



A STUDY ON UTILIZATION OF ICU BEDS IN A TERTIARY CARE TEACHING HOSPITAL

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Abstract : Background: Efficient allocation and use of intensive care unit (ICU) beds are critical to patient outcomes, staff workload, and hospital performance. Understanding core utilisation indicators helps prioritise operational improvements. Objective: To quantify average length of stay (ALOS), bed occupancy rate (BOR), bed turnover rate (BTOR), and bed turnover interval (BTOI) across Medical ICU (MICU), Surgical ICU (SICU), Neuro-Surgical ICU (NSICU), and Coronary Care Unit (CCU) in a tertiary care teaching hospital. Methods: Retrospective audit of ICU admissions and discharges over four months (January–April 2019) at JSS Tertiary Care Teaching Hospital, Mysore. Data were abstracted from unit records and the hospital information system. Standard operational definitions were used: ALOS (cumulative inpatient days/number of admissions), BOR (cumulative inpatient days $\times 100 / [\text{ICU beds} \times 365]$), BTOR (admissions/ICU beds), BTOI $((365 - \text{ALOS}) / \text{BTOR})$. Weighted ALOS was calculated using monthly admissions as weights. Results: Total admissions over the study period were MICU 555, SICU 250, NSICU 138, and CCU 374. Weighted ALOS was highest in NSICU (3.65 days), followed by SICU (2.60), MICU (1.75), and CCU (1.38). Month-wise BOR ranged widely by unit (e.g., NSICU 19–77%, SICU 32–67%, MICU 44–59%, CCU 33–52%), with corresponding variations in BTOR and BTOI. Conclusions: ICU bed utilisation varied by unit type: NSICU demonstrated the longest stays and CCU the shortest. Targeted improvements—e.g., standardised discharge planning, infection prevention best practices, and early rehabilitation—could optimise throughput while maintaining safety.

Index Terms - Intensive Care Units, Bed Occupancy Rate, Average Length of Stay, Bed Turnover Rate, Bed Turnover Interval, Hospital Resource Utilisation, Critical Care Management, and Tertiary Care Hospital

I. INTRODUCTION

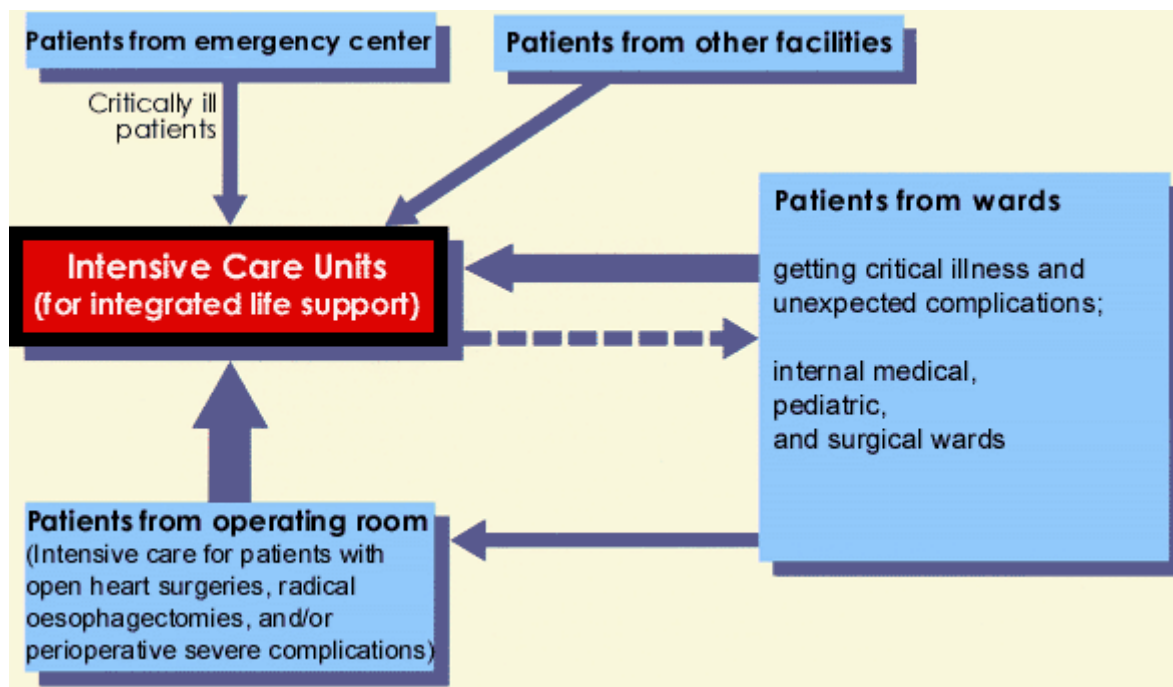
1.1 HealthCare

According to Cambridge dictionary of English “Health Care is the set of services provided by a country or an organization for the treatment of the physically and the mentally ill”⁽¹⁾ Healthcare in its important core is greatly known by a nation for the public good.⁽²⁾ Healthcare is a public right, and it is the responsibility of the government of a nation to offer this care to all to all people in equal measure⁽³⁾ Distributive justice in healthcare is an significant feature of the health system of a nation. The wealth of a nation depends on the health conditions prevailing in its structure. The economic health of a country depends first on the physical health of its people.⁽⁴⁾ Strategies such as Health for All and Millennium Development Goals proposed by WHO reflects the initiatives taken worldwide in the direction of the betterment of health situation prevailing in developing and underdeveloped countries. The notion of healthcare extends way further than the idea of medical care.⁽³⁾ consciousness regarding diseases and preventive medicines are now given priority over curative medicines, which is evident with the upcoming institutes like wellness clinics.

1.2 Healthcare System- Hospital and Role of Hospitals

According to World Health Organization “The hospital is an integral part of a social and medical organization, the function of which is to provide for the population complete healthcare, both curative and preventive, and whose out-patient services reach out to the family in its home environment; the hospital is also a centre for the training of health workers and for bio-social research”³⁸

Hospital is instrumental for care coordination and integration and it has a key role to play in supporting other health-care providers (including primary health care) and in community outreach and home-based services. It also frequently provides a setting for education of doctors, nurses, paramedical and other health-care professionals and it is a critical base for clinical research. They must be flexible and able to maintain high-level services in emergency situations. The hospital sector is not gigantic. The relative significance and operationalization of hospitals’ functions differ according to health-care delivery organizations and each hospital’s distinctive position in the system.³⁹

1.3 Role of ICU in HospitalFigure1:¹⁹ role of ICU in hospital(Source- https://www.jsicm.org/en/whats_e/role.htm)**1.4 What is an intensive care unit (ICU)?**

Intensive care refers to the dedicated treatment given to patients who are severely ill and require critical medical care.

An intensive care unit (ICU) provides critical care and life support to extremely ill and injured patients.

Unless patients are an emergency admission, they need a referral from their specialist to be admitted for ICU.

1.5 Who has cared in the ICU?

Patients might have planned admission following surgery, an unanticipated admission after an accident or be admitted for sudden and critical deterioration of their health.

ICU teams are made up of well-skilled intensive care doctors, nurses and specialists trained in providing critical care for patients with a mixture of medical, surgical and trauma conditions.

Some hospital ICUs focus on rendering care for particular health conditions including:

- Severe burns
- Respiratory failure
- Organ transplants
- Major trauma
- Complex spinal surgery
- Cardiothoracic surgery.

1.6 What to expect in ICU

All ICU in a hospital has a different setting that will replicate the specialist medical and surgical procedures they perform.

The majority of ICUs are large sterile areas with highly specialized, technical and monitoring equipment required to care for critically ill patients.

The ICU atmosphere can confront for some patients and visitors who may find the activity, sounds, machines, tubes, and monitors intimidating.

Normally ICUs have a higher ratio of doctors and nurses to patients¹⁸.

1.7 Utilization of Hospital Beds

Hospital bed utilization is influenced by different factors, which can be categorized into patient-related, physician-related, and administration-related issues. It might be argued that the causes of improper hospital bed utilization would be professed in a different way by the clinicians and the patients.⁵ The hospital bed management is very important task nowadays. Scarce healthcare resources require carefully made policies ensuring optimal bed allocation, quality healthcare service, and adequate financial support. This proposes a complete analysis of resource allocation in a greater than many hospital department by integrating in the same structure a queuing system, a compartmentalized model, and an evolutionary-based optimization.⁶ Proper utilization of hospital beds, decline of adverse occurrences and efficient use of healthcare resources can have a major impact on healthcare finance.⁷

1.8 Utilization of ICU Beds

Care of critically ill patients is an integral part of hospital care, but ICU beds are a limited resource in many hospital settings. How ICU beds are used to have implications for the care of individual patients, as well as resource use and costs at the hospital and regional level. Some aspects of ICU bed utilization may be specific to individual hospitals, but others are more generalized across hospitals and health care systems. This chapter reviews many of the factors that impact how ICU beds are used and then discusses potential approaches to optimizing their use.

