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Analysing the Relationship Between the Length of The Stay and Economic Burden in ICU Patients

Likhith N[1], Mohana G[1], Dr. Monalisa G[2], Dr. Mukesh Kumar Dharmalingam Jothinathan[3*], Dr. Suresh. S[4,5], Dr Suresh Babu SV[6]

[1]PhD Scholar - Saveetha Institute Of Medical And Technical Sciences (SIMATS - Deemed to be University), Chennai, Tamil Nadu, India.
[2]PhD Scholar - Sri Siddhartha Academy of Higher Education (SSAHE - Deemed to be University).
[3]Associate Professor, Centre for Global Health Research, Saveetha Institute Of Medical And Technical Sciences (SIMATS - Deemed to be University), Chennai, Tamil Nadu, India.
[4]Assistant Professor, Dept. of Medicine
[5]HOD and In-charge of Dept. of Cardiology, Shridevi Institute Of Medical Sciences & Research Hospital, Tumakuru, Karnataka, India.
[6]Research Co-ordinator, HOD & In-charge of Central Research Facility, Sri Siddhartha Academy of Higher Education (SSAHE - Deemed to be University), India.
Email: itsmemukesh@gmail.com

With a view towards finding crucial aspects impacting healthcare costs in critically sick patients, this study looks at the relationship between the length of stay (LOS) in intensive care units (ICUs) and the corresponding economic burden. ICUs are high-cost environments since they depend on modern technology, specialised personnel, and careful use of resources; LOS is therefore a main predictor of financial spending. Driven by additional procedures, extended use of medical devices, and increased risk of consequences, longer stays often result in mounting costs. Using a retroactive analysis of ICU patients, this paper looks at both direct costs—such as hospital charges, drugs, and procedural expenses—as well as indirect costs—such as carer load and loss of productivity. LOS and economic results were investigated using regression analysis and other statistical methods, so allowing mediating elements including comorbidities, degree of sickness, and demographic characteristics. LOS and total healthcare expenditure show a significant positive association with patient age, mechanical ventilation length, and underlying diseases clearly influencing cost variability. These findings underline the need of early discharge planning, application of step-down care units, and targeted interventions for high-risk patients in order to maximise ICU resource use. By means of systematic inefficiencies, the study provides useful guidance for doctors, legislators, and healthcare managers on reducing the financial burden of ICU treatment while maintaining patient outcomes. This paper adds evidence-based recommendations to increase financial sustainability in resource-intensive healthcare environments, so contributing to the greater knowledge of cost control in critical care settings.

Keywords: Intensive Care Unit (ICU), Length of Stay (LOS), Economic Burden, Healthcare Costs, Critical Care, Resource Utilization.

1. Introduction

Considered as a pillar of modern medicine, the Intensive Care Unit (ICU) provides life-saving treatments and specialist therapy for very unwell patients. But this level of focus is costly, so the ICU is among the most resource-intensive part of a medical system. Among the various factors affecting ICU costs, length of stay (LOS) is obviously one of the most crucial one. Extended ICU stays are defined as connected with greater healthcare expenditures by extended use of advanced medical technologies, specialist personnel needs, additional procedures, medications, and monitoring. The financial weight of such stays is increased by indirect expenses including psychological and financial impact on families as well as loss of productivity for patients and carers. While ICU therapy determines both the control of complex medical conditions and the increase of survival rates, there is growing need to find a balance between high-quality treatment and financial sustainability. Dealing with this challenge hinges on a knowledge of the link between LOS and economic burden, especially as healthcare systems all over struggle with mounting prices, limited resources, and increasing demand for critical care therapies. While past studies have highlighted the financial costs of ICU stays, many have not thoroughly looked at how patient demographics, clinical factors, and systematic inefficiencies affect this link. Age, comorbidities, disease severity, and mechanical ventilation need all help greatly in determining LOS and related expenses. Moreover affecting the financial situation of ICU treatment are institutional practices, regional healthcare policies, and refund systems. By means of an analysis of the relationship between LOS and economic burden in ICU environments, this study aims to address these gaps and hence provide information on the cost drivers and likely intervention sites. By means of powerful statistical methodologies and analysis of real-world data, this study intends to lead policies for best use of resources, enhancement of patient outcomes, and reducing of financial burden on healthcare systems, patients, and families. By doing this, it satisfies a great need for evidence-based ICU management techniques and offers realistic recommendations for hospital managers, legislators, and clinicians to increase the sustainability and efficacy of important medical treatments.

