Risk factors for infectious complications after abdominal surgery

Factores de riesgo para complicaciones infecciosas tras cirugía abdominal

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Abstract

Infections are relevant complications of surgical procedures, significantly increasing morbidity, mortality, length of stay, and financial costs. Proper risk management and preventive measures have shown to decrease the overall burden of infectious complications. Risk factors vary according to the type of complication and surgery location, making the formulation of predictive models rather difficult. Age, sex, chronic conditions, habits, and antibiotic selection are some of the preoperative risk and protective factors to consider. On the other hand, surgery duration, type of suture, need for transfusions, and closure suture techniques fall within the intraoperative risk factors. While enough evidence is available regarding a wide variety of factors, there is a lack of predictive models or consensus concerning them. Further research is needed to establish appropriate tools to decrease the incidence of postoperative infectious complications. This review aims to analyze the evidence concerning risk factors associated with postoperative infectious complications, including preoperative and intraoperative factors.

Keywords: Infectious complications, postoperative infections, postoperative complications, abdominal surgery, risk factors.

Resumen

Las infecciones son complicaciones relevantes de los procedimientos quirúrgicos, aumentando significativamente la morbilidad, la mortalidad, la estancia hospitalaria y los costes económicos. Se ha demostrado que la gestión adecuada del riesgo y las medidas preventivas reducen las complicaciones infecciosas. Los factores de riesgo varían según el tipo de complicación y el lugar anatómico de la cirugía, lo que dificulta la formulación de modelos predictivos. La edad, el sexo, las condiciones crónicas, los hábitos y la selección de antibióticos son algunos de los factores de riesgo y protección preoperatorios a considerar. Por otro lado, la duración de la cirugía, el tipo de sutura, la necesidad de transfusiones y las técnicas de sutura de cierre se encuentran dentro de los factores de riesgo intraoperatorios. Si bien hay suficiente evidencia disponible con respecto a una amplia variedad de factores, hay una falta de modelos predictivos o consenso al respecto. Se necesita más investigación para establecer herramientas apropiadas para disminuir la incidencia de complicaciones infecciosas posoperatorias. Esta revisión tiene como objetivo analizar la evidencia sobre los factores de riesgo asociados con las complicaciones infecciosas posoperatorias, incluidos los factores preoperatorios e intraoperatorios.

Palabras clave: Complicaciones infecciosas, infecciones postoperatorias, complicaciones postoperatorias, cirugía abdominal, factores de riesgo.

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Introduction

Surgery is a foundational component of healthcare, and specialists in this area are among the most demanded worldwide. It is estimated that at least 312 million surgical procedures would be needed to fulfill the burden of surgical diseases worldwide. Logically, disease distribution of the worldwide surgical burden is uneven, and unintentional injuries rank the highest by far[1]. Furthermore, injured patients have a substantial risk of developing abdominal or chest trauma, making this the most common cause of surgical intervention within the emergency department (ED)[2]. On top of that, acute abdominal pain, non-injury-related, represents one of the most common motives for consultation, amounting to almost 6% of all consultations in the ED[3]. A compelling number of patients with abdominal pain need surgical management, and a significant proportion of elective procedures fall in the general surgery service, making abdominal procedures one of the most common types of surgery worldwide[4,5].

The benefits of surgery, in most scenarios, outweigh the risk of complications; however, that does not mean there are no risks regarding surgical procedures. In developed countries, perioperative complication rates range between 3-16%, and nearly half of all adverse events are preventable[6]. The proportion of complications significantly increases in developing countries to nearly 40% due to a lack of personnel, proper training, equipment, infrastructure, and standardized procedures[7]. Postoperative complications embody a heterogeneous group of conditions, ranging from infections to cardiac arrest. However, epidemiological reports confirm that infectious complications, including superficial surgical site infection (SSI), deep SSI, pneumonia, urinary tract infection (UTI), and sepsis are the most common adverse outcomes[8].

Most surgical protocols include proper asepsis and antisepsis procedures and prophylactic antibiotic treatment[9]. Regardless, infectious complications remain a significant health problem in postoperative patients[10]. To address the previous issue, understanding what risk factors are associated with increased rates of infectious complications is a must. Conditions like diabetes mellitus (DM), obesity, smoking, and many others seem obvious risk factors, a statement supported by a significant body of evidence. However, factors like sex, duration of the operation, and surgical approach might be underestimated[11]. This review aims to analyze the evidence

Infectious complications in abdominal surgery: are they preventable?

