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Increased Physician Literacy as an Intervention to Improve Value-Based Care and Reduce Cost in the Surgical Setting

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INCREASED PHYSICIAN LITERACY AS AN INTERVENTION TO IMPROVE VALUE-BASED CARE AND REDUCE COST IN THE SURGICAL SETTING

A Scoping Review

BY

Melissa A. Boyles

A doctoral project submitted to the faculty of the Medical University of South Carolina
in partial fulfillment of the requirements for the degree
Doctor of Health Administration
in the College of Health Professions

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Chair, Project Committee	Annie N. Simpson, PhD	4/17/2023 Date
Member, Project Committee	Daniel Brinton, PhD	4/17/2023 Date
Member, Project Committee	Faisal Aziz, MD	4/17/2023 Date

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Abstract of Dissertation Presented to the
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In Partial Fulfillment of the Requirements for the
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Chairperson:	Annie N. Simpson, PhD
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Abstract

The primary goal of this scoping review was to identify studies where an intervention of education and awareness of surgical supply costs with surgeons was employed as a possible stimulus for healthcare organization cost reduction in the surgical/procedural service space. Surgical procedures are performed on approximately 25 percent of all inpatient hospital admissions. In 2018 that equated to 14.4 million surgical procedures and $210.3 billion dollars in health system costs. Surgical Procedures are a substantial portion of healthcare system expenditure and are one of the highest revenue producing services provided to patients. Additionally, there exists high variability in costs based on surgeon preference and choice. Healthcare expenditures associated with surgery are expected to grow to $912 billion dollars annually by the year 2025.

Research aims were; is there an existing gap in knowledge of the cost of medical supplies for surgeons, does educating surgeons who make decisions regarding the selection of medical supplies/devices using the primary data points of price per procedure result in cost control and lead to lower costs of care and is there enough evidence to support a specific clinician education program for cost reduction?

100% of the ten studies included in this review articulate the foundational problem of surgeons not having knowledge of the cost of the supplies that they utilize every day in the operating room and an objective to educate or increase cost awareness for these decision makers. Interventions savings generated by procedure range from 4.1% to 54%. When savings were averaged for each study across all case types; the study's average cost saving ranged from 5.9% to 40%. Averaging identified cost savings across the two primary classifications of intervention yielded a 20% cost savings associated with education being provided through meetings and/or cost sharing. Surgical

Receipt and Report programs leveraged a 9.6% savings. Meetings and Cost Sharing education are documented as easier to launch then other initiatives. Surgical Receipt and Report programs are often difficult to operationalize depending on a health system's clinical documentation method and platform employed in the surgical setting

Keywords: Physician Cost Literacy, Cost Savings, Medical Supply Costs, Cost Per Case, Physician Preference

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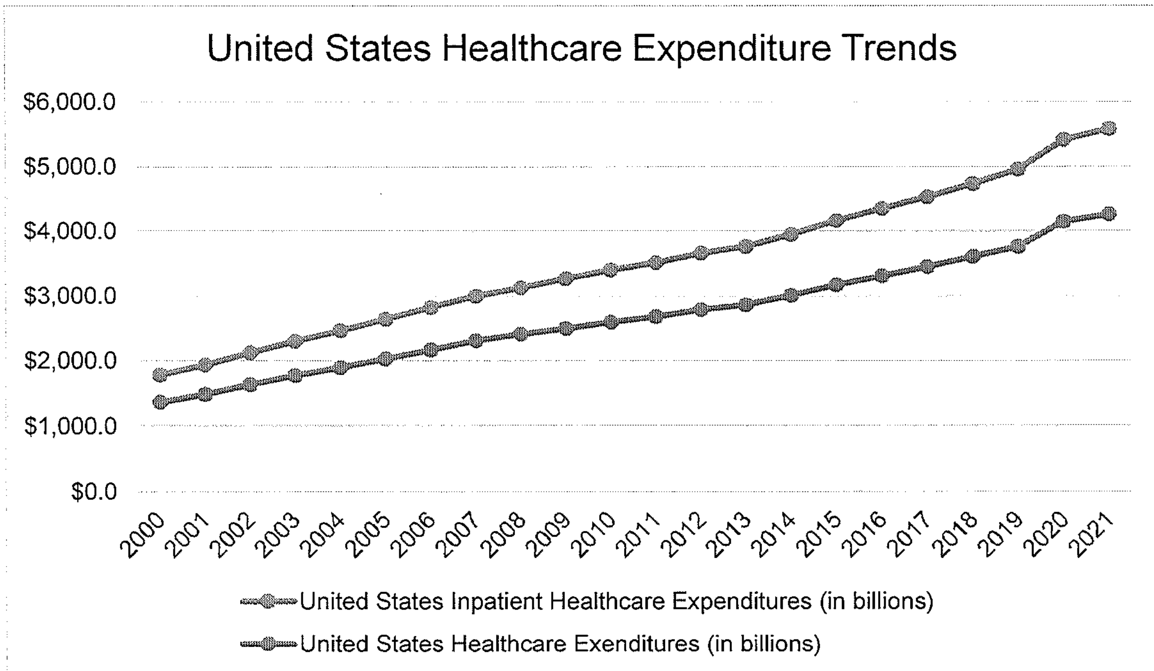
1 CHAPTER I INTRODUCTION

1.1 Background and Need

The United States continues to outpace other countries in healthcare expenditures. In 2021, the United States spent $4.3 trillion dollars on healthcare equating to a 18.4% stake of the economy and Gross Domestic Product (GDP) which totaled $23.32 trillion dollars (Center for Medicare & Medicaid Services [CMS], 2021). In comparison to the United States, Germany's healthcare expenditures as a percentage of their GDP were the next highest at 12.8%; followed by France at 12.2% and the United Kingdom at 12% (Organisation for Economic Co-operation and Development [OECD], 2020). This demonstrates a large financial liability for the United States, the country's population, and the healthcare industry. The trajectory of spending is unsustainable and when compared to other countries, it exemplifies a gap that needs further understanding and mitigation efforts to close. It should be recognized that a portion of the unprecedented increase in 2020 can be attributed to the pandemic response and the programs implemented to address COVID-19. This documented spending equated to the largest documented increase since 2002 but when normalized, removing pandemic response funds expended for testing, vaccine development and vaccine administration, the Provider Relief Fund, and other forms of assistance; the United States experienced a slower growth than experienced during the prior year 2019. The country did see spending slow in 2021 and another acceleration in 2022 as the population has returned to seeking care, this expecting to normalize post 2022 to an average increase of 5.5 percent per year (CMS, 2021).

