# Chapter 4
# Ethics in Surgical Research

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## Introduction

The ethical practice of both medicine and research remains a cornerstone of the physician's duty. The physician-patient relationship is dependent upon sound ethics and good judgment. This is especially true when patients invest in clinical or translational research efforts to further medical knowledge. Ethical decision-making is particularly relevant in surgical research, where goals are extended beyond the development of novel drug therapies to include the evaluation of new technologies and techniques. Further, as surgeons take the lead in quality improvement initiatives, the ethical principles of the research environment must be taken into account as health systems and processes are changed. As a surgeon, these additional research aims require a nuanced understanding of ethical principles beyond those required of our non-surgical colleagues. Ethical concerns around clinical research include informed consent, respect for autonomy, an acceptable risk-benefit ratio, and ensuring that the research is scientifically rigorous enough to justify human subject involvement. Investigators involved in basic science research frequently find themselves confronted with issues of honesty and objectivity, multiple conflicts of interest, as well as controversy regarding authorship and publication of data. Investigators involved in quality improvement initiatives often strive to understand the risk conveyed to patients, identify and define rigorous outcome measures for study, and determine the level of ethical oversight and review board involvement required for the work. Learning to identify and handle ethical issues in research is an important skill for academic surgeons. Ethical conduct of

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surgical research is not only part of each surgeon's professional identify, but also defines us as leaders among peers. Although an exhaustive review of the ethical issues involved in surgical research is beyond the scope of this chapter, we herein highlight the main ethical issues that arise in the setting of surgical research.

## The Dual Loyalties of the Surgeon-Scientist

Research is an important aspect of the surgeon-scientist identity. As clinicians we have a duty to place the needs of our patients above all else. As investigators, we have a duty to future patients who may benefit from our research. The goals of research can sometimes conflict with our fiduciary duty to the individual patient in front of us. Furthermore, personal gain from research discoveries (even just the extreme satisfaction of benefiting a large number of future patients or advancing science, not-withstanding academic advancement) can bias our personal assessment about what is right.

In effect, the surgeon-scientist can find him/herself in the role of double-agent: surgeon versus scientist. This problem is exemplified by the story of William Beaumont [1]. A young military surgeon, Dr. Beaumont acutely treated and saved the life of the French-Canadian fur trapper, Alexis St. Martin in 1822. St. Martin was injured when his shotgun accidentally discharged at close range leaving him with a gaping hole in his abdomen. Due in large part to Dr. Beaumont's surgical care, St. Martin survived the incident, but was left with a persistent gastro-cutaneous fistula. Over the next 20 years, Beaumont and St. Martin shared a unique relationship dominated by Beaumont's dual loyalties. While Beaumont continued to care for his "patient," he also performed multiple studies to define the physiology of the stomach using St. Martin as his research subject. In turn, Beaumont advanced critical knowledge about the functioning of the stomach and benefitted professionally from this relationship as he went on to help define the theory of how humans digest their meals in his landmark publication, "*Experiments and Observations of the Gastric Juice and the Physiology of Digestion*". Unfortunately, the relationship between Beaumont and St. Martin evolved as St. Martin became healthy enough to not need Beaumont's constant supervision and care. At multiple points during their patient-doctor relationship St. Martin dissolved their relationship in order to put an end to Beaumont's uncomfortable and frequently painful experiments. Nonetheless, Beaumont used his special position as St. Martin's doctor to coerce his patient to participate in additional studies.

The example of Dr. Beaumont and Mr. St. Martin highlights the conflicted loyalties of the surgeon-scientist. Not infrequently our goal to advance surgical science can compete with our responsibility for patient care. This conflict is inherent in the enterprise of surgical research and is particularly prominent in clinical trials and other human subjects research. Specifically, as we act in our traditional fiduciary role as care-providers, we must also be cognizant of how the goals of research and scientific discovery can impact our actions and decisions. While the conflict of dual loyalties cannot be completely eliminated, it can be managed through safeguards to protect the interests of patients. For example, principal investigators should avoid personally consenting and enrolling their own patients in their clinical trials. In addition, surgeon-scientists should constantly re-evaluate who the stakeholders are in the research environment and who serves to benefit from the interaction or intervention.

