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The Perioperative Surgical Home (PSH)

A Comprehensive Literature Review for the American Society of Anesthesiologists

by

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Contents

INTRODUCTION

The concept of a perioperative surgical system has been evolving, described, studied and recorded mostly in the western world, including countries within North America, Europe and Australia, in the last forty years. This observed paradigm shift in surgical care processes has been explained as part of a general international trend of surgical specialties and capabilities moving from the inpatient to the ambulatory care setting (Reed & Ford, 1976), as well as market expectations for high quality surgery outcomes, reductions in the cost of surgeries, and expected government payment and incentive programs. A recent review of perioperative surgical systems identified several specific activities that are associated with this new concept of a more coordinated surgical care model, which moves from the traditional reactive and sequential surgery process to a more proactive, coordinated and team-based approach to the same surgery process (Lee, Kerridge, Chui, Chiu, & Gin, 2011). Although hospitals and health professionals engaged in these new systems of coordinated perioperative surgery vary dramatically in the stage of implementation, how they operate, team composition, program leadership, and scope and depth of coordination and communication among care teams, the following key elements or features (Table 1) have been identified in the current international literature to describe the nature of the perioperative surgical home:

Table 1. Perioperative Surgical Home Elements

PreoperativeKey Elements	Intraoperative Key Elements	Postoperative Key Elements
• Admission through a centralized preoperative area/clinic • Early preadmission assessments • Centralized systems to gather health and other information about patients before hospital admission • Preoperative innovations such as “prehabilitation” programs for targeted patients • A triage system to identify which patients need to attend a preadmission clinic or program • Use of a multidisciplinary team based clinical care processed within the hospital to coordinate complex preparation of patients before surgery	• Integrated pain management • Fast-track surgery and discharge home • Precise fluid management • OR delay reduction techniques • Increased OR efficiency through improved OR flow • Scheduling initiatives to reduce cancellations and increase efficiency	• Integrated pain management • Early postoperative mobilization by physical therapy and integrated acute-care and rehabilitation care • Improved coordination of care from postoperative to discharge home • Improved discharge protocol • Increased patient and caretaker education concerning post-discharge care

Surgery systems with some or all of these key features are often referred to as the “Perioperative Surgical Home” (PSH) in the United States, as it resembles the well-known and recorded elements and purpose of the patient-centered medical home (PCMH) initiatives for chronic disease management and primary care coordination. Today, in the United States (US) the “perioperative process” of surgery is often referred to and studied as a “surgical home” program or components of the PSH, including patient-centered coordinated surgery programs and fast-track

programs or enhanced recovery after surgery (ERAS). This report is based on a comprehensive literature review that included search terms broad enough to capture various types of "medical home" concepts and elements of PSH studies to cover the depth of knowledge and activities in this evolving field. The report then organizes the broad search results into relevant topic categories, offers relevant findings by topic category and tabulates relevant articles by the topic categories in the appendices. These topic categories allow the reader to understand the current state of activities within these PSH and PSH-like programs in terms of preoperative, intraoperative, postoperative, and perioperative initiatives, expected and reported cost and clinical outcomes, and surgery specialties.

The first section (topic category) of this comprehensive literature review focuses on the history, purpose and evolution of the perioperative surgical home model, building on our experience and learning from the well-established concept of a patient centered medical home (PCMH). A recent review of randomized controlled trials evaluating patient-centered approaches in healthcare reports various patient engagement initiatives, such as the concept of empowered care and educating patients on how to manage their health, and finds that the PCMH benefits were associated mostly with improved patient satisfaction and perceived quality of care (McMillan et al., 2013). Today, more and more evidence appears in the healthcare literature to support PCMH models and the underlying principle of one personal doctor who coordinates the patient's care and engages a team of professionals and the patient in an individualized treatment and management plan (Pourat, Lavarreda, & Snyder, 2013). The PCMH is a patient centered care model that embodies principles laid out by the Institute of Medicine (IOM) and is thought to be the means to improved care coordination and patient satisfaction (Robert Graham Center, 2007). In general, patient centered care initiatives have improved clinical outcomes, perceptions of quality of care, and patient satisfaction; both the medical home and the surgical home share a vision of improved outcomes in quality and cost of care while incorporating similar elements of patient engagement and care coordination (Vetter, Goeddel, et al., 2013). Coordination is often lacking in the surgical care process; the medical home concept provides a relevant model to address this lack of coordination that has recently been evaluated for both impact on clinical outcomes and cost of surgery (Warner, 2011). The surgical home concept seems to be well positioned to fill a void similar to the void observed in the primary care and chronic disease management arena, as it focuses on the coordination of care and patient engagement in all aspects of the perioperative care process.