Figure 1.1

United States Health Care Spending Trajectory



The continuous increase in spending has challenged healthcare systems in the United States to remain financially solvent and profitable. Figure 1.1 depicts United States healthcare spending from 2000-2021 with the orange line. The blue line indicates the portion of healthcare spending that is attributed to hospital care; defined as required an inpatient stay (CMS, 2022). It is also expected that hospital price growth and healthcare inflation will continue to increase over the next few years due to the excessive cost of labor and other costs associated with the rate of inflation and the state of the economy. In 2019, 30% of hospitals reported a negative operating margin. Sixty-three percent (63%) of hospitals reported losses associated with Medicare beneficiaries which on average contribute forty-six percent (46%) of a hospital's episode of care volume and in 2020 the AHA reported a loss of $323.1 billion dollars in hospital financial losses. The American Hospital Association (AHA) is projecting that all non-labor category expenses will continue to increase in 2022. Supplies are estimated to increase by $11 billion, drugs by $1 billion and purchase service categories by $7 billion dollars in calendar year 2022 (AHA, 2022).

The United States government as the largest payer for healthcare beneficiaries in the country has incentive to control healthcare costs. Medicare, Medicaid, and the State Children's Health Insurance Program are three programs administered by the Center for Medicare and Medicaid Services (CMS) that represent nearly ninety million Americans in the health insurance industry (CMS, 2016).

To control costs, increase access, and improve quality, the Patient Protection and Affordable Care Act (ACA) was passed March of 2010 with three primary goals. The first was to extend affordable healthcare insurance coverage to more American citizens, the second to expand Medicare coverage to a larger portion of the population through Medicaid expansion and third to support delivery care methods that lower costs and improve quality.

The third goal set forth a movement to change the traditional care delivery model. The traditional fee for service or pay per episode of care model that healthcare systems had become comfortable with was quickly seen as outdated and not centered on creating a healthier population of people. The ACA became the roadmap for healthcare's journey to value-based care at the intersection of the triple aim, Cost, Quality and Outcome.

The continued rise in healthcare costs without a correlating increase in the quality of care delivered or in reimbursement give rise to the increasing importance that healthcare systems look to meet that triple aim of cost control, quality, and improved outcomes. This financial cost increase has been stated consistently in the literature as an unsustainable trajectory for the United

States that will result in a larger percentage of the population with limited or no access to care. Other healthcare industry driving forces of price transparency requirements have increased consumerism and cost savvy patients in healthcare. This has driven market competition which provides additional reasons to examine strategies to control cost and increase quality for healthcare services.

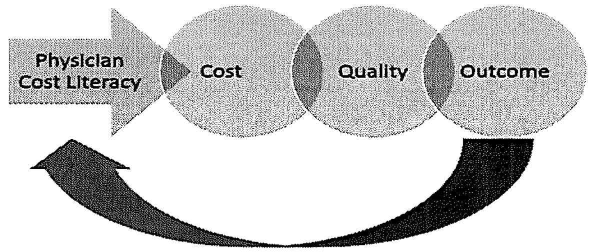
1.2 Problem Statement

As healthcare expenditure continue to rise, hospital administrators and healthcare systems are looking for areas where cost can be controlled. On average a hospital's typical total operating expense has 45% dedicated to its supply chain, the department responsible for the procurement and price negotiation of drugs, consumables, and surgical supplies (Alotaibi & Mehmood, 2018). The healthcare industry has been slow to adopt and adapt to efficiency gains that other industries have assessed across time and supply chain is no anomaly in that regard. Traditionally the function of supply chain in healthcare has been to reduce costs through purchasing and contracting practices but as the healthcare industry continues to shift from a volume-based reimbursement structure to a value-based reimbursement structure the realization is that healthcare organizations need more from their supply chain, their programs, and their customers.

Healthcare supply chain's mission is to meet the objective of the five rights; right product in the right quantity in the right place procured at the right price at the right time. This concept, connecting those dots in this cycle is complex for multiple reasons and further complicated by the fact that at the center of the process is the patient and the inputs to the cycle are controlled by physician choice, especially in surgical services. Figure 1.2 demonstrates that outside the triple aim of cost, quality and outcome is a missing feedback loop providing details of whether a chosen supply meets the objectives of the triple aim that could be used to influence physician choice.

Figure 1.2

Feedback Loop Diagram



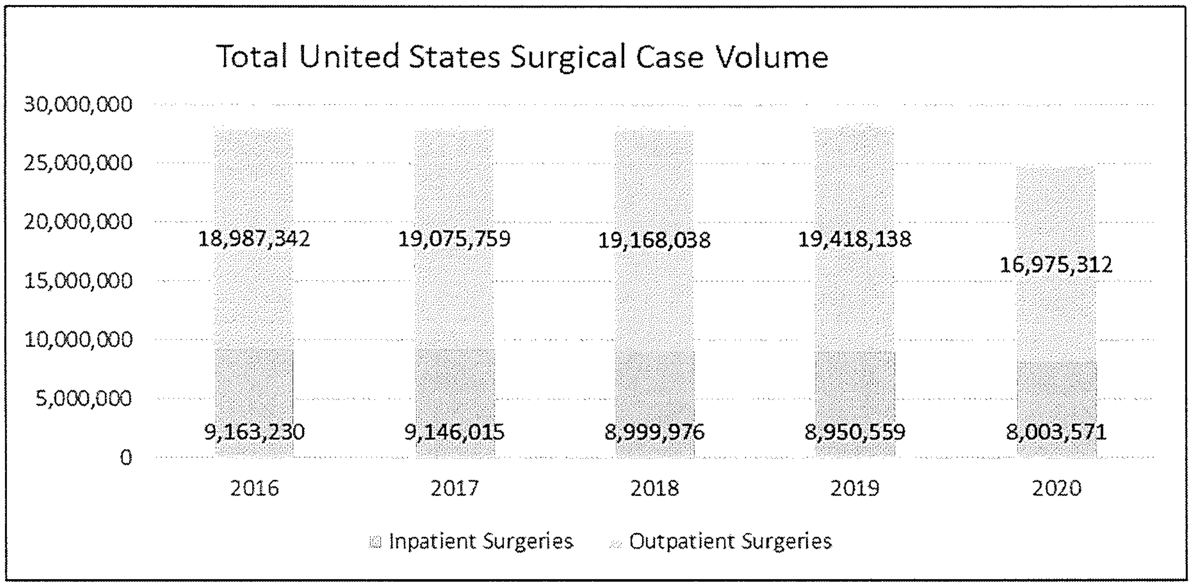
Feedback Loop

It is recognized that surgical procedures are performed on approximately 25 percent of all inpatient hospital admissions and in 2018 that equated to 14.4 million surgical procedures and approximately $210.3 billion dollars in healthcare costs (AHRQ, 2021). By the year 2025 surgical procedure costs are expected to contribute 7% of the total United States GDP (Mũnoz et al., 2010). Supplies used in surgical procedures and the cost of doing these procedures are the largest expenditure for health systems and is one of the highest revenue producing services. It is also a service line where there exists high variability in costs; many times, based on surgeon preferences for supplies used in their surgical cases. These cost differences do not always directly correlate to better quality of care or improved clinical outcomes with the use higher cost supplies. The triple aim which is associated with the ACA's objectives is requiring healthcare to pay close attention to those three pillars of cost, quality, and outcome as well as the inputs and outputs that feed that equation.

