In this issue of the Journal, Itani and colleagues\(^1\) describe a study in which 1002 patients were randomly assigned to receive either ertapenem or cefotetan in a single dose before elective colorectal surgery. Many experienced surgeons and hospital epidemiologists will probably be surprised that the overall rate of failure in the modified intention-to-treat analysis was approximately 40% for patients receiving ertapenem and 50% for those receiving cefotetan. A possible explanation for these high failure rates is that the authors of the study, unlike those of most previous trials, included unexplained use of postoperative antibiotics and anastomotic leaks in their definition of prophylaxis failure. However, this fact does not explain why nearly one in six patients receiving ertapenem and approximately one in four patients receiving cefotetan had a surgical-site infection. These rates are substantially higher than those reported by the National Nosocomial Infections Surveillance System and our infection-control network of 36 community hospitals.\(^2\) Although the authors cite previous reports with similarly high rates of surgical-site infection with cefotetan, most studies examining outcomes of colorectal surgery have reported lower rates of infection.\(^3\)

The high rates of surgical-site infection reported by Itani et al. may relate to a combination of factors. For example, more than a quarter of the patients were obese, and as in other studies,\(^4,5\) obesity was identified as an independent risk factor for surgical-site infection. Failure of antibiotic therapy in many obese patients may be related both to technical factors, such as inadequate obliteration of nonvascularized “dead space” during wound closure, and to inadequate administration of antibiotics and subsequent low drug levels in serum and tissue at the end of long procedures.\(^6\) Other surgery-related factors that could have contributed to the high rates of postoperative infection were inappropriate (or inappropriately early) removal of hair, technical errors (such as bowel perforation or spillage of fecal material), the failure to maintain normothermia, and uncontrolled hyperglycemia during the perioperative period. The Surgical Infection Prevention and Surgical Care Improvement Projects have emphasized the need for careful management of these factors in preventing infections after colorectal surgery.\(^7\) Thus, it is important to remember that the selection of an antimicrobial agent as prophylaxis is only one of many considerations in reducing rates of postoperative infection.

Even though the authors demonstrated that ertapenem was superior to cefotetan in this trial, is it reasonable to conclude that ertapenem should be a preferred agent for prophylaxis before colorectal surgery? Only one third of Medicare patients undergoing colorectal surgery currently receive cefotetan as prophylaxis,\(^7\) and there are numerous
other antibiotic regimens with a long track record of safety and efficacy. Although Itani et al. found that failure rates with cefotetan were high, previously published trials involving other commonly used prophylactic antibiotics showed much lower failure rates. Unfortunately, we do not have data that directly compare ertapenem with other agents, so caution should be exercised in extrapolating relative efficacy of antimicrobial prophylaxis in colorectal surgery by comparing the outcome of this study with studies of other agents or combinations of agents.

Another important question this trial raises is whether the routine use of carbapenem-resistant pathogens, as well as the local or general community, to the emergence of resistant organisms. It is probably true that a single dose of any antimicrobial agent is less likely to produce resistant microorganisms than is repeated administration. However, the cumulative effect of tens of thousands of individual doses of carbapenems for prophylaxis could result in local or widespread emergence of carbapenem resistance. If, as is often the case, individual surgeons prolong the duration of antimicrobial prophylaxis into the postoperative period, resistance is even more likely to emerge.

Although some investigators have shown that bowel colonization with carbapenem-resistant gram-negative bacilli rarely appears after treatment with ertapenem, these results are contrary to common experience and common sense. Widespread use of almost any antimicrobial agent will be followed, sooner or later, by the emergence of antimicrobial resistance to that agent. This emergence of resistant organisms is rarely detected in short-term studies.

If the emergence of resistance is inevitable with the widespread use of any antibiotic, why is the emergence of resistance to carbapenems more important than resistance to other agents? The most compelling answer to this question is that carbapenems are currently the last and best available agent to treat serious infections with aerobic gram-negative organisms that produce extended-spectrum beta-lactamase or contain genetic material that otherwise renders these bacteria resistant to cephalosporins, fluoroquinolones, or other widely used antimicrobial agents.