Today, PSH program titles and descriptions still vary across hospitals, states, and countries. These variations in program terminology, program features, and foci required us to approach the literature review in a systematic and comprehensive manner. We started with broad concepts and search terms describing this new paradigm shift in surgical care and moved to more specific search terms covering particular features and phases of a perioperative surgery system or PSH. This review of literature covers the history, nature, elements, processes, and empirical research on outcomes and performance of PSH programs studied in the US and internationally. In order to help categorize and organize relevant studies of and literature on the PSH, the research team organized the literature review approach and reporting of results by targeting the following seven topic categories:

1. **Surgical home concept:** This includes references, general literature reviews, and the history of coordinated surgical care that might refer to programs as a perioperative surgical home, a patient-centered coordinated surgery program, or any combination of two or more of the preoperative, intraoperative and postoperative phases in order to reduce cost and improve clinical outcomes. This search category is aimed at an improved understanding of the PSH concept and its current stage of development.

2. **Early patient engagement:** This search category focuses on programs or other organized activities to engage patients in the surgery process before the scheduled surgery. Efforts and initiatives might include: engaging patients to create open communications, supporting and educating patients to make decisions and participate in the process of undergoing surgery as either an inpatient or outpatient, and reducing unrealistic expectations.

3. **Reduced pre-op testing:** Early research results on PHS models and programs have shown promising results, such as reducing the need for and duplicated efforts in pre-op testing and associated risks. Unnecessary and

duplicative testing results in significantly increased costs with no benefit to patients, physicians, or healthcare facilities. By coordinating preoperative testing and ensuring that only those tests that are necessary based on the patient's individual medical conditions are given, the PSH is expected to achieve cost savings without negatively impacting patient care.

4. **Intraoperative efforts leading to better efficiency:** Other promising efficiencies linked to the PSH concept include reducing delays, increasing surgical facility throughput, and optimizing equipment and devices utilized. These efficiencies allow the PSH team to achieve more efficient care without sacrificing quality. The literature review aims to find examples of better efficiencies in PSH initiatives studied.

5. **Postoperative care initiatives:** The PSH concept includes elements that improve patient outcomes and reduce costs related to postoperative care coordination and innovation. Having the PSH team coordinate postoperative care may result in improvements in the incidence of postoperative nausea and vomiting, reductions in the severity and duration of postoperative pain, achieving patient mobility sooner and, for patients undergoing inpatient surgical procedures, the likelihood of earlier discharge from the hospital setting. This step in the literature review aims to find specific examples of such programs and initiatives and evidence for improved quality and cost outcomes and new knowledge.

6. **Reduced postoperative complications:** The PSH team approach to patient care may result in fewer postoperative complications. In addition, when such complications do occur, they are likely to be recognized sooner and treated more efficiently. These improvements will result in lower overall costs associated with postoperative complications. This section of the literature reviews seeks to find actual examples of specific approaches to detection and reduction of post-op complications and their reported and expected outcomes.

7. **Care coordination and transition planning:** Early discharge planning, especially for patients undergoing inpatient procedures, will result in decreased hospital stay and thus decreased cost of care, allowing earlier transfers to more appropriate care settings, such as rehabilitation centers, skilled nursing facilities or, with the proper support, to the patient's home. The review focused on identifying and describing such initiatives.

The literature review was designed to address each of the elements of the PSH concept by finding specific examples of efforts linked to the element, such as patient engagement, pre-op testing and care coordination and transition planning, and to quantify the expected outcomes in terms of clinical outcomes and reductions in cost of care. Therefore, all of the above topic areas were studied in terms of two criteria:

- **Clinical outcomes:** Better care coordination and increased standardization while still allowing for patient variability has been shown to result in better clinical outcomes.
- **Cost reduction:** Just as the PCMH results in cost savings across ambulatory care settings, the PSH is expected to result in cost reductions in both inpatient and outpatient surgical settings.

The research team was also interested in non-peer reviewed literature that might offer PSH program details, such as processes, pathways, and guidelines that resulted in savings to the healthcare systems, particularly those providing care to patients under the newer payment models, such as bundled payment. Peer-reviewed sources of empirical studies of PSH programs are covered in Phase 1 of the literature review and are distinguished from reports and other sources of information gathered and analyzed in Phase 2. Phase 2 literature review incudes any source of information, including published newsletters, websites, professional blogs, public reports, and interviews with experts in the field. Phase 2 findings are summarized and presented by emerging themes and organized into topic categories covered. We also attempted to focus on a select number of PSH examples covered in this literature, offering a more detailed evaluation and description of a few models of practice.

