

## Review Article

# Surgical High-Value Care: A Practical Guide to Developing Cost Awareness During Surgical Residency

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## Abstract

The coronavirus-19 pandemic highlighted major flaws in the way healthcare is delivered globally, which invoked the need to reevaluate how healthcare systems are structured. The United States spends more money on healthcare than any other country in the world, yet the US ranks 40th in life expectancy. Factors contributing to US healthcare spending are too numerous and complex, and a major factor is the role of the healthcare provider. Clinician-driven decisions, especially if socioeconomically uninformed, can have a large impact on healthcare expenditure. To address this, High-Value Care (HVC) emerged as a concept with the goal of providing optimal, efficient and cost-effective medical care. The American Council on Graduate Medical Education (ACGME) incorporated high value care as a core competency for resident training, however many residency programs do not have a formalized curriculum to reference. Surgeons are in a unique position to create an impact as costs associated with surgical services contribute to a major portion of healthcare expenditure, and surgical residents are the best cohort to educate about high value care. In this manuscript we propose a simple framework to cultivate more cost-effective practices: by dividing the surgical care episodes into preoperative, intraoperative and postoperative periods, we can pinpoint areas that disproportionately impact costs and offer ways to start addressing them.

**Keywords:** Surgical high-value care; Cost efficiency; Surgical education

## Introduction

The Coronavirus-19 (COVID) pandemic has claimed the lives of 1.2 million Americans, and is responsible for approximately 17% of the 2024 global death toll [1], reported to the World Health Organization (WHO). At the height of the pandemic, the exponential rise in infection rates paired with the lagging response of the healthcare system highlighted major flaws in the structure and delivery of healthcare services in the United States (US) and worldwide. These include inadequate access, high cost, and provider shortages. Interestingly, while the US has the highest healthcare spending in the world [2], it ranks 40th in health expectancy at 78.5 years [3]. This multifactorial discrepancy is well documented and beyond the scope of this manuscript, however it does raise an important and very relevant question: Why are we not reaping the benefits of our healthcare spending?

## Background

To begin understanding factors that contribute to high healthcare

spending we must understand the structure of the system. To simplify this, think of healthcare systems as being composed of and driven by three main entities: the patient, the payer, and the provider. The “payer” refers to the source of payment, which can be public or private (or a combination of). The “provider” refers to and encompasses all aspects of healthcare delivery including facilities, providers, resources, and administration. Healthcare system models such as Beveridge or Bismarck [4], differ based on how the healthcare is funded and delivered. The Beveridge model for example is funded by the government through taxes and the care is delivered by government employees in facilities owned and operated by the government. By contrast an out-of-pocket model requires patients to pay the cost of their healthcare upfront to private entities independent of the government. The US healthcare system is a hybrid system in that the government provides public health services as well as the equivalent of universal care to certain populations (lower income, veterans, elderly, and differently-abled) while the majority of working adults receive healthcare coverage through their employers. People outside of these groups often have to seek coverage through private insurance, pay out-of-pocket-for services, or forgo healthcare altogether. The contributions of the “patient” and “payer” to the US healthcare expenditure will not be discussed in this manuscript as our focus is largely on the “provider” component.

From an economic perspective, rising healthcare expenditure can have both positive and negative effects on the economy. Healthcare spending can lead to improved health, which can increase productivity and spending which can in turn stimulate the economy [5]. Conversely, increased healthcare spending can lead to increased government borrowing, reduced investment, higher taxation, and

**Citation:** Akam EA, Akam EY, Dhanani H, Nembhard C, Tee M, Fullum T. Surgical High-Value Care: A Practical Guide to Developing Cost Awareness During Surgical Residency. *Ann Surg Edu.* 2024;5(2):1056.

