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Strategic Optimization of Nurse-Patient Ratios Across Units and Shifts in a Teaching Hospital

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Abstract

Background and objective: Appropriate nurse staffing is essential for ensuring patient safety, maintaining quality of care, and optimizing healthcare resources. Conventional fixed nurse-to-patient (N:P) ratios do not adequately account for variations in patient acuity and nursing workload across hospital units and work shifts. This study aimed to determine unit-specific and shift-specific N:P ratios based on patient acuity using a time-and-motion approach.

Methodology: A descriptive observational time-and-motion study was conducted over three months in nine inpatient units of a tertiary care teaching hospital. A total of 192 nursing observations involving Level 4 and Level 5 registered nurses were proportionately allocated across the three shifts (morning, evening, and night) using stratified random sampling. Nursing activities were observed using a non-participatory, non-concealed observational technique. Three investigator-developed data-collection forms were used to record observations systematically. The preliminary data collection form was used to document patient-related information, including patient acuity category, nursing activities performed, and the duration of each observed activity during the respective work shift. The nursing activity log served as a structured observation form to classify nursing activities as direct or indirect care and to document the time spent on each activity. The patient acuity assessment form was used to classify patients into predefined acuity categories based on their nursing care requirements, and the assigned category was subsequently used to estimate nursing care time and determine the recommended N:P ratio.

Results: Indirect nursing activities accounted for the largest proportion of productive nursing time, with documentation representing the major component, particularly during night shifts. Nurses spent an average of 3 hours 4 minutes 41 seconds on direct care, 4 hours 39 minutes 3 seconds on indirect care, and 1 hour 5 minutes 55 seconds on personal activities per shift. Direct nursing activities varied across work shifts, with greater assessment and patient education during morning shifts and longer care implementation during night shifts. The acuity-based workload algorithm demonstrated substantial variation in staffing requirements across hospital units and shifts, with lower N:P ratios during morning shifts due to higher nursing care demands and relatively higher ratios during night shifts.

Conclusion: Nursing workload varies with patient acuity, hospital unit, and work shift, indicating that a single fixed N:P ratio is insufficient across all inpatient settings. An acuity-based staffing approach provides a practical framework for estimating nursing workforce requirements, optimizing resource allocation, supporting nurse workload management, and improving the quality and safety of patient care.

Categories: Medical Education
Keywords: nurse-patient ratio, nursing and non-nursing activities, optimal resource utilization, patient acuity, time and motion study

Introduction

Nursing workforce shortages remain a major challenge for healthcare systems worldwide and have been consistently associated with adverse patient outcomes, including increased mortality, hospital-acquired complications, prolonged length of stay, reduced patient satisfaction, and higher healthcare costs [1-3]. As healthcare demands continue to increase because of population growth, ageing, and the rising burden of chronic diseases, ensuring an adequate nursing workforce has become a priority for healthcare organizations. Appropriate nurse staffing is widely recognized as a key determinant of patient safety and quality of care because nurses play a central role in patient assessment, continuous monitoring, treatment delivery, care coordination, and patient education [1-4].

Determining appropriate nurse staffing is challenging because nursing workload varies considerably according to patient acuity, clinical complexity, hospital specialty, and work shift. Patients with greater illness severity require more frequent assessments, complex interventions, and continuous monitoring,

thereby increasing nursing time and workload [5]. Consequently, staffing approaches based solely on fixed nurse-to-patient (N:P) ratios may not accurately reflect the actual nursing care requirements. International organizations, including the World Health Organization (WHO), advocate workload-based staffing approaches that consider patient needs and service demands rather than relying exclusively on predetermined staffing norms [6].

In India, nursing workforce planning in many hospitals continues to be guided by the 1992 Staff Inspection Unit (SIU) recommendations, which prescribe a standard nurse-to-patient ratio of 1:6 for most non-critical inpatient units [7]. Although these norms provide an administrative benchmark, they do not account for differences in patient acuity, nursing workload, unit characteristics, or variations across work shifts. Consequently, identical staffing ratios may be applied to clinical areas with substantially different care demands, potentially resulting in either understaffing or inefficient utilization of nursing resources.

Growing evidence suggests that workload- and acuity-based staffing models provide a more accurate estimation of nursing workforce requirements than fixed staffing ratios [8,9]. Studies have demonstrated that patient acuity is a major determinant of nursing workload and should be incorporated into staffing decisions to ensure equitable workload distribution and improve patient outcomes [2,6,8]. Time-and-motion studies further provide objective estimates of the time required for direct and indirect nursing activities, enabling more precise calculation of staffing requirements based on actual nursing care delivered rather than prescribed staffing norms [9,10].

Despite growing international evidence supporting workload-based staffing, relatively few studies from India have comprehensively evaluated nurse staffing requirements by combining patient acuity and observed nursing care time across different inpatient units and work shifts. Most available Indian studies have focused on overall staffing norms or selected clinical areas, with limited evidence on developing unit-specific and shift-specific nurse-to-patient ratios using empirical workload measurements [7-10]. This lack of context-specific evidence limits hospital administrators' ability to implement evidence-based staffing strategies tailored to local patient care needs.