2. Background

Importance of ICU Care in Modern Healthcare

Modern healthcare systems depend on the Intensive Care Unit (ICU), which helps to manage critically ill patients needing sophisticated medical expertise, continuous monitoring, and advanced therapeutic treatments. ICUs provide lifesaving treatment for a broad spectrum of diseases including major infections, organ failure, catastrophic trauma, and post-surgical complications when fast and accurate intervention can make all the difference between life and death. Equipped with current medical technologies such ventilators, haemodynamic monitoring, and extracorporeal life support systems—all of which are essential for ensuring physiological stability in patients with complicated medical needs—they symbolise a hub of invention. The multidisciplinary nature of ICU teams—which comprises intensivists, nurses, respiratory therapists, chemists, and other specialists—guarantees a great degree of coordinated treatment. Furthermore of great importance for public health systems are ICUs since they act as front-line resources during emergencies such pandemics, natural disasters,

and mass casualty events, so stressing their value in insuring community resilience and preparedness. Despite their life-saving abilities—limited resources, end-of-life decisions, and balancing aggressive treatment with quality of life concerns—ICUs are associated with ethical questions. ICUs are very important in managing not only emergency clinical needs but also more general healthcare issues since they offer both curative and palliative treatment. Apart from particular patient outcomes, ICU treatment influences hospital efficiency, healthcare delivery systems, and national health statistics, therefore impacting national health indices. In this sense, optimising ICU operations is crucial to maintain the sustainability of healthcare systems, particularly in regions with ageing populations, rising burden of chronic diseases, and growing population. Though ICU treatment is absolutely necessary, it also falls among the most resource-intensive areas of medicine and calls for comprehensive study of its social, financial, and operational effects.

High Costs Associated with ICU Stays

Although vital, ICU treatment is among the most expensive aspects of healthcare delivery; it accounts for a significant portion of hospital fees and overall general healthcare costs. The huge expense load of ICU stays results from several factors: the requirement of continuous monitoring, modern equipment, and a highly specialised staff. Advanced technology like mechanical ventilators, dialysis equipment, and intrusive monitoring gadgets which demand regular maintenance, calibration, and updates adds to the cost as well. Because of the seriousness of the patient conditions in the ICU, many of the drugs used there—including antibiotics, vasoactive agents, and sedatives—are expensive and utilised in somewhat large quantities. Furthermore, ICU staffing ratios are higher than in regular wards; one nurse is often given one or two patients, and the presence of intensivists and other specialists increases even more the labour costs. Extended ICU stays aggravate financial limitations since the demand for constant treatment, diagnostics, and supportive care multiplies over time. Indirect costs—such as the loss of productivity for patients and caregivers—also add to the financial strain especially in cases when serious diseases cause long-term disability or death. The infrastructure required to run an ICU—advanced air filtration systems, backup power sources, and infection control policies—adds still another level of expenses. During pandemics or other public health events, rising demand for beds, equipment, and personnel causes the increase in ICU treatment costs, potentially leading to resource limitations and further cost escalation. The financial dynamics of ICU treatment also rely significantly on insurance coverage and payment policies; differences in coverage might leave patients and families to pay significant out-of-pocket expenses. In low- and middle-income countries especially, the financial cost of ICU treatment is especially more apparent since systematic inefficiencies and insufficient resources raise costs while generally degrading the quality of treatment. Healthcare systems trying to balance the provision of high-quality ICU treatment with financial sustainability must understand and control these costs; hence, strategies that maximise resource use and lower unnecessary expenditure become quite important.

