Multidisciplinary Reviews

MINI REVIEW
Published Online: October 30, 2024
https://doi.org/10.31893/multirev.2025084

Understanding the financial burden of surgical site infections: A narrative review

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Abstract Surgical site infection (SSI) therefore poses a worldwide threat to morbidity and mortality as well as financial implications. A significant anatomic and physiologic change results in surgical site infection management, increasing medical costs for hospitals, such as surgeries, tests, imaging, medications, wound care, infection control, and treatments. The aim is to identify the economic burden of SSI in terms of costs, resource utilization, effects on healthcare personnel, and means of reducing the cost burden. In this respect, SSIs increase the financial burden of hospitals through cost per patient stay, increased revenue cuts from reimbursement, and long lengths of stay for affected patients. The primary cause of this is the adverse health impacts that occur in people infected with the virus, which can lead to sickness or even death. Some of the findings highlighted in this research documentation report that SSIs significantly contribute to increased hospital costs, as a result of longer hospital stays and increased use of resources such as antibiotics and surgical procedures. Because the costs associated with managing SSIs are only associated with patients and healthcare systems, it is important to promote targeted interventions to reduce this complication. However, the lack of resources in health institutions in developing countries means that the necessary resources are lacking, thus causing enormous negative impacts on patients. This review was conducted to assess the cost consequences of healthcare-associated SSIs and their consequences for patients. The implementation and adoption of best practices, antimicrobial stewardship, and quality improvement of SSIs can improve patients' experiences and optimize hospital resources. In conclusion, several considerable direct and indirect costs are associated with SSIs.

Keywords: resource allocation, healthcare-associated infections, economic impact, infection control, cost analysis, antibiotic therapy

1. Introduction

The term "surgical site infection" (SSI) was initially defined in 1992. According to the Centers for Disease Control and Prevention, a surgical site infection is an infection that occurs within 30 days after surgery or a year if an implant is left in the body (Costabella et al., 2023). SSIs are a significant issue in healthcare services worldwide and are major contributors to illness and death. As the most common complication following surgery, SSIs cause both mental and physical distress for patients, leading to prolonged recovery periods (Tevis & Kennedy, 2016). The complications associated with SSIs make them difficult to manage medically and surgically, resulting in higher rates of morbidity and mortality (Clements et al., 2007; Monahan et al., 2020). The majority of these infections result from pathogens being transmitted from one patient to another, often because healthcare workers do not consistently follow infection prevention measures (Alonso-Aguilar et al., 2017; Mohan et al., 2020). SSIs negatively impact patients' physical and mental well-being (Badia et al., 2017).

Hospital costs are the financial value a hospital spends to deliver services. Hospital revenue refers to the monetary value obtained from business activities, whereas hospital fees are expenses billed to payers and patients. Hospital charges are bills given to both insurance companies and patients. The Centers for Disease Control and Prevention approximates that 45 million surgeries are conducted annually in the United States (Shepard et al., 2013). Despite improvements in infection prevention, SSIs remain a major issue, causing harm, death, and increased expenses for patients in hospitals (Sparling et al., 2007). Hospitals will incur increased costs for healthcare-acquired conditions such as infections in the future. We aimed to calculate the expenses related to healthcare-acquired infections and perform a sensitivity analysis to compare different analytical approaches (Roberts et al., 2010).

Multiple risk factors are linked to the onset of SSIs, which can generally be categorized on the basis of patient and surgical characteristics. Patient-related factors include older age, inadequate nutritional status, and an increasing number of severe comorbid conditions. Surgery-related factors include a lengthy procedure duration, high wound classification, and lack of antibiotic prophylaxis (Clements et al., 2007). SSI prediction scores have been developed to identify individuals at risk on the basis of these factors, targeting patients with a high likelihood of acquiring SSIs (Culver et al., 1991).

 Received: June 22, 2024 | Accepted: September 17, 2024

The economic outcomes of SSIs vary on the basis of the specific causative agent, each with its distinct pathogenesis and clinical results (Boltz et al., 2011). Estimating the true cost of SSIs is challenging due to methodological differences that use inconsistent intrinsic and extrinsic costs (Boltz et al., 2011). SSIs are associated with various negative consequences that result in increased healthcare costs, including longer hospital stays and additional expenses for surgeries. The number of emergency room visits after discharge has more than doubled due to SSIs (Urquhart et al., 2021).