Figure 1.2 depicts data from the American Hospital Association showing surgical case volume in United State hospitals and ambulatory surgical centers classified as inpatient procedures (requiring a hospital stay) and outpatient procedures from 2016 through 2020 (AHA, 2020).

Figure 1.3

United States Surgical Case Volume per Year



Medical device expenditures represented approximately 6% of total healthcare spending in 2011 (Burns, 2018) and many of those are the choice of the practicing physician and are often classified as a Physician Preference Item (PPI). PPI often refers to the portion of medical supplies where physician choice is a major influence. Atilla et.al (2018) recognized in their study that physicians; especially surgeons who participate in high-risk, high acuity surgical cases have developed a more significant relationship with vendors of their supplies than with their internal supply chain teams. Many times, this creates friction internally in hospitals where healthcare administrators are left balancing physician autonomy and costs that can be outside of their realm of control without addressing the relationship between vendor and physician.

Surgeons in training during residency and fellowships are exposed to the tools of their mentors. In the medical device market and the surgical implant market this translates into a level of comfortability with clinical platforms or systems of specific vendors and then the development of personal relationships during their formidable years of independent practice with those who support and sell those systems. The supplies and implants that are attributed to surgical procedures are expensive, constantly evolving due to investments of companies in research and development and are also many times a personal choice of the surgeon. Do surgeons know the cost of the common supplies they use to complete their work? Do they care what those costs are and how they relate to the solvency of their organization? Based on the results from one published study, the answer is that two-thirds of the surveyed surgeons say that their knowledge and understanding of the costs of surgical supplies would change their clinical practice (Jackson, et al., 2015). This recognition presents a huge gap in the triple aim given that surgeons have a great amount of control over surgical expense based on choice and preference above most other costs in healthcare (Reddy, et al., 2022).

Research shows that most medical education programs do not include coursework related to the cost of care. Surgeons and surgical residents as an example do not have knowledge of the cost of care associated with post-operative complications (Chandawarkar et al. 2007) and in a 2011 study conducted using an online survey at Children's Hospital of Philadelphia concluded that the majority of physicians and residents surveyed had minimal knowledge of hospital finances including the tests and treatments that they order for patients (Rock et al., 2013). In addition, a study published in 2018 in London found that medical students receive little education in health economics and finance during their training and that practice does not provide them with that knowledge. The authors concluded that there was no difference in the knowledge base regarding costs and reimbursement for health services rendered between new residents and tenured practitioners (Ryan et al., 2018).

Couple that knowledge gap with a medical device industry that continues to evolve, expand, and remain profitable, this may be a recipe for rising costs. In 2019 the medical device industry consisted of 859 individually rostered businesses in the United States and represented $41.3 billion dollars in revenue (Kesavan & Dy, 2020). The industry, like healthcare, has been challenged with absorbing changes brought on by reforms. These have included changes to the market approval process increasing the costs to bring a device to market. These costs will continue to be shared by hospitals and ultimately patients.

Many studies published exploring the gap in education find that in surveys, physicians attest to wanting to know more regarding costs. The survey answers also reveal that physicians state that if they possessed that information regarding costs, it would and could have an influence on their clinical practice from ordered diagnostic testing to choices of surgical implants.

1.3 Research Questions and Research Hypotheses

Dr. Herbert Fred (2016) penned in an editorial "that the most expensive technology in American healthcare is the proverbial pen that is held by the physician" with which they prescribe, or in this case choose, a care plan. It is estimated that 80% of healthcare costs can be derived from decisions made by physicians (Fred, 2016). The objective of this scoping review is to understand if there is a correlation between clinician education related to the cost of medical products and devices and their choices made in the delivery of care and thus subsequent healthcare costs. Does a cost educated choice impact the cost of healthcare? Does educating clinicians who make decisions regarding the selection of medical supplies/devices using the primary data points of price per procedure result in cost control and lead to lower costs of care?

Could we as future healthcare leaders impact the overall cost of care by improving education and collaboration with physicians?

These questions are extremely important in the American healthcare journey to value-based care and as healthcare leaders redesign care models to maximize quality and outcomes while reducing costs to the health system, the patient, and the country. Therefore, this study aims to summarize the current evidence by performing a scoping review of recent studies that examine physician education about care costs and subsequent behavior change.

2 CHAPTER II METHODOLOGY

2.1 Research Design or Method

The primary goal of this systematic review was to identify studies where an intervention of education and awareness of surgical supply costs with physicians and surgeons was employed as a possible stimulus for healthcare organization cost reduction in the surgical/procedural service space. PRISMA Scoping Review guidelines for Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension using inclusion and exclusion criteria to determine applicability (PRISMA-ScR). Peer reviewed articles published in the timeframe March 2010 – September 2022 were reviewed for inclusion. Additional inclusion criteria incorporated only studies conducted in the United States, after the enactment of the Affordable Care Act, studies with a clear intervention of cost sharing, increased cost awareness or education with the physician study participants and self-collected pre and post intervention cost data.

2.2 Search Strategy

The process for the scoping review began with the development of a list of broad key terms and concepts related to the hypothesis that physician education intending to increase cost awareness of supplies and their applicable price would yield reduced hospital costs. The identified high-level terms and search methods were discussed with an MUSC librarian seeking advice and guidance for conducting the initial search. These terms and methods were used as identifiers in the initial searches performed in PubMed and ProQuest Healthcare Administration Database.

An initial search with the broad terms of cost-awareness, physician education, supply costs, and impact were conducted looking specifically for studies that employed a clear intervention or attempt to reduce costs using a form of physician education or increased awareness. These MeSH search terms (((cost awareness) AND physician education) AND supply costs) AND impact was used in PubMed. These search terms for the purpose of this systematic review are defined in the following ways:

- Cost is defined as the acquisition, utilization or reprocessing price or expense incurred by the hospital or healthcare organization to procure an instrument or supply.
- Cost awareness refers to the knowledge of the physician or surgeon in relation to the term cost as defined above.
- Physician education could be part of a formal training on healthcare costs, sharing costs of processes, supplies and instrumentation, feedback regarding costs, or any combination of these.
- Education could also be surgeon to surgeon education of less expensive clinical practice using supplies

This initial high-level search terms yielded 1,611 results from ProQuest and six results from PubMed. Inclusion criteria were applied to the articles which included being published after the enactment of the Affordable Care Act (March 10, 2010), designated as peer-reviewed, and published and conducted within the United States. The results from ProQuest when including these key terms that included physician and supply returned many articles related to the supply of physicians and lack thereof in the United States leaving none that were related to the targets of this search. The six results from PubMed were imported into the screening phase of the software program Covidence.

Results from the first search were further discussed with the MUSC librarian who suggested to employ more targeted search terms and criteria. Additional search terms were added to include cost awareness, medical supply costs, health economics, physician cost literacy, reduction of costs and surgeon. The search was revisited in both engines using the terms cost awareness, medical supply costs and surgeon. The high-level search produced 315 results in ProQuest and no results in PubMed. MeSH terms utilized were (((((cost awareness) AND (medical supply costs)) AND (health economics)) AND (physician cost literacy)) AND (reduction of costs)) AND (surgeon). Application of the other identified inclusion criteria resulted in no results that were applicable to this systematic review.