Brief Mention of the Length of Stay (LOS) as a Critical Determinant of Costs

The length of stay (LOS) in the ICU determines healthcare expenditures most importantly and influences both direct and indirect spending in critical care settings. Extended LOS is associated with higher resource consumption since every day spent in the ICU requires

constant use of costly medical gear, medications, and specialised personnel. Longer ICU stays can call for more frequent diagnostic testing—including imaging and laboratory studies—to monitor patients' state and direct treatment, hence raising costs. Extended stays also increase the risk of complications including hospital-acquired infections, pressure ulcers, and delirium, which not only effect patient outcomes but also add to the economic burden by means of further treatments, longer recovery times, and increased mortality risk. These components taken together make LOS a main focus for cost containment in ICUs since reducing unnecessary stay length helps to significantly alleviate financial pressures on healthcare systems. Although shorter stays are not typically indicative of cost savings, LOS and expenses have a non-linear relationship; early discharges may lead to readmissions, complications, and negative impacts that ultimately increase total expenses. This complexity highlights the need of a comprehensive strategy for LOS control in which the focus is on extending the length of ICU treatment to ensure both cost efficiency and clinical efficacy. Patient-specific factors including age, underlying diseases, and degree of illness largely define LOS; equally essential are systemic factors including hospital regulations, staffing levels, and availability of step-down care facilities. Among other evidence-based strategies, early mobilisation, infection control, and protocolised weaning from mechanical ventilation have shown to reduce LOS and related expenses while yet improving patient outcomes. LOS thus offers a surrogate for the quality and efficiency of ICU therapy as well as a measure of resource use. Therefore, an investigation of the elements and consequences of LOS helps one to design targeted therapies to maximise ICU operations, reduce costs, and improve the general sustainability of critical care services.

Significance of the Study

Since it addresses a fundamental issue at the confluence of healthcare quality, economic sustainability, and resource optimisation, the relationship between ICU length of stay (LOS) and cost burden makes this study very relevant. Modern healthcare systems depend on the ICU, which is also among the most resource-intensive departments; so, efficient management of its operations is absolutely vital to combine patient care quality with financial sustainability. Examining the financial effects of longer ICU stays allows one to better grasp one of the primary cost elements in critical care. Its impact can be seen in both macro-level healthcare policies and micro-level clinical decisions guiding both. Clinically, knowing the link between LOS and expenditures allows intensivists and hospital managers to uncover opportunities for actions lowering LOS without compromising patient safety or outcomes. Such approaches could include early mobilisation strategies, infection control measures, and efficient discharge planning systems. Moreover, the study highlights the role of patient-specific factors such age, comorbidities, and sickness severity in predicting LOS, so enabling the development of customised treatment plans maximising the use of resources. Policy-wise, the study emphasises the need of methodical changes designed to raise the cost-efficiencies of ICU operations. Policymakers can use the findings to design reward systems for hospitals adhering to evidence-based recommendations reducing LOS while maintaining high treatment standards of quality. Moreover, the study affects healthcare fairness more generally, particularly in settings with limited resources where the economic load of ICU treatment can restrict access. Stressing the financial impact of LOS helps the study to advocate expenditures in reasonably priced ICU technologies, staff training, and the expansion of post-ICU care

facilities to reduce cost burden on patients and families. Using robust statistical analyses to disentangle the complexity of the LOS-cost relationship and accounting for confining variables including insurance coverage, hospital infrastructure, and regional healthcare systems, the relevance of the study also relates to its methodological contributions. This all-encompassing approach not only validates the findings but also establishes a benchmark for upcoming research in the field. Furthermore, the focus of the research on the financial burden matches the global goal of establishing sustainable healthcare systems notably in the backdrop of rising healthcare costs, ageing populations, and enhanced incidence of chronic diseases. By providing useful insights for maximising ICU activities, the study serves to further the larger overall objective of improving the efficiency, accessibility, and quality of critical care services. Its significance finally stems from its ability to fill the gap between clinical excellence and financial sustainability by giving healthcare institutions a way to offer high-quality ICU treatment while underlining cost control. Therefore, this study is not only a valuable addition to the body of present knowledge but also a helpful guidebook for healthcare professionals aiming to increase the long-term viability of critical care services.

