Report to Congress

An Assessment of Sepsis in the United States and its Burden on Hospital Care

AHRQ Agency for Healthcare Research and Quality

PATIENT SAFETY

Report to Congress

An Assessment of Sepsis in the United States and its Burden on Hospital Care

Required by the Fiscal Year 2023 Omnibus Spending Bill

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Executive Summary

In the Fiscal Year 2023 Omnibus Spending Bill, the U.S. Congress directed the Agency for Healthcare Research and Quality (AHRQ) to "*conduct a comprehensive set of studies that calculate the morbidity, readmission, and mortality related to sepsis with respect to pediatrics, maternal sepsis, nursing home care, and rehabilitation, and the association of pandemic-related changes in the healthcare system on the burden of sepsis*."[3,i]

This report offers a comprehensive assessment of hospital care for sepsis in the United States. It begins with an overview of the Congress's directive in the Fiscal Year 2023 Omnibus Spending Bill, then provides background on sepsis, including causes, disease progression, comorbidities, risk factors, complications, and treatment.

In this report, AHRQ presents detailed statistics on hospital use related to sepsis and its burden on the hospital system, including:

- National trends in sepsis-related hospital utilization, aggregate in-hospital mortality, and hospital costs associated with sepsis.
- Trends in sepsis-related hospital utilization, morbidity, and in-hospital mortality for key subgroups, including nonmaternal adult, maternal, pediatric, and neonatal populations.
- Trends and disparities in overall hospital utilization related to sepsis and associated outcomes by patient race and ethnicity, sex, residence in socially vulnerable communities, and urban/rural location.

To inform strategies and initiatives that reduce the burden of sepsis, the report investigates State-level and hospital-level variation in sepsis-related hospital care and outcomes and reviews existing guidelines, quality improvement resources, and initiatives for early identification and management of sepsis.

In addition, the report presents data on the prevalence, clinical characteristics, and outcomes of sepsis resulting from COVID-19. To understand the burden of sepsis on non-Federal acute-care hospitals in the United States, the report examines trends in utilization, hospital costs, and in-hospital mortality before and after the onset of the COVID-19 pandemic.

Background on Sepsis (Chapters 1 and 2)

Sepsis is a dysregulated systemic inflammatory response to infection that results in tissue damage and organ failure and that can lead to death.[4] It is one of the most expensive conditions treated in hospitals in the United States.[5] Anyone can develop sepsis,[6] but it disproportionately affects older adults and people with significant comorbidities, impaired immune function, and specific conditions like cancer, chronic lung disease, and heart failure.[7,8,9,10] Sepsis can begin suddenly and requires urgent medical care.[6] There are important differences in sepsis etiology, progression, and treatment among certain subpopulations of patients.[11] Although maternal sepsis is similar to adult sepsis, the specific signs of organ dysfunction differ from those seen in other adult populations, due to the normal physiologic changes of pregnancy. Neonatal sepsis is a

[i] Appendix E.1 includes an explanatory statement from the Senate Appropriations Committee that provides a summary of estimates and Committee recommendations related to sepsis from the Labor, Health and Human Services, and Education, and Related Agencies (Labor-HHS-Education) appropriations bill.

bloodstream infection in newborn infants, caused by pathogens transmitted during pregnancy or during delivery or by pathogens from the surrounding environment, such as healthcare facilities.[12] Bacterial pathogens cause pediatric sepsis, common among children living with chronic diseases.[13]

Across all populations, early recognition of sepsis is equally important. Early recognition of sepsis and timely use of guideline-based interventions are associated with reduced in-hospital mortality.[14,15] Physicians and nurses in hospital settings play a critical role in timely detection and treatment of sepsis; however, the symptoms of sepsis can be similar to many other conditions, making sepsis hard to diagnose in its early stages.[16] Patients with sepsis need rapid treatment, including antibiotics, fluids, and intensive monitoring.[17]

Several guidelines exist for management and treatment of patients with sepsis, such as the *Surviving Sepsis Campaign (SSC) International Guidelines for the Management of Sepsis and Septic Shock* for the care of hospitalized adult patients with (or at risk for) sepsis.[17] Compliance with early identification tools and bundled care, such as the *SSC Guidelines*, can improve the management of sepsis and reduce sepsis-related mortality.[18] However, not all SSC recommendations apply to all types of sepsis. Many recommendations focus on bacterial sepsis—the most common type—and may not apply to patients with viral or fungal sepsis. The *SSC Guidelines* are extensive but do not offer a "one size fits all" approach.[ii]

Many patients who survive sepsis experience poor long-term outcomes, including new or worsened cognitive impairments, physical disability, and vulnerability to further health complications.[19] In addition, sepsis creates a significant economic burden and is associated with increased inpatient, outpatient, and readmission costs.[5,20,21,22,23] Long-term health outcomes, such as cognitive impairments and physical disability, may lead to societal economic impacts including loss of employment and increased caregiving needs.[23]

The emergence of the COVID-19 pandemic in 2020 changed the epidemiology of sepsis in two ways. First, it increased the risk of developing sepsis. Second, the COVID-19 pandemic increased the incidence of viral sepsis, adding complexity to sepsis diagnosis and treatment.[25,26,27]

Data and Methods (Chapter 3)

This report used data from the Healthcare Cost and Utilization Project (HCUP), a family of healthcare databases and related software tools and products developed through a Federal-State-Industry partnership and sponsored by AHRQ.[28] HCUP databases bring together the data collection efforts of State data organizations, hospital associations, and private data organizations—the HCUP Data Partners—to create a national information resource of hospital inpatient, ambulatory surgery and services, and emergency department (ED) data (encounter-level hospital care data). HCUP would not be possible without the HCUP Data Partners.[iii]

[ii] The *SSC Guidelines* offer guidance for clinicians caring for patients with sepsis in the hospital setting, but they are not intended to replace the clinician's judgment in addressing patient-specific clinical issues.

[iii] Appendix A of this report provides a list of partner organizations providing data to HCUP and a description of the HCUP databases used for the analyses presented in this report. Appendix B provides descriptions of the data sources used to augment the information available in the HCUP databases. Appendix C describes the clinical coding of sepsis. Appendix D defines measures, patient and hospital characteristics, and calculations used in this report. Appendix E provides supporting information for each chapter of this report.

In this report, AHRQ used State-level and nationally representative HCUP data from 2016 to 2021 to present information on sepsis-related inpatient stays and ED visits at non-Federal acute-care hospitals in the United States. The report does not include detailed information about sepsis-related encounters in other healthcare settings such as ambulatory, rehabilitation, and long-term care. AHRQ used administrative data to identify sepsis, following the Sepsis-3 definition from the Third International Consensus Definitions Task Force.[4,iv]

Findings

Morbidity and In-Hospital Mortality Related to Sepsis (Chapter 4)

Inpatient stays related to sepsis at non-Federal acute-care hospitals in the United States increased from 1.8 million in 2016 to 2.5 million in 2021, an increase of nearly 40 percent over five years. For the majority of these inpatient stays, sepsis was the reason for the stay. Nonmaternal adults 18 years and older accounted for about 95 percent of sepsis-related inpatient stays. The aggregate hospital cost for sepsis inpatient stays (inpatient stays due to sepsis) at non-Federal acute-care hospitals in the United States increased from $31.2 billion in 2016 to $52.1 billion in 2021. Between 2016 and 2021, Medicare was expected to pay over half of the aggregate hospital costs for sepsis, and Medicaid almost 20 percent of the costs.

Sepsis diagnosis often occurs in the ED, where many hospitalized patients with sepsis receive their initial care. Hospital EDs served as the entry point for the inpatient admissions related to sepsis (ranging from 77.7 percent in 2016 to 85.6 percent in 2021).

Patients who experience sepsis, with or without post-sepsis syndrome, may need home healthcare, long-term care, or skilled nursing to address a range of short- and long-term effects, including issues with thinking, physical function, mood, behavior, and other worsening medical problems.[29] In 2021, nearly one-third of sepsis-related stays ended with a transfer to a post-acute care health facility, such as a skilled nursing, intermediate care, or rehabilitation unit. Additionally, almost one-quarter of sepsis-related stays resulted in a transfer to a short-term hospital.

Patients with sepsis face a high risk of hospital readmission, with rates comparable to those with congestive heart failure, acute myocardial infarction, pneumonia, and chronic obstructive pulmonary disease.[30] In 2021, about 16 percent of sepsis inpatient stays (156 all-cause readmissions per 1,000 sepsis inpatient stays) resulted in the patient being readmitted to hospitals within 30 days of discharge.

The emergence of COVID-19 significantly altered the epidemiology of sepsis, leading to a noticeable rise in sepsis-related hospital encounters, costs, and in-hospital mortality, particularly for patients with a COVID-19 diagnosis. Before 2020, the in-hospital mortality rate for sepsis hospital encounters was declining (from 143 in 2016 to 118 in-hospital deaths per 1,000 sepsis hospital encounters in 2019). In 2020, the in-hospital mortality rate was higher than that in 2016. In 2021, one in six patients with sepsis died in the hospital; among sepsis hospital encounters involving septic shock, one in three stays resulted in death.

[iv] Appendix D includes more information on the measures, definitions, and calculations used in this report.

Disparities in Sepsis Outcomes (Chapter 5)

Despite standardized treatment guidelines, there are disparities in sepsis hospital encounters and complications based on race and ethnicity, sex, and place of residence.[31] The in-hospital mortality rate, total hospital cost, and length of stay for sepsis hospital encounters was higher among non-White patients.[v] The percentage of inpatient stays related to sepsis was higher among male patients than female patients (9.0 vs. 6.3 percent in 2021). The in-hospital mortality rate for sepsis hospital encounters was higher among patients living in the most socially vulnerable communities[vi] than those living in the less socially vulnerable communities (181 vs.159 per 1,000 sepsis hospital encounters).

Disparities in sepsis hospital encounters and complications exist among different racial, ethnic, and geographic subpopulations of patients with sepsis. In 2021, nonmaternal adult patients aged 18 to 64 years living in rural areas were more likely to die during a hospital encounter for sepsis than patients in metropolitan areas. Such disparities highlight the need for sepsis care standards to account for at-risk and underserved populations. Similar considerations are important for initiatives related to patient education, to improve the early detection of sepsis and management of associated long-term effects after hospital discharge.

Hospital Burden of Sepsis (Chapter 6)

Physicians and nurses in the ED and inpatient settings play a critical role in prompt detection and treatment of sepsis. Variations in prompt recognition, diagnosis, treatment, and management of sepsis across hospitals can contribute to inter-hospital variation in the burden of sepsis on patients and hospitals.

Hospital-level outcomes for sepsis-related stays can vary by hospital location. About 85 percent of sepsis-related inpatient stays occurred in urban hospitals (2.1 out of 2.5 million inpatient stays in 2021). Urban hospitals had a higher proportion of sepsis-related stays, longer inpatient stays, greater costs, and higher in-hospital mortality rates compared with rural hospitals in 2019 and 2021. In rural areas, over 40 percent of patients diagnosed with sepsis and admitted for inpatient care were transferred to an inpatient setting at another hospital. In rural communities, patients with sepsis in public, non-Federal hospitals were five times more likely to be transferred to another hospital compared with those in private, for-profit hospitals (60.0 versus 13.1 percent in 2021).

Sepsis-related inpatient stays (caseload) vary by hospital characteristics. Among rural hospitals, the sepsis caseload was nearly twice as high as at private, for-profit hospitals compared with public, non-Federal hospitals (6.0 vs. 3.4 percent). Hospitals affiliated with a multi-hospital system had a sepsis caseload that was 84 percent higher than hospitals not affiliated with a multi-hospital system.

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[v] Non-White patient populations include the following racial and ethnic groups: Asian and Pacific Islander, Hispanic, and non-Hispanic Black patients.

[vi] Social vulnerability designation in this report is based on the Social Vulnerability Index (SVI). SVI is a measure of a community's ability to prevent human suffering and financial loss during a disaster. U.S. ZIP Codes were categorized into quartiles based on the SVI value of the Zip Code. Hospital ZIP Codes with values in the fourth quartile were categorized as being in the most vulnerable communities; hospitals in other ZIP Codes categorized as being in less vulnerable communities. See Appendix D for more information on hospital characteristics.

Outcomes associated with sepsis hospital encounters (encounters due to sepsis) also varied by hospital characteristics. In-hospital mortality rate for sepsis hospital encounters varied by hospital ownership, bed size, and intensive care unit (ICU) bed capacity. Among rural hospitals, private for-profit hospitals had a rate that was 52.1 percent higher than public non-Federal hospitals (143 vs. 94 per 1,000 sepsis hospital encounters). In contrast, among urban hospitals, public non-Federal hospitals had the highest rate—20.4 percent higher than private for-profit hospitals (189 vs. 157 per 1,000 sepsis hospital encounters). Among urban hospitals, public non-Federal hospitals had the highest cost, 58.4 percent higher than private for-profit hospitals ($34,500 vs. $21,800).

State Variation in Hospital Encounters Involving Sepsis (Chapter 7)

The percentage of inpatient stays for sepsis, the percentage of hospital costs related to sepsis, and the in-hospital mortality rate for sepsis hospital encounters vary by State. From 2019 to 2021, the in-hospital mortality rate among sepsis inpatient stays increased for every State and the District of Columbia, and 15 States experienced at least a 20 percent increase. In the same period, 45 States and the District of Columbia saw an increase in the percentage of aggregate hospital cost attributable to sepsis stays.

Conclusion (Chapters 8 and 9)

This report offers a comprehensive overview of hospital care for sepsis in the United States from 2016 to 2021. It includes background information on the causes, progression, comorbidities, risk factors, complications, and treatment of sepsis, along with detailed statistics on hospital encounters for sepsis and its burden on the hospital system. The report also examines the hospital stays and outcomes of sepsis for hospital encounters involving COVID-19.

Tracking sepsis incidence, treatment, and outcomes is challenging due to the absence of a "gold standard" diagnostic protocol. Due to the increasing concern about sepsis-related hospital use and outcomes, Federal and State agencies, along with nongovernmental organizations, have invested in surveillance and quality improvement efforts to enhance the use of evidence-based practices in sepsis care and to monitor sepsis morbidity and mortality over time.

Disparities and geographic variation—in sepsis caseloads, in-hospital mortality rates, and total hospital costs—highlight the need for targeted initiatives to improve patient outcomes and to reduce financial strain on healthcare institutions. To sustain and improve care and outcomes, international guidelines for sepsis recognition and management must be updated and refined on an ongoing basis, together with care bundles and quality improvement initiatives. Such efforts will also require continued investments by Federal, State, and nongovernmental entities to further strengthen the surveillance and quality improvement systems that ensure access to evidence-based care and resources for patients with sepsis. In addition, more research is needed to understand the root causes that lead to the burden of sepsis in acute, post-acute, and ambulatory settings and the long-term impacts on patients and healthcare providers in the United States.

Chapter 1. Introduction

Always with a smile on her face, our 6-year-old daughter, Evelyn, was on the go from morning to night. She had to be doing something, and we had to keep up! Evelyn was a kindergarten student and loved going to school, often doing schoolwork even when she did not have to. Evelyn lived life big, and her love for her family was endless.

On Tuesday, January 3, 2023, Evelyn came home from school not feeling well. That evening, she had a fever of 103.4 degrees Fahrenheit, along with vomiting and an overall feeling of being ill. We decided to call the pediatrician's office for peace of mind. The doctor reassured us that fevers happen and advised treating with fever-reducing medication. Evelyn's fever came down, and she showed signs of improvement. The next day, we decided to keep Evelyn home from school just to be safe. She continued to show signs of improvement, with normal eating, drinking, and full of energy. However, that evening, she spiked a fever again, and she lacked energy into the next day.

On the morning of Friday, January 6th, Evelyn woke up with rapid breathing and complained of abdominal pain. At this point, we were concerned and decided to take her to the ER. Our brave girl walked herself into the ER. Within a few hours of being in the ER, it was determined that Evelyn needed higher medical care and was transported to a children's hospital by ambulance.

During transport to the children's hospital is when I first heard the words "septic shock." The paramedics worked to stabilize Evelyn's vitals, as she had a very high heart rate and very low blood pressure. I was completely confused and had no idea what was happening. At this point, Evelyn continued to complain of abdominal pain and a lack of feeling in her feet.

When we arrived at the children's hospital, we were met with a team of doctors. Within an hour of arrival, Evelyn was placed on a ventilator in hopes of giving her body a chance to rest and giving the antibiotics a chance to fight the infection. From that point on, her condition continued to deteriorate. At one point early Friday night, just 12 hours from her walking into the emergency room, we asked the doctor about her chances of making it through the night and were met with an answer we could not comprehend: "50/50." With each passing hour, she was being placed on more life-supporting machines as her body was shutting down. Her body was being supported by the ventilator, extracorporeal membrane oxygenation (ECMO), and continuous renal replacement therapy (CRRT). As if these machines were not overwhelming enough, we were also told that Evelyn might need her extremities amputated due to the lack of blood flow to her hands and legs. Evelyn survived the night and continued her fight into Saturday. We were so proud of our brave girl and the strength and courage she showed during her fight.

On Saturday, Evelyn's vitals continued to be unstable; however, she did have some very small victories. By late afternoon, her infection numbers were plateauing, and bloodwork showed slight signs of improvement. We had some hope. Saturday evening, we were told that Evelyn might need a CT scan because there was a concern that she had decreased brain function. When the CT scan was complete, it showed that she had suffered a stroke on the left side of her brain. A couple of hours after that, it was determined that the clot

had traveled to her spinal cord. There was nothing more they could do for our sweet Evelyn.

On Sunday morning, we had to call our two older children (12 and 14), who were staying with family during this, and explain to them that they needed to come say goodbye to their sister. We stood by Evelyn's side as her brother, sister, grandparents, aunts, uncles, and cousins said their goodbyes. Nothing can prepare you for this moment. Sunday evening at 5:48, Evelyn passed away after being removed from life support.

The doctors determined that Evelyn most likely had a urinary tract infection, and she also tested positive for Strep A. At one point, a doctor told us it was the worst case of sepsis they had ever seen. We had no idea that sepsis could be so ugly and attack a beautiful, healthy little girl the way that it did. Since the passing of Evelyn, we have had a need to spread awareness about sepsis in children. We will continue to tell Evelyn's story, which now, unfortunately, includes sepsis. She had such a bright personality that will continue to shine through us.

-Story told by Evelyn's mother, Beth, through END SEPSIS[32]

Background

Sepsis is one of the most expensive conditions treated in hospitals in the United States.[5] From 2016 to 2019, the number of sepsis-related inpatient stays in the United States increased by 20.1 percent to 2.1 million stays.[33] Two years later (2021), the number climbed to about 2.5 million sepsis-related inpatient stays. The majority of these stays were principally for sepsis, accounting for $52.1 billion or 9.9 percent of all hospital costs.[33] One in three patients who died in a hospital had sepsis during their hospitalization.[34]

Anyone can develop sepsis.[6] It can begin suddenly and requires urgent medical care.[6] Clinicians in hospital settings play a critical role in the timely detection and treatment of sepsis; however, the symptoms of sepsis can resemble those of many other conditions, making sepsis hard to diagnose early.[16] Patients with sepsis need rapid treatment, including antibiotics, fluids, and intensive monitoring.[17] Across hospitals, differences in practice patterns and resource capacity contribute to variations in sepsis-related health outcomes.[35,36] Delays in recognition, diagnosis, and treatment contribute to the high death rate for sepsis.[37]

Sepsis-related mortality also varies geographically within the United States. The southeastern and mid-Atlantic regions have higher rates of sepsis-related mortality than other regions.[38] Higher rates may reflect lower socioeconomic status, lack of healthcare access, and prevalence of other risk factors.[39,40]

Patients from certain racial and ethnic minority populations experience increased hospitalization and complications from sepsis.[41,42,31] Compared with White patients, Black patients have higher rates of hospitalization for sepsis.[43,44] Black patients also have higher rates of severe sepsis.[45] Black, Hispanic, and American Indian and Alaska Native patients have higher sepsis-related mortality rates than White patients.[45,46]

In the United States, maternal sepsis is the fourth leading cause of maternal mortality, occurring in a relatively small percentage of deliveries (0.04 percent) but accounting for 23 percent of all

maternal deaths.[47] The overall incidence of maternal sepsis has been on the rise: between 2016 and 2021, there was a 61 percent increase in the number of maternal sepsis-related inpatient stays.[33] As with sepsis overall, there are racial and ethnic disparities in maternal sepsis: Black women are more likely to experience maternal sepsis than other racial and ethnic groups.[46] For U.S. children, sepsis is a leading cause of death.[48] From 2016 to 2019, aggregate hospital costs increased by 42.6 percent for pediatric (children aged 28 days–17 years) sepsis stays, to $1.0 billion and remained at that level through 2021.[33] Between 2016 and 2021, sepsis-related stays decreased for neonates (infants less than 28 days old); however, in-hospital mortality rates increased.[33] Neonatal sepsis is more likely to affect pre-term infants.[49]

Many patients who survive sepsis experience poor long-term outcomes, with new or worsened cognitive impairments, physical disability, and vulnerability to health complications.[50] Sepsis also creates a significant economic burden and is associated with increased inpatient, outpatient, and readmission costs.[5,20,21,22,23] From 2016 to 2021, aggregate hospital costs for sepsis-related inpatient stays increased by 66.8 percent, to $52.1 billion dollars.[33] Long-term outcomes, such as cognitive impairment and physical disability, can also lead to societal economic impacts including loss of employment and increased caregiving needs.[24]

Report Overview

In this report, AHRQ responds to the charge from the U.S. Congress in the Fiscal Year 2023 Omnibus Spending Bill directing the Agency for Healthcare Research and Quality (AHRQ) to "*conduct a comprehensive set of studies that calculate the morbidity, readmission, and mortality related to sepsis with respect to pediatrics, maternal sepsis, nursing home care, and rehabilitation, and the association of pandemic-related changes in the healthcare system on the burden of sepsis*."[3] Appendix E.1 includes an explanatory statement from the Senate Appropriations Committee that provides a summary of recommendations related to sepsis from the Labor, Health and Human Services, and Education, and Related Agencies (Labor-HHS-Education) appropriations bill.

The report presents descriptive statistics on the burden of sepsis to the hospital system in the United States, including the prevalence and cost of sepsis inpatient stays (inpatient stays due to sepsis) and ED visits, demographic and socioeconomic patient characteristics of those hospitalized with sepsis, and geographic and hospital variation in sepsis-related hospital care and outcomes from 2016 to 2021. With the emergence of COVID-19 in 2020, more patients presented to hospitals with sepsis, and patients with COVID-19-associated sepsis have had higher in-hospital mortality rates than those with bacterial sepsis.[6,51] The impact of COVID-19 and sepsis together is highlighted throughout this report.

AHRQ offers this report as a comprehensive overview of hospital care for sepsis in the United States, to help develop effective strategies to combat sepsis. The report's eight chapters are organized into three parts, as follows:

Context of sepsis in the United States

- Chapter 2: What is Sepsis?
- Chapter 3: Methods
- Chapter 4: Morbidity and In-Hospital Mortality Involving Sepsis

Variation in sepsis-related hospital care and outcomes

- Chapter 5: Disparities in Sepsis Outcomes
- Chapter 6: Hospital Burden of Sepsis
- Chapter 7: State Variation in Hospital Encounters Involving Sepsis

Resources and programs to identify and manage sepsis

- Chapter 8: Resources and Programs for Early Identification and Management of Sepsis

Chapter 2. What is Sepsis?

2.1 Clinical Background

Sepsis is the body's dysregulated inflammatory response to an infection that results in tissue damage and organ failure and can lead to death.[4] It is commonly caused by bacterial infections (for example, *Staphylococcus aureus [Staph]*, *Escherichia coli [E.coli],* and some species of *Streptococcus*)[52] but can result from other infectious sources, including viruses (such as COVID-19) and fungi.[34] The definition of sepsis has changed over time; the current consensus definition requires clinically significant organ dysfunction in the setting of suspected infection (Appendix E.2.1).

Patients with sepsis can die or suffer significantly, experiencing severe co-occurring conditions, prolonged hospital stays (averaging 7 to 10 inpatient days[34,53]), and readmissions. The most severe form of sepsis is septic shock, which occurs when a patient's blood pressure drops to dangerously low levels despite adequate fluid volume in the body. Septic shock requires specific medications called vasopressors to keep blood pressure high enough to support life, and can result in the failure of multiple organ systems, increasing the risk of death.[4] The mortality rate for sepsis is estimated to be between 15 and 28 percent,[34,52,54] and almost 40 percent of patients with septic shock die within 90 days.[55]

2.1.1 Risk factors

Sepsis disproportionately affects older adults and those who have other major medical problems or impaired functional status.[7,56] Patients who are immunocompromised (for example, organ transplant recipients or patients with cancer diagnoses, HIV/AIDS, or renal/hepatic failure) are at increased risk of developing sepsis. Patients with immune dysfunction experience higher mortality associated with sepsis.[57]

Certain comorbidities may place patients with sepsis at increased risk of death, including hypertension, fluid and electrolyte disorders, cancer, chronic lung disease, heart failure, liver or kidney disease, neurologic disorders, and peripheral vascular disease.[9,58]

2.1.2 Post-sepsis syndrome

Post-sepsis syndrome refers to a variety of short- and long-term effects and impairments among those who survive sepsis, including problems with thinking, physical function, mood and behavior, and other worsening medical conditions.[57,59,60,61,62,63] Such effects and impairments can lead to increased healthcare utilization, including hospital readmissions, use of home healthcare, and long-term or skilled nursing facility stays.[64,65,66] Risk factors for post-sepsis syndrome include chronic health conditions, delirium during hospitalization, vision and hearing impairments, older age, prior nursing home care, socioeconomic factors, and lack of family support.[67,68,69] Inpatient and outpatient interventions can prevent and decrease symptoms of post-sepsis syndrome, using prompt and effective management strategies to address delirium, early mobilization to improve physical function, and pain management.[70]

2.2 Sepsis in Maternal, Pediatric, and Neonatal Patient Subpopulations

There are important differences in sepsis etiology, progression, and treatment among certain subpopulations of patients.[71] See Appendix E.2.1 for more about the definitions of sepsis in subpopulations.

