Abdominal infections in the intensive care unit: characteristics, treatment and determinants of outcome

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Abstract

Background: Abdominal infections are frequent causes of sepsis and septic shock in the intensive care unit (ICU) and are associated with adverse outcomes. We analyzed the characteristics, treatments and outcome of ICU patients with abdominal infections using data extracted from a one-day point prevalence study, the Extended Prevalence of Infection in the ICU (EPIC) II.

Methods: EPIC II included 13,796 adult patients from 1,265 ICUs in 75 countries. Infection was defined using the International Sepsis Forum criteria. Microbiological analyses were performed locally. Participating ICUs provided patient follow-up until hospital discharge or for 60 days.

Results: Of the 7,087 infected patients, 1,392 (19.6%) had an abdominal infection on the study day (60% male, mean age 62 ± 16 years, SAPS II score 39 ± 16, SOFA score 7.6 ± 4.6). Microbiological cultures were positive in 931 (67%) patients, most commonly Gram-negative bacteria (48.0%). Antibiotics were administered to 1366 (98.1%) patients. Patients who had been in the ICU for ≤2 days prior to the study day had more Escherichia coli, methicillin-sensitive Staphylococcus aureus and anaerobic isolates, and fewer enterococci than patients who had been in the ICU longer. ICU and hospital mortality rates were 29.4% and 36.3%, respectively. ICU mortality was higher in patients with abdominal infections than in those with other infections (29.4% vs. 24.4%, p < 0.001). In multivariable analysis, hematological malignancy, mechanical ventilation, cirrhosis, need for renal replacement therapy and SAPS II score were independently associated with increased mortality.

Conclusions: The characteristics, microbiology and antibiotic treatment of abdominal infections in critically ill patients are diverse. Mortality in patients with isolated abdominal infections was higher than in those who had other infections.

Keywords: Abdominal infection, Abscess, Peritonitis, Severe sepsis, Critical care, Antibiotic therapy, Microbiology

Background

Abdominal infection is a common indication for admission to the intensive care unit (ICU) and the abdomen is the second most common site of invasive infection among critically ill patients in epidemiological [1-3] and therapeutic [4] studies. Abdominal infections are more often associated with septic shock and acute kidney injury than are infections in other sites [5,6]. The spectrum of disease and severity is broad and management of these infections is challenging [7-9].

Multicenter data on the clinical features and microbiology of abdominal infections in the critically ill are rare, and often limited to a single region or country. In recent years, an increase in abdominal infections due to nosocomial and resistant organisms has been reported [10-14], but large-scale data are lacking. Although outcomes may have improved over the years [15], abdominal infections still carry a significant mortality risk. Isolation of nosocomial microorganisms [16], enterococci [17] or fungi [18,19] is often cited as contributing
to mortality, but the extent to which these organisms contribute to that risk is unknown. The role of comorbidities as well as demographic characteristics has also not been studied on a large scale. Prolonged stay in a critical care environment may be associated with changes in microbiology, thus affecting empirical antibiotic treatment, yet recent guidelines do not include length of stay as a potential surrogate marker for the presence of nosocomial or less susceptible microorganisms [20].

The Extended Prevalence of Infection in the ICU (EPIC) II study was a large one-day point-prevalence study of infections in the ICU. The study showed that half of all ICU patients were infected on the study day and 71% were being treated with antibiotics [1]. We used the data collected in the EPIC II study to (1) analyze the characteristics of abdominal infections (patient characteristics, micro-organisms) as well as the antibiotics used to treat these infections; (2) explore the differences in microbiology according to the length of stay in the ICU; and (3) identify clinical and microbiological factors associated with mortality.