Implications for Policy and Practice

The findings of this study on the relationship between ICU length of stay (LOS) and economic burden would be much welcomed in policy and clinical practice. Policymakers and healthcare management can utilise these findings to implement targeted strategies aimed to optimise resource usage, reduce needless costs, and improve important care environment patient outcomes. At the policy level, the study underlines the need of the development of evidence-based policies addressing the effective use of modern technologies in ICUs, staffing ratios, and resource allocation. For those who might benefit from expedited recovery courses or transfer to step-down care facilities, this entails following guidelines promoting early patient identification. Practically, the results can be applied to enhance decision-making processes by means of interventions meant to reduce LOS without compromising the quality of therapy. For instance, standardised approaches for weaning patients off mechanical ventilators or early mobility programmes might help to lower ICU stays while maintaining good health outcomes. Furthermore underlined in the study is the importance of including predictive analytics and machine learning approaches to identify high-risk patients most likely to have prolonged stays, therefore enabling the distribution of resources where most needed. Red redesign of discharge planning systems could also help to ensure better transitions from ICUs to less intensive care units, hence perhaps reducing costs and freeing ICU capacity. The study gives insurance companies a basis to modify reimbursement rules to provide cost-effective treatment top priority and inspire hospitals to follow guidelines lowering too high LOS. Training programs stressing the need of multidisciplinary teamwork and continuous education for ICU staff to use cost-effective techniques with success also have consequences. More generally, especially in low-resource settings, ensuring that limited resources are managed equitably and effectively can help to reduce the financial strain of ICU stays, therefore promoting more healthcare fairness. These effects taken together point to a varied approach in which clinical advances, legislative changes, and resource optimisation combine to increase the sustainability of ICU treatment.

3. Review of literature

(Amaravadi et al., 2000) in the study "ICU nurse-to-patient ratio is associated with complications and resource use after esophagectomy" and said that The night-time nurse-to-patient ratio (NNPR) in the intensive care unit (ICU) was shown to be connected with clinical and economic outcomes following esophageal resection, according to the findings of a study that was carried out in the state of North Carolina. The ratio of one nurse caring for one or two patients being greater than one to two (> 1:2) is greater than the ratio of one nurse caring for three or more patients being less than one to two (< 1:2). On the other hand, a NNPR of less than 1:2 was associated with a 39% increase in the median length of stay (LOS) in the hospital, as well as a 32% increase in expenses ($4,810 - $7,952). According to the findings of the study, there was no statistically significant connection between NNPR and death rates within the hospital.

(Cook et al., 2001) in the study "The attributable mortality and length of intensive care unit stay of clinically important gastrointestinal bleeding in critically ill patients" and said that The study analyzed the mortality and ICU stay due to clinically important gastrointestinal bleeding in critically ill patients. Out of 1666 patients, 59 developed bleeding. The risk of death increased in bleeding patients, but not significant for regression methods. Clinically important bleeding significantly increases morbidity and mortality.

(Ely et al., 2001) in the study "The impact of delirium in the intensive care unit on hospital length of stay" and said that The major purpose of the study was to determine the relationship between delirium in the critical care unit and other hospital outcomes, including length of stay. Researchers tracked 48 patients in this prospective cohort study; 24 of those individuals received mechanical ventilation. Delirium typically began at 2.6 days and lasted between 3.4 and 1.9 days on average. In addition to 29.60% having issues while hospitalised, 30.31 percent suffered from delirium. After accounting for factors such as age, gender, race, and the number of days after medicine was administered, delirium was found to be the most significant predictor of hospital stay. There has to be more research into the link between delirium and hospital stays.

(Chertow et al., 2005) in the study "Acute Kidney Injury, Mortality, Length of Stay, and Costs in Hospitalized Patients" and said that A study of 19,982 adults admitted to an urban university medical centre found that acute renal damage significantly increases costs, length of stay (LOS), and mortality. Even little increases in serum creatinine concentrations were associated with increased mortality rates, durations of stay, and healthcare expenses. Serum creatinine levels typically climbed slightly. The degree of acute renal injury is directly correlated with the results, and this injury can be assessed by either a nominal or percentage change in serum creatinine.