2.2.1 Maternal sepsis

Maternal sepsis presents during pregnancy or the postpartum period.[72] While similar to adult sepsis, maternal sepsis is marked by specific signs of organ dysfunction that differ from those evident in other adult populations, due to normal physiologic changes during pregnancy. Cesarean delivery is the most common risk factor for maternal sepsis, along with smoking, co-occurring conditions (such as diabetes or hypertension), prolonged labor, autoimmune disease, obesity, and poor nutrition.[46,47,73] Maternal sepsis is associated with an increased risk of multiple adverse perinatal outcomes, including preterm birth, stillbirth, maternal mortality, and transmission of pathogenic bacteria to the newborn, causing early-onset neonatal sepsis.[74,75]

2.2.2 Pediatric sepsis

Pediatric sepsis occurs in children 28 days through 18 years of age. For children, the definition of sepsis has recently been aligned with the definition for adults, to focus on a suspected infection with life-threatening organ dysfunction.[76,77,78] The most common bacterial pathogens in pediatric sepsis include *Staph*, *E.coli*, *Streptococcus* species other than *Streptococcus pneumoniae*, *Candida* species, and *Pseudomonas aeruginosa*—all common among children with chronic diseases.[13]

2.2.3 Neonatal sepsis

Neonatal sepsis is defined as detection of a pathogen from a normally sterile body fluid, such as blood or cerebrospinal fluid, in infants less than 28 days old.[79] There are two types of neonatal sepsis, based on pathogenesis and microbiology: 1) early-onset sepsis generally develops within 72 hours of birth from pathogens transmitted during pregnancy or birth, commonly due to Group B *Streptococcus* and *E.coli*; and 2) late-onset sepsis, which develops more than 72 hours after birth and is primarily caused by transmission of pathogens (commonly from *Staph*) from the surrounding environment such as healthcare facilities.[49,75] For neonatal sepsis, maternal risk factors include maternal history (for example, exposure to infectious diseases, bacterial colonization, immunity), chorioamnionitis (a bacterial infection of the membranes that surround the fetus and the amniotic fluid), urinary tract infections; neonatal factors include prematurity, low birth weight, and need for invasive devices such as central lines.[80]

2.3 Early Recognition of Sepsis

Early recognition of sepsis is important for all populations. Together with timely use of guideline-based interventions, early recognition is associated with improved in-hospital mortality.[14,15] Early recognition with attention to infection source control (that is, surgery or drainage) can also improve in-hospital mortality.[81]

For maternal sepsis, three pregnancy-specific scoring systems that account for normal pregnancy-related physiologic changes can support early recognition of maternal deterioration and sepsis—the Modified Obstetric Early Warning System (MOEWS),[82] the Sepsis in Obstetrics Score (S.O.S),[83] and the obstetric modified quick Sequential Organ Failure Assessment (omqSOFA).[84] Recognizing sepsis in neonates relies on laboratory values since symptoms are rarely identifiable.[80]

Diagnosing sepsis in adults can be challenging, as the presentation is often subtle, the time of onset usually unknown, and symptoms may be attributed to non-infectious conditions.[85,86,87] Several organizations have developed tools to support a standardized approach for early detection of sepsis in adults (for example, care bundles, checklists, protocols),[88] but evaluations of tool implementation have yielded mixed results.[89]

Recent studies have explored using machine learning (ML)-based early warning systems for early recognition of sepsis. The algorithms use electronic health record (EHR) data such as blood pressure, heart rate, lactate level, age, and comorbidities to identify patients at increased risk for sepsis before clinicians typically make the diagnosis.[90] Studies have shown improved early recognition using ML models; additional studies with better experimental methods are needed to demonstrate consistent and system-wide improvement in patient-centered outcomes.[91] See Appendix E.2.2 for more information about evaluations of ML models.

2.4 Management and Treatment of Sepsis

There are several guidelines for managing and treating patients with sepsis. The Surviving Sepsis Campaign (SSC) *International Guidelines for the Management of Sepsis and Septic Shock* provide guidance on the care of hospitalized adult patients with (or at risk for) sepsis.[17] The Society for Critical Care Medicine (SCCM) and the European Society of Intensive Care Medicine (ESICM) sponsor the guidelines, with methodological support from the Guidelines in Intensive Care Development and Evaluation (GUIDE) group and endorsement by 24 additional societies.

The 2021 SSC *Guidelines* outline recommendations based upon the strength and quality of evidence, including:

- Standardized approach to screening for patients with sepsis and septic shock
- Initial fluid resuscitation for most patients unless clinically contraindicated
- Appropriate and early antimicrobial administration with assessment for multi-drug resistant (MDR) organisms
- Control of infection source, such as repair of perforation of the gastrointestinal tract or removal of an infected device
- Use of vasopressors (blood pressure-supporting medications) for shock

In recent years, MDR organisms have become a particular concern. A 2021 Infectious Diseases Society of America (IDSA) position paper notes that overuse of antibiotics for presumed bacterial sepsis may contribute to the emergence of MDR organisms without clear benefit to patients. The IDSA suggests immediate antibiotics administration (within one hour) for patients with septic shock.[92]

As noted earlier, use of early identification tools such as the SSC *Guidelines* and of bundled care can improve management of sepsis and reduce sepsis-related mortality.[86] The 2021 SSC *Guidelines* include recommendations to treat many aspects of organ dysfunction in sepsis, but there is no "one size fits all" approach. Many recommendations focus on bacterial sepsis—the most common type—and may not apply to patients with viral or fungal sepsis. In addition, patients with sepsis require ongoing reevaluation to determine the need for further life-saving measures (for example, ongoing assessment for additional fluid resuscitation). See Appendix E.2.3. for more information on managing and treating sepsis.

2.4.1 Treatment considerations for patient subpopulations

Maternal sepsis treatment

More research is needed to evaluate the efficacy of sepsis bundles and clinical care pathways for rapid diagnosis and treatment of maternal sepsis. However, experts recommend implementing sepsis bundles on the premise that standardized care will help improve outcomes.[18] The "golden hour" of sepsis management for obstetric patients entails quick recognition of sepsis, timely administration of antibiotics, and escalation of care to reduce poor outcomes and the risk of maternal death.[93,94,95]

In addition, timely consultation with infectious disease and critical care specialists may contribute to sepsis survival, especially for septic shock, which is associated with higher risk of maternal mortality.[96] Due to the risk of preterm birth, maternal-fetal medicine and neonatology specialist may decide to administer corticosteroids for fetal lung maturity and additional obstetric interventions, depending on gestational age.

Pediatric and neonatal sepsis treatment

In 2020, SCCM and ESICM published consensus-based recommendations for managing septic shock and sepsis-associated organ dysfunction in full-term newborns and children (37 weeks gestation at birth to 18 years old).[97] The recommendations include those specific to general sepsis management, adjusted to patient age and physiological development. Some of the strongest recommendations concern the administration of antibiotics within one hour for patients in septic shock and the administration of bolus fluids only in intensive care unit (ICU) settings, to ensure safe patient care. As with maternal sepsis, the "golden hour" for managing neonatal sepsis requires prompt initiation of intravenous fluids and antibiotics and may lead to better patient outcomes.[98]

See Appendix E.2.4. for more information on treatment considerations.

2.5 COVID-19 and Sepsis

Until 2020, the majority of hospitalized sepsis cases were bacterial and viral sepsis was less common.[99] The COVID-19 pandemic brought a temporary, fundamental change to sepsis epidemiology in the United States, with many cases of COVID-19-related viral sepsis in the early months of the pandemic.

Understanding sepsis in the context of COVID-19 requires assessing the prevalence, clinical characteristics, and outcomes of sepsis caused by the SARS-CoV-2 infection compared with

other pathogens. Retrospective analyses of patients admitted during the height of the pandemic (March 2020 through November 2022) showed that in-hospital mortality for patients admitted with SARS-CoV-2-associated sepsis was higher than for patients with presumed bacterial sepsis, although case counts and in-hospital mortality trended downward by November 2022.[51] The COVID-19 pandemic underscored longstanding challenges in managing sepsis, related to its overall complexity, the importance of early recognition and informed treatment decisions, and the potentially devastating impacts of sepsis. Lessons learned from managing COVID-19-related viral sepsis are "critical in informing better prevention and treatment strategies and guiding research, policy, and resource allocation decisions to combat sepsis (including viral and other pathogens caused sepsis)."[100]

Chapter 3. Methods

This chapter provides: 1) an overview of the Healthcare Cost and Utilization Project (HCUP); 2) background on the data sources used in this report; and 3) the methods used with HCUP databases to identify inpatient stays and emergency department (ED) visits involving sepsis.

3.1 Healthcare Cost and Utilization Project (HCUP)

This report uses data from HCUP, a family of healthcare databases and related software tools and products developed through a Federal-State-Industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ).[28] HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information that became publicly available in 1988. These databases enable research on a broad range of health policy issues, including cost and quality of health services, medical practice patterns, access to healthcare programs, and outcomes of treatment at the national-, State-, and local market-levels. HCUP databases bring together the data collection efforts of State data organizations, hospital associations, and private data organizations—the HCUP Data Partners—to create a national information resource of hospital inpatient, ED and ambulatory surgery and services data (encounter-level hospital care data). HCUP would not be possible without their contributions. There are 49 HCUP Data Partners representing 48 States and the District of Columbia. See Appendix A for a current list of HCUP Data Partners.

This report uses 2016–2021 HCUP data to present information on sepsis-related inpatient stays and ED visits at non-Federal, acute-care hospitals in the United States. Detailed information is not included about sepsis-related encounters in other healthcare settings such as ambulatory, rehabilitation, and long-term care.

3.2 Data Sources

3.2.1 HCUP databases

This report uses four HCUP databases:

- The **National Inpatient Sample (NIS)**[101] is a sample of inpatient stays from all HCUP States that yields national estimates of inpatient utilization and outcomes when weighted.
- The **Nationwide Emergency Department Sample (NEDS)**[102] is a sample of hospital-owned EDs from HCUP States that yields national estimates of ED utilization and outcomes when

weighted. The NEDS contains ED encounters for patients treated and released from the ED and patients admitted to the same hospital through the ED.

- The **State Inpatient Databases (SID)**[103] contain inpatient discharge information from most acute-care hospitals in HCUP States, translated into a uniform format to facilitate multi-State comparisons and analyses.
- The **State Emergency Department Databases (SEDD)**[104] include discharge information from HCUP States on ED visits that do not result in an inpatient admission to the same hospital (that is, patients being evaluated before transfer to another acute-care hospital, being discharged to their home or to rehabilitation/long-term care health facility, leaving against medical advice, or dying in the ED before admission). The SID also includes information on ED visits that resulted in an admission to the same hospital.

See Appendix A for more information about the HCUP databases.

3.2.2 Additional data sources

AHRQ supplemented the HCUP databases with data from the following sources:

- American Hospital Association Annual Survey of Hospitals, for most hospital characteristics (for example, bed size, ownership, teaching status).[105]
- Compendium of United States Health Systems (a data resource for AHRQ's Comparative Health System Performance Initiative), for information on hospital system affiliation.[106]
- Trauma Information Exchange Program, to identify hospital trauma center level.[107]
- Federal Office of Rural Health Policy, for ZIP Code-level data to identify rural areas.[108]
- National Center of Health Statistics county-level classifications, to distinguish between small and large metropolitan areas; these classifications are designed to study associations between urbanization level of residence and health.[109]
- Social Vulnerability Index (SVI) developed by the Department of Health and Human Services Office of Minority Health in partnership with the U.S. Centers for Disease Control and Prevention (CDC), to identify socially vulnerable communities.[110]
- United States Census Bureau (USCB) annual county-level resident population estimates, used to develop population-based rates,[111] with one exception. The population denominators for reporting by community-level income were based on ZIP Code-level resident population estimates from Claritas (a vendor that produces population projections based on data from USCB).[112]

See Appendix B for more information about data sources for the report.

3.3 Defining Sepsis

This report is consistent with the Third International Consensus Definitions Task Force definition of Sepsis-3[4]—identification of inpatient stays and ED visits related to sepsis is based on ICD-10-CM diagnoses for septic shock, severe sepsis, or another sepsis diagnosis with an indication of organ dysfunction for maternal stays (regardless of age) and adults (aged 18 years and older). The identification of maternal stays is specific to there being an indication of a maternal condition at the hospitalization involving sepsis. To identify sepsis for neonates and children (under 18 years of age), criteria include the same sepsis diagnoses as for adults but do not require an indication of organ dysfunction when there is no report of septic shock or severe

sepsis. See Appendix C for the clinical coding criteria used to define sepsis, organic dysfunction, and maternal stays.

Inpatient stays for patients with sepsis present on admission—community-acquired sepsis—account for 80 to 90 percent of all cases.[9,113] This report does not distinguish between inpatient stays in which sepsis was community-acquired and cases that developed after the patient was admitted (hospital-onset).

For this report, AHRQ used measures of inpatient and ED utilization and population rates based on any diagnosis of sepsis, whether or not sepsis was the reason for the hospital encounter (reported as the principal diagnosis on an inpatient stay or the first-listed diagnosis on an ED visit)[vii] or whether sepsis was reported as a co-occurring condition or complication of the hospital encounter (reported as a secondary diagnosis). Sepsis was required to be the reason for the hospital encounter for measures including length of stay, hospital cost, in-hospital mortality, discharge disposition, and readmission rates. For stays in which sepsis was only a co-occurring condition or complication, other conditions such as cancer or heart failure may be the reason for the hospitalization and might contribute to increased length of stay or to hospital costs; outcomes for such stays cannot be attributed solely to sepsis. See Appendix D for more information on the measures, definitions, and analyses used in the report.

3.4 Statistical Methods

There are several considerations related to statistical analysis in this report:

- For the national weighted estimates derived from the HCUP NIS and HCUP NEDS, the significance level for determining whether differences are statistically significant is 0.05. Statistical tests adjust for multiple comparisons that occur when two or more hypotheses are tested. The significance level varied by the number of comparisons: level of 0.05 for 1–2 tests and 0.01 for 3–10 tests.[viii]
- State-specific and hospital-level estimates generated from the HCUP SID and/or SEDD are reported as observed in the data.
- Consistent with the HCUP Data Use Agreement,[114] no estimates based on 10 or fewer observations or based on data from fewer than two hospitals are reported.

The large sample size of the HCUP databases means that small differences can be statistically significant but not clinically important. For this reason, only differences of at least 10 percent are discussed in the report text.

[vii] ICD-10-CM Coding Guidelines often require the sepsis infection to be reported as the principal diagnosis and the R65.2 codes for severe sepsis to be coded as a secondary diagnosis. See Appendix C for more information.
[viii] Reducing the p-value used for multiple significance testing aims to ensure that the overall "experiment-wise" Type I error rate (false positive rate) does not exceed 10 percent.

Chapter 4. Morbidity and In-Hospital Mortality Involving Sepsis

HIGHLIGHTS

- From 2016 to 2019, hospital utilization and costs related to sepsis increased, while in-hospital mortality rates for sepsis decreased.
- Starting in 2020, there has been an increase in sepsis-related hospital encounters, hospital costs, and in-hospital mortality, especially for patients with COVID-19.
- In 2021, more than one in ten patients hospitalized for sepsis died in the hospital. For sepsis hospital encounters involving septic shock, one in three hospital encounters resulted in death.
- In 2021, the average hospital stay for sepsis was 9.2 days and cost $28,800. There were over 16.7 million hospital days for sepsis and aggregate hospital costs of over $52.1 billion.
- Over 70 percent of costs for sepsis inpatient stays were expected to be billed to public payers, with an aggregate annual cost of $38 billion in 2021.

To understand the morbidity and mortality related to sepsis, it is important to examine trends in sepsis-related hospital encounters, hospital costs, and in-hospital mortality before and after the onset of the COVID-19 pandemic. According to the U.S. Centers for Disease Control and Prevention (CDC), most cases of sepsis start before a patient goes to the hospital.[38] Hospital EDs are common entry points for acute illness, and sepsis is no exception, as early symptoms often overlap with conditions commonly treated in the ED.[115] Early symptoms of sepsis can be indistinct or nonspecific and suggest different infectious and non-infectious diagnoses. Even when infection is known, projected course and severity can be difficult to predict on initial assessment. Such uncertainty can lead to missed or delayed diagnoses of sepsis, overdiagnosis with antibiotics overtreatment (which contributes to antimicrobial resistance), and/or delayed or missed diagnoses of other non-infectious conditions (for example, pulmonary embolism, cardiogenic shock) that require immediate intervention.[53] Treating sepsis early is critical; however, competing diagnoses (with different care guidelines) and varied evidence for managing sepsis are challenging for clinicians to address in their brief interactions with clients in an ED.[53] Once admitted for an inpatient stay for sepsis, patients with a severe infection may need resource-intensive services and mechanical ventilation.[116]

The emergence of the COVID-19 pandemic in 2020 changed the epidemiology of sepsis in two ways. First, it increased the risk of developing sepsis. Second, it added complexity to sepsis diagnosis and treatment by significantly increasing the incidence of viral sepsis, which can require different treatment from bacterial sepsis.[25,26,27]

This chapter is organized into four sections. The first section presents trends in sepsis-related hospital utilization in the United States from 2016 to 2021. The second section focuses on trends in aggregate in-hospital mortality and hospital costs associated with sepsis. The third section examines trends in sepsis-related hospital utilization, morbidity, and in-hospital mortality

for key subgroups—adults (nonmaternal), maternal, pediatric, and neonatal populations. The final section reviews sepsis epidemiology related to the COVID-19 pandemic.

Methods in Chapter 4: Data are from the 2016–2021 Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) and Nationwide Emergency Department Sample (NEDS) and the 2021 State Inpatient Databases (SID) and State Emergency Department Databases (SEDD).

Results are considered statistically significant at the 0.05 significance level or lower. Statistical tests adjust for multiple comparisons that occur when two or more hypotheses are tested. The large sample size of HCUP databases means that small differences may be statistically significant but not clinically important. Thus, only differences of at least 10 percent that are statistically significant are presented.

See Appendix C for the clinical coding criteria for sepsis; Appendix D for more information about measures, characteristics, and analyses; and Appendix E for data tables that support this chapter.

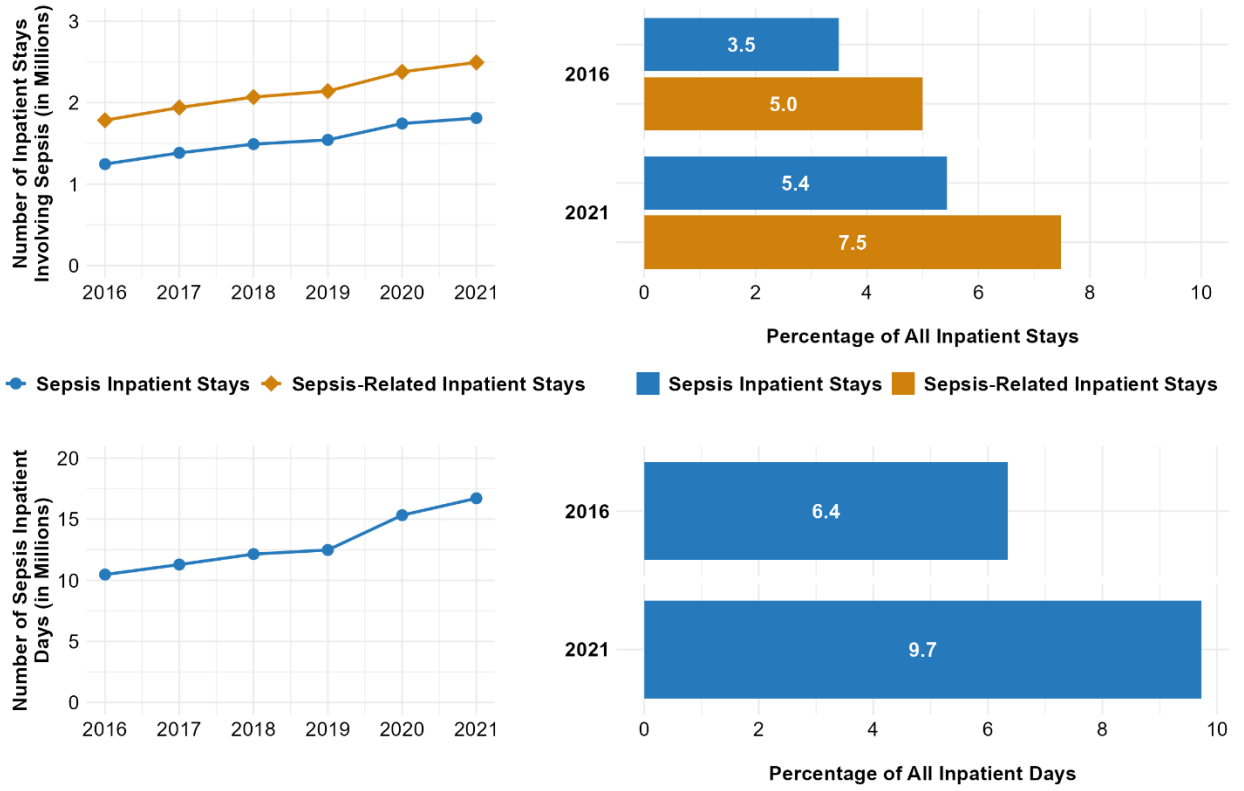
4.1 Overview of Hospital Encounters Involving Sepsis in the United States

4.1.1 Trends in inpatient stays involving sepsis

Inpatient stays. From 2016 to 2021, the number of sepsis-related inpatient stays at non-Federal acute-care hospitals in the United States increased by almost 40 percent, from 1.8 million to 2.5 million over the five-year period; see Exhibit 4.1. Most inpatient stays were principally for sepsis (1.2 million stays in 2016 and 1.8 million in 2021). In 2016, sepsis was diagnosed in approximately 5 percent of all inpatient stays in the United States, rising to 7.5 percent by 2021; see Appendix Table E.4.1.

Hospital days. For sepsis inpatient stays (inpatient stays due to sepsis), the total number of hospital days increased by about 60 percent, from 10.5 million in 2016 to 16.7 million in 2021. From 2016 to 2021, sepsis inpatient stays rose from 6.4 percent to 9.7 percent of total hospital days. The average length of hospital stay for sepsis was 8.4 days in 2016 and 9.2 days in 2021; see Appendix Table E.4.1.

Exhibit 4.1. Trends in Inpatient Stays and Days Involving Sepsis, 2016–2021



Note: Sepsis-related inpatient stays were identified using all available diagnoses. Sepsis was not required to be the reason for the stay. For sepsis inpatient stays, sepsis was the reason for the stay (principal diagnosis). See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.4.1 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2016–2021.

4.1.2 Emergency department care involving sepsis

Inpatient stays involving ED services. A first diagnosis of sepsis frequently occurs in the ED, where many hospitalized patients with sepsis first receive care.[53,117] From 2016 to 2021, EDs were the entry point for most sepsis-related inpatient stays (from 77.7 percent in 2016 to 85.6 percent in 2021); see Appendix Table E.4.2. However, the ED is not the primary treatment location, as the severity of sepsis usually requires hospitalization.

Sepsis-related ED visits. The number of sepsis-related ED visits that did not result in an inpatient admission at the same hospital was much smaller than sepsis-related inpatient stays (104,700 ED visits vs. 2.5 million inpatient stays in 2021); see Appendix Tables E.4.1 and E.4.2. Such ED visits involved patients being evaluated before transfer to another acute-care hospital; being discharged to their home, a nursing home, or hospice with palliative care; leaving against medical advice; or dying in the ED before admission. About half were transferred to another acute-care hospital (from 52.4 percent in 2016 to 49.9 percent in 2021).[150] A relatively small

percentage of in-hospital deaths for sepsis hospital encounters occurred in the ED (from 1.5 percent in 2016 to 1.2 percent in 2021); see Appendix Table E.4.6.

4.1.3 Post-acute care transitions following sepsis-related inpatient stays

Transition to post-acute care. After hospitalization for sepsis, rehabilitation often begins in the hospital, but ongoing support and resources are needed for continued recovery post-discharge. Patients who experience sepsis, with or without post-sepsis syndrome, may need home healthcare, long-term care, or skilled nursing to address a range of short- and long-term effects, including issues with thinking, physical function, mood, behavior, and other medical problems.[29]

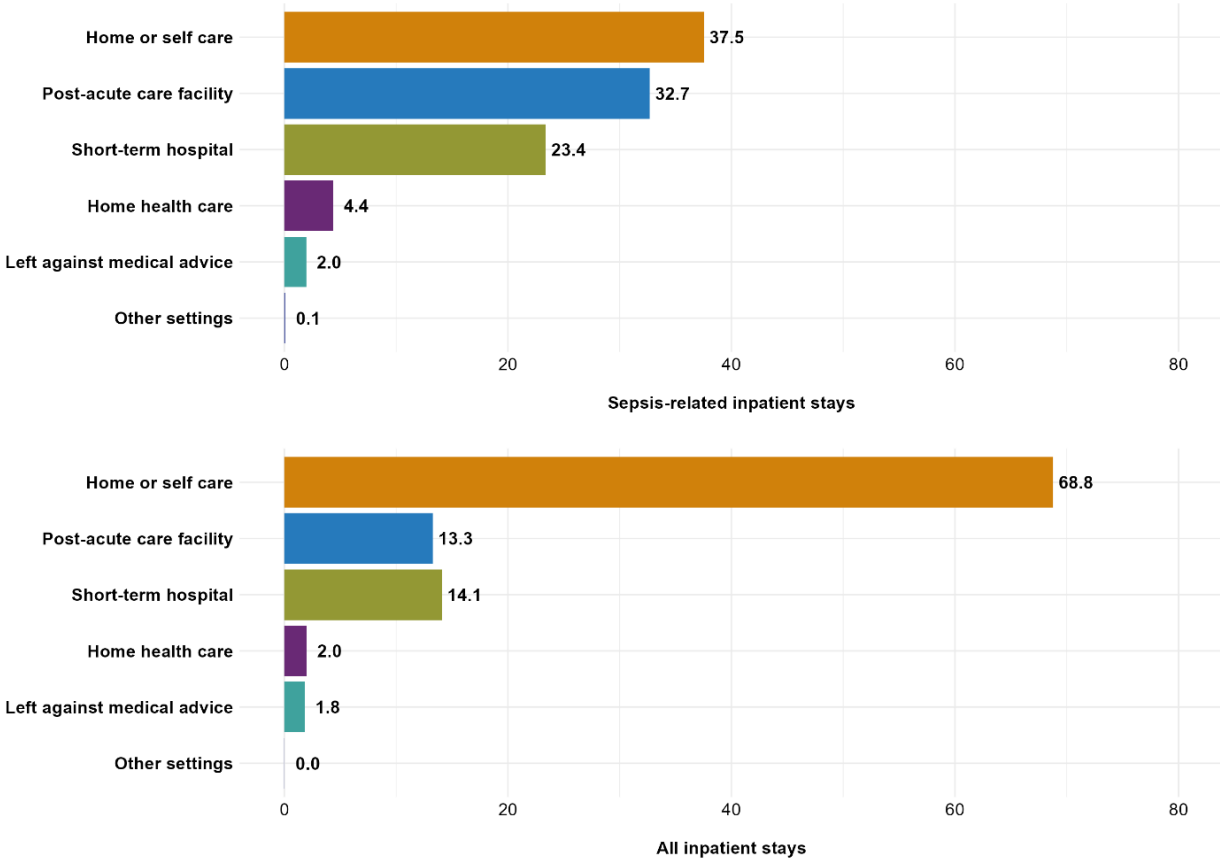
In 2021, just over one-third of sepsis-related inpatient stays that did not result in an in-hospital death ended with the patient discharged to their home or to a self-care setting.[ix] By comparison, more than two-thirds of all inpatient stays ended with discharge to home or a self-care setting; see Exhibit 4.2.