1.9 Definition of an ICU bed

The lack of an agreed on definition of an ICU bed remains a barrier to understanding bed utilization. Some countries, such as the United Kingdom, have a clear definition, describing Level 3 care (ICU-level care) as patients receiving advanced respiratory support alone, or having a minimum of two organs supported. Many countries do not seem to have any definitions. In the United States, there are no standard definitions, but a proposed system of categorization broadly defined the highest level of care as including “sophisticated equipment, specialized nurses, and physicians with critical care training”. Across developed countries, the majority of ICU beds have the availability of mechanical ventilation and some form of renal support and other organ support. The meaning of an “ICU bed” in developing countries is much more questionable as it does not necessarily include resources to provide specific organ support. This chapter will discuss the use of ICU beds in systems, with the ability to provide mechanical ventilation and other basic organ support as part of intensive care.⁸

In India private hospitals contribute to majority of critical care beds, whereas only 10% of ICU beds contribute to the intensive care services in public hospitals that offer either free or subsidized services to its patients.⁹ While availing critical care services, more than half of the total healthcare bill is paid as out of pocket by patients or their families, thus getting exhausted with their savings. In the absence of comprehensive health insurance coverage, more than 80% of patients have to pay out of their pockets for healthcare services.¹⁰

The Objectives of the study are to:

1. To calculate the average length of stay of patients in ICUs - MICU, SICU, NSICU, and CCU.
2. To study the Bed occupancy Rate, Bed Turnover Rate and Turnover Interval of MICU, SICU, NSICU and, CCU patients.
3. To suggest recommendation, if any.

An intensive care unit is a designated area of a hospital provision that is devoted to the care of patients who are critically ill.¹¹ as well as who need constant medical attention. It consists of highly specialized equipment to support breathing, control bleeding, prevents shock and to control toxemia. The patients will come either from the recovery room of OT, from wards or from the admission section of hospital.¹²

These speciality units are planned, equipped and staffed to treat critically ill patients or to those who require specialized care and equipment. ICU has the capability of constant observation of vital functions of patients and can support their quick recovery.¹³ these functions can be done more promptly and efficiently than elsewhere in the hospital¹⁴. An intensive care unit is defined as “A specially staffed and equipped, separate section of a hospital dedicated to the observation, care and treatment of patients with liver complications, injuries or illnesses that are threatening from which there is a possibility of recovery”. It facilitates strangely extraordinary expertise and facilities supporting the vital functioning by utilizing skills of medical nursing along with other staff with experience in the management of such problems¹⁵

Many engineering services are required by this unit in the form of the controlled environment, medical gases, and compressed air and power sockets.

1.10 History of Critical Care Services in India

These services in critical care area have started very recently in India. Farokh E Udawadia, a physician certified with an international Pulmonologist training, had established respiratory care unit and coronary care units in 1970s.¹⁶ A group of trained and specialized individuals came forward and established the Indian Society of Critical Care Medicine (ISCCM) in 1992. Since Intensive Care services depend on technology, financial resources majorly drove them. For the same reason, since the commencement, establishment and maintenance of intensive care units has contributed to less than 10% of both community and district hospitals in

India.¹⁶ Vast numbers of private and corporate hospitals are better in providing intensive care services as compared to the public sector hospitals. ISCCM is organizing special training modules; certificate courses and also offering Post Doctoral Fellowship in Critical Care Medicine for training critical care professionals.¹⁶ still the quality of intensive care services and their performance has to be improved according to the standards prescribed.

1.11 Intensive monitoring is normally required in the following cases

- Cranial neurosurgery
- Head injuries with airway obstruction
- Intubated patients, including tracheostomy
- After surgery for major trauma
- Abdominal surgery
- Chest drain in the first 24 hours
- Ventilation difficulties
- Airway difficulties, potential or established: e.g. post thyroidectomy, removal of a large goitre
- Blood pressure, high or low
- Surgical sepsis
- Difficulties during anaesthesia or surgery, specially unexpected haemorrhage
- Hypothermia
- Hypoxia
- Neonates, after any surgery.¹⁷

1.12 Functions of ICU

Various functions of ICU are mentioned as follows:

1. Close monitoring and treatment of critically ill patients.
2. To provide treatment with centralized highly skilled manpower and specialized equipment.
3. Care for post surgical patients.
4. To render care for medical emergencies.
5. Coronary care units to render care for cardiac emergencies.
6. To provide Basic and Advance life support to critically ill patients.
7. Provide adequate monitoring of vital functions.¹²

1.13 Types of ICUs

Intensive care units are grouped into various types basing on level of patient care, functionality and according to the organizational structure.

On the basis of patient care

ICUs are divided into four categories according to the level of care provided to patients.

Category 1 ICU:

These types of ICUs provide advanced medical care, with 24 hours coverage by critical care medicine doctors.

Category 2 ICU:

They are basic medical intensive care units 24 hours in-hospital coverage by regular house officers.

Category 3 ICU:

This is an intensive nursing care unit with 24 hours coverage by registered trade nurses and at least, one doctor on call in the house.

Category 4 ICU:

They provides basic emergency services; no specific set up of ICU will be made²⁰

On the basis of functionality

Classification of ICUs can also be done on the basis of functionality/ specialty includes

- MICU- Medical Intensive Care Unit
- RICU- Respiratory Intensive Care Unit
- CCU- Coronary Intensive Care Unit
- SICU- Surgical Intensive Care Unit
- PICU- Paediatric Intensive Care Unit
- BICU- Burns Intensive Care Unit¹²

On the basis of organisational structure:

Classification can also be done on the basis of organisational structure²¹

1. Open Unit: All attending physicians may admit and care for their patients²²
However, triage decisions fall on the director of the ICU whenever there are bed or staff shortages.
2. Semi-Closed Unit: The directors of ICUs and/or associates must review and approve all admissions. However, they should take into account the appropriateness of care and staffing level. All final decisions are of administrators.
3. Closed Unit: The director and/or associates are responsible for all admissions and discharges. It is the critical team that decides on patient admissions.²² Once the patient is admitted, the unit team looks after them in collaboration with the admitting team for efficient patient care. A closed system of ICU is always preferred to open system of ICU which results in the better outcomes of morbidity, mortality in terms of gravity of disease and interventions used^{22, 34}. Also, a closed unit of ICU contributes to the better utilization of resources than an open unit³⁴.

An Intensive Care Unit being a crucial patient care area of the hospital needs standardized procedures to be in place for admissions and discharges. It should be viewed as a technologic treatment modality, and as such is a very expensive one. Criteria for admission into ICU include physiology of the patient requiring technologic intensive care nursing, with a reasonable life expectancy. Physician's assessment of patient condition is required to be referred for intensive care²³. Critically ill patients with potential for

recovery should be preferred for admission into ICU. Researchers have proved that admission of critically ill obstetric patients and adult patients have decreased the mortality rates^{24,25}. Patients should not be confined to ICUs unless there is some expectation of benefit as measured by patient value system. As such patients who are terminally ill do not belong to these units. As soon as it clear that the diagnosis is unpromising, the patient should be made as foundation for decision making rather than completely depending on clinical prognosis²⁶.

Admissions to ICU come from in-house transfer of patients along with referral cases to be admitted in to. Admission will be restricted and refused for possible reasons other than the severity of illness, such as shortage of beds and limited staffing²⁷. So there is an immense need for standard protocols to be in places while making rational decisions for admission as patients to ICUs.

An intensive care admission also comes from Emergency Departments, which were increasing at a greater rate than regular ED visits²⁸. A greater emphasis on ED-ICU interface and critical services in ED should be made reasonably available with direct communication channels to physicians for attending patients requiring emergency critical care^{28,29}. For the same reason, emergency departments have also started to establish the intensive care services, called as ED ICUs. However, emergency department intensive care units appear to be categorized for 'reduced benefit cases', providing palliative care as its prime service³⁰. Hospitals and health care administrators should formulate special policies to manage such patients

1.13 Utilization of ICU Beds

ICU depicts an independent hospital unit, which has an infrastructure made to accommodate sophisticated equipment, qualified nursing staff, and intensivists working round the clock to provide efficient services for the critically ill. As the prospects for survival in ICU are much greater than care in the general ward, resources should be allocated judiciously to benefit for critically ill³¹. The strength of a hospital/ICU is determined by the number of beds in possesses. As ICU services are high in demand globally, improving the quality of service, decreasing the average length of stay of patients, and proper utilization of ICU beds will lead to better utilization of ICU services³². ICU beds are scarce resources for which the demand often exceeds the supply. Many factors such as a sudden outbreak of diseases, the severity of illness and the need for specific treatment in these areas contribute to the shortage of ICU beds. Alternative locations should also be thought in advance to provide critical care services while encountering such situations.³³

Most critically ill patients require intensive care immediately and cannot be cared in other parts of the hospital³⁴. ICU resources are those that supply intensive care to critically ill, injured or physiologically unstable. Even though it is referred to as ICU beds which contain beds with the full complements of specialized staff and capacity for physiological monitoring and invasive diagnostic and therapeutic interventions. Health care professionals must act more efficiently in allocating ICU resources. In intensive care unit occupancy is regarded as a measure of resource use, unit activity, workload, and increasingly as a quality indicator.³⁵

ICU utilization includes various types of intensive care including psychiatric, trauma, burn, coronary, pulmonary, surgery and medical. Charges for a stay in hospital and treatment availed are obtainable for discharges with and without an ICU stay. Situation and procedures concerned with the high and low utilization of ICU services are submitted with the percentage of total hospital charges. Including that utilization of ICU is compared for conditions and procedures with complications and also without complications. Finally, the types of hospitals with high and low ICU utilization are presented³⁶.