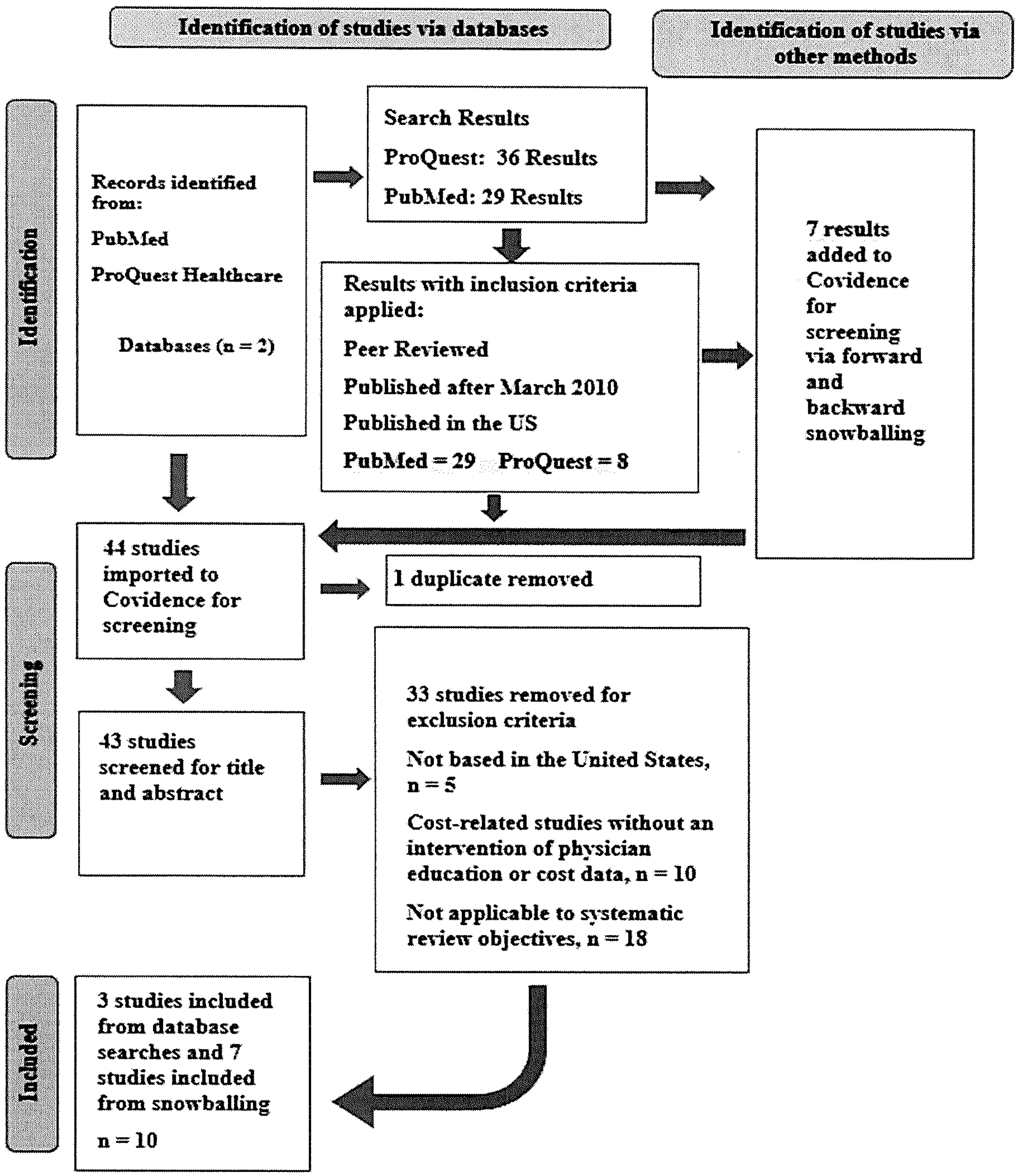
Search terms were revisited with the MUSC librarian, and a new search was conducted using the terms cost awareness, medical supply costs and surgeon. MeSH search string included ((cost awareness) AND (medical supply costs)) AND (surgeon). These search terms returned 3,688 articles in ProQuest and twenty-eight articles in PubMed. When inclusion criteria were applied to these search results twenty-three studies from PubMed and eight studies from ProQuest were imported into the screening module of Covidence. Covidence is a web-based collaboration software platform that organizes and tracks the creation of systematic and literature reviews (Covidence, 2022).

Title and abstract screening were performed within Covidence with additional inclusion and exclusion criteria. These criteria included clear pre-intervention data that was self-collected and reported and clear post-intervention data. This identified a starter set of three studies from database searches.

Once that starter set of articles were discovered, snowballing was employed to identify complimentary articles for background, content, and inclusion into the systematic review. This exercise conducted in a forward and backward direction assisted in clearly identifying studies and material that met the objectives of the study. The snowball searches identified seven (7) studies that met all inclusion criteria that were uploaded into the screening phase of Covidence. After title and abstract screenings and the application of inclusion criteria one article was then excluded due to the study setting being in Canada and not the United States. This provided ten studies to be included in this scoping review. Figure 2.1 is the PRISMA search diagram.

Figure 2.1

PRISMA Search Diagram



Data elements that were documented during extraction were study design, type of education intervention, cost pre intervention, cost post intervention, number of surgeon participants, number of surgical cases, type of surgical cases, and the documented percentage of cost savings. Another data element that was recorded, when available, was intraoperative time as this is many times a contributing factor that is cited in the choice of supplies. Choice of supply can contribute to intraoperative time which is one of the most significant drivers of overall surgical case costs. Studies were assessed for quality and bias using the Newcastle-Ottawa Quality Assessment Scale (Wells et. al, 2019). Studies were rated good, fair, or poor based on star assignment for nine criterions across three domains. Those domains are selection of cohorts, comparability, and assessment of outcome. A quality score of good was assigned for studies scoring 7-9 stars, a quality score of fair for studies scoring 5-6 stars and a poor-quality score for studies scoring four and below. Figure 2.2 demonstrates each studies rating.