Nearly one-third of sepsis-related stays ended with a transfer to a post-acute care health facility—such as a skilled nursing, intermediate care, or rehabilitation unit—and almost one-quarter resulted in a transfer to a short-term hospital.

Transitions by subgroups. Among neonatal, pediatric (nonmaternal), and maternal populations, 75–85 percent of sepsis-related inpatient stays ended with a discharge to home or a self-care setting, and less than 15 percent transitioned to home healthcare or a post-acute care health facility; see Appendix Table E.4.4. Among nonmaternal adults with sepsis-related hospital stays, adults aged 65 and older were more likely to be discharged to home healthcare or a post-acute care facility (71 percent), compared with adults aged 18–64 years (41 percent).

[ix] Inpatient stays resulting in death during the stay were excluded from the analysis.

Exhibit 4.2. Post-Acute Care Transitions Following Sepsis-Related Inpatient Stays, 2021



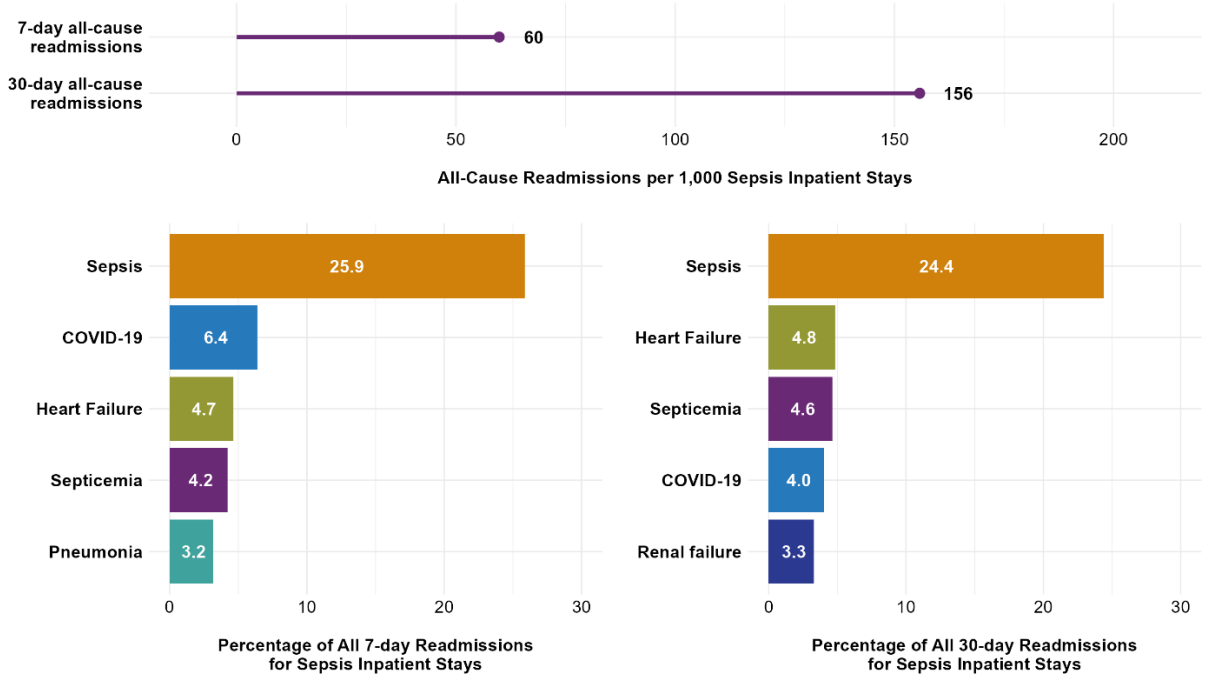
Notes: Sepsis-related inpatient stays were identified using all available diagnoses; sepsis was not required to be the reason for the stay. Inpatient stays resulting in death during the stay were excluded from the analysis. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.4.4 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2021.

4.1.4 Rehospitalizations following sepsis inpatient stays

Readmissions. Patients with sepsis face a high risk of hospital readmission, with rates comparable to those for congestive heart failure, acute myocardial infarction, pneumonia, and chronic obstructive pulmonary disease.[30] In 2021, the readmissions rate for any cause was 60 per 1,000 sepsis inpatient stays (7 days post-discharge) and 156 per 1,000 sepsis inpatient stays (30 days post-discharge); see Exhibit 4.3. At 7 days post-discharge, the most common reasons for readmission following a sepsis inpatient stay were sepsis, COVID-19, heart failure, septicemia with no indication of organ failure, and pneumonia (in descending order). At 30 days post-discharge, the only change in common reasons was acute renal failure rather than pneumonia; see Appendix Table E.4.5.

Exhibit 4.3. Rate of Sepsis Inpatient Stays with a Readmission for Any Cause, 2021



Notes: Sepsis was the reason for the stay (principal diagnosis). The "Septicemia" category represents records that have a principal diagnosis at the readmission of a sepsis infection, but no indication of organ dysfunction (required for the identification of sepsis for nonmaternal adult and maternal sepsis stays). See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.4.5 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases, 23 States with HCUP Revisit Data Elements, 2021

Subsequent ED visits. In 2021, the rate of sepsis inpatient stays with a subsequent ED visit not resulting in admission was 41 per 1,000 sepsis inpatient stays (7 days post-discharge). The most common reasons for such visits were COVID-19, respiratory signs and symptoms, abdominal pain, urinary tract infections, and malaise. The rate of sepsis inpatient stays where there was an ED visit within 7 days before admission and the patient was discharged home from the ED provides insights on likelihood of a missed diagnosis; in 2021, this rate was 58 per 1,000 sepsis inpatient stays. The most common reasons for such ED visits were COVID-19, urinary tract infections, abdominal pain, pneumonia, and musculoskeletal pain (excluding back pain).

4.2 Hospital Costs and In-Hospital Mortality for Hospital Encounters Involving Sepsis

4.2.1 Trends in hospital costs for sepsis inpatient stays

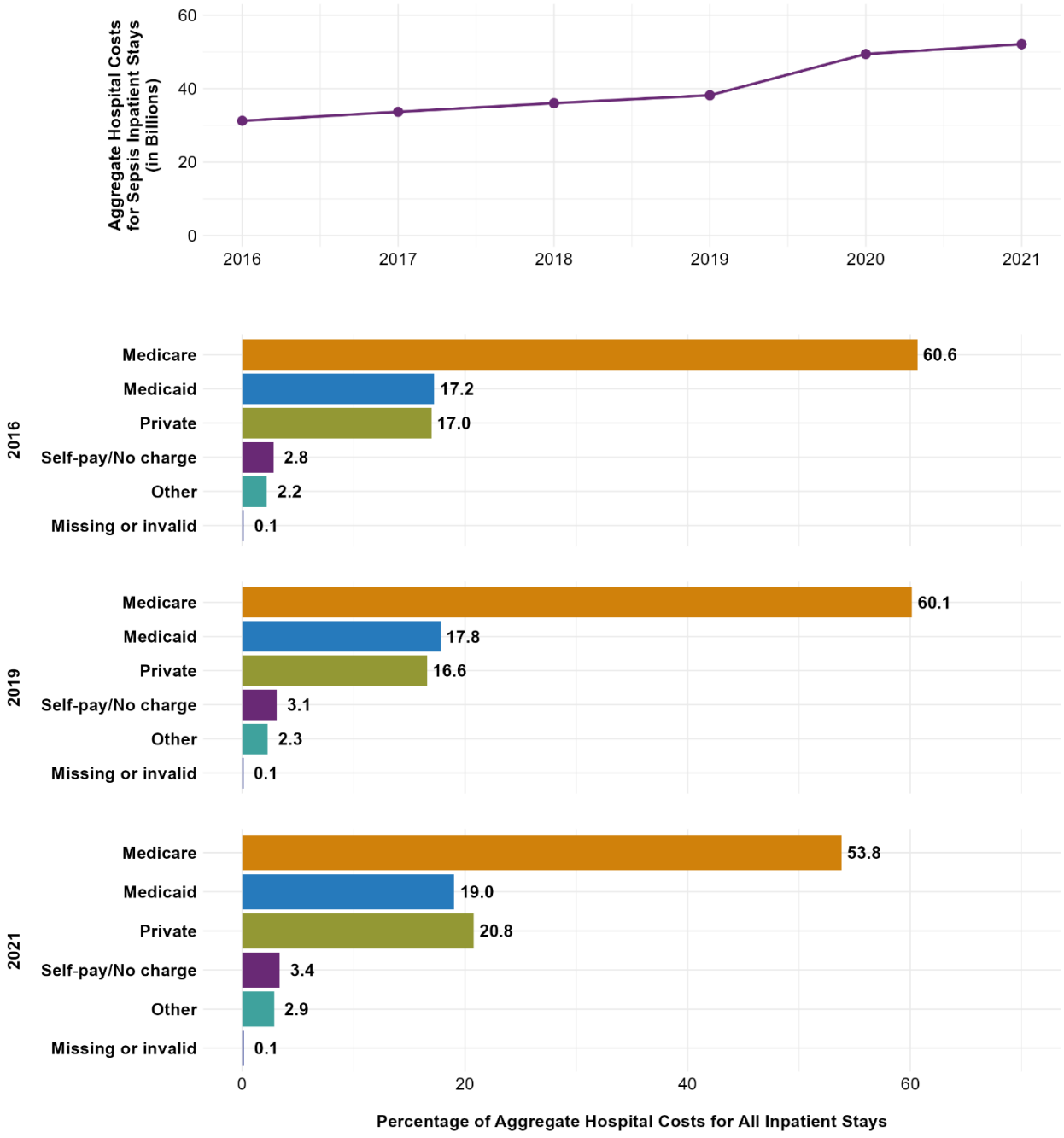
Costs for inpatient stays. From 2016 to 2021, the aggregate hospital cost for sepsis inpatient stays (inpatient stays due to sepsis) at non-Federal acute-care hospitals in the United States increased from $31.2 billion to $52.1 billion; see Exhibit 4.4. During the same time period, the

average total hospital cost of sepsis inpatient stays increased from $25,100 to $28,800; see Appendix Table E.4.6.

Hospital costs by payer. Over 70 percent of the hospital costs for sepsis were billed to public payers, while 20 percent was billed to private insurance. Medicare was expected to pay over half of the aggregate hospital costs for sepsis (60.6 percent in 2016; 60.1 percent in 2019; and 53.8 percent in 2021). Medicaid was expected to cover almost 20 percent of the costs (17.2 percent in 2016 and 19.0 percent in 2021) and private insurance about 20 percent (17.0 percent in 2016 and 20.8 percent in 2021).

Costs for ED visits. From 2016 to 2021, the aggregate hospital cost for sepsis ED visits (that did not result in admission) increased by 267 percent, from $58.2 million to $155.7 million; see Appendix Table E.4.6. However, such visits only accounted for 0.3 percent of total hospital costs for sepsis encounters.

Exhibit 4.4. Trends in Aggregate Hospital Cost for Sepsis Inpatient Stays, Overall and by Expected Payer, 2016–2021



Note: For sepsis inpatient stays, sepsis was the reason for the stay (principal diagnosis). The hospital cost estimates by payer were based on the expected primary payer, as indicated in the hospital encounter record. Hospital total charges were imputed to account for missing information prior to conversion to costs. Hospital costs were adjusted to the base year 2021. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.4.6 for supporting information.

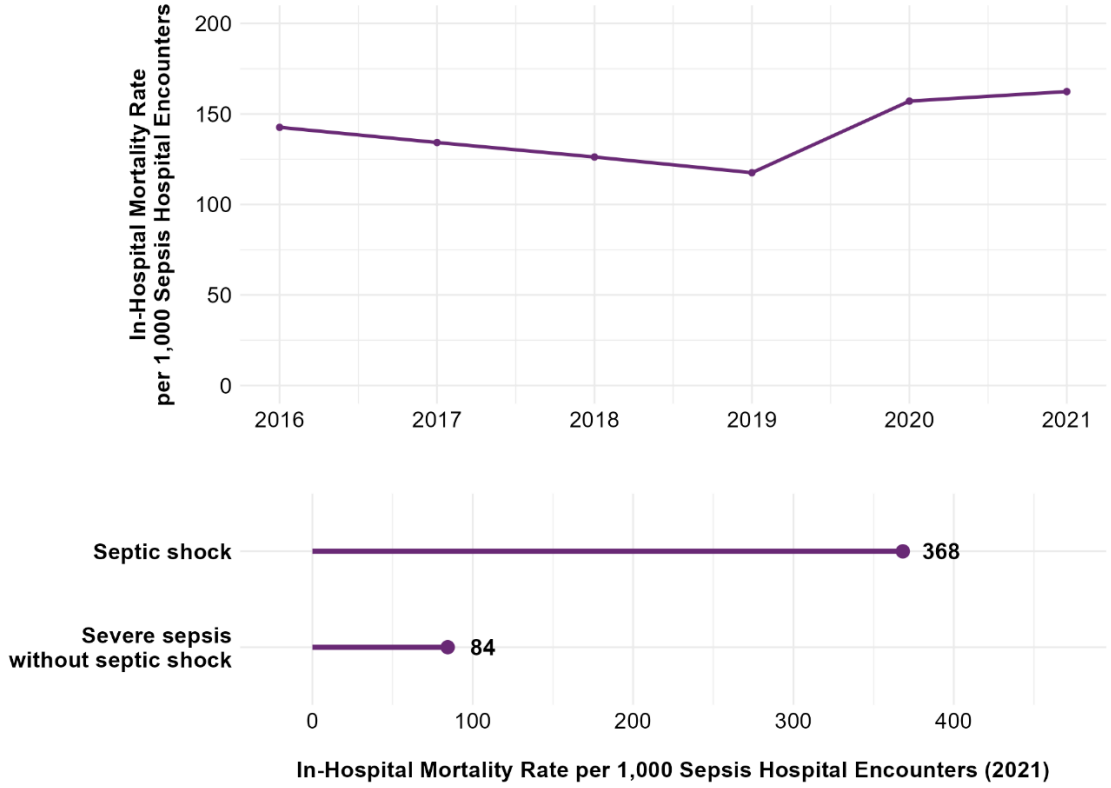
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2016–2021.

4.2.2 Trends in in-hospital mortality for sepsis hospital encounters

Before 2020, the in-hospital mortality rate[x] for sepsis hospital encounters was declining (from 143 in 2016 to 118 in-hospital deaths per 1,000 sepsis hospital encounters in 2019). After the onset of the COVID-19 pandemic in 2020, the in-hospital mortality rate increased to above that seen in 2016. In 2021, one in six patients with sepsis died in the hospital (162 in-hospital deaths per 1,000 sepsis hospital encounters); see Exhibit 4.5. In 2021, 302,300 patients with sepsis died in the hospital—over 1.6 times more than the number that died in the hospital in 2016 (181,700 patients); see Appendix Table E.4.6.

Patients with severe sepsis were much more likely to die in the hospital; see Exhibit 4.5. In 2021, among hospital encounters involving septic shock, one in three stays resulted in death (368 per 1,000 sepsis hospital encounters).

Exhibit 4.5. Trends in In-Hospital Mortality for Sepsis Hospital Encounters, 2016–2021



Notes: Sepsis was the reason for the encounter (the principal/first-listed diagnosis). In-hospital mortality included deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Tables E.4.6 and E.4.7 for supporting information.

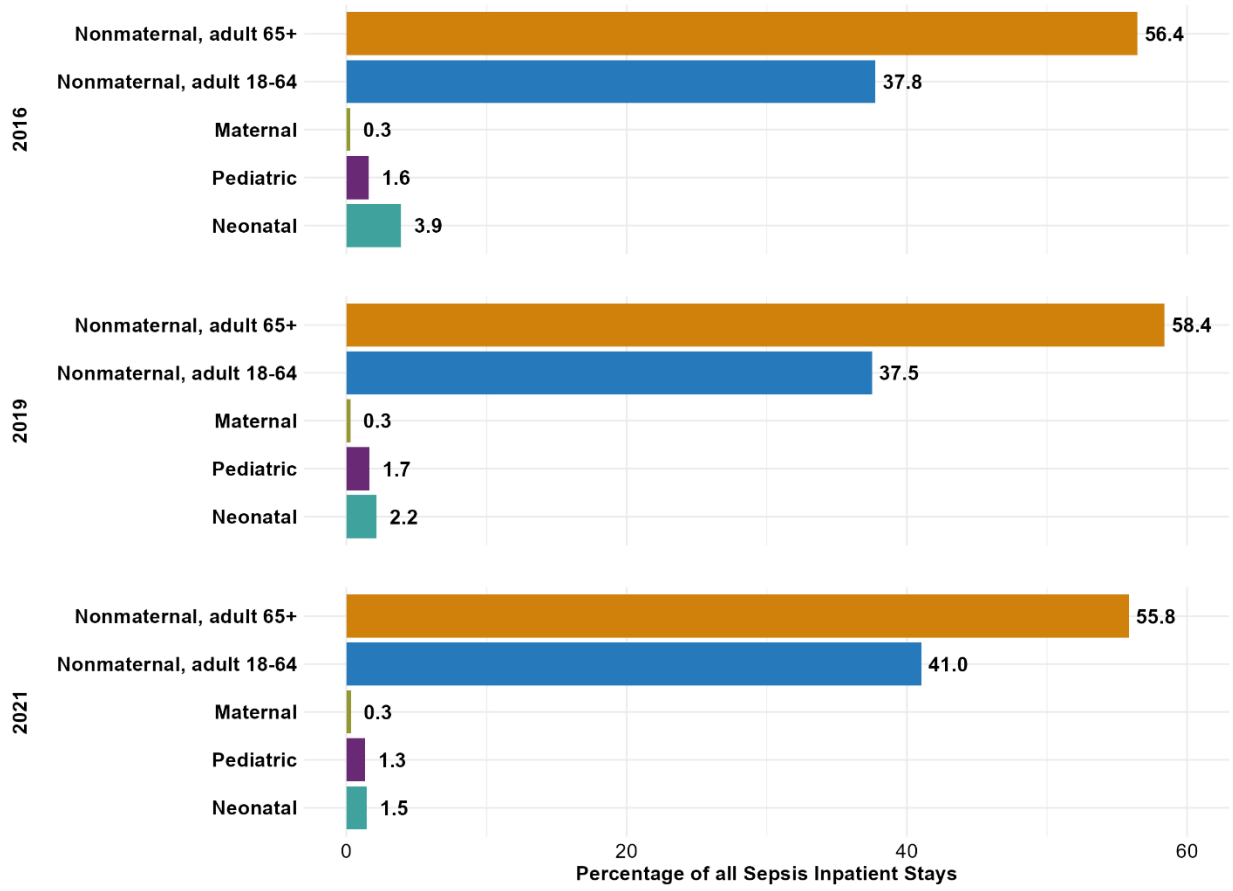
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2016–2021; Nationwide Emergency Department Sample (NEDS), 2016–2021.

[x] In-hospital mortality for sepsis hospital encounters includes deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting.

4.3 Sepsis-Related Hospital Utilization and Outcomes for Key Population Subgroups

This section presents estimates for hospital utilization, morbidity, and in-hospital mortality related to sepsis for specific populations—nonmaternal adult, maternal, pediatric, and neonatal patients.[xi] There are important differences in the causes, disease progression, and treatment for each population. Nonmaternal adults aged 18 years and older accounted for about 95 percent of sepsis-related inpatient stays in 2016, 2019, and 2021; see Exhibit 4.6. During this five-year period, other patient populations comprised less than 6 percent of sepsis-related inpatient stays; see Appendix Exhibit E.4.7.

Exhibit 4.6. Inpatient Stays Related to Sepsis, by Patient Population—2016, 2019, and 2021



Notes: Sepsis was identified using all available diagnoses and was not required to be the reason for the stay. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.4.7 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2016, 2019 and 2021.

[xi] In this report, nonmaternal adult refers to a person with a sepsis diagnosis unrelated to pregnancy or postpartum experience.

4.3.1 Sepsis among nonmaternal adult patients aged 65 years and older

The population of adults aged 65 years and older experienced a 7.1 percent increase in sepsis-related inpatient stays from 2016 (1.0 million sepsis-related stays, or 79 per 1,000 inpatient stays) to 2021 (1.4 million sepsis-related stays, or 112 per 1,000 inpatient stays); see Appendix Table E.4.7. For sepsis inpatient stays (inpatient stays due to sepsis), hospital costs also rose during the five-year period; the average total hospital cost for sepsis inpatient stays was $21,900 in 2016 (at an aggregate cost of $16.7 billion) and $25,000 in 2021 (aggregate cost of $26.3 billion). The average length of stay for sepsis increased from 2016 (7.7 days) to 2021 (8.5 days).

In-hospital mortality decreased between 2016 and 2019 but was higher in 2021 than in previous years with 188 per 1,000 sepsis hospital encounters resulting in death in the hospital (198,403 in-hospital deaths).

4.3.2 Sepsis among nonmaternal adult patients aged 18–64 years

Nonmaternal adult patients aged 18–64 years saw about a 66.9 percent increase in sepsis-related inpatient stays from 2016 (0.7 million, or 50 per 1,000 inpatient stays) to 2021 (1.0 million, or 84 per 1,000 inpatient stays); see Appendix Table E.4.7. For sepsis inpatient stays, the average total hospital cost for sepsis inpatient stays increased from 2016 ($29,600) to 2021 ($33,500), and aggregate hospital costs nearly doubled from 2016 ($13.6 billion) to 2021 ($24.5 billion). The average length of sepsis inpatient stays increased from 2016 (9.5 days) to 2021 (10.3 days).

In-hospital mortality increased from 2016 (117 per 1,000 sepsis hospital encounters) to 2021 (140 per 1,000 sepsis hospital encounters). In 2021, 102,337 adults aged 18–64 years with sepsis died in the hospital.

4.3.3 Maternal sepsis

In 2021, about 2 of every 1,000 maternal inpatient stays were sepsis-related; see Appendix Table E.4.7. From 2016 to 2021, there were fewer than 10,000 sepsis-related maternal inpatient stays per year, with about 30 percent of the stays involving a delivery. The average total hospital cost for maternal sepsis inpatient stays increased from 2016 ($34,400, at an aggregate cost of $39.9 million) to 2021 ($43,800, an aggregate cost of $62.2 million). The average length of maternal sepsis inpatient stays increased from 2016 (8.8 days) to 2021 (9.7 days).

In-hospital mortality for sepsis hospital encounters increased from 2016 (40 deaths) to 2021 (60 deaths).

4.3.4 Pediatric sepsis

For the population of children aged 28 days to 17 years, sepsis-related inpatient stays increased from 2016 (28,715) to 2021 (33,415); see Appendix Table E.4.7. Average total hospital cost for sepsis inpatient stays increased from 2016 ($36,800, an aggregate cost of $703 million) to 2021 ($41,500, an aggregate of $1.0 billion). From 2016 to 2021, there was little change in average length of sepsis pediatric inpatient stays (about 9.1 days).

In 2016 and in 2021, over 600 children with sepsis died in the hospital.

4.3.5 Neonatal sepsis

For the population of neonatal patients (age 0–27 days), sepsis-related inpatient stays decreased from 2016 (69,645) to 2021 (36,330); see Appendix Table E.4.7. The average total hospital cost for sepsis neonatal inpatient stays increased from 2016 ($36,700, at an aggregate cost of $199 million) to 2021 ($56,300, an aggregate of $207 million). The average length of sepsis neonatal inpatient stays increased from 2016 (11.8 days) to 2021 (16.2 days).

In 2016 and 2021, 225 neonates with sepsis died in the hospital each year.

4.4 COVID-19 and the Epidemiology of Sepsis

As described in Chapter 2, the spread of COVID-19 in 2020 introduced complexity into the diagnosis and management of sepsis—previously understood to be caused by bacterial pathogens—and intensified debate about sepsis care guidelines. This section presents sepsis-related utilization and outcomes associated with hospital encounters involving COVID-19 in 2021.