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**Publisher Name:** Medtext Publications LLC

**Manuscript compiled:** Dec 04<sup>th</sup>, 2024

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inflation [6]. “Providers” play a major role in the rising costs of healthcare as patient-care decisions are largely driven by clinicians. Overutilization of resources, defensive medical practices, and lack of cost awareness all contribute to increased healthcare spending. In fact, a systematic review published in 2023 by Desai et al [7], concluded that 91% of the articles in the analysis demonstrated low awareness of costs amongst physicians in medical and surgical specialties regardless of training level and experience. Additionally, the lack of awareness of the cost of devices seems to be higher than that of the cost of services [8]. Operating room costs are major drivers of hospital expenditure and are therefore subject to scrutiny. A single-center observational study at a French university hospital demonstrated that wasted supplies accounted for 20.1% of the cost allocated to surgical supplies [9], while a single-center cross-sectional study at Johns Hopkins Hospital demonstrated that all members of the operating team (including surgeons, trainees, nurses and technicians) exhibited a lack of awareness of the cost of surgical supplies [10]. Fortunately, the literature demonstrates that there is a strong desire amongst physicians to cultivate knowledge about cost awareness [11] and that interventions aimed at cultivating cost awareness (such as displaying the total cost of surgery on the electronic health record) appear to be effective [12].

While it is important to limit unnecessary healthcare spending, it is equally important to ensure that patient care is not compromised in the process. The delivery of optimal, effective, and cost-efficient care is termed High-Value Care (HVC), and it is widely accepted in the medical community that HVC should be incorporated into medical school education [13]. An analysis of 2011 Medicare claims data by Chen et al from 2014 concluded that spending patterns during residency training influenced future healthcare expenditure and that interventions aimed at post graduate trainees may reduce healthcare costs [14], yet a national survey of residency program directors in 2014 demonstrated that less than 15% of programs had a formal curriculum aimed at providing high value care [15], despite this being an American Council on Graduate Medical Education (ACGME) Common Program requirement. For surgery programs, the ACGME Surgery Milestones specifically require residency programs to evaluate resident competency in Systems Based Practice (SBP 3: The Physician’s Role in Healthcare Systems). However, a multi-institutional survey of surgical residents in 2019 demonstrated that the majority of residents report poor exposure to cost-conscious care education, with formal curricula being in their infancy [16].

Like many others during the pandemic our hospital experienced resource and provider shortages, which necessitated implementing systems that conserved resources while optimizing patient care. For the surgical department this meant delaying elective surgeries, utilizing the post-anesthesia recovery unit as a non-COVID Surgical Intensive Care Unit (SICU), and rationing personal protective equipment. As the pandemic evolved and resources became available, we continued to assess our practices in the department to understand how we could reduce waste in the event of another surge. We observed that the delivery of surgical care in our area varies greatly between hospitals, service lines, and operating surgeons. Being part of this experience as residents has impacted our education and understanding of HVC. Program curriculum development on this topic has been based on the national Surgical Council on Resident Education (SCORE) curriculum, which itself is limited on HVC education. We therefore believe that surgical residents have a unique opportunity to develop cost awareness in real-time if they are provided with a simple

framework that they can utilize for this purpose. In this manuscript, we categorize costs incurred during surgical care into three phases: preoperative, intraoperative, and postoperative. We discuss what contributes to costs in each phase and how to approach decision-making from a high-value care perspective. Our aim is to disseminate this information to a wide body of surgical educators that wish to promote such learning in their own curricula.

## Cost Drivers in the Preoperative Period

### Initial assessment

The preoperative period starts with a surgical consultation or referral. In many cases taking a thorough history and performing a physical examination is sufficient for diagnosis, while in other cases further diagnostic testing may be warranted. After the diagnosis the first decision to make is whether or not this diagnosis is treated with surgery. If the condition cannot be managed operatively, recommendations for conservative/nonoperative management should be outlined and discussed with the patient and his/her care team with appropriate follow up arranged. If the diagnosis can be managed operatively the next decision should be if the patient should undergo surgery. This decision is multifactorial and depends on patient fitness for surgery, surgeon capabilities, and resource availability. Finally, once the decision is made to proceed with surgery the patient must be medically optimized to increase the likelihood of a successful outcome and mitigate risks of perioperative complications. Figure 1 outlines a decision tree for preoperative evaluation.