Figure 2.2

Newcastle-Ottawa Assessment Scale

Author(s)	Selection				Comparability	Outcome			Total Rating
	1	2	3	4	1	1	2	3	
Vigneswaran, Linn, Gitelis, Muldoon, Lapin, Denham, Talamonti & Ujiki	•	•		•	•	•	•		•••••• Fair Quality
Agarwal, Agarwal, Querry, Mazurkiewicz, Whiteside, Marroquin, Koscumb, Wecht & Friedlander	•	•		•	•	•	•		•••••• Fair Quality
Croft, Mattingly, Bosse & Naumann	•	•		•		•	•		••••• Fair Quality
Asher, Mansour, Wheeler, Kendrick, Cunningham, Parikh, Zidar, Harford, Simon & Kashyap	•	•		•	•	•	•		•••••• Fair Quality
Reddy, Gill, Hwang, Wilson, Shahlaie, Harsh, Strong & Steele	•	•		•	•	•	•	•	••••••• Good Quality
Gitelis, Vigneswaran, Ujiki, Denham, Talamonti, Muldoon & Linn	•	•		•	•	•	•		•••••• Fair Quality
Tseng, Sax, Gewertz, Margulies, Alban	•	•		•		•	•		••••• Fair Quality
Zhao, Tyree, Lin, Vaida, Stock, Hamelin & Clary	•	•		•	•	•	•		•••••• Fair Quality
Zygourakis, Valencia, Moriates, Boscardin, Catschegn, Rajkomar, Bozic, Hoo, Goldberg, Pitts, Lawton, Dudley, Gonzales	•	•		•	•	•	•		•••••• Fair Quality
Gunaratne, Cleghorn, & Jackson	•	•		•		•	•		••••• Fair Quality

3 CHAPTER III RESULTS

3.1 Results/Findings

Healthcare Industry literature consistently cites the current consistent growth of healthcare expenditures as unsustainable for patients and healthcare systems. Munoz, et. al concluded in an article published in 2010 that the rise of healthcare expenditure is of great issue for the United States population. The studies examined in this scoping review focus particularly on the rise of surgical healthcare expenditures and the impact of those on the health system. Surgical health expenditures are expected to grow to $912 billion dollar annually by the year 2025 (Munoz, et. al. 2010).

Literature documents that surgeons consistently underestimate the price of high-cost surgical supplies and overestimate the price of lower cost commodity items. Surgeons have considerable influence over the selection or choice of supplies used during their surgical procedures and the absent of cost literacy limits cost-control. Literature searches identified ten (10) studies from two (2) databases of peer-reviewed studies that met the criteria for this scoping review. The characteristics and results of those studies are listed in Table 1.

All studies were published between 2012 and 2018 and were cohort design. Six (6) studies were prospective pre/post cohort studies and four (4) were retrospective pre/post studies in design.

The nature of these studies is difficult to randomize and there is no true blinding, contributing to the quality scores overwhelming being fair under the Newcastle-Ottawa Assessment. Eight (8) of these studies received a quality score of 6 start based on the duration of the intervention cohort follow up duration being shorter than ideal to understand the long-term impact of the intervention. One of the studies does follow the cohort for 18 months which provides a more realistic suggestion of a sustained change. The study by Zygourakis, et al. also received a quality score of good (7 stars) based on the study design of controlled, non-randomized which by nature is a better-quality study design.

The study settings ranged from a single hospital site (5) with only one of those being an academic medical center setting to a single hospital/health system with multiple hospital sites. This also impacted the quality and power of the study in the ranking process.

The sample size of number of surgeon participants in the studies ranged from 4 to 63. Only two of the studies examined surgical cases across different surgical specialties. The other populations of interest; number of patients will be discussed in Table 2.

Table 1. Included Study Characteristics

Author(s)	Year	Study Design	Number of Participating Surgeons	Study Setting	Study Quality
Vigneswaran, Linn, Gitelis, Muldoon,Lapin, Denham, Talamonti & Ujiki	2015	Prospective Pre/Post Cohort Study	6 surgeons	Single Health System, Multi Hospital	Fair
Agarwal, Agarwal, Querry, Mazurkiewicz, Whiteside, Marroquin, Koscumb, Wecht & Friedlander	2016	Prospective Pre/Post Cohort Study	Unknown	Single Hospital	Fair
Croft, Mattingly, Bosse & Naumann	2015	Prospective Pre/Post Cohort Study	13 surgeons	Academic Affiliated Community Hospital	Fair
Asher, Mansour, Wheeler, Kendrick, Cunningham, Parikh, Zidar, Harford, Simon & Kashyap	2012	Prospective Pre/Post Cohort Study	9 surgeons	Single Hospital	Fair
Reddy, Gill, Hwang, Wilson, Shahlaie, Harsh, Strong & Steele	2018	Retrospective Pre/Post Cohort Study	7 surgeons	Single Health System, Multi Hospital	Good
Gitelis, Vigneswaran, Ujiki, Denham, Talamonti, Muldoon & Linn	2014	Retrospective/ Pre/Post Cohort Study	15 surgeons	Single, Regional Health System	Fair
Tseng, Sax, Gewertz, Margulies, Alban	2018	Prospective Pre/Post Cohort Study	7 surgeons	Single Academic Medical Center	Fair
Zhao, Tyree, Lin, Vaida, Stock, Hamelin & Clary	2015	Retrospective Pre/Post Cohort Study	unknown	Single Health System, Multi Hospital	Fair
Zygourakis, Valencia, Moriates, Boscardin, Catschegn, Raikomar, Bozic, Hoo, Goldberg, Pitts, Lawton, Dudley, Gonzales	2015	Prospective Controlled, Non-randomized Study	63 surgeons	Single Health System, Multi Hospital	Good
Gunaratne, Cleghorn, & Jackson	2014	Prospective Pre/Post Cohort Study	4 surgeons	Single Hospital	Fair

All the ten studies had a clear intervention with a goal to educate or increase the awareness of the cost of supplies utilized in surgery. A calculated p-value of < .05 in each study is considered significant. The specific data and results for each study are presented in Table 2.

The first study by Vigneswaran and colleagues targeted a common surgical procedure, surgical inguinal hernia repair performed both laparoscopically and as an open procedure as the population of interest (Vigneswaran, et. al, 2015). There were ten surgeon participants across three hospitals in a single health system. The method of intervention was cost sharing on both individually and compared to the system average cost per case benchmark. That benchmark was obtained by analyzing 258 laparoscopic procedures and 366 open procedures with an average cost per case of $1088±$473 and $315±$253 respectively that were performed in FY13. Expenses that were excluded from the cost analysis were anesthesia costs and reusable instrumentation. Physicians with the lower cost per case shared peer to peer their techniques and surgical approaches as well as presented alternatives to higher cost supplies.

The cost impact post educational intervention was calculated as a 21% reduction in costs for a laparoscopic repair and an 8.6% reduction in costs for an open repair. In the post period, the Vigneswaran captured 274 laparoscopic procedures and 286 open procedures in FY14 with an average cost per case of $860±$441 and $288±$130 which were significantly lower than the pre-period costs (p-value of $p<0.001$ laparoscopic and $p<0.01$ open) for each surgical approach.

Primary drivers of the cost decrease were attributed to physician selection of less expensive supplies such as mesh for hernia repair and reduction in the use of fixation devices. One confounding factor in the study is that simultaneously due to patient outcome, a type of mesh was removed from the approved supply list, however the author notes that the impact to the results were not statistically significant. Intra-operative time was not impacted positively or negatively due to change in practice/supply choice nor was patient outcome or quality of care.

