ASSESSING THE PATIENT CARE EXPENSES AND COST PER BED OF A MEDICAL INTENSIVE CARE UNIT (MICU) OF A TERTIARY CARE TEACHING HOSPITAL USING COST BLOCK METHOD

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ABSTRACT
Health care, an organized provision of medical care to individuals or a community, is one of the most important aspects of providing quality services to the needy individuals. Cost of healthcare depends on (a) Disease condition; (b) Coverage by insurance; (c) Medical service provider; and (d) Healthcare infrastructure. Patients in need of critical medical care and continuous monitoring by specialized staff are treated under specific areas of hospital called Intensive Care Units (ICUs), which have been known to consume ~34% of hospital budgets. The present study thus focuses on identifying major cost drivers of MICU of a tertiary care teaching hospital. The aim of the study is to identify various patient care expenses in MICU, find out various cost drivers that contribute to the running cost of MICU and compute the cost per bed. A cost block method of costing was applied in identifying the costs, and the annual cost of services were divided into per month and per day costs. The study found that the construction cost was the major cost drive with 50% contribution to the overall patient care expenses per day. Laboratory costs stood as the second major cost driver with 27% contribution. Running cost and cost per bed were reasonable when compared with the previous studies conducted on similar grounds.

Key words: Cost Block Method, Cost Per Bed, ICU Costing, Patient Care Expenses, Running Cost In ICU
1. INTRODUCTION

1.1. Healthcare

According to Oxford dictionary of English, “Healthcare is the organized provision of medical care provided to individuals or a community”. It not only merely includes medical care but also all aspects of pro preventive care. Healthcare in its essential core, is vastly recognized by a nation for public good (1). Healthcare is a public right, and it is the responsibility of government of a nation to provide this care to all people in equal measure(2). The economic health of a country depends first and foremost on the physical health of its people (3). Strategies such as Health for All and Millennium Development Goals proposed by WHO reflects the initiatives taken worldwide towards the betterment of health conditions prevailing in developing and under developed countries. The concept of healthcare extends way beyond the concept of medical care(2). Awareness about diseases and preventive medicines are now given priorities over curative medicines, which is evident with the establishment of healthcare institutes such as wellness clinics

1.2. Cost of Healthcare

Cost of healthcare depends on various modalities such as patients disease condition, coverage by insurance, medical service provider, healthcare infrastructure and institutional healthcare amenities provided to the patient(4). Distributive justice and quality in healthcare services are still finding its way difficult to reach a common man. There is still a clear distinction in rural urban division especially in terms of healthcare services. Also, the rising cost of these services, clearly make quality health unaffordable for an individual/family. According to WHO, 70% of Indians continue to pay out of pocket for their medical expense, still failing to get access to quality medicines and facilities. The National Sample Survey Office (NSSO) reports an increase of healthcare expenditure from 6.6% to 6.9% in rural India and 5.2% to 5.5% in urban areas during the period 2004-05 and 2011-12. Health Research Institute (HRI) estimates the medical costs to rise upto 6.8% in the current year from 6.5% in 2014 (5).

The healthcare spending per capita per annum in India was about $109, with total healthcare spending as 4.9% of the country’s GDP. The private sector contributes to the major portion with public sector spends to a mere $19 per capita per annum(4). Though Indian GDP contribution on healthcare in current scenario has increased than past, there are still lacunae in the system such as economic disparities, poor healthcare infrastructures, illiteracy and shortage of qualified medical professionals(6).

1.3. Healthcare – Hospitals and Role of Intensive Care Units

According to World Health Organization, 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 outpatients services reach out to the family and its home environment; the hospital is also a centre for the training of
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health workers and for biosocial research (7). Among various specialty units in the hospital, Intensive Care Units (ICUs) play vital roles in treating critically ill patients. An intensive care unit (ICU) is a specially staffed, specially equipped, separate section of a hospital dedicated to the observation, care and treatment of patients with life threatening illnesses, injuries or complications from which recovery is possible. It provides special expertise and facilities for the support of vital functions of patients and utilizes the skill of medical, nursing and other para-medical staff experienced in the management of patient care(8). In definition, Intensive Care Units (ICUs) are “specific area of the hospital where sophisticated monitoring, titrated life support, specific therapy and specialized nursing, can be best provided for potentially salvageable critically ill patients with life threatening illness or injury” (9).

