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CASE AND COMMENTARY: PEER-REVIEWED ARTICLE

Should Organizational Investment in Robotic Surgical Technology Ever Influence Surgeons' Decisions About Surgical Approach to Patients' Surgical Care?

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Abstract
This commentary on a case considers balancing prospective benefits and harms of robotic technology use and argues that health care organizations should invest in centralizing robotic expertise in departments rather than having a mere collection of surgeons trained in robotics. This commentary also examines costs that should be considered in organizational determinations of robotics investments.

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Case

Dr M is a surgeon drawn to work in University Hospital, given the organization's reputation for leadership and investment in robot-assisted surgical technology. During her job interviews, Dr M is asked how many robotic-assisted procedures she has performed, and University Hospital's marketing director invites Dr M to discuss strategies for showcasing her robotic skills on the organization's website and in advertising campaigns. During negotiations in her hiring process, Dr M is offered dedicated block time in University Hospital's operating room (OR), where she could board 2 full days of surgery with access to the robot. Dr M is enthusiastic about this prospect, but she is also concerned that being hired as a minimally invasive surgeon—and, more specifically, as a robotic surgeon—could, over time, limit the scope of her professional decision making about how to approach surgical care of her patients, especially those for whom open or laparoscopic surgical techniques might be indicated.

Dr M wonders how to broach this set of concerns without appearing to extinguish University Hospital's interest in her enthusiasm for robotic surgical innovation. Dr M also wonders how to address conflicts of interest that could emerge, especially in striving to balance University Hospital's investment interests with appropriate exercise of her overall surgical autonomy and growing robotic surgical technique skill set. Dr M feels strongly that the professional autonomy she exercises when making decisions about her patients' surgical care should remain uncompromised by organizational pressure to maximize profit generated from robotics use in the OR. Dr M considers how to proceed in her negotiations.

Commentary

Robotic surgery is a relatively new and evolving technology with several promising features, including improved visualization and surgeon ergonomics and the ability to perform procedures that laparoscopy cannot achieve. It is rapidly being introduced in many fields, including general surgery, colorectal surgery, thoracic surgery, gynecology, urology, and even select cardiac and head and neck procedures.[1] While much of the growth is driven by the pursuit of decreased pain, improved cosmesis, and better surgical outcomes, the robot is not exempt from ethical issues arising from any new medical technology. Due to the high costs of the robot, minimally invasive surgeons who persuade administrators to invest in robotic technology—or those who are hired specifically for their robotic expertise—may feel extrinsic pressure to utilize the robot to justify the investment or their dedicated robotic block time. Examining the fixed and variable costs of robotic technology and surgical reimbursement, along with the relevance of the economic concepts of scarcity and opportunity cost, suggests that surgeons should continue to recommend the technique they expect to yield the best result, regardless of perceived pressures to use the robot. Robotic surgery also presents challenges when obtaining informed consent for surgery, including framing effects, incompletely defined risk-benefit profiles, and lack of a consensual training and credentialing process. Surgeons need to be honest and forthcoming with patients to overcome these challenges and to obtain proper consent and maintain ethical integrity.

Investment in and Reimbursement of Robotic Surgery

Newly hired minimally invasive surgeons may feel pressure (consciously or subconsciously) to utilize the robot in an attempt to maximize organizational return on technological investment and justify their hiring. In actuality, the relationship between robotic utilization and profitability is not straightforward. Economically, it is important to examine both fixed and variable costs of robotic surgery. The fixed costs include the purchase price (up to 2.5 million USD) and annual service contract and maintenance costs (150 000-200 000 USD),[2,3,4] which health care organizations absorb regardless of robot utilization. The decision to purchase robotic technology commits the organization to this fixed cost. Variable costs—primarily the cost of robotic instruments, which are often limited to a predetermined number of uses before they must be replaced—will (by definition) vary. In a simplistic microeconomic model, if an organization's variable costs exceed its profit, it behooves the organization to shut down. While shutting down seems counterintuitive, the organization's fixed costs must be paid regardless of profit, so it becomes "cheaper" to shut down and stop the loss incurred by the excess variable costs. Multiple studies[5,6,7,8] have shown that the magnitude of variable costs are routinely higher for robotic than laparoscopic procedures across multiple specialties.[9,10,11,12] The higher costs are primarily related to instruments and accessories but can also be attributed to longer operative times.[13] While a supplemental *Current Procedural Terminology* (*CPT*®) code exists for surgical techniques requiring the use of robotic systems (*CPT* code S2900), these techniques are considered part of the primary procedure and their cost is not reimbursed by Medicare[14] or many private insurers.[15,16] Therefore, it is possible that robot use for an operation that could be safely performed by another method could increase organizational costs without a corresponding increase in reimbursement. With this possibility in mind, young surgeons should follow the ethical principle of beneficence when considering their surgical approach, setting aside organizational financial considerations.