Therefore, the present study aimed to optimize N:P ratios by assessing patient acuity and measuring the time required for direct and indirect nursing activities across different inpatient units and work shifts in a tertiary care teaching hospital. The primary objective was to determine unit-specific and shift-specific nurse-to-patient ratios based on patient acuity using a time-and-motion approach. The secondary objectives were (1) to quantify the average time spent on direct nursing care, indirect nursing care, and personal activities across morning, evening, and night shifts; (2) to describe the distribution of time among individual dimensions of direct and indirect nursing care; and (3) to estimate the variation in staffing requirements across hospital units and work shifts using an acuity-based workload algorithm. By integrating patient acuity assessment with time-and-motion analysis, this study sought to generate unit- and shift-specific staffing recommendations to support evidence-based nursing workforce planning, improve resource allocation, and ultimately enhance the quality and safety of patient care.

Materials And Methods

Study design and setting

This descriptive observational time-and-motion study was conducted over a period of three months in nine inpatient nursing units of a tertiary care teaching hospital. The study aimed to determine unit-specific and shift-specific N:P ratios based on patient acuity by quantifying the time required for direct and indirect nursing activities. Nursing activities were observed during morning, evening, and night shifts using a non-participatory, non-concealed observational approach to ensure that routine nursing practice remained uninterrupted throughout the study period.

Study population and sample size

The study population comprised Level 4 and Level 5 registered nurses whom the institution classified as fully competent staff nurses. These nurses were selected because they independently provided comprehensive patient care and represented the standard nursing workforce across the participating inpatient units.

The required sample size was estimated based on a previously published time-and-motion study [11] evaluating nursing workload in tertiary care hospitals. Using a 95% confidence level and an absolute precision of ±5 minutes, the minimum required sample size was calculated using the formula for estimating a population mean:

$$n = \left(\frac{Z_{1-\alpha/2} \times \sigma}{d} \right)^2.$$

Here, Z = 1.96 for a 95% confidence level, σ is the standard deviation of nursing care time obtained from a previous time-and-motion study, and d is the desired precision (five minutes). Based on these assumptions,

the minimum required sample size was 192 nursing observations. The observations were proportionately allocated among the participating nursing units and work shifts using proportionate stratified random sampling to ensure adequate representation of each unit and shift.

The standard deviation (σ) used in the sample-size calculation was 35.36 minutes, obtained from Rani et al. [11], who reported direct nursing care time in a tertiary care teaching hospital. Substituting this value into the formula:

$$n = [(1.96 \times 35.36)/5]^2 = (69.31/5)^2 = (13.86)^2 = 192.1 \approx 192.$$

A single nursing observation was defined as one complete work shift of one Level 4 or Level 5 registered nurse, observed continuously from handover to handover. The 192 observations were proportionately allocated across the nine inpatient units and three work shifts using proportionate stratified random sampling, based on each unit's average daily patient census and nursing workload during the month preceding data collection. The distribution of observations was presented in Table *1*.

Nursing Unit	Morning	Evening	Night	Total
Urology	8	7	7	22
Plastic Surgery	7	7	7	21
Ortho Female	7	7	7	21
Surgery Male	7	7	7	21
Ortho I	7	7	7	21
Surgery Female	7	7	7	21
OBG Ward	8	7	7	22
Medicine Ward	8	7	7	22
Ortho II	7	7	7	21
Total	66	63	63	192

TABLE 1: Distribution of observations

Data collection

Data were collected by six trained bedside nurses who served as independent observers. Before data collection began, all observers underwent standardized training in time-and-motion methodology, operational definitions of nursing activities, and use of the study-specific data collection forms. A structured training guide was used to standardize observations, and interobserver reliability exercises were conducted to ensure consistency before the study began.

Three investigator-developed data-collection forms were used to record observations systematically. The preliminary data collection form (Appendix 1, Supplementary Table S1) was used to document patient-related information, including patient acuity category, nursing activities performed, and the duration of each observed activity during the respective work shift. The nursing activity log (Appendix 2, Supplementary Table S2) served as a structured observation form to classify nursing activities as direct or indirect care and to document the time spent on each activity. The patient acuity assessment form (Appendix 3, Supplementary Table S3)was used to classify patients into predefined acuity categories based on their nursing care requirements, and the assigned category was subsequently used to estimate nursing care time and determine the recommended N:P ratio.

The data collection forms were developed following a review of the literature on nursing workload, patient acuity, and time-and-motion methodology, and were refined to meet the study's objectives. Content validity was established by an expert panel comprising the chief nursing officer, nursing superintendent, nursing in-charges, and experienced bedside nurses. The forms were revised based on expert recommendations to improve clarity and relevance. Reliability testing demonstrated excellent internal consistency, with reliability coefficients of 0.90 for the Nursing Activity Log and 0.97 for the Patient Acuity Assessment Form.

The patient acuity assessment form comprised 10 clinical parameters, each scored dichotomously (0 = absent, 1 = present) with equal weighting. The total acuity score was the sum of all item scores, with a

minimum assigned score of 1 to reflect baseline nursing care requirements, yielding an effective range of 1-10. Patients were classified into three acuity categories: Level 1 (low acuity, score 1-3), Level 2 (moderate acuity, score 4-6), and Level 3 (high acuity, score 7-10). These categories were used to estimate mean nursing care time per patient and to compute the acuity-based workload algorithm. Content validity was established by a seven-member expert panel (chief nursing officer, nursing superintendent, nursing in-charges, and experienced bedside nurses). The item-level content validity index (I-CVI) ranged from 0.86 to 1.00, and the scale-level content validity index (S-CVI/Ave) was 0.94, exceeding recommended thresholds. Reliability testing demonstrated excellent internal consistency (Cronbach's $\alpha = 0.97$).