1.4. Cost of intensive Care Services
India being a rapidly developing country dominated with lower middle-income group of population, intensive care services are expensive to be afforded and often a challenge to the socio-economic status of the population(10). Private hospitals in India contribute to majority of critical care beds, where as only 10% of ICU beds contribute to the intensive care services in public hospitals that offer either free or subsidized services to its patients(10). While availing critical care services, more than half of the total health care 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% patients have to pay out of their pockets for healthcare services (11). Intensive care services are not only critical to severely ill patients but also contribute largely to the bulk of medical care expenses. Critical care services are not only a burden on patient’s side but also consumes major chunk of hospital resources. It is an expensive area where intensive nursing and medical care are provided round the clock. Intensive care beds account for at least 10% of the hospital beds and 20-40% of all hospital costs. They may also consume 34% of hospital budgets (12). It contributes to a third of total inpatient costs(13). Costing of such critical care services identifies major factors that drive the costs and aids to implement control measures. Thus optimizing the hospital resources and cutting down patient care expenses. Therefore, it is important to study various aspects of ICUs for effective resource management and efficient patient care.

2. OBJECTIVES
The objectives of the study include:

- Assessing key factors that majorly influences the cost of service in Medical Intensive Care Unit (MICU)
- Computing the cost of patient care expenses and running cost
- Calculate cost per bed in MICU

3. METHODOLOGY
The study was conducted at 16-bedded MICU of a tertiary care hospital, Mysuru, Karnataka, after obtaining the consent from the concerned authorities
3.1. Data Collection
Data for the study was collected retrospectively by examining the hospital records from February 2014 to March 2015; and prospectively by personal interactions with the staff, between March 2015 and May 2015

3.2. Cost Block Method of Costing
By adopting Cost Block Methodology, costs associated with ICUs were divided into 6 major Cost Blocks (CB) such as CB1 - Equipment costs, CB2 - Construction and electricity costs, CB3 - Non-clinical expenses and salaries to non-clinical staff, CB4 - Clinical services, CB5 - Consumable costs and CB6 - Salaries of clinical staff (14). The costs were considered per year, which was further divided into per month and per day (running cost). The cost per bed is then computed by dividing the running cost by the total number of beds

4. RESULTS AND DISCUSSION
ICU areas of hospital are critical and expensive areas. Due to diverse case mix and intensive patient care requirements, costing of ICUs were often considered as a difficult task. In the current study, Cost Block Method of costing was adopted as formulated by Edbrooke, et al., 1999. According to the method, various costs involved in the ICU are identified under various heads as cost blocks. These cost blocks were then studied as per various expenses involved in the patient care.

4.1 Patient Care Expenses in MICU

![Pie chart showing patient care expenses in MICU](image)

**Figure 1** Comparison of patient care expenses in MICU

Figure 1 representing the intra-unit comparison of patient care expenses per day in MICU. According to the figure, major cost drive in patient care expenses in MICU was construction cost contributing to half of the total, as 50% of the charges. Laboratory expenses stood as next highest contributor towards MICU expenses with 27%. Staff salaries including clinical and non-clinical services were found to be the next cost drives with 7% contribution and electricity expenses with 6%, standing as
the third highest cost drive. Consumables including stores and drug supplies have contributed to 5% and radiology services with 4% contribution added up to patient care expenses per day in MICU. Equipment cost, Linen and CSSD expenses were negligible when compared to the other cost drives.

4.2. Equipment Cost: CB1
The advancements in medical field have a drastic impact on diagnostic and therapeutic procedures, there by physician becoming equipment oriented(15).Since ICU provides specialized care to critically ill patients, it is an equipment centric unit that consumes more resources. It is also been observed through previous studies that equipment costs contribute to two third and biggest contribution of the establishment cost(16). Cost containment strategies therefore should be kept in place in order to keep this consumption under control. Instead of procuring the equipments from other countries, encouraging the Indian medical device market would contribute significantly to the control of equipment costs. Re-using the instruments and components after proper sterilization also helps in decreasing the cost of care and maintaining optimum inventory(17). Involvement of critical care professional or intensivist in decisions of equipment purchase with his role clearly defined also contributes to the right selection of equipment. Thus leading to cost saving on purchasing substandard products(10). Other options for cost saving includes pool sharing of equipments among ICUs, hire or leasing of equipments rather than one time huge capital investments.