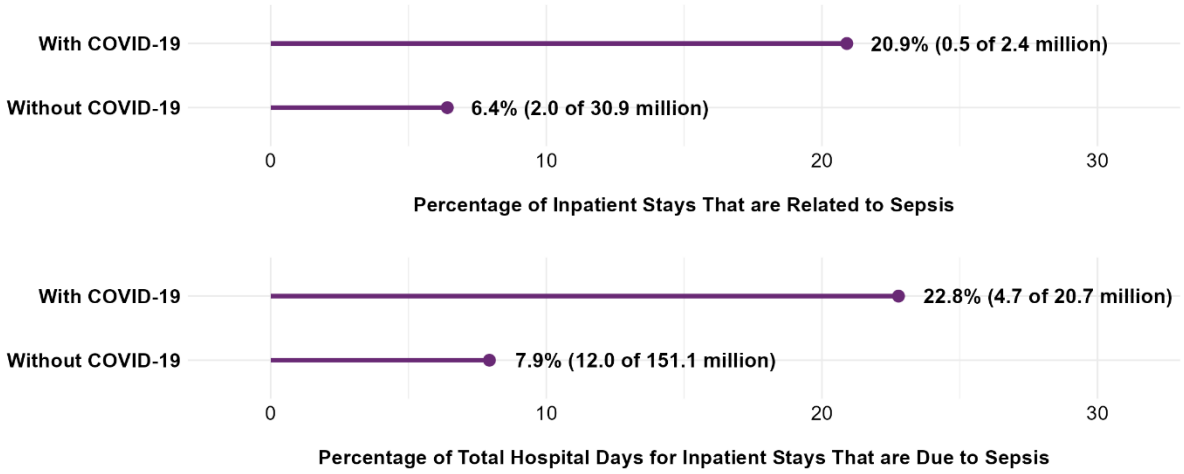
4.4.1 Sepsis-related inpatient stays involving COVID-19

In 2021, about 7 percent (2.5 million) of all inpatient stays at non-Federal acute care hospitals in the United States involved a diagnosis of COVID-19.

Inpatient stays. About one in five inpatient stays involving COVID-19 (20.8 percent) also included a sepsis diagnosis; see Exhibit 4.7. In contrast, 6.5 percent of all non-COVID-19 inpatient stays were sepsis-related; see Appendix Table E.4.8.

Hospital days. Sepsis inpatient stays (inpatient stays due to sepsis) were 22.7 percent of total hospital days for stays involving COVID-19 but only 7.9 percent of total hospital days for stays that did not involve COVID-19; see Exhibit 4.7.

Exhibit 4.7. Inpatient Stays and Days Involving Sepsis and COVID-19, 2021



Notes: Sepsis-related inpatient stays were identified using all available diagnoses; sepsis was not required to be the reason for the stay. Inpatient stays involving COVID-19 were identified using all available diagnoses; COVID-19 was not required to the reason for the stay. For total hospital days for sepsis inpatient stays, sepsis was the reason for the stay (principal diagnosis). See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.4.8 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2021.

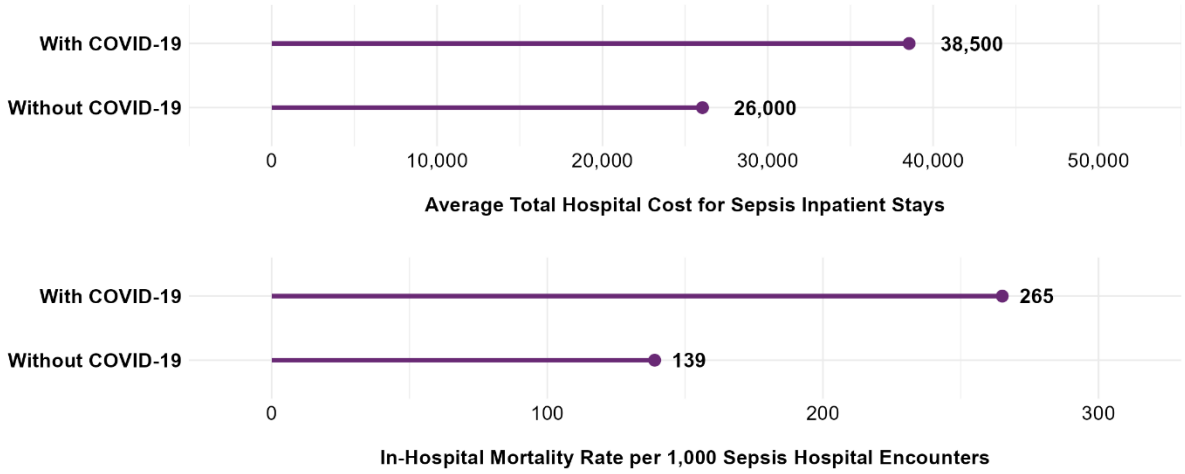
4.4.2 Hospital costs and in-hospital mortality for sepsis inpatient stays involving COVID-19

Hospital costs. In 2021, the average total hospital cost of sepsis inpatient stays that involved COVID-19 was $38,500, 48 percent higher than the cost of stays that did not involve COVID-19 ($26,000); see Exhibit 4.8. Sepsis inpatient stays accounted for 25 percent of aggregate hospital costs for inpatient stays involving COVID-19 ($15.2 of $59.9 billion); see Appendix Table E.4.8. Among inpatient stays that did not involve COVID-19, sepsis inpatient stays accounted for 8 percent of aggregate hospital costs ($36.9 of $468 billion).

In-hospital mortality rate.[xii] Deaths for hospital encounters involving COVID-19 were almost two times higher (265 deaths per 1,000 sepsis hospital encounters) than those that did not involve COVID-19 (139 per 1,000 sepsis hospital encounters); see Exhibit 4.8.

[xii] In-hospital mortality for sepsis hospital encounters includes deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting.

Exhibit 4.8. Hospital Costs and In-Hospital Mortality for Sepsis Hospital Encounters Involving COVID-19, 2021



Notes: Sepsis was the reason for the stay/encounter (principal/first-listed diagnosis). Hospital total charges were imputed to account for missing information prior to conversion to costs. Hospital costs were rounded to the nearest hundreds. In-hospital mortality included deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.4.8 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2021; Nationwide Emergency Department Sample (NEDS), 2021.

Summary

From 2016 to 2019, hospital utilization and costs related to sepsis increased, while in-hospital mortality rates for sepsis hospital encounters decreased. The emergence of COVID-19 in 2020 significantly changed the epidemiology of sepsis. In 2021, one year into the COVID-19 pandemic, there was a marked rise in sepsis-related hospital encounters, costs, and in-hospital mortality, especially among patients diagnosed with COVID-19.

Public payers, such as Medicare and Medicaid, were expected to cover more than 70 percent of the costs for sepsis inpatient stays. Nearly one-third of sepsis-related stays ended with a transfer to a post-acute care health facility, such as a skilled nursing, intermediate care, or rehabilitation unit. Almost one-quarter of sepsis-related stays resulted in a transfer to a short-term hospital. Nearly 1 in 10 sepsis hospital encounters in 2021 resulted in death. For patients with septic shock, the mortality rate was even higher, with over 3 in 10 hospital encounters ending in death.

Trends in hospital utilization, costs, and mortality also varied across different population groups. In 2021, nonmaternal adult patients aged 65 and older accounted for over half of all sepsis inpatient stays and had higher in-hospital mortality rates compared with other groups. However, the average total hospital cost for neonatal patients with sepsis was double that of nonmaternal adult patients.

Chapter 5. Disparities in Sepsis Outcomes

Highlights

- Overall, in 2021, non-White patients and those living in the most socially vulnerable and large metropolitan communities, on average, incurred longer stays and higher costs for sepsis inpatient stays.
- Among Hispanic patients, inpatient stays related to sepsis increased by 35.4 percent from 2019 to 2021, a higher percentage increase than for non-Hispanic patients (from 20.8 percent to 30.0 percent).
- In 2021, male patients saw a higher average cost for a sepsis inpatient stay than did females ($30,500 vs. $26,900).
- In 2021, patients living in the most socially vulnerable communities were more likely to die during a hospital encounter for sepsis than patients in other communities (181 vs.159 per 1,000 sepsis hospital encounters).
- For adults aged 18–64 years, patients in rural areas were more likely to die during a hospital encounter for sepsis than patients in large and small metropolitan areas (156 vs.134 and 141 per 1,000 sepsis hospital encounters).

Disparities in sepsis incidence, hospital encounters, and complications persist, despite standard guidelines for management and treatment.[31] Racial and ethnic minority patient populations and those with lower socioeconomic status have experienced higher rates of hospitalization for sepsis and are more likely to be readmitted to the hospital within 30 days following discharge after hospitalization for sepsis.[118,119] In addition, sepsis-related mortality is higher among individuals living in rural communities and in socially vulnerable areas.[31,120,121] Such disparities reflect inadequate access to medical care, the influence of social determinants of health, as well as other factors.[119] In 2020, COVID-19 became another important factor contributing to disparities among hospital encounters involving sepsis.[122]

This chapter is organized into five sections. The first four sections examine trends and disparities in overall hospital utilization related to sepsis from 2016 to 2021 and associated outcomes for sepsis hospital encounters in 2021. Disparities are discussed separately by patient race and ethnicity[xiii], sex, social vulnerability designation (for county of residence), and urban-rural location. The fifth section presents findings about disparities in hospital encounters involving sepsis among the nonmaternal adult[xiv], maternal, pediatric, and neonatal patient populations in 2021. The chapter presents descriptive statistics on hospital encounters involving sepsis by certain patient characteristics, highlighting differences within groups. Results do not account for confounding factors that may contribute to observed disparities.

[xiii] This chapter presents results by patient race and ethnicity for the following categories: Hispanic and non-Hispanic Asian and Pacific Islander, Black, and White. Categories including non-Hispanic American Indian and Alaska Native and Other are not discussed as part of the results but are included in this chapter's accompanying Appendix E data tables.

[xiv] In this report, nonmaternal adult refers to a person with a sepsis diagnosis unrelated to pregnancy or postpartum experience.

Methods in Chapter 5: Data are from the 2016, 2019, and 2021 Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) and Nationwide Emergency Department Sample (NEDS) and the 2021 State Inpatient Databases (SID) and State Emergency Department Databases (SEDD).

Results are considered statistically significant at the 0.05 significance level or lower. Statistical tests adjust for multiple comparisons that occur when two or more hypotheses are tested. The large sample size of HCUP databases means that small differences may be statistically significant but not clinically important. Thus, only differences of at least 10 percent that are statistically significant are presented.

See Appendix C for the clinical coding criteria for sepsis; Appendix D for more information about measures, characteristics, and analyses; and Appendix E for data tables that support this chapter.

5.1 Racial and Ethnic Differences in Hospital Encounters Involving Sepsis

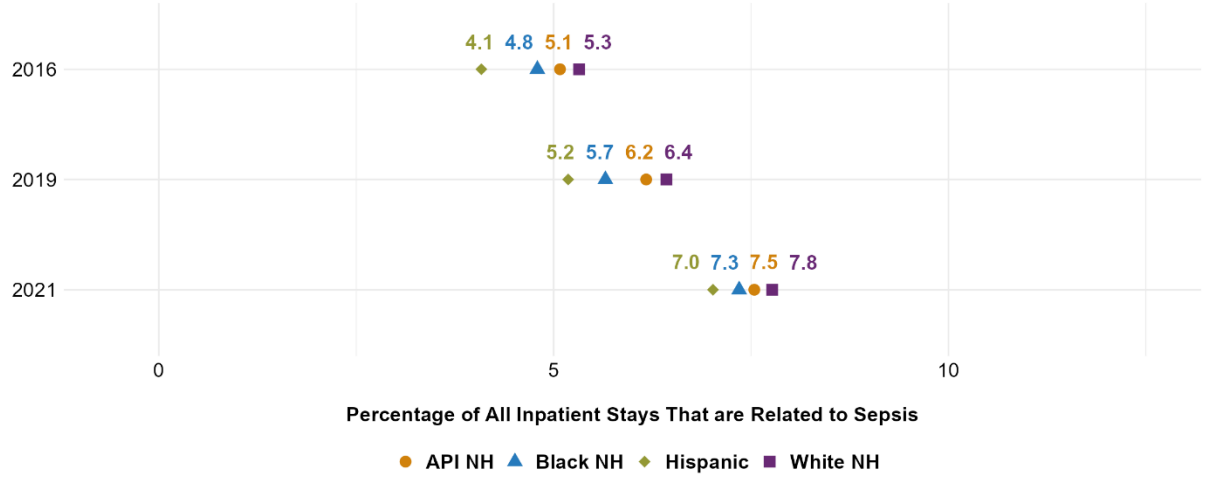
5.1.1 Inpatient stays involving sepsis

In 2016, sepsis-related inpatient stays were 5.0 percent of all inpatient stays at non-Federal acute-care hospitals in the United States; see Appendix Table E.4.1. The percentage of sepsis-related inpatient stays and of returning visits after sepsis inpatient stays (inpatient stays due to sepsis) varied by race and ethnicity; see Exhibit 5.1.

Inpatient stays. In 2016, Hispanic patients had the lowest percentage of inpatient stays related to sepsis (4.1 percent) and saw an increase of 35.4 percent from 2019 to 2021. The percentage among White non-Hispanic patients was 5.3 percent in 2016 and saw an increase of 20.8 percent from 2019 to 2021. The percent increase from 2019 to 2021 among patients in other racial and ethnic groups was 30.0 percent for Black non-Hispanic patients and 22.2 percent for Asian and Pacific Islander non-Hispanic patients. In 2021, the percentage of inpatient stays that were related to sepsis ranged from 7.0 percent among Hispanic patients to 7.8 percent among White non-Hispanic patients.

Rehospitalizations. In 2021, the rate of sepsis inpatient stays with a readmission for any cause within 30 days of discharge ranged from 148 per 1,000 sepsis inpatient stays among Asian and Pacific Islander non-Hispanic and Hispanic patients to 167 per 1,000 sepsis inpatient stays among Black non-Hispanic patients; see Appendix Table E.5.2. Compared with other racial and ethnic patient groups, Asian and Pacific Islander non-Hispanic patients had the lowest rate of sepsis inpatient stays with a subsequent ED visit (that did not result in admission to the same hospital) for any cause within 14 days of discharge (54 per 1,000 sepsis inpatient stays).

Exhibit 5.1. Percentage of All Inpatient Stays That are Related to Sepsis by Patient Race and Ethnicity, 2016, 2019, and 2021



Abbreviations: API=Asian and Pacific Islander; NH=non-Hispanic.

Notes: The percentage of all inpatient stays related to sepsis was identified using all available diagnoses; sepsis was not required to be the reason for the stay. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Tables E.5.1 for supporting information.

Source: Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2016, 2019, and 2021.

5.1.2 In-hospital mortality rate, average total hospital cost, and average length of stay for sepsis hospital encounters

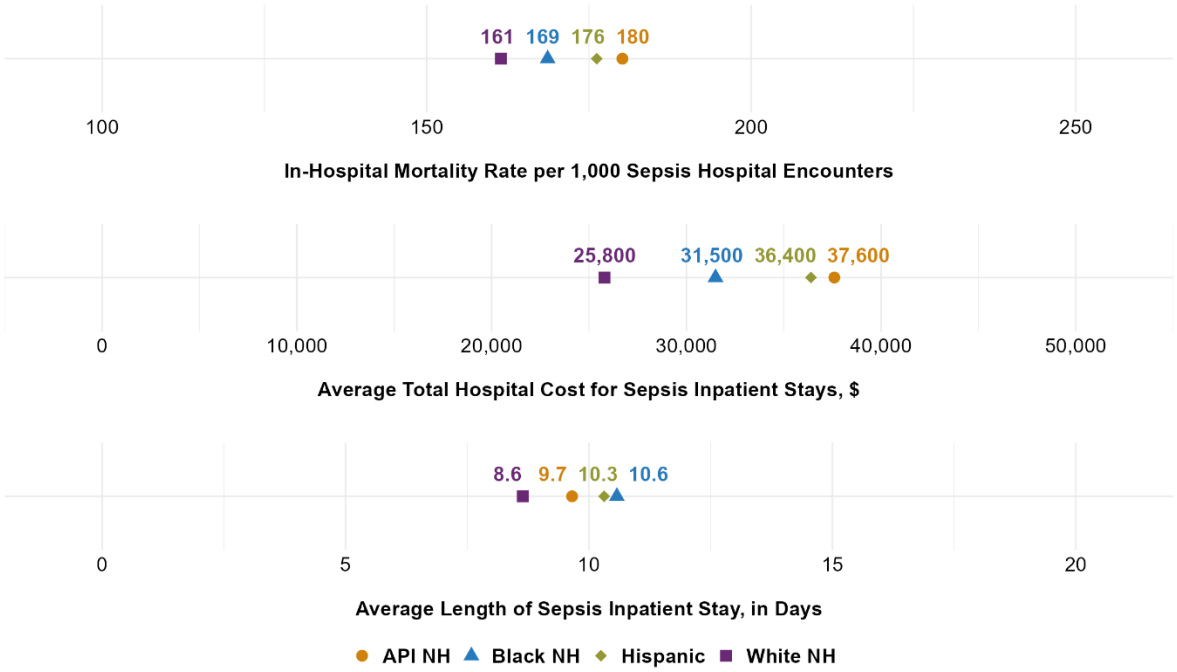
In-hospital mortality rate. [xv] In 2021, the in-hospital mortality rate was higher among Asian and Pacific Islander non-Hispanic patients than among White non-Hispanic patients (180 vs. 161 per 1,000 sepsis hospital encounters, respectively); see Exhibit 5.2. The in-hospital mortality rate per 1,000 sepsis hospital encounters among patients in other racial and ethnic groups was 176 for Hispanic patients and 169 among Black non-Hispanic patients.

Total hospital cost. The average total hospital cost for sepsis inpatient stays was lowest among White non-Hispanic patients at $25,800 while costs among patients from other racial and ethnic groups ranged from $31,500 to $37,600.

Length of stay. The average length of a sepsis inpatient stay was lowest among White non-Hispanic patients (8.6 days) and ranged for patients from other racial and ethnic groups (from 9.7 to 10.6 days).

[xv] In-hospital mortality for sepsis hospital encounters includes deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting.

Exhibit 5.2. Outcomes for Sepsis Hospital Encounters by Patient Race and Ethnicity, 2021



Abbreviations: API=Asian and Pacific Islander; NH=non-Hispanic.

Notes: Sepsis was the reason for the inpatient stay/hospital encounter (principal/first-listed diagnosis). In-hospital mortality included deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting. Charges were imputed to account for missing information prior to conversion to hospital costs. Average total hospital costs were rounded to the nearest hundreds. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Tables E.5.3 for supporting information.

Source: Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS) and Nationwide Emergency Department Sample (NEDS), 2021.

5.2 Differences by Sex in Hospital Encounters Involving Sepsis

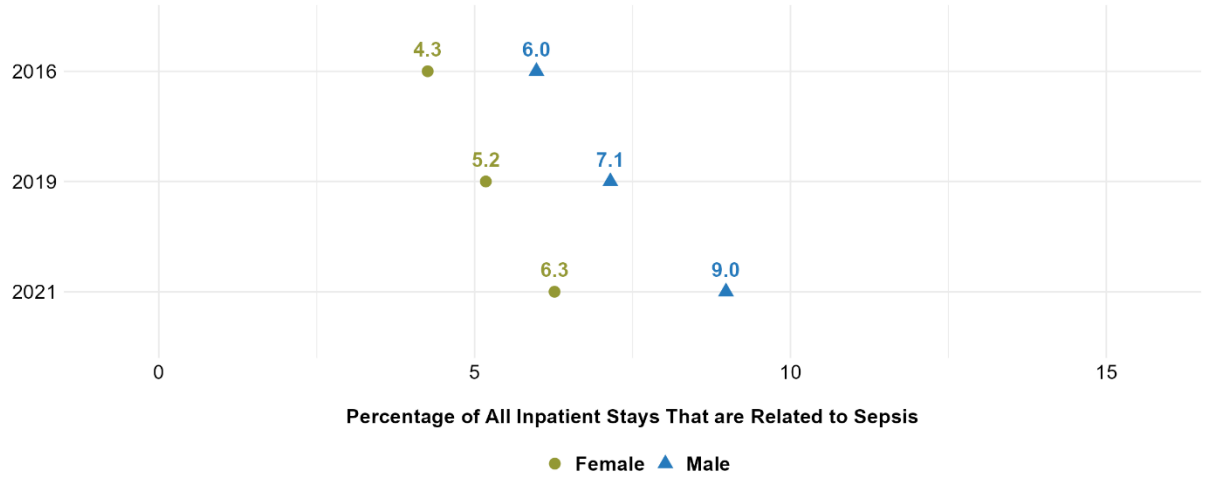
5.2.1 Inpatient stays involving sepsis

Inpatient stays. In 2016, 4.3 percent of inpatient stays for females were related to sepsis, and the percentage increased by 21.0 percent from 2019 to 2021. In comparison, the percentage of sepsis-related inpatient stays for males in 2016 was higher (6.0 percent) and increased by 25.6 percent from 2019 to 2021; see Exhibit 5.3. In 2021, the percentage of sepsis-related inpatient stays was higher for male patients (9.0 percent) than for female patients (6.3 percent).

Rehospitalizations. In 2021, the rate of sepsis inpatient stays (inpatient stays due to sepsis) with a readmission for any cause within 30 days of discharge was 153 per 1,000 sepsis inpatient stays among females and 158 per 1,000 sepsis inpatient stays among males; see Appendix Table E.5.2. The rate of sepsis inpatient stays with a subsequent ED visit (that did not result in admission to the same hospital) for any cause within 14 days of discharge was 66 per

1,000 sepsis inpatient stays among females and 68 per 1,000 sepsis inpatient stays among males.

Exhibit 5.3. Percentage of All Inpatient Stays Related to Sepsis by Patient Sex—2016, 2019, and 2021



Notes: The percentage of all sepsis-related inpatient stays was identified using all available diagnoses; sepsis was not required to be the reason for the stay. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Tables E.5.1 for supporting information.

Source: Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2016, 2019, and 2021.

5.2.2 In-hospital mortality rate, average total hospital cost, and average length of stay for sepsis hospital encounters

In-hospital mortality rate.[xvi] In 2021, the in-hospital mortality rate per 1,000 sepsis hospital encounters was 172 for males and 160 for females; see Appendix Table E.5.3.

Total hospital cost. The average total hospital cost for sepsis inpatient stays was higher among male than females ($30,500 vs. $26,900, respectively).

Length of stay. The average length of sepsis inpatient stay was 9.6 days for males and 8.8 days for females.

[xvi] In-hospital mortality for sepsis hospital encounters includes deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting.

5.3 Social Vulnerability Differences in Hospital Encounters Involving Sepsis

5.3.1 Inpatient stays involving sepsis

Inpatient stays. In 2016, 5.2 percent of inpatient stays for patients living in the most socially vulnerable communities were related to sepsis, and the percentage increased by 24.3 percent from 2019 to 2021; see Appendix Table E.5.1. In 2016, 4.9 percent of inpatient stays for patients living in less socially vulnerable communities were related to sepsis. This percentage increased by 21.4 percent from 2019 to 2021. In 2021, the percentage of sepsis-related inpatient stays was 7.9 percent among patients living in the most socially vulnerable communities and 7.2 percent among patients living in less socially vulnerable communities.

Rehospitalizations. In 2021, the rate of sepsis inpatient stays (inpatient stays due to sepsis) with a readmission for any cause within 30 days of discharge was 162 per 1,000 sepsis inpatient stays among patients living in the most socially vulnerable communities and 151 per 1,000 sepsis inpatient stays among patients living in less socially vulnerable communities; see Appendix Table E.5.2. The rate of sepsis inpatient stays with a subsequent ED visit (that did not result in admission to the same hospital) for any cause within 14 days of discharge was 66 per 1,000 sepsis inpatient stays among patients living in the most socially vulnerable communities and 68 per 1,000 sepsis inpatient stays among patients living in less socially vulnerably communities.

5.3.2 In-hospital mortality rate, average total hospital cost, and average length of stay for sepsis hospital encounters

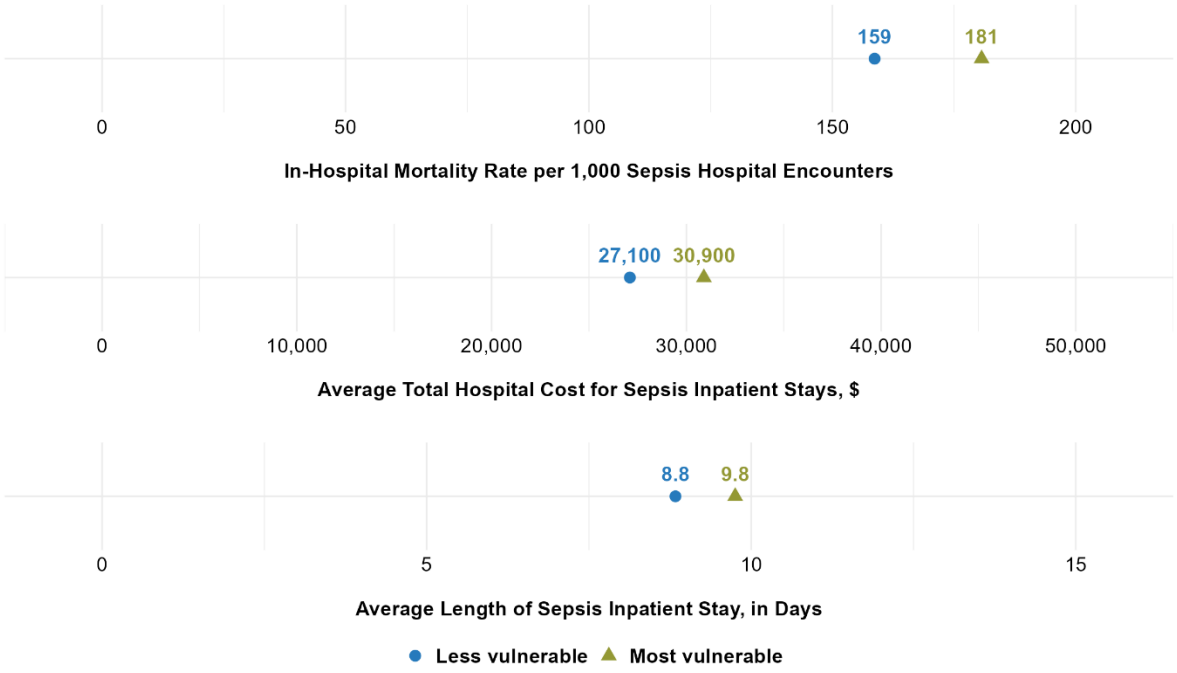
In-hospital mortality rate.[xvii] In 2021, the in-hospital mortality rate for sepsis hospital encounters was higher among patients living in the most socially vulnerable communities than those living in less socially vulnerable communities (181 vs.159 per 1,000 sepsis hospital encounters, respectively); see Exhibit 5.4.

