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The risk of surgical site infection is reduced with perioperative oxygen

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Selected Article


Abstract

Objective: Does supplemental perioperative oxygen reduce the risk of surgical wound infection after colorectal surgery? Design: Randomized controlled trial. Setting: Multicentre trial that included 14 hospitals in Spain. Patients: 300 patients aged 18–80 years who underwent elective colorectal resection. Patients who had surgery performed laparoscopically or who had minor colon surgery were excluded. Intervention: Patients were randomly allocated to either 30% or 80% fraction of inspired oxygen (FiO2) intraoperatively and for 6 hours postoperatively. Anesthetic treatment and antibiotic administration were standardized. Main Outcome Measure: Surgical site infection (SSI) as defined by the Center for Disease Control. Results: SSI occurred in 35 of 143 patients (24.4%) who were administered 30% FiO2 and in 22 of 148 patients (14.9%) who were administered 80% FiO2 ($p = 0.04$). The risk of SSI was 39% lower in the 80% group (relative risk [RR], 0.61; 95% confidence interval [CI], 0.38–0.98) versus the 30% FiO2 group. Conclusions: Patients receiving supplemental oxygen have a significant reduction in risk of surgical site infection.

Commentary

Surgical site infections, although usually thought of as relatively minor complications, do increase the risk of patient mortality. In addition, they significantly increase hospital length of stay and healthcare costs. Because they are relatively commonplace, they have become a focus for international quality improvement activities. This study evaluated whether a simple intervention, the use of supplemental perioperative oxygen, could decrease the risk of surgical site infection in patients undergoing colorectal surgery.

The hypothesis is that oxidative killing by neutrophils is dependent on tissue oxygen partial pressure, which is increased by supplemental oxygen. Local and systemic warming, which also decreases surgical site infection, increases tissue oxygen tension. One randomized, controlled trial administering 80% oxygen during the operation and for 2 hours postoperatively showed a 50% decrease in wound infection rate, while a second trial had contradictory results, showing the risk of infection more than doubled with perioperative supplemental oxygen.

This was a multicentre trial; randomization was stratified by study centre and was performed with computer-generated codes maintained in opaque envelopes, opened after the induction of anesthesia. Three hundred patients were enrolled, with 150 in each arm. Four patients were enrolled in error, having met exclusion criteria (2 had low preoperative albumin and 2 underwent laparoscopic operations); 5 were withdrawn due to incomplete data. Patients, surgeons and investigators were blinded to treatment. Care was taken to ensure that the surgical team was blinded; measures included cardboard covers on the digital readout of the anesthesia machine and placing the anesthetic and postoperative records in a sealed envelope after patients’ 6-hour stay in the postoperative care area. These records were not available to the treating surgical team. Care was standardized, particularly those aspects known or suggested to affect wound infection: administration of mechanical bowel preparation, use of intravenous antibiotics, amount of fluid administered and degree of pain control. Antibiotics active against colonic and skin flora were standardized and were given 60–90 minutes before incision. Fluid was given on a weight-based regimen. The anesthesiologist responsible for intraoperative care and for care during the first 6 postoperative hours was not blind to treatment.

The groups were similar in all respects, except for the lower number of women in the experimental group (48% v. 64%). Because male sex has been associated with an increased risk of infection, the sex difference in the groups may be a potential conservative bias, increasing confidence in the intervention.

Patients were excluded if they had diabetes mellitus and were taking either oral hypoglycemics or insulin. They were also excluded if they were malnourished, with a serum albumin < 30 g/L or had weight loss > 20% in 6 months, had HIV, or had a leukocyte count < 2500 cells/mL. Laparoscopic cases were excluded, as were minor cases expected to last < 1 hour. Most of the patients did not smoke and were relatively healthy as evidenced by an American Society of Anesthesiologist (ASA) class II; the underlying diagnosis was cancer in just over 85%. Most of the patients underwent sigmoid colectomy or right or left hemicolectomy.

The primary outcome was surgical site infection, as defined by the Center for Disease Control. This definition includes all infections within 30 days of an operation; the definition of infection is met by pain or tenderness, redness or heat accompanied by opening of the wound by the surgeon, purulent drainage, positive culture or wound infection otherwise diagnosed by the surgeon. Surgical site infection was also defined by the ASEPSSIS score (additional treatment, scrotal discharge, erythema, purulent exudates, separation of deep tissues, isolation of bacteria and duration of hospital stay). Wounds were observed for 14 days, which will underreport surgical site infections by 15%–25%. Secondary outcomes included time to bowel function, first
solid food intake, walking, date of staple removal and readmission rate.

All cases were standard colorectal operations performed by general surgeons. The baseline surgical site infection rate, on which the study was powered, was estimated to be 25%. Although the authors quote that an acceptable surgical site infection rate for colorectal surgery is up to 36% in high-risk patients, they excluded many of these high-risk patients (those who were malnourished or who had diabetes) from the study. Based on data from the National Nosocomial Infections Surveillance System, the expected surgical site infection rate is 4%–12% in an appropriately prepped colon operation (clean contaminated case). The upper 90% confidence limit for wound infection after colorectal surgery in the highest risk group reported in the NNIS data is 23%. The infection rates found in the previous trial supporting the use of perioperative oxygen in colorectal surgery were 5% and 11%.6

In this study, treatment with FiO2 at 80% reduced surgical site infection from 24.4% to 14.9%; the relative risk of infection for the experimental group was 0.61. The 95% confidence interval (CI) was wide (0.38–0.98), so the estimate of effect was relatively imprecise. Owing to incomplete follow-up data in 5 patients, the relative risk was recalculated, assuming none of these patients developed a wound infection. Four of these patients were in the control group and 1 was in the experimental group. This resulted in a relative risk of infection for experimental treatment of 0.62. The 95% CI using this assumption included 1, so the difference would not be statistically significant with this assumption. Assuming all 5 of these patients developed a surgical site infection, the relative risk of infection for experimental treatment would be 0.58, with a CI of 0.37–0.92.

The evidence supports the use of intraoperative supplemental oxygen continued for 6 hours postoperatively. The conclusions are limited to a relatively healthy population undergoing colorectal surgery for cancer. There have been 2 other trials. One trial was positive (SSI rates of 11.2% in the 30% FiO2 group v. 5.2% in the 80% FiO2 group).6 The second showed that the 80% FiO2 group actually did worse (25% v. 11% SSI rates respectively).7 A heterogeneous patient population, lack of standardization of antibiotic administration and retrospective determination of surgical site infection in the latter trial might have confounded the results.

Appropriate prophylactic antibiotics given at the right time, avoiding shaving, maintaining normothermia and maintaining normoglycemia, are all part of decreasing the risk of surgical site infections. The evidence supporting these interventions is stronger than the body of evidence supporting the use of supplemental oxygen. In general, widespread adoption of clinical practice change requires a preponderance of evidence. However, there is little cost and no risk to the administration of perioperative supplemental oxygen. Given that the intervention makes sense from a biological and scientific perspective, being easy to perform and relatively noninvasive, practical, and with an excellent risk:benefit profile, incorporating it into current quality improvement activities aimed at reducing surgical site infection should be relatively straightforward.

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References