METHODS: LITERATURE REVIEW APPROACH

Phase 1: Peer-Reviewed Literature

For the first version of this comprehensive literature review, we performed searches between June 2013 and August 2013 of the English-language literature indexed in PUBMED (1975 to 2013) and Google Scholar using a broad set of terms to maximize sensitivity. This project incorporated three means of article retrieval: 1) a comprehensive search of available literature using PubMed and Google Scholar, 2) reference crawling of all selected articles, and 3) articles provided to the research team by the ASA contact person. The research team retrieved and evaluated a total of 258 potentially relevant studies related to the general topic of the PSH, its history, development, and elements of a PSH. Of this total, 133 were deemed relevant; 8 of these articles were in non-peer-reviewed publications. The search parameters for the comprehensive literature review included empirical studies, review articles, and other materials that directly related to the concept of a perioperative surgical system. These articles were identified using search terms listed in Table 2. Researchers reviewed the abstract and methods section of each paper to determine if the contents of the paper fit the selection criteria for the seven enumerated topic categories related to the surgical home concept. Exclusion criteria were driven by publication date; in general, researchers excluded articles published prior to 1975 except for topic 6 (Reduced Postoperative Complications), which had to be restricted to more recent articles to ensure relevancy to the general concept of PSH. The ASA provided a total of 34 articles for inclusion, of which 28 were in peer-reviewed journals, yielding a total of 153 peer-reviewed articles. The 153 included articles have been cited a total of 28,638 times in the current peer-reviewed literature. A total of 68 peer-reviewed studies were conducted in the US. These studies were published between 1980 and 2013. See Phase 2 of this section for a discussion of non-peer-reviewed sources.

This search process was reperformed in January and May of 2014 in order to (a) update findings to include items published after August 2013 and (b) include articles suggested by interested parties after reading the first version of the document. In January, the searches of the published literature yielded a total of 23 articles for inclusion, 19 of which were in peer-reviewed journals. A total of 22 articles were suggested by the ASA and other interested parties, 20 of which were in peer-reviewed journals. In May, the searches of the published literature yielded a total of 21 articles for inclusion, all of which were in peer-reviewed journals. A total of 15 articles were suggested by the ASA and other interested parties, 15 of which were in peer-reviewed journals. Thus, a total of 228 peer-reviewed articles are now included in this report. These articles have been cited a total of 27,988 times.

Table 2. Literature Search Strategy

Search Category	Search Terms Used	Selection Criteria	Exclusion Criteria
1. The Surgical Home Concept	• "perioperative surgical home" • "surgical home" • patient-centered coordinated surgery program • "cost" or "outcome"	Related to the concept of the surgical home, or any combination of two or more of the following: preoperative, intraoperative and postoperative coordination	Articles published prior to 1975
2. Early Patient Engagement	• "early patient engagement" • "perioperative surgical home" • "patient-centered	Focuses on programs and efforts to engage patients in the surgery process before the scheduled surgery	Articles published prior to 1975

Table 2. Literature Search Strategy			
Search Category	**Search Terms Used**	**Selection Criteria**	**Exclusion Criteria**
	coordinated surgery program” • "cost" or "outcome"		
3. Reduced Preoperative Testing	• “perioperative surgical home” • “reduced preoperative testing” • "Unnecessary testing "OR” duplicative testing” • “patient-centered coordinated surgery program” • "cost" or "outcome"	Focus on ensuring provision of only tests that are necessary based on the patient’s individual medical conditions	Articles published prior to 1975
4. Intraoperative Efforts to Improve Efficiencies	• "intraoperative efficiency” • "surgical facility“ or ”equipment” or ”devices utilized” • “reducing delays” • “perioperative surgical home” • “patient-centered coordinated surgery program” • "cost" or "outcome"	Linked to the PSH concept and reducing delays, increasing surgical facility throughput and optimizing equipment and devices utilized	Articles published prior to 1975
5. Postoperative Care Initiatives	• "Post-procedural care initiatives" • "care initiatives" • "post-procedural"	Directly related to the concept of a surgical home	
6. Reduced Postoperative Complications	• “reduce complications” • “efficiency”	Directly related to the concept of a surgical home	Articles published prior to 2005
7.Care Coordination and Transition Planning	• "care coordination" • "transition planning" • "inpatient procedures" • "skilled nursing facilities" • "rehabilitation centers" • "cost reduction" • “post surgery” • “after surgery”	Directly related to the concept of a surgical home	