The ICU performance indicators were the average length of stay, bed turnover, bed occupancy rate, and turnover interval, which were calculated with the following definitions and formulas.

The average length of stay (ALOS) in ICU: This measure refers to the average number of days that a patient is admitted in an ICU. It is calculated as:

$$ALOS = \frac{\text{cumulative inpatient days}}{\text{Number of admissions}}$$

Bed occupancy rate (BOR): This indicates the percentage of beds occupied by patients in a specified period, usually one year. It reflects the ratio between beds used and beds provided. It is calculated as³⁵:

$$BOR (\%) = \frac{\text{cumulative inpatient days}}{\text{Number of ICU beds} \times 365} \times 100$$

Bed turnover (BTOR): Bed turnover rate is a measure of the productivity of ICU beds and represents the number of patients per bed in a particular period of time, usually one year, and it is calculated as:

$$BTOR = \frac{\text{Number of admissions}}{\text{Number of ICU beds}}$$

Turnover interval (TI): This measure is related to Bed Turnover Rate. It measures the average time that beds are unoccupied between successive patient admissions, and this is calculated as:

$$TI = \frac{365 - ALOS}{BTOR}$$

Bed complement is the number of beds available for the admission of inpatients. It includes general ward beds, intensive care unit beds, special ward beds and isolation beds. Beds that are not normally available for full-time care are excluded from the bed complement. Such beds include recovery room beds, beds in the labour room, observation beds in the casualty and beds located in the diagnostic area. Hospital bed utilisation is the manner in which a certain community utilises the hospital beds. Hospital utilisation indices help in the proper allocation of hospital resources and the Formulation of better healthcare policies for hospitals.

In the current study, from among all the hospital bed utilisation indices, the bed occupancy rate has been calculated. The bed occupancy rate is an indicator that shows the actual utilisation of an inpatient health facility for a given time period. It is calculated based on the Midnight bed census at the hospital.

$$BOR = (\text{Daily average number of occupied beds}) / (\text{Bed complement}) * 100$$

Hospitals with bed occupancy levels above 85 per cent can expect to have regular bed shortages, which can increase the risk of problems such as infections, quality of care, overworked staff, staff unable to go on leave and the lack of effective care delivery. A bed shortage can result in cancellations of admissions for planned surgery, admission to inappropriate wards, and delay in admitting emergency patients and transfers of existing inpatients between wards, which will add a day to a patient's length of stay³⁷.

II METHOD AND METHODOLOGY

2.1 Study Location: The study was conducted at Tertiary Care Teaching Hospital, Mysore. **Study area:** The study was conducted in various ICUs like Medical intensive care unit (MICU), surgical intensive care unit (SICU), Neuro-surgical intensive care unit (NSICU) and Coronary care unit (CCU) of JSS Hospital.

2.2 Study period: Study was conducted for a period of 4 months.

2.3 Sample size: Patients admitted and discharged to and from MICU, SICU, NSICU and CCU during the period of 4 months was considered as the sample size for this study.

2.4 Data collection methods: A Retrospective study was conducted to assess the utilization of ICU beds in a tertiary care teaching hospital on the basis of past records. Records for the past 4 months were considered for collecting the data required for the study. The data was obtained from available records in MICU, SICU, NSICU and CCU and from the IT Department of the hospital for the past four months.

2.5 Methodology: To conduct the study about the utilisation of ICU beds in a tertiary care teaching Hospital, initial permission was obtained from the Director of the hospital, and also permission was taken from our co-guide, in charge of ICU department, to collect data from respective ICUs and from IT department of the hospital.

2.6 Instruments: Secondary data was collected from the respective ICUs and was computed and entered using formulas in MS-EXCEL. The data was analysed using the relevant formulae as applicable.

2.7 Limitations: This study was conducted in a Tertiary care teaching hospital for only 4 months

2.8 Inclusion and Exclusion Criteria: only patients who were admitted during between 4-month study period were considered, and the patients who were admitted before or after the study period as inpatients were not considered for this study.

III RESULTS and DISCUSSION

Table 1: Statistical analysis of ALOS, BOR, BTOR and BTOI of Patients in MICU from January to April

MICU	Total Patients	ALOS	BOR (%)	BTOR	BTOI
Jan	161	1.62	44.29	10.06	1.46
Feb	145	1.80	58.75	9.06	1.29
March	132	1.78	47.47	8.25	1.97
April	117	1.82	44.29	7.31	2.28

Figure 1: Graphical representation of Table 1

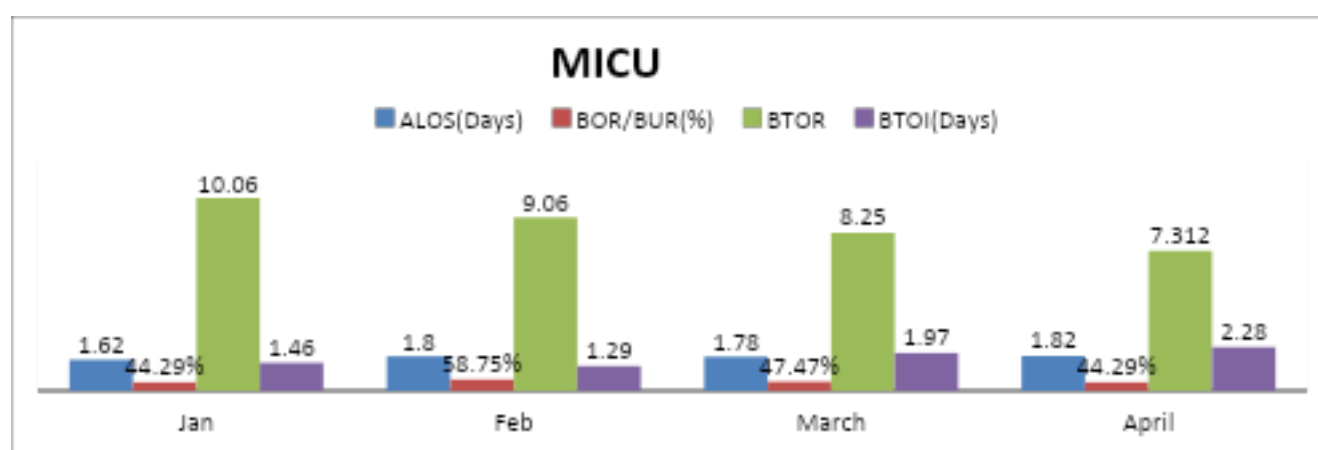


Table 1 and Figure 1 depict that;

- The total number of admissions and discharges to and from MICU in January was 161, in February 145, in March 132, and in April it was 117.
- The average length of stay of patients was highest in April, i.e. 1.82 days, whereas in February it was 1.80 days and in March it was 1.78 days, followed by January, 1.62 days.
- The bed occupancy rate of MICU was highest in February, i.e. 58.75%, whereas in March, it was 47.47%, and in January and April, it was 44.29%.
- The bed turnover rate in MICU was highest in January, i.e. 10.06, whereas in February it was 9.06 and in March it was 8.25, followed by April 7.31.

- The bed turnover interval in MICU was highest in April, i.e. 2.28 days; whereas in March it was 1.97 days, and in January it was 1.46 days, followed by February, 1.29 days.

Table 2: Statistical analysis of ALOS, BOR, BTOR and BTOI of Patients in SICU from January to April

SICU	Total number of patients	ALOS	BOR (%)	BTOR	BTOI
January	73	2.57	60.49%	7.8	1.4
February	60	3.14	67.29%	6	1.53
March	66	2.67	56.74%	6.6	2.03
April	51	1.91	32.48%	5.1	3.97

Figure 2: Graphical representation of Table 2

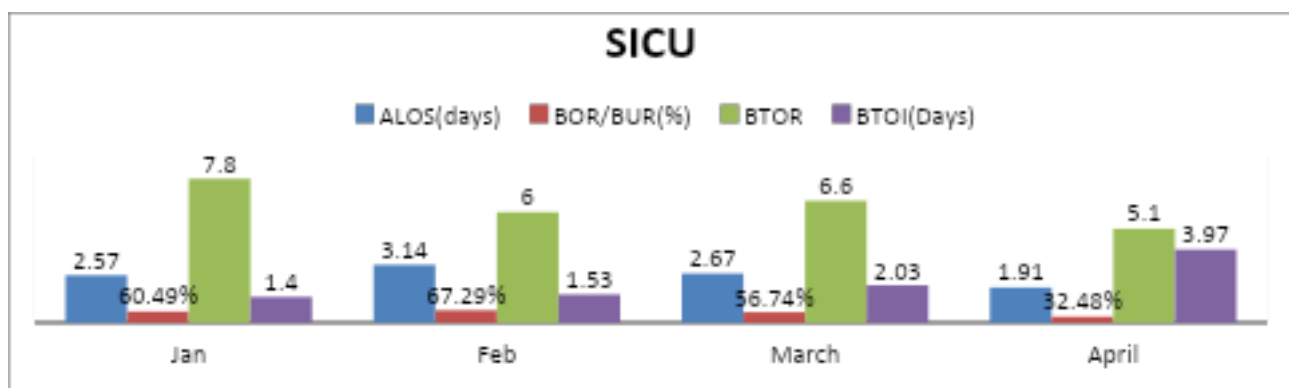


Table 2 and Figure 2 depict that.