(Thomason et al., 2005) in the study "Intensive care unit delirium is an independent predictor of longer hospital stay: a prospective analysis of 261 non-ventilated patients" and said that Most ventilated patients may have delirium at some point, and this condition is independently associated with worse mortality, a longer hospital stay, and higher costs. Despite the lack of evidence in nonventilated patients, recommendations recommend keeping an eye out for delirium in all intensive care unit patients. The major objective of the study was to determine the relationship between delirium and outcomes for patients in the critical care unit who were

not ventilated.

(Kane et al., 2007) in the study "The Association of Registered Nurse Staffing Levels and Patient Outcomes: Systematic Review and Meta-Analysis" and said that The major goal of the research was to determine the relationship between the number of registered nurses on staff and the results for patients in acute care hospitals. According to 28 studies, the prevalence of hospital-acquired infections decreased in the surgical, medical, and critical care units where there were more registered nurses on staff. An increase in the number of registered nurses on staff led to a decrease in cardiac arrest, respiratory failure, hospital-acquired pneumonia, and unintentional extubation. Patients in critical care units and those having surgery also had shorter stays. According to the research, factors like patients' and hospitals' commitment to getting top-notch medical treatment may impact the causative route.

(Mauldin et al., 2010) in the study "Attributable Hospital Cost and Length of Stay Associated with Health Care-Associated Infections Caused by Antibiotic-Resistant Gram-Negative Bacteria" and said that Researchers found that 29% of healthcare-associated illnesses (HAIs) were caused by gram-negative (GN) bacteria among 662 people polled between 2000 and 2008. These infections resulted in a 29.3% increase in total hospital expenditure and a 23.8% increase in length of stay (LOS) as compared to antibiotic-responsive GN pathogens. The study also found that age ≥12 years, neutropenia, pneumonia, and critical care unit stay were important variables in the multivariate analysis. If the data show that particular diseases are more common than expected, it can be a good indicator that efforts to lower their prevalence are worthwhile.

(Shehabi et al., 2010) in the study "Delirium duration and mortality in lightly sedated, mechanically ventilated intensive care patients:" and said that The length of delirium remained the most significant independent predictor of mortality, ventilation duration, and length of stay in the intensive care unit (ICU) following adjustment for pertinent confounding variables in patients who were either ventilated or lightly sedated.

(Kollef et al., 2012) in the study "Economic Impact of Ventilator-Associated Pneumonia in a Large Matched Cohort" and said that In this study, the financial burden of ventilator-associated pneumonia (VAP) was assessed by looking at the length of stay and hospital expenditures for 88,689 eligible patients. With an incidence rate of 1.27 per 1,000 ventilation-days, 2.5% of the 88,689 patients who met the eligibility criteria acquired ventilator-associated pneumonia (VAP). Patients with ventilator-associated pneumonia had shorter rates of death during admission, but they required mechanical ventilation for longer periods of time and spent more time in the intensive care unit and the hospital overall. A cost-effective solution is required because VAP is still happening with the new specific ICD-9 number and is linked to a significant strain on resources, as shown in the study.

(Griffiths et al., 2013) in the study "An exploration of social and economic outcome and associated health-related quality of life after critical illness in general intensive care unit survivors: a 12-month follow-up study" and said that According to a European study that examined the socio-economic repercussions of critical illnesses on patients and their families, income, social and economic stability, care demands, and access to health services are often significantly impacted when patients leave the intensive care unit (ICU). Half of people who care for loved ones also notice a decrease in their employment stability. Between admission

and 6 months, mobility impairments nearly triple, and 73% report moderate to severe pain. The study found that after a serious illness, patients and their families could have to deal with a lot of social and financial problems. This highlights the need of ensuring they receive sufficient care and resources.

(Hunter et al., 2014) in the study "Reduction of Intensive Care Unit Length of Stay: The Case of Early Mobilization" and said that This study investigated the effects of early mobilisation on critically ill intensive care unit (ICU) patients with a focus on length of stay (LOS), healthcare costs, and medical complications. An analysis of the available literature revealed a variety of positive outcomes, including a two-fold reduction in the number of days of delirium, a lower risk of death or readmission, and fewer instances of ventilator-assisted pneumonia, central line infections, and catheter infections. The small amount of study on intensive care unit length of stay cost has shown savings potential, suggesting that critically ill patients should routinely be mobilised early.