Management of the problem of dual-loyalties will be case specific and needs to be individualized based on the context of the clinical and research circumstance. It is important to recognize that even the perception that the surgeon scientist is not acting in the best interest of his or her patient can erode the foundation of trust in the physician-patient relationship. As such, it is critical that surgeon-scientists are aware of the potential problem of dual-loyalties so that it can be recognized and managed. Additional management strategies for the problem of dual-loyalties include transparency, full-disclosure, and possible third-party mediation/facilitation.

At times, a surgeon may in fact be asked to serve as the third-party mediator, or facilitator, for other research endeavors. In these cases, dual loyalties can extend beyond the surgeon's own research and include situations where the surgeon acts as a gatekeeper for patient recruitment in others' research endeavors. This is an increasingly frequent scenario as multi-institutional and multi-investigator alliances are formed to investigate relatively rare diseases or increasingly specific subsets of more common disease presentations. Particularly when surgical care represents the gold-standard for current therapy (as is frequently the case in early-stage oncologic disease, operative trauma, and many other areas of general surgery), the recruitment of patients into clinical trials will often take place in a surgical setting. In this role, surgeons (along with potential bias and conflicts of interest) have the capacity to either inhibit or increase trial enrollment. There are instances where a surgeon may be incentivized to participate (either through the potential for academic advancement or even at times through financial gain). In other cases, surgeons may be apt to not participate due to a lack of incentive (perhaps allowing a patient and third party investigator to occupy a clinic room for an additional hour may be detrimental to other patients or the health system in general). A participating surgeon-scientist must recognize the ethical questions and potential for bias raised by physician incentives when acting as a gatekeeper in research. Finally, as a gatekeeper, it is imperative that the surgeon-scientist be well versed in the risk-benefit profile of the proposed research and ensures that research is conducted with the health and safety of the patient foremost in mind.

In addition to the problem of dual loyalties, professional judgment regarding the best interest of the patient can be unduly influenced by secondary concerns such as career advancement or even financial gain. In an environment often defined by "publish or perish" the surgeon-scientist is required to be academically productive. Although the surgeon-scientist's primary goal is to improve the status of the surgical patient, the academic environment creates a tension whereby surgeon-scientists are driven to produce data, publish, and get promoted.

## Human Subject Research

Many academic surgeons are involved in research that directly involves the use of human subjects. Such research may include clinical trials or investigations that introduce new procedures or technologies into the clinical setting. Unfortunately, there are many examples of human subject research that have been characterized by unethical behavior [2]. Many surgeons are familiar with atrocities committed during World War II when the Nazi regime subjected individuals to horrible unethical experiments. The subsequent

Nuremberg trials and Nuremberg code established informed consent as a central tenet to protect human subjects involved in research [3]. The Nuremberg code states that the "voluntary consent of the human subject is absolutely essential." In addition, the Nuremberg code notes that "the experiment should be such as to yield fruitful results for the good of society, unprocurable by other methods or means of study, and not random and unnecessary in nature." [3] In 1964, the World Medical Association adopted the Declaration of Helsinki on the Ethical Principles for Medical Research Involving Human Subjects [4]. The Declaration of Helsinki, which has been subsequently amended, further clarifies the ethical principles for medical research involving human subjects. The Declaration of Helsinki clearly establishes the primacy of individual patient interests over any greater societal good that might be achieve through research. Specifically, the Declaration notes that "the health of the patient will be the first consideration" and that "the well-being of the individual research subject must take precedence over all other interests" [4]. Despite these codes and declarations, multiple examples of unethical research behavior can be identified in the history of the United States. Examples include the well-known unethical Tuskegee Syphilis studies [5] as well as the example at the Jewish Chronic Disease Hospital where 22 elderly patients were injected with live cancer cells by Chester Southam from the Memorial Sloan-Kettering Hospital [6].