- The total number of admissions and discharges to and from SICU in January was 73, in February 60, in March 66, and in April it was 51.
- The average length of stay of patients was highest in February, i.e. 3.14 days; whereas in March it was 2.67 days, and in January it was 2.57 days, followed by April, 1.91 days.
- The bed occupancy rate of SICU was highest in February, i.e. 67.29%, whereas in January it was 60.49%, and in March it was 56.74%, followed by April 32.48%.
- The bed turnover rate in SICU was highest in January, i.e. 7.8 whereas in March it was 6.6 and in February it was 6, followed by April, 5.1.
- The bed turnover interval in MICU was highest in April, i.e. 3.97 days; whereas in March it was 2.03 days and in February it was 1.53 days. The least was in the month of January, which was found to be 1.4 days.

Table 3: Statistical analysis of ALOS, BOR, BTOR and BTOI of Patients in NSCU from January to April

NSICU	Total Number of Patients	ALOS	BOR (%)	BTOR	BTOI
January	43	4.47	77.45%	5.37	1.3
February	33	3.31	48.79%	4.13	3.47
March	40	3.9	62.85%	5	2.3
April	22	2.1	19.22%	2.75	8.81

Figure 3: Graphical representation of Table 3.

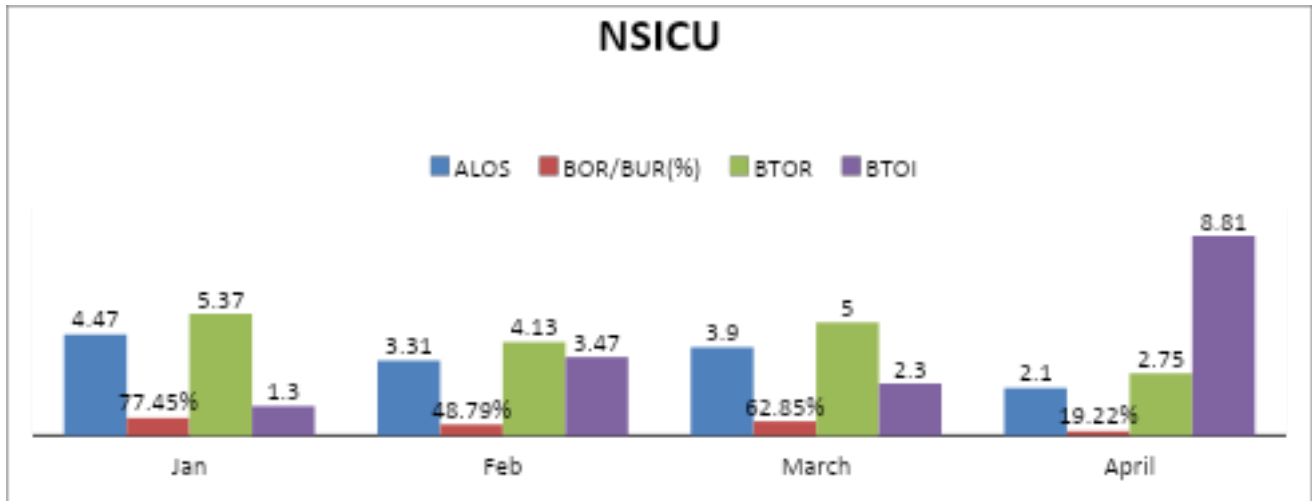


Table 3 and Figure 3 depict that.

- The total number of admissions and discharges to and from NSICU in January was 43, in February 33, in March 40, and in April it was 22.
- The average length of stay of patients was highest in January, i.e. 4.47 days, whereas in March it was 3.9 days and in February it was 3.31 days. The least was in the month of April, which was found to be 2.1 days.
- The bed occupancy rate of NSICU was highest in January, i.e. 77.45%, whereas in March it was 62.85%, and in February it was 48.79%. The lowest bed occupancy rate was in the month of April, which was found to be 19.22%.
- The bed turnover rate in NSICU was highest in January, i.e. 5.37, whereas in March it was 5, and in February it was 4.13. The least was in April, which was found to be 2.75.
- The bed turnover interval in NSICU was highest in April, i.e. 8.81 days; whereas in February it was 3.47 days and in March it was 2.3 days. The least was in the month of January, which was found to be 1.3 days.

Table 4: Statistical analysis of ALOS, BOR, BTOR and BTOI of Patients in CCU from January to April

CCU	Total number of Patients	ALOS	BOR (%)	BTOR	BTOI
January	118	1.51	52.30%	10.73	1.37
February	79	1.39	35.66%	187	2.51
March	102	1.17	34.94%	9.27	2.17
April	75	1.45	33.03%	6.81	2.95

Figure 4: Graphical representation of Table 4.

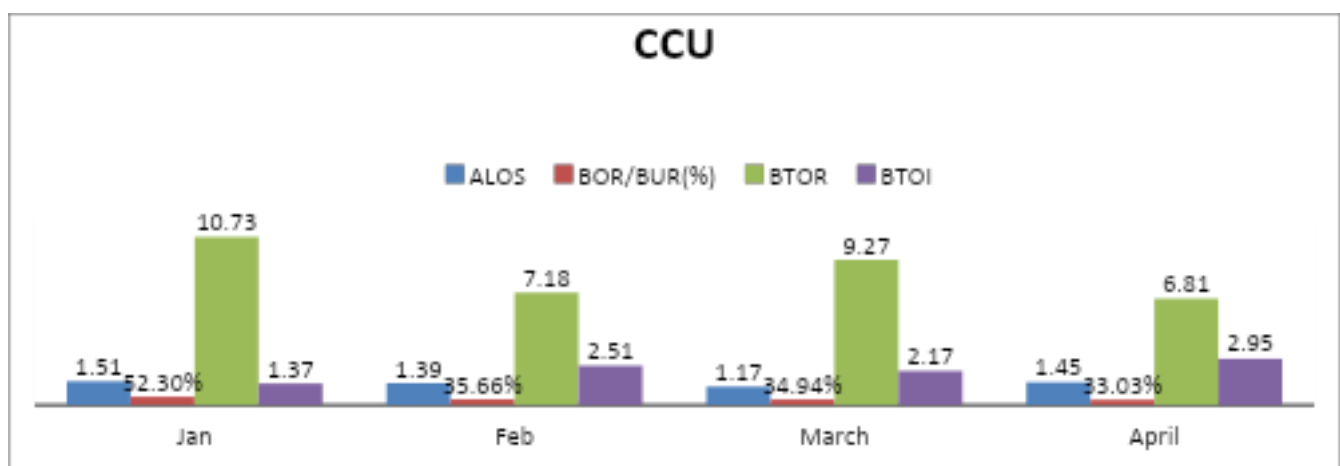


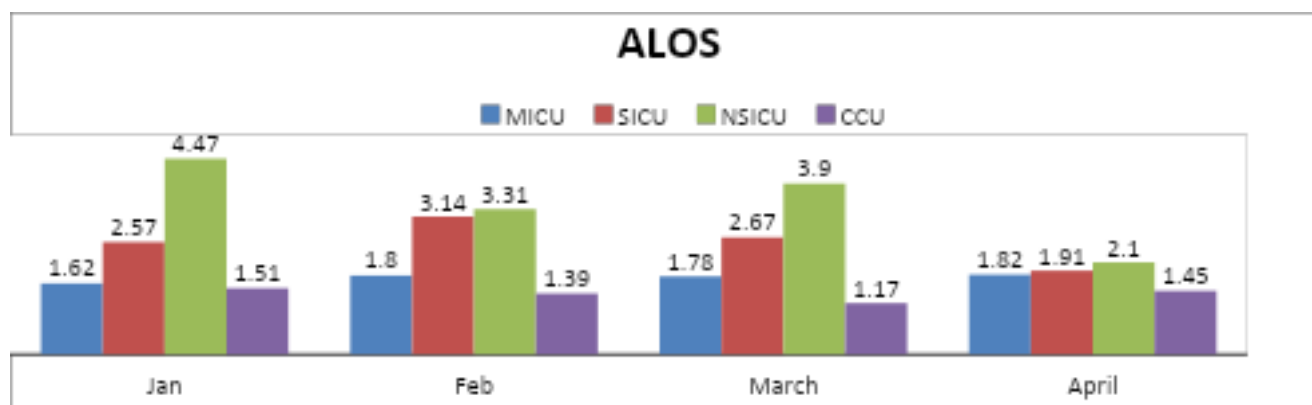
Table 4 and Figure 4 depict that.

- The total number of admissions and discharges to and from CCU in January was 118, in February 79, in March 102, and in April it was 75.
- The average length of stay of patients was highest in January, i.e. 1.51 days, whereas in April it was 1.45 days and in February it was 1.39 days. The least was in the month of March, which was found to be 1.17 days.
- The bed occupancy rate of CCU was highest in January, i.e. 52.30%, whereas in February it was 35.66%, and in March it was 34.94%. The lowest bed occupancy rate was recorded in April, at 33.03%.
- The bed turnover rate in CCU was highest in January, i.e.10.73, whereas in March it was 9.27 and in February it was 7.18. The least was in April, which was found to be 6.81.
- The bed turnover interval in CCU was highest in April, i.e. 2.95 days; whereas in February it was 2.51 days and in March it was 2.17 days. The least was in the month of January, which was found to be 1.37 days.

