

# Canadian Association of General Surgeons and American College of Surgeons Evidence Based Reviews in Surgery. 21.

## The risk of surgical site infection is reduced with perioperative oxygen

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### CAGS Evidence Based Reviews in Surgery

The term “evidence-based medicine” was first coined by Sackett and colleagues as “the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients.”<sup>1</sup> The key to practising evidence-based medicine is applying the best current knowledge to decisions in individual patients. Medical knowledge is continually and rapidly expanding, and it is impossible for an individual clinician to read all the medical literature. For clinicians to practise evidence-based medicine, they must have the skills to read and interpret the medical literature, so that they can determine the validity, reliability, credibility and utility of individual articles. These skills are known as critical appraisal skills. Generally, critical appraisal requires that clinicians have some knowledge of biostatistics, clinical epidemiology, decision analysis and economics, as well as clinical knowledge.

The Canadian Association of General Surgeons and the American College of Surgeons jointly sponsor a program entitled “Evidence Based Reviews in Surgery (EBRS),” which is supported by an educational grant from ETHICON and ETHICON ENDO SURGERY, both units of Johnson & Johnson Medical Products, a division of Johnson & Johnson, and ETHICON INC. and ETHICON ENDO-SURGERY, INC. divisions of Johnson & Johnson Inc. The primary objective of this initiative is to help practising surgeons improve their critical appraisal skills. During the academic year, 8 clinical articles are chosen for review and discussion. They are selected not only for their clinical relevance to general surgeons but also because they cover a spectrum of issues important to surgeons; for example, causation or risk factors for disease, natural history or prognosis of disease, how to quantify disease (measurement issues), diagnostic tests and the early diagnosis of disease and the effectiveness of treatment. A methodological article is supplied that guides the reader in critical appraisal of the clinical article. Both methodological and clinical reviews of the article are performed by experts in the relevant areas and posted on the EBRS Web site. As well, a listserv discussion is held where participants can discuss the monthly article. Members of the Canadian Association of General Surgeons and the American College of Surgeons can access Evidence Based Reviews in Surgery through the Canadian Association of General Surgeons Web site ([www.cags-accg.ca](http://www.cags-accg.ca)) or the American College of Surgeons Web site ([www.facs.org](http://www.facs.org)). All journal articles and reviews are available electronically through the EBRS Web site. We also have a library of past articles and reviews that can be accessed at any time. Surgeons who participate in the monthly packages can obtain Royal College of Physicians and Surgeons of Canada Maintenance of Certification credits and/or continuing medical education credits for the current article only by reading the monthly articles, participating in the listserv discussion, completing the monthly online evaluation and answering the online multiple choice questionnaire. For further information about EBRS, the reader is directed to the CAGS or ACS Web site or should email the administrator, Marg McKenzie, at [mmckenzie@mtsinai.on.ca](mailto:mmckenzie@mtsinai.on.ca).

In addition to making the reviews available through the CAGS and ACS Web sites, 4 of the reviews are published in condensed versions in the *Canadian Journal of Surgery* and 4 in the *Journal of the American College of Surgeons* each year. We hope readers will find EBRS useful in improving their critical appraisal skills and also in keeping abreast of new developments in general surgery. Comments regarding EBRS may also be directed to [mmckenzie@mtsinai.on.ca](mailto:mmckenzie@mtsinai.on.ca).

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## Selected Article

Belda FJ, Aguilera L, García de la Asunción J, et al. Supplemental perioperative oxygen and the risk of surgical wound infection. A randomized controlled trial. *JAMA* 2005;294(16):2035-42.

## 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 (FiO<sub>2</sub>) 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% FiO<sub>2</sub> and in 22 of 148 patients (14.9%) who were administered 80% FiO<sub>2</sub> ( $p = 0.04$ ). 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% FiO<sub>2</sub> 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.<sup>1</sup> In addition, they significantly increase hospital length of stay and healthcare costs.<sup>2</sup> 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.<sup>3</sup>

The hypothesis is that oxidative killing by neutrophils is dependent on tissue oxygen partial pressure, which is increased by supplemental oxygen.<sup>4</sup> Local and systemic warming, which also decreases surgical site infection, increases tissue oxygen tension.<sup>5</sup> One randomized, controlled trial administering 80% oxygen during the operation and for 2 hours postoperatively showed a 50% decrease in wound infection rate,<sup>6</sup> while a second trial had contradictory results, showing the risk of infection more than doubled with perioperative supplemental oxygen.<sup>7</sup>

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 ASEPIS score (additional treatment, serous 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%.<sup>6</sup>

In this study, treatment with FiO<sub>2</sub> 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% FiO<sub>2</sub> group v. 5.2% in the 80% FiO<sub>2</sub> group).<sup>6</sup> The second showed that the 80% FiO<sub>2</sub> group actually did worse (25% v. 11% SSI rates respectively).<sup>7</sup> 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.

**Competing interests:** None declared.

## References

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