In India, cesarean sections are frequently performed. It is crucial for all patients involved to accurately determine the frequency, impact, and costs of postcesarean SSIs to distribute resources effectively (Hirani et al., 2022). Healthcare-associated infections refer to infections contracted in healthcare facilities during clinical, diagnostic, or therapeutic procedures that are absent upon patient admission (Assefa et al., 2020). Infections acquired in hospitals are a significant public health issue, causing high levels of illness and death on a global scale (Melaku et al., 2012).

The financial consequences of these infections are significant, and methods for reducing this issue by efficiently implementing standardized care bundles are essential. Even though the risk factors and preventive measures for SSIs are well understood, the rates of SSIs remain elevated (Megan & Johan, 2019). The significant economic challenges faced by society have become especially crucial during recent economic crises (Piednoir et al., 2021). Preventing and managing SSIs is crucial because these infections can prolong the duration of treatment. Thoroughly examining the primary causes of SSIs, assessing risks related to each modifiable factor, and implementing strong SSI prevention initiatives are essential (Barnes, 2011). Extraneous expenses are significant and include lost work time, decreased functionality, legal disputes, the reputation of the healthcare facility, and the effects of varying compensation and sanctions related to performance. Hospitalization due to SSIs results in additional complications for patients, including emotional, physical, psychological, social, and economic distress, all of which add to the burden of treatment (Dal-Paz et al., 2010).

This review aimed to investigate the financial implications of healthcare-related SSIs and their impact on patient outcomes. Our goal was to evaluate recent research on SSIs, compare cost research methodologies, and analyze the magnitudes of SSI-related costs.

2. Methodology

This narrative review explores the financial impact of surgical site infection on hospitals. Our search encompassed databases such as PubMed (Medline) and Google Scholar, as well as governmental sources such as the Ministry of Health, and the Centers for Disease Control and Prevention. Additionally, we consulted the National Health Portal of India and Google. The PubMed search strategy was tailored for databases, covering the following approach: (financial impact of surgical site infection [MeSH Terms]) AND (hospital [MeSH Terms]). We also carefully reviewed the citations of potentially related studies to find additional research. Identifying pertinent articles involved full-text searches via medical subject heading (MeSH) terms, and we also examined references in the bibliography section of relevant works. The review encompasses studies published between 2005 to 2023 and removes duplicates, abstracts, works written in languages other than English, unpublished materials, and resources that are not directly related to the financial impact of surgical site infection on hospitals. The keywords used for this review, are resource allocation, healthcare-associated infections, economic impact, infection control, legal cost, and antibiotic therapy.

3. Discussion

3.1. Surgical site infections

Surgical site infection or postoperative infection refers to infections that occur at the surgery site, affecting the location where the surgery was performed. As previously mentioned, SSIs can involve the skin, subcutaneous tissue, organs, or any foreign body placed in the body. Proper management of SSIs is crucial because they are indicative of 'hospital-acquired' conditions, leading to increased morbidity, longer hospital stays, and higher treatment costs. To reduce the occurrence of the spread of SSIs, a coordinated approach is needed, with a focus on patient and staff practices, surgical procedures, the environment, and postoperative care. Therefore, it is important to adhere to guidelines and continue investigating new approaches. Effective management of SSIs not only enhances patient outcomes but also helps alleviate pressure on the health system.

3.2. Cost of healthcare in surgical site infections

SSIs also lead to significant negative impacts, such as increased morbidity, longer hospital stays, prolonged antibiotic treatment, unplanned hospital readmissions, worse long-term patient outcomes, and the need for additional surgeries (Hirani et al., 2022). Healthcare costs linked to SSIs have approximately doubled (Broex et al., 2009). Despite many years of dedicated effort and advancements in medical care, surgical site infections continue to be a major concern for both patients and healthcare facilities. SSIs directly affect the financial situation of hospitals by contributing to direct and indirect healthcare costs. Patients are associated with increased medical expenses, longer hospital stays, and higher readmission rates, which are prevalent in the healthcare system. SSIs reduce efficiency, incur legal costs, and can cause adverse lifestyle changes for those

