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***Retrospective* *Study***

**Sepsis during short bowel syndrome hospitalizations: Identifying trends, disparities, and clinical outcomes in the United States**

Dahiya DS *et* *al*. Sepsis during short bowel syndrome hospitalizations

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**Abstract**

BACKGROUND

Short bowel syndrome (SBS) hospitalizations are often complicated with sepsis. There is significant paucity of data on adult SBS hospitalizations in the United States and across the globe.

AIM

To assess trends and outcomes of SBS hospitalizations complicated by sepsis in the United States.

METHODS

The National Inpatient Sample was utilized to identify all adult SBS hospitalizations between 2005-2014. The study cohort was further divided based on the presence or absence of sepsis. Trends were identified, and hospitalization characteristics and clinical outcomes were compared. Predictors of mortality for SBS hospitalizations complicated with sepsis were assessed.

RESULTS

Of 247097 SBS hospitalizations, 21.7% were complicated by sepsis. Septic SBS hospitalizations had a rising trend of hospitalizations from 20.8% in 2005 to 23.5% in 2014 (*P* trend < 0.0001). Compared to non-septic SBS hospitalizations, septic SBS hospitalizations had a higher proportion of males (32.8% *vs* 29.3%, *P* < 0.0001), patients in the 35-49 (45.9% *vs* 42.5%, *P* < 0.0001) and 50-64 (32.1% *vs* 31.1%, *P* < 0.0001) age groups, and ethnic minorities, *i.e.*, Blacks (12.4% *vs* 11.3%, *P* < 0.0001) and Hispanics (6.7% *vs* 5.5%, *P* < 0.0001). Furthermore, septic SBS hospitalizations had a higher proportion of patients with intestinal transplantation (0.33% *vs* 0.22%, *P* < 0.0001), inpatient mortality (8.5% *vs* 1.4%, *P* < 0.0001), and mean length of stay (16.1 d *vs* 7.7 d, *P* < 0.0001) compared to the non-sepsis cohort. A younger age, female gender, White race, and presence of comorbidities such as anemia and depression were identified to be independent predictors of inpatient mortality for septic SBS hospitalizations.

CONCLUSION

Septic SBS hospitalizations had a rising trend between 2005-2014 and were associated with higher inpatient mortality compared to non-septic SBS hospitalizations.

**Key Words:** Short bowel syndrome; Sepsis; Outcomes; Mortality; Trends

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**Core Tip:** Short bowel syndrome (SBS) is a well-known complication of small bowel surgical resection. Sepsis is a well-documented complication of SBS, particularly in infants and children. However, there is limited data on adult SBS hospitalizations complicated by sepsis in the United States. In this study, we noted that about one-fifth of SBS hospitalizations were complicated by sepsis. There was a higher proportion of men, individuals in the 35-64 age group, and ethnic minorities (Blacks and Hispanics) in the septic SBS cohort compared to the non-sepsis cohort. Septic SBS hospitalizations also had a higher length of stay and inpatient mortality compared to the non-sepsis cohort. Furthermore, younger age, female gender, White race, anemia, and depression were identified to be independent predictors of inpatient mortality for septic SBS hospitalizations.

**INTRODUCTION**

Short bowel syndrome (SBS) is a well-known complication of surgical resection of the small bowel[1]. Nonsurgical causes include inflammatory bowel disease, cancer of the intestine, or ischemic and hemorrhagic vascular diseases of the gut[1,2]. Sepsis is a well-documented complication of SBS in infants and children, and these recurrent bloodstream infections (BSI) have been associated with higher rates of childhood morbidity and mortality[3,4]. The primary pathophysiologic mechanism implicated in the development of BSI is bacterial translocation from the gut to the bloodstream during enteral feeding in children with SBS[5].

Most patients with SBS derive their nutrition *via* parenteral routes using indwelling venous catheters. Hence, these patients are at a greater-than-average risk of BSI from skin flora, especially if the indwelling catheter has been placed for a prolonged duration[4]. Moreover, parenteral nutrition leads to the impairment of immunological barriers (altered inflammatory responses) and physical barriers (secondary to villous atrophy) which may increase the risk of small bowel bacterial overgrowth (SBBO)[4,6].