Currently, in the United States, the protection of human subjects who participate in research is governed by the United States Department of Health and Human Services Title 45 CFR 46 known as the "The Common Rule" [7]. The Common Rule has four parts which describe basic principles governing human subject research in the general population and among vulnerable populations. Any systematic data collection using human subjects, whether during research development, testing, or evaluation, designed to develop or contribute to generalizable knowledge is considered "human subjects research" and is subject to the Common Rule. In turn, all research using human subjects is required by law to undergo an objective external review to ensure that the research is ethically appropriate, scientifically sound and does not pose undue risk to the participants. This independent review usually takes the form of an institutional review board (IRB). IRBs are comprised of individuals who ensure adequate review of research activities and are typically made up of individuals both from within an institution and from the community. IRBs are charged to (a) evaluate research protocols and determine appropriateness (most commonly providing findings for approval, disapproval, or approval with modification), (b) monitor the progress and conduct of a study, and (c) suspend, terminate, restrict, or request modification to a study as necessary [8]. Investigators have an ethical responsibility not to proceed with human subject research prior to IRB approval. In addition, researchers must report to the IRB any adverse or unanticipated events that may occur over the course of the research. Finally, researchers must participate in annual IRB review and renewal.

In addition to the independent IRB review described above, human subject research must meet other certain minimal requirements in order to be ethical [9, 10]. Emanuel and colleagues have proposed seven key ethical requirements for clinical research (Table 4.1). Research involving human subjects must provide an aggregate benefit to society or future patients to warrant the risk (however small) to current research subjects. In addition, all research should be scientifically valid with robust

**Table 4.1** Seven requirements for determining whether a research trial is ethical

| Requirement | Explanation | Justifying Ethical Values | Expertise for Evaluation |
|---|---|---|---|
| Social or scientific value | Evaluation of a treatment, intervention, or theory that will improve health and well-being or increase knowledge | Scarce resources and nonexploitation | Scientific knowledge; citizen's understanding of social priorities |
| Scientific validity | Use of accepted scientific principles and methods, including statistical techniques, to produce reliable and valid data | Scarce resources and nonexploitation | Scientific and statistical knowledge; knowledge of condition and population to assess feasibility |
| Fair subject selection | Selection of subjects so that stigmatized and vulnerable individuals are not targeted for risky research and the rich and socially powerful not favored for potentially beneficial research | Justice | Scientific knowledge; ethical and legal knowledge |
| Favorable risk-benefit ratio | Minimization of risks; enhancement of potential benefits; risks to the subject are proportionate to the benefits to the subject and society | Nonmaleficence, beneficence, and nonexploitation | Scientific knowledge; citizen's understanding of social values |
| Independent review | Review of the design of the research trial, its proposed subject population, and risk-benefit ratio by individuals unaffiliated with the research | Public accountability; minimizing influence of potential conflicts of interest | Intellectual, financial, and otherwise independent researchers; scientific and ethical knowledge |
| Informed consent | Provision of information to subjects about purpose of the research, its procedures, potential risks, benefits, and alternatives, so that the individual understands this information and can make a voluntary decision whether to enroll and continue to participate | Respect for subject autonomy | Scientific knowledge; ethical and legal knowledge |

(continued)

**Table 4.1** (continued)

| Requirement | Explanation | Justifying Ethical Values | Expertise for Evaluation |
|---|---|---|---|
| Respect for potential and enrolled subjects | Respect for subjects by<br>1. Permitting withdrawal from the research;<br>2. Protecting privacy through confidentiality;<br>3. Informing subjects of newly discovered risks or benefits;<br>4. Informing subjects of results of clinical research;<br>5. Maintaining welfare of subjects | Respect for subject autonomy and welfare | Scientific knowledge; ethical and legal knowledge; knowledge of particular subject population |

Used with permission, Emanuel et al. [10]
[a]Ethical requirements are listed in chronological order from conception of research to its formulation and implementation

methodology. Researchers must also ensure that all enrolled subjects are shown the highest respect, which is facilitated by the researcher being honest, careful, and transparent with relevant information. Finally, as noted, all human subjects must provide informed consent and be notified that withdrawal from the research study is not only permitted, but will also not affect any aspect of their future care.