affected (Sparling et al., 2007; Sullivan et al., 2017). A study from 2017 indicated that the frequency of reported SSIs has remained consistent over the last fifty years, highlighting the importance of investigating the financial impact of SSIs on healthcare providers and patients (Sullivan et al., 2017). Surgical site infections add pressure to the healthcare system and challenge its effectiveness. The increasing demand to control healthcare resources and address rising expenses has led to reduced payments for treating avoidable complications such as SSIs (Patel et al., 2017). There is a growing focus on lowering healthcare expenses through the prevention of SSIs. The assessment of healthcare expenses includes three parts: direct costs (extended hospitalization, cost of treatments, and surgeries), indirect costs (loss of productivity, caregiver expenses), and intangible costs (pain and suffering). SSIs can impact healthcare costs through expenses related to readmission, surgeries, medications, and lab tests; indirect costs such as decreased quality of life and productivity loss; and spending on primary healthcare. Some studies have measured the impact of SSIs by examining hospital stays and treatment costs (Maksimovic et al., 2008). Inadequate surgical infrastructure, human resources, and equipment contribute to the high costs of SSIs. Challenges in reducing the SSI rate in low- and middle-income countries include inadequate monitoring of infection occurrence and the absence of guidelines for preventative antibiotics, resources, skilled personnel, and basic sanitation (Costabella et al., 2023).

3.3. Health care costs and patient outcomes linked to surgical site infection

Surgical site infections are major healthcare problems because of their impact on patient outcomes and healthcare costs. The duration patients spend in the hospital, post-surgery death rates, and the need for further procedures, such as reoperations, are outcomes that impact healthcare costs. SSIs are a significant concern in healthcare because of their potential to increase morbidity, mortality, and healthcare costs (Costabella et al., 2023).

Increased healthcare costs: SSIs can significantly increase healthcare costs due to extended hospital stays, direct medical costs, utilization of resources, financial loss, indirect costs, legal and ligation costs, additional medical procedures (such as antibiotics and surgical interventions), and the need for extra resources such as staff and specialized equipment.

Impact on Patient Outcomes: SSIs can lead to a range of adverse patient outcomes, increased morbidity, prolonged hospitalization, readmission rates, reduced quality of life, increased risk of complications, impaired wound healing, and, in severe cases, mortality (Costabella et al., 2023; Fenny et al., 2020).

SSIs can lead to several complications, including an extended hospital stay, and additional surgery costs, which significantly increase healthcare costs. The increase in the patient readmission rate has doubled due to SSIs (Urquhart et al., 2021). SSIs are the most common issue that arise from postoperative processes, leading to both psychological and physical anxiety in patients experiencing prolonged healing (Tevis & Kennedy, 2016).

The amount of time a patient spends in the hospital, the likelihood of death after surgery, and the need for further procedures, such as reoperations, directly impact healthcare costs. The prudent consequence of SSIs is the significant added healthcare financial cost due to increased charges for doctor fees, hospital duration, and job inefficiency. SSIs can also have negative effects on patients. Preventative measures are essential to reduce these effects of SSIs and improve patient outcomes. Addressing the financial burden of SSIs should be a priority in healthcare (Fenny et al., 2020).

3.4. Financial burden faced by patients dealing with surgical site infections

There is an increasing focus on decreasing healthcare expenses through the prevention of SSIs. Healthcare costs related to SSIs (whether direct or indirect) have approximately doubled (Broex et al., 2009; Costabella et al., 2023). Therefore, hospitals are required to increase patient care and safety by having infrastructure to support interventions aimed at reducing adverse events such as SSIs. Hospitals and their administrators require data to support their interests in balancing budgets and promoting infection prevention and other groups aimed at enhancing performance. Unfortunately, hospitals are not experiencing significant cost reductions because of the decrease in SSIs (Graves et al., 2010; Shepard et al., 2013). Surgical site infections can have significant financial impacts on patients, primarily due to the additional medical costs associated with treating the infection and potential complications. Patients facing surgical site infections (SSIs) often endure significant financial strain. Prolonged hospital stays, additional treatments, and lost income due to illness contribute to this burden. Patients may struggle with paying for medication, outpatient care, and other expenses. Financial stress can lead to emotional hardship and impact individuals' ability to meet basic needs. Support from friends, family, and healthcare professionals is most needed. Preventive measures to reduce SSIs are essential to alleviate this financial burden on patients.