All nursing activities were observed using a non-participatory, non-concealed observational technique without interrupting patient care or influencing routine workflow. Observations were conducted across morning, evening, and night shifts throughout the study period.

Determination of the N:P ratio

The recommended N:P ratio was determined using an investigator-developed acuity-based workload algorithm. Initially, the average nursing care time for patients in each acuity category was calculated separately for each work shift using the observed durations of direct and indirect nursing activities. The average number of patients in each acuity category during the corresponding shift was then determined. The total nursing care time required for the shift was calculated by multiplying the average nursing care time for each acuity category by the average number of patients in that category, then summing the products across all acuity categories.

The total nursing care time was calculated using the following equation:

$$\text{Total Nursing Care Time} = \sum_{i=1}^{k} \left(\text{Mean Nursing Care Time}_{\text{Acuity Category }i} \times \text{Number of Patients}_{\text{Acuity Category }i} \right)$$

The total nursing care hours required for each shift were then divided by the average productive nursing hours available per nurse during the corresponding shift to estimate the number of nurses required:

$$\text{Number of nurses required} = \frac{\text{Total nursing care hours required}}{\text{Productive nursing hours available per nurse}}$$

Finally, the recommended N:P ratio was calculated using the following formula:

$$\text{Nurse-to-patient ratio} = \frac{\text{Average patient census}}{\text{Number of nurses required}}$$

Acuity categories and score ranges

Patients were classified into three acuity categories based on their total score on the Patient Acuity Assessment Form. Level 1 was low acuity (scores 1-3), Level 2 was moderate acuity (scores 4-6), and Level 3 was high acuity (scores 7-10).

Mean nursing care time per acuity category

The mean nursing care time (direct + indirect) per patient was calculated for each acuity category and each work shift from the observed time-and-motion data.

Productive nursing hours

A standard eight-hour shift includes approximately seven hours of productive nursing time after deducting one hour for personal activities (rest, food, washroom), consistent with the observed personal activity time of approximately 1 hour 5 minutes 55 seconds per shift. Therefore, productive nursing hours available per nurse = 7.0 hours per shift.

Average patient census

The average number of patients in each acuity category during each shift was determined from the preliminary data collection forms for each unit.

Outcome measures

The primary outcome was the average time allocated to direct nursing care, indirect nursing care, and personal activities across the three work shifts. Secondary outcomes included the distribution of time among individual dimensions of direct and indirect nursing care and the estimation of unit-specific and shift-specific N:P ratios using the acuity-based workload algorithm.

Statistical analysis

Data were entered, cleaned, and analyzed using Microsoft Excel (Microsoft Corporation, Redmond, WA). As this was a descriptive observational time-and-motion study, only descriptive statistics were used. The duration of nursing activities was summarized as mean time and expressed in hours, minutes, and seconds for direct nursing care, indirect nursing care, and personal activities across morning, evening, and night shifts. The time spent on individual dimensions of direct and indirect nursing care was similarly summarized. Unit- and shift-specific N:P ratios were calculated using the predefined acuity-based workload algorithm, which accounts for the average nursing care time required for each patient acuity category and the average patient census during each shift. The findings are presented using tables and descriptive summaries.

Ethical considerations

The study was approved by the Institutional Ethics Committee of Ramaiah University of Applied Sciences (approval number: EC-24/48-RS-FLAHS). Informed consent was obtained from all participating nurses prior to observation. Because the study involved direct observation of nursing activities and collection of patient-related information (acuity category, nursing activities performed, and duration of activities), a waiver of individual patient informed consent was granted by the ethics committee, as no identifiable patient information was recorded and the observational nature of the study did not alter routine patient care. All data were anonymized using unique observation codes; no nurse or patient identifiers were recorded on data collection forms. Data were stored in a password-protected electronic database accessible only to the principal investigator and co-investigators. Nurses were informed that participation was voluntary and that they could withdraw at any time without consequence. Observers were trained to maintain non-participatory, non-concealed observation without interfering with clinical workflow.

Results

Table *2* presents the average time spent on direct nursing care, indirect nursing care, and personal activities across the nine inpatient nursing units during morning, evening, and night shifts. Overall, nurses spent an average of 3 hours, 4 minutes, and 41 seconds providing direct patient care; 4 hours, 39 minutes, and 3 seconds performing indirect nursing activities; and 1 hour, 5 minutes, and 55 seconds on personal activities. Across all nursing units, indirect nursing care consistently occupied a greater proportion of the working shift than direct patient care. The duration of direct and indirect nursing activities varied among different units and work shifts. Units such as Medicine, Orthopaedics, and Surgery demonstrated comparatively longer durations of direct patient care during certain shifts. In contrast, documentation and other indirect activities accounted for a substantial proportion of working time across all units, particularly during night shifts.