Total hospital costs. The average total hospital cost for sepsis inpatient stays was higher among patients living in the most socially vulnerable communities compared with those living in less socially vulnerable communities ($30,900 vs. $27,100, respectively).

Length of stay. The average length of stay for sepsis inpatient stays was longer among patients living in the most socially vulnerable communities than those living in less socially vulnerable communities (9.8 vs. 8.8 days, respectively).

[xvii] In-hospital mortality for sepsis hospital encounters includes deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting.

Exhibit 5.4. Outcomes for Sepsis Hospital Encounters by Social Vulnerability, 2021



Notes: Sepsis was the reason for the stay/encounter (principal/first-listed diagnosis). In-hospital mortality included deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting. Charges were imputed to account for missing information prior to conversion to hospital costs. Average total hospital costs were rounded to the nearest hundreds. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Tables E.5.3 for supporting information.

Source: Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS) and Nationwide Emergency Department Sample (NEDS), 2021.

5.4 Rural and Urban Differences in Hospital Encounters Involving Sepsis

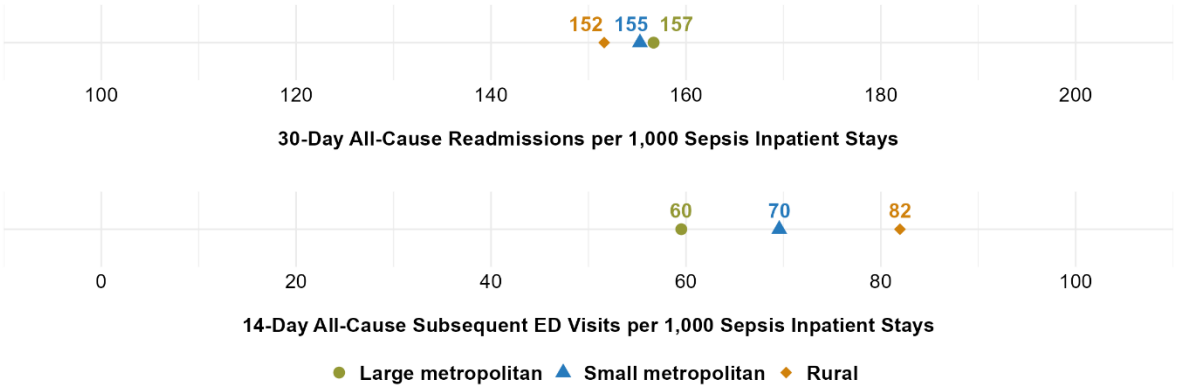
5.4.1 Inpatient stays involving sepsis

Inpatient stays. In 2016, 5.1 percent of inpatient stays among patients from rural areas were related to sepsis; see Appendix Table E.5.1. The percentage increased by 23.4 percent from 2019 to 2021. Similarly, 5.1 percent of inpatient stays among patients from small metropolitan areas were related to sepsis in 2016. This percentage increased by 23.0 percent from 2019 to 2021. Among patients from large metropolitan areas, 4.9 percent of inpatient stays were related to sepsis in 2016. This percentage increased by 24.1 percent from 2019 to 2021. In 2021, the percentage of inpatient stays related to sepsis ranged from 7.4 percent among patients in large metropolitan areas to 7.6 percent among patients in small metropolitan areas.

Rehospitalizations. In 2021, the rate of sepsis inpatient stays (inpatient stays due to sepsis) with a readmission for any cause within 30 days of discharge ranged from 152 per 1,000 sepsis

stays for patients living in rural areas to 157 per 1,000 sepsis stays for patients living in large metropolitan areas; see Exhibit 5.5. Rural patients had the highest rate of sepsis inpatient stays with a subsequent ED visit (that did not result in admission to the same hospital) for any cause within 14 days of discharge compared with patients living in large and small metropolitan areas (82 vs. 60 and 70 per 1,000 sepsis inpatient stays, respectively).

Exhibit 5.5. Rehospitalizations for Sepsis Inpatient Stays by Patient Urban and Rural Location, 2021



Notes: Sepsis was the reason for the stay (principal diagnosis). See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Tables E.5.2 for supporting information.

Source: Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID) and State Emergency Department Databases (SEDD) for 23 States with HCUP Revisit Data Elements, 2021.

5.4.2 In-hospital mortality rate, average total hospital cost, and average length of stay for sepsis hospital encounters

In-hospital mortality rate.[xviii] The in-hospital mortality rate per 1,000 sepsis hospital encounters ranged from 163 among patients living in small metropolitan areas to 177 among patients living in rural areas (Appendix Table E.5.3).

Total hospital costs. The average total hospital cost for sepsis inpatient stays was highest among patients living in large metropolitan areas at $31,100 compared to patients living in small metropolitan and rural areas.

Length of stay. The average length of stay for sepsis inpatient stays was higher among patients living in large metropolitan areas than for patients living in rural areas (9.6 vs. 8.6 days, respectively).

[xviii] In-hospital mortality for sepsis hospital encounters includes deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting.

5.5 Disparities in Hospital Encounters Involving Sepsis Among Patient Populations

5.5.1 Nonmaternal adult patients

In 2021, outcomes for nonmaternal adult sepsis hospital encounters varied by age groups for adults and by patient and community characteristics; see Appendix Tables E.5.4 through E.5.6.

Race and ethnicity. The in-hospital mortality rate was lowest among White non-Hispanic adult patients aged 65–79 years (168 per 1,000 sepsis hospital encounters) and those 80 years and older (191 per 1,000 sepsis hospital encounters), compared with adult patients of similar age from other racial and ethnic groups; see Appendix Table E.5.4. Across all adult age groups, White non-Hispanic patients had the lowest average total hospital cost for sepsis inpatient stays (inpatient stays due to sepsis) at $25,700, with costs for other racial and ethnic groups ranging from $31,000 to $37,500; see Appendix Table E.5.5. Similarly, White non-Hispanic adult patients had the shortest average length of stay for sepsis inpatient stays (8.6 days), while for adult patients from other racial and ethnic groups, the length of stay ranged from 9.7 to 10.5 days; see Appendix Table E.5.6.

Sex. For adults aged 18–64 years, the in-hospital mortality rate was higher among male patients than for female patients (148 vs. 131 per 1,000 sepsis hospital encounters, respectively); see Appendix Table E.5.4. Across all adult age groups, male patients had a higher average total hospital cost for sepsis inpatient stays compared with female patients ($30,300 vs. $26,600, respectively); see Appendix Table E.5.5. The average length of stay for sepsis inpatient stays across all adult age groups was 9.6 days for male patients and 8.8 days for female patients; see Appendix Table E.5.6.

Socially vulnerable communities. Across all adult age groups, patients living in the most socially vulnerable communities had a higher in-hospital mortality rate compared with patients living in less socially vulnerable communities (184 vs. 161 per 1,000 sepsis hospital encounters, respectively); see Appendix Table E.5.4. Similarly, adult patients living in the most socially vulnerable communities had a higher average total hospital cost for sepsis inpatient stays compared with adult patients living in less socially vulnerable communities ($30,700 vs. $26,900, respectively); see Appendix Table E.5.5. The average length of stay for sepsis inpatient stays across all adult age groups was 9.7 days for patients living in the most socially vulnerable communities and 8.8 days for patients living in less socially vulnerable communities; see Appendix Table E.5.6.

Location. For adults aged 18–64 years, the in-hospital mortality rate was higher among patients in rural areas (156 per 1,000 sepsis hospital encounters) than for those in large and small metropolitan areas (134 and 141 per 1,000 sepsis hospital encounters, respectively); see Appendix Table E.5.4. Across all adult age groups, patients in large metropolitan areas had the highest average total hospital cost for sepsis inpatient stays ($30,800); see Appendix Table E.5.5. And patients in large metropolitan areas had a longer average length of sepsis inpatient stays across all adult age groups compared with patients in rural areas (9.5 days vs. 8.6 days, respectively); see Appendix Table E.5.6.

5.5.2 Maternal

In 2021, outcomes for maternal sepsis hospital encounters varied across racial and ethnic groups and across locations; see Appendix Table E.5.7.

Race and ethnicity. The in-hospital mortality rate per 1,000 sepsis hospital encounters ranged from 0 among Asian and Pacific Islander non-Hispanic maternal patients to 83 among Black non-Hispanic maternal patients. The average total hospital cost for sepsis inpatient stays ranged from $37,200 among Black non-Hispanic maternal patients to $48,400 among White non-Hispanic maternal patients. The average length of stay for sepsis inpatient stays ranged from 9.2 days among both Black non-Hispanic and Hispanic maternal patients to 9.9 days among White non-Hispanic maternal patients.

Socially vulnerable communities. The in-hospital mortality rate per 1,000 sepsis hospital encounters was 61 among maternal patients living in the most socially vulnerable communities and 26 among maternal patients living in the less socially vulnerable communities. The average total hospital cost for sepsis inpatient stays was $47,700 among maternal patients living in the most socially vulnerable communities and $40,400 among maternal patients living in the less socially vulnerable communities. The average length of stay for sepsis inpatient stays was 10.7 days among maternal patients living in the most socially vulnerable communities and 8.9 days among maternal patients living in the less socially vulnerable communities.

Location. The in-hospital mortality rate per 1,000 sepsis hospital encounters ranged from 27 among maternal patients in large metropolitan areas to 93 among maternal patients in rural areas. The average total hospital cost for sepsis inpatient stays ranged from $30,800 among maternal patients in rural areas to $53,300 among maternal patients in large metropolitan areas. The average length of stay for sepsis inpatient stays was 8.9 days among maternal patients in rural and small metropolitan areas and 10.5 among maternal patients in large metropolitan areas.

5.5.3 Pediatric

In 2021, outcomes for pediatric sepsis hospital encounters outcomes varied by patient and community characteristics; see Appendix Table E.5.8.

Race and ethnicity. The in-hospital mortality rate per 1,000 sepsis hospital encounters ranged from 19 among Hispanic pediatric patients to 36 among Black non-Hispanic pediatric patients. The average total hospital cost for sepsis inpatient stays ranged from $37,200 among White non-Hispanic pediatric patients to $59,300 among Black non-Hispanic pediatric patients. Black non-Hispanic pediatric patients had the longest average length of sepsis stay (12.1 days), while for patients from other racial and ethnic groups, the length of stay ranged from 8.1 to 8.7 days.

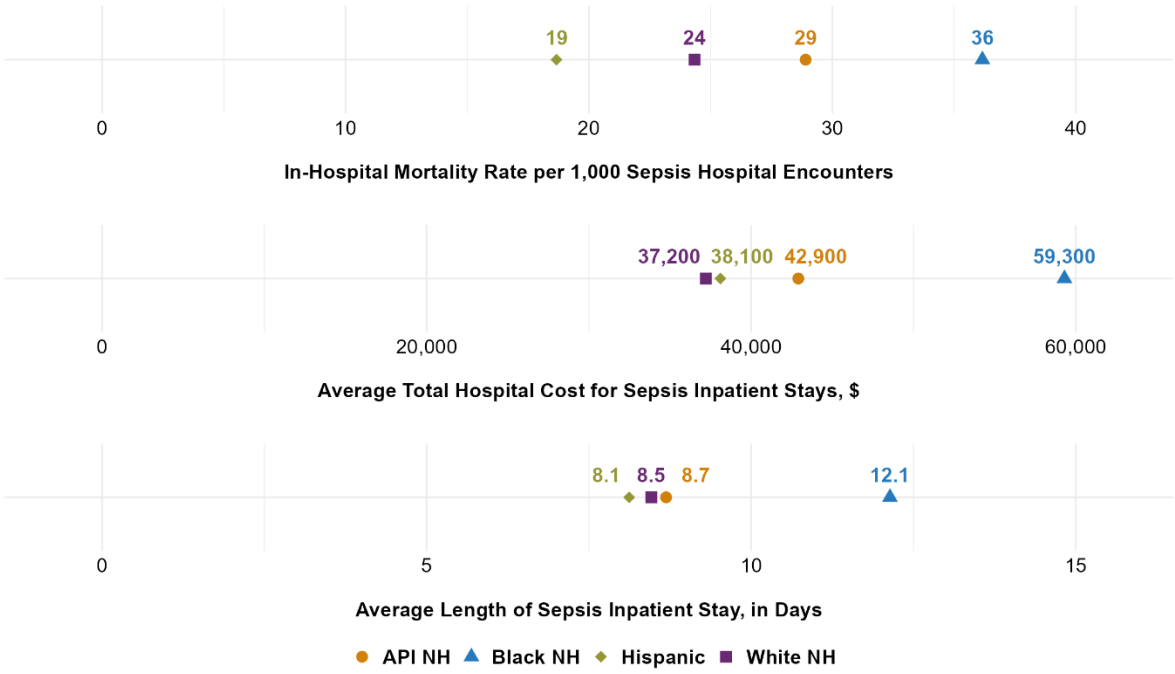
Sex. The in-hospital mortality rate per 1,000 sepsis hospital encounters was 29 among male pediatric patients and 23 among female pediatric patients. The average total hospital cost for sepsis inpatient stays was $43,500 for male pediatric patients and $39,700 for female pediatric patients. The average length of stay for sepsis inpatient stays was 9.6 days among male pediatric patients and 8.6 days among female pediatric patients.

Socially vulnerable communities. The in-hospital mortality rate per 1,000 sepsis hospital encounters was 26 among pediatric patients living in the most socially vulnerable communities

and 27 among pediatric patients living in the less socially vulnerable communities. The average total hospital cost for sepsis inpatient stays was $42,100 among pediatric patients living in the most socially vulnerable communities and $41,100 among pediatric patients living in the less socially vulnerable communities. The average length of stay for sepsis inpatient stays was 9.2 days among pediatric patients in the most socially vulnerable communities and 8.9 days among pediatric patients in the less socially vulnerable communities.

Location. The in-hospital mortality rate per 1,000 sepsis hospital encounters ranged from 22 among pediatric patients in large metropolitan areas to 39 among pediatric patients in rural areas. The average total hospital cost for sepsis inpatient stays ranged from $36,800 among pediatric patients in small metropolitan areas to $45,800 for pediatric patients in large metropolitan areas. The average length of stay for sepsis inpatient stays ranged from 8.5 days for pediatric patients in small metropolitan areas to 9.4 days among pediatric patients in large metropolitan areas.

Exhibit 5.6. Outcomes for Pediatric Hospital Encounters Involving Sepsis by Patient Race and Ethnicity, 2021



Abbreviations: API=Asian and Pacific Islander; NH=non-Hispanic.

Notes: Sepsis was the reason for the stay/encounter (principal/first-listed diagnosis). In-hospital mortality included deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting. Charges were imputed to account for missing information prior to conversion to hospital costs. Average total hospital costs were rounded to the nearest hundreds. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Tables E.5.8 for supporting information.

Source: Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS) and Nationwide Emergency Department Sample (NEDS), 2021.

5.5.4 Neonatal

In 2021, outcomes for neonatal sepsis hospital encounters varied by patient and community characteristics; see Appendix Table E.5.9. Any observed differences in outcomes of neonatal sepsis may be driven by differences in important risk factors such as gestational age or birthweight.

Race and ethnicity. The in-hospital mortality rate per 1,000 sepsis hospital encounters ranged from 43 among White non-Hispanic neonatal patients to 69 among Black non-Hispanic neonatal patients. The average total hospital cost for sepsis inpatient stays ranged from $30,300 among Asian and Pacific Islander non-Hispanic neonatal patients to $65,600 among Black non-Hispanic neonatal patients. The average length of stay for sepsis inpatient stays ranged from 7.7 days among Asian and Pacific Islander non-Hispanic neonatal patients to 21.3 days among Black non-Hispanic neonatal patients.

Sex. The in-hospital mortality rate per 1,000 sepsis hospital encounters was 57 among male neonatal patients and 68 among female neonatal patients. The average total hospital cost for sepsis inpatient stays was $58,100 among male neonatal patients and $53,600 among female neonatal patients. Both male and female neonatal patients had an average length of stay for sepsis inpatient stays of 16.2 days.

Socially vulnerable communities. The in-hospital mortality rate per 1,000 sepsis hospital encounters was 59 among neonatal patients living in the most socially vulnerable communities and 61 among neonatal patients living in the less socially vulnerable communities. The average total hospital cost for sepsis inpatient stays was $60,200 among neonatal patients living in the most socially vulnerable communities and $53,800 among neonatal patients living in the less socially vulnerable communities. The average length of stay for sepsis inpatient stays was 17.2 days among neonatal patients living in the most socially vulnerable communities and 15.6 days among neonatal patients living in the less socially vulnerable communities.

Location. The in-hospital mortality rate per 1,000 hospital encounters ranged from 44 among neonatal patients in small metropolitan areas to 68 among neonatal patients in large metropolitan areas. The average total hospital cost for sepsis inpatient stays ranged from $50,800 among neonatal patients in rural areas to $58,700 among neonatal patients in small metropolitan areas. The average length of stay for sepsis inpatient stays ranged from 15.4 days among neonatal patients in large metropolitan areas to 17.5 days among neonatal patients in small metropolitan areas.

Summary

This chapter presented descriptive statistics on hospital encounters involving sepsis by patient characteristics, highlighting differences across groups; however, results did not account for confounding factors that may contribute to observed disparities. Overall, in 2021, the average sepsis inpatient stay was longer and incurred higher costs for non-White patients and those living in the most socially vulnerable and large metropolitan communities. Observed disparities highlight the need for current standards of sepsis care to account for at-risk and underserved populations. Similar considerations are important for initiatives related to patient education to improve the early detection of sepsis and management of associated long-term effects following discharge from the hospital.

Chapter 6. Hospital Burden of Sepsis

Highlights

- About 85 percent of all inpatient stays related to sepsis were at urban hospitals (2.1 of 2.5 million in 2021).
- Compared with rural hospitals, urban hospitals had a higher proportion of stays related to sepsis, longer lengths of stay, higher total hospital cost, and a higher in-hospital mortality rate for sepsis inpatient stays.
- At rural hospitals, over 40 percent of admissions to the emergency department for inpatient care led to a transfer to another hospital, compared with less than 1 percent of cases at urban hospitals.
- In rural areas, private for-profit hospitals saw a higher in-hospital mortality rate for sepsis hospital encounters (encounters due to sepsis), about 50 percent higher than for public, non-federal hospitals (143 vs. 94 per 1,000 sepsis hospital encounters).
- In urban areas, public non-Federal hospitals had higher a cost rate for sepsis hospital encounters, almost 60 percent higher than at private for-profit hospitals ($34,500 vs. $21,800).

Sepsis poses a significant burden for hospital systems. Physicians and nurses in emergency department (ED) and inpatient settings play a critical role in prompt detection and treatment of sepsis. Most sepsis cases originate in the community,[62] but initial diagnosis typically occurs on hospital admission and a substantial proportion of hospitalized patients with sepsis receive initial care in the ED.[53,117] Hospital intensive care units (ICU) provide specialized care and advanced interventions for patients with severe sepsis or septic shock, to optimize management and improve patient outcomes.[123] Variations in timely recognition, diagnosis, treatment, and management of sepsis can contribute to variation across hospitals in the burden of sepsis for patients and for hospitals.

This chapter looks at the burden of sepsis on at non-Federal, acute-care hospitals in the United States and how it varies by community and hospital characteristics. It presents hospital variation in: 1) sepsis caseloads in ED, ICU, and inpatient settings; 2) average length of stay; 3) average total hospital costs for sepsis inpatient stays (inpatient stays due to sepsis); and 4) in-hospital mortality rate for sepsis hospital encounters.[xix] Variation in sepsis hospitalization rates and outcomes reflects the racial and ethnic composition of patient populations, socioeconomic characteristics of the community, and the number (volume) of a hospital's sepsis cases. Variation may also reflect hospital characteristics such as ownership, affiliation with a multi-hospital system, inpatient and ICU bed capacity, teaching status, designation as a critical access hospital (CAH) or as a safety-net institution, and trauma center level. Findings consider the influence of hospital characteristics by whether hospitals are urban or rural, as rural

[xix] The measure of in-hospital mortality for sepsis hospital encounters includes deaths in the inpatient and ED settings. Deaths occurring in the ED setting were included because the person who died likely would have been admitted to the hospital, had they survived.

hospitals face significant challenges due to limited resources, lack of specialized ICUs, geographic isolation, and financial constraints.

Methods in Chapter 6: Data are from the 2019 and 2021 Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID) and State Emergency Department Databases (SEDD) for 47 States and the District of Columbia. This chapter presents findings for non-Federal acute care hospitals, excluding rehabilitation and long-term acute care facilities (4,244 hospitals in 2019 and 4,228 hospitals in 2021).

The report summarizes the distribution of hospital-level averages using measures of central tendency (median, interquartile range). The large size of HCUP databases means that small differences may not be clinically important. Thus, only differences of at least 10 percent are presented.

See Appendix C for the clinical coding criteria for sepsis; Appendix D for more information about measures, characteristics, and analyses; and Appendix E for data tables that support this chapter.

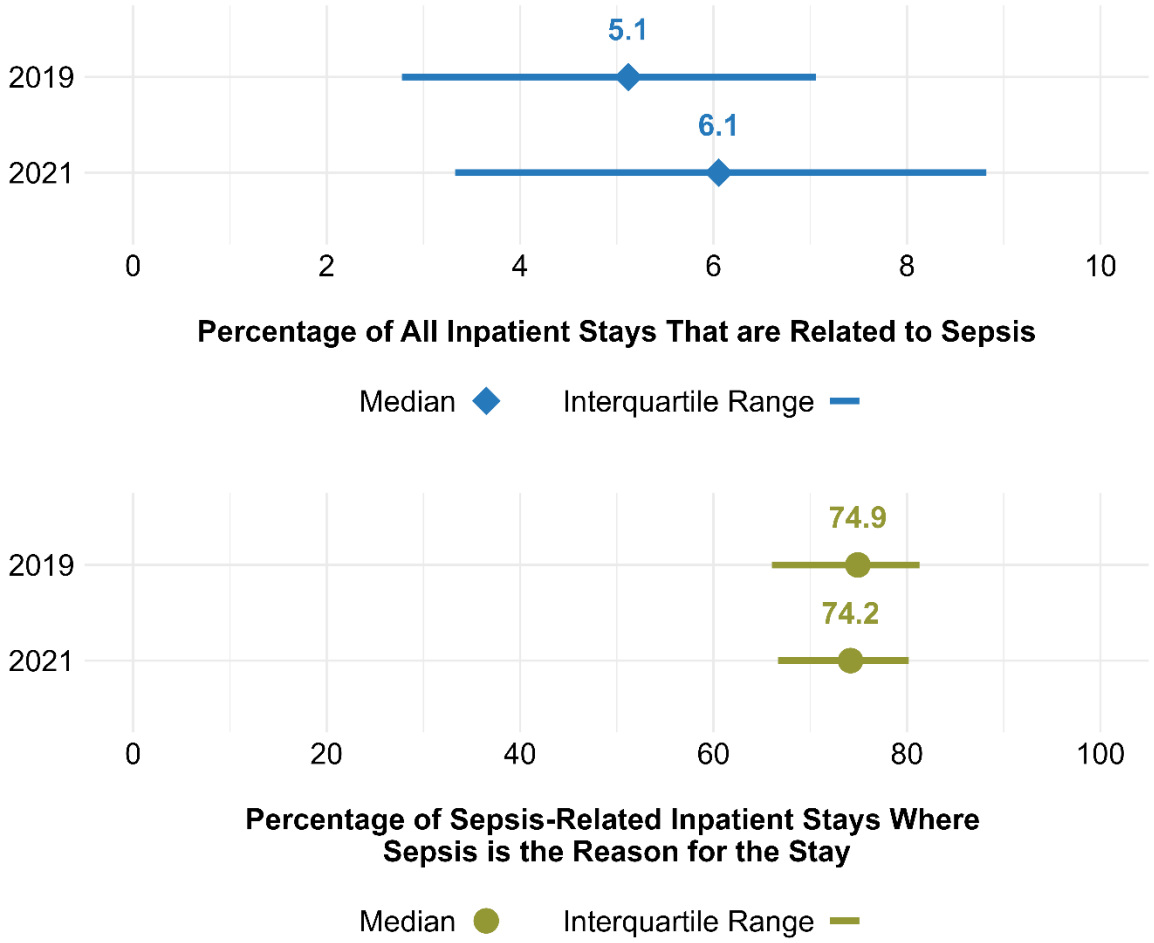
6.1 Overview of Hospital Encounters Involving Sepsis

6.1.1 Inpatient stays related to sepsis

The percentage of inpatient stays related to sepsis at non-Federal acute-care hospitals increased from 2019 (5.1 percent) to 2021 (6.1 percent); see Exhibit 6.1.[xx] Over 74.2 percent of stays related to sepsis had sepsis as the principal reason for admission to the hospital; 35.8 percent of sepsis-related stays related to sepsis had another reason for hospital admission (sepsis inpatient stays). In 2021, sepsis inpatient stays accounted for 4.3 percent of all inpatient stays. Almost half of all sepsis-related inpatient stays in 2019 and 2021 included an ICU stay. The rate of ICU utilization varied widely across hospitals (interquartile range [IQR]=24 percent). In 2019 and 2021, urban hospitals had a higher percentage of inpatient stays related to sepsis (7.1 percent), compared with rural hospitals (4.4 percent); see Appendix Tables E.6.2 and E.6.3.

[xx] The statistics presented in this chapter are the mean and inter-quartile range of hospital-level average outcomes.

Exhibit 6.1. Hospital Variation in Sepsis-Related Inpatient Stays, 2019 and 2021



Note: Sepsis-related inpatient stays were identified using all available diagnoses; sepsis was not required to be the reason for the stay. For sepsis inpatient stays, sepsis was the reason for the stay (principal diagnosis). See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.6.1 for supporting information.