Table 5: Month-wise comparison of ALOS of Patients between MICU, SICU, NSICU, and CCU from Jan to April

ALOS	MICU	SICU	NSICU	CCU
January	1.62	2.57	4.47	1.51
February	1.8	3.14	3.31	1.39
March	1.78	2.67	3.9	1.17
April	1.82	1.91	2.1	1.45

Figure 5: Graphical representation of Table 5



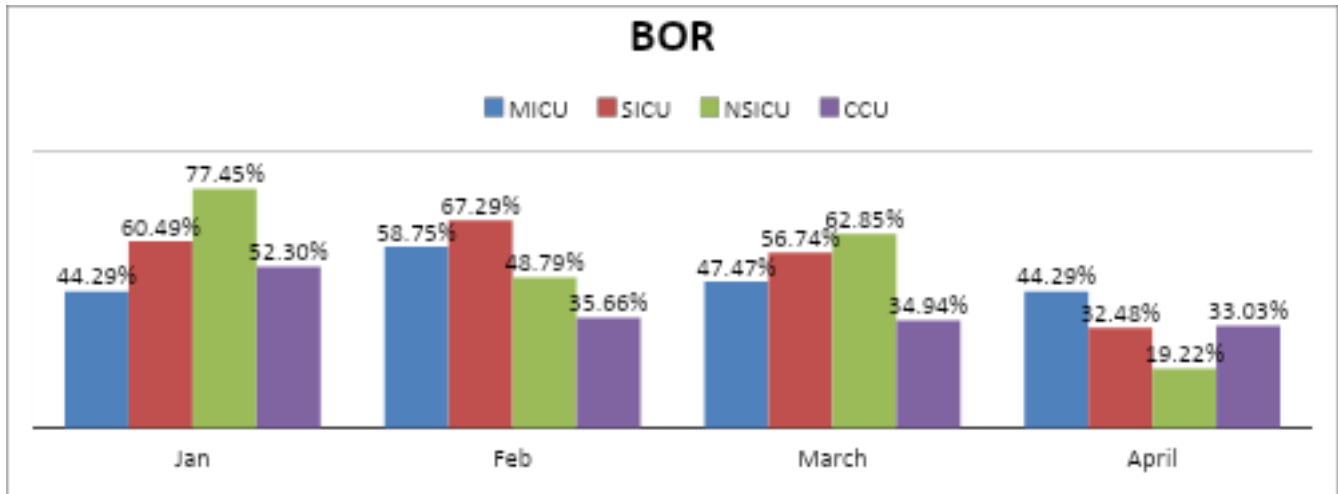
The above Table 5 and Figure 5 depict that.

- The average length of stay for January was found to be highest in NSICU, i.e. 4.47 days, followed by SICU- 2.57 days; MICU was 1.62 days and lastly CCU- 1.51 days.
- The average length of stay for February was found to be highest in NICU, i.e. 3.31 days, followed by SICU- 3.14 days, MICU- 1.8 days and lastly, CCU was 1.39 days.
- The average length of stay for March was found to be highest in NSICU, i.e. 3.9 days, SICU -2.67 days, MICU -1.78 days and lastly, CCU was 1.17 days.
- The average length of stay of patients for April was found to be highest in NSICU, i.e. 2.1 days, SICU, -1.91 days, MICU, -1.82 days and lastly, CCU was 1.45 days.\

Table 6: Month-wise comparison of BOR between MICU, SICU, NSICU and, CCU from January to April-19.

ALOS	MICU	SICU	NSICU	CCU
January	44.29%	60.49%	77.45%	52.30%
February	58.75%	67.29%	48.79%	35.66%
March	47.47%	56.74%	62.85%	34.94%
April	44.29%	32.48%	19.22%	33.03%

Figure 6: Graphical representation of Table 6



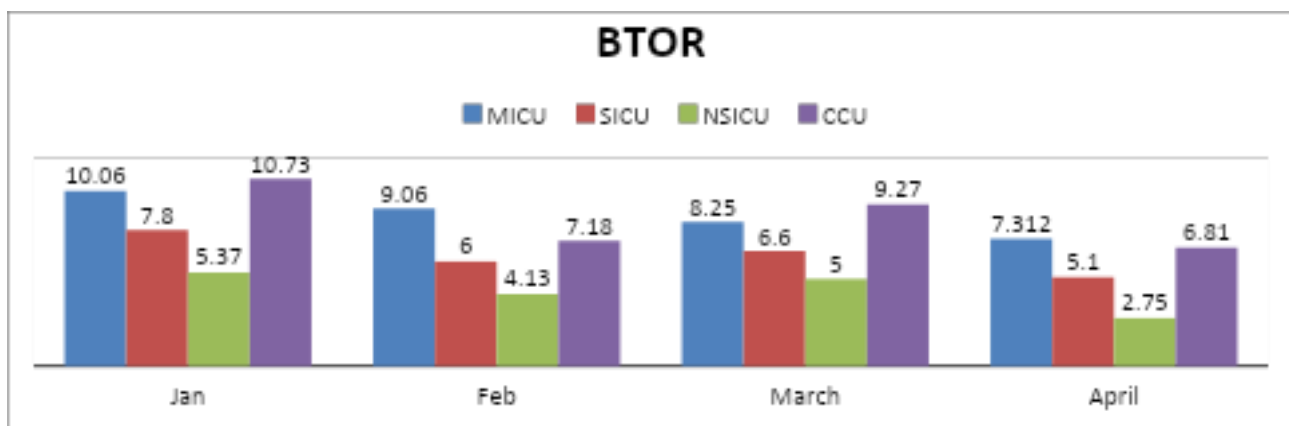
The above Table 6 and Figure 6 depict that.

- The Bed occupancy rate for January was found to be highest in NSICU, i.e. 77.45% followed by SICU-60.49%, CCU, 52.30% and lastly, MICU was 44.29%.
- The Bed occupancy rate for February was found to be highest in SICU, i.e. 67.29% followed by MICU-58.75%, NSICU, 48.79% and lastly, CCU was 35.66%
- The Bed occupancy rate for March was found to be highest in NSICU, i.e. 62.85%, SICU -56.74%, MICU -47.47% and lastly, CCU was 34.94%.
- The Bed occupancy rate for April was found to be highest in MICU, i.e. 44.29%, CCU -33.03%, SICU -32.48% and lastly, NSICU was 19.22%

Table 7: Month-wise comparison of BTOR between MICU, SICU, NSICU and CCU from January to April.

BTOR	MICU	SICU	NSICU	CCU
January	10.06	7.8	5.37	10.73
February	9.06	6	4.13	7.18
March	8.25	6.6	5	9.27
April	7.32	5.1	2.75	6.81

Figure 7: Graphical representation of Table 7.



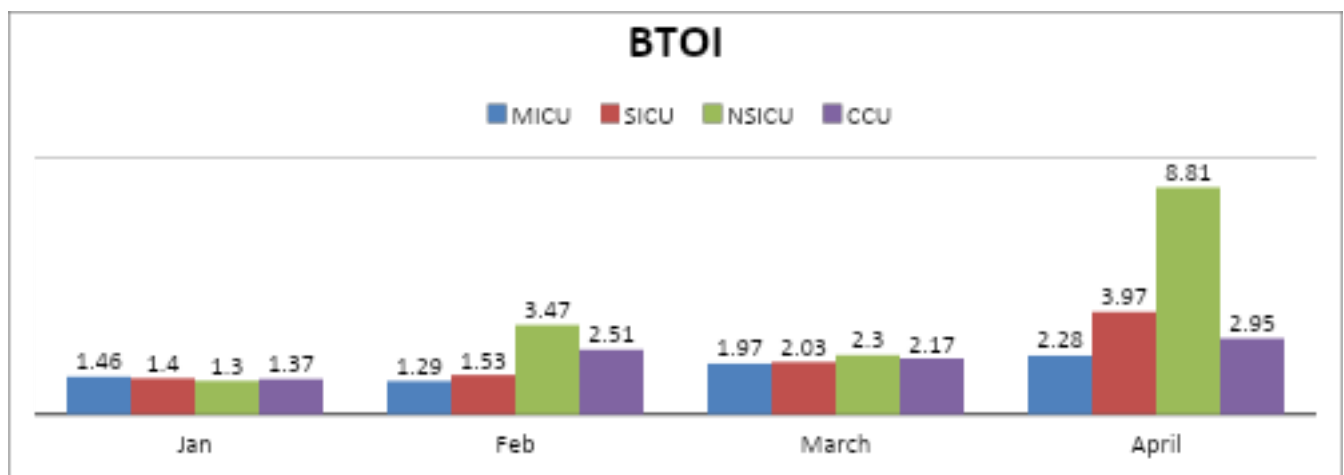
The above Table 7 and Figure 7 depict that.