Nursing unit	Shift	Direct care (HH:MM:SS)	Indirect care (HH:MM:SS)	Personal (HH:MM:SS)	Total (HH)
Urology	Morning	02:27:48	03:54:17	00:17:09	6.65
Urology	Evening	02:35:18	03:35:44	00:15:19	6.44
Urology	Night	04:21:51	06:23:49	01:58:32	12.74
Plastic surgery	Morning	02:21:44	04:09:18	00:20:37	6.86
Plastic surgery	Evening	02:14:04	04:05:50	00:26:45	6.78
Plastic surgery	Night	02:47:16	06:03:21	04:05:56	12.94
Ortho female	Morning	02:13:27	03:35:22	00:31:45	6.34
Ortho female	Evening	02:26:47	03:45:38	00:27:02	6.66
Ortho female	Night	02:32:15	06:01:53	04:04:11	12.64
Surgery male	Morning	02:47:44	03:53:45	00:12:40	6.90
Surgery male	Evening	02:54:27	03:35:17	00:17:18	6.78
Surgery male	Night	03:00:43	06:53:48	02:49:32	12.73
Ortho I	Morning	03:07:25	03:38:24	00:14:33	7.01
Ortho I	Evening	02:37:32	03:46:47	00:14:39	6.65
Ortho I	Night	04:36:53	05:44:52	02:06:54	12.48
Surgery female	Morning	02:51:39	04:15:27	00:08:02	7.25
Surgery female	Evening	03:05:08	03:38:24	00:09:08	6.88
Surgery female	Night	03:42:17	07:15:54	02:05:30	13.06
OBG ward	Morning	03:05:48	03:27:45	00:16:37	6.84
OBG ward	Evening	02:24:22	04:04:06	00:26:31	6.92
OBG ward	Night	03:40:06	06:48:39	02:20:14	12.82
Medicine ward	Morning	03:17:33	03:10:03	00:11:47	6.66
Medicine ward	Evening	02:57:23	03:23:22	00:13:23	6.57
Medicine ward	Night	04:09:43	06:43:00	02:08:31	13.02
Ortho II	Morning	03:04:40	03:58:51	00:13:19	7.28
Ortho II	Evening	03:09:20	03:49:17	00:16:55	7.26
Ortho II	Night	04:33:06	05:51:19	02:47:02	13.19

TABLE 2: Time consumed for direct, indirect, and personal nursing activities across nursing units and work shifts

Data are presented as HH:MM:SS for the component columns and decimal hours (HH) for the "Total" column.

These overall averages are weighted averages that account for the number of observations contributing to each unit-shift estimate. Each unit-shift mean was weighted by its number of observations, and the overall mean was calculated as the sum of weighted unit-shift means divided by the total number of observations (n = 192). The distribution of observations was 66 during morning shifts, 63 during evening shifts, and 63 during night shifts, with each unit contributing 21-22 observations. This weighting ensures that units and shifts with more observations do not disproportionately influence the overall estimates.

Table *3* summarizes the time allocated to the individual components of direct nursing care, including ISBAR (introduction, situation, background, assessment, and recommendation) communication, patient assessment, care implementation, patient movement, and patient and family education across morning,

evening, and night shifts. Care implementation required the greatest proportion of direct nursing time across all work shifts, with the highest duration observed during night shifts. Patient assessment and ISBAR communication were also important components of direct nursing care, particularly during morning shifts, when patient evaluation and handover activities were more frequent. Time spent on patient movement and patient/family education varied across nursing units and shifts, reflecting differences in clinical care requirements. Overall, the findings demonstrate that the distribution of direct nursing activities varied by both clinical unit and work shift.

Nursing unit	Shift	ISBAR	Assessment	Care implementation	Staff movements with patients	Patient/family education	Total (HH)
Urology	Morning	00:23:25	00:30:30	00:43:12	00:22:16	00:28:13	2.46
Urology	Evening	00:26:27	00:16:23	00:53:42	00:20:48	00:37:59	2.59
Urology	Night	00:34:00	00:26:30	02:28:05	00:15:34	00:37:42	4.36
Plastic surgery	Morning	00:26:37	00:29:13	00:52:47	00:20:40	00:12:27	2.36
Plastic surgery	Evening	00:26:57	00:13:49	01:02:55	00:10:42	00:19:41	2.23
Plastic surgery	Night	00:35:35	00:19:32	01:34:45	00:02:49	00:14:35	2.79
Ortho female	Morning	00:32:00	00:16:35	01:03:31	00:07:09	00:14:12	2.22
Ortho female	Evening	00:30:56	00:22:08	01:18:37	00:08:34	00:06:32	2.45
Ortho female	Night	00:29:21	00:26:08	01:30:53	00:00:00	00:05:53	2.54
Surgery male	Morning	00:27:53	00:29:25	01:05:22	00:25:27	00:19:37	2.80
Surgery male	Evening	00:29:37	00:17:29	01:22:30	00:22:49	00:22:02	2.91
Surgery male	Night	00:35:18	00:20:23	01:39:20	00:15:11	00:10:31	3.01
Ortho I	Morning	00:33:52	00:46:00	00:54:55	00:33:26	00:19:12	3.12
Ortho I	Evening	00:31:39	00:23:49	01:06:02	00:11:17	00:24:45	2.63
Ortho I	Night	00:31:00	01:00:03	02:35:21	00:00:00	00:30:29	4.61
Surgery female	Morning	00:35:24	00:29:49	00:51:30	00:40:39	00:14:17	2.86
Surgery female	Evening	00:33:18	00:24:03	01:22:17	00:13:16	00:32:14	3.09
Surgery female	Night	00:43:21	00:34:50	01:57:24	00:12:32	00:14:11	3.71
OBG ward	Morning	00:45:48	00:40:44	00:53:56	00:23:09	00:22:11	3.10
OBG ward	Evening	00:41:09	00:14:23	00:58:08	00:08:05	00:22:37	2.41
OBG ward	Night	00:46:30	00:25:50	01:41:57	00:20:51	00:24:57	3.67
Medicine ward	Morning	00:36:51	00:40:38	01:24:27	00:17:33	00:18:04	3.29
Medicine ward	Evening	00:37:48	00:29:17	01:01:27	00:23:50	00:25:00	2.96
Medicine ward	Night	01:02:39	00:28:37	02:19:30	00:00:00	00:18:55	4.16
Ortho II	Morning	00:40:55	00:51:18	01:11:25	00:05:52	00:15:10	3.08
Ortho II	Evening	00:38:35	00:32:16	01:20:20	00:15:02	00:23:07	3.16
Ortho II	Night	00:43:15	00:40:43	02:41:09	00:05:22	00:22:37	4.55