Phase 2: Non-Peer Reviewed Literature

As a secondary phase of our literature review, we searched for and analyzed non-peer-reviewed sources of information on the perioperative surgical home. Examples of non-peer-reviewed articles are ASA information briefs

and articles, governmental publications, and health organizations' white papers, other briefs, and model documentation. These sources were identified with the input of ASA members (6 sources), a comprehensive search of the ASA website for the term 'surgical home' (9 sources), Google searches for 'perioperative surgical home' (4 sources), and grey literature sources identified in the course of the peer-reviewed search (8 sources) for a total of 27 sources. These searches were also reperformed in January and May of 2014, yielding a total of 8 new sources and bringing the total number of non-peer-reviewed items to 35.

PHASE 1: RESULTS BY CATEGORY

1. THE SURGICAL HOME CONCEPT

Data Sources and Search Strategy

The search terms for this topic category included: "perioperative surgical home" which retrieved 29 results, "patient-centered coordinated surgery program" which retrieved 4 results, "preoperative" and "intraoperative" and "cost" or "outcome" which retrieved 35 results, "preoperative" and " postoperative " and "cost" or "outcome" which retrieved 108 results, and "intraoperative" and "postoperative" and "cost" or "outcome" which retrieved 86 results.

After a detailed review of these articles, we only selected those papers that focused on PSH and PSH-like programs. The final number of peer-reviewed articles for this topic was 73. See Appendix A for a detailed description of these articles. Some of the articles not included in Appendix A are included in one of the other six sections and relevant appendices.

The literature studied within this first general PSH topic category falls into three main sub-topics: the history and evolution of PSH concept, concepts related to the PSH, and review of different PSH models.

History and Evolution

The surgical home concept has evolved over the last two decades. In the 1960s, primary care was recognized as a separate entity and a primary care medical home was created for ill children (Kilo & Wasson, 2010). In the 1970s and 1980s, innovations in information technology improved capabilities that facilitated continuity of care and patient behavioral interventions (A. Lee et al., 2011). In the 1990s, driven by the emphasis on cost containment in the healthcare delivery system, the department of anesthesiology at the University of Pittsburgh developed the concept of the "perioperative process" (Rotondi et al., 1997). Rotondi, Williams and other researchers benchmarked the perioperative process. Their findings showed that a real-time patient routing system, which tracks the progress of patients during the perioperative process, could increase the operating room (OR) utilization efficiency and reduce OR delay. They also proved that anesthesia clinical pathways improved process outcomes, reduced nursing labor intensity, and saved costs.

In addition, during the late 1990s and early 2000s, the VA system was developing the National Surgical Quality Improvement Program (NSQIP) to improve the quality of surgical care. Several studies document the NSQIP development process and its success in improving quality of care in both the VA and in the private sector (S. F. Khuri, 2006; S. F. Khuri et al., 1998; S. F. Khuri et al., 1997).

In 2006, the ASA Task Force on Future Paradigms in Anesthesia Practice advised anesthesiology training programs to expand their focus beyond operating rooms to include perioperative management and critical care (Fleisher et al., 2007). Since the release of this report, more academic institutions have expanded their training programs accordingly (Johnstone, 2012). The Patient Protection and Affordable Care Act (PPACA) of 2010 included legislation promoting Accountable Care Organizations (ACOs), which are generally designed to hold multiple providers jointly accountable for achieving target quality and reductions in cost of care per capita for a designated

patient population within an integrated health system. As two-thirds of hospital costs relate to surgical care, operating room efficiency is a primary focus for the ACO initiative within PPACA. According to Johnstone (2012), in order to meet ACO requirements, the anesthesiologist must include the preoperative and postoperative process under their director responsibilities (Johnstone, 2012a). The PSH is one way for anesthesiologists to do this (Szokol & Stead, 2014). The ASA has reaffirmed a growing commitment to perioperative care, stating that "through perioperative homes, anesthesiologists can help hospitals and other healthcare organizations meet the aims and priorities of national quality strategy" (Johnstone, 2012).