## Informed Consent

The process of informed consent remains a cornerstone of human subjects research. While not sufficient in itself, informed consent is a necessary prerequisite for virtually all research that involves human subjects. Paramount to the practice of surgery and the conduct of research is the ability to instill trust and facilitate communication. Over the past 50 years, patient autonomy as well as the right to individual self-determination has come to the forefront of medicine and medical research. Informed consent epitomizes the shift toward a patient-centered paradigm of care and clinical research and represents a formal mechanism both to recognize patient autonomy and to address human subjects as self-determined moral agents. Informed consent serves to identify and respect an individual's best interests by giving each person the opportunity to decide autonomously what his or her best interests are in light of the research protocol.

Informed consent is particularly important in the realm of the surgeon-scientist. Research subjects need a significant amount of information to decide whether to enroll in a clinical trial, as many of the attendant risks and benefits are not inherently obvious. At times, researchers must approach patients who are facing significant illness and a bleak prognosis to ask them to participate in a clinical trial. Patients may have a wide range of

emotions, from "profound distrust to unquestioned faith" in the surgeon and the research process, thereby further complicating the process [11]. For pragmatic purposes there are three general steps to informed consent: disclosure/information exchange, ensuring adequate understanding/answering of questions, and subject decision-making/consent. Disclosure should convey the relevant and germane information about the study including informing subjects about the purpose of the research, the procedures or medications involved in research, their potential risks, benefits and alternatives [10]. The scope and nature of the information should be determined, in part, by an understanding of the subject's situation and context. This naturally dictates that though an informed consent document may be standardized for each study, the language of the consent process is unique for each potential subject. It is critical that researchers bear in mind that disclosure of information may sometimes be mundane for research personnel, but the process is often novel and confusing for potential participants. As such, information should be presented as clearly as possible with honest admissions of variables that are not well-known or understood. Informed consent may require the use of lay terminology, diagrams, or similar strategies to educate the potential study participant and evaluate that individual's understanding. The language used by the surgeon-scientist in the information disclosure process should be as objective as possible. Surgeons with direct involvement in a clinical trial (either as primary investigator or as potential financial beneficiary) should involve other members of the research team to secure the informed consent process to avoid a potential conflict of interest. Many patients will want their surgeon's subjective opinion of whether they should participate in a specific clinical trial. In general, it is best that the surgeon withhold an opinion until after the research team has met with the potential study participant and discussed the details of the study. By separating the surgeon from the informed consent process for research, the clinical relationship and the surgeons' fiduciary responsibility to the individual patient can be maintained.

Patients can come through the informed consent process without truly being "informed". Having an individual simply sign a consent form to satisfy a legal requirement does not necessarily reflect that the person understands the risks and benefits of a research study. As such, while written consent is a routine and necessary part of the informed consent process, researchers should not overly focus on the paper while ignoring the process. Notwithstanding these comments, the study subject's signature is almost always necessary to proceed with participation in clinical research, and therefore some form of documentation must exist. The informed consent process is critical in respecting human subject autonomy and the right to self-determination as a moral agent. As such, the researcher must ensure that adequate time and priority are allocated for this process.