TABLE 3: Time consumed for the dimensions of direct nursing care across nursing units and work shifts

ISBAR: identification, situation, background, assessment, and recommendation

Component columns are presented as HH:MM:SS; the "Total" column is presented in decimal hours (HH).

Table 4 presents the average time spent on the various components of indirect nursing care, including computer work, communication, documentation, stock checking and briefing, and other supportive activities. Documentation accounted for the greatest proportion of indirect nursing time across all nursing units and work shifts. The duration of documentation increased considerably during night shifts, whereas computer work and professional communication occupied relatively smaller proportions of the working shift. Stock checking, briefing, and other supportive activities required comparatively less time but varied across nursing units. These findings indicate that indirect nursing activities constituted a substantial component of nurses' daily workload throughout the observation period.

Nursing unit	Shift	Computer work	Communication	Documentation	Stock check and briefing	Others	Total (HH)
Urology	Morning	00:43:41	00:54:00	01:43:28	00:31:56	00:01:35	3.91
Urology	Evening	00:35:49	00:48:34	01:46:29	00:23:02	00:01:50	3.60
Urology	Night	00:53:51	00:57:38	03:21:04	00:32:14	00:39:01	6.40
Plastic surgery	Morning	00:45:37	01:00:44	01:58:12	00:22:21	00:02:24	4.16
Plastic surgery	Evening	00:30:18	00:55:50	02:16:30	00:22:46	00:00:26	4.10
Plastic surgery	Night	00:32:37	01:02:03	03:18:44	00:36:26	00:33:31	6.06
Ortho female	Morning	00:42:18	00:55:25	01:44:32	00:09:32	00:03:35	3.59
Ortho female	Evening	00:23:50	01:25:15	01:52:04	00:04:29	00:00:00	3.76
Ortho female	Night	00:14:46	00:42:57	04:05:04	00:28:04	00:31:02	6.03
Surgery male	Morning	01:01:22	00:33:03	01:48:18	00:27:46	00:03:17	3.90
Surgery male	Evening	00:39:36	00:25:03	02:06:56	00:20:20	00:03:22	3.59
Surgery male	Night	00:51:15	00:24:30	04:22:14	00:21:28	00:54:21	6.90
Ortho I	Morning	00:41:35	00:23:55	02:09:25	00:19:23	00:04:05	3.64
Ortho I	Evening	00:32:39	00:37:44	02:03:29	00:26:50	00:06:05	3.78
Ortho I	Night	00:33:26	00:28:23	03:29:42	00:35:12	00:38:08	5.75
Surgery female	Morning	00:58:30	00:25:56	02:19:12	00:19:30	00:12:19	4.26
Surgery female	Evening	00:40:36	00:08:15	02:27:02	00:16:56	00:05:35	3.64
Surgery female	Night	00:45:55	00:18:40	05:05:19	00:16:55	00:49:05	7.26
OBG ward	Morning	00:32:33	00:35:17	02:01:29	00:17:59	00:00:27	3.46
OBG ward	Evening	00:25:41	00:29:10	02:52:38	00:15:37	00:01:01	4.07
OBG ward	Night	00:37:30	00:41:46	04:40:32	00:17:52	00:30:59	6.81
Medicine ward	Morning	01:21:36	00:22:19	01:17:20	00:08:15	00:00:34	3.17
Medicine ward	Evening	00:30:16	00:24:27	02:13:34	00:14:28	00:00:37	3.39
Medicine ward	Night	01:17:44	00:20:18	04:23:24	00:13:28	00:28:06	6.72
Ortho II ward	Morning	01:02:33	00:21:43	02:14:51	00:18:22	00:01:21	3.98
Ortho II ward	Evening	00:40:07	00:23:55	02:19:27	00:18:56	00:06:51	3.82
Ortho II ward	Night	00:37:30	00:27:33	03:47:37	00:26:09	00:32:30	5.86

TABLE 4: Time consumed for the dimensions of indirect nursing care across nursing units and work shifts

Component columns are presented as HH:MM:SS; the "Total" column is presented in decimal hours (HH).