- The Bed turnover rate for January was found to be highest in CCU, i.e. 10.73 days, followed by MICU-10.06 days, SICU, 6 days, and lastly, NSICU was 4.13 days.
- The Bed turnover rate for February was found to be highest in MICU i.e.9.06 days, CCU -7.18 days, SICU -6 days and lastly, NSICU was 4.13 days.
- The Bed turnover rate for the month of March was found to be highest in CCU, i.e. 9.27 days, followed by MICU-8.25 days, SICU, 6.6 days, and lastly NSICU was 5 days.
- The Bed turnover rate for the month of April was found to be highest in MICU i.e.7.32 days, CCU -6.81 days, SICU -5.1 days, and lastly NSICU was 2.75.

Table 8: Month-wise comparison of BTOI between MICU, SICU, NSICU and, CCU from January to April

BTOI	MICU	SICU	NSICU	CCU
Jan	1.46	1.4	1.3	1.37
Feb	1.29	1.53	3.47	2.51
March	1.97	2.03	2.3	2.17
April	2.28	3.97	8.81	2.95

Figure 8: Graphical representation of Table 8.



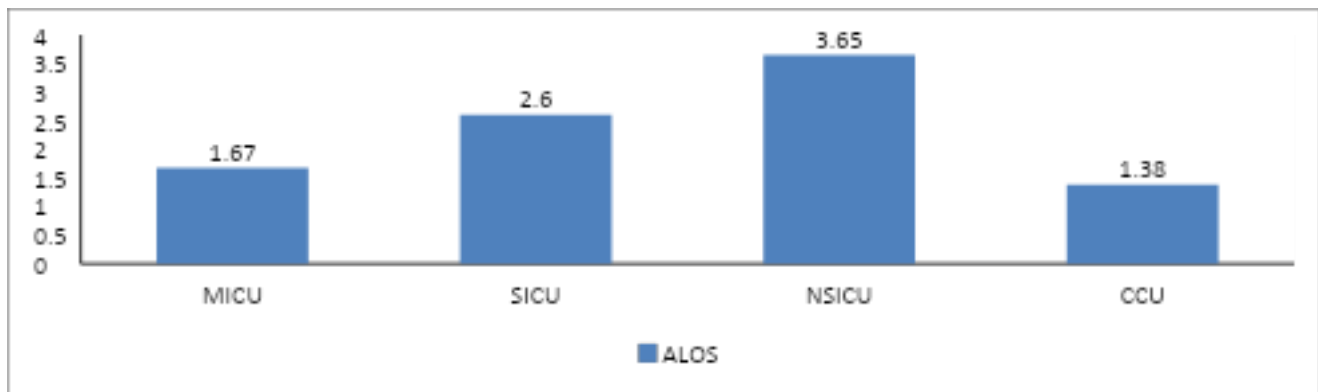
The above Table 8 and Figure 8 depict that;

- The Bed turnover interval for January was found to be highest in MICU, i.e. 1.46 days, followed by SICU-1.4 days, CCU-1.37 days and lastly, NSICU was 1.3 days.
- The Bed turnover interval for February was found to be highest in NSICU i.e., 3.47 days, CCU, -2.51 days, SICU, .153 days and lastly, MICU was 1.29 days.
- The Bed turnover interval for the month of March was found to be highest in CCU i.e.2.17 days, followed by NSICU-2.3 days, SICU, 2.03 days and lastly, MICU was 1.97 days.
- The Bed turnover interval for April was found to be highest in NSICU i.e.8.81 days, SICU -3.97 days, CCU -2.95 days and lastly, MICU was 2.28.

Table 9: Comparison of ALOS of patients between MICU, SICU, NSICU and, CCU total of all 4 months.

ICUs	MICU	SICU	NSICU	CCU
Total patients	555	250	138	374
ALOS	1.67	2.6	3.65	1.38

Figure 9: Graphical representation of Table 9.



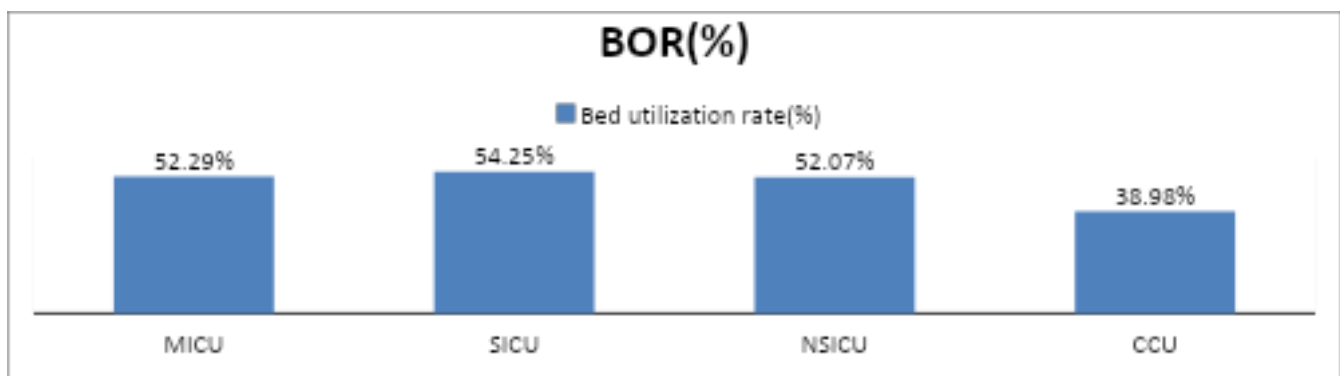
The above table 9 and figure 9 depict that,

- Admission and discharge to and from MICU were 555, in SICU were 250, in NSICU were 138 and lastly in CCU were 374 in 4 months (Jan to April).
- The average length of stay of the patient was found to be highest in NSICU, i.e. 3.65 days, followed by SICU- 2.6 days; MICU was 1.67 days and the least was found to be 1.38 days in CCU.

Table 10: Comparison of BOR of patients between MICU, SICU, NSICU and, CCU total of all 4 months.

ICUs	MICU	SICU	NSICU	CCU
Total patients	555	250	138	374
BOR	54.25%	52.29%	52.07%	38.98%

Figure 10: Graphical representation of Table 10



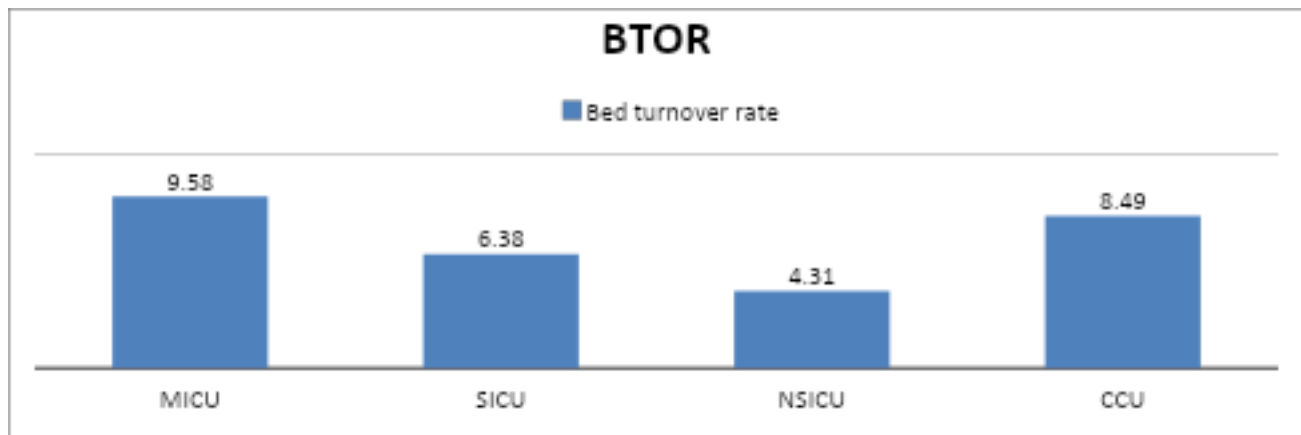
The above table 10 and figure 10 depict that,

- Admission and discharge to and from MICU were 555, in SICU were 250, in NSICU were 138 and lastly in CCU were 374 in 4 4-month time period (Jan to April).
- The bed occupancy rate of ICUs was found to be highest in SICU, i.e. 54.25% followed by MICU-52.29%; NSICU was 52.07% and the least was found to be 38.98% in CCU

Table 11: Comparison of BTOR between MICU, SICU, NSICU and, CCU total of all 4 months.

ICUs	MICU	SICU	NSICU	CCU
Total patients	555	250	138	374
BTOR	9.58	6.38	4.31	8.49

Figure11: Graphical representation of table 11.