Methods

The EPIC II study was performed on May 8, 2007. Demographic, physiological, bacteriological and therapeutic data were collected from 13,796 adult (>18 years) patients in 1,265 participating ICUs from 75 countries (see Appendix for list of participating centers) on the study day as previously described [1]. The EPIC II study was approved by the Erasme Hospital ethics committee. Local ethical committee approval at each participating center was expedited or waived because of the purely observational nature of the study. Infection was defined according to the criteria of the International Sepsis Forum (ISF) [21] and classified by the attending physician. Microbiological analyses were performed locally. Participating ICUs were asked to provide patient follow-up until hospital discharge or for 60 days.

For the purposes of this study, we analyzed data from the patients who were diagnosed with an intra-abdominal infection.

Statistics

Statistical analyses were performed using PASW Statistics 18 for windows (SPSS Inc., Chicago, USA). Data are presented as mean (±standard deviation [SD]), median (interquartile range [IQR]), or number (%) as appropriate. To identify factors associated with mortality, a multivariable logistic regression model (single step, forced entry) was constructed using variables for which the P-value was <0.1 in univariable analysis. Goodness of fit was assessed by the Hosmer-Lemeshow statistic. All tests were two-tailed, and a P < 0.05 was considered statistically significant.

Results

Of the 7,087 infected patients, 1,392 (19.6%) were diagnosed as having an abdominal infection on the study day (Table 1). Cancer and chronic obstructive pulmonary disease (COPD) were the most frequent comorbidities. The majority of the patients (885 [63.7%]) had undergone emergency surgery. Other concomitant infections were frequently present, with respiratory infections and bloodstream infections occurring in 26.8% and 11.6% of the patients, respectively (Additional file 1: Table S1).

Table 1 Patient characteristics

| Characteristic                        | Mean ± SD or n (%) |
|--------------------------------------|--------------------|
| Age, mean ± SD, year                 | 62 ± 16            |
| Male, n (%)                          | 831 (60)           |
| SAPS II score, mean ± SD             | 38.9 ± 16.4        |
| SOFA score, mean ± SD                | 7.6 ± 4.6          |
| Length of ICU stay before May 8, median (IQR), days | 6 (1–15) |
| Type of admission, n (%)             |                    |
| Surgical - emergency                 | 885 (63.7)         |
| Medical                              | 260 (18.7)         |
| Surgical - elective                  | 198 (14.2)         |
| Trauma                               | 47 (3.4)           |
| Admission source, n (%)              |                    |
| OR/recovery room                     | 488 (35.3)         |
| Hospital floor                       | 465 (33.6)         |
| ER/ambulance                         | 199 (14.4)         |
| Other hospital                       | 194 (14.0)         |
| Other                                | 36 (2.6)           |
| Comorbidities, n (%)                 |                    |
| Cancer                               | 321 (23.1)         |
| COPD                                 | 225 (16.2)         |
| Chronic renal failure                | 140 (10.1)         |
| Insulin dependent diabetes mellitus  | 131 (9.4)          |
| Heart failure (NYHA III-IV)          | 107 (7.7)          |
| Cirrhosis                            | 79 (5.7)           |
| Hematological cancer                 | 24 (1.7)           |
| HIV                                  | 12 (0.9)           |
| Organ support on the study day       |                    |
| Mechanical ventilation               | 863 (62.0)         |
| Renal replacement therapy            | 220 (15.8)         |
| Outcome measures                     |                    |
| ICU LOS, median (IQR), days          | 16 (6–34)          |
| Hospital LOS, median (IQR), days     | 30 (14–59)         |
| ICU mortality, n (%)                 | 382 (29.4)         |
| Hospital mortality, n (%)            | 472 (36.3)         |

SAPS II = Simplified Acute Physiology Score II; SOFA = Sequential Organ Failure Assessment; HIV = Human Immunodeficiency Virus; NYHA III-IV = New York Heart Association class III-IV.
Microbiological data were available for 931 patients (67%), with a total of 1,289 microorganisms isolated (Table 2). Polymicrobial infections were present in 40.1% of the patients. Escherichia coli was isolated most frequently, with Pseudomonas spp. and Klebsiella spp. ranking second and third among the Gram-negative isolates. Enterococcus was the most prevalent Gram-positive isolate. Antibiotic resistance was relatively rare: ampicillin-resistant enterococci were isolated in 70 patients (7.5%), methicillin-resistant staphylococci in 59 patients (6.3%). Candida species were isolated in 156 patients (16.8%), 75.6% of these isolates were Candida albicans.