In the present study, major equipments identified in MICU were ventilators-8 (Maquet), cardiac monitors- 16 (Goldway), syringe pumps – 4 (Optimars) and infusion pumps – 4 (Optimars) along with alpha beds, nebulizers, defibrillators, ECG machines, and X-ray view box. A total of 98 equipments were found in MICU including cots, mattresses and cardiac tables. The total cost of equipments was computed as Rs. 8091000, by multiplying the total number of equipment with the unit cost of purchase. Depreciation of 10% is considered, where the cost less depreciation was Rs. 7281900. The unit cost of equipment is thus computed as Rs 74305, by proportionately dividing the total cost among all the equipments. A contribution of 6% equipment charges per day was shown in the study conducted by Edbrooke in 1999 (14). As the equipments in the current study were all brand new, annual maintenance contract was already included in the package, warranty is still operational and cost of repair was voided, resulting in lesser contribution to patient expenses per day when compared to other cost blocks (Fig., 1)

4.3. Estate and Electricity Costs: CB2
Estate cost includes cost of land, utilities, building and engineering, maintenance and decoration that are needed for the effective functioning of ICUs(14). In the present study, the total area of MICU was found to be as 5441.11Sq.ft. The cost of construction was 1.5 L per 100 Sq. ft, which includes civil, electrical and mechanical aspects of infrastructure. The total cost of constructing MICU was Rs. 81.61 lakhs per year and Rs. 22,671.29 per day, which is found to contribute 50% of patient care expenses per day, standing as the major cost drive (Fig., 1).

According to the previous studies, the minimum electricity requirements per hospital bed per day is 1KW (7). Since intensive care units are equipment dependent, they consume more electrical power for efficient monitoring of patients round the clock. Electricity consumption include the electrical equipment usage, lighting and
AHU. Total consumption of electricity by MICU is 18127 Watts/ Hour and per day consumption was 435.048 KW. Per hour electrical charges were 5.9 Rs/-. Total electricity charges per day in MICU were Rs. 2566.78, which included major consumption by AHU as 5500 VA. A power factor of 0.95 is considered for conversion of VA into Watts. Fig., 1 represents the electrical charges towards patient care expenses as 6% of the overall patient expenses per day.

4.4. Non-clinical expenses: CB3

Non-clinical services are the support services, which are not directly associated with the patient care, but assist the functioning of the diagnostic and therapeutic services. They play an indispensible role for efficient patient care services. The non-clinical services include linen and laundry, housekeeping, dietary services, central sterile supply services and administration expenses for staff other than wages. Since it is difficult to calculate the per unit cost of these services, the composite costs of these services are apportioned in proportion to the number of beds in respective ICUs(11).

In the current study, non-clinical expenses include linen cost, cost of CSSD (Central Sterile Supply Department) supplies and salaries paid to supporting staff. Total units of linen processed for MICU were 16217 in number during the study period. Cost per unit of linen was Rs.8/-, which included the cost of RO water, equipment maintenance and detergent costs. Total linen cost in MICU was Rs 1,29,736 per year and Rs 360.37 per day. The contribution of linen cost towards the patient care expenses per day was negligible as 1% in comparison to other expenses as represented in Fig., 1.

The cost to produce a medium sterile set was Rs. 57.00. The total sets issued from CSSD to MICU during the study period were 67, thus the total cost was Rs 347.18 per month and Rs.11.57 per day. Salaries of non-clinical staff include housekeeping, security and porters. Security person was posted round the clock in two shifts, housekeeping staff one per shift where as one porter per shift who provide services in common to MICU along with adjacent ICUs. Their salaries per day were calculated as Rs. 200, Rs. 400 and Rs. 200 respectively.

Fig., 1 represents the salaries of non-clinical staff contribute to 3% of the total patient care expenses per day in MICU. When compared amongst the participated ICUs the salaries of non-clinical staff were found to be similar. Edbrooke’s study shows a total of 7-8% of non-clinical charges were contributed towards per day cost of a 4-11 bedded ICU(14). The current study shows the cost of non-clinical services as 4% of the total cost of MICU per day in comparison with the other cost blocks (Fig., 1).