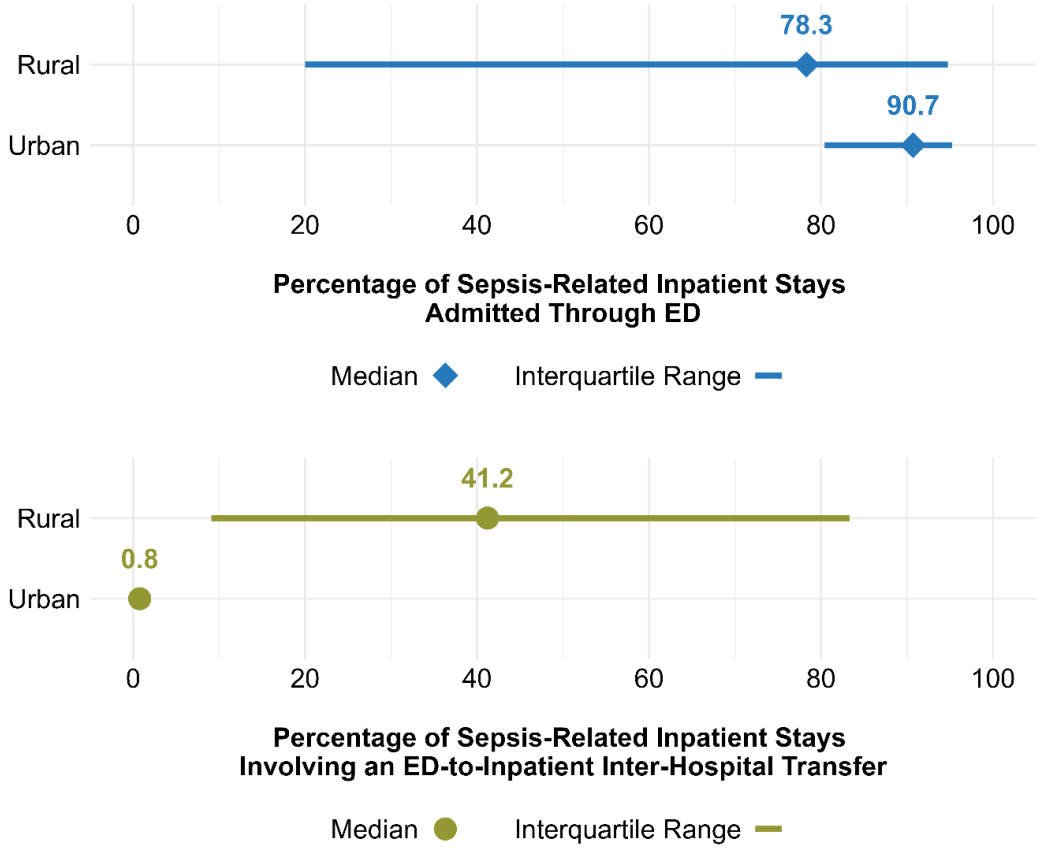
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019 and 2021, 47 States and the District of Columbia.

6.1.2 Emergency department utilization related to sepsis

ED as site for hospital admission. Clinicians in the ED play a key role in early detection and treatment of sepsis. On average, the ED was the site for almost 90 percent of all admissions for sepsis-related inpatient stays in 2019 and 2021; see Appendix Table E.6.2. However, the percentage of such stays that began in the ED was 16 percent lower in rural hospitals compared with urban hospitals (78.3 vs. 90.7 percent); see Exhibit 6.2. The percentage did not change meaningfully from 2019 to 2021 for urban and rural hospitals; see Appendix Tables E.6.2 and E.6.3.

Inter-hospital transfers for inpatient care. In 2019 and 2021, patients diagnosed with sepsis and admitted through the ED at rural hospitals for inpatient care were significantly more likely to be transferred to another hospital for inpatient care. Such inter-hospital transfers may delay prompt detection and treatment, critical for successfully managing sepsis. Among rural hospitals, on average, over 40 percent of sepsis-related inpatient stays admitted through the ED involved a transfer to an inpatient setting at another hospital; see Exhibit 6.2. One of four rural hospitals transferred over 80 percent of their sepsis inpatient encounters to an inpatient setting at another hospital; see Appendix Table E.4.2. Among urban hospitals, less than one percent of all inpatient stays related to sepsis admitted through the ED involved a transfer to an inpatient setting at another hospital.

Exhibit 6.2. Variation in ED Utilization and Inter-Hospital Transfers Involving Sepsis, 2021



Abbreviation: ED=emergency department.

Notes: Sepsis-related inpatient stays were identified using all available diagnoses; sepsis was not required to be the reason for the stay. For sepsis inpatient stays, sepsis was the reason for the stay (principal diagnosis). ED treat-and-release visits were encounters that did not result in admission to the same hospital; patients were evaluated in an ED before transfer to another acute-care hospital. Inter-hospital transfers were defined as all admissions through the ED for inpatient care that result in a transfer to an inpatient setting at a different hospital. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Tables E.6.1 and E.6.2 for supporting information.

Sources: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 47 States and the District of Columbia; State Emergency Department Databases (SEDD), 2021, 38 States and the District of Columbia.

6.2 Variation in Inpatient Stays Related to Sepsis

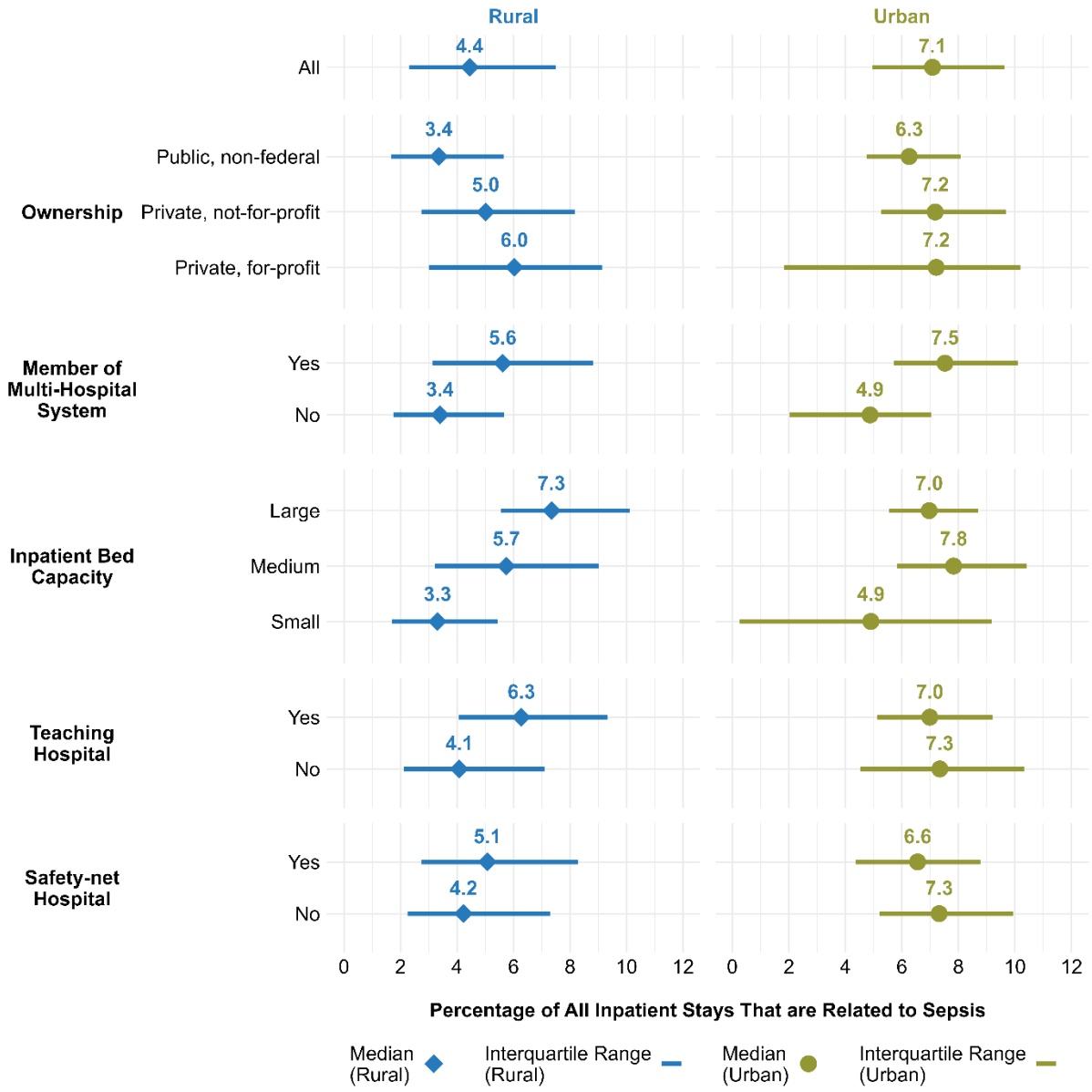
6.2.1 Variation in sepsis-related inpatient stays

The percentage of inpatient stays related to sepsis varied by hospital urban-rural location. In 2021, about 85 percent of all sepsis inpatient stays (inpatient stays due to sepsis) were at urban hospitals. For rural hospitals, limited resources, lack of specialized ICUs, geographic isolation, and financial constraints may hinder timely access to advanced care and require patient transfers to larger, urban hospitals, in turn delaying critical treatment and increasing patient risks. In 2021, about 7.1 percent of inpatient stays at urban hospitals were sepsis-related, compared with 4.4 percent of inpatient stays among rural hospitals; see Exhibit 6.3.

The percentage of inpatient stays related to sepsis was higher at private, for-profit, hospitals affiliated with a multi-hospital system, and large, rural hospitals. In 2021, among rural hospitals, the sepsis caseload at private, for-profit hospitals was nearly twice that of public, non-Federal hospitals (6.0 vs. 3.4 percent for rural hospitals). Private, urban hospitals had a higher sepsis caseload than public, non-federal urban hospitals. Hospitals affiliated with a multi-hospital system had a sepsis caseload 84 percent higher than that of non-affiliated hospitals. Among rural hospitals, large hospitals (100 or more beds) had the highest sepsis caseload, which was over two times higher than small hospitals (1–25 beds) (7.3 vs. 3.3 percent). In contrast, among urban hospitals, medium-sized hospitals (100–299 beds) had a higher sepsis caseload than small hospitals (1–99 beds) (7.8 vs. 4.9 percent) and large hospitals (300 or more beds) (7.8 vs. 7.0 percent).

In rural communities, the sepsis caseload was higher at safety-net and teaching hospitals. Safety-net hospitals had a sepsis caseload that was, on average, 21.4 percent higher than rural hospitals that were not safety-net institutions (5.1 vs. 4.2 percent). Teaching hospitals had a sepsis caseload 53.8 percent higher than that for rural non-teaching hospitals (6.3 vs. 4.1 percent).

Exhibit 6.3. Hospital Variation in Percentage of All Inpatient Stays Related to Sepsis, 2021



Note: Sepsis was identified using all available diagnoses and was not required to be the reason for the stay. The definition of inpatient bed capacity varied for rural and urban hospitals. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.6.3 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2021, 47 States and the District of Columbia.

ICU utilization. For adult inpatient stays related to sepsis, ICU utilization varied based on the community's socially vulnerability, ICU bed capacity, and trauma center designation. Hospitals in the most socially vulnerable communities had a higher percentage of sepsis-related inpatient stays that involved ICU services than those in less socially vulnerable communities (49.5 vs.

44.0 percent); see Appendix Table E.6.4. Rural hospitals with five or more ICU beds had sepsis caseloads involving ICU services that were 24 percent higher than those with fewer than five beds (49.5 vs. 39.8 percent). Sepsis caseloads involving ICU services at Level 1 trauma center hospitals were 22.9 percent higher than those at non-trauma center hospitals (55.2 vs. 44.9 percent).

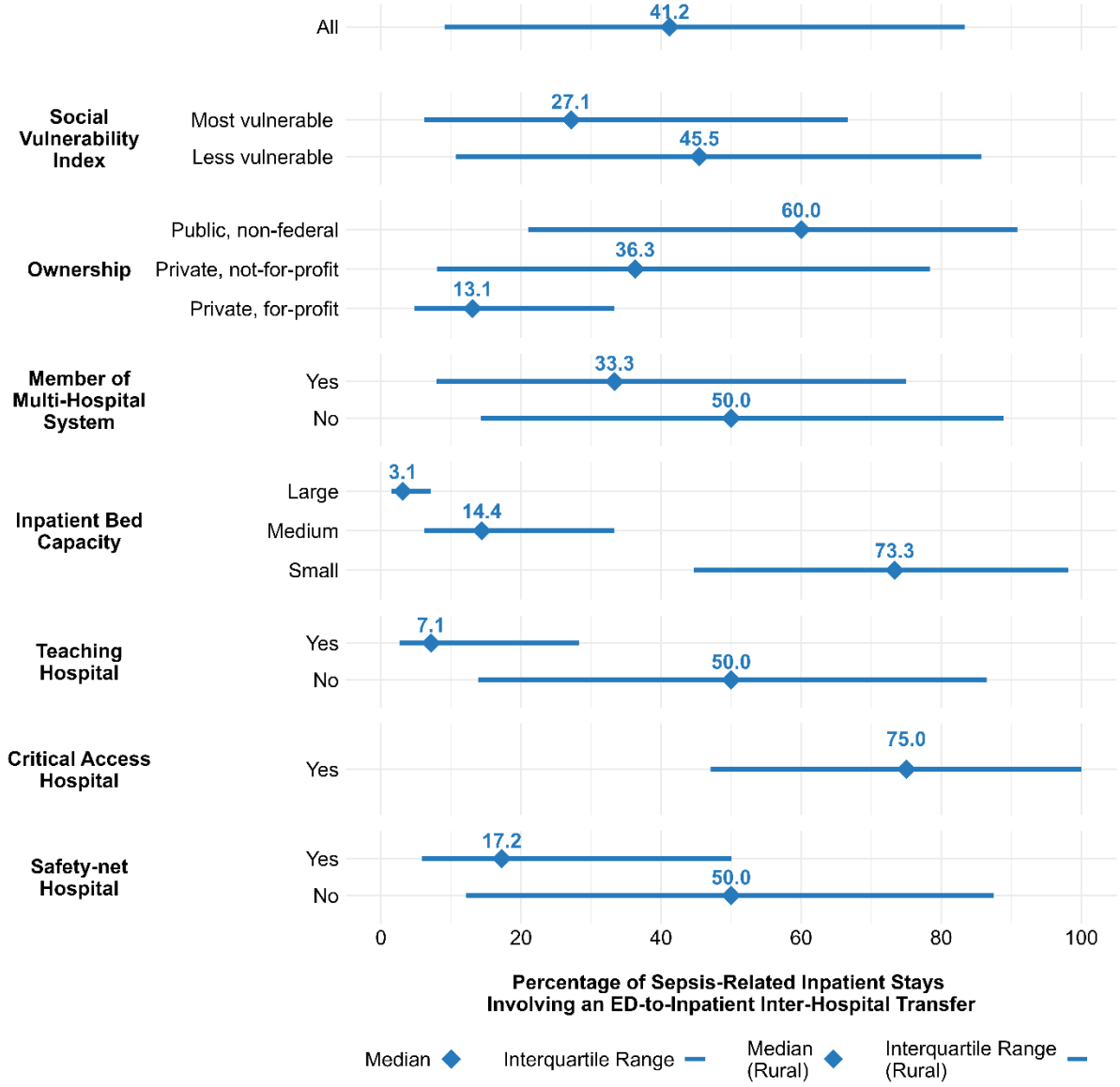
6.2.2 Variation in inter-hospital transfers for sepsis-related inpatient stays among rural hospitals

Compared with urban hospitals, rural hospitals had higher rates of inter-hospital transfers for sepsis and showed significant variation in transfer rates. The percentage of sepsis-related inpatient stays with an inter-hospital transfer at rural hospitals was higher at hospitals in less socially vulnerable communities, at public non-Federal hospitals, and at hospitals not affiliated with a multi-hospital system. Hospitals in the most socially vulnerable communities had a lower percentage than those in less socially vulnerable communities (27.1 vs. 45.5 percent); see Exhibit 6.4.[xxi] The percentage among public, non-Federal hospitals was almost five times higher than among private, investor-owned hospitals (60.0 vs. 13.1 percent). The percentage among hospitals not affiliated with a multi-hospital system was 50.2 percent higher than among those affiliated with a multi-hospital system (50.0 vs. 33.3 percent). Almost three in four sepsis-related inpatient encounters admitted through the ED at small hospitals (1–25 beds) involved a transfer to an inpatient setting at another hospital.

Among rural hospitals, non-teaching, non-safety-net, and critical access hospitals had higher rates of inter-hospital transfers for sepsis-related hospital encounters. Non-teaching hospitals had a rate seven times higher than at teaching hospitals (50.0 vs. 7.1 percent). CAHs had a rate almost 10 times higher than non-critical access hospitals (75.0 vs. 8.5 percent). Non-safety-net hospitals had rate about three times higher than safety-net hospitals (50.0 vs. 17.2 percent).

[xxi] Social vulnerability designation in this report is based on the Social Vulnerability Index (SVI). SVI is a measure of a community's ability to prevent human suffering and financial loss during a disaster. U.S. ZIP Codes were categorized into quartiles based on the SVI value of the ZIP Code. Hospital ZIP Codes with values in the fourth quartile are categorized as being in the most vulnerable communities; hospitals in other ZIP Codes are categorized as being in less vulnerable communities. See Appendix D for more information on hospital characteristics.

Exhibit 6.4. Variation in Inter-Hospital Transfers for Sepsis-Related Inpatient Stays Among Rural Hospitals, 2021



Note: Inter-hospital transfers were defined as all admissions through the ED for inpatient care that result in a transfer to an inpatient setting at a different hospital. Sepsis was identified using all available diagnoses and was not required to be the reason for the stay. Hospitals located in ZIP Codes in the highest quartile of CDC's Social Vulnerability Index (SVI) were categorized as being in the most vulnerable communities, and the remaining quartiles were categorized as being in less vulnerable communities. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.6.5 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 47 States and the District of Columbia; State Emergency Department Databases (SEDD), 2021, 38 States and the District of Columbia.

6.3 Overview of Outcomes Associated with Hospital Encounters for Sepsis

Urban hospitals had a higher in-hospital mortality rate for sepsis hospital encounters (hospital encounters due to sepsis), a longer average length of stay, and a higher average total hospital cost, compared with rural hospitals; see Exhibit 6.5.

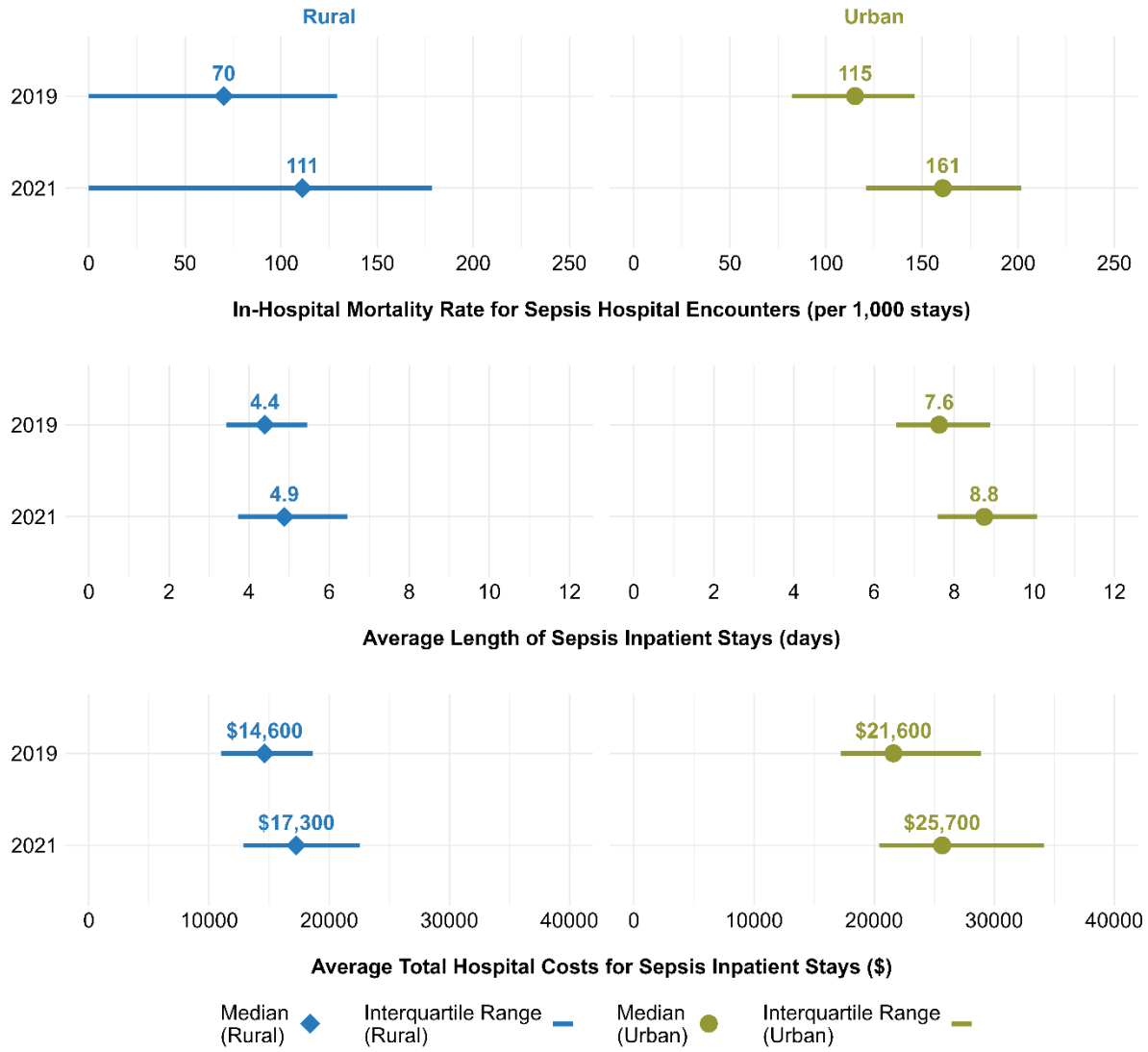
In-hospital mortality rates. In 2019, about 1 in 10 hospital encounters for sepsis at urban hospitals resulted in death.[xxii] From 2019 to 2021, the in-hospital mortality rate for sepsis hospital encounters increased by 39.7 percent for urban hospitals (from 115 to 161 per 1,000 sepsis hospital encounters) and by 58.3 percent for rural hospitals (from 70 to 111 per 1,000 sepsis hospital encounters).

Length of stay. From 2019 to 2021, the average length of stay for sepsis stays increased by 14.8 percent for urban hospitals (from 7.6 days to 8.8 days) and by 11.2 percent for rural hospitals (from 4.4 to 4.9 days).

Total hospital cost for sepsis. From 2019 to 2021, the average total hospital cost for sepsis stays increased by 18.7 percent at urban hospitals (from $21,600 to $25,700) and rural hospitals saw a similar percentage increase (from $14,600 to $17,300).

[xxii] In-hospital mortality for sepsis hospital encounters included deaths in the inpatient as well as ED settings. Deaths occurring in the ED setting were included because the person who died probably would have been admitted to the hospital, had they survived.

Exhibit 6.5. Outcomes Associated with Sepsis Hospital Encounters, 2019 and 2021



Note: Sepsis was the reason for the stay/encounter (principal/first-listed diagnosis). Charges were imputed to account for missing information prior to conversion to hospital costs. Hospital costs were adjusted to the base year of 2021. In-hospital mortality included deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Tables E.6.6. and E.6.7 for supporting information.

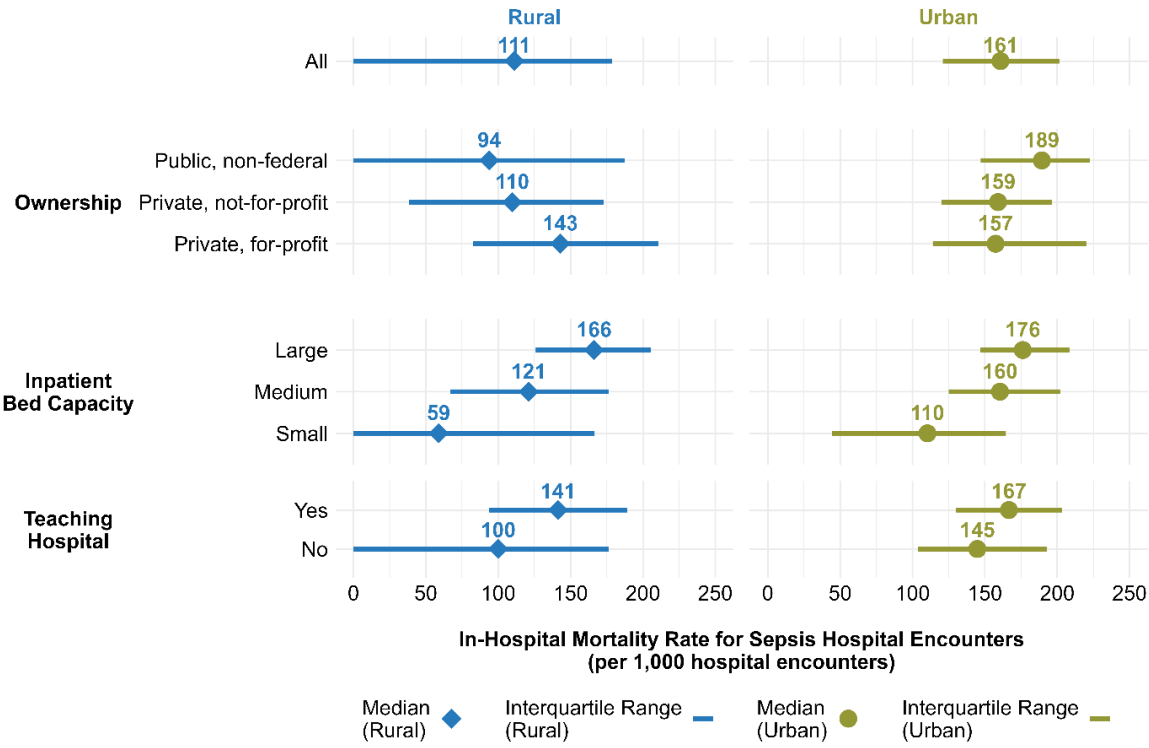
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 47 States and the District of Columbia; State Emergency Department Databases (SEDD), 2019 and 2021, 38 States and the District of Columbia.