Infectious complications are the leading cause of postoperative morbidity in abdominal surgery[12]. In order to decrease the incidence of these complications, risk factors must be established through proper statistical analysis. Proper risk management results in decreased complications rates, with decreased morbidity and financial costs[13]. Notably, evidence suggests that risk factors for infectious complications differ between colorectal and non-colorectal surgery; as a result, they will be addressed separately[11,14]. Likewise, risk factors for SSI and nonabdominal infections such as pneumonia and UTI, may also differ, making risk management and stratification somewhat complex in terms of predictive models[8,15].

Firstly, SSI is the principal cause of postoperative infectious complications and increased medical expenses[16]. Incidence of SSI varies regarding its nature, incisional or superficial SSI tends to be more frequent than organ/space or deep SSI. A prospective study that analyzed over 2,800 patients undergoing colon and rectum surgery stated that the overall prevalence of superficial and deep SSI was 4.7% and 3%, respectively. Likewise, it has been reported that American Society of Anesthesiology (ASA) scores over 2, male gender, creation of ostomy, preoperatively contaminated wounds, and intraoperative or postoperative blood transfusions significantly raise the risk for any presentation of SSI[14].

More recently, Pedroso-Fernandez et al.[17] executed a retrospective study from patients undergoing colorectal surgery between 2007 and 2013. The prevalence of SSI 30 days after surgery was 24%, a significant increase compared to other sources. After multivariate analysis, significant independent predictors of SSI were contaminated surgeries, open surgery, over 72 hours of preoperative stay and, contrary to the previous study, female sex. Given the disparities regarding sex across the evidence and the elevated rate of non-significant differences, a recent meta-analysis concluded that most evidence supports male sex as a risk factor for SSI[18]. Along these lines, Chida et al.[19] reported that suture material, blood loss, and wound length are significantly associated with superficial SSI. However, after multivariate analysis the only factor independently associated with superficial SSI was continuous mass closure, showing an important decrement in the risk of SSI compared to interrupted suture techniques.

Silvestri et al.[20] performed a retrospective analysis in patients who underwent colorectal surgery. The total prevalence of SSI was 20%, and after univariate and

multivariate analysis, older age, DM, and high infection risk index were identified as risk factors for SSI. Likewise, Zhang et al.[21] reported that hypertension, another chronic condition, was significantly associated with the incidence of SSI, with an odds ratio (OR) of 1.903 (95% CI; 1.088-3.327, P= 0.025). However, it was also reported that laparoscopic and robotic surgery were protective factors against SSI, along with the use of adhesive incise drapes. In addition, Blumetti et al.[22] demonstrated that factors associated with superficial or deep SSI rarely overlapped, suggesting that risk models and treatment strategies should be developed separately.

Regarding protective factors against SSI, antibiotic prophylaxis shows the most extent amount of evidence. Although antibiotic choice is still controversial, the usage of any antibiotic prior to surgery and after surgery has been correlated with a lower risk of SSI, however duration of the treatment after surgery has not been significantly associated with lower odds of SSI[23]. Alkaaki et al.[24] reported that only 23% of the cultured bacteria in his research were sensitive to the prophylactic antibiotic given preoperatively. As a result, the authors suggest to adapt the antibiotic prophylactic regimen to commonly isolated organisms in the region. Furthermore, other preventive measures have been studied in order to decrease SSI rates. For instance, mechanical bowel preparation (MBP) plus oral antibiotics has shown better results than antibiotics alone. Likewise, utilization of sterile closure trays and pre-closure glove changes have shown a significant reduction in SSI incidence[25].

In regards to noncolorectal surgery (NCS), SSI appears to be three times less likely than in colorectal surgery. While some risk factors are shared between the two types of surgeries, some of them are bound to surgery type. In general, it has been reported that DM type 1 and type 2 are related to SSI in NCS. Moreover, male gender, ASA score, operation time and emergency surgery are also linked to increased SSI risk[26]. Another study by Pessaux et al.[11] reported that cirrhosis, vertical abdominal incisions, underweight patients, and patients with previous bowel surgery or anastomosis in the digestive tract had higher risk of developing SSI in NCS. Moreover, multivariate analysis showed that receiving anticoagulant therapy, undergoing surgical management for cancer treatment, presence of abdominal drainage and preoperative presence of cutaneous infections significantly increased the risk of SSI.