3.5. Some of the financial impacts faced by patients dealing with SSI are as follows:

Extended Hospital Stay: SSIs are associated with longer hospitalization of patients who need additional surgical and medical interventions, which adds up to hospital charges such as room tariffs, drugs, and others.

Additional medical procedures: Additional interventions that may be required to treat SSIs, which may include debridement, wound drainage, or even surgical re-exploration, may be necessary for treating SSIs, leading to increased expenses for patient care.

Medication costs: Patients may incur expenses for antibiotics, pain management medications, and other drugs required to treat infection and manage associated symptoms (Costabella et al., 2023; Shepard et al., 2013; Mohan et al., 2023). Hospital stays and SSIs are still a financial concern globally, highlighting the importance of developing and implementing cost-effective strategies to decrease the incidence of infection.

Lost Income: Patients may have to be out of work for weeks because of their injuries or conditions or may require time off from work during hospitalization, or later follow-up visits. Long periods of hospitalization mean loss of wages or income for the patient or caregiver; repeat visits to the hospital mean more days off from work.

Outpatient Care: Even after discharge, patients may incur initial and repeated costs for treatment, medication and dressings, follow-up visits, and transportation costs.

Psychological impact: Treating SSIs adds extra financial stress to patients and may also negatively affect their mental health, increasing the infection load.

Complications and long-term effects: In severe cases, SSIs may result in extensive complications, including pain, disability, or recurrent operations, which never end and are costly both to the patient and the insurance company, with potential loss of income.

Insurance Coverage: Insurance coverage may also have costs related to antibiotics, pain relievers, and other medicines that may be needed to address the infection and other discomforts. Hospital stays and SSIs are still a financial concern globally, highlighting the importance of developing and implementing cost-effective strategies to decrease incidence rates. Figure 1: shows the financial burden of surgical site infection in the hospital.

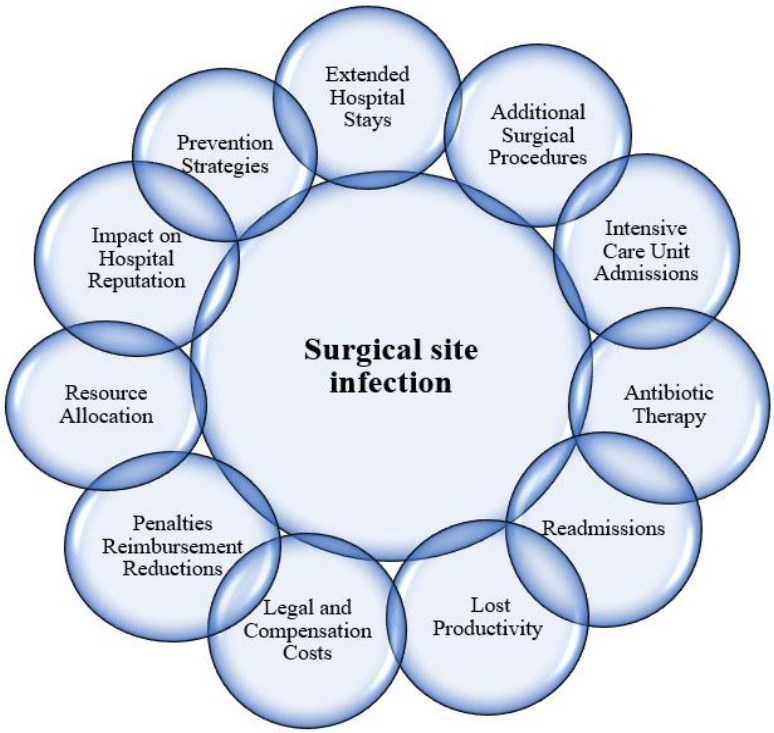

Figure 1 Financial burden of surgical site infection in hospitals.