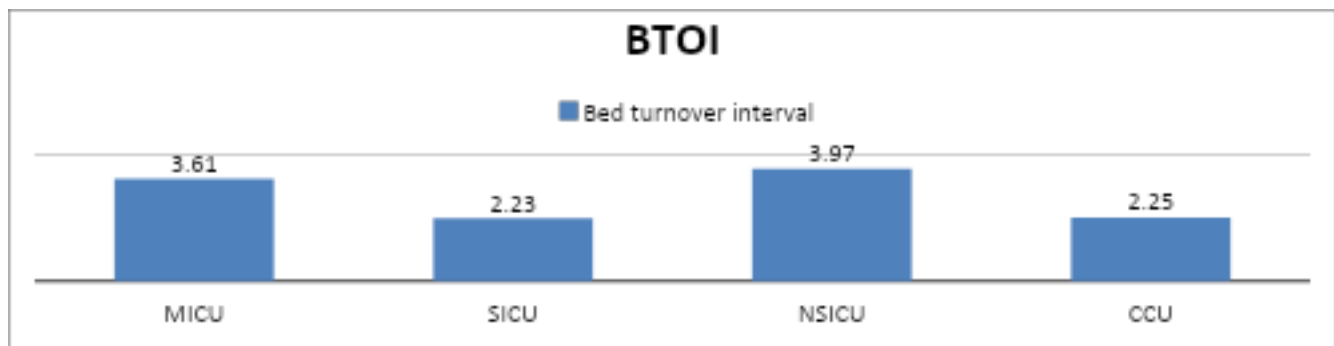
The above table 11 and figure 11 depict that,

- Admission and discharge to and from MICU were 555, in SICU were 250, in NSICU were 138 and lastly in CCU were 374 in 4 month time period (Jan to April).
- The bed turnover rate of ICUs was found to be highest in MICU i.e. 9.58 days followed by CCU-8.49 days; SICU was 6.38 days and least was found to be 4.31 days in NSICU.

Table 12: Comparison of BTOI between MICU, SICU, NSICU and CCU total of all 4 months.

ICUs	MICU	SICU	NSICU	CCU
Total patients	555	250	138	374
BTOI	3.61	2.23	3.97	2.25

Figure 12: Graphical representation of Table 12.



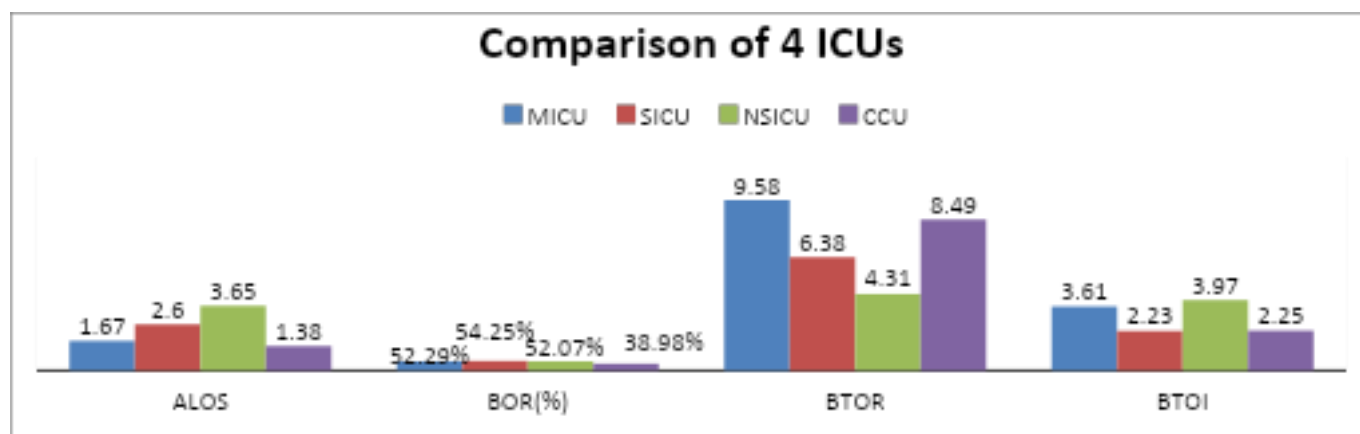
The above table 12 and figure 12 depict that,

- Admission and discharge to and from MICU were 555, in SICU were 250, in NSICU were 138 and lastly in CCU were 374 in 4 4-month time period (Jan to April).
- The bed turnover interval of ICUs was found to be highest in NSICU, i.e. 3.97 days, followed by MICU-3.61 days; CCU was 2.25 days and the least was found to be 2.23 days in NSICU.

Table 13: Comparison of ALOS, BOR, Bed turnover rate and Bed turnover interval in MICU, SICU, NSICU and CCU for the total 4 months

ICUs	Total Patients	ALOS	BOR (%)	BTOR	BTOI
MICU	555	1.62	52.29%	9.58	3.61
SICU	250	2.6	54.25%	6.38	2.23
NSICU	138	3.65	52.07%	4.31	3.97
CCU	374	1.38	38.98%	8.49	2.25

Figure 13: Graphical representation of table 13.



The above table 9 and figure 9 depict that,

- Admission and discharge to and from MICU were 555, in SICU were 250, in NSICU were 138 and lastly in CCU were 374 in 4 4-month time period (Jan to April).
- The average length of stay of patients was found to be highest in NSICU, i.e. 3.65 days, followed by SICU- 2.6 days; MICU was 1.67 days and the least was found to be 1.38 days in CCU.
- The bed occupancy rate of ICUs was found to be highest in SICU, i.e. 54.25% followed by MICU-52.29%; NSICU was 52.07% and the least was found to be 38.98% in CCU.
- The bed turnover interval of ICUs was found to be highest in NSICU, i.e. 3.97 days, followed by MICU-3.61 days; CCU was 2.25 days and the least was found to be 2.23 days in NSICU.

3.1 DISCUSSION

There is necessitating for optimizing an efficient allocation and use of costly ICU resources. Statistical indicators can advise issues for quality enhancement, further analysis and performance management. The first performance indicator of ICU bed utilization is the Average Length of Stay (ALOS) of patients. Prolonged ICU stay can negatively influence the health position by raising the risk of infection, difficulties and possibly mortality. It impacts upon the availability of ICU beds and it results in cancellation of voluntary surgeries, which leads to long waiting time. Patients with prolonged ICU stay acquire a major share of the ICU resources.³⁵

•Admission and discharge to and from MICU were 555, in SICU were 250, in NSICU were 138 and lastly in CCU were 374 in 4 month time period (Jan to April).

•The average length of stay of the patient was found to be highest in NSICU i.e. 3.65 days followed by SICU- 2.6 days; MICU was 1.67 days and least was found to be 1.38 days in CCU.

•On the whole, by considering all 4 months, ALOS in MICU in the current study was found to be 1.67 days. Earlier research shows an ALOS in a MICU as 3.08 days for 1 month (⁴⁰).

•On the whole, by considering all 4 months, ALOS in SICU in the current study was found to be 2.6 days. Earlier research shows an ALOS in an SICU as 6.37 days for 1 month. (⁴⁰).

•On the whole, by considering all 4 months, ALOS in NSICU in the current study was found to be 3.65 days. Earlier research shows an ALOS in an NSICU as 5.82 days for 1 month. (⁴⁰).

•On the whole, by considering all 4 months, ALOS in CCU in the current study was found to be 1.38 days. Earlier research shows an ALOS in a CCU as 1.23 days for 1 month. (⁴⁰).

•Among the 4 considered ICUs, NSICU has the highest average length of stay i.e. 3.65 days in the current study because most of the patients will be ventilated patients and the recovery time is more.

•The Average Length of Stay should be as less as possible but it differs from ICU to ICU depending upon the level of emergency, type of cases and criticality of illness. ALOS is being recommended to maintain around 5-6 days for efficient utilization of ICU.

A second performance indicator is the ICU bed occupancy rate (BOR). Currently, there is perfect evidence on what is the most favourable target for ICU occupancy or bed utilization rate. But there should be, still, it could be around 70–75%. This is based on the assertion that 100% occupancy is unattainable as the existing patient's discharge and succeeding admission of new patients is not immediate and it requires time for service and resetting of the bed space.³⁵

•The bed occupancy rate of ICUs was found to be highest in SICU i.e. 54.25% followed by MICU-52.29%; NSICU was 52.07% and least was found to be 38.98% in CCU. The average bed occupancy rate of all the 4 ICUs was 50% in the current study.

•On the whole, by considering all 4 months, the average bed occupancy rate of all 4 ICUs in the current study was found to be 50%. Earlier research shows a BOR in an ICU as 69.75% for 1 year³⁵. As the data in the current study was collected for only 4 months period, extending the time period to 8 more months would increase the Bed occupancy rate.

The increased occupancy rates will have a negative outcome on the patient and confine access to ICU services. High occupancy rates, mainly those above 80%, were seen to have a direct association with hospital and ICU mortality and readmission within 7 days of discharge.

The third performance indicator is bed turnover rate (BTOR) the speed with which patients on any ICU bed are rotated. Little BTOR would specify fewer people utilizing the hospital. Whereas, High in BTOR shows the result of increasing admission rates and also indicate that the hospital is performing at a high level of effectiveness concerning bed utilization.

•The bed turnover rate of ICUs was found to be highest in MICU i.e. 9.58 days followed by CCU-8.49 days; SICU was 6.38 days and least was found to be 4.31 days in NSICU. The average bed turnover rate of all the 4 ICUs was 7.19 days in the current study.

•On the whole, by considering all 4 months, the average bed turnover rate of all 4 ICUs in the current study was found to be 7.19 times for 4 months. Earlier research shows a BTOR in an ICU as 38.60 times for 1 year³⁵. As the data in the current study was collected for only 4 months period, extending the time period to 8 more months would increase the Bed turnover rate.

The fourth performance indicator is the bed turnover interval (BTOI). Quickly decreasing turnover intervals reflect the shortage of ICU beds.