6.4 Variation in Outcomes Associated with Hospital Encounters for Sepsis

6.4.1 Variation in in-hospital mortality rate of sepsis hospital encounters

The in-hospital mortality rate for sepsis hospital encounters (hospital encounters due to sepsis) varied by hospital location, ownership, inpatient bed capacity, and teaching status; see Exhibit 6.6. In 2021, the rate in urban hospitals was 45.0 percent higher than in rural hospitals (161 versus 111 per 1,000 sepsis hospital encounters). For rural hospitals, private for-profit hospitals had a rate that was 52.2 percent higher than public non-Federal hospitals (143 vs. 94 per 1,000 sepsis hospital encounters). In contrast, among urban hospitals, public non-Federal hospitals had the highest rate—20.3 percent higher than private for-profit hospitals (189 vs. 157 per 1,000 sepsis hospital encounters). For urban hospitals, large hospitals (300 or more beds) had a rate that was 59.7 percent higher than small hospitals (1–99 beds) (176 vs. 110 per 1,000 sepsis hospital encounters). Among rural hospitals, large hospitals (100 or more beds) had a rate almost three times higher than small hospitals (1–25 beds) (166 vs. 59 per 1,000 sepsis hospital encounters). For rural hospitals, teaching hospitals had an in-hospital mortality rate 41.3 percent higher than non-teaching hospitals (141 vs. 100 per 1,000 sepsis hospital encounters).

Exhibit 6.6. Hospital Variation in In-Hospital Mortality Rate of Sepsis Hospital Encounters, 2021



Note: Sepsis was the reason for the hospital encounter (principal/first-listed diagnosis). In-hospital mortality included deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.6.8 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2021, 47 States and the District of Columbia; State Emergency Department Databases (SEDD), 2021, 38 States and the District of Columbia.

6.4.2 Variation in average total hospital cost for sepsis inpatient stays

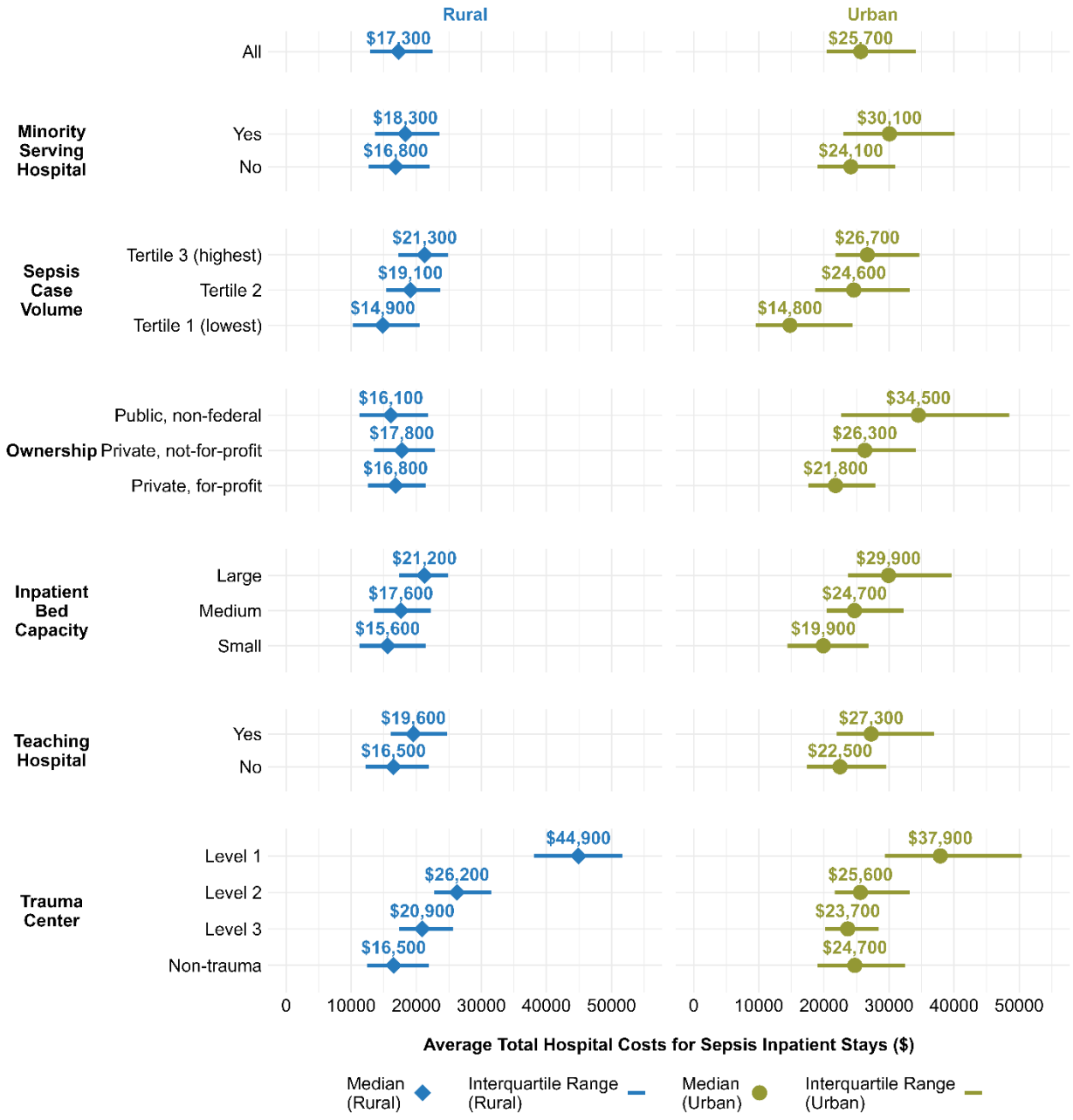
Average total hospital cost for sepsis inpatient stays (inpatient stays due to sepsis) varied based on the hospitals' location, racial and ethnic composition of the patient population, and volume of sepsis-related inpatient stays; see Exhibit 6.7. In 2021, the cost at urban hospitals was 48.6 percent higher than at rural hospitals ($25,600 vs. $17,300). Urban hospitals with the highest proportion of racial and ethnic patients had a higher cost than those with lower proportions ($30,100 vs. $24,100).[xxiii] Urban hospitals with the highest volume of sepsis-related inpatient stays saw 80.4 percent higher costs than the lowest volume hospitals ($26,700 vs. $14,800).

Average total hospital cost for sepsis inpatient stays varied by hospital ownership and inpatient bed capacity. Among urban hospitals, public non-Federal hospitals had the highest cost, 58.4 percent higher than at private for-profit hospitals ($34,500 vs. $21,800). Large rural hospitals (100 or beds) had a higher cost than small rural hospitals (1–25 beds) ($21,200 vs. $15,600). Similarly, among urban hospitals, large hospitals (300 or more beds) had a higher cost than small hospitals (1–99 beds) ($29,900 vs. $19,900).

Average total hospital cost for sepsis inpatient stays varied by teaching status and trauma center level. Among urban hospitals, teaching hospitals had costs 21.3 percent higher than at non-teaching hospitals ($27,300 vs. $22,500). Rural hospitals with Level 1 trauma centers had a cost nearly three times higher than rural, non-trauma center hospitals ($44,900 vs. $16,500). Among urban hospitals, Level 1 trauma center hospitals had a cost 53.1 percent higher than non-trauma center hospitals ($37,900 vs. $24,700).

[xxiii] All U.S. non-federal acute care hospitals were grouped into quartiles based on the distribution of the proportion of racial and ethnic minority patient admissions. Hospitals in the top quartile (highest proportion) were categorized as minority serving hospitals. See Appendix D for more information on hospital characteristics.

Exhibit 6.7. Hospital Variation in Average Total Hospital Costs of Sepsis Inpatient Stays, 2021



Abbreviation: ICU=intensive care unit.

Note: Sepsis was the reason for the stay (principal diagnosis). Hospitals located in ZIP Codes that are in the highest quartile of CDC's Social Vulnerability Index (SVI) were categorized as in the most vulnerable communities, with all other hospitals categorized as in less vulnerable communities. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.6.9 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Database (SID), 2021, 47 States and the District of Columbia.

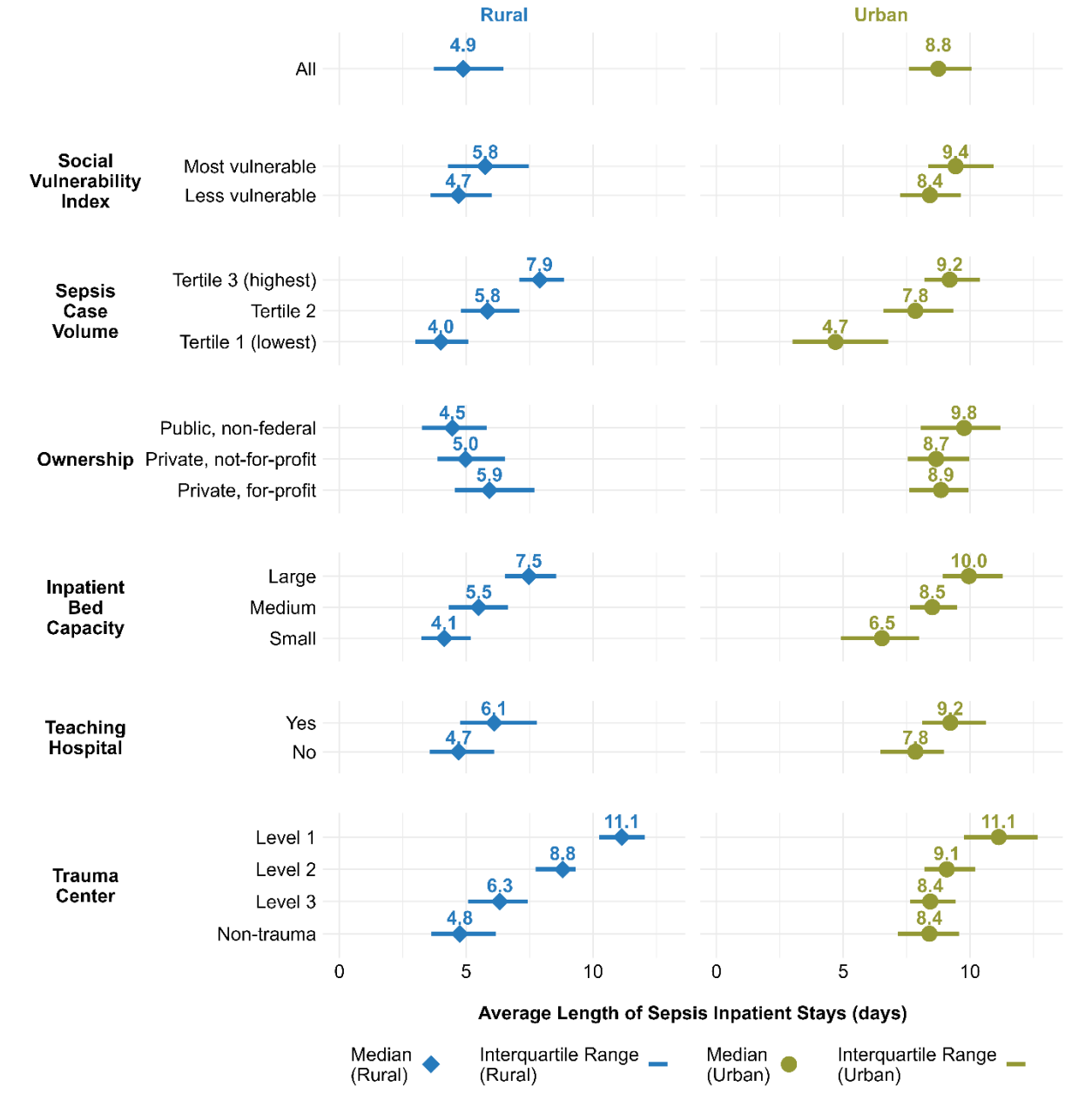
6.4.3 Variation in average length of stay for sepsis inpatient stays

The average length of sepsis inpatient stays varied by hospital location, community socioeconomic characteristics, and volume of sepsis-related inpatient stays; see Exhibit 6.8. The length of stay at urban hospitals was about 80 percent longer than at rural hospitals (8.8 vs. 4.9 days). Rural hospitals in the most socially vulnerable communities had a length of stay 22.5 percent longer than those in less socially vulnerable communities (5.8 vs. 4.7 days). For both urban and rural hospitals, the length of stay for hospitals with the highest volume of sepsis-related inpatient stays was nearly two times longer than at the lowest volume hospitals.

The average length of sepsis inpatient stays also varied by hospital ownership and inpatient bed size. Among rural hospitals, private for-profit hospitals had a length of stay 32.8 percent longer than at public non-Federal hospitals (5.9 vs. 4.5 days). Among rural hospitals, large hospitals (100 or more beds) had a length of stay 80.4 percent longer than small hospitals (1–25 beds) (7.5 vs. 4.1 days). Similarly, among urban hospitals, large hospitals (300 or more beds) had a length of stay 52.6 percent longer than small hospitals (1–99 beds) (10.0 vs. 6.5 days).

The average length of sepsis inpatient stays varied by teaching status and trauma center level. Length of stay in rural teaching hospitals was 29.6 percent longer than at rural non-teaching hospitals (6.1 vs. 4.7 days). For rural hospitals, Level 1 trauma centers had a length of stay over two times longer than non-trauma center hospitals (11.1 vs. 4.8 days). Among urban hospitals, the length of stay at Level 1 trauma center hospitals was 32.6 percent longer than at non-trauma center hospitals (11.1 vs. 8.4 days).

Exhibit 6.8. Hospital Variation in Average Length of Sepsis Inpatient Stay (Days), 2021



Note: Sepsis was the reason for the stay (principal diagnosis). Hospitals located in ZIP Codes in the highest quartile of CDC's Social Vulnerability Index (SVI) were categorized as being in the most vulnerable communities, and the rest were categorized as in less vulnerable communities. Hospitals in the top quartile of the distribution of the proportion of racial and ethnic patient subgroups were categorized as minority-serving hospitals. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.6.10 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2021, 47 States and the District of Columbia.

Summary

Sepsis poses a significant burden on hospital systems. Variation in sepsis-related hospital encounters and outcomes by hospital characteristics—such as ownership, affiliation with multi-hospital systems, and bed capacity—highlights the need for tailored strategies to address sepsis management across diverse healthcare settings. Rural hospitals face challenges with early detection and access to specialized care. As a result, they often have lower rates of sepsis-related inpatient stays and higher rates of transfers to other hospitals. The transfers may indicate difficulties in managing sepsis effectively at rural facilities. Additionally, the disparities observed for in-hospital mortality rates and average total hospital costs underscore the importance of targeted interventions to improve outcomes and to mitigate financial strain on healthcare institutions.

Chapter 7. State Variation in Hospital Encounters Involving Sepsis

Highlights

- In both 2019 and 2021, Delaware, Rhode Island, Vermont, and Wyoming were among the five States with the lowest percentages of inpatient stays involving sepsis, while California, Kentucky, and West Virginia were among the five States with the highest percentages.
- From 2019 to 2021, the percentage of aggregate hospital cost attributable to sepsis inpatient stays increased in 45 States and the District of Columbia. Costs increased by over 20 percent each year in Arizona, Delaware, Florida, Tennessee, and Texas.
- From 2019 to 2021, the in-hospital mortality rate among sepsis hospital encounters increased for every state and the District of Columbia, with 15 States seeing an increase of 20 percent or more. In both 2019 and 2021, Colorado, Kansas, Utah, and Vermont had the lowest in-hospital mortality rates among sepsis hospital encounters while the District of Columbia, New Jersey, and New York had the highest.

Assessing State-level variation in sepsis can identify opportunities to improve sepsis care through quality improvement and policy initiatives. There is little public information on the geographic distribution of sepsis inpatient stays (inpatient stays due to sepsis), but research and data show that sepsis mortality in the United States varies by location. In 2021, four of the five States with the highest age-adjusted sepsis mortality were in the Southwest.[124] From 2005 to 2018, the highest sepsis mortality rates in the United States were in the South and the lowest in the West.[44]

State-level variation in sepsis mortality may relate to variations in patient risk factors, comorbidities, and patterns of care, as well as to prevalence of antimicrobial resistance.[125] Variation may also reflect different strategies to mitigate sepsis, such as legislative mandates to implement sepsis protocols and statewide hospital initiatives to support evidence-based practices.

This chapter presents State-level variation in sepsis-related inpatient stays, in aggregate hospital cost attributable to sepsis inpatient stays, and for in-hospital mortality[xxiv] among sepsis hospital encounters for 2019 and 2021. Data for 2021 allow analysis of State-level variation for key patient populations, including adult nonmaternal[xxv], maternal, pediatric, and neonatal patients.

[xxiv] In-hospital mortality for sepsis hospital encounters includes deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting.

[xxv] In this report, nonmaternal adult refers to a person with a sepsis diagnosis unrelated to pregnancy or postpartum experience.

Methods in Chapter 7: Data are from the 2019 and 2021 Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID) and State Emergency Department Databases (SEDD) for 47 States and the District of Columbia.

Statistics in this chapter are State-level measures among non-Federal hospitals in 2019 and 2021, for a subset of states and the District of Columbia with available Healthcare Cost and Utilization Project (HCUP) data. The total number of states for each analysis varies by the setting of care.

See Appendix C for the clinical coding criteria for sepsis; Appendix D for more information about measures, characteristics, and analyses; and Appendix E for data tables that support this chapter.

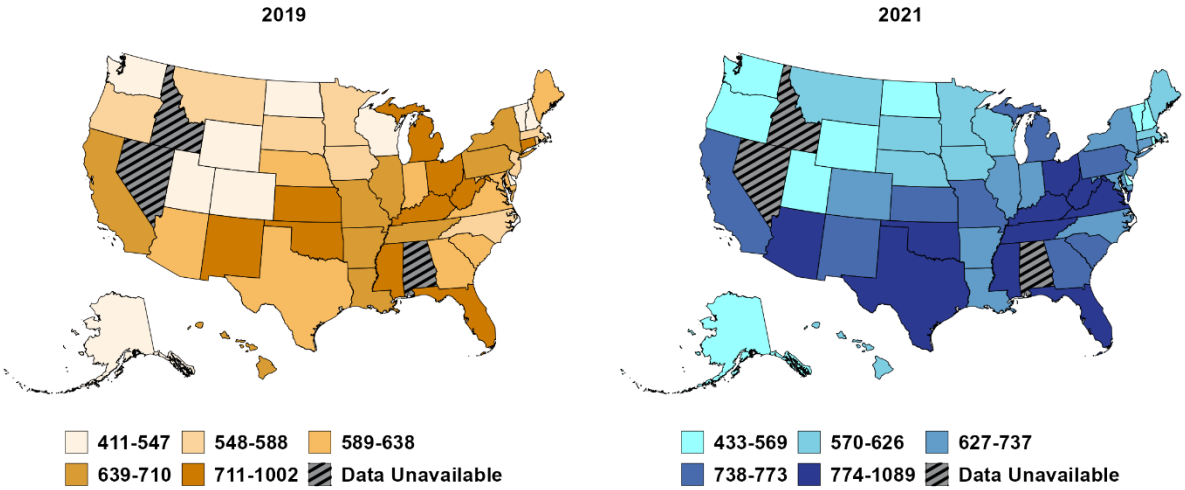
7.1 State Variation in Inpatient Stays Involving Sepsis

7.1.1 Population rate of sepsis-related inpatient stays across States

The population rate of sepsis-related inpatient stays (per 100,000 population) varies by State. In 2019, the rate ranged from 411 per 100,000 population (Wyoming) to 1,002 per 100,000 population (West Virginia); see Exhibit 7.1. In 2021, rates ranging from 433 per 100,000 population (Wyoming) to 1,089 per 100,000 population (West Virginia).

In 2019, Delaware, North Dakota, Utah, Vermont, and Wyoming had the lowest rates, and Kentucky, Michigan, Mississippi, Oklahoma, and West Virginia had the highest rates. State rankings were largely similar in 2021: North Dakota, Rhode Island, Utah, Vermont, and Wyoming had the lowest rates, and Florida, Kentucky, Mississippi, Tennessee, and West Virginia had the highest rates.

Exhibit 7.1. Population Rate of Sepsis-Related Inpatient Stays, 2019 and 2021



Note: Sepsis was identified using all available diagnoses and was not required to be the reason for the stay. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.7.1 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019 and 2021, 47 States and the District of Columbia.

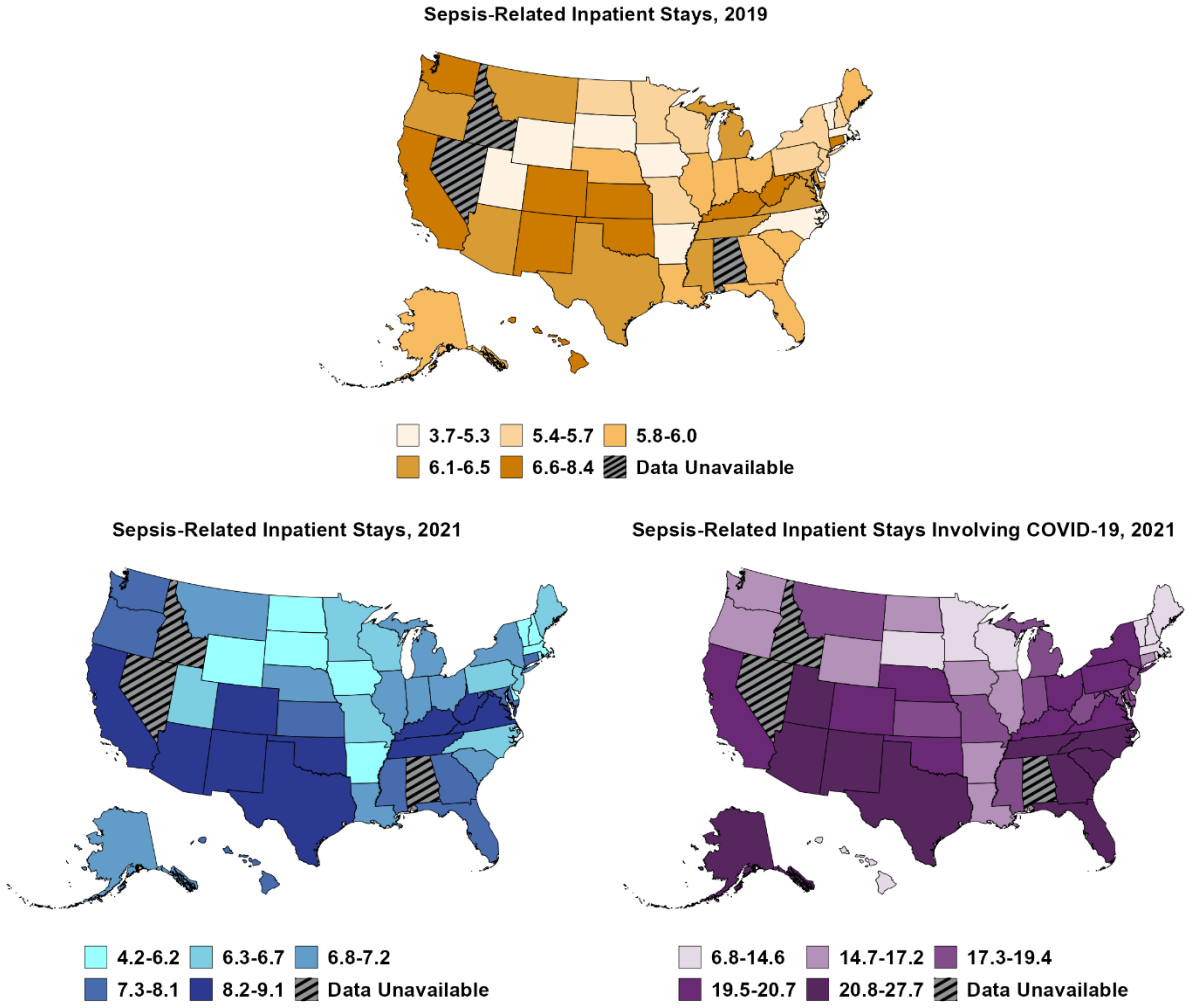
7.1.2 State variation in the percentage of inpatient stays related to sepsis

The percentage of inpatient stays related to sepsis is based on the State in which the stay occurred, rather than measuring at the population level.

In 2019, the percentage of inpatient stays related to sepsis ranged from 3.7 percent (Delaware) to 8.4 percent (Hawaii); see Exhibit 7.2. In 2021, the percentage ranged from 4.2 percent (Rhode Island) to 9.1 percent (Arizona). In 2019, Delaware, Massachusetts, Rhode Island, Vermont, and Wyoming had the lowest percentages and California, Hawaii, Kentucky, New Mexico, and West Virginia had the highest. In 2021, Delaware, Rhode Island, South Dakota, Vermont, and Wyoming had the lowest percentages and Arizona, California, Kentucky, Tennessee, and West Virginia had the highest.

In 2021, some sepsis-related inpatient stays also involved COVID-19. The percentage ranged from 6.8 percent in Vermont to 27.7 percent in Arizona; the District of Columbia, Hawaii, Maine, Rhode Island, and Vermont had the lowest percentages, while Arizona, Florida, Georgia, New Mexico, and Texas had the highest. See Appendix Table E.7.5 for more information on sepsis-related inpatient stays involving COVID-19.

Exhibit 7.2. State Variation in Percentage of Sepsis-Related Inpatient Stays, 2019 and 2021



Note: Sepsis was identified using all available diagnoses and was not required to be the reason for the stay. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. Appendix Table E.7.3 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019 and 2021, for 47 States and the District of Columbia.

In 2021, there was State-level variation in the percentage of inpatient stays related to sepsis for the following patient populations:

Nonmaternal adults aged 65 years and older with sepsis. From 6.7 percent (Rhode Island) to 14.5 percent (California). In 31 States and the District of Columbia, over 10 percent of inpatient stays were sepsis related.

Nonmaternal adults aged 18–64 years with sepsis. From 4.1 percent (Rhode Island) to 11.4 percent (Arizona). In five States (Arizona, Colorado, New Mexico, Tennessee, and Texas), over 10 percent of inpatient stays were sepsis related.