3.6. Incidence of surgical site infection among various countries

Determining the global occurrence of general surgical site infections is crucial for gaining insight into the prevalence of this issue and assisting policymakers in enhancing surgical care planning and delivery (Gillespie et al., 2021). Several prior studies have reported that fluctuations in the rates of healthcare-associated infections are closely tied to fluctuations in hospital expenses. The incidence of surgical site infections (SSIs) varies among countries due to factors such as healthcare infrastructure, infection control measures, and surgical practices. Developed countries with advanced healthcare systems typically have lower SSI rates than do developing nations with limited resources and infrastructure. However, within each country, there can be variations depending on factors the type of surgeries performed, the adherence to infection control protocols, and the prevalence of antibiotic-resistant bacteria. Studies and surveillance programs help track and compare SSI

rates globally, facilitating efforts to implement effective preventive measures and improve patient outcomes (Olsen et al., 2010; Shepard et al., 2013).

Bacteria entering incisions during surgery cause surgical site infections. Each year, SSIs endanger the lives of millions of patients and add to the problem of antibiotic resistance. Eleven percent of individuals who undergo surgery in low- and middle-income countries acquire infections during the procedure. Implementing international recommendations for preventing SSIs can be difficult in different clinical environments, particularly in low- and middle-income countries, because of resource constraints and inadequate infrastructure (Ling et al., 2019).

An increase in the number of SSI cases leads to higher overall medical costs, encompassing both direct and indirect healthcare expenses incurred after hospital discharge. Low-income countries spend more money in total than do high- and middle-income countries because they do not have proper infrastructure and safety regulations in place (Costabella et al., 2023). In Africa, approximately 20% of women who undergo a cesarean section develop a wound infection, which affects both their health and their ability to care for their infant. However, surgical site infections are not exclusive to underdeveloped nations. They result in approximately 400,000 more hospital days for patients in the U.S., costing an additional US$ 900 million annually. (World Health Organization, 2024). Table 1 shows the incidence of surgical site infection in various countries (Mengistu et al., 2023).

Table 1 Incidence of surgical site infection among various countries.

S.no.	Name of Countries	Incidence of Surgical site infection
1	India	0.54
2	Iran	1.18
3	Poland	1.8
4	Cameroon	2.61
5	China	0.22
6	Herzegovina	0.84
7	Germany	1.73
8	Australia	3.6
9	Nepal	4.67
10	USA	2.12
11	Tunisia	2.34
12	Ethiopia	24.6
13	Georgia	16.7
14	Benin	7.81
15	Tanzania	26
16	Germany	3.44
17	Hong Kong	1.1
18	Switzerland	3.2
19	Argentina	2.9
20	Rwanda	8.2
21	Malawi	3.81
22	Ghana	2.85
23	France	0.3
24	Turkey	8.05
25	Cuba	1.9
26	Thailand	0.71
27	Albina	4.7

Source: Mengistu et al. (2023).

3.7. Limitations and financial challenges of surgical site infections

There are no data concerning baseline compliance with the prevention bundle items, and these data were missing to allow for further comparison with the pre-implementation period. Some recommendations, including antibiotic prophylaxis and the timing of antibiotic administration, are already being implemented through institutional protocols, and with the remaining recommendations, including the use of a wound protector, intracavity lavage, and the chosen closure strategy, surgeons' judgment is relied upon. The confounding variables that could have been issued in the choice of available datasets were minimized because of the commitment of the independent surveillance committee to focus only on items that can be easily available. The implications, costs, and risks of SSI are numerous and widespread, and they can be broadly classified as follows: the costs of treating SSIs in the form of extra days in hospitals, redo surgeries, and expensive antibiotics are likely to

challenge any healthcare fiscal plan. Another factor associated with cancer-related fatigue is the additional costs incurred in terms of further loss of productivity and income due to the additional time needed to recover from treatments fully. Furthermore, SSIs can result in chronic disease that requires more subsequent care and physical therapy, increasing expenses. Similarly, the prevention of SSIs entails expenditures on infection control practices, training healthcare workers, and surveillance, which puts pressure on already limited healthcare systems, especially in poverty-stricken regions. Overcoming these challenges requires a more complex effort where the processes of preventing infections at a lower cost form part of the care trajectory of those who undergo surgery, affirming that the issue of infection should be the top priority in surgical care (Sparling et al., 2007; Weber et al., 2008). Table 2 list of included studies in the review.