Two thirds of the gram-negative pathogens isolated from patients receiving cefotetan in the study by Itani et al. were resistant to this agent. This finding and the high failure rates seen in patients receiving cefotetan as prophylaxis could have been a direct consequence of years of repeated use of this drug as surgical prophylaxis. If this is true, how long will it take for carbapenem-resistant pathogens to appear routinely in clinical practice? And when and if this occurs, what therapy will be available when a serious infection develops? Itani et al. have not addressed the questions of whether ertapenem is better than currently used agents other than cefotetan and whether it is safe for the local, regional, or national community of patients who could be at risk for serious infection that is silently linked by the unapparent spread of carbapenem-resistant microorganisms that mutated and amplified in the gut of patients who received ertapenem as prophylaxis for bowel surgery.

Traditionally, the choice of any antimicrobial agent for use as prophylaxis or treatment hinged on two key questions: Is the drug safe, and is it effective? Perhaps the concept of safety should include the risk of promotion of antimicrobial resistance that can harm the individual patient, as well as others in the community. Further data on the safety and efficacy of other widely used agents in colorectal surgery (derived from the strict criteria used by Itani et al.) would allow us to answer three important unanswered questions. Does the benefit of ertapenem as prophylaxis for colorectal surgery outweigh the risk of further promoting carbapenem resistance in the community? Is ertapenem as good as or better than commonly used regimens other than cefotetan? Finally, will the use of ertapenem as surgical prophylaxis aggravate an already worrisome and serious trend of infection caused by carbapenem-resistant organisms?

Dr. Sexton reports receiving research grants from Pfizer and Arrow International and consulting fees from Pfizer and Johnson & Johnson. No other potential conflict of interest relevant to this article was reported.

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Medical education is undergoing a paradigm shift, from the traditional experience-based model to a program that requires documentation of proficiency. \(^1\) Technological advances in health care, the development of day-case surgery, and the setting of quality-assurance targets have led to a striking reduction in training opportunities for young doctors. It is no longer acceptable, or appropriate, for students at any level of training to practice new skills on patients, even if they have a patient’s explicit consent.

As Reznick and MacRae point out in this issue of the Journal, these “changes in the wind” are beginning to transform surgical residency programs. \(^2\) A primary aim is for trainees to practice skills in a safe environment, before refining them in the real world. At present, simulation-based training is a prerequisite for all high-reliability organizations (e.g., in the airline, nuclear, and oil industries) yet remains a niche player in medical education. \(^3\) The often-quoted criticism is that surgical simulators lack “fidelity,” or are not truly lifelike, though the real problem has more to do with a lack of motivation or understanding on the part of educational leaders than with the eventual outcomes, which for the most part have been remarkably good. \(^4-6\)

This success notwithstanding, there remains a chasm between proficiency in technical skills and the translation of those skills into expert performance in a complex clinical environment. It may be unrealistic to expect even technically proficient trainees to move directly into a dynamic space such as the operating room and exercise appropriate judgment, especially during crisis situations such as those involving major-vessel bleeding. To some extent, judgment — which relies on both cognitive and professional skills — can be modeled in an environment such as a simulated operating room, enabling trainees for the first time to receive feedback about both their technical and their nontechnical performance. \(^7\) Though difficult to assess objectively, this type of training can translate into improved performance in the clinical setting. \(^8\)

With the development of proficiency-based training and practice comes the need to set benchmarks of achievement in skills and behaviors during prespecified tasks. \(^9\) Such criteria can be used not only to confirm the completion of a particular training module with the attainment of an appropriate level of technical proficiency, but also to reconfirm the soundness of the skills that have been acquired. We believe that in the future, expertise rather than experience will underlie competency-based practice and specialty certification. Validation and revalidation of expertise necessitate the use of tools that have high validity and reliability for assessing performance, many of which are described by Reznick and MacRae.

At present, these tools assess only technical skill, though recent advances in eye-tracking technology may enable us to elucidate the cognitive processes behind surgical tasks. For example, an analysis of eye movements during laparoscopic surgery can provide, on a two-dimensional screen, information regarding depth perception. This technology has already been used to assess skill in reading radiologic images, enabling research-