Maternal patients with sepsis. There was relatively little variation in percentage across the States (0.1 percent to 0.3 percent of inpatient sepsis-related stays).

Pediatric patients with sepsis. From 1.1 percent (Rhode Island) to 4.3 percent (Texas).

Neonatal patients with sepsis. From 0.2 percent (Rhode Island) to 2.3 percent (District of Columbia).

See Appendix Table E.7.4 for detailed statistics on patient populations.

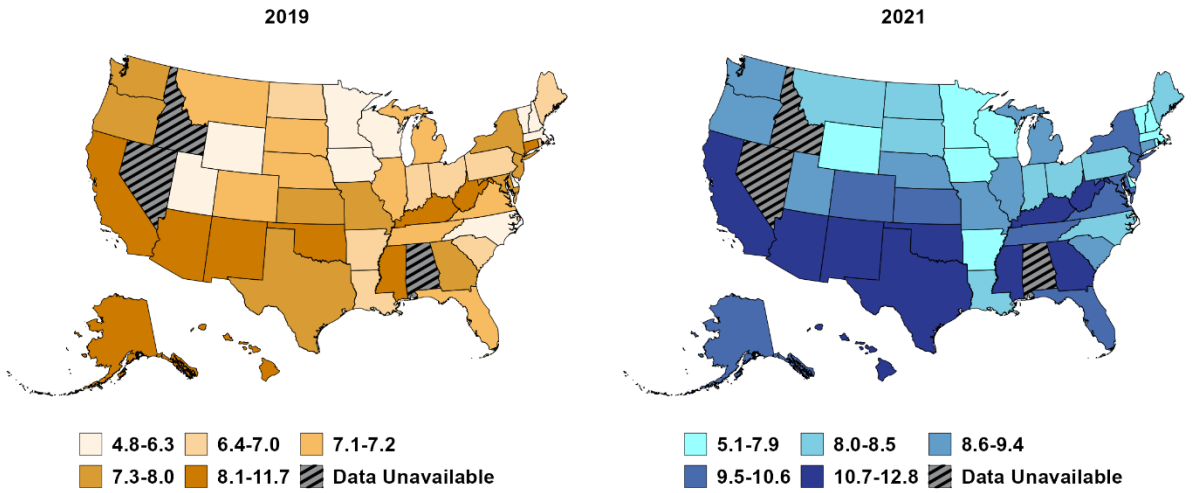
7.2 State Variation in Hospital Cost for Sepsis Inpatient Stays

7.2.1 Percentage of aggregate hospital cost for sepsis inpatient stays across States

In 2019, the percentage of aggregate hospital cost attributable to sepsis inpatient stays (inpatient stays due to sepsis) ranged from 4.8 percent (Delaware) to 11.7 percent (Hawaii); see Exhibit 7.3. The range increased in 2021, from 5.1 percent (Rhode Island) and to 12.8 percent (Arizona). In 2019, the percentage was lowest in Delaware, Iowa, Massachusetts, Vermont, and Wyoming, and the highest percentages were in hospitals located in California, Hawaii, New Mexico, Oklahoma, and West Virginia. In 2021, the percentage was lowest in Delaware, Massachusetts, Rhode Island, Vermont, and Wyoming and highest in Arizona, California, Kentucky, New Mexico, and Texas.

From 2019 to 2021, most States saw an increase in the percentage of aggregate hospital cost for sepsis inpatient stays. Only two States saw a decreased percentage (by 10.7 percent per year for Rhode Island and 3.0 percent per year for Hawaii). All other States and the District of Columbia had an increased percentage, with 29 States and the District of Columbia seeing at least a 10 percent increase per year. The greatest annual percentage increases were 20.4 percent (Delaware), 21.3 percent (Tennessee), 21.4 percent (Florida), 21.4 percent (Texas), and 24.0 percent (Arizona).

Exhibit 7.3 State Variation in Percentage of Aggregate Hospital Cost Attributable to Sepsis Stays



Note: Sepsis was the reason for the stay (principal diagnosis). Charges were imputed to account for missing information prior to conversion to hospital costs. Hospital costs were adjusted to the base year of 2021. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.7.6 for supporting information.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2021, 47 States and the District of Columbia.

In 2021, there was State-level variation in the percentage of aggregate hospital cost attributable to sepsis inpatient stays for specific patient populations:

Nonmaternal adults aged 65 years and older with sepsis. From 6.2 percent (Vermont) to 15.4 percent (California).

Nonmaternal adults aged 18–64 with sepsis. From 5.3 percent (Rhode Island) to 15.4 percent (Arizona).

Maternal patients with sepsis. Percentages were small, ranging from 0.1 to 0.5 percent.

Pediatric patients with sepsis. From 1.6 percent (Massachusetts) to 8.5 percent (West Virginia).

Neonatal patients with sepsis. From 0.2 percent (Kansas, Nebraska) to 6.0 percent (the District of Columbia).

See Appendix Table E.7.7 for more information on these patient populations.

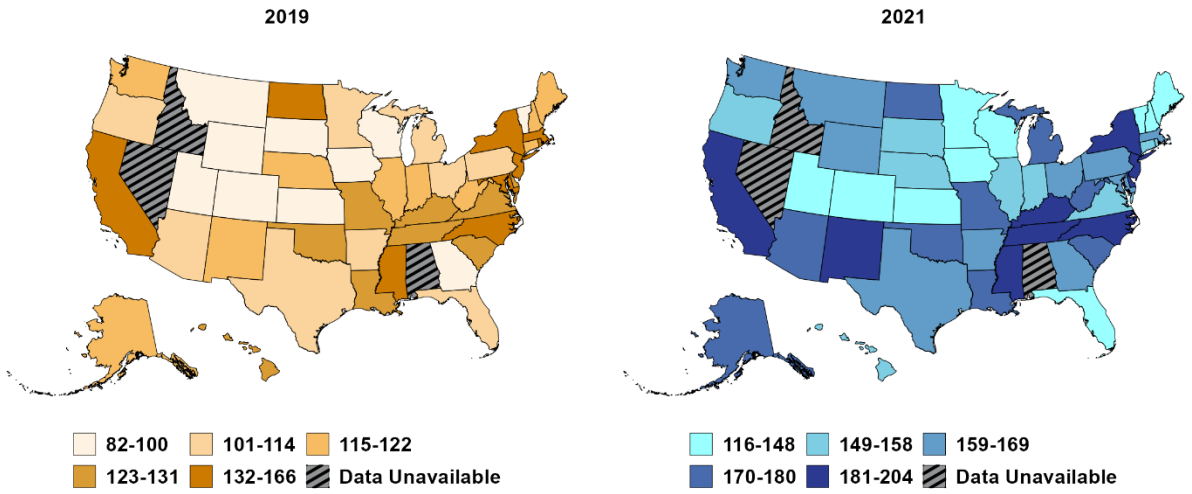
7.3 State Variation in In-Hospital Mortality Rates for Sepsis Hospital Encounters

7.3.1 In-hospital mortality among sepsis hospital encounters

In 2019, in-hospital mortality rate of sepsis hospital encounters (hospital encounters due to sepsis) ranged from 82 per 1,000 sepsis hospital encounters (Colorado, Utah) to 166 per 1,000 sepsis hospital encounters (District of Columbia); see Exhibit 7.4. In 2021, the range increased, from 116 per 1,000 sepsis hospital encounters (Utah) to 204 per 1,000 sepsis hospital encounters (District of Columbia). In 2019, the rate was lowest among hospitals in Colorado, Kansas, Montana, Utah, and Vermont and highest in the District of Columbia, Massachusetts, New Jersey, New York, and North Dakota. In 2021, the rate was lowest in Colorado, Kansas, Utah, Vermont, and Wisconsin and highest in Delaware, the District of Columbia, Mississippi, New Jersey, and New York.

From 2019 to 2021, every State and the District of Columbia saw an increase in in-hospital mortality among sepsis hospital encounters. The rate increased by at least 20 percent per year in 15 States; four States saw a 30 percent increase or more (30.8 percent in Wyoming, 31.2 percent in Arizona, 31.6 percent in Georgia, and 32.5 percent in Montana).

Exhibit 7.4. State Variation in In-Hospital Mortality Rate for Sepsis Hospital Encounters, 2019 and 2021



Note: Sepsis was the reason for the encounter (the principal/first-listed diagnosis). In-hospital mortality included deaths in inpatient and ED settings. Deaths that occurred in the ED setting were accounted for, as the deaths most likely occurred before the patient was transferred to the inpatient setting. See Appendix C, Clinical Coding for Sepsis, for criteria. See Appendix D, Background on Measures, Characteristics, and Calculations, for definitions. See Appendix Table E.7.8 for supporting information.
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019 and 2021, 47 States and the District of Columbia; State Emergency Department Databases (SEDD), 2019 and 2021, 38 States and the District of Columbia.

In 2021, there were limited data on in-hospital mortality for specific patient populations, due to the small number of cases of neonatal, pediatric, and maternal sepsis hospital encounters.

Nonmaternal adults aged 65 years and older with sepsis. Mortality rates ranged from 125 per 1,000 sepsis hospital encounters (Utah) to 250 per 1,000 sepsis hospital encounters (District of Columbia).

Nonmaternal adults aged 18–64 years with sepsis. Mortality rates ranged from 97 per 1,000 sepsis hospital encounters (Vermont, Colorado) to 173 per 1,000 sepsis hospital encounters (District of Columbia).

See Appendix Table E.7.9 for more detailed statistics on patient populations.

Summary

From 2019 to 2021, there was State-level variation in the percentage of inpatient stays related to sepsis, the percentage of aggregate hospital cost attributable to sepsis stays, and the rate of in-hospital mortality among sepsis hospital encounters. Forty-five States and the District of Columbia saw an increase in the percentage of aggregate hospital cost attributable to sepsis stays, and the in-hospital mortality among sepsis hospital encounters increased in every State and the District of Columbia.

Findings presented in this chapter can be used to identify States that may benefit from sepsis quality improvement initiatives and policies related to sepsis identification, treatment, and reporting.

Chapter 8. Resources and Programs for Early Identification and Management of Sepsis

Lack of a "gold standard" diagnostic protocol means that tracking sepsis incidence, treatment, and outcomes is hard to do comprehensively and reliably.[126,127] In response, Federal and State agencies and nongovernmental organizations have invested in surveillance and quality improvement efforts to increase use of evidence-based practices to identify and treat sepsis and to monitor sepsis morbidity and mortality over time. This chapter provides an overview of guidelines, quality improvement resources, and initiatives.

8.1 Sepsis Guidelines, Bundles, and Quality Improvement Resources

8.1.1 Sepsis guidelines

The Surviving Sepsis Campaign (SSC) established international guidelines for managing sepsis in adults in hospital settings, with best practices for systematically and promptly identifying sepsis, initiating timely resuscitation, and providing effective treatment.[128] The guidelines aim to promote consistent implementation of evidence-based practices for early detection and management of sepsis across all hospitals; see Appendix E.2.3 for more information. These guidelines are updated on an ongoing basis to reflect advancements in clinical knowledge and best practices.

Sepsis guidelines provide recommendations for the early recognition, diagnosis, and management of sepsis and septic shock.

Sepsis bundles guide implementation of optimal care processes distilled from evidence-based practice guidelines.

Sepsis quality improvement programs guide implementation of structures and processes in hospitals to promote collaboration across disciplines and continuous improvement in sepsis care.

8.1.2 Sepsis bundles

The Institute for Healthcare Improvement and the SSC have developed sepsis care bundles—standardized approaches and checklists based on sepsis guidelines—to bring key elements of the guidelines to the hospital bedside. Sepsis care bundles help healthcare teams provide timely and effective treatment to patients with sepsis, to improve outcomes and to reduce the risk of complications and death. The bundles include key interventions and measures such as early administration of antibiotics, fluid resuscitation, and monitoring of vital signs.

8.1.3 Sepsis quality improvement programs

Hospital quality improvement programs for sepsis offer guidance to foster collaboration across clinical disciplines and hospital departments to effectively manage and optimize guideline-recommended care. The programs assist in implementing the organizational changes and resource allocations needed to implement evidence-based bundles have been associated with improved health outcomes in a wide range of hospitals and health systems.[129,130] Exhibit 8.1 describes sepsis quality improvement resources.

Exhibit 8.1. Sepsis Quality Improvement Resources

Surviving Sepsis Campaign Implementation Guide for the Hour-1 Bundle

- Offers best practices and screening strategies for early identification of sepsis on hospital floors, establishing team structure, and overcoming implementation barriers.

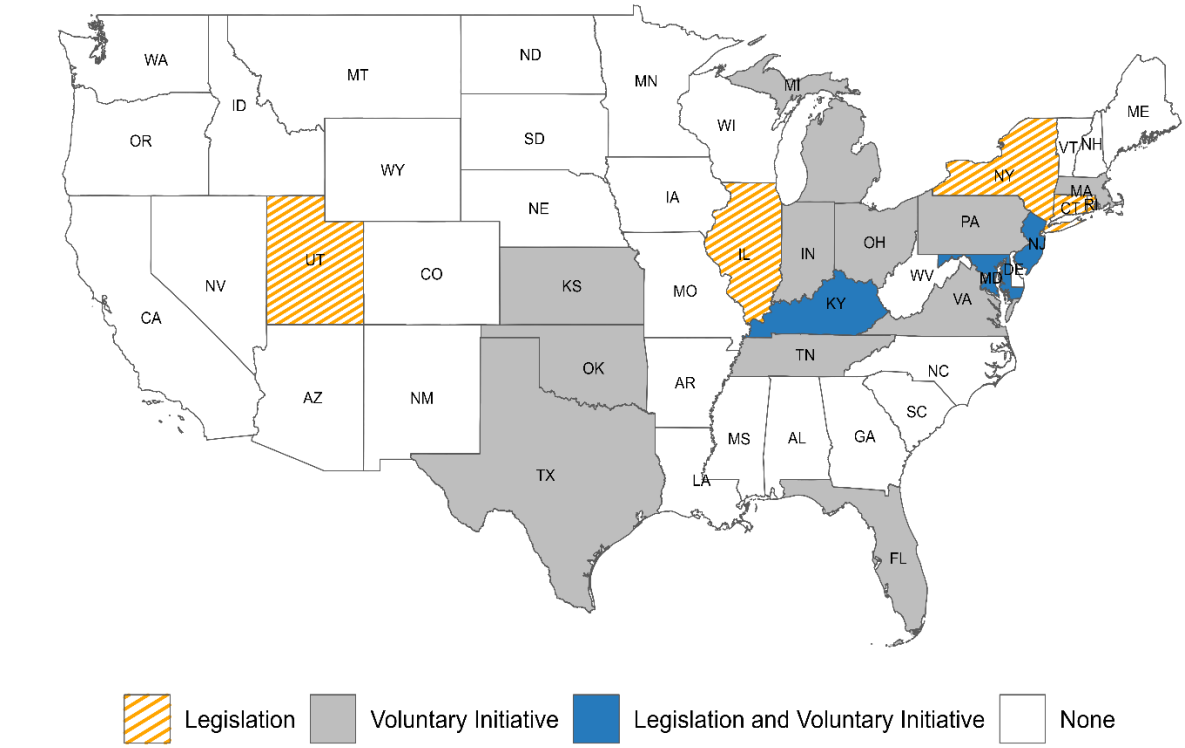
Centers for Disease Control and Prevention Hospital Sepsis Program Core Elements

- Assists hospitals in creating, structuring, and resourcing quality improvement programs to implement evidence-based sepsis guidelines.

8.2 State Initiatives and Resources for Quality Improvement and Surveillance

This section summarizes State-level initiatives and resources to promote implementation of evidence-based practices for early detection and rapid treatment of sepsis and septic shock. AHRQ identified a group of initiatives in 19 States, active in 2016 or more recently. The most common approaches were legislation and/or initiatives to mandate or encourage hospitals to adopt sepsis protocols and to make educational resources available to both providers and the public. See Exhibit 8.2 for a map depicting locations of the initiatives and Appendix E.8.1 for more information about the initiatives and resources.

Exhibit 8.2. Sepsis Legislation and Initiatives by State



**No legislation or voluntary initiatives found in AK, HI, or DC*

8.2.1 State regulatory programs

Eight States—New York, New Jersey, Illinois, Rhode Island, Utah, Maryland, Kentucky, and Connecticut—have legislation related to sepsis: see Exhibit 8.3.[131,132,133,134,135,136,137,138]

Exhibit 8.3. State Legislative and Regulatory Mandates Related to Sepsis

Legislative and Regulatory Mandates	State
Requires the collection and reporting of sepsis-related data.	New York, Illinois, Rhode Island
Mandates hospitals maintain and implement sepsis protocols and make protocols available to the State Health Department. Maryland legislation also requires specialty psychiatric hospitals to develop screening procedures and transfer protocols; hospitals have until January 1, 2025, to comply.	New York, New Jersey, Illinois, Rhode Island, Maryland
Offers hospitals the option to develop protocols for treating sepsis and septic shock; the State Health Department may request to inspect the protocols.	Utah
Requires the incidence of neonatal bacterial sepsis be reported to the State Health Department.	Connecticut

Legislative and Regulatory Mandates	State
Requires a workgroup to develop a sepsis public awareness campaign.	Kentucky
Requires the Department of Medicaid Services and contracting managed care organization to use specific clinical criteria to diagnose sepsis.	Kentucky

Several State initiatives concern data collection. New York specifies that sepsis-related data be reported to the State and used to develop risk-adjusted mortality rates for sepsis and septic shock. Rhode Island and Illinois mandate that data collection focus on quality measures related to identifying and treating sepsis. Illinois legislation notes that hospitals submitting sepsis data to the Centers for Medicare & Medicaid Services (CMS) are presumed to fulfill State requirements and that rules may be adopted for future sepsis data collection submission to the State Health Department.

One noteworthy aspect of New York's legislation has been the State Health Department's implementation of the New York State Sepsis Care Improvement Initiative. The Initiative is a collaboration among hospitals and other partners to enhance sepsis detection and treatment and to reduce sepsis mortality. Reports on hospital quality performance related to sepsis are made available online, and New York produces an annual report on sepsis mortality rates. The Initiative has been associated with a decrease in sepsis mortality.[139]

8.2.2 State voluntary programs

AHRQ identified voluntary State initiatives in 14 States; such programs promote best practices through provider education and/or hospital collaboration. See Exhibit 8.2 for a map depicting the locations of States voluntary initiatives and Appendix Table E.8.1 for more information about State-level activities and resources related to sepsis. Initiatives are most often facilitated by State hospital associations, although state health departments, universities, and other organizations have also served in this role:

- In 2021, the Michigan Hospital Medicine Safety (HMS) Consortium launched the Sepsis Initiative, fully implemented in all HMS hospitals by 2023. The Initiative aims to reduce long-term morbidity and short-term mortality through implementing best practices, education, and sharing information.[140]
- An initiative in Indiana developed and disseminated a toolkit to improve sepsis screening and treatment.[141]
- In Kansas, an initiative focused on training sessions for healthcare providers.[142,143]
- Other States facilitated efforts bringing hospitals and partners together to implement best practices for sepsis identification and care and mortality reduction.[143,144,145,146,147,148,149,150,151,152]

Several States (Rhode Island, California, Minnesota, and Wisconsin) had voluntary initiatives prior to 2016 that are not presented, as the initiatives concluded before the sampling period for this report.[153,154]

8.3 Resources to Measure Sepsis Quality of Care

8.3.1 Tracking sepsis rates and quality of care

Clinical registries, electronic health record (EHR) data, death records, and medical billing and encounter data are commonly used to track sepsis rates and to measure quality of care and outcomes.[16]

- **Clinical registries** are valuable for surveillance and to measure protocol adherence but face limitations related to administrative burdens and costs for providers.
- **EHR-based sepsis surveillance** can offer accurate and consistent data across diverse settings if supported by robust information technology resources.
- **Death records** capture mortality risk beyond hospital settings but cannot be used to track sepsis incidence.
- **Medical billing and encounter data from administrative sources—**such as the Agency for Healthcare Research and Quality's (AHRQ) Healthcare Cost and Utilization Project (HCUP) or CMS' Medicare claims data**—**offer nationwide coverage and availability that enables comprehensive tracking of sepsis rates and impacts on patients and hospitals. However, using such sources for surveillance presents challenges related to data timeliness, ability to link records across encounters and datasets, and variability in clinical coding practices across hospitals and over time.

The U.S. Centers for Disease Control and Prevention (CDC) offers a toolkit for adult sepsis surveillance in hospitals, with guidelines to implement surveillance using EHR or chart review data.[154] Such methodologies enable the tracking of facility-level sepsis incidence and outcomes, allowing more informed decision making and targeted interventions.

8.3.2 Federal initiatives to inform the quality of sepsis care in United States hospitals

Federal initiatives are multifaceted and focus on both policy and practical guidelines. This section highlights two initiatives, CMS' *Severe Sepsis and Septic Shock Early Management Bundle (SEP-1)* and AHRQ's *Patient Safety Indicator Measure*.

Severe Sepsis and Septic Shock Early Management Bundle (SEP-1). The National Quality Forum (NQF) has endorsed SEP-1, a process measure that standardizes procedures for timely sepsis detection and early life-saving intervention. The measure represents the proportion of eligible patients with sepsis that receive all components of the sepsis care bundle; the measure calculation includes patients aged 18 and over admitted to the inpatient setting with a diagnosis of severe sepsis or septic shock.[xxvi] The SEP-1 was first integrated into the Hospital Inpatient Quality Reporting (Hospital IQR) program in 2015 and became publicly accessible on CMS' Hospital Compare website in 2018. In 2024, Medicare's Value-Based Purchasing (VBP) Program included SEP-1 as a measure under the safety domain.

AHRQ Patient Safety Indicators Measure. The AHRQ Quality Indicators (QI) initiative includes a Patient Safety Indicators (PSI) measure focused on postoperative sepsis rates for adults.

[xxvi] Please refer to the specifications manual for the National Inpatient Quality Measures for additional details: https://www.jointcommission.org/-/media/tjc/documents/measurement/specification-manuals/hiqr_specsman_july2019_v5_6.pdf

AHRQ Patient Safety Indicators Measure. The AHRQ Quality Indicators (QI) initiative includes a Patient Safety Indicators (PSI) measure focused on postoperative sepsis rates for adults. AHRQ offers free standardized, evidence-based software to generate actionable information about the quality of care in ambulatory and acute-care settings. The PSI measure tracks potential in-hospital complications and adverse events following surgeries, procedures, and childbirth; number 13 (PSI-13) measures postoperative sepsis rates for adults undergoing elective surgery. [xxvii] Elective surgery admissions to all non-Federal acute-care hospitals are included in the measure. AHRQ's National Healthcare Quality and Disparities Report uses the QI software and HCUP data to track nationally representative trends in postoperative sepsis rates. [xxviii]

[xxvii] Please refer to the technical specifications for the Patient Safety Indicator 13 (PS 13) Postoperative Sepsis Rate for additional details: https://qualityindicators.ahrq.gov/Downloads/Modules/PSI/V2023/TechSpecs/PSI_13_Postoperative_Sepsis_Rate.pdf

[xxviii] HCUP National Inpatient Sample data was used to calculate the nationally representative trends in postoperative sepsis rates.

Chapter 9. Conclusion

The Agency for Healthcare Research and Quality (AHRQ) presents this report in response to Congress's directive in the Fiscal Year 2023 Omnibus Spending Bill[3], to offer a comprehensive assessment of sepsis in the United States. The report provides detailed statistics on the prevalence of sepsis and its impact on the hospital system. It includes background information on the causes, disease progression, comorbidities, risk factors, complications, and treatment of sepsis for context. The report also aids in understanding the prevalence, clinical characteristics, and outcomes of sepsis resulting from COVID-19. Physicians and nurses in the ED and inpatient settings play a critical role in prompt detection and treatment of sepsis. To understand the burden of sepsis on non-Federal acute-care hospitals in the United States, the report examines trends in utilization, hospital costs, and in-hospital mortality before and after the onset of the COVID-19 pandemic. It also explores trends and disparities in overall hospital utilization related to sepsis and associated outcomes by patient race and ethnicity, sex, residence in socially vulnerable communities, and urban-rural location. Additionally, to inform strategies and initiatives aimed at combating sepsis, the report investigates State-level and hospital-level variations in sepsis-related hospital care and outcomes.

Report findings show that the number of sepsis-related inpatient stays at non-Federal acute-care hospitals in the United States increased from 1.8 million in 2016 to 2.5 million in 2021, with a faster rate of increase following the spread of COVID-19 in 2020. The COVID-19 pandemic significantly altered the epidemiology of sepsis, leading to a marked rise in sepsis-related hospital encounters, hospital costs, and in-hospital mortality, particularly for patients with a COVID-19 diagnosis.

Hospital encounters involving sepsis were more common among non-White patients and those living in socially vulnerable communities. For adults aged 18–64 years, patients in rural areas were more likely to die during a hospital encounter for sepsis than patients in large and small metropolitan areas.

The variation in sepsis-related hospital encounters and outcomes based on hospital characteristics such as ownership, affiliation with multi-hospital systems, and bed capacity highlights the need for tailored strategies to address sepsis management across diverse healthcare settings. Rural hospitals face challenges with early detection and access to specialized care. As a result, they often have lower rates of sepsis-related inpatient stays and higher rates of transfers to other hospitals. These transfers may indicate difficulties in managing sepsis effectively at rural facilities.

The disparities and geographic variation for in-hospital mortality rates and in average total hospital costs emphasize the need for targeted initiatives to improve patient outcomes and mitigate financial strain on healthcare institutions. To improve care and outcomes for patient populations, it is essential to continually update and refine international guidelines for the recognition and management of sepsis, care bundles, and quality improvement guidelines and initiatives. Improving the quality of sepsis care for patients and reducing the burden of sepsis on the hospital system will require continued investments by Federal, State, and nongovernmental entities to further strengthen the surveillance and quality improvement systems to ensure access to evidence-based care and resources for patients with sepsis. More research on the burden of sepsis in acute, post-acute, and ambulatory settings is needed to understand its root causes and long-term impacts for patients and healthcare providers in the United States.

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