## Surgical Innovation and Surgical Research

Surgeons are uniquely positioned to be innovators in medical therapy, specifically in surgical technique. As most surgeons are constantly tinkering to perfect their intraoperative skills and postoperative outcomes, there is a natural tendency and desire to

improve surgical care incrementally. However, the boundaries between tinkering, innovation and research are not always clear cut. A great majority of surgical advancement is the result of surgical innovation, an unregulated process that can spread valuable and effective therapies rapidly but also has the potential to harm patients who are unaware of the innovation in progress. Furthermore, there are a large number of surgical innovations that ultimately proved to be hazardous to patients (historical examples include frontal lobotomy and internal mammary ligation for angina).

It is helpful to define the distinction between innovation and research in order to determine the level of oversight required, as well as patient consent for participation. First, a minor modification (i.e. tinkering) is generally unplanned and involves a slight shift in technique. The evolution of the ileo-anal pull-through with numerous pouch conformations is a good example of a minor modification. It is helpful to remember that surgical research is defined as the systematic investigation of a surgical problem that leads to generalized knowledge. A randomized trial of carotid endarterectomy versus carotid stenting is a good example of surgical research. Innovation is much more difficult to define. The Society of University Surgeons defined innovation as any surgical procedure that has not been described in a North American Surgical text. In addition to endorsing this definition of innovation, the Society of University Surgeons went on to recommend that all innovative procedures must be disclosed ahead of time when planned or discussed postoperatively with patients if the innovation was unplanned [12]. Awareness of the distinction between innovation and minor surgical modification is important for the protection of our patients as, "surgeons must remain alert to the possibility of acceptable clinical innovation, creeping inexorably toward reckless experimentation." [13].

The application of robotic instrumentation in the operating room is a particularly good example of how an evolving modern innovation can be advanced in the context of historical ethical standards [14]. There are several unique aspects of robotic technology that require special attention. The first is the technical capacity to perform a safe operation on a new platform. Similar to the issues navigated during the advent of laparoscopy, complete disclosure and an appropriate risk-benefit analysis must be conveyed during the informed consent process in the context of a surgeon progressing along the learning curve with a new technology. The successful application of robotic technology in complex surgical procedures relies on appropriate mentorship to guide surgeons through a period of rapid innovation. The role of such mentors, and the roles of other members of the operating team such as trainees, nursing staff, and industry representatives, should be discussed in the context of principles of ethical surgical innovation as laid out by guidelines from organizations such as the Society of University Surgeons.

## Conflict of Interest

Ethical scientific research should strive to be devoid of bias. One form of bias that has garnered much attention in the lay press has been the issue of conflict of interest [15], which can be defined in many ways. Commonly, it refers to a set of conditions

in which professional judgment concerning a primary interest may be perceived to be unduly influencing a secondary interest [16]. Conflicts of interest may revolve around financial reimbursement, industry support of research, or – as previously mentioned – publication and promotion. It is important to understand that even the perception of a conflict of interest can damage the trust that the public, patient or subject has in the medical and research enterprise. Conflicts of interest that are handled poorly can also injure the surgeon-scientist's reputation and career. The surgeon-scientist must therefore be aware of any and all potential conflicts of interest when it comes to his/her research. In an era when surgeons frequently partner with industry in the conduct of research, it is not possible to eradicate all potential for conflict of interest. In fact, a conflict does not necessarily imply unethical behavior, but rather the potential to have bias influence the outcome of the study. As such, the ethical ramifications are determined more by the manner in which the surgeon-scientist handles and addresses any potential conflict of interest.

Full disclosure can mitigate some conflicts of interest. Academic institutions typically have a specific policy that outlines the rules of what and how potential conflicts of interest must be disclosed. It is each surgeon-scientist's responsibility to familiarize themselves with their respective institution's policy and ensure compliance with these policies. Researchers are ethically obliged to divulge connections between any third party and their research that may seem to benefit themselves or their research. Disclosure should include not only financial remuneration for the specific investigator, but in most circumstances any family members with financial ties. As it is often difficult for individual investigators to objectively assess the potential for personal conflict of interest, independent institutional verification and review is warranted. Most institutions focus on determining the degree to which a conflict of interest may be present and ensuring appropriate management of any conflicts identified. Some conflicts can be managed with external oversight to allow researchers to continue their work. In some circumstances, however, certain conflicts cannot be managed and researchers may need to divest from a specific area of research or the industry tie.