Table 2 List of studies included in the review.

Sr. No.	Author	Year	Type of article	Findings
1	Costabella et al.	2023	Review article	Surgical site infections are common in Low and middle-income countries, causing financial strain. Preventative interventions are crucial, but resource-limited institutions struggle with outcomes.
2	Shepard et al.	2013	Original article	The information indicates that hospitals are motivated to lower surgical site infections for financial reasons, however, they should anticipate a rise in both expenses and income as a result of reducing surgical site infections.
3	Roberts et al.	2010	Original article	Preventing healthcare-associated infections is crucial as it can save costs, and lives, and improve hospital services, impacting future cost analyses.
4	Weber et al.	2008	Original article	Surgical site infections are expensive and impose a significant and possibly avoidable load on both patients and healthcare providers.
5	Sparling et al.	2007	Original article	Controlling patients in the control group is laborious for financial and clinical staff. Analyzing data has improved efforts to prevent SSIs and align strategies to reduce them while promoting quality and financial benefits.
6	Urquhart et al.	2021	Original article	Surgical site infections resulted in higher rates of emergency room visits and surgery after patients were discharged. Patients experienced a delayed recovery but showed improvement during the initial year after surgery.
7	Hirani et al.	2022	Original article s	The emergence of postcesarean surgical site infections places a substantial burden on both clinical care and financial resources. The research emphasizes the importance of implementing successful preventative actions to reduce the occurrence of surgical site infection.
8	Assefa Jet al.	2020	Original article	Many healthcare providers lacked sufficient knowledge and practiced infection prevention unsafely. Adequate training both before starting work and while on the job should be provided to enhance healthcare workers' understanding of infection prevention.
9	Maksimovic et al.	2008	Original article	There is a high rate of surgical site infections compared to developed and some developing countries. Interventions could involve reducing

				team size, enhancing wound care, and quicker intervention timelines.
10	Turner et al.	2019	Original article	Surgical site infection after colorectal surgery leads to poor outcomes, longer hospital stays, and increased readmissions. Surgical site infection rates reflect surgical care quality, affecting finances and reputation. Prevention strategies are crucial due to persistently high surgical site infection rates.
11	Badia et al.	2017	Review article	The review highlights their significant economic toll, emphasizing the importance of strict protocols to lower surgical site infections. More research is necessary for accurate cost evaluation and understanding of their impact.
12	Mengistu et al.	2023	Original article	SSI risk factors in general, vascular, and cardiothoracic surgery are similar. Costs and hospital stays are lower but still significant.
13	Fenny et al.	2020	Review article	Surgical site infection patients experienced prolonged hospital stays, increased healthcare costs, and higher indirect expenses compared to direct costs.
14	Gillespie et al.	2021	Review article	Decreasing surgical site infections in general surgery is crucial for patient safety and organizational success, necessitating exploring and implementing interventions.
15	Ling et al.	2019	Review article	Healthcare facilities should pursue safe surgery practices through evidence-based methods and quality improvement processes to achieve effective and sustainable outcomes.

4. Conclusion

The occurrence of SSIs remains a large financial burden on hospitals, contributing to rising direct medical costs and overall health costs. SSIs lead to increased healthcare costs, longer hospitalization, higher readmission rates, loss of productivity, pressure on the healthcare system, and loss of wages, which affect the overall economy. Hospitals need to learn more about the financial impact of SSIs to develop good strategies for their prevention, control, management and enhanced patient care, which can lead to an overall decrease in the costs associated with the healthcare sector. SSIs become a source of reduced production, legal costs, and adverse health effects if human beings are involved. Controlling the financial impact of SSIs is complex since it must be based on strict infection control practices, the provision of prevention programs, and the optimization of resources in the healthcare sector. This review suggests that addressing the financial burden of SSIs should be a priority in healthcare. It includes a clear vision of goals, prioritizing preventive measures, focusing on effective allocation of resources in the case of SSI development, and ensuring efficient strategies for combating SSIs within healthcare systems.

Ethical Considerations

Not applicable.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Funding

This research did not receive any financial support.

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