Costs associated with ventricular shunt placements and craniotomies were examined in a single hospital study by Agarwal, et al. This study not only measured supply costs with an intervention of increased awareness but the consequence of increased awareness of infection rates on surgical site infections as well. For this scoping review, supply cost was the focus. The study focused on two procedures in an entire surgical service line with attending neurosurgeons and residents. An exact number of physician participants was not disclosed and was mentioned as a limitation of the study based on the absence of a control and intervention group. The study targeted specific high-cost supplies that are physician choice items. Ventricular shunts and dural grafts were determined to have the greatest variation and cost impact for these cases. Hospital acquisition costs for these supplies, less expensive alternatives and advantages and disadvantages were shared at faculty and resident staff meetings as an intervention vehicle. Shunts varied greatly in costs from $676 - $3,007. Benchmarks and average costs for each procedure calculated from FY15 were shared to be $2,345 for ventricular shunt insertions and $191 for craniotomies.

The documented results of the intervention demonstrated a 26% decrease in average case costs for ventricular shunt insertions to $1,747 and a 54% decrease in costs for craniotomy cases reporting $88 per case. Overall hospital expenditure for these two supplies were also reduced. Total hospital expenditures for shunts in FY15 was $426,764 and that decreased in FY16 to $318,004 and spending on dural grafts used in craniotomies decreased from FY15 $191,515 to $88,513 in FY16. This study also reported an associated decrease in the rate of surgical site infections because of education and the sharing of data with the surgeons and residents.

Laparoscopic Hysterectomies are another commonly performed surgical procedure in the United States that was the selected study group for an article published in 2016 by Croft, et al. The setting was one academic affiliated community hospital. Cost data was collected for all surgeons who performed ten or more procedures from April 2014 through May 2015 and that data was used as the control for the study. This control group included 271 procedures performed by thirteen (13) surgeons that met criteria. Supply costs were categorized into five (5) categories. Average intraoperative case times were also collected.

The intervention was implemented as sharing the cost data collected with the physicians in the form of an average cost per case for their cases including the cost and category of each supply. Alternatives were then identified for high-cost supplies and that information disseminated. Cost per case was then monitored for the assessment period of July through September of 2015. In that timeframe 69 cases were performed with an average case cost of \$1,282.62±\$235.03 which improved 17% over the average case cost of the control group of \$1,539.47±\$294.16. This intervention demonstrated a statistically significant reduction with a p-value of $p = .022$. Individually 12 of 13 surgeons delivered reduced case costs. The additional data of intraoperative time with the control group was collected at 178±26 minutes decreased to 163±50 minutes after the intervention, however, this difference was not statistically significant ($p = 0.36$).

A study conducted by Asher, et. al, at single hospital including nine (9) interventional cardiologists determined that increased cost awareness of supplies produced a decrease in the total procedural cost for single vessel percutaneous coronary interventions (PCI). Baseline costs were developed based on case cost data from July-September 2012 (n=90) and was calculated across seven (7) variables which included intravenous contrast media, medication, diagnostic supplies, interventional supplies, closure devices and imaging equipment and intraoperative time. This scoping review focuses on specifically on outcomes for supply categories including closure devices and contrast media.

Intervention methods were two-fold and included the labeling of endovascular supplies with their acquisition cost and then using the circulating and scrub staff in the room to announce that cost to the surgeon when requested. The supply was not opened and introduced to the sterile field until the surgeon heard the cost announced and confirmed the request.

The intervention group collected data on ninety (90) PCI procedures. The post-intervention patients had similar demographics to the pre-intervention group. Post-intervention, there was a decreased use in contrast media utilization. Pre-intervention contrast cost per case was \$506.60±\$30 and post-intervention \$462.22±\$53.11 (p=0.02). Interventional supplies yielded a statistically significant difference (p=0.047) between pre-intervention costs \$2,677.11±\$218.22 versus post-intervention costs \$2,502.77±\$197.33. Closure device costs and diagnostics supplies were not impacted significantly by the intervention (p=0.14 and p=0.39 respectively). Overall, the intervention impact to the total cost of a single vessel PCI procedure pre-intervention was \$3,983.22±\$135.90 and post-intervention \$3,748.40±\$244.20, a difference of \$234.82 per case (p=0.01), with six (6) of the nine (9) interventional cardiologists experiencing a decrease in their average case costs. The calculated net savings across the ninety (90) procedures for the organization was \$21,129.30. Limitations associated with this study were the small sample at only one healthcare facility and the focus on only one vessel PCI procedures.

A study by Reddy and colleagues evaluated the hypothesis that a surgical cost feedback and cost education intervention would reduce intraoperative case costs was conducted at multiple hospitals in a single health system. The study collected data in three phases extending 15 months beyond the intervention. In the Newcastle-Ottawa scale for quality, the period beyond the intervention earned this study another star toward an overall rating of good. The first phase collected baseline cost data associated with endoscopic skull base surgery from January 2017 until March 2018. This phase included thirty-six (36) surgical cases. This control cost data was not shared with the seven (7) participating surgeons performing this procedure. This intervention provided surgeons with a training session to familiarize them with the surgical receipt platform and subsequent to that training weekly emails were sent to the surgeon to remind them to review their cost data. The second phase of data was collected in the first six (6) months after the surgeon training with the intention of allowing for an adjustment period to the system and to clinical practice and included seventeen endoscopic skull base surgeries. The third phase;

September 2018 – December 2019 included fifty-two surgical cases. The real time availability of a surgeon's surgical receipts inside the platform and the weekly email required the surgeon to be completely self-directed in any practice change.

The baseline cost per case was calculated as $3,824.41 ± $1,058.36 and the post-intervention cost per case in phase two fell to $$3,527.59 ± $788.14 and then additionally to $3,010.35 ± $1,101.79 in phase three. This decrease was statistically significant with a p-value of p=0.002. Of note, the intervention and practice change associated with the intervention did not significantly change intraoperative time (p=0.51) and there was no significant difference in the rate of surgical complications. Authors do recognize that the small sample size is a limitation. It also notes that one high-cost surgical case outlier with a surgical supply need above the norm that is related to patient anatomy or intraoperative complications can cause significant effect on the overall average case costs.

Laparoscopic cholecystectomy is a common surgical procedure and approach used in healthcare. Gitelis, et. al. performed a hypothesis driven study to decrease disposable supply costs at a single regional health system with fifteen (15) participating general surgeons performing laparoscopic cholecystectomies.

Pre-intervention data for laparoscopic cholecystectomies (n=536) was collected for FY13 and included the compilation of acquisition costs of supplies and the corresponding utilization of those supplies. Those data points were used to determine the most used supplies amongst the surgeons and the discrepancies that existed in supply usage. This information was presented to the division of general surgery and surgical oncology by two peer surgeons with the intention of highlighting the impact of surgeon supply choice on surgical case cost. Specific data points included in this presentation were average case cost for the surgical division, individual surgeon average costs, a list of the most expensive items with more cost-effective alternatives and strategies to drive different supply choices without compromising patient outcome. There was a consensus agreement to engage in cost reduction efforts in the first quarter FY14.