SBS has established itself to be one of the strongest predictors of BSI in the pediatric population. However, there is a significant paucity of data on adult SBS hospitalizations complicated by sepsis, both in the United States and across the globe. Hence, this study was designed to investigate trends, hospitalization characteristics, predictors, racial disparities of Elixhauser co-morbidities, and gender disparities of Elixhauser co-morbidities for septic SBS hospitalizations in the United States. Furthermore, we also performed a comparative analysis for trends, hospitalization characteristics, and predictors between septic SBS and non-septic SBS hospitalizations.

**MATERIALS AND METHODS**

***Data* *source***

The National Inpatient Sample (NIS) is the largest, publicly available, multi-ethnic, all-payer inpatient database which is a part of the healthcare cost and utilization project (HCUP)[7,8]. HCUP is a family of healthcare databases and related software tools developed through a unique Federal-State-Industry partnership and sponsored by the Agency for Healthcare Research and Quality[9]. The NIS, when weighted, estimates more than 35 million hospitalizations nationally[7]. HCUP databases are limited data sets, which can be used to generate United States regional and national estimates[7].

***Study* *population,* *design,* *and* *outcomes***

We used the International Classification of Diseases, Clinical Modification (ICD-9-CM) codes to identify all adults (≥ 18 years of age) with SBS from the NIS database for the 2005-2014 period. The precedence of utilization of ICD-9-CM codes for SBS hospitalizations has already been established in previous studies[10,11]. Individuals < 18 years of age were excluded from the analysis. This study population was further divided based on the presence and absence of sepsis using the Clinical Classification Software diagnosis code “2”, which has been used previously in multiple NIS-based studies[12,13]. We then compared hospitalization characteristics (age, race, and gender), hospital-level characteristics (bed size, location, and admission type), and clinical outcomes [length of stay (LOS), all-cause inpatient mortality, and disposition status] between septic and non-septic SBS hospitalizations. Furthermore, the rates of comorbidities were calculated using Elixhauser Comorbidity Index codes provided by HCUP[14].

***Statistical* *analysis***

Statistical Analysis Software 9.3 (SAS Institute, Cary, NC, United States) was used for univariate and multivariate analyses. We used weighted values provided by HCUP to produce nationally representative estimates for all variables[15]. Categorical variables like gender, race, and comorbidities were compared using the Chi-squared (*χ2*) test, and continuous variables like age and LOS were compared using the Wilcoxon rank-sum test. We also created a multivariate logistic regression model to determine predictors of inpatient mortality for SBS hospitalizations complicated by sepsis. All *P* value ≤ 0.05 was considered statistically significant.

***Ethical* *considerations***

A review by our institutional review board was not required as the NIS database is Health Insurance Portability and Accountability Act protected and does not contain identifiable patient and hospital-level data[10].

**RESULTS**

***Trends* *of* *septic* *SBS* *hospitalizations***

Between 2005-2014, there were 247097 adult SBS hospitalizations in the United States. Of these, 53550 (21.7%) were complicated by sepsis. We noted a rising trend of SBS hospitalizations complicated by sepsis from 20.8% in 2005 to 23.5% in 2014 (*P* < 0.0001) (Table 1).

***Hospitalization* *characteristics* *and* *clinical* *outcomes***

Compared to non-septic SBS hospitalizations, septic SBS hospitalizations had a higher proportion of males (32.8% *vs* 29.3%, *P* < 0.0001), and patients in the 35-49 (45.9% *vs* 42.5%, *P* < 0.0001), and 50-64 (32.1% *vs* 31.1%, *P* < 0.0001) age groups. However, within the septic SBS cohort, a female predominance was noted (Table 2).

Racial disparities were also prevalent as we noted a higher proportion of ethnic minorities such as Blacks (12.4% *vs* 11.3%, *P* < 0.0001) and Hispanics (6.7% *vs* 5.5%, *P* < 0.0001) in the septic SBS cohort, while there was a higher proportion of Whites (80.0% *vs* 77.3%, *P* < 0.0001) in the non-septic cohort (Table 2).