Later studies revealed the difficulty of establishing practice guidelines in the implementation of the key elements of a PSH, which are highly concentrated within the preoperative process. For example, related to the reduction of unnecessary preoperative tests and content unmet preoperative assessment needs in large health systems, Newman et al. argued:

> *"If clear guidelines can be implemented, then the preoperative assessment can be appropriately designed, delays prevented, surgery completed, and outcomes improved. In other cases in which diagnostic findings do not require further presurgical assessment or intervention but instead define long-term risk, this information should be passed forward with electronic health records or other mechanisms to allow the timely yet appropriate care of the patient."* (M. F. Newman, Mathew, & Aronson, 2013)

A more recent paper by Vetter and colleagues based on the PSH at UAB explains the basic components of a PSH and discusses a methodology to evaluate the effectiveness of PSH initiatives, including both the measures necessary for a thorough evaluation and suggestions concerning study design (Vetter, Ivankova, & Goeddel, 2013).

Related Concepts

Currently, there are several concepts being researched related to the PSH concept, including patient-centered coordinated surgery programs and fast-track programs or enhanced recovery after surgery (ERAS).

Patient-Centered Coordinated Surgery Programs: The Institute of Medicine defines patient-centered care as care that establishes a partnership between providers and patients and provides patients with the support they need to make decisions and participate in their own care (Oates, Weston, & Jordan, 2000). In 2010, Bakhtiari proposed four key success factors for patient centered care: 1) "Link the care continuum", 2) "Involve families", 3) "Listen to the patient" , and 4) "Improve OR efficiency" (Bakhtiari, 2010). A more patient center surgical model can improve the quality and speed of the operation, which will influence patient satisfaction and reduce costs and mistakes.

Enhanced recovery after surgery (ERAS) programs: Eskicioglu and colleagues (2009) describe ERAS programs as "multimodal perioperative programs that aim to accelerate recovery, shorten hospital stay, and reduce complication rates following surgery" (Eskicioglu, Forbes, Aarts, Okrainec, & McLeod, 2009). ERAS programs include many preoperative, intraoperative, and postoperative interventions. The preoperative interventions include "extensive preoperative counseling, avoidance of mechanical bowel preparation (MBP), avoidance of fasting, avoidance of premedication, administration of pre- and probiotics, and preoperative carbohydrate loading until 2 h prior to surgery" (Wind et al., 2006). Intraoperative interventions include "strict fluid management to avoid fluid overload, normothermia, hyperoxia, and tailored optimal analgesia"(Fearon et al., 2005). Postoperative interventions include "epidural anesthesia, early routine mobilization, early enteral nutrition, avoidance of nasogastric (NG) tubes, avoidance of peritoneal drains, and early removal of catheters" (Wind et al., 2006). PSH programs contain many of the same components of ERAS, but are expanded in terms of patient care coordination (Cannesson & Kain, 2014).

Models

Different stakeholders have proposed alternative but closely related surgical home models. Two frequently cited models are the Michigan Surgical Quality Collaborative program and the PSH model developed at the University of Alabama at Birmingham.

The Michigan Surgical Quality Collaborative (MSQC) Program: This program is funded by Blue Cross Blue Shield of Michigan and Blue Care Network (BCBSM) (Prager, Moscucci, Birkmeyer, & Arbor, 2005). The program measures surgical outcomes and quality improvement programs in cardiac, bariatric and other areas of general vascular surgery and participating hospitals state-wide and incentivizes these hospitals using a pay-for-participation scheme. (Prager et al., 2005). Hospitals participating in the plan show reductions in operative mortality and complication and lower costs as a result of lower complication rates. However, this program costs nearly $5 million to implement annually. If the program cannot provide a substantial and sustainable improvement of quality and reduction of cost for these hospitals, the funding will be an issue (Prager et al., 2005).

The UAB model: This model proposes "a seamless continuity of current best practices of care" provided by the anesthesiologists, who are serving as the surgical patient's primary "perioperativist." The model asks for engagement of the patient, family, and other healthcare provide and emphasizes shared decision-making (Vetter, Goeddel, et al., 2013). In the UAB Perioperative Surgical Home model, anesthesiologists are charged with ensuring continuity of care across the entire perioperative process. (Vetter, Goeddel, et al., 2013). The primary goal of this model is to improve "clinical outcomes and decrease unnecessary resource utilization" (Vetter, Goeddel, et al., 2013).

The UC Irvine Model: Findings from early studies on the UC Irvine PSH program show promising results in terms of improved patient outcomes and efficiency. The UC Irvine PSH program has focused on the development of detailed clinical care pathways that span the perioperative spectrum in certain surgery lines. Findings from a small-scale study following the implementation of PSH care pathways in the joint surgery line showed no incidence of major complication or death, low perioperative blood transfusion rates (6.2%), and median length of stay of 3 days (Garson et al., 2014).