Almost all the patients with abdominal infections (98.1%) were receiving antibiotics: penicillins and other beta-lactam antibiotics (excluding cephalosporins) were used most frequently (38.6% and 34.4% of the patients, respectively) (Additional file 1: Table S2); 29.4% of the patients were receiving antifungal agents.

ICU (median 16 [IQR 6–34] days vs. 17 [7–34] days, P = 0.07) and hospital (30 [14–59] days vs. 29 [14–56] days, P = 0.68) lengths of stay (LOS) were similar in patients with abdominal infections and those with other infections. Overall ICU and hospital mortality rates were 29.4% and 36.3%, respectively (Table 1). Mortality rates were higher in patients who had abdominal infections than in patients from the EPIC II cohort who had other infections (ICU mortality 29.4% vs. 24.4%, P < 0.001, and hospital mortality 36.3% vs. 32.3%, P = 0.005). ICU and hospital mortality rates in non-infected patients in the EPIC-II cohort were 10.7% and 14.8%, respectively.

Non-survivors were older, had higher SAPS II and SOFA scores on the study day, and were more likely to have cirrhosis, heart failure, or hematological cancer. They were also more likely to be receiving mechanical ventilation or renal replacement than survivors (Table 3). Survivors and non-survivors had similar patterns of infecting organisms, except for P. aeruginosa and Stenotrophomonas maltophilia, which were isolated more frequently in non-survivors than in survivors (Additional file 1: Table S3). In multivariable analysis, hematological cancer, mechanical ventilation, cirrhosis, renal replacement therapy and SAPS II score on the study day were independently associated with increased mortality (Table 4).

In patients who had been in the ICU for 2 days or less prior to the study day, there were more E. coli, methicillin-sensitive S. aureus and anaerobic isolates and fewer enterococci than in patients who had been in the ICU for a longer period of time; there was also a trend towards fewer P. aeruginosa, Citrobacter spp. and C. albicans isolates (Table 5).

Discussion

This study is one of the first to look at abdominal infections in critically ill patients from a global perspective.

### Table 2 A total of 1289 micro-organisms were recovered from the 931 patients with abdominal infections and positive cultures

| Group                  | n (%)   |
|------------------------|---------|
| Gram-negative bacteria | 619 (48.0%) |
| Escherichia coli       | 211     |
| Pseudomonas aeruginosa | 86      |
| Klebsiella spp.        | 85      |
| Enterobacter spp.      | 77      |
| Proteus spp.           | 47      |
| Acinetobacter spp.     | 35      |
| Stenotrophomonas maltophilia | 17   |
| Citrobacter spp.       | 13      |
| Bacillus               | 13      |
| Enterobacteria, other  | 9       |
| Campylobacter spp.     | 7       |
| Salmonella spp.        | 7       |
| Serratia spp.          | 6       |
| Pseudomonas, other than P aeruginosa | 4 |
| Haemophilus spp.       | 2       |
| Gram-positive bacteria | 366 (28.4%) |
| Enterococci, ampicillin-sensitive | 122 |
| Enterococci, ampicillin-resistant | 70 |
| Methicillin-resistant Staphylococcus aureus (MRSA) | 34 |
| Methicillin-sensitive coagulase-negative staphylococci | 27 |
| Streptococcus, other than group A, B, C and D | 31 |
| Methicillin-resistant coagulase-negative staphylococci | 25 |
| Methicillin-sensitive S. aureus | 21 |
| Group A, B, C, G Streptococcus | 15 |
| Gram-positive cocci, other | 8 |
| Gram-positive bacilli, other | 8 |
| Streptococcus pneumoniae | 5 |
| Anaerobes              | 146 (11.3%) |
| Clostridium            | 94      |
| Bacteroides            | 29      |
| Anaerobes, other       | 16      |
| Anaerobic cocci        | 7       |
| Fungi                  | 130 (10.1%) |
| Candida albicans       | 118     |
| Candida non-albicans   | 38      |
| Fungi, other           | 5       |
| Aspergillus spp.       | 2       |
| Viruses                | 12 (0.9%) |
| Other                  | 16 (1.2%) |
The results show that abdominal infections are associated with significant mortality rates and that concomitant infections are frequent. Microbiology patterns and antibiotic treatments were diverse in this group of patients, and pathogens were different in patients who had been in the ICU for a longer period of time than in those more recently admitted. The severity of disease and presence of comorbidities determined outcome in these patients.