## Publication and Authorship

Publication is the "coin" of the academic realm. Authorship – particularly primary or "first" author and "senior" author status – is important to the surgeon-scientist as it has implications for career advancement and promotion. Unfortunately, issues around authorship can be ethically problematic. Common issues include providing appropriate recognition for those who do the most work and avoiding the listing of those who may not have contributed in a meaningful way to the work. In one scenario, junior researchers can be denied first authorship despite having contributed significantly to the study (through study design, data collection, data analysis, drafting and/or revision of the article). At other times, authorship is "awarded" on an honorary or "quid pro quo" basis to senior individuals who have not had a

meaningful contribution to the research project. In an effort to standardize criteria for authorship, the Vancouver Group has defined requirements for recognition as an author based on several criteria [17]. Authors should be involved in (a) the design of the experiment and/or the analysis and interpretation of the data, (b) drafting or critically revising the manuscript and (c) final approval of the product to be published. In essence, all manuscript authors need to have made substantial contributions to the work and be able to take responsibility for the work. Participation as a co-author based solely on seniority, funding, or collection of the data (e.g. the surgeon who solely operated on the cases being studied) does not constitute authorship.

Discussion about authorship is best done when the project is beginning. The principal investigator and junior researcher should have open, transparent, and frank conversations about expectations regarding the project. Specifically, the principal investigator should establish what his/her expectations are regarding the amount and type of work that is expected of the junior researcher if he/she is to be the first author. The junior researcher then has a much better idea of what will be required in order to claim primary authorship. In some instances, discussions about possible contingency plans should also be explored (e.g. "if you are unable to finish the project and the next researcher does most of the work, we will need to re-examine the issue of authorship"). As with most ethical dilemmas, the key to successfully navigating the waters of authorship is good communication and a relationship built on mutual respect and trust.

## Special Considerations Regarding Quality Improvement Initiatives

The Accreditation Council for Graduate Medical Education and the American College of Surgeons now tasks all residency programs to ensure that graduates have experience in quality improvement processes and initiatives [18]. While this experience likely varies dramatically across the spectrum of surgical residencies, the goal of developing national leaders in quality improvement is clear. Importantly, however, the designation of a project as a quality improvement measure does not mitigate the need for ethical evaluation when patient care is impacted. In fact, the ethical questions that face researchers in other fields may be more difficult to answer for many studies completed under the auspices of quality improvement. Nevertheless, whenever data from human subjects is obtained in an effort to provide generalizable knowledge this is considered "human subjects research" and is subject to The Common Rule (as discussed earlier in this chapter).

In quality improvement research, the direct target of the intervention typically focuses on system processes, environment, or clinician behavior. The end-results, however, are routinely patient-centered outcomes. This raises questions that may be difficult to answer, such as actual "trickle-down" risk to patients, the relative benefits to patients, and the appropriate consent or disclosure method that should be

entertained [19]. Even determining who should undergo consent, and if certain quality improvement projects are appropriate at all can be ethically challenging. The role of an IRB in approving quality improvement projects may also vary from the historical norm. Rather than an IRB insisting on rigorous methodology (such as randomization) and statistical planning (with well-defined primary outcome measures identified), often quality improvement initiatives are deemed to meet the federal definitions of minimal risk and undergo expedited ethical consideration. Surgeon-scientists must avoid, however, casually defining a research project as a quality initiative solely for the purposes of an expedited IRB review and remember that the ethical considerations for quality improvement work are likely just as important as "standard" research.