2. EARLY PATIENT ENGAGEMENT

Data Sources and Search Strategy

The search terms for this topic included: "early patient engagement" and "perioperative surgical home" which retrieved 25 results, "early patient engagement" and "patient-centered coordinated surgery program" which retrieved 3 results, and "early patient engagement" and "cost" or "outcome" which retrieved 15 results.

After a detailed review of these articles, we only selected those papers that focused on programs and efforts to engage patients in the surgery process before the scheduled surgery. The final number of peer-reviewed articles for this topic was 23. See Appendix B for a detailed description of these articles.

The literature studied under this topic falls into three sections: the effect of early patient engagement on the patient's risk assessment, the effect of early patient engagement on OR efficiency improvement, and the effect of early patient engagement and surgical outcomes.

Early Patient Engagement on Patient's Risk Assessment

Previous research shows efforts and initiatives to engage patients early is beneficial to both the patient and the healthcare enterprise by creating open communications, supporting and educating patients to make decisions and participate in the process of undergoing surgery, and reducing unrealistic expectations (Carli, Charlebois, Baldini, Cachero, & Stein, 2009; Ergina, Gold, & Meakins, 1993; Ferschl, Tung, Sweitzer, Huo, & Glick, 2005; Knox, Myers, Wilson, & Hurley, 2009; Leichtle, Mouawad, Welch, Lampman, & Cleary, 2012).

A critical paper in the initial research into early patient engagement studied the effects of preoperative care on patients with COPD (Ergina et al., 1993). This used "patient education to promote postoperative compliance, cessation of smoking, training in breathing techniques, deep breathing exercises, or incentive spirometry, and if needed, weight reduction" as preoperative care measures (Ergina et al., 1993). To ascertain which patients needed these measures, the providers in this study provided a risk assessment for each patient to ascertain risk level and

tailored the care management for different risk profile patient. They concluded the preoperative risk assessment is important since it leads to "appropriate perioperative management strategies" to get optimal outcomes (Ergina et al., 1993). This study was the impetus for the emphasis on preoperative risk assessments in later early patient engagement literature. For example, more recent research studying colorectal surgery found that preoperative evaluations helped to distinguish patients requiring more intensive postoperative surveillance for anastomotic leakage and to reduce complications (Leichtle et al., 2012). Another study found that preoperative risk assessment can accurately predict non-home discharge, which can assist in the coordination of care and potentially reduce costs by minimizing hospital stays for these patients (Pattakos, Johnston, Houghtaling, Nowicki, & Blackstone, 2012).

A study by Knox and colleagues (2009) shows that standardizing the preoperative assessment process by reducing "redundancy, avoiding surgery delays and cancellations, [and] improved reimbursement coding, [preoperative testing could] offset the increased costs of setting up and running the clinic" (Knox et al., 2009). The standardizing process includes collecting complete patient history and results of physical examinations; coordinating the surgical, anesthesiology, and nursing assessments; ordering tests; and providing information for documentation and billing (Knox et al., 2009).

However, other researchers found that abnormal preoperative tests have limited ability to predict adverse perioperative outcomes(Fritsch et al., 2012). Similarly, Mythen affirmed the positive influence of preoperative clinic, but questioned the timing of preoperative evaluation in the setting studied (Mythen, 2011). According to Mythen, the preoperative evaluation should take place before the initial surgical evaluation, which gives patients an opportunity to participate in the decision as to whether or not the surgery is necessary (Mythen, 2011).

Recent research has also focused on the efficacy of 'prehabilitation,' or prescribed exercise programs before surgery to reduce postoperative complications and/or speed up recovery. A literature review on this topic found that preoperative aerobic exercise was associated with reduced postoperative and ICU stay and improved postoperative physical fitness (O'Doherty, West, Jack, & Grocott, 2013).

Early Patient Engagement and OR Efficiency Improvement

Other research focuses on the reduction of operating room (OR) cancellations and delays by preoperative program (Correll et al., 2006; Ferschl et al., 2005). Ferschl et al. reviewed all 6 month surgical cases of University of Chicago Hospitals and found a visit to an anesthesia preoperative medicine clinic (APMC) were associated fewer same-day surgery cancellation and an earlier room entry time than the non AMPC patients (Ferschl et al., 2005). Correll and colleagues found similar results in a study of 5,083 patients in a preoperative clinic at Brigham and Women's Hospital in Boston. They also found that preoperative evaluation was useful in identifying and resolving medical issues through information retrieval or testing (Correll et al., 2006). Later articles brought out the issue of the impact of the preoperative clinic beyond surgery cancellations. Glick confirmed APMCs could decrease perioperative morbidity and mortality, as well as improve OR efficiency by reducing OR turnover time and cancellations (Glick, Tung, Ferschl, & Sweitzer, 2006).