Table 3 Characteristics of survivors and non-survivors

|                        | Survivors (n = 917) | Non-survivors (n = 382) | p     |
|------------------------|---------------------|-------------------------|-------|
| Age, mean ± SD         | 61.6 ± 16.5         | 65.2 ± 14.9             | <0.001|
| Male, n (%)            | 546 (59.7)          | 223 (58.5)              | 0.7   |

Severity score on study day

|                        | Survivors (n = 917) | Non-survivors (n = 382) | p     |
|------------------------|---------------------|-------------------------|-------|
| SAPS II, mean ± SD     | 34.2 ± 13.5         | 50.1 ± 17               | <0.001|
| SOFA, mean ± SD        | 6.2 ± 3.8           | 10.5 ± 4.6              | <0.001|
| ICU stay before May 8, median (IQR) | 5 (1–13)          | 8 (1–18)                | <0.001|

Type of admission, n (%)

|                        | Survivors (n = 917) | Non-survivors (n = 382) | p     |
|------------------------|---------------------|-------------------------|-------|
| Surgical/elective      | 124 (13.5)          | 62 (16.3)               | 0.58  |
| Medical                | 179 (19.5)          | 69 (18.2)               |       |
| Surgical/emergency     | 580 (63.2)          | 237 (62.4)              |       |
| Trauma                 | 34 (3.7)            | 12 (3.2)                |       |

Admission source, n (%)

|                        | Survivors (n = 917) | Non-survivors (n = 382) | p     |
|------------------------|---------------------|-------------------------|-------|
| OR/recovery room        | 349 (38.2)          | 120 (31.7)              | 0.12  |
| Hospital floor          | 290 (31.8)          | 141 (37.2)              |       |
| ER/ambulance            | 135 (14.8)          | 50 (13.2)               |       |
| Other hospital          | 116 (12.7)          | 57 (15)                 |       |
| Other                  | 23 (2.5)            | 11 (2.9)                |       |

Comorbidities, n (%)

|                        | Survivors (n = 917) | Non-survivors (n = 382) | p     |
|------------------------|---------------------|-------------------------|-------|
| COPD                   | 149 (16.2)          | 62 (16.2)               | 0.99  |
| Cancer                 | 203 (22.1)          | 97 (25.4)               | 0.20  |
| Heart failure (NYHA III-IV) | 62 (6.8)           | 40 (10.5)               | 0.02  |
| Insulin dependent diabetes mellitus | 87 (9.5)          | 37 (9.7)                | 0.91  |
| Chronic renal failure  | 83 (9.1)            | 44 (11.5)               | 0.17  |
| Cirrhosis              | 39 (4.3)            | 33 (8.6)                | <0.01 |
| Hematological cancer   | 9 (1.0)             | 14 (3.7)                | <0.001|
| HIV                    | 6 (0.7)             | 6 (1.6)                 |       |

Treatment on the study day, n (%)

|                        | Survivors (n = 917) | Non-survivors (n = 382) | p     |
|------------------------|---------------------|-------------------------|-------|
| Mechanical ventilation  | 534 (58.2)          | 329 (86.4)              | <0.001|
| RRT (hemodialysis or hemofiltration) | 110 (12.0)         | 110 (28.9)              | <0.001|