Minimally invasive surgeons may also feel extrinsic pressure to utilize the robot to validate their dedicated block time, which raises issues of scarcity and opportunity cost. Scarcity—the idea that there are finite resources to supply theoretically unlimited demand—requires making resource allocation decisions. As mentioned previously, the costs associated with purchasing and maintaining a surgical robot are significant. Therefore, many hospital systems only possess one or two robotic systems, and, with increasing numbers of surgeons utilizing the robot, availability is limited. In a retrospective review of robotic surgeries conducted at the University of California, San Diego, organizational robotic case volume nearly quadrupled from 2006 to 2016 (from 120 to 586 cases), while the number of unique surgeons utilizing robotic technology more than doubled (from 12 to 28) over the same period.[17] A similar trend was seen in general surgery from 2012 to 2018 in the state of Michigan, which saw an increase from 1.8% to 15.1% in general surgery procedures being performed on the robot and a corresponding increase from 8.7% to 35.1% of general surgeons utilizing the robot.[18] Opportunity cost—the value of the next-best alternative foregone when making a decision—can be important to consider when one is attempting to maximize allocation of a scarce resource. Anytime a robotic procedure is performed, particularly one that could be performed laparoscopically with similar results, the opportunity cost is equivalent to the value of the same surgery performed laparoscopically *plus* the value of another procedure that could only have been performed on the robotic platform in its stead. Until robotic systems become ubiquitous, minimally invasive surgeons should avoid boarding robotic cases that can be performed with equivalent outcomes using other techniques simply to fill their block time. Performing unnecessary robotic surgeries can worsen the robot scarcity problem and limit opportunities for other surgeons to use the robot. Additionally, while an association has been found between hospital profitability and robotic ownership, both the diversity of procedures performed and total surgery volume were important contributors to profitability.[19] To maximize return on robotic investment, hospital organizations should regard the goal of their investment as developing a robust robotic surgery department rather than collecting robotic technology and individual surgeons. As robotic surgery becomes more popular and as more robotic surgeons are hired, it will become more important for surgical departments to maximize the robot's utility and "spread the wealth" among multiple surgeons and surgical specialties.

Challenges of Informed Consent in Robotic Surgery

When considering an operative approach, the surgeon is legally and ethically bound to obtain informed consent from the patient. This process involves a clear and accurate discussion of the patient's disease process and natural course, the proposed operation and its associated risks and benefits, and alternative operative approaches and their risks and benefits. Informed consent should be a collaborative effort, with the surgeon listening carefully to the patient and considering their values and opinions. Robotic surgery, however, presents several challenges to the informed consent process.

Framing effect. The framing effect is a form of cognitive bias, wherein decision making is influenced by the manner of presentation (positive vs negative).[20] Experiments have shown that people are more willing to engage in risky behaviors when presented with positive frames and are more risk averse when presented with negative frames (ie, glass half full vs half empty).[21] Specifically applied to robotic surgery, patients are more likely to elect to undergo a robotic procedure when it is described as "innovative" or "state-of-the-art" than when uncertainty about the evidence of its effectiveness is disclosed.[22] However, the magnitude of the framing effect can be reduced (if not eliminated entirely) by providing clear, credible, and unbiased information. As outlined in the American

College of Surgeons Statements on Principles,[23] the information presented in the informed consent process "must be presented fairly, clearly, accurately, and compassionately.... The surgeon should not exaggerate the potential benefits of the proposed operation nor make promises or guarantees." This statement highlights the importance of having an honest, unbiased preoperative conversation about the perceived vs measurable benefits of performing the operation robotically or via other methods to allow the patient to make the best decision about their care.