From a hospital perspective, large (69.4% *vs* 64.6%, *P* < 0.0001), urban teaching (57.3% *vs* 51.8%, *P* < 0.0001) hospitals had a higher proportion of septic SBS hospitalizations compared to the non-septic cohort. Furthermore, there was a higher proportion of emergent or urgent (19.3 *vs* 18.9%, *P* < 0.0001) septic SBS hospitalizations compared to the non-septic SBS cohort (Table 2).

The all-cause inpatient mortality was significantly higher for septic SBS hospitalizations (8.5% *vs* 1.4%, *P* < 0.0001) compared to the non-sepsis cohort. Additionally, we noted a longer mean LOS for septic SBS hospitalizations (16.1 d ± 0.4 d *vs* 7.7 d ± 0.1 d, *P* < 0.0001) compared to the non-septic cohort (Table 2).

***Predictors* *of* *inpatient* *mortality* *for*** ***septic* *SBS* *hospitalizations***

For septic SBS hospitalizations, the 18-44 age group had a 5.85 times higher risk of inpatient mortality compared to the ≥ 85 age group [odds ratio (OR): 5.85; 95% confidence interval (95%CI): 3.95-8.66, *P* < 0.0001; Table 3]. Hence, the risk of inpatient mortality decreased with increasing age. Additionally, women had a higher risk of inpatient mortality as compared to men (OR: 1.18; 95%CI: 1.02-1.38, *P* = 0.03). Race was also identified to be an independent predictor of all-cause inpatient mortality. Whites were noted to have a higher mortality risk (OR: 1.65; 95%CI: 1.17-2.33, *P* = 0.005) compared to other races. Furthermore, the presence of comorbidities such as deficiency anemias and depression were associated with a significantly higher risk of inpatient mortality for septic SBS hospitalizations (Table 3).

***Intestinal* *transplantation* *and*** ***septic* *SBS* *hospitalizations***

We noted a higher proportion of patients who had transplant of the intestine (TOI) for septic SBS hospitalizations (0.33% *vs* 0.22%, *P* < 0.0001) compared to the non-septic cohort (Table 1). However, due to limitations of the NIS database, we were unable to ascertain whether these hospitalizations took place within a year of undergoing TOI or later.

***Racial* *disparities* *in* *exhauster* *comorbidities* *for*** ***septic* *SBS* *hospitalizations***

A significantly higher proportion of septic SBS hospitalizations for Whites had comorbidities such as congestive heart failure, chronic pulmonary diseases, hypothyroidism, depression, and other psychiatric disorders (Table 4). Meanwhile, Blacks had significantly higher rates of comorbidities such as deficiency anemias, drug abuse, hypertension, obesity, and renal failure. Furthermore, Hispanics had the highest rates of comorbidities like coagulopathy, uncomplicated diabetes, and liver disease (Table 4).

***Gender* *disparities* *in* *exhauster* *comorbidities* *for*** ***septic* *SBS* *hospitalizations***

Septic SBS hospitalizations for women were noted to have higher rates of comorbidities such as deficiency anemias, depression, rheumatic disorders, chronic pulmonary disease, hypothyroidism, and obesity; however, men had higher rates of diabetes, drug abuse, liver disease, and renal failure (Table 5).

**DISCUSSION**

After surgical resection of the bowel in adults, there is a significant alteration of the nutritional, fluid, and electrolyte homeostasis, along with significant changes in the gut microbiome. These changes may lead to malabsorptive diarrhea, micronutrient deficiency, malnutrition, and SBBO[16]. Disruption of the intestinal microbiome seen in patients with SBBO impacts the production of antimicrobial peptides and immunomodulatory cells[17]. Furthermore, commensal bacteria dysbiosis may disrupt intestinal permeability leading to bacterial translocation in surrounding areas, thereby increasing the risk of sepsis[17]. Despite known alteration of the intestine, current literature lacks data to support the routine use of antibiotics in SBS patients to prevent inflammatory gut changes[16]. Management for these patients is primarily focused on nutrition. However, patients with SBS who rely on parenteral nutrition are at increased risk of sepsis from catheter-associated infections, leading to increased hospitalizations[16]. This finding was highlighted in our study as we noted a rising trend of septic SBS hospitalizations from 20.8% in 2005 to 23.5% in 2014.