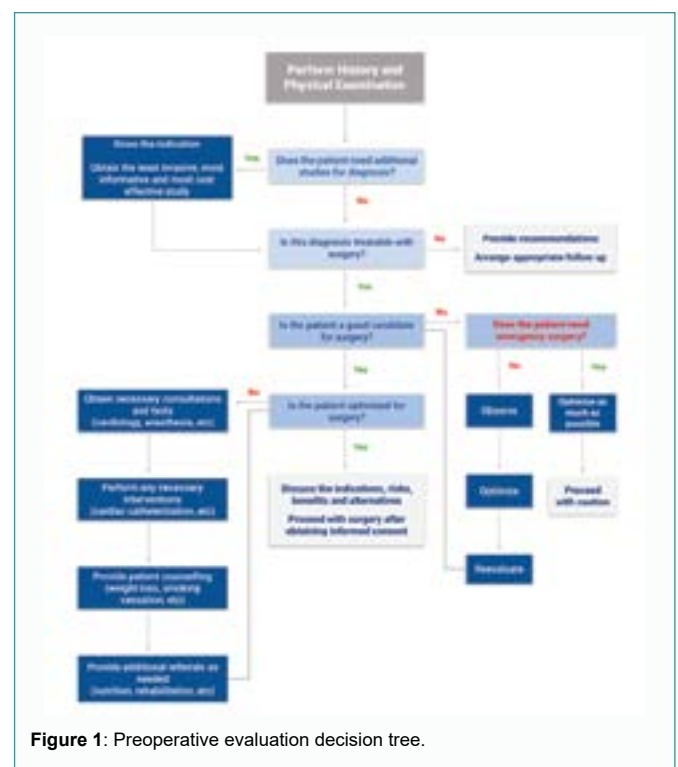


Figure 1: Preoperative evaluation decision tree.

### Diagnostic approach

In the event that history and physical examination is limited or a diagnosis cannot be made clinically further diagnostic testing may be warranted. Frequently by the time a surgical consultation is placed a workup has been completed that includes laboratory and imaging studies. If further diagnostic studies are warranted a differential diagnosis must be identified AND the highest yield test must be

ordered with appropriate indications in order to avoid unnecessary and invasive tests. The American College of Radiology (ACR) developed the ACR Appropriateness Criteria [17], a web-based tool that helps clinicians choose the appropriate diagnostic study. When in doubt, we recommend using this tool before ordering imaging. In addition to imaging, it is tempting to obtain screening preoperative laboratory studies, but this practice is not routinely recommended, especially in healthy patients [18]. Figure 2, adapted from a paper published by Halaszynski et al [19] in 2004, outlines suggested adult preoperative testing based on the type of surgery and medical factors. Figure 3 shows the average cost of different laboratory and imaging studies based on the Center for Medicare and Medicaid Services (CMS) Physician Fee Schedule in non-facility settings (i.e. not in the hospital) as of 2024. Please note that the actual pricing of imaging and laboratory studies varies based on insurance coverage, geographic location, setting of service rendered, etc.