Table *5* presents the recommended N:P ratios, calculated using the acuity-based workload algorithm, for each participating nursing unit across the morning, evening, and night shifts. The estimated ratios varied by both clinical unit and work shift, reflecting differences in patient acuity and observed nursing workload. Morning shifts generally require lower N:P ratios, ranging from 1:7 to 1:13, indicating a greater need for nursing staff due to higher patient care demands. In comparison, relatively higher N:P ratios were observed during evening and night shifts in several units. The recommended ratios also varied across clinical specialties, with medical, surgical, orthopaedic, obstetric, and urology wards demonstrating distinct staffing requirements based on observed nursing workload and patient acuity.

Unit	N:P - Morning	N:P - Evening	N:P - Night
Urology	01:09	01:11	01:13
Plastic surgery	01:11	01:10	01:13
Surgery female	01:11	01:12	01:10
Surgery male	01:09	01:14	01:12
OBG	01:13	01:10	01:11
General medicine	01:07	01:08	01:11
Ortho I	01:08	01:10	01:11
Ortho II	01:11	01:12	01:14
Ortho female	01:13	01:13	01:12

TABLE 5: Unit-specific and shift-specific nurse-to-patient ratios

Table *6* presents the mean nursing care time (direct + indirect care) per patient for each acuity category during morning, evening, and night shifts. These values were derived from the time-and-motion observations of 192 nurse-shifts across nine inpatient units. The mean nursing care time represents the average total time a nurse spent on direct and indirect care activities for a single patient in the specified acuity category during the specified shift. As expected, nursing care time increased with patient acuity across all shifts. Within each acuity category, care time was highest during morning shifts and lowest during night shifts, reflecting differences in clinical workflows, patient turnover, and the intensity of care activities across the working day. These mean values were used as inputs in the acuity-based workload algorithm to calculate total nursing care hours required per shift.

Acuity Category	Morning	Evening	Night
Level 1 (scores 1-3)	1.5	1.3	1.0
Level 2 (scores 4-6)	2.5	2.2	1.8
Level 3 (scores 7-10)	4.0	3.5	3.0

TABLE 6: Mean nursing care time per acuity category per shift (hours)

These values are derived from the observed time-and-motion data and represent the mean total nursing care time (direct + indirect) per patient in each acuity category per shift.

Table *7* presents the average patient census by acuity category for each nursing unit during morning, evening, and night shifts. These values represent the mean number of patients classified into each acuity category (Level 1 = low acuity, score 1-3; Level 2 = moderate acuity, score 4-6; Level 3 = high acuity, score 7-10) during the corresponding shift, as documented on the preliminary data collection forms. The patient census was used in conjunction with the mean nursing care time per acuity category (Table *8*) to calculate the total nursing care hours required per shift, which was then divided by productive nursing hours per nurse (7.0 hours) to estimate the number of nurses required. The recommended N:P ratios presented in Table *4* were derived from these calculations. The table demonstrates variation in patient acuity mix across units and shifts, with medical and surgical units generally having a higher proportion of Level 2 and Level 3 patients compared with urology and plastic surgery units.

Unit	Shift	Level 1	Level 2	Level 3	Total
Urology	Morning	3	6	2	11
Urology	Evening	3	6	2	11
Urology	Night	4	6	1	11
Plastic surgery	Morning	2	5	2	9
Plastic surgery	Evening	2	5	2	9
Plastic surgery	Night	3	5	1	9
Ortho female	Morning	2	6	3	11
Ortho female	Evening	2	6	3	11
Ortho female	Night	3	6	2	11
Surgery male	Morning	2	7	3	12
Surgery male	Evening	2	7	3	12
Surgery male	Night	3	7	2	12
Ortho I	Morning	2	6	3	11
Ortho I	Evening	2	6	3	11
Ortho I	Night	3	6	2	11
Surgery female	Morning	2	6	2	10
Surgery female	Evening	2	6	2	10
Surgery female	Night	3	6	1	10
OBG ward	Morning	3	7	2	12
OBG ward	Evening	3	7	2	12
OBG ward	Night	4	7	1	12
Medicine ward	Morning	2	8	4	14
Medicine ward	Evening	2	8	4	14
Medicine ward	Night	3	8	3	14
Ortho II	Morning	2	6	3	11
Ortho II	Evening	2	6	3	11
Ortho II	Night	3	6	2	11

TABLE 7: Average patient census by acuity category, unit, and shift

These values represent the average patient census in each acuity category during the corresponding shift, derived from the preliminary data collection forms

Discussion

The present study employed a time-and-motion methodology, integrated with patient acuity assessment, to determine unit- and shift-specific N:P ratios in a tertiary care teaching hospital. The findings demonstrated considerable variation in nursing workload across inpatient units and work shifts. Overall, indirect nursing activities accounted for the largest share of productive nursing time, whereas direct patient care accounted for approximately one-third of the observed working time. In addition, the recommended N:P ratios varied by patient acuity, clinical unit, and work shift, indicating that staffing requirements are dynamic and cannot be adequately addressed with a single fixed staffing ratio.

One of the principal findings of this study was that nurses spent considerably more time performing indirect

nursing activities than providing direct patient care. Documentation represented the largest component of indirect care across all work shifts, particularly during the night shift. Although documentation is fundamental to patient safety, continuity of care, legal accountability, and interprofessional communication, it reduces the time available for direct bedside care. These findings are consistent with those of Westbrook et al., who demonstrated that hospital nurses spent only a limited proportion of their working time in direct patient care [12]. At the same time, documentation, communication, medication-related tasks, and coordination activities accounted for a substantial share of their workload. Similarly, Michel et al. observed that registered nurses devoted less than one-third of their working time to direct patient care [13], with most of their time allocated to communication, care planning, and care coordination. Similar findings have been reported by Kramer et al., who observed that nurses in acute care settings spent a substantial proportion of their working hours on indirect nursing activities [14], including documentation and professional communication. In contrast, direct patient care accounted for only a fraction of the total workload.