Unknown benefits and risks. As robotic technology is relatively new, there are few studies on its long-term risk profile. While the robot has several *potential* advantages over laparoscopic surgery, including a 3-dimensional field of view, increased wrist motion and dexterity, elimination of tremors, and improved surgeon ergonomics, these advantages have not been shown to improve clinical outcomes. As a historical parable, laparoscopic cholecystectomies were first introduced with the promise of decreased postoperative pain and decreased hospital length of stay and were rapidly incorporated into general surgery practices without the proposed benefits having been proven.[24] Moreover, the procedure was not first proven safe, and later studies revealed higher rates of bile duct injury.[25,26,27] Although laparoscopic cholecystectomy has become the standard of care, patients who consented to laparoscopic cholecystectomies in their infancy were unaware of the true risk-benefit profile. Modern comparisons of laparoscopic vs robotic cholecystectomy have shown that robotic surgery reduces hospital length of stay without a subsequent increase in bile duct injury or postoperative bile leak rates.[28,29,30] However, in one study, robotic cholecystectomies were performed in patients with symptomatic cholelithiasis and chronic cholecystitis but not in patients with acute cholecystitis,[30] which could skew these beneficial results. Similar results have been demonstrated for inguinal hernias,[31,32] hysterectomies,[12,33] and radical nephrectomies,[34] suggesting that robotic surgery is safe, but few definite benefits of robotic over laparoscopic operations have been shown. When consenting for a robotic surgical approach, the surgeon is ethically bound to fairly present the known risks and benefits as well as the uncertainties, thereby empowering the patient to make an informed decision.

Variable training and time to mastery. Further complicating the informed consent process is the variability of the credentialing process and the learning curve for performing robotic surgery. While there is no consensus, most surgeons are required to complete an online course on the basic use of the robot, followed by an in-person training course (both offered by the robot company directly), and then to complete a number of proctored cases before gaining robotic credentials. While the current credentialing process is designed to ensure that surgeons are practicing safely, it does not necessarily ensure the best patient outcomes. In fact, it has been demonstrated that while it only takes execution of 5 to 20 cases to build basic proficiency on the robot,[35,36,37,38,39] it can require at least 150 robotic laparoscopic prostatectomies to achieve oncologic outcomes comparable to those achieved with radical retropubic prostatectomy[40]—suggesting that the true learning curve is substantially longer than the credentialing process. Furthermore, robotic credentials are not granted on an operation-by-operation basis; surgeons are generally proctored on relatively simple procedures but then are credentialed for all robotic surgeries in their field. This credentialing process suggests that there may be discordance between the complexity of proctored cases and subsequent cases performed. Without a consensual credentialing process or defined learning curve,[41] calling oneself a "robotic surgeon" can confuse patients and complicate decision making. The loss-of-chance doctrine[42]—a legal concept traditionally utilized in contract law—has recently been applied to cases of medical malpractice. While traditional medical malpractice requires physician negligence resulting in patient injury,[43] loss-of-chance allows consideration of the lost chance of a better outcome.[44] Applied directly to surgery, patients have a right to undergo the surgical procedure by the technique and surgeon that offer optimal results. While there may not be a deviation from the standard of care, the patient is "harmed" by a relatively poorer outcome than they might have received otherwise. Therefore, surgeons should disclose their experience, skill, and comfort level with the proposed and alternative surgical approaches, thereby enabling the patient to make the best choice about care and have the best chance for a positive outcome.

Conclusion

It is imperative that surgeons avoid external pressures that may affect patient care. The American Board of Internal Medicine has defined several principles of medical professionalism, among them the primacy of patient welfare and patient autonomy.[45] Primacy of patient welfare ensures that the patient's best interests are at the forefront of the surgical plan, while autonomy ensures that the patient is allowed to make informed decisions about their care. To maximize patient autonomy, surgeons must explain the proposed operative approach in detail, including the risks and benefits and alternative options. By eliminating framing bias and disclosing their experience with the proposed technique, surgeons allow the patient to make a truly educated care decision. Moreover, while all physicians are subject to conflicts of interest, the American College of Surgeons Code of Professional Conduct requires all conflicts that might influence patient care decisions to be disclosed and resolved.[23] If all else fails, the surgeon should focus on operating *for* their patients rather than *on* their patients, and the goal should not be to "convince" the patient to agree to their plan.[46] Following this simple principle will likely alleviate any significant conflicts of interest. While minimally invasive surgeons may feel economic pressure to utilize the robot, they should remember that profitability is not directly related to robotic utilization and only perform robotic operations they feel are in the best interest of the patient in order to allow equitable access to the robot for other surgeons.

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Editor's Note
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