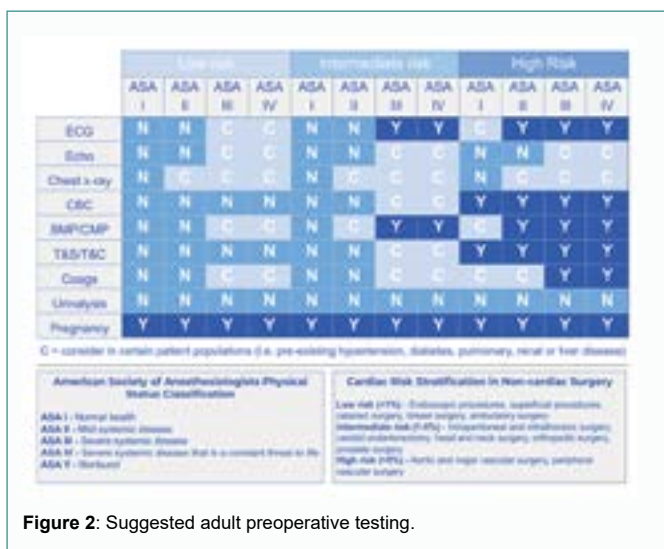


Figure 2: Suggested adult preoperative testing.

**Patient optimization**

If the patient is determined to be a candidate for surgery, the patient’s fitness for surgery is assessed to identify any comorbidities that affect the surgical outcome. From a medical standpoint this increases the chance of a successful outcome for the patient, and from an economic perspective this decreases the risk of postoperative complications that may increase overall costs. The assessment begins with a history and physical examination and includes age, gender, systemic or psychiatric conditions, functional and nutritional status, lifestyle, and social support. There are several tools that help assess overall risk for morbidity and mortality using this demographic data, but one of the most practical and validated tools is the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) Surgical Risk Calculator. Once the morbidity and mortality risk are estimated, further tests, consultations, counseling, and intervention may be warranted to medically optimize the patient for surgery, keeping in mind that each consultation and referral increases the overall cost for the surgical episode. Optimizing the patient prior to surgery will reduce the risk of morbidity and mortality, which in turn will reduce hospital length of stay, a major driver of inpatient hospital costs [19]. If ever in doubt about the patient’s medical fitness for surgery, a referral to the patient’s primary care physician for a preoperative evaluation is always a wise decision.

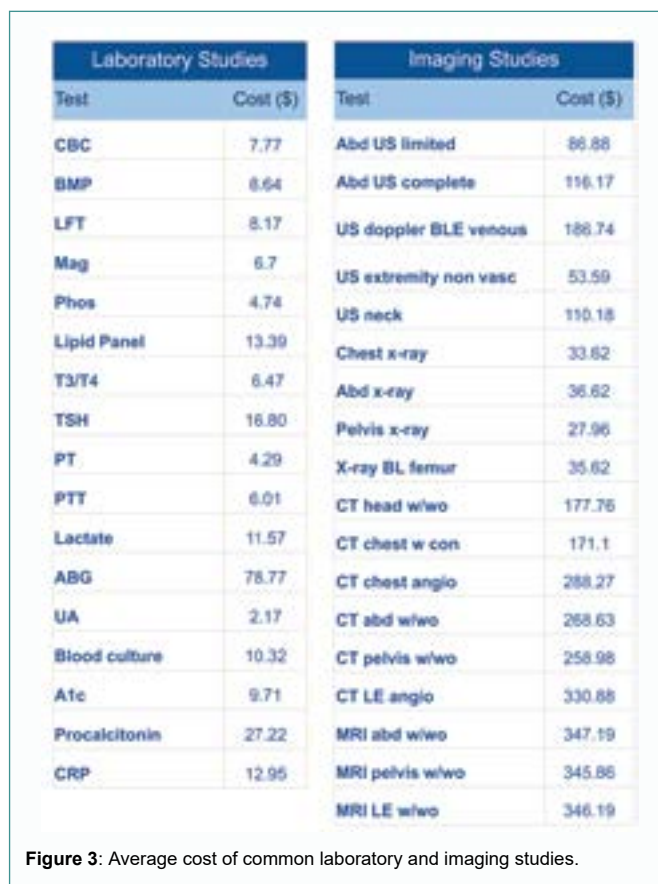


Figure 3: Average cost of common laboratory and imaging studies.