•The bed turnover interval of ICUs was found to be highest in NSICU i.e. 3.97 days followed by MICU-3.61 days; CCU was 2.25 days and least was found to be 2.23 days in NSICU. The average bed turnover interval of all the 4 ICUs was 3 days in the current study.

•On the whole, by considering all 4 months, the average bed turnover interval of all 4 ICUs in the current study was found to be 3 days. Earlier research shows a BTOT in an ICU as 2.86 days for 1 year³⁵. As the data in the current study was collected for only 4 months period, extending the time period to 8 more months would increase the Bed turnover rate.

IV CONCLUSION

The current study has successfully analysed on Utilization of ICU Beds in the tertiary care teaching hospital. The Study result shows utilization of ICU beds, Average length of stay, Bed turnover rate and bed turnover interval that closely meets the International standards for hospitals (60-70%). Hence it can be considered that the hospital is following set standards in ICU administration aspects. Better improvements in ICU services can increase the effective utilization of ICU beds.

Limitation of the Study: Further study can be conducted by considering all the ICUs of the respective hospital and increasing the sample size from 4 months to one year for better results.

V SUMMARY

A Retrospective study was conducted to assess the utilization of ICU beds in tertiary care teaching hospital on the basis of past records. Records for past 5 months are considered for collecting the data required for the study. The data was obtained from available records in MICU, SICU, NSICU and CCU and from IT Department of the hospital for the past five months (January to April).

Secondary data was collected from respective ICU's and was computed and entered using formulas in MS-EXCEL. The data was analysed using the relevant formulae as applicable.

The following are the summary of this study.

- The total number of admission and discharge to and from MICU in the month of January was 161, in February 145, in March 132 and in April it was 117.
- The average length of stay of patients was highest in the month of April i.e. 1.82 days, Whereas in February month it was 1.80 days and in the month of March it was 1.78 days, followed by January 1.62 days.
- The bed occupancy rate of MICU was highest in the month of February i.e. 58.75%, whereas in the month of March it was 47.47%, and in the month of January and April it was 44.29%.
- The bed turnover rate in MICU was highest in the month of January i.e. 10.06 whereas in February month it was 9.06 and in the month of March it was 8.25, followed by April 7.31.
- The bed turnover interval in MICU was highest in the month of April i.e. 2.28 days; whereas in March month it was 1.97 days and in the month of January it was 1.46 days, followed by February 1.29 days.
- The total number of admission and discharge to and from SICU in the month of January was 73, in February 60, in March 66 and in month of April it was 51.
- The average length of stay of patients was highest in the month of February i.e. 3.14 days; whereas in March month it was 2.67 days and in the month of January it was 2.57 days, followed by April 1.91 days.
- The bed occupancy rate of SICU was highest in the month of February i.e. 67.29%, whereas in the month of January it was 60.49%, and in the month of March it was 56.74%, followed by April 32.48%.
- The bed turnover rate in SICU was highest in the month of January i.e. 7.8 whereas in March month it was 6.6 and in the month of February it was 6, followed by April 5.1.
- The bed turnover interval in MICU was highest in the month of April i.e. 3.97 days; whereas in March month it was 2.03 days and in the month of February it was 1.53 days. The least was in the month of January that was found to be 1.4 days.
- The total number of admission and discharge to and from NSICU in the month of January was 43, in February 33, in March 40, in April month it was 22.
- The average length of stay of patients was highest in the month of January i.e. 4.47 days, whereas in March month it was 3.9 days and in the month of February it was 3.31 days. The least was in the month of April that was found to be 2.1 days.
- The bed occupancy rate of NSICU was highest in the month of January i.e. 77.45%, whereas in the month of March it was 62.85%, and in the month of February it was 48.79%. The least bed occupancy rate was in the month of April it was found to be 19.22%.
- The bed turnover rate in NSICU was highest in the month of January i.e. 5.37, whereas in March month it was 5 and in the month of February it was 4.13. The least was in the month of April that was found to be 2.75.
- The bed turnover interval in NSICU was highest in the month of April i.e. 8.81 days; whereas in February month it was 3.47 days and in the month of March it was 2.3 days. The least was in the month of January that was found to be 1.3 days.
- The total number of admission and discharge to and from CCU in the month of January was 118, in February 79, in March 102 and in April it was 75.

- The average length of stay of patients was highest in the month of January i.e. 1.51 days, whereas in April month it was 1.45 days and in the month of February it was 1.39 days. The least was in the month of March that was found to be 1.17 days.
- The bed occupancy rate of CCU was highest in the month of January i.e. 52.30%, whereas in the month of February it was 35.66%, and in the month of March it was 34.94%. The least bed occupancy rate was in the month of April it was found to be 33.03%.
- The bed turnover rate in CCU was highest in the month of January i.e.10.73, whereas in March month it was 9.27 and in the month of February it was 7.18. The least was in the month of April that was found to be 6.81.
- The bed turnover interval in CCU was highest in the month of April i.e. 2.95 days; whereas in February month it was 2.51 days and in the month of March it was 2.17 days. The least was in the month of January that was found to be 1.37 days.
- The average length of stay for the month of January was found to be highest in NSICU i.e. 4.47 days followed by SICU- 2.57 days; MICU was 1.62 days and lastly CCU- 1.51 days.
- The average length of stay for the month of February was found to be highest in NICU i.e. 3.31 days followed by SICU- 3.14 days, MICU- 1.8 days and lastly CCU was 1.39 days.
- The average length of stay for the month of March was found to be highest in NSICU i.e. 3.9 days, SICU -2.67 days, MICU -1.78 days and lastly CCU was 1.17 days.
- The average length of stay of patients for the month of April was found to be highest in NSICU i.e. 2.1 days, SICU -1.91 days, MICU -1.82 days and lastly CCU was 1.45 days.
- The Bed occupancy rate for the month of January was found to be highest in NSICU i.e. 77.45% followed by SICU- 60.49%, CCU- 52.30% and lastly MICU was 44.29%.
- The Bed occupancy rate for the month of February was found to be highest in SICU i.e. 67.29% followed by MICU- 58.75%, NSICU- 48.79% and lastly CCU was 35.66%
- The Bed occupancy rate for the month of March was found to be highest in NSICU i.e.62.85%, SICU -56.74%, MICU - 47.47% and lastly CCU was 34.94%.
- The Bed occupancy rate for the month of April was found to be highest in MICU i.e.44.29%, CCU -33.03%, SICU - 32.48% and lastly NSICU was 19.22%.
- The Bed turnover rate for the month of January was found to be highest in CCU i.e. 10.73 days followed by MICU-10.06 days, SICU- 6 days and lastly NSICU was 4.13 days.
- The Bed turnover rate for the month of February was found to be highest in MICU i.e.9.06 days, CCU -7.18 days, SICU - .6 days and lastly NSICU was 4.13 days.
- The Bed turnover rate for the month of March was found to be highest in CCU i.e. 9.27 days followed by MICU-8.25 days, SICU- 6.6 days and lastly NSICU was 5 days.
- The Bed turnover rate for the month of April was found to be highest in MICU i.e.7.32 days, CCU -6.81 days, SICU -5.1 days and lastly NSICU was 2.75.
- The Bed turnover interval for the month of January was found to be highest in MICU i.e. 1.46 days followed by SICU-1.4 days, CCU- 1.37 days and lastly NSICU was 1.3 days.
- The Bed turnover interval for the month of February was found to be highest in NSICU i.e.3.47 days, CCU -2.51 days, SICU -1.53 days and lastly MICU was 1.29 days.
- The Bed turnover interval for the month of March was found to be highest in CCU i.e.2.17 days followed by NSICU-2.3 days, SICU- 2.03 days and lastly MICU was 1.97 days.
- The Bed turnover interval for the month of April was found to be highest in NSICU i.e.8.81 days, SICU -3.97 days, CCU -2.95 days and lastly MICU was 2.28.
- Admission and discharge to and from MICU were 555, in SICU were 250, in NSICU were 138 and lastly in CCU were 374 in 4 month time period (Jan to April).
- The average length of stay of patient was found to be highest in NSICU i.e. 3.65 days followed by SICU- 2.6 days; MICU was 1.67 days and least was found to be 1.38 days in CCU.
- The bed occupancy rate of ICUs was found to be highest in SICU i.e. 54.25% followed by MICU-52.29%; NSICU was 52.07% and least was found to be 38.98% in CCU.
- The bed turnover rate of ICUs was found to be highest in MICU i.e. 9.58 days followed by CCU-8.49 days; SICU was 6.38 days and least was found to be 4.31 days in NSICU.
- The bed turnover interval of ICUs was found to be highest in NSICU i.e. 3.97 days followed by MICU-3.61 days; CCU was 2.25 days and least was found to be 2.23 days in NSICU.

VI RECOMMENDATION

- Implementation of ICU service packages can increase new admissions to ICUs and it leads to good utilization of ICU beds.
- Implementation of ICU Health schemes can increase the new admission to ICUs and leads to good utilization of ICU beds.
- Extended period of study is likely to provide additional information pertaining to the current study.
- The average length of stay in ICU has direct impact on hospital associated infections. Hand hygiene in ICUs should be improved and staff should enhance their knowledge, attitude and practices of hand hygiene.
- Implementation of rehabilitation for breathing in ICU will help patients for speedy recovery without ventilator support and also can be shifted to wards in short period of time.

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