The utilization of prebiotics, probiotics, or antibiotics use in SBS patients is controversial[16]. Intestinal transplantation is indicated in SBS patients with recurrent sepsis or those who are unable to receive total parenteral nutrition due to end-stage liver disease or end-stage loss of venous access[18]. Intestinal transplant significantly improves intestinal transit time, peristalsis, and the absorptive functions of the gut[19]. However, like any transplant, post-operative care for these patients requires lifelong immunosuppression, which imminently increases the risk for subsequent infections and sepsis. Expectedly, in our study, we noted a higher proportion of patients who had TOI in septic SBS hospitalizations compared to the non-sepsis cohort (Table 1).

Traditionally, sepsis tends to affects the elderly. However, a multicenter longitudinal cohort study in California from 2008-2015 noted that the highest overall increase in rates of sepsis and severe sepsis were for patients 18-44 years of age[20]. Although there were higher incidence rates of sepsis in the elderly, there was a notable increase in the relative risk of sepsis among young adults[20].This was consistent with the findings in our study. In the septic SBS cohort, the 35-49 age group had the highest proportion of patients, while the ≥ 65 age group had the lowest proportion of patients (Table 2). On comparative analysis, septic SBS hospitalizations had a higher proportion of patients between the ages of 35-64 compared to the non-septic cohort. The exact reasons for the higher hospitalization rates of septic SBS younger patients is currently unknown, but may, in part, be due to a greater degree of awareness of sepsis in this subset population prompting them to seek immediate care or due to complications from comorbidities not previously common in this age group[20]. Nonetheless, additional prospective studies are needed to further investigate these findings.

A prospective observational cohort study of critically ill patients from 2011-2014 showed similar rates of sepsis and mortality between men and women[21]. However, there was a greater degree of endothelial cell activation in young women compared to men[21]. Increased gut permeability, often seen in patients with SBS, coupled with increased endothelial disruption of the vasculature may lead to transportation of antigens and commensal gut microbiota from the intestine to blood, making females more even more prone to sepsis[22]. The findings of our study aligned with this current literature as females made up more than two-thirds of the total septic SBS hospitalizations in the United States.

The study by Siddiqui *et* *al*[2] reported that Whites made up 78% of all SBS hospitalizations in the United States. We report similar findings as septic SBS hospitalizations had a higher proportion of Whites (77.3%) compared to other ethnic minorities such as Blacks or Hispanics (Table 2). However, on comparative analysis, septic SBS hospitalizations had a higher proportion of Blacks (12.4% *vs* 11.3%, *P* < 0.0001) and Hispanics (6.7% *vs* 5.5%, *P* < 0.0001) compared to the non-septic cohort. This may, in part, be due to lack of healthcare facilities, and awareness about SBS among ethnic minorities leading to a progression of their disease and further complication by sepsis. Hence, we advocate for the need for urgent interventions to improve healthcare access, increase awareness about sepsis in SBS, and improve outpatient follow-up for these high-risk populations.

The all-cause inpatient mortality for SBS hospitalizations was found to be 1.4%. However, when these hospitalizations were complicated by sepsis, the all-cause inpatient mortality increased to 8.5%. This was in line with current literature which reports increased inpatient mortality for septic SBS hospitalizations[2]. Moreover, the presence of a greater number of comorbidities is also associated with higher rates of mortality in patients with sepsis[23]. A cohort study evaluating adult sepsis survivors identified age, sex, race, severe comorbidities, and site of initial infection to be long-term risk factors for mortality[24]. Similarly, in our study, independent risk factors that increased inpatient mortality for septic SBS hospitalizations as follows.

***Age***

In our study, the risk of inpatient mortality was almost six times higher in the 18-44 age group compared to individuals ≥ 85 years of age. In 2013, a Quality and Cost of Primary Care study reported that younger patients were more likely to visit a healthcare provider for both mental and physical health conditions compared to the elderly population[25]. The increased health awareness, highly accurate provider evaluation in younger adults without non-specific baseline symptoms, and presence of additional comorbidities which were previously not common in this age group may have led to increased diagnosis and associated inpatient mortality.