FY14 cost data demonstrated a decrease in costs for laparoscopic cholecystectomy surgery from $589 per-intervention to $531 (n=428) post-intervention. This totaled an annual cost savings of ten percent (10%) and $33,000 in total which was statistically significant ($p<.001$). Twelve (12) of the fifteen (15) surgeons experienced a decrease in their surgical case costs. Additionally, the study showed no decrease in quality care or patient outcome associated with the cost saving initiative or procedural time. Limitations of the study were noted as retrospective collection of data and the inability to distinguish individual supply impact because selection was being changed real-time intraoperatively.

Surgical technique and choices of instrumentation can drive clinical variation in almost all procedures and is evident even in those most frequently performed across the United States. Investigators at a single academic affiliated community hospital investigated the consequence of increase surgical supply costs awareness with surgeons on the average case cost for a laparoscopic appendectomy procedure (Tseng, et. al, 2020). A team of surgeons, hospital administrators and operating room leaders retrospectively examined supplies and their costs used in laparoscopic appendectomies during the pre-intervention period of March 2017 – February 2018 (n=207) for seven (7) surgeons. The pre-intervention average cost per case was calculated as $854.35. The variation between surgeons were $754 to $1189 average cost per case.

The intervention consisted of educating surgeons on their individual surgical costs and the costs of their team. They were provided with the cost of individual supplies and lower cost alternatives to those supplies. There were also provided with additional data point of supplies that were open and wasted during cases.

Post-intervention laparoscopic appendectomies (n=158) performed between March 2018 – October 2018 produced an average case cost of $731.11. Individually only one participating surgeon did not see an average cost per case decrease. The reduction in cost was significant ($p<.001$) and presented a 14.4% cost savings which when annualized equaled $29,151. This study did not control for patient demographics or collected other important cost contributing factors such as intraoperative time and patient complications and outcomes.

One study published in 2015 by Zhao et. al. addressed five (5) procedures performed in general surgery. Retrospective collection of the median cost for these cases was collected from an 18-month period allowing for a one-month transition period between intervention and collection of cost data for the post-intervention period. Intraoperative time and patient outcome data was also collected. The objective of the study was to understand if an implemented surgical receipt system could decrease average surgical case costs. The following case types and their median costs were identified; 245 laparoscopic cholecystectomy cases ($886.77), 228 laparoscopic appendectomy cases ($1,321.50), 158 open inguinal hernia cases ($429.45), 385 lumpectomy surgical cases ($325.67), and 205 thyroidectomies ($861.21). Any change in the price of supplies was controlled for by calculating an average cost of each supply across the period of the study.

The intervention began in October 2015 with each surgeon performing these procedures receiving a surgical receipt via email within 3 days of case close for each case completed. The receipt contained a list of supplies and their acquisition costs, a list of any surgical implants and their acquisition cost and the total surgical case cost. It also provided the surgeon with a comparison of his case cost and the system average.

The median cost post intervention decreased significantly for three (3) of the five (5) procedures. Laparoscopic cholecystectomies (n=259) decreased to $816.60, p-value < 0.001(adjusted), thyroidectomy procedures (n=243) decreased $812.90, p-value = 0.003 (adjusted) and open inguinal hernia repairs (n=184) decreased $410.73, p-value < 0.001 (adjusted). Laparoscopic appendectomies and lumpectomy procedures did not see a reduction in costs associated with the surgical receipt program. Appendectomy procedures (n=211) increased insignificantly to $1,342.30, p-value=0.166 (adjusted). Lumpectomy procedures (n=426) increased significantly $403.88, p-value< 0.001(adjusted). Overall patient outcomes did not seem to be impacted by the surgical receipt program. There was a moderate increase in intraoperative time for laparoscopic cholecystectomies.

Patient demographics and comorbidities were not documented as a part of this study which is a limitation. The study design being retrospective does not allow for a control group and there was not a documented effort to understand the percentage of surgeons who examined their receipts to affect action.

A prospective controlled, non-randomized study by Zygourakis et. al. was conducted in calendar year 2015 at a single health system with multiple hospitals and multiple surgical departments participating. This study received a quality score of good in the Newcastle-Ottawa scale based on the study design and the number of surgeon participants specifically.

The study separated the control group from the intervention group by surgical specialty. The control group of surgeons (n=186) consisting of cardiothoracic, general, vascular, pediatric, obstetrics/gynecology, ophthalmology, and urology surgeons and the intervention group of surgeons represented orthopedics, otolaryngology-head and neck surgery and neurosurgery (n=63). Baseline supply costs were collected from surgical case costs performed in the period July 1, 2012, through November 30, 2014, for individual surgeons and for all surgeons to develop a baseline supply cost per surgical procedure for the control group and the intervention group. Surgical departments were offered a financial incentive for cost savings achieved in this study.

The intervention for this study was cost sharing by sharing a monthly scorecard via email with the intervention group that included surgical supply costs and the top ten (10) items categorized by unit cost and by utilization. The scorecard also identified a "bang for your buck" list that included the most frequently used item multiplied by the unit cost which was to represent opportunity for cost savings (Zygourakis, et. al, 2016). Lead surgeons for each surgical department conducted educational sessions to assimilate surgeons to the scorecard. Both the control and intervention group were eligible for financial incentive if they achieved the 5% cost reduction goal set by hospital administration.

The primary outcome of a 6.54% decrease in surgical supply costs was achieved in the intervention group where pre-intervention (n=10,637) median cost was $1,398 and the post-intervention (n=11,820) median cost was $1,307 which was significant with a p-value=.003 when calculated over the calendar year and controlling for surgeon, patient demographics and clinical indicators given the breadth of the study sample. The control group saw a supply cost increase of 7.42% from a pre-intervention (n=16,441) median of $712 to a post-intervention (n=17,227) median of $765.

It can be determined that there was a difference in the control and intervention group who received the monthly scorecard however savings could be attributed partially to the financial incentive offered for cost savings.

Finally, a study conducted a pilot program with the intervention of providing feedback for four (4) general surgeons performing gastric bypass surgery (Gunaratne, et. al, 2016). The pre-intervention data collected for surgical cases January–May 2014 (n=114) had a mean supply cost of $3,038±$305. This exercise also discovered considerable clinical variation and cost between surgeons.

The cost report card was distributed bi-weekly to surgeons beginning in June 2014 and contained case costs for all four surgeons. The report utilized a stoplight red, yellow, and green indicator to benchmark peer surgeons to each other and to present areas of the greatest opportunity for cost savings.

Three (3) month post-intervention data was collected September-December 2014 (n=88) and demonstrated a 5.9% decrease in supply cost to $2,859±$391. Seven (7) month post-intervention data collected (n=107) showed a sustained cost decrease of 6.9% from baseline to a supply cost per case of $2,827±$402. Annualizing this cost savings was summarized as a $160,000 annual savings. This is the equivalent of sixty-four procedures at the three (3) month minimum case cost calculation of $2,468 per case.