On the other hand, pneumonia is another important infectious complication of abdominal surgery. Observational studies have reported prevalence rates ranging between 3-28% depending on various factors, mainly the type of surgery. Lowest pneumonia rates are reported in gastric surgeries at 2-4%[26,27]; followed by hepatic surgery, at 10-15%[28,29]. Esophagectomy and esophageal resection had the highest incidence at almost 30%[30]. Concerning risk factors, few studies differentiate between NCS and colorectal surgery.

Nobili et al.[29] reported intraoperative blood transfusion (OR 1.9, 95% CI; 1.3-4.5; P=0.05) and DM (OR 2.2, 95% CI; 1.1-4.5; P=0.01) as important risk factors for postoperative pneumonia (POP). Likewise, Pessaux et al.[28] reported similar findings, adding the use of a nasogastric tube during the operation (OR 1.8, 95% CI; 1.1-2.9; P=0.01). Another study found that patients aged over 70 and with history of smoking had greater risk of developing POP[31]. Sakamoto et al.[32] further researched the impact of smoking in the appearance of this complication. Results showed that patients with a Brinkman index over 400 had increased risk of POP (OR 4.29; 95% CI; 1.44-12.8; P< 0.01). Furthermore, presence of bacteria in sputum 1 day after the surgery was heavily associated with postoperative pneumonia (OR 9.43, 95% CI; 2.11-42.0; p< 0.01)[32].

Along these lines, Kim et al.[33] reported that chronic obstructive pulmonary disease (COPD) increased the risk of POP (OR 3.1, 95% CI; 1.01-9.79; P= 0.049), but only in its severe forms, findings for mild and moderate COPD were nonsignificant. Similarly, Xiang et al.[34] also reported COPD as a risk factor for POP. However, it was also demonstrated that postoperative reduced albumin levels, longer bed rest and prolonged ventilation were also significant risk factors for POP. Chen et al.[35] demonstrated that upper abdominal surgery had greater risk of developing POP than lower abdominal surgeries. In congruence with the above, Yang et al.[36] found that esophageal procedures had the highest risk of pulmonary complications along with ASA score, suggesting that the higher the location of the surgery, the higher the odds of complications.

Nearly 5% of all patients undergoing colorectal surgery tend to develop UTI, significantly compromising postoperative morbidity and costs[37]. According to Regenbogen et al.[38] the incidence of UTI is greater after colorectal surgery than other types of surgery, like gastrointestinal surgery or NCS. Likewise, it was reported that patients over 75 years, females, and those with high ASA score had the highest risk of developing UTI after surgery. Likewise, Kang et al.[39] performed a retrospective analysis using the Nationwide Inpatient Sample 2006-2009 to determine risk factors for postoperative UTI. Multivariate logistic regression analysis showed that DM, chronic kidney disease and underweight patients had higher risk of developing postoperative UTI. Finally, Qin et al.[40] reported that longer procedure duration was significantly more associated with postoperative UTI than shorter procedure duration, which was reported as a protective factor.

Conclusions

Infections are relevant complications of surgical procedures, significantly increasing morbidity, mortality, length of stay, and financial costs. Although preventive measures, like asepsis/antisepsis protocols and antibiotic prophylaxis have been taken to reduce the incidence of these complications, they remain a significant public health problem. Proper risk management and additional preventive measures have shown to decrease the overall burden of infectious complications. Risk factors vary according to the type of complication and surgery location, making the formulation of predictive models rather difficult. Age, sex, chronic conditions, habits, and antibiotic selection are some of the preoperative risk and protective factors to consider. On the other hand, surgery duration, type of suture, need for transfusions, and closure suture techniques fall within the intraoperative risk factors. While enough evidence is available regarding a wide variety of factors, there is a lack of predictive models or consensus concerning them. Further research is needed to establish appropriate tools to decrease the incidence of postoperative infectious complications.

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