Outcome

|                        | Survivors (n = 917) | Non-survivors (n = 382) | p     |
|------------------------|---------------------|-------------------------|-------|
| ICU LOS, median (IQR)  | 14 (5–32)           | 18 (9–38)               | <0.001|

Other sites of infection, n (%)

|                        | Survivors (n = 917) | Non-survivors (n = 382) | p     |
|------------------------|---------------------|-------------------------|-------|
| Respiratory            | 221 (24.1)          | 120 (31.4)              | <0.01 |
| Blood stream           | 97 (10.6)           | 56 (14.7)               | 0.04  |
| Renal/urinary tract    | 53 (5.8)            | 33 (8.6)                | 0.06  |
| Skin                   | 29 (3.2)            | 23 (6)                  | 0.02  |
| Catheter-related       | 28 (3.1)            | 21 (5.5)                | 0.04  |
| CNS                    | 1 (0.1)             | 0 (0)                   | 0.52  |
| Others                 | 19 (2.1)            | 16 (4.2)                | 0.03  |

SAPS II = Simplified Acute Physiology Score II; SOFA = Sequential Organ Failure Assessment; HIV = Human Immunodeficiency Virus; RRT = renal replacement therapy; NYHA III-IV = New York Heart Association class III-IV.
Mortality in patients who had abdominal infections was significantly higher than in patients who had other infections (most of which were respiratory infections), which was not found in previous studies. In an analysis of patients from the Sepsis Occurrence in Acutely Ill Patients (SOAP) study, Volakli et al. reported no differences in mortality rates among patients with abdominal infections and those with respiratory infections [6]. The higher mortality rate in patients with abdominal infections in our study may be explained by a number of differences between abdominal and other infections. First, timely source control is particularly important in the management of abdominal infections [22], and the method by which source control is obtained may influence outcomes [23]. Failed source control is often difficult to identify and can be a cause of persistent infection. In addition, abdominal infections are typically polymicrobial and often associated with resistant organisms; in the current study, non-survivors more frequently had P. aeruginosa and Stenotrophomonas maltophilia as pathogens. Finally, the large number of concomitant infections may also have affected outcomes.

As expected, comorbidities, such as cirrhosis and hematological cancer, were associated with increased mortality, as was found in the EPIC II patients in general [1]. Most notably, the impact of cirrhosis was considerable with a 2.3-fold increase in the risk of death. A recent analysis of the Project Impact database also showed that cirrhosis was independently associated with an increased risk of 30-day mortality [24].

The microbiology patterns were diverse, and quite different from those in the overall EPIC II study population, in which staphylococci were isolated most frequently, and Gram-positive and Gram-negative organisms were equally present [1]. In the patients with abdominal infections, the picture was substantially different: Gram-negative bacteria were isolated almost twice as frequently as Gram-positive bacteria, with E. coli being the most prevalent pathogen; typical nosocomial microorganisms, such as P. aeruginosa and Enterobacter spp. were also frequently isolated. Indeed, P. aeruginosa was the second most frequently isolated Gram-negative microorganism, which may in part be due to the design of the study, but the percentages are comparable to other studies in this field [25]. Among the Gram-positive microorganisms, enterococci were most prevalent, whereas staphylococci were uncommon. Furthermore, there were important differences in microbiology between survivors and non-survivors, with P. aeruginosa and Stenotrophomonas maltophilia isolated twice and four times more often, respectively, in non-survivors than in survivors. These pathogens may have a greater degree of pathogenicity (although Stenotrophomonas is generally not considered to be a major pathogen), or may be more difficult to treat. Detailed data regarding antibiotic resistance, including information regarding resistance to specific antibiotics, were not collected so we are unable to comment further on these aspects.