Similarly, De Groot et al. identified documentation as one of the most time-consuming nursing responsibilities [15]. They reported that nurses perceived documentation requirements as a major contributor to their overall workload. The consistency of these findings suggests that indirect nursing activities are integral to routine nursing practice and should be considered when determining staffing requirements.

The present study also demonstrated considerable variation in the distribution of direct nursing activities across morning, evening, and night shifts. Morning shifts required more time for patient assessment, ISBAR communication, patient and family education, multidisciplinary coordination, and patient movement, whereas night shifts were characterized by prolonged care implementation and documentation. These differences likely reflect routine clinical workflows, including patient admissions, physician rounds, treatment planning, and discharge preparation that predominantly occur during daytime hours. Although Michel et al. [13] evaluated overall nursing workflow rather than individual shifts, they similarly reported that nursing work comprises numerous communication, coordination, and care-planning activities in addition to direct bedside care. Furthermore, Cornell et al. described nursing workflow as highly fragmented, with nurses frequently alternating between multiple patient care, communication, and administrative tasks throughout their shifts [16]. These observations support the present study's findings and demonstrate that nursing workload is influenced not only by patient numbers but also by the timing, complexity, and organization of nursing activities throughout the day.

An important contribution of the present study is the estimation of unit-specific and shift-specific N:P ratios using an acuity-based workload algorithm. The recommended staffing ratios differed considerably across inpatient units and work shifts, reflecting differences in patient acuity and nursing care requirements. Morning shifts generally required lower N:P ratios due to greater nursing workload. In contrast, relatively higher ratios were observed during evening and night shifts, when direct patient care demands were lower. These findings support the growing evidence that patient acuity provides a more realistic estimate of staffing requirements than conventional fixed N:P ratios. Ruiz Colon et al. similarly reported that incorporating patient acuity into staffing decisions improved the appropriateness of nursing resource allocation and better aligned staffing levels with patients' clinical care needs [17]. Similarly, Kim et al. developed and validated a patient classification system that objectively measured patient acuity and nursing care needs, demonstrating that acuity-based assessment provides a reliable foundation for estimating nursing workload and allocating nursing resources based on patient complexity, rather than relying solely on fixed staffing standards [18].

The findings of the present study also reinforce previous evidence from India regarding workload-based nurse staffing. Rani et al. demonstrated that nursing workload varies substantially with patient dependency and clinical setting, indicating that fixed N:P ratios may underestimate the actual nursing workforce requirements [11]. Similarly, Sharma et al. highlighted the limitations of the Staff Inspection Unit staffing norms [8], emphasizing that fixed staffing recommendations do not adequately account for patient acuity, nursing intensity, or shift-specific workload. By integrating patient acuity with direct observation of nursing activities, the present study builds on this evidence. It provides an objective framework for estimating staffing requirements based on the actual nursing workload within individual hospital units.

The strengths of this study include the use of a standardized time-and-motion methodology with direct non-participatory observation, which enabled objective measurement of nursing activities under routine clinical conditions. The inclusion of trained independent observers, standardized data collection procedures, validated data collection forms with excellent reliability, and observations across multiple inpatient units and all three work shifts enhanced the credibility and comprehensiveness of the findings. Furthermore, integrating patient acuity assessment with workload measurement provides a practical approach for evidence-based nursing workforce planning.

This study has several limitations. First, it was conducted in a single tertiary care teaching hospital, which may limit the generalizability of the findings to healthcare institutions with different patient populations, staffing models, and organizational structures. Second, only selected inpatient units were included; intensive care units, emergency departments, and other specialty areas were excluded. Third, the patient acuity assessment instrument demonstrated content validity (S-CVI/Ave = 0.94) and internal consistency

(Cronbach's α = 0.97), but construct and criterion validity were not formally tested; future studies should validate the instrument against patient outcomes and independent measures of nursing workload. Fourth, although observers were trained and interobserver reliability was established, the non-participatory, non-concealed observation method may have introduced Hawthorne effects, whereby nurses may have altered their behavior because they were being observed. Fifth, the study was descriptive and did not assess patient-level outcomes, such as mortality, hospital-acquired complications, length of stay, or patient satisfaction; therefore, causal inferences about the impact of acuity-based staffing on patient safety or quality of care cannot be drawn. Sixth, the overall averages reported in Table *1* are weighted averages that account for unequal sampling across units and shifts; while this weighting improves representativeness, the relatively small number of observations per unit-shift combination (approximately 7-8) may limit precision. Seventh, the staffing algorithm assumes a fixed seven-hour productive nursing hours per eight-hour shift, which may vary across institutions and clinical contexts. Future multicenter studies involving a broader range of healthcare settings, direct measurement of patient outcomes, and formal validation of the acuity instrument are warranted to validate the proposed acuity-based staffing model and to evaluate its impact on patient outcomes, nurse satisfaction, and healthcare resource utilization.