## Special Considerations Regarding Basic Science Research in an Academic Environment

David Resnik has argued that there are several aspects of the research environment that may make it particularly susceptible to moral strain [20]. Researchers are pressured to publish papers, effectively utilize limited laboratory resources, and obtain funding. Unfortunately, occasionally a researcher may succumb to these pressures and begin to ignore ambiguous data, negative results, or begin to "massage" the data. The laboratory environment – not unlike surgical training itself – can often be hierarchical in nature, making some students or residents feel pressured to do things to "satisfy" the expectations of their supervisor. Power imbalances between the lead researcher and mentees may potentially affect how research is performed and how results are reported. Because positive results are often rewarded and negative results are frequently seen as failures, investigators may feel tempted to "fudge" the results. As most researchers can anticipate the "desired" or "correct" results, they may try to justify this behavior by telling themselves "I know this is how it really would have turned out if…." Dishonesty in scientific research, however, undermines the most fundamental ethical principles: trust, honesty, and validity.

Dishonesty includes fabrication, falsification, and plagiarism [21]. Whereas fabrication is the baseless creation of data in the absence of empirical experimental results, falsification is the manipulation or misrepresentation of data or results that were obtained from experiments. Misrepresentation most commonly involves the purposeful omission of findings that contradict the desired outcome. In data collection, this can include omission of certain data points to "tighten up" the data (e.g. "I am going to leave these three data points out because they are clearly 'outliers'"). In data analysis, this often includes guided manipulation of the data (e.g. "torturing" the data with statistics to get a desired or anticipated result). Finally, the most overt form of dishonesty is plagiarism, which is the wholesale appropriation of another researcher's ideas, work, or written word as your own. Plagiarism can include the reproduction of another researcher's ideas at a meeting or the reproduction of another researcher's written word in publication. Plagiarism is a serious infraction

of research ethics and can have long-term negative implications for a researcher's career. As such, investigators should take particular effort to give credit where it is due and fastidiously avoid reproducing the work of others. All forms of dishonesty seriously undermine and erode the integrity of scientific research and therefore should be avoided at all costs.

The hallmark of good, ethical laboratory research also includes a commitment to an open research environment and a dedication to meticulous methodology. An open research environment can help cultivate the scientific process by allowing ambiguous or "wrong" results to be discussed and examined. Errors can be quickly identified in a non-punitive manner and corrective measures can be implemented expeditiously. Negative results can also be openly accepted and research efforts can be directed towards novel ideas or solutions. Mentors and research leaders are therefore ethically obligated to help foster open communication in the research setting. Mentors should interact with mentees not only to exchange research ideas but also to model good scientific standards and ethical research behavior. It is imperative that scientists avoid careless research as it is fundamentally unethical. In addition to wasting societal resources, it also exposes subjects (e.g. humans and/or animals) to unnecessary risks, and may result in erroneous findings that can damage future research endeavors or even injure patients. As such, researchers need to exercise caution in their research to identify and obviate "avoidable" errors. The standard of triple-checking key findings should be regarded as a minimum requirement for the ethical conduct of research. While at times this may delay the desire to produce results quickly, it may prevent the propagation of technical errors of experimentation or unconscious bias from finding their way to published conclusions. While some errors are honest mistakes, the ethical surgeon-scientist strives to avoid errors in their research as a means to respect the scientific process, as well as the resources entrusted to him/her.

## Conclusion

Surgeon-scientists are frequently faced with ethical challenges both at the bedside and in the laboratory. The research environment is enmeshed with issues requiring objectivity, honesty, and respect for persons. Seniority, hierarchy, and power imbalances can further complicate the ethical landscape of the surgeon-scientist. An environment characterized by open communication, high ethical standards, and a focus on doing "what is right" should be the goal of each surgeon-scientist. To be a scientist is to engage in behavior with certain moral and ethical implications [22]. Surgeons should not shrink from this responsibility. Instead, academic surgeons should actively engage in the moral issues inextricably linked to their research. It is only through this engagement that we are empowered to not only be better researchers, but also to be better physicians, improving the quality of care we deliver to those who depend on us for help.

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