**Reducing the risk of complications**

The overall incidence of postoperative complications is estimated to be around 15% and significantly increase the hospital length of stay [20]. Common complications include surgical site infections, cardiac and thromboembolic events, postoperative pneumonia, and urinary tract infections. Well-known risk factors for the development of complications postoperatively including age, presence of medical comorbidities, American Society of Anesthesiology (ASA) grading, open and emergency surgery, duration of surgery, and intraoperative complications. Prevention is the best way to decrease postoperative complications, and it starts with patient selection and identification of the surgeon’s own limitations when it comes to performing the surgery. Using intraoperative tools such as the surgical safety checklist and the NSQIP measures are validated methods for decreasing the incidence of perioperative complications.

**Facility selection**

For select patients and procedures, an ambulatory surgery center is cost-efficient and can help decrease the overall cost associated with the surgery [21]. Ambulatory surgery centers are highly specialized and offer a smaller range of services and are therefore more efficient and have lower overhead costs. If the patient has comorbidities that may warrant an inpatient observation or admission, it is safer to schedule their procedure at a hospital-based ambulatory surgery center [22].

**Cost Drivers in the Intraoperative Period**

While data on the percentage of perioperative costs incurred in the operating room is lacking and poorly understood, there is literature suggesting that operating room costs are the second highest drivers of inpatient surgical costs after room and board [23-25].

Overt intraoperative factors that contribute to the perioperative cost of care include provider and facility fees, medications, and supplies. Intraoperative errors and complications also contribute to increased costs of care, therefore careful patient selection, risk stratification, and risk mitigation are crucial. The surgeon's role in modifying operative costs include the choice of procedure, technical approach, and selection of supplies and equipment.

### Surgical approach

Determining the appropriate surgical approach is a multifactorial and complex assessment as it is driven by patient factors and the surgeon's ability to perform the procedure. Additionally, there are costs and benefits associated with each approach and it is difficult to quantify which approach is best for each patient. For example, while a robotic approach is associated with higher costs than a laparoscopic or an open approach, it is also associated with shorter lengths of stay and fewer perioperative complications [26]. Making this determination as a surgeon requires comfort with all three modalities, and this begins in residency. Surgical trainees should aim to become familiar and comfortable with performing a variety of procedures using different approaches because having options is safer for both the surgeon and the patient. After determining the technical approach, the surgeon must request all necessary equipment, supplies, and implants. The operating room is where the surgeon has the most influence over cost containment as she/he decides which supplies to use.

### Instrument trays

Instrument trays account for the majority of the cost of reusable supplies. The costs incurred include the initial cost of the instrument, reprocessing after use, and replacement. There have been multiple studies analyzing the utilization of instruments in surgical trays and the cost of reprocessing them [27-29]. It is estimated that overall, less than 20% of the instruments in each tray are used and that it costs approximately \$0.51 to reprocess each instrument. Interventions aimed at reducing these costs include eliminating rarely used instruments from the tray and packaging them in a peel-pack to be used on an as-needed basis. Surgical trainees are in a unique position because training with different surgeons and hospitals expands their knowledge of surgical instruments and trays, and having that awareness can foster cost consciousness when it comes to creating and updating preference cards.

### Equipment

As surgical technology continues to evolve, the influx of advanced surgical instruments provides a certain appeal - these instruments make the operation easier, smoother, and safer, but they can also make the operation very expensive. For example, using an ultrasonic energy device during a cholecystectomy will increase the cost of the operation in contrast to using diathermy, and we then find ourselves moving away from older and equally effective methods of performing the same steps during the operation. While the trade-off may be shorter operative time, it is worth taking the time to weigh the benefit of using an advanced instrument against the cost. For straightforward symptomatic cholelithiasis, using diathermy may be the more cost-effective choice, while an ultrasonic scalpel may be the safer choice for acute cholecystitis. Similarly, using an Endoloop™ to divide the appendix during appendectomy is much more cost-effective than using a stapler. Cultivating the discernment to make these types of intraoperative decisions begins in residency, as surgical residents are often working with many different surgeons who all have different

styles and methods for performing different steps in surgery. As previously mentioned, the literature demonstrates that many surgeons lack cost awareness when making decisions about which instruments to use intraoperatively, and developing this awareness early in training can guide later intraoperative decision-making.