***Gender***

In 2011, a prospective clinical trial of intensive care unit patients reported that females with sepsis had higher mortality rates than males with sepsis[26]. Another study by Wilcox *et* *al*[27] noted similar gender outcomes. Similarly, in our study, septic SBS female patients had higher rates of all-cause inpatient mortality compared to males. Furthermore, we noted higher rates of deficiency anemias and depression in females compared to males, which was also independently associated with higher mortality rates in septic SBS hospitalizations.

***Race***

We noted that White septic SBS hospitalizations had a 1.65 times greater risk of inpatient mortality compared to other races. A study of Caucasians with acute respiratory distress syndrome (ARDS) secondary to pneumonia evaluated the FER rs4957796 TT genotype as a means of determining 90-d mortality risk[28]. Although this study specifically assessed ARDS patients and their survival in the setting of pneumonia, interestingly the FER gene is known to play a key role in the regulation of intestinal barrier function[29]. White septic SBS hospitalizations may have a higher mortality risk due to the absence of FER protein which may exacerbate intestinal dysfunction and increase bacterial translocation into the bloodstream leading to a greater severity of sepsis. However, additional prospective studies are needed to further validate our findings.

***Comorbidities***

In our study, deficiency anemias and depression were found to coincide with significantly greater mortality risk in septic SBS hospitalizations. Deficiency anemias are highly prevalent in SBS patients due to altered anatomy[30-33]. In septic SBS hospitalizations, deficiency anemia can negatively impact the host’s defense and immunomodulatory response, increasing the severity of sepsis and overall mortality risk. Furthermore, severe depression has a known association with increased BSI, leading to sepsis and higher mortality rates[34,35]. Depression ultimately leads to decreased immune function and disruption of the brain-gut-microbiome axis, which may increase the host’s risk for sepsis and adverse clinical outcomes.

***Limitations***

A key strength of this study is the study population which has been derived from one of the biggest, national, diverse, multi-ethnic databases in the United States. Through our analysis over 10 years, we are able to provide meaningful information on the trends of septic SBS hospitalizations. Furthermore, we also perform a unique comparative analysis between septic and non-septic SBS hospitalizations and identify predictors of inpatient mortality for septic SBS hospitalizations to give gastroenterologists real-world data on the patients at the highest risk of adverse clinical outcomes. However, we do acknowledge all the limitations associated with our study. We were unable to perform a detailed analysis after the 2014 study period as the NIS changes from ICD-9-CM to ICD-10-CM coding at the beginning of October 1, 2015. Converting ICD-9 to ICD-10 is an extremely challenging process as there are differences in the structure and granularity of codes. Hence, it would be impossible to find the exact matches for the codes with a high level of confidence Additionally, the NIS database lacks information on the time from hospitalization to diagnosis of sepsis, hospital course, treatment aspects, inpatient procedures, and pharmacological aspects of management. Lastly, the NIS is an administrative database. Therefore, the possibility of coding errors cannot be excluded. Despite these limitations, we believe that our study helps fill the current knowledge gaps for SBS hospitalizations complicated by sepsis in the US as this entity has not been studied extensively. We hope that the findings of our study can serve as a foundation for future prospective studies and randomized controlled trials.

**CONCLUSION**

In conclusion, SBS is a well-known complication of surgical resection of the intestine. Due to their dependence on parenteral nutrition using indwelling venous catheters, these patients are at increased risk of BSI and sepsis from bacterial translocation from the gut to the blood stream during enteral feeding. In the United States from 2005-2014, we noted a rising trend of septic SBS hospitalizations with a significant female predominance. Compared to the non-septic cohort, septic SBS hospitalizations had a higher proportion of patients with TOI, higher all-cause inpatient mortality, and longer mean LOS. Independent predictors of mortality for septic SBS hospitalizations included White race, female gender, younger age, and those with associated comorbidities such as deficiency anemias and depression.

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**Footnotes**

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**Informed consent statement:** The National Inpatient Sample lacks specific patient identifiers. Hence, informed consent was not required.