The findings in this study suggest that physicians around the world seem to comply with international guidelines in this field as most patients receive broad-spectrum antibiotics, often in combination with agents aimed at fungi or even at resistant Gram-positive microorganisms. We also found that patients who had stayed in the ICU for 2 days or less on the study day had different characteristics to those who had been longer on the ICU. Microbiological isolates and antibiotic treatments were remarkably different between these groups with fewer carbapenems, glycopeptides and antifungals used in patients with shorter stays. Current guidelines for the selection of antibiotic therapy in critically ill patients do not mention length of stay in the hospital as a consideration for empirical treatment in patients with high-severity non-nosocomial infections. Nevertheless, this group represents a category of patients, presumably with community-acquired infection, who could potentially be treated with narrower spectrum antibiotics when local ecology allows. This hypothesis warrants further evaluation.

Fungal infections have received considerable attention in the last decade. Although the debate continues as to whether fungi are relevant in community-acquired disease, the situation is different in nosocomial infections and in severely ill patients [20]. Candida isolation has been identified as an independent predictor of mortality in some studies [19,26,27], which has triggered widespread use of empiric antifungal coverage with fluconazole in this setting. In the current study, fungi were isolated in approximately 1 in 6 patients, but antifungal therapy was administered to almost 30% of the patients, reflecting the high use of antifungal prophylaxis in this group. Fungi were found more often in patients who had been in the ICU for more than 2 days, but were not linked to mortality in the current study. Identifying which patients are at risk of fungal infection and may

| Table 4 Multivariable analysis with ICU mortality as the dependent variable |
|---------------------------------|----------------|----------------|
| Odds ratio (95% CI) p-value      |                |                |
|---------------------------------|----------------|----------------|
| Hematological cancer            | 4.04 (1.47-11.11) <0.01 |                |
| Mechanical ventilation          | 2.97 (2.03-4.35)  <0.001 |                |
| Cirrhosis                       | 2.35 (1.29-4.30)  <0.01 |                |
| RRT (hemodialysis or hemofiltration) | 1.51 (1.03-2.21) 0.04 |                |
| SAPS II score on the study day (per point) | 1.06 (1.05-1.07) <0.001 |                |

Legend. Adjusted for hospital, organizational factors and for geographic region. CI = confidence interval; SAPS II = Simplified Acute Physiology Score II; RRT = renal replacement therapy. Hosmer-Lemeshow goodness of fit: chi2 = 5.315 with 8 df, p-value = 0.723; the c-statistic 0.82 (95% CI:0.80-0.85), p-value < 0.0001.
benefit from preemptive antifungal therapy remains a challenge; length of stay in the hospital and other risk factors for fungal infection, such as upper gastrointestinal tract perforation and previous antibiotic exposure [28], should be considered before initiating antifungal therapy. The prevalence of *Candida* non-albicans isolates was lower than frequently reported in invasive candidiasis studies or other studies in patients with *Candida* peritonitis. For example, Montravers et al. reported that only 58% of patients with *Candida* peritonitis had *C. albicans* isolated from intraoperative cultures [18]. In patients with invasive candidiasis, a systematic review by Andes et al. indicated that just 44% of the isolates were *C. albicans* [29]; patients with *Candida* peritonitis accounted for only 1% of the patients in this review, however. It is not clear whether the infecting *Candida* species or its susceptibility plays a major role in determining outcome [18].

This study has a number of limitations. Because the study was not primarily focused on abdominal infections, the exact source and extent of infection were not recorded and the efficacy of source control and appropriateness of antimicrobial therapy could not be evaluated. The rate of superinfection and/or tertiary peritonitis could not be assessed. Data on the community-acquired versus nosocomial nature of infections were also not available and we, therefore, used the length of stay as a surrogate marker, but acknowledge that this has its limitations. Finally, as in all point-prevalence studies, patients who are admitted for a long period of time may skew the findings with more data collected on those who stay in the ICU for a longer period of time.

### Table 5 Microbiology and antibiotic use in patients who had been admitted for 2 days or less vs. more than 2 days on the study day (Continued)

| Fungi | LOS ≤2d (n = 492) | LOS >2d (n = 899) | P  |
|-------|------------------|------------------|----|
| Candida albicans | 29 (11.2) | 89 (13.3) | 0.38 |
| Candida non-albicans | 6 (2.3) | 32 (4.8) | 0.09 |
| Aspergillus | 0 (0.0) | 2 (0.3) | 0.38 |
| Fungi, other | 1 (0.4) | 4 (0.6) | 0.69 |

### Antibiotic use

| Cephalosporins | 115 (23.4) | 145 (16.1) | <0.001 |
| Penicillins | 191 (38.9) | 290 (32.3) | 0.01 |
| Other beta lactams | 116 (23.6) | 331 (36.8) | <0.001 |
| Aminoglycosides | 64 (13.0) | 114 (12.7) | 0.85 |
| Quinolones | 67 (13.6) | 131 (14.6) | 0.64 |
| Glycopeptides | 78 (15.9) | 252 (28) | <0.001 |
| Macrolides | 7 (1.4) | 23 (2.6) | 0.17 |
| Other antibiotics | 194 (39.5) | 355 (39.5) | 0.99 |
| Antifungals | 80 (16.3) | 266 (29.6) | <0.001 |
Conclusion
In conclusion, this study found that abdominal infections were present in about one fifth of ICU patients on the study day and concomitant infections were common. Microbiology patterns and choice of antibiotic therapy were diverse and differed in patients who had stayed in the ICU for 2 days or less compared to those with longer stays. Abdominal infections carry a poor prognosis, with higher mortality rates than in patients with infections from other sources. Disease severity, need for organ support and presence of comorbidities were independently associated with mortality in our cohort.

Appendix: List of participating centers by country, alphabetically
Andorra: Hospital Nostra Senyora de Meritxell (A Margarit);
Argentina: Centro de Educación Médica E Investigaciones Clínicas (R Valentini); Clínica de Especialidades Villa Maria (A Zazu); Clínica Modelo de Morón (C Bevilacqua); Clínica Y Maternidad Suizo (M Curone); CMIC (R Rabuffetti); Hospital Aleman (P Comignani); Hospital Argerich (M Torres Boden); Hospital Britanico (F Chertcoff); Hospital Central de San Isidro (G Cardonnet); Hospital de Niños Dr. Héctor Quintana (F Adén); Hospital del Niño Jesús (L Marcos); Hospital Dr Pedro Ecay (M Dónofrio); Hospital Español de Mendoza (R Fernández); Hospital Español Medical Plaza (R Lamberghini); Hospital Internacional General de Agudos "José de San Matín" (S Balasini); Hospital Interzonal Dr. O. Alende (J Teves); Hospital Italiano de Buenos Aires (M Las Heras, J Sinner); Hospital Juan A. Fernández (D Ceraso); Hospital Municipal de Chivilcoy (D Curcio); Hospital Profesor Alejandro Posadas (L Aguilar); Hospital Provincial de Rosario (C Weller); Hospital Provincial del Centenario (L Cardonnet); Hospital Regional Río Gallegos (R Santa Cruz); Hospital Regional Ushuaia (E Andorra); Hospital Nostra Senyora de Meritxell (A Margarit);

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Additional file

Additional file 1: Table S1. Sites of infection. Table S2. Antibiotic use in patients with abdominal infections. Table S3. Microbiology and antibiotic use in survivors and non-survivors.

Abbreviations
ICU: Intensive care unit; EPIC: Extended Prevalence of Infection in the ICU; SAPS: Simplified acute physiology score; SOFA: Sequential organ failure assessment; ISF: International Sepsis Forum; SD: Standard deviation; IQR: Interquartile range; LOS: Length of stay; SOAP: SEPSIS Occurrence in Acutely Ill Patients.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
JLV, JL, YS and JM designed the study, JLV and JDW analyzed the data and drafted the manuscript, JL, YS, JM, PV, CBG, ML revised it critically for important intellectual content. All authors read and approved the final manuscript.

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