### Supplies and surgical implants

In the US we have access to an abundance of resources including disposable surgical supplies, surgical implants and prosthetics, as well as biological resources such as blood products. This freedom unfortunately generates a significant amount of waste, and it is estimated that 20% of the cost of surgical supplies is attributed to waste [30]. One of the most successful strategies for reducing operating room waste is cost awareness, with data showing a cost reduction of 14.4% percent in certain cases [12]. Many of the modern electronic health records now provide cost data for surgeons to review. Additionally, an easily modifiable practice is to have supplies available in the room but to limit opening them until they are ready for use.

### Reducing risk of complications

Two major interventions that have decreased the risk of surgical complications are the implementation of the WHO Surgical Safety Checklist and the ACS NSQIP. Both were born out of a need to monitor and improve the quality of surgical care to reduce surgical morbidity and mortality. Implementation of a surgical safety checklist decreased the incidence of morbidity and mortality by as much as one-third [31], while using measures described by NSQIP reduced postoperative morbidity and mortality by 45% and 27% respectively [32]. These include administration of carefully selected antibiotic prophylaxis within 1 hour of the incision and discontinuation within 24 hours, maintenance of normothermia and euglycemia in the perioperative period, hair removal with clippers, early removal of urinary catheters, continuation of beta-blockers for patients in the perioperative period, and administering venous thromboembolism prophylaxis. Developing and adhering to a surgical safety protocol is crucial for mitigating postoperative complications, and maintaining open lines of communication with the entire operating room staff ensures adherence to these measures. Figure 4 shows a sample surgical safety checklist and Figure 5 shows surgical care improvement project measures.

### Cost Drivers in the Postoperative Period

While many procedures can be performed as a same-day outpatient procedure, other procedures require inpatient care for postoperative management. Room and board contribute the most to costs incurred while inpatient, followed by operating room costs. Patients receiving inpatient care after surgery can be divided into three groups:

- Patients who were admitted for an acute medical or surgical problem
- Patients who had a major surgical procedure that requires inpatient postoperative management and
- Patients who had a complication.

### Admission orders

When the patient is deemed a candidate for a postoperative admission to the hospital, the type of admission and level of care must be determined as this has implications for insurance coverage and reimbursements. An "inpatient" admission order is warranted if the patient is expected to need inpatient services for more than 48



Figure 4: Common components of ERAS protocol.

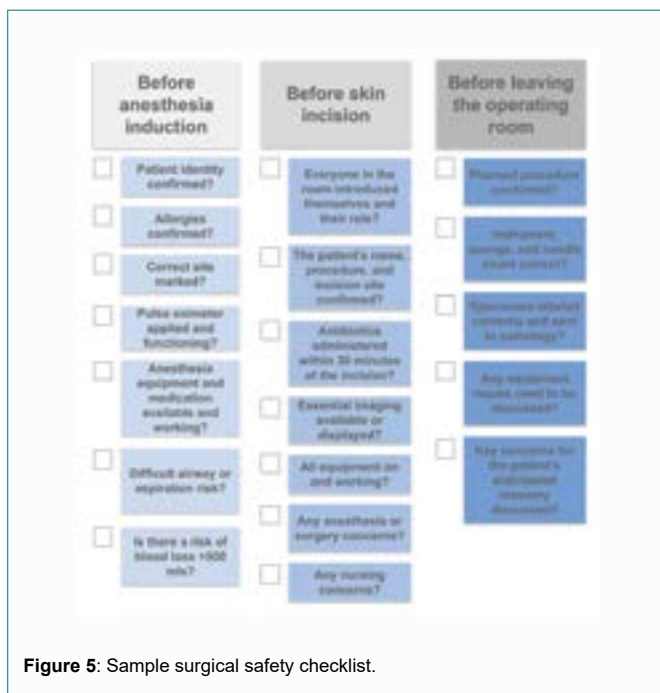


Figure 5: Sample surgical safety checklist.