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**Data sharing statement:** The National Inpatient Sample (NIS) is a large, publicly available, all-payer inpatient care database in the United States containing data on millions of hospital stays per year. The large sample size derived from the NIS database provides sufficient data for analysis of common diseases, uncommon disorders, and procedures. The NIS is publicly available at: https://www.hcup-us.ahrq.gov/

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**Table 1 Trends for short bowel syndrome hospitalizations and septic short bowel syndrome hospitalizations in the United States from 2005-2014**

|  |  |  |  |
| --- | --- | --- | --- |
| **Years** | **Short bowel syndrome hospitalizations** | **Septic short bowel syndrome hospitalizations** | **% of sepsis in short bowel syndrome hospitalizations** |
| 2005 | 4199 | 20198 | 20.8 |
| 2006 | 3908 | 20206 | 19.3 |
| 2007 | 4083 | 20206 | 20.2 |
| 2008 | 5762 | 26411 | 21.8 |
| 2009 | 5869 | 25810 | 22.7 |
| 2010 | 5640 | 25423 | 22.2 |
| 2011 | 5805 | 27647 | 21.0 |
| 2012 | 5780 | 27015 | 21.4 |
| 2013 | 6105 | 26900 | 22.7 |
| 2014 | 6400 | 27280 | 23.5 |
| Total | 53550 | 247097 | 21.7 |

**Table 2 Baseline hospitalization characteristics and clinical outcomes for septic and non-septic short bowel syndrome hospitalizations in the United States from 2005-2014**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Non-septic short bowel syndrome hospitalizations** | **%** | **Septic short bowel syndrome hospitalizations** | **%** | ***P* value** |
| Number of obs. (*n*) | 193547 | 78.30 | 53550 | 21.70 |  |
| Mean age (yr ± SE) | 58.0 ± 0.3 | - | 57.9 ± 0.2 | - |  |
| Age in yr |  |  |  |  | < 0.0001 |
| 18-34 | 41979 | 21.70 | 10000 | 18.70 |  |
| 35-49 | 82308 | 42.50 | 24561 | 45.90 |  |
| 50-64 | 60113 | 31.10 | 17333 | 32.40 |  |
| ≥ 65 | 9149 | 4.70 | 1655 | 3.10 |  |
| Gender |  |  |  |  | < 0.0001 |
| Male | 56601 | 29.30 | 17545 | 32.80 |  |
| Female | 136916 | 70.80 | 36005 | 67.20 |  |
| Race |  |  |  |  | < 0.0001 |
| White | 130004 | 80.00 | 35660 | 77.30 |  |
| Black | 18436 | 11.30 | 5730 | 12.40 |  |
| Hispanic | 8866 | 5.50 | 3091 | 6.70 |  |
| Others | 5274 | 3.20 | 1651 | 3.60 |  |
| Hospital location |  |  |  |  | < 0.0001 |
| Rural | 22155 | 11.50 | 4576 | 8.60 |  |
| Urban nonteaching | 70692 | 36.70 | 18187 | 34.10 |  |
| Urban teaching | 99780 | 51.80 | 30509 | 57.30 |  |
| Hospital bed size |  |  |  |  | < 0.0001 |
| Small | 22978 | 11.90 | 5107 | 9.60 |  |
| Medium | 45289 | 23.50 | 11219 | 21.10 |  |
| Large | 124360 | 64.60 | 36946 | 69.40 |  |
| Admission type |  |  |  |  | 0.0100 |
| Elective | 157070 | 81.20 | 43201 | 80.70 |  |
| Emergent or Urgent | 36477 | 18.90 | 10349 | 19.30 |  |
| Intestinal Transplant | 430 | 0.22 | 178 | 0.33 | < 0.0001 |
| Disposition status |  |  |  |  | < 0.0001 |
| Home | 156802 | 81.10 | 34439 | 64.40 |  |
| Facility | 33898 | 17.50 | 14497 | 27.10 |  |
| Inpatient mortality | 2724 | 1.40 | 4537 | 8.50 | < 0.0001 |
| Mean LOS (d ± SE) | 7.7 ± 0.1 | - | 16.1 ± 0.4 | - | < 0.0001 |

LOS: Length of stay.