4.5. Clinical Expenses: CB4

Clinical support services are a set of patient care departmental services, which include laboratory, physiotherapy and radiology services. These support services individually provide collective patient care with the medical staff for better patient outcomes. These services are directly related in providing diagnostic and therapeutic services to patients but are not directly been provided by ICUs. Clinical expenses in the current study include cost of laboratory services and radiology expenses occurred from MICU.
Table 1: Laboratory Expenses of MICU

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Total investigations</th>
<th>Total cost (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemistry</td>
<td>7523</td>
<td>2408598</td>
</tr>
<tr>
<td>Microbiology</td>
<td>2747</td>
<td>1459240</td>
</tr>
<tr>
<td>Pathology</td>
<td>4218</td>
<td>656150</td>
</tr>
</tbody>
</table>

Figure 2 Total cost of laboratory investigations from MICU

According to Table 2, total of 14488 investigations are performed on MICU patients, which include biochemistry, microbiology and pathology services. Total cost of laboratory investigations were Rs 45,23,988 per year and Rs 12,566.63 per day. From Fig., 2, investigations from biochemistry laboratory were more when compared to microbiology and pathology. Fig., 1, shows that laboratory costs contribute to 27% of total cost of MICU per day, standing as the second most prominent cost drive.

Table 2: Radiology Expenses of MICU

<table>
<thead>
<tr>
<th>Radiology services</th>
<th>Total investigations</th>
<th>Total cost (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT scan</td>
<td>103</td>
<td>271760</td>
</tr>
<tr>
<td>MRI</td>
<td>20</td>
<td>77545</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>369</td>
<td>160560</td>
</tr>
<tr>
<td>X ray</td>
<td>1082</td>
<td>221060</td>
</tr>
</tbody>
</table>
According to Table 2, total cost of radiology services incurred from MICU was Rs. 7,30,925 per year and Rs. 2030.34 per day. Fig., 3, depicts the comparison between various radiology services and their cost. According to which, it is evident that more number of CT Scans were performed than X-ray, MRI and Ultrasound. Radiology services contribute to 4% of the total expenses of MICU per day (Fig., 1).

On the whole, this cost block is the second highest contributor with 31%, towards per day patient care expenses in MICU (Fig., 1). Studies show clinical support services make a total contribution of 7-9% of per day patient care expenses (11, 14). The percentage contribution towards laboratory charges was relatively very high in the present study. Repetition of investigations could be one of the reasons.

4.6. Cost of Consumables: CB5

This cost block includes cost of pharmaceuticals, blood and blood products, fluids and nutrition and disposables needed by patient care activities (14). In this study, consumables consists of drugs, store supplies that include disposables, stationary, cleaning and disinfecting materials which are supplied from the central stores and drug stores to MICU. Research conducted by Biswal (2006) has shown that among consumables, antibiotics account for more than 50% of the average expenditure on drugs (18). Study conducted by Edbrooke for two years shows that cost of consumables was found to be 21-24% approximately towards annual cost of ICU (14). Fig., 1 shows the consumables contribution as 5% of per day patient care expenses from MICU, which is relatively lower when compared to the previous studies. This is because drug costs from patient perspective were not considered, only the cost of emergency medicines used on MICU patients were included in medication costs. The total cost of consumables in MICU during the study period was Rs8, 13, 541.29 per year and Rs 2, 259.83 per day. Studies show that the average cost of consumables in a 15 bedded ICU per day were Rs. 1727.97 (19) which is reasonable with the current results.
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4.7. Salaries of Clinical Staff: CB6

<table>
<thead>
<tr>
<th>Nursing Staff</th>
<th>Total Number including Ward I/C</th>
<th>Salary of nursing personnel (Rs)</th>
<th>Salary of Ward I/C (Rs)</th>
<th>Total salary per day (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICU</td>
<td>20</td>
<td>19466</td>
<td>648.86</td>
<td>36960</td>
</tr>
<tr>
<td></td>
<td></td>
<td>238</td>
<td>36960</td>
<td>1232</td>
</tr>
</tbody>
</table>

Since intensive care is a labor-intensive area, specialized staff should be working round the clock. It was made evident by earlier researches at West, that manpower cost accounts about 50% of the total cost of ICU. Research shows that 62% of the ICU budget was consumed by staff cost in France; staff salary contributed to 55% of the running costs of NICU and daily expenditure on salary constituted to 37% of the total ICU cost and 86% of the fixed costs in a RICU. In spite of these figures, Indian intensive care is found to be still low because of the abundant human resource. In the present study, since the consultants were not paid per visit, consultation charges of doctors were not considered. Salaries of nurses and ward in-charges were only considered under this cost block. Fig., 1 represents the salary of clinical staff contributes to 4% of patient care expenses in MICU per day when compared to other cost drives. When salaries paid to clinical and non-clinical staff are combined, it makes a total contribution of 7% towards patient care expenses in MICU per day (Fig., 1). These percentage contributions are lesser when compared to the earlier studies discussed. Salaries of clinicians, not being considered in the current study could be a possible reason for lesser contribution.