hours. Any other admission orders (i.e. "observation") are considered non-inpatient. After determining the type of admission, the type of services ("room and board") must be determined. In general, "routine services" include admissions to "floor" units. "Special care units" include admissions to intensive care units (SICU, CCU, MICU, etc), and "sub-intensive units" include admissions to intermediate care, subacute care, or progressive care units [33]. As the intensity or "level of care" increases, so do the charges, and the room and board charges are higher in the special care units than the sub-intensive and floor units. Therefore, as a general rule always choose the least

intensive setting required for the patient with the understanding that the patient's level of care can always be upgraded should the patient require those services.

### Postoperative management of comorbidities

The human body must exert a tremendous amount of effort to recover from a traumatic event like major surgery, and studies have demonstrated that patients undergoing an inpatient procedure have a higher risk of morbidity and mortality than patients undergoing the same procedure electively [34]. The goal of postoperative care in these patients is to manage comorbidities so that they are as close to physiological hemostasis as possible to facilitate healing and recovery, which may require a multidisciplinary approach. Restarting home medications as early as possible, managing blood glucose in patients with diabetes, ensuring that patients with end-stage renal disease receive dialysis in a timely manner, ensuring early and adequate nutrition, encouraging early ambulation/rehabilitation and pulmonary toileting, ensuring adequate pain management, and administering venous thromboembolism prophylaxis are all ways to support the recovery of medically complex surgical patient.

### Enhanced recovery protocols

Major surgical procedures may require hospital admission for postoperative management until discharge criteria (such as ability to tolerate oral intake or adequate pain control) are met. Enhanced Recovery After Surgery (ERAS) Protocols were developed in the early 2000s after a landmark paper by Kehlet et al demonstrated earlier recovery and shorter hospital stays in patients with colon resection for malignancy when certain postoperative practices were modified [35,36]. The first ERAS protocol was developed in 2005, and since then enhanced recovery protocols have been modified and adapted for a variety of surgeries and surgical specialties. Many of the principles are similar and include preoperative counselling and optimization, performing minimally invasive surgery when possible, utilizing multimodal pain regimens, encouraging early ambulation and enteral feeding, minimizing disturbances, and early removal of tubes and drains. Figure 6 shows common components of the ERAS protocol.

### Discussion

In addition to the economic effects of high US healthcare spending is the astounding environmental cost. Eighteen percent of the gross domestic product in the United States is spent on healthcare, and some studies estimate that approximately 25%, or \$760-935 billion, of healthcare spending may be attributed to waste [37]. Notably, these costs do not account for indirect expenditures related to the health impacts of greenhouse gas emissions and climate change, which are estimated to cost the US healthcare system an excess of \$800 billion per year [38]. Unfortunately, the healthcare industry is complicit in exacerbating climate change. Experts estimate that US healthcare is responsible for 8.5% of all US greenhouse gas emissions, making the American healthcare industry the 13<sup>th</sup> largest greenhouse gas emitter globally [39].