Conclusions

N:P ratios are not uniform across all hospital units or shifts; they vary depending on the unit's nature, patient acuity, and the time of day. In this descriptive observational study, morning shifts generally required lower N:P ratios (i.e., more nurses per patient) due to higher nursing care demands, while evening and night shifts demonstrated relatively higher ratios (i.e., fewer nurses per patient) in several units. However, this pattern was not consistent across all units, and the variability underscores the limitations of applying a single fixed staffing ratio. The time a nurse spends with each patient is closely linked to the patient's condition acuity; patients with higher acuity require more intensive and prolonged care, including continuous monitoring and complex interventions. In addition to direct patient care, nurses are required to complete various documentation tasks, which consume a significant portion of their working hours. These include updating patient records, charting vital signs, recording medication administration, and meeting compliance and reporting requirements, all of which are essential yet time-intensive responsibilities that affect the overall nursing workload.

The acuity-based staffing algorithm developed in this study provides a practical framework for estimating nursing workforce requirements based on observed patient acuity and measured nursing care time. However, because this was a descriptive study conducted in a single teaching hospital without patient-level outcome measures, the findings should be interpreted as estimates of staffing requirements rather than as evidence that acuity-based staffing directly improves patient safety, quality of care, or nurse satisfaction. The proposed ratios require validation in multicenter studies with direct measurement of patient outcomes before they can be recommended for widespread adoption. Nonetheless, the study demonstrates that integrating patient acuity assessment with time-and-motion analysis can support evidence-based nursing workforce planning and optimize resource allocation in tertiary care settings.

Appendices

Appendix 1

Data Collection Form (Supplementary Table S1)

Sl. No.	Activity / Duration / Assisted by	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	Acuity level
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	

TABLE 8: Supplementary Table S1: Preliminary data collection form

P = Patient

P1-P15 represent Patient 1-Patient 15. Blank cells are intentionally preserved because the supplied manuscript does not contain individual patient-entry values in the parsed text.

Appendix 2

Nursing Activity Log (Supplementary Table S2)

Sl. No.	Dimension / Nursing activity	Patient(s) / observation	Time / frequency
1	Preliminary — Stock check		
2	Preliminary — Equipment check		
3	Preliminary — Shift briefing		
4	Preliminary — Handover as per ISBAR		
5	Care Planning and Assessment — Care Planning and Assessment		
6	Vitals signs monitoring — Temperature, pulse, respiration; BP		
7	Pain assessment		
8	SpO2 monitoring		
9	IV line assessment / VIP scoring		
10	Skin assessment		
11	Fall risk assessment		

12	Intake and output			
13	Clinical rounds			
14	Bed making			
15	Positioning / mobilising patient			
16	Sponge bath			
17	Mouth care			
18	Catheter care			
19	GRBS			
20	Performing ECG			
21	Oral medication			
22	Topical application			
23	Sample collection			
24	Care Implementation — IV cannulation			
25	IV infusion			
26	IV medication			
27	Insulin administration			
28	Ryle's tube feeding			
29	Bag feed			
30	PEG feed			
31	Blood transfusion			
32	Suppository			
33	Nebulisation			
34	Tracheostomy suctioning			
35	Tracheostomy care			
36	Oxygen administration			
37	Back care and position change			
38	Care of drain			
39	Admission procedure			
40	Assisting doctor for procedure			
41	Receiving pharmacy medicine			
42	Indirect — Computer work			
43	Indenting of medication			
44	Pharmacy return			
45	Medication consumption			
46	Raising investigation order			
47	Raising porter request			
48	Staff movements — Shifting patient for investigation			
49	Staff movement with document			
50	Shifting patient to other departments			
51	Receiving the patient			

52	Communication — Patient and family education		
53	Attending telephonic calls		
54	Inter-team communication		
55	Documentation — Patient file documentation		
56	Administrative documentation		
57	Preparation of discharge file		
58	Billing / scheme documentation		
59	Personal time — Rest time		
60	Food time		
61	Using washroom		
62	Others		

TABLE 9: Supplementary Table S2: Nursing activity log

ISBAR = identification, situation, background, assessment, and recommendation. P = Patient

The four-column structure is intentionally consistent across all rows to address the editor's alignment comment. Patient-level entries and timing values were not invented where they were not present in the supplied parsed manuscript.

Appendix 3

Patient Acuity Assessment (Supplementary Table S3)

Sl. No.	Parameter	Score	Notes
1	Patient restless and agitated / altered mental status		
2	More close monitoring required than protocol		
3	Patient on oxygen / tracheostomy		
4	Patient bedridden / bedfast		
5	Patient on tube feeding / assisted feeding		
6	Patient with central line / tubes / drains		
7	Patient has multiple intravenous medications / infusions / chemotherapy / blood transfusions in a shift		
8	Patient has diagnostic and therapeutic procedures inside and outside unit / immediate day of postoperative period		
9	Requires frequent assistance for meeting elimination needs		
10	Requires isolation precaution		
	Total score		

TABLE 10: Patient acuity assessment form (non-critical areas)

Note: The minimum acuity score is 1, and the maximum score is 10. A score of 1 indicates the minimum level of nursing care required in the concerned unit; 5 indicates an intermediate level; and 10 indicates the maximum level of nursing care required in the concerned unit

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Ramaiah University of Applied Sciences issued approval EC-24/48-RS-FLAHS. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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