Table 2. Included Study – Data and Results

Author(s)	Intervention/ Education Type	Surgical Procedure	# of procedures pre-intervention	Case Cost pre-intervention	# of procedures post-intervention	Case Cost post-intervention	Percent of Savings	p-value
Vigneswaran, Linn, Gitelis, Muldoon, Lapin, Denham, Talamonti, & Ujiki	Meeting of Surgeons Peer to Peer Education	Laparoscopic Inguinal Herniorrhaphy	258	$1,088 ± $473	274	$860 ± $441	21%	p<0.001
		Open Inguinal Herniorrhaphy	366	$315 ± $253	286	$288 ± $130	8.6%	p<0.01
Agarwal, Agarwal, Querry, Mazurkiewicz, Whiteside, Marroquin, Koscumb, Wecht & Friedlander	Cost Education in Faculty and Resident Meetings on cost of shunts and dural grafts	Ventricular Shunt Placement	182	$2345	154	$1747	26%	p<0.001
		Craniotomy	1003	$191	980	$88	54%	p<0.001
Croft, Mattingly, Bosse & Naumann	Meetings, cost sharing	Laparoscopic Hysterectomy	271	$1,539 ± $294.16	69	$1,282.62 ± $235.03	17%	p=.022
Asher, Mansour, Wheeler, Kendrick, Cunningham, Parikh, Zidar, Harford, Simon & Kashyap	Reported physician costs and calling out cost of supplies during procedure	Single Vessel Percutaneous Coronary Intervention		$3,983.22 ± $135.90	90	$3,748.40 ± $244.20		p=0.01
Reddy, Gill, Hwang, Wilson, Shahlaie, Harsh, Strong & Steele	Surgical Receipt Program	Endoscopic Skull Base Surgery	36	$3,824.41 ± $1,058.36	17	$3,527.59 ± $788.14		p=0.002
					52	$3,010.35 ± $1,101.79		
Gitelis, Vigneswaran, Ujiki, Denham, Talamonti, Muldoon & Linn	Sharing of cost data and variables in cost. Peer to Peer.	Laparoscopic Cholecystectomy	586	$589	428	$531	10%	p<.001
Tseng, Sax, Gewertz, Margulies, Alban	Sharing of cost data	Laparoscopic Appendectomy	207	$854.35	158	$731.11	14.4%	p<.001
Zhao, Tyree, Lin, Vaida, Stock, Hamelin & Clary	Surgical Receipt Program	Open Inguinal Hernia Repair	158	$429.45	184	$372.49		p<0.001
		Laparoscopic Cholecystectomy	245	$886.77	259	$816.13		p=0.002
		Thyroidectomy	205	$861.21	243	$825.90		p=0.034
		Laparoscopic Appendectomy	228	$1,321.50	211	$1,351.20		p=0.101
		Lumpectomy	385	$325.67	426	$420.53		p<0.001
Zygourakis, Valencia, Moriates, Boscardin, Catschegn, Rajkomar, Bozic, Hoo, Goldberg, Pitts, Lawton, Dudley, Gonzales	Surgical Receipt Program & Peer Bench-marking		10,637	Median = $1,398 (IQR $316 - $5,181)	11,820	Median = $1,307 (IQR $319 - $5,037)	6.54%	p=.003
Gunaratne, Cleghorn, & Jackson	Surgeon Cost Report Card	Rouxen-Y Gastric Bypass	114	$3,038 ± $305	88	$2,859 ± $391	5.9%	

4 CHAPTER IV DISCUSSION

This scoping review provides an overview of study results from ten (10) peer-reviewed interventions aimed at increasing surgeon awareness or education on the cost of surgical procedures in the United States. The results demonstrated that regardless of the method of increased awareness, there was at least a short-term return in the form of medical supply cost per surgical case reduction.

Characteristics of the Interventions

The type of interventions was varied across the studies but all either used a type of a surgical receipt/report program (40%) or educational session and meetings with the purpose of educating physicians on the costs of their supplies (60%). In the studies that held meetings to educate surgeons of the cost of the medical supplies that were used, there was an advantage if the education was performed surgeons to surgeons. This was also the case in the studies that provided a supply and cost receipt for surgical cases. In the study by Reddy, et. al, the authors discuss in their conclusions that it is vital to equip surgeons with the tools to educate their teams and peers.

Surgical receipt programs and benchmarking a surgeon against his peers either blinded by providing the health system average cost per case or open reporting is cited as a catalyst for cost savings. Four (4) studies utilized a report or scorecard shared with the physician at a preplanned frequency which reported individual case costs and consistently benchmarked them against their organizational and peer averages. Eight (8) of these studies shared a form of peer or health system benchmarking costs as a part of their intervention.

Nine (9) of the studies chose general surgery procedures or in the case of the study using PCI, chose a basic procedure, where it is easy to control for patient acuity and comorbidities. The prospective, controlled non-randomized study design (Zygourakis et. al, 2016) was confounded because of the differences in surgery services and patients within those services between the intervention and control groups, provided CMI adjusted results to account for case complexity and patient acuity.

Some of the studies recognize that physicians are not the only operating room staff who have the ability to make contributions to cost control efforts. Residents, circulating nurses and scrub nurses and technicians are mentioned as an untapped resource in these endeavors.

Intervention Goals

The primary goal of 100% of the articles contained in this scoping review was to understand the influence that the intervention of increased physician awareness and education would have on healthcare's supply cost related to surgical procedures.

In addition to the primary goal, all the studies recognized that intraoperative time, a measure of the length of the surgical case and patient outcome are significant contributors to surgical case and episode of care costs. It was important to understand correlation between changes in supply selection or surgical technique/approach and those two factors.

One (1) study coupled medical supply costs with infection rates and capitalized on the focus of the audience of physicians to use the same intervention period to educate each surgeon on their own and their peers infection rates.

Conclusions

As healthcare administrators search for opportunities for better fiscal control, the absence of financial literacy for physicians has been highlighted as a key cost driver by each one of these studies. Healthcare organizations are faced with the balancing of physician autonomy and the growing need for fiscal responsibility to its institution and patients. In turn, physicians hold the responsibility of choice. They choose the surgical approach and the supplies utilized to treat their patients. If two supplies are equal in ease of use and clinical efficacy; the next decision point a physician should consider would be the acquisition cost of that supply to the organization.

Despite study average quality of fair, this scoping review found consistent results to conclude that peer-to-peer or physician to physician education is the most effective method in cost control efforts in the surgical setting. That premise ties back to the Figure 1.2 where a physician feedback loop enhances the triple aim of cost, quality and outcome and becomes that infusion of information to cost.

4.1 Future Research

There remains a need to further study the impact of physician literacy on healthcare costs Potentially more importantly, on patient outcomes. The impact could be further reaching if it is understood how choice could be impacted by creating this knowledge base. The creation of a choice architecture for standards of care could lead to predictable and improved outcomes and costs for the general population contributing to the goals of population health and health equity.

4.2 Conclusions

The involvement of the physician in the business of healthcare is essential to the financial solvency of any healthcare organization. This is demonstrated by the outcomes of these studies in this scoping review. Value has long term skepticism associated with the term as a "code word for cost reduction" with physicians and the work begins with them to change that perception. There remains opportunity in the connection of outcome data and physician feedback to the triple aim of Cost, Quality and Outcome that could have tremendous impact to the selection of supplies and our overarching goals towards health equity.

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