Early Patient Engagement and Surgical Outcomes

Preoperative education and counseling have been shown to improve surgical outcomes in multiple studies. For example, a study by Jones and colleagues in 2011 on knee joint arthroplasty patients shows that a preoperative education program significantly reduces the length of stay after surgery, and lower complication and readmission rates within 3 months of discharge (Jones et al., 2011). Carli and colleagues investigated the impact of a series of coordinated programs on colonic surgery outcomes. The coordinated programs included "preoperative patient education and counseling, a laparoscopic approach, provision of postoperative epidural analgesia, early food intake and mobilization, and structured surgical and nursing care practices" (Carli et al., 2009). The results show that those coordinated programs are feasible and have positive effect on readmission rates (Carli et al., 2009).

Preadmission behavior counseling may also have an effect on clinical outcomes. Mayo et al. reported that preoperative exercise may influence recovery of functional capacity after colorectal surgery (Mayo et al., 2011).

Wong et al. reviewed short-term preoperative smoking cessation and found smoking cessation more than four weeks before surgery may decrease the risk of postoperative respiratory complications (Wong, Lam, Abrishami, Chan, & Chung, 2012).

Note that many enhanced recovery programs include preoperative patient engagement and management. See the literature in section 5 for more information.

The Role of the Anesthesiologist

Thilen et al. explored the opportunity for anesthesiologists to add value by controlling preoperative resources (S. Thilen, Treggiari, & Weaver, 2012). Using a 20% n ational random sample of Medicare part B claims data from 2006, they found a large number use of preoperative consultations and preoperative testing for low risk patients who had ordinary procedures. They suggested more rational use of these tests, which could achieve considerable savings. According to Thilen, "Anesthesiologists are well positioned to guide and implement such use" (S. Thilen et al., 2012).

3. REDUCED PRE-OP TESTING

Data Sources and Search Strategy

The search terms for this topic included: "perioperative surgical home" and "reduced preoperative testing" which retrieved 23 results, "preoperative" and "cost" or "outcome" which retrieved 55 results, "Unnecessary testing " or " duplicative testing" " and "cost" or "outcome" which retrieved 67 results.

After a detailed review of these articles, we only selected those papers that focused on programs and efforts to reduce unnecessary preoperative testing before the scheduled surgery. The final number of peer-reviewed articles for this topic was 25. See Appendix C for a detailed description of these articles.

The literature studied under this topic falls into two categories: cost reductions as a result of preoperative testing and the effect of reduced preoperative testing on surgical outcomes.

Cost Reductions as a Result of Decreased Preoperative Testing

The costs of preoperative testing are considerable (Chung, Yuan, Yin, Vairavanathan, & Wong, 2009). Minimizing unnecessary preoperative tests could reduce nationwide healthcare costs by $10 billion and actually improve patient experience and care (Brown & Brown, 2011). Early research results on PHS models and programs have shown promising results in terms of reduced testing.

In 2005, Finegan and his colleagues found that selective ordering of investigations by anesthesiology staff as opposed to non-anesthesiologist staff decreased the number and cost of testing, saving the clinic on average $73/patient (Finegan, Rashiq, McAlister, & O'Connor, 2005). Clinical decision support systems have also reduced unnecessary preoperative tests and reduced costs (Procop, Yerian, Wyllie, Harrison, & Kottke-Marchant, 2014). Various other studies have shown that routine testing, rather than selective testing, accrues no benefit to the patient population but excessive costs to the healthcare organization (Cooper et al., 2013; J. P. Fischer et al., 2014; Mantha et al., 2005; Sousa Soares et al., 2013).

Effect on Clinical Outcomes

Canadian researchers investigated the possibility of eliminating the preoperative tests without escalation of "the perioperative incidence of adverse events" in an ambulatory surgry setting and found that patients that did not receive standard preoperative tests showed no increase in adverse perioperative events compared to those who did (Chung et al., 2009). This is even supported for vulnerable populations. Aarts and colleagues reviewed previous literature and found that for the majority of older patients with well-controlled coexisting diseases, routine lab testing is a waste of resources (Aarts et al., 2012).