**Table 3 Predictors of mortality for septic short bowel syndrome hospitalizations in the United States from 2005-2014**

|  |  |  |
| --- | --- | --- |
| **Characteristics/co-morbidities** | **Odds ratio (95% confidence interval)** | ***P* value** |
| Age (yr) |  |  |
| 18-44 | 5.85 (3.95-8.66) | < 0.0001 |
| 45-64 | 3.30 (2.37-4.59) | < 0.0001 |
| 65-84 | 1.75 (1.27-2.41) | 0.001 |
| ≥ 85 | Referent |  |
| Gender |  |  |
| Male | Referent |  |
| Female | 1.18 (1.02-1.38) | 0.030 |
| Race |  |  |
| White | 1.65 (1.17-2.33) | 0.005 |
| Black | 1.28 (0.86-1.90) | 0.220 |
| Hispanic | 1.22 (0.79-1.88) | 0.360 |
| Others | Referent |  |
| Hospital bed size | | |
| Small | 1.16 (0.90-1.51) | 0.250 |
| Medium | 1.10 (0.92-1.31) | 0.320 |
| Large | Referent |  |
| Hospital type | |  |
| Rural | 1.05 (0.79-1.38) | 0.360 |
| Urban non-teaching | 0.94 (0.80-1.10) | 0.420 |
| Teaching | Referent |  |
| Median household income | | |
| Quartile 1 | Referent |  |
| Quartile 2 | 0.96 (0.78-1.18) | 0.690 |
| Quartile 3 | 1.03 (0.83-1.27) | 0.800 |
| Quartile 4 | 1.18 (0.94-1.47) | 0.150 |
| Co-morbidities | |  |
| Deficiency anemias | 1.58 (1.35-1.85) | < 0.0001 |
| Rheumatic disorders | 1.20 (0.80-1.79) | 0.380 |
| Depression | 1.66 (1.30-2.13) | < 0.0001 |
| Drug abuse | 1.51 (0.95-2.40) | 0.090 |
| Hypertension | 1.16 (0.98-1.36) | 0.080 |
| Hypothyroidism | 1.06 (0.83-1.34) | 0.650 |
| Lymphoma | 2.48 (0.99-6.21) | 0.050 |
| Valvular disease | 1.02 (0.73-1.41) | 0.920 |

**Table 4 Racial distribution of Elixhauser co-morbidities for septic short bowel syndrome hospitalizations in the United States from 2005-2014**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Elixhauser co-morbidity** | **Whites** | **Blacks** | **Hispanics** | **Others** | ***P* value** |
| Acquired immunodeficiency syndrome | 0.0 | 1.0 | 0.3 | 0.0 | < 0.0001 |
| Alcohol abuse | 1.6 | 2.4 | 0.8 | 1.4 | < 0.0001 |
| Deficiency anemias | 38.8 | 49.0 | 45.4 | 37.6 | < 0.0001 |
| Rheumatic disorders | 4.3 | 4.1 | 2.9 | 4.0 | 0.0040 |
| Chronic blood loss anemia | 2.1 | 2.1 | 2.3 | 3.2 | 0.0200 |
| Congestive heart failure | 11.2 | 10.8 | 8.6 | 9.8 | < 0.0001 |
| Chronic pulmonary disease | 19.7 | 14.6 | 10.6 | 18.4 | < 0.0001 |
| Coagulopathy | 15.4 | 16.9 | 19.1 | 16.9 | < 0.0001 |
| Depression | 18.0 | 10.9 | 14.2 | 11.5 | < 0.0001 |
| Uncomplicated diabetes | 11.4 | 14.4 | 17.7 | 17.0 | < 0.0001 |
| Diabetes with chronic complications | 2.8 | 5.8 | 5.4 | 5.0 | < 0.0001 |
| Drug abuse | 4.8 | 6.6 | 4.4 | 5.0 | < 0.0001 |
| Hypertension | 32.4 | 42.5 | 34.5 | 34.6 | < 0.0001 |
| Hypothyroidism | 13.5 | 10.4 | 8.8 | 8.6 | < 0.0001 |
| Liver disease | 5.8 | 7.0 | 9.9 | 6.9 | < 0.0001 |
| Lymphoma | 1.1 | 1.1 | 1.2 | 0.9 | 0.7500 |
| Fluid and electrolyte disorders | 57.5 | 62.5 | 61.2 | 58.2 | < 0.0001 |
| Metastatic cancer | 4.5 | 4.4 | 5.2 | 8.6 | < 0.0001 |
| Neurological disorders | 8.8 | 8.3 | 6.7 | 7.9 | 0.001 |
| Obesity | 5.6 | 6.3 | 5.7 | 6.9 | 0.0300 |
| Paralysis | 2.3 | 3.3 | 4.2 | 4.9 | < 0.0001 |
| Peripheral vascular disorders | 6.8 | 7.4 | 7.0 | 6.5 | 0.4300 |
| Psychiatric disorder | 6.1 | 5.5 | 5.6 | 4.1 | 0.0030 |
| Pulmonary circulation disorders | 4.0 | 5.5 | 2.3 | 3.4 | < 0.0001 |
| Renal failure | 21.2 | 30.7 | 16.7 | 18.8 | < 0.0001 |
| Solid tumor without metastasis | 2.6 | 2.8 | 2.9 | 5.2 | < 0.0001 |
| Peptic ulcer disease excluding bleeding | 0.1 | 0.1 | 0.1 | 0.0 | 0.3400 |
| Valvular disease | 5.2 | 4.8 | 3.8 | 5.3 | 0.0050 |
| Weight loss | 40.4 | 40.9 | 39.3 | 47.9 | < 0.0001 |