(Salluh et al., 2015) in the study "Outcome of delirium in critically ill patients: systematic review and meta-analysis" and said that Objectives The purpose of this study is to identify the factors that contribute to delirium in critically sick patients and to identify the consequences that these patients experience both while hospitalised and after discharge.

(Awad et al., 2017) in the study "Patient length of stay and mortality prediction: A survey" and said that Efficiency is being enhanced in hospitals through the use of data mining and machine learning techniques, particularly in intensive care units. Important for patient happiness and budgetary concerns, research seeks to predict outcomes including as morbidity, mortality, and length of stay (LOS). Loss of function (LOS) is a popular metric for gauging the impact of illness and healthcare resource utilisation, among other common uses.

(Founou et al., 2017) in the study "Clinical and economic impact of antibiotic resistance in developing countries: A systematic review and meta-analysis" and said that Forty studies met the inclusion and exclusion criteria out of 27033 that were thoroughly searched between 2000 and 2016. There was a correlation between bacterial resistance and mortality, with ESKAPE infections taking the cake. Eight studies found that antibiotic-resistant ESKAPE bacteria significantly increased healthcare costs. Multiple chronic non-communicable diseases were used to designate a high-risk group.

(Manoukian et al., 2018) in the study "Estimating excess length of stay due to healthcare-associated infections: a systematic review and meta-analysis of statistical methodology" and said that Longer hospital stays and increased healthcare costs are consequences of healthcare-associated infections (HAIs), which affect millions of people globally. An accurate evaluation of unnecessary length of stay is crucial for efficient and successful infection management and prevention programs. Although studies using time-varying methods had higher quality, the majority of the 92 papers included in the review (75% of the total) used time-fixed procedures. Because of the wide variety of demographics, research designs, and reporting systems, conducting a meta-analysis is no easy feat. Strong estimates are necessary for investing in interventions for IPC that are both effective and economical.

(Rees et al., 2020) in the study "COVID-19 length of hospital stay: a systematic review and data synthesis" and said that Worldwide, healthcare systems have been hit hard by the COVID-

19 epidemic, which has increased the need for healthcare resources. The duration of hospitalisation and intensive care unit stays for COVID-19 patients was the subject of an initial systematic review. The majority of the 52 studies that were discovered in the analysis were from China. In China, the median length of stay (LoS) in a hospital was 14 days, while it was just 5 days abroad. China and the rest of the world had more comparable ICU LoS durations, at 8 days and 7 days, respectively. Patients who make it out of the hospital alive appear to have a better LoS compared to those who pass away while there.

(Allel et al., 2023) in the study "The impact of inpatient bloodstream infections caused by antibiotic-resistant bacteria in low- and middle-income countries: A systematic review and meta-analysis" and said that Background Bacteria that are resistant to antibiotics and cause bloodstream infections (BSIs) are a major contributor to the worldwide epidemic of disease. The problem is that most estimates are based on high-income nations, which doesn't guarantee they are representative of the global population at large. Adult inpatients in low- and middle-income countries (LMICs) are more likely to die from ARB BSIs, have longer hospital stays, be admitted to the intensive care unit (ICU), and incur economic expenses as compared to antibiotic-sensitive bacteria (ASB).

4. Conclusion

This study highlights the significant relationship between ICU length of stay (LOS) and the economic burden on healthcare systems, patients, and families. Prolonged ICU stays drive costs through increased resource utilization, complications, and extended use of specialized care. By identifying key factors influencing LOS, such as patient demographics, comorbidities, and clinical practices, this research provides actionable insights for optimizing resource use and reducing unnecessary expenditures. The findings emphasize the need for evidence-based policies, efficient discharge planning, and targeted interventions to enhance ICU efficiency. Ultimately, this study contributes to improving critical care sustainability while maintaining high standards of patient outcomes.

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Conflict of Interest:

The authors declare no competing financial or personal interests that could have influenced

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