Operating rooms are a particularly energy-intensive part of the hospital, utilizing three to six times more energy than other hospital facilities due to ventilation, heating, and cooling requirements [40]. Moreover, meta-analyses by Rizan et al [41] and Robinson et al [42] found that surgical devices and consumable/disposable products used in the operating room are a source of significant carbon emissions. Given this it is important to factor the indirect costs associated with

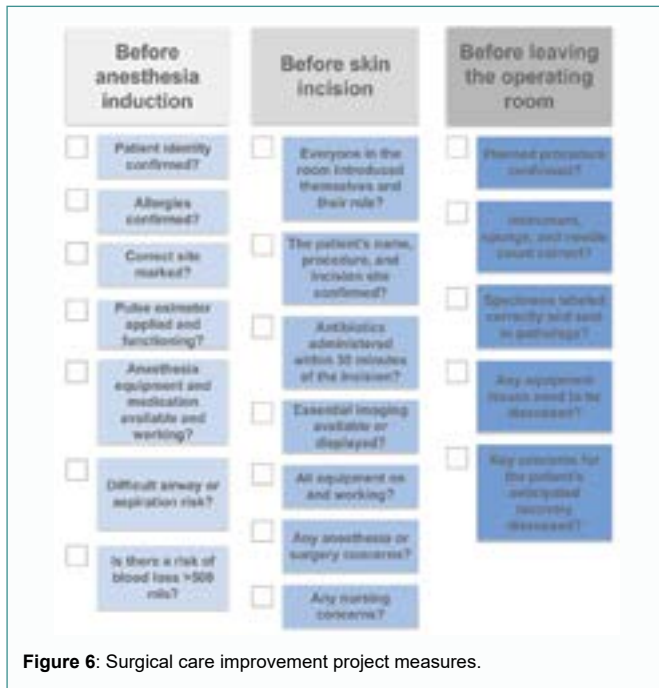


Figure 6: Surgical care improvement project measures.

healthcare, including surgical care, into high-value care decision-making. The pre-, intra-, and postoperative decisions discussed above can mitigate hospital carbon emissions, thereby serving to reduce indirect costs in addition to direct costs. The benefits of this go beyond monetary/economic value: we live in a time where carbon emissions and climate change are rising at an unprecedented rate, and having significant negative impact on human health [43]. Responsible use of energy intensive care is necessary along with innovation for greener surgical care. Galvanizing existing surgical societies and hospital systems to invest in climate conscious operating rooms is an important first step in reducing emissions.

The economic and environmental problems associated with healthcare expenditure are extensive, however we can discover solutions by focusing on what we can do individually and collectively to affect change. As humans, we can be more conscious of our own carbon footprint. As trainees, we can learn the discipline of surgery to the best of our ability, including the delivery of high value surgical care. As attendings, we can commit to participating in discussions at the institutional or societal level to lend our expertise on the matter of high value surgical care. How do we do all of this? Through leading by example, joining institutional committees, conducting research, attending national meetings, and sharing ideas with each other.

## Conclusion

While most factors contributing to US healthcare expenditure are outside of the clinician's control, we must recognize and acknowledge our role. The first step to change is understanding how we contribute to healthcare costs, and this begins with developing a working knowledge of how the healthcare system functions and how spending is allocated. We then need to identify how we as physicians contribute to healthcare spending and make modifications to decrease overall costs without compromising patient care. Lastly, our specialty is unique in that we directly influence the areas with the highest spending: hospital room and operating room costs. This provides us with a unique opportunity to modify practice to be more cost-effective.

By categorizing the surgical episode into preoperative,

intraoperative, and postoperative phases, we can identify and potentially target high-cost areas. There are some limitations in our approach: we do not have sufficient data to understand exactly how and where healthcare dollars are being spent. Second, because the costs of supplies and services vary between hospitals, healthcare systems, regions, and states, we are unable to accurately quantify healthcare spending. Finally, while we may introduce interventions that help decrease costs in one area, this can lead to increasing costs in other areas that we may not be able to easily identify and measure. Nonetheless, being more aware of how our healthcare system works and how we can help contain costs is a valuable skill to learn and develop in our efforts to provide high-value surgical care. Beyond assigned readings to residents and supplemental lectures on these core competencies, we hope to contribute to the overall discourse of incorporating a high value surgical care module into the SCORE curriculum for surgical residents to access to learn more.

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