despite a very conservative allotment of 10 min per patient. This was followed by securing IV access, discharge or transfer of patients and triaging in that order. In the practical setting in this ED, nurses wasted considerable time to locate patients in the ED due to the sheer volumes of patients on trolleys kept for observation in a high strung chaotic environment (approximately a floating population of 300 patients per day and their attendants) who may be awaiting further investigations to be done outside the ED. Availability of the number of nebulisers, infusion pumps etc was frequently insufficient to cater to the patients needs, leading to increase in waiting times and more crowding. These not too uncommon instances of chaos need to be streamlined to increase nurse productivity.

Due to high work demands, communication with patients and their attendants was limited which often led to complaints or grievances or violent outbursts among attendants of patients. Also, due to shortage of medical social workers (MSW), only those patients who were specifically referred to them were dealt by the MSW. This could be improved

by engaging the services of social work interns or students who would gain experience while simultaneously contributing to the ED. Communication specific workshops may be organised by the hospital administration for the nursing staff to improve their skills and cope with the workload.

5. Limitations

The results of this study cannot be generalised as the staffing requirement is driven by the quality and quantity of workload of a particular healthcare facility during a particular period of time. Since the patient volumes usually increase every succeeding year, nurse staffing may require periodic revisions. The availability of baseline WISN data may help to make subsequent revisions easier if the percentage changes in service statistics are made available. Staffing apart, the quality of nursing care needs to be addressed in order to improve outcomes.

6. Recommendations

Similar studies are required at different levels of the health system in order to generate data for ED staffing at a population level and to establish validity and reliability of the WISN tool.

7. Conclusion

Emergency Departments (ED) being inherently stressful [22], need to be appropriately staffed in order to assure satisfaction and improve outcomes for both patients and nurses. The appropriate number of staff needs to be judiciously determined as this has high financial implications.

The WISN tool is a simple, easy to use method that can prospectively measure direct and indirect nursing activities and translate workload into nursing full time equivalents for the ED. This method is also useful to identify activities that do not require nursing professional skills and prescribe the skill mix of staff as desired. Alternately, the tool may be used to expand the role of nursing and strategise staffing to enhance ED efficiency.

Ethical Statement

This research project was undertaken at the All India Institute of Medical Sciences, New Delhi with permission. No human subjects were recruited as part of the study sample. The unit of sampling was the type of nursing activity. All the authors confirm that this content has not been published or submitted for publication elsewhere. All the authors listed on this manuscript have equally contributed to the research paper and are all in agreement with the content of the manuscript.

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Declaration of Competing Interest

None.

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