4.8. Overview of Cost Blocks associated with MICU

Fig., 4 represents CB2 containing construction and electricity costs, as a major cost contributor towards patient care expenses in MICU. CB4 stands as the second major contributor, which includes cost of clinical services such as laboratory and radiology. Following the ranks is CB5, while CB3 and CB6 are standing with equal contribution towards per day expenses in MICU. CB1 consisting of equipment cost was the minor cost contributor, which is negligible among all the others.
4.9. Running Cost and Cost per bed in MICU

Table 4: Running cost and Cost per bed in MICU

<table>
<thead>
<tr>
<th>Cost Blocks (CB)</th>
<th>Categories of costs</th>
<th>Cost per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB1</td>
<td>Equipment cost</td>
<td>204.13</td>
</tr>
<tr>
<td>CB2</td>
<td>Construction cost</td>
<td>22675</td>
</tr>
<tr>
<td>CB2</td>
<td>Electricity</td>
<td>2566.78</td>
</tr>
<tr>
<td>CB3</td>
<td>CSSD</td>
<td>11.57</td>
</tr>
<tr>
<td>CB3</td>
<td>Linen</td>
<td>360.37</td>
</tr>
<tr>
<td>CB3</td>
<td>Salary of non-clinical</td>
<td>1266.66</td>
</tr>
<tr>
<td>CB4</td>
<td>Lab</td>
<td>12566.63</td>
</tr>
<tr>
<td>CB4</td>
<td>Radiology</td>
<td>2030.34</td>
</tr>
<tr>
<td>CB5</td>
<td>Consumables</td>
<td>2259.83</td>
</tr>
<tr>
<td>CB6</td>
<td>Staff salaries clinical</td>
<td>1880.86</td>
</tr>
<tr>
<td></td>
<td>Running cost</td>
<td>45822.17</td>
</tr>
<tr>
<td></td>
<td>Cost per bed</td>
<td>2863.886</td>
</tr>
</tbody>
</table>

Table 4 represents various costs involved with operations of MICU per day and Cost Block wise representation of costs. The running cost of MICU was found as Rs. 45,822.17, which is obtained by summing up all the per day expenses of MICU. Cost per bed was calculated as Rs. 2863.886, which is obtained by dividing the running cost by bed strength of MICU. Earlier studies conducted on similar grounds shows the running cost of ICU as Rs. 26076.74 (19). Another study shows that cost per day for a 8-bedded RICU was Rs. 10,364 (13), which could possibly increase when the increase in the bed strength. The results revealed from earlier studies shows that the running costs associated with respective ICUs are reasonably acceptable.

5. CONCLUSION

Intensive care areas, major resource consuming areas by their inherent nature, should be carefully managed for optimization of resources. Physician’s participation in financial terms of running an ICU should be encouraged to achieve the objective. The increasing financial demands placed upon healthcare systems dictate that clinicians need to allocate and utilize resources responsibly. Role of clinical and non-clinical staff cannot be considered in lighter vein, as they perform patient care activities after physician’s orders. Providing adequate education and training to staff in handling clinical services with financial figures in mind would ensure cost control practices throughout the hospital organization. In order to achieve this, accurate and comparable costing information is vital. Identifying its importance, an attempt was made in the current study to find out the patient care expenses per day, identify the cost drives in each ICU and to compute the running cost of each ICU.

6. STUDY LIMITATIONS AND FUTURE SCOPE

The study had identified the running costs associated with MICU, which are found to be in relevant with the earlier studies conducted on the same ground. The cost drives identified helps in formulation of cost control measures to reduce the cost of patient care. However, the following can be considered to further refine the study:

- Considering the pharmaceutical expenses from patient’s perspective can bring in the enhanced values of drug costs. Also, data related to cost of blood and blood products could be collected and added to consumables cost
- Consultation charges and salaries of consultants can be considered, to bring in a complete figure of MICU expenses
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- A comparative study among various ICUs can be conducted to identify the cost factors that play a prominent role in functioning critical care units

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