However, some studies do find beneficial clinical outcomes for preoperative evaluations. For example, Vazirani and colleagues found that "a structured medical preoperative evaluation may benefit medically complex patients and improve perioperative processes and outcomes" (Vazirani, Lankarani ‐ Fard, Liang, Stelzner, & Asch, 2012).

Factors Contributing to Excessive Preoperative Testing

Researchers from the University of Arizona identified five key factors related to unnecessary preoperative tests through provider surveys. (Huesch, 2013). They found that "practice tradition, belief that other physicians want the tests done, medicolegal wrries, concerns about surgical delays or cancellation, and lack of awareness of evidience and guidelines" prompted the excessive testing. (Huesch, 2013). These tests may, in many cases, be performed even when not indicated by testing guidelines; one study found that only 12.1% of surgical patients received testing that complied with institutional recommendations; this cost the institution an estimated $200,000 (Siriussawakul et al., 2013). Another study found that too many tests are performed perioperatively due to a lack of perioperative data sharing (Frost, 2012). Frost suggested that better communication with surgeons, consultants, and patients could impvore healthcare needs and decrease costs at simultaneously.

4. INTRAOPERATIVE EFFORTS LEADING TO BETTER EFFICIENCY

Data Sources and Search Strategy

The search terms for this topic included: "intraoperative efficiency" and "perioperative surgical home" which retrieved 8 results, "reducing delays" and "surgical facility "or" equipment" or" devices utilized" which retrieved 35 results, and "intraoperative efficiency" and "patient-centered coordinated surgery program" which retrieved 3 results.

After a detailed review of these articles, we only selected those papers that focused on programs and efforts leading to greater efficiencies in the surgery process. The final number of peer-reviewed articles for this topic was 22. See Appendix D for a detailed description of these articles.

The literature studied under this topic falls into two sections: OR efficiency and reduction of delays.

Delays

Rotondi and his colleagues benchmarked the perioperative process by designing and applying a real-time patient routing system to trace the patient throughout the perioperative process to predict delays (Rotondi et al., 1997). They summarized three major causes of OR delay: patient issues, such as insurance problems, tardiness, lack of adherence to preoperative protocol, or complications; system issues, such as unavailability of tests, transportation delays, unavailability or malfunction of equipment, or insufficient post-procedure care beds; and practitioner issues, such as tardiness, lack of consent, or unavailability of anesthesiologists or OR staff. (Rotondi et al., 1997). Their study found that the real-time patient routing system was very useful to decrease OR delays and improve perioperative surgery efficiency (Rotondi et al., 1997).

Cosgrove and colleagues performed an audit of the perioperative process in an urgent surgery setting and then disseminated guidelines for reducing delays and performed a second audit. They found "a significant reduction of delays, a significant increase in the availability of surgeons and a significant decrease in the median waiting time for urgent surgery compared to the first audit cycle and a previous standard" (Cosgrove, Gaughan, Snowden, & Lees, 2008). Another method to reduce delays was implemented in the PSH model developed by the University of Alabama at Birmingham. It mitigates the risk of case delays and cancellations on the day of surgery by using a real-time electronic dashboard to ensure access electronic medical record and efforts of the preanesthesia clinic (Vetter, Goeddel, et al., 2013).

Overall Efficiency

One study examined the influence of deliberate perioperative system design on operative room throughput (Sandberg et al., 2005). The authors designed a three-room suite including an OR, a preoperative preparing room,

and an early recovery area. By changing traditional sequential activates to parallel design, the new workflow processed more cases per day and used less time for both operative and non-operative processes. The results proved that deliberate OR and perioperative process redesign can improve throughput without sacrificing quality (Sandberg et al., 2005). Newman et al.suggest that preanesthesia clinics can increase efficiencies if they are run in the conjunction with the rest of the perioperative process but can be difficult to implement successfully if they are not (M. F. Newman et al., 2013). A recent initiative at the Mayo clinic used Lean and Six Sigma methodologies to streamline OR processes by creating a value stream map depicting personnel, information processing, and time at each step. The newly designed process yielded decreased wait times, increased on-time arrivals and starts, decreased turnover and operating time, and increased operating margin (Cima et al., 2011).

Improved Quality of Care

One study investigated whether laparoscopic same-day surgery, which is associated with shorter operating time, improved or hurt patient outcomes and found that odds of postoperative complications increased with increased operating time, indicating that faster operations (i.e. laparