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Incidence, in- hospital mortality and risk factors for hospital-acquired pneumonia in patients with intra-abdominal surgical procedures hospitalized in a tertiary hospital in Belgrade, Serbia: A matched case-control study

Incidenca, bolnička smrtnost i faktori rizika za nastanak bolnički stečene pneumonije kod bolesnika nakon intraabdominalnih hirurških procedura, hospitalizovanih u bolnici tercijernog nivoa zdravstvene zaštite u Beogradu, Srbija: *case-control* studija

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Abstract

Background/Aim. Hospital-acquired pneumonia (HAP) in a surgical population significantly increases morbidity and mortality, prolongs hospitalization and increases total treatment costs. In the present study, we aimed to determine incidence, in-hospital mortality and risk factors (RFs) of HAP in patients with intra-abdominal surgical procedures hospitalized in a tertiary hospital in Belgrade (Serbia). **Methods.** Through regular hospital surveillance of patients who underwent intra-abdominal surgical procedures, we prospectively identified postoperative HAP during five years. In the matched case-control study, every surgical patient with HAP was compared with four control patients without HAP. In the group of patients with HAP, those who died were compared with those who survived. **Results.** Overall 1.4% of all intra-abdominal surgical patients developed HAP in the postoperative period. The incidence of HAP (per 1,000 operative procedures) was greatest in patients undergoing exploratory laparotomy (102.6), followed by small bowel surgery (36.6), and gastric surgery (22.7). Multivariate logistic regression analysis (MLRA) identified three independent risk factors (RF) associated with HAP: multiple transfusion [p = 0.011; odds ratio (OR): 4.26; 95% confidence interval (CI): 1.59–11.33], length of hospital stay (p = 0.024; OR: 1.02; 95%CI: 1.00–1.03) and hospitalization in the Intensive care unit (ICU) (p = 0.043; OR: 2.83; 95%CI: 1.03–7.71). MLRA identified only surgical site infection as an independent RF associated with the poor outcome of HAP (p = 0.017; OR: 5.929; CI95%: 1.37–25.67). **Conclusion.** The results of the present study are valuable in documenting the relations between RFs and HAP in patients undergoing intra-abdominal surgical procedures.

Key words:
cross infection; pneumonia; digestive system surgical procedures; risk factors; incidence; mortality.

Apstrakt

Uvod/Cilj. Bolnički stečena pneumonija u populaciji hirurških bolesnika značajno povećava obolevanje i smrtnost, produžava vreme bolničkog lečenja i povećava troškove lečenja. Cilj rada je bio da se odrede incidenca, bolnička smrtnost i faktori rizika (FR) za nastanak bolnički stečene pneumonije kod bolesnika podvrgnutih intrabdominalnim hirurškim procedurama, bolnički lečenim u ustanovi tercijernog nivoa zdravstvene zaštite u Beogradu, Srbija. **Metode.** Kroz uobičajeni bolnički nadzor hirurških bolesnika nakon intraabdominalnih hirurških procedura, prospektivno smo identifikovali postoperativno nastale bolnički stečene pneumonije u periodu od pet godina. U "mečovanoj" slučaj-

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kontrola studiji, svaki hirurški bolesnik sa bolnički stečenom pneumonijom je poređen sa četiri kontrolna ispitanika (bez bolnički stečene pneumonije). U grupi bolesnika sa bolnički stečenom pneumonijom, umrli su poređeni sa preživelim bolesnicima. **Rezultati.** Od svih bolesnika, 1,4% je razvilo bolnički stečenu pneumoniju u postoperativnom periodu nakon intraabdominalne hirurške procedure. Incidenca bolnički stečene pneumonije (na 1000 operativnih procedura) bila je najveća kod bolesnika koji su bili podvrgnuti eksploralivnoj laparotomiji (102,6), potom hirurgiju tankog creva (36,6) i hirurgiji želuca (22,7). Multivarijantnom logističkom regresionom analizom (MLRA) identifikovana su tri nezavisna FR udružena sa bolnički stečenom pneumonijom: multiple transfuzije [p = 0,011; *odds ratio* (OR): 4,26; 95% *confidence interval* (CI): 1,59–11,33), dužina bolničkog lečenja (p = 0,024; OR: 1,02; 95% CI: 1,00–1,03) i lečenje u jedinici intenzivne nege (p = 0,043; OR: 2,83; 95% CI: 1,03–7,71)]. MLRA je identifikovala samo infekciju hirurškog mesta kao nezavisni FR povezan sa lošijim ishodom bolnički stečene pneumonije (p = 0,017; OR: 5,929; CI 95%: 1,37–25,67). **Zaključak.** Rezultati studije su značajni u potvrđivanju odnosa između FR i bolnički stečene pneumonije kod bolesnika podvrgnutih intraabdominalnim hirurškim procedurama.

Ključne reči:
infekcija, intrahospitalna; pneumonija; hirurgija digestivnog sistema, procedure; faktori rizika; incidenca; mortalitet.

Introduction

Hospital-acquired pneumonia (HAP) is a very serious health problem in hospitals all over the world [1–3]. It is the infection of lower respiratory tract that occurs clinically two or more days after hospitalization and was not incubating at the time of hospital admission [4]. The reported incidence of HAP varies according to the type of population studied, ward location and length of hospital stay [1, 2, 5]. Critically ill patients admitted to intensive care units (ICUs) carry higher risk of HAP than those treated outside ICUs. Ventilator-associated pneumonia (VAP) refered to HAP develops among patients on mechanical ventilators (MV) and presents more than 48 hours after endotracheal intubation [6]. HAP in surgical population significantly increases morbidity and mortality, prolonging hospitalization and increasing total treatment costs [7–10]. Surveillance of HAP provides useful data in identifying risk factors (RF) that contribute to the development and outcome of HAP. In the present study, we aimed to determine incidence, in-hospital mortality and RFs of HAP in patients with intra-abdominal surgical procedures hospitalized in a tertiary hospital in Belgrade (Serbia).

Methods

Setting

The Military Medical Academy (MMA), Belgrade, Serbia, a teaching hospital of the University of Defence, is a 1200-bed tertiary healthcare center with 27 departments according to medical specialities. The Clinic for General Surgery is a 72-bed department of the MMA. The Department of Infection Control performs continuous surveillance of healthcare-associated infections (HAI), including HAP, on surgical patients of MMA.

Study population

Through regular hospital surveillance of patients who ubnerwent intra-abdominal surgical procedures, we prospectively identified postoperative HAP during the study period, from 1st January, 2007 to 31st December, 2011. Reviewing the clinical chart information on patient characteristics, RFs related to health care were collected. We gathered data on the following variables: patients characteristics existing before operative procedures – gender, age, body mass index (BMI), the presence of underlying diabetes mellitus, tobacco use, preoperative infection, the American Society of Anesthesiologists (ASA) score, factors related to health care including the length of hospital stay, ICU admission, MV, central vascular catheter (CVC), histamine-2-receptor antagonists (H2RAs) use, proton-pump inhibitors (PPIs) use and preoperative antibiotic prophylaxis, red blood cell transfusion, outcome of treatment (live/dead) and characteristics of operative procedure – elective surgery, upper abdominal surgery, duration of operation, class of contamination of surgical site, drainage, duration of drainage and surgical site infection (SSI). In the case-control study, every surgical patient with HAP was compared with four control patients without HAP. Control patients were matched to the cases by age (± 5 years), ASA score and date of surgical operation. In the group of patients with HAP those who died were compared with those who survived.

Definition

Pneumonia is defined as "new lung infiltrates plus clinical evidence that the infiltrate is of an infectious origin, which include the new onset of fever, purulent sputum, leukocytosis, and decline in oxygenation" [11]. HAP was diagnosed by the consultative specialist of pulmonology based on the presence of radiographic shadowing [3, 4, 12]. SSI is defined according to the Center for Disease Control and Prevention/National Healthcare Safety Network (CDC/NHSN) surveillance definitions [12]. All patients were assessed before operation by anesthesiologist for the ASA score [13]. The National Research Council operative site classification was used by surgeon to class surgical wounds as clean, clean/contaminated, contaminated, and dirty/infected [14].

Multiple transfusions is defined as more than one pack of red blood cell.

Patients with preoperative pneumonia and pneumonia that developed after postoperative respiratory failure were excluded.

No post-discharge surveillance was performed.

Microbiological testing

The microbiological testing was performed at the MMAs Institute of Medical Microbiology. The microbiological methods were used according to the protocol for HAP included sputum or tracheal aspirate cultures and serial blood cultures.

Statistical analysis

Incidence rate (IR) was defined as the number of HAP per 1,000 specific intra-abdominal operative procedures. The in- hospital mortality rate was defined as the number of deaths per 100 patients with HAP.

Data analyses were performed with SPSS, version 18.0 (SPSS, Inc, Chicago, IL). Results were expressed as the mean ± standard deviation (SD) or as proportion of the total number of patients. The χ^2-test or Fischer's exact test were used for categorical variables and relative risk, and their corresponding 95% confidence intervals (CI) were calculated. For parametric continuous variables, mean values were compared using Student's *t*-test. For nonparametric continuous variables, the Mann-Whitney *U* test was used. RFs independently associated with HAP were identified by the stepwise logistic regression analysis of variables selected by univariate analysis, with a limit for entering and removing variables at 0.05.

The informed written consent was obtained from all participants. The Ethics Committee of the MMA approved the research protocol.

Results

Study population

During 2007–2011 in the Clinic for General Surgery of the MMA, the surveillance of HAIs after 8,003 operative procedures was performed. In this study only patients with intra-abdominal operations were included. In the sample of 3,758 intra-abdominal operations, colorectal surgery was the most common operative procedure performed, accounting 1,524 or 40.6% (Table 1). Appendix surgery was the second most common intra-abdominal operative procedure (accounting 474 or 12.6%), followed by small bowel surgery (accounting 464 or 12.3%), gastric surgery (accounting 441 or 11.7%) and bile duct, liver or pancreatic surgery (accounting 361 or 9.6%). Other operative procedures included exploratory laparotomy (accounting 39 or 1.0%) and spleen surgery (accounting 36 or 0.096%).

Incidence of HAP

Overall 1.4% (51 of 3,758) of all intra-abdominal surgical patients developed HAP in the postoperative period. The incidence of HAP (per 1,000 operative procedures) was greatest in patients undergoing exploratory laparotomy (102.6 per 1,000 operative procedures), followed by small bowel surgery (36.6 per 1,000 operative procedures), gastric surgery (22.7 per 1,000 operative procedures), gallbladder surgery (9.5 per 1,000 operative procedures), colorectal surgery (8.4 per 1,000 operative procedures), bile duct, liver or pancreatic surgery (5.5 per 1000 operative procedures) and appendix surgery (2.1 per 1,000 operative procedures). Spleen surgery was not complicated by HAP.

Forty-one surgical patients with HAP were enrolled in the case-control study. A random sample of 164 control patients matched by age (± 5 years), ASA score and date of surgical operation were selected from a total of 3,707 potentially matched controlled subjects. For 10 patients data were incomplete, so we excluded them from the study of RF. Of 41 patients with HAP, 34 or 82.9% were treated in the ICU more than 48h and 16 or 39.0% were at some time on MV. Twelve or 29.3% patients were diagnosed with VAP.

Risk factors for the acquisition of HAP

The patients with HAP had mean age of 63.54 ± 12.85 and 61.0 % were male.

Patients' characteristics, procedures during hospitalization, and characteristics related to surgical procedure performed in the case and control groups according to univariate logistic regression analysis (ULRA) are shown in Table 2. According to ULRA, the next characteristics were more frequent in cases with HAP than in controls: better outcome, longer hospitalization, hospitalization in the ICU, CVC, MV, H2RA or PPI use, multiple transfusion, preoperative antibiotic prophylaxis, elective surgery, contaminated and dirty/infected class of contamination, drainage, longer duration of drainage and SSI.

Table 1
Number and percentage of specific intra-abdominal surgical procedures among all intra-abdominal surgical procedures and hospital-acquired pneumonia (HAP) rate in the study population

Surgical procedure	Number	%	HAP rate per 1,000 surgical procedures
Colorectal surgery	1,524	40.6	8.4
Appendix surgery	474	12.6	2.1
Small bowel surgery	464	12.3	36.6
Gastric surgery	441	11.7	22.7
Gallbladder surgery	419	11.1	9.5
Bile duct, liver or pancreatic surgery	361	9.6	5.5
Exploratory laparotomy	39	1.0	102.6
Spleen surgery	36	1.0	/

Table 2
Potential risk factors for acquisition and poor outcome of hospital acquired-pneumonia (HAP) in intra-abdominal surgical patients: results of univariate logistic regression analysis

Patient characteristics	With HAP (n = 41)	Without HAP (n = 164)	*p*	Survive (n = 21)	Death (n = 20)	*p*
General data						
Age (years), mean ± SD	63.54 ± 12.85	64.27 ± 13.16	0.707	62.95 ± 13.07	64.15 ± 12.92	0.770
Male, n (%)	25 (61.0)	90 (54.9)	0.482	14 (66.7)	11 (55.0)	0.445
Body mass index (kg/m^2), mean ± SD	24.85 ± 3.65	25.01 ± 4.35	0.603	25.76 ± 3.54	23.90 ± 3.59	0.103
Diabetes mellitus, n (%)	6 (14.6)	10 (6.1)	0.077	3 (14.3)	3 (15.0)	0.948
Tobacco use, n (%)	14 (34.1)	44 (26.8)	0.461	6 (28.6)	8 (40.0)	0.442
ASA, n (%)			1.000			0.138
2	15 (36.6)	60(36.6)		10 (47.6)	5 (25.0)	
3	26 (63.4)	104 (63.4)		11 (52.4)	15 (75.0)	
Preoperative infection, n (%)	3 (7.3)	4 (2.4)	0.143	1 (4.8)	2 (10)	0.529
Malignancy, n (%)	15 (36.6)	85 (51.8)	0.116	8 (38.1)	7 (35.0)	0.837
Treatment outcome, n (%)	20 (48.8)	11 (6.7)	< 0.001	/	/	
Characteristics related to hospitalization						
Preoperative hospitalization (days), mean ± SD	12.00 ± 18.27	7.61 ± 9.51	0.725	11.52 ± 18.90	12.50 ± 18.06	0.687
Length of hospital stay (days), mean ± SD	46.63 ± 30.38	21.88 ± 19.96	< 0.001	47.19 ± 35.67	46.05 ± 24.56	0.906
Hospitalization in ICU, n (%)	34 (82.9%)	60 (36.6%)	< 0.001	15 (71.4)	19 (95.0)	0.074
Central venous catheter, n (%)	29 (70.7)	69 (42.1)	< 0.001	12 (57.1)	17 (85.0)	0.059
Mechanical ventilation, n (%)	16 (39.0)	7 (4.3)	< 0.001	5 (23.8)	11 (55.0)	0.045
H2 receptor antagonist (H2RA), n (%)	24 (58.3)	56/159 (35.2)	0.007	9 (42.9)	15 (75.0)	0.077
Proton-pump inhibitors (PPI), n (%)	13 (31.7)	29/159 (18.2)	0.059	8 (38.1)	5 (25.0)	0.572
Acid suppressive medications (H2RA or PPI), n (%)	37 (90.2)	85/159 (53.4)	< 0.001	17 (81.0)	20 (100.0)	0.107
Multiple transfusion, n (%)	38 (92.7)	62/159 (38.9)	< 0.001	18 (85.7)	20 (100.0)	0.125
Characteristics related to surgical procedure						
Preoperative prophylaxis, n (%)	40 (97.6)	137 (83.5)	0.046	21 (100.0)	19 (95.0)	0.488
Elective surgery, n (%)	21 (51.2)	116 (70.7)	0.019	9 (42.9)	12 (60.0)	0.275
Upper abdominal surgery, n (%)	17 (41.5)	61 (37.2)	0.746	9 (42.9)	8 (40.0)	0.853
Duration of operation (minutes), mean ± SD	121.83 ± 56.68	118.78 ± 68.49	0.473	122.38 ± 59.21	121.25 ± 55.43	0.950
Class of contamination, n (%)						0.150
clean	5 (12.2)	36 (22.0)	0.239	3 (14.3)	2 (10.0)	0.954
clean/contaminated	12 (29.3)	82 (50.0)	0.315	8 (38.1)	4 (20.0)	0.794
contaminated	6 (14.6)	17 (10.4)	0.001	2 (9.5)	4 (20.0)	0.383
dirty/infected	18 (43.9)	29 (17.7)	0.008	8 (38.1)	10 (50.0)	0.541
Drainage, n (%)	39 (95.1)	127 (77.4)	0.018	20 (95.2)	19 (95.0)	0.972
Drainage (days), mean ± SD	11.72 ± 6.35	8.93 ± 4.93	0.006	12.70 ± 7.55	10.68 ± 4.77	0.329
Surgical site infection, n (%)	16 (39.0)	14 (8.5)	< 0.001	4 (19.0)	12 (60.0)	0.010

Multivariate logistic regression analysis (MLRA) identified three independent RFs associated with HAP in surgical patients: multiple transfusion [p = 0.011; odds ratio (OR): 4.26; 95% CI: 1.59–11.33], length of hospital stay (p = 0.024; OR: 1.02; 95% CI: 1.00–1.03) and hospitalization in the ICU (p = 0.043; OR: 2.83; 95%CI: 1.03–7.71).

Risk factors for the poor outcome of HAP

The mortality rate in patients with HAP in this study was 48.8% and it was significantly higher in the cases than in the control group (p < 0.001).

Patients' characteristics, procedures during hospitalization, and characteristics depending on the surgery procedure in the survived and patients who died according to ULRA are shown in Table 2. The patients with HAP who died had significantly greater frequency of the MV use (p = 0.045) and SSI (p = 0.010) than surgical patients with HAP who survived. MLRA identified only SSI as an independent RF associated with the poor outcome in surgical patients with HAP (p = 0.017; OR: 5.929; 95% CI: 1.37–25.67).

Microbiological etiology

In 11 (26.8%) patients with HAP, microbiological etiology of the disease could be confirmed. *Pseudomonas aeruginosa* was the most frequent etiology, diagnosed in 5 cases (by blood culture in one case and by sputum or tracheal

aspirate culture in four cases of HAP). *Klebsiella* spp. was diagnosed in 4 cases (by blood culture in two cases and by sputum or tracheal aspirate culture in 2 cases of HAP). *Staphylococcus aureus* was diagnosed in 3 cases (by blood culture in one case and by sputum or tracheal aspirate culture in 2 cases of HAP). *Acinetobacter* spp. was diagnosed in 4 cases by sputum or tracheal aspirate culture.

Discussion

HAP in patients undergoing intra-abdominal surgical procedures causes significant morbidity and mortality and prolongs hospital stays [8, 9]. In this study we analyzed postoperative HAP in large cohort of intra-abdominal surgical patients. During the study period 51 or 1.4% of surgical patients were diagnosed with HAP in the postoperative period. The overall incidence of HAP was similar to incidence reported in the study of Delagdo-Rodriguez et al. [15], but lower than that reported in studies of Mohri et al. [7], Thompson et al. [8], and Patel et al. [9]. These differences could be related to differences in type of operative procedures conducted, characteristics of hospital populations studied, and surveillance methods used. In our study the incidence of HAP was greatest in the group of 39 patients undergoing exploratory laparotomy (102.6 per 1,000 operative procedures). In that population of patients, Thompson et al. [8] reported rate of 16.5, but their sample included 9,054 operative procedures. Ewdards et al. [16] estimated rate of 6.0 postoperative pneumonias per 1,000 colon surgery procedures. In our study, colorectal surgery was the most common operative procedure performed, accounting 1,524 or 40.6% of the operative procedures with HAP rate of 8.3 per 1,000 procedures.

Spleen surgery was not complicated by HAP in our patients (36 patients with splenectomy as a separate operative procedure) because we most commonly performed that procedure in younger patients after trauma or to treat underlying medical conditions such as thrombocytopenia, certain leukemia, or lymphomas.

Risk factors for the acquisition of HAP

In the study of 571 elective operations for gastric cancer, Thompson at al. [8] found that female patients were two times more likely than male patients to develop HAP. On the other hand, Mohri et al.[7] found that after surgery for gastric cancer male patients had five times greater risk to acquire HAP. Our study showed that gender was not associated with HAP as well as with HAP poor outcome.

Our study identified three independent RFs for acquiring HAP: multiple transfusions, length of hospital stay and hospitalization in the ICU.

Systematic review and meta-analysis of the randomized trials conducted among hospitalized patients showed that a restrictive red blood cells (RBC) transfusion strategy compared with a liberal transfusion strategy was not associated with a reduced risk of health care–associated infection overall, although it was associated with a reduced risk of serious infection [17]. In a survey of 2,809 colorectal resections, transfusion was the single most powerful RF for postoperative infection [18]. Intra- and/or postoperative blood transfusions were independent RFs for development of postoperative HAP after elective resection of gastric cancer [7]. Our patients with multiple transfusions were four times likely than patients without history of multiple transfusions to develop HAP ($p = 0.011$; OR: 4.258; 95% CI: 1.59–11.33).

The prospective multicenter cohort study of 268 major elective abdominal surgery procedures showed that postoperative pulmonary complications, with pulmonary infection as most common (9% of all patients), had the most striking impact on lenght of hospital stay (median length of hospital stay was extended from 3 to 10 days) [9]. Also, Thomson et al. [8] reported that the mean length of hospital stay for intra-abdominal surgery patients who developed HAP was significantly greater compared with patients who did not develop HAP (17.10 ± 18.66 vs. 6.07 ± 5.37 days; $p < 0.001$). In our study, length of hospital stay in patients with HAP was 46.63 ± 30.38 days, and in patients without HAP it was 21.88 ± 19.96 days ($p = 0.024$; OR: 1.02; 95% CI: 1.00–1.03). Prolonged hospitalization in our patients is explain by the fact that the majority of our patients were primarily hospitalized at the Clinic for Gastroenterology of the MMA because of implementation of preoperative diagnostic procedures, which was then followed by the hospitalization at the Clinic of Abdominal Surgery where surgery was performed.

HAP is a frequent and severe infection in the ICU, with the highest morbidity and mortality [19]. Alp et al. [20] showed that the rate of HAP, in patients in the ICU was much higher in medical than in surgical patients (11.7% *vs* 5.8%). Also, they showed that MV was more frequently used in medical than surgical patients ($p < 0.01$). In our study of intra-abdominal surgical patients with HAP, 34 or 82.9% were treated in the ICU more than 48h and 16 or 39.0% were at some time on MV. In the study of the ICU treated patients, Karhu et al. [2] reported that 80% of HAP patients needed MV. Our study showed that the ICU and MV were associated with the acquisition of HAP, but MV did not retain significance as an independent RF in MLRA.

In a large, hospital-based pharmacoepidemiologic cohort study, Herzig et al. [21] found that acid-suppressive medication use was associated with 30% increased odds of HAP. In subset analyses, the risk for HAP was significantly increased with PPI, but not with histamine H2RA. Our patients with HAP received acid suppressive medications (H2RA or PPI) more frequently than patients in the control group (90.4% vs. 53.4%, respectively), but according to ULRA only H2RAs significantly increased the risk of HAP ($p = 0.007$), without being significant independent RF.

Risk factors for the poor outcome of HAP

The combination of hospital-acquired pneumonia and ventilator-associated pneumonia constitutes the most common cause of death among all hospital-acquired infections, with mortality rates of up to 33% [22]. In surgical population, mortality from postoperative HAP ranges from 10.7% [8] to 45% [23]. The prognosis in patients with HAP depends primar-

ily on host defenses, existing comorbidities and initial empiric therapy. The mortality rate in patients with HAP in our study was 48.8% and it was significantly higher in the case than in the control group ($p < 0.001$). In our patients HAP was not the primary cause of death but it was mentioned in the clinical chart information. We identified SSI as an independent RF for the poor outcome of HAP. Some previous study of the relationship between hospital-acquired infection and in-hospital mortality in surgical patients showed that the association of SSI and either a respiratory tract infection or a bloodstream infection also significantly increased the risk of in-hospital mortality [24]. The longitudinal study based on prevalence data from a large emergency and referral teaching hospital in Norway, found that hospital-acquired bloodstream infection, hospital-acquired lower respiratory tract infections or more than one simultaneous hospital-acquired infection were independently and strongly associated with increased mortality 30 days and one year after inclusion in the study [25].

Microbiological etiology

After systematic review Jones concluded that top six most prevalent pathogens (*Staphyloccocus aureus, Pseudomonas aeruginosa, Klebsiella* species, *E. coli, Acinetobacter* species, and *Enterobacter* species) consistently cause 80% of all HAP or VAP episodes, in contrast to only 3.7–7.3% by *S. pneumoniae* and *Haemophilus* spp. [26]. As reported in the study of Sopena et al. [5], the etiology of HAP was known in less than one-third of our patients because of the inability to perform the invasive diagnostic procedure in most of cases. In our study identification of the causative agent was possible in only 11 or 26.8% patients with HAP. *Pseudomonas aeruginosa* was the most frequent causative agent of HAP in our study.

Limitation and strength of the study

Limitation of the study is the possibility of presence of confounding variables that were not examined. Although confounding variables were chosen after an exhaustive search of the literature, the potential for oversight and exclusion does exist. We did not include some parameters, namely existing of chronic obstructive pulmonary diseases and other chronic lung diseases, alcohol use, appropriate empiric treatment and analyzing these factors could have enhanced the relevance of our results. Furthermore, we did not evaluate the HAP cases and the controls in relation to the age and ASA score, because HAP cases and controls were matched according to them. Besides, this was the single centre study and the number of patients with HAP was relatively small. Finally, our mortality outcome was limited to in-hospital mortality rate. However, it is unlikely that other measures of mortality, such as 30-day mortality, would give more precise RF for the poor outcome of HAP.

The strength of our study is that it could be generalized to surgical patients with intra-abdominal surgical procedures.

Conclusion

During the study period, 1.4% of intra-abdominal surgical patients were diagnosed with HAP in the postoperative period. We identified three independent risk factors for acquiring HAP: multiple transfusions, length of hospital stay and hospitalization in the Intensive care unit. Also, we identified SSI as an independent RF for the poor outcome of HAP. The results of the present study are valuable in documenting the relations between RFs and HAP in patients undergoing intra-abdominal surgical procedures.

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