**Table 5 Gender distribution of elixhauser co-morbidities for septic short bowel syndrome hospitalizations in the United States from 2005-2014**

|  |  |  |  |
| --- | --- | --- | --- |
| **Elixhauser co-morbidity** | **Male** | **Female** | ***P* value** |
| Acquired immunodeficiency syndrome | 0.3 | 0.1 | < 0.0001 |
| Alcohol abuse | 2.9 | 1.0 | < 0.0001 |
| Deficiency anemias | 36.8 | 39.7 | < 0.0001 |
| Rheumatic disorders | 2.0. | 5.1 | < 0.0001 |
| Chronic blood loss anemia | 1.9 | 2.1 | 0.0800 |
| Congestive heart failure | 10.7 | 10.8 | 0.9000 |
| Chronic pulmonary disease | 16.7 | 19.0 | < 0.0001 |
| Coagulopathy | 16.8 | 15.0 | < 0.0001 |
| Depression | 12.4 | 18.1 | < 0.0001 |
| Uncomplicated diabetes | 12.6 | 11.6 | 0.0010 |
| Diabetes with chronic complications | 3.9 | 2.7 | < 0.0001 |
| Drug abuse | 5.1 | 4.5 | 0.0010 |
| Hypertension | 33.6 | 32.1 | 0.0010 |
| Hypothyroidism | 6.0 | 14.9 | < 0.0001 |
| Liver disease | 7.4 | 5.3 | < 0.0001 |
| Lymphoma | 1.4 | 0.9 | < 0.0001 |
| Fluid and electrolyte disorders | 56.6 | 57.9 | 0.0030 |
| Metastatic cancer | 4.9 | 4.4 | 0.0020 |
| Neurological disorders | 7.0. | 8.8 | < 0.0001 |
| Obesity | 3.8 | 6.4 | < 0.0001 |
| Paralysis | 3.5 | 2.1 | < 0.0001 |
| Peripheral vascular disorders | 8.1 | 5.9 | < 0.0001 |
| Psychiatric disorder | 4.7 | 6.3 | < 0.0001 |
| Pulmonary circulation disorders | 4.2 | 3.8 | 0.0400 |
| Renal failure | 26.3 | 18.8 | < 0.0001 |
| Solid tumor without metastasis | 2.6 | 2.7 | 0.5900 |
| Peptic ulcer disease excluding bleeding | 0.0 | 0.1 | < 0.0001 |
| Valvular disease | 5.2 | 4.7 | 0.0100 |
| Weight loss | 39.1 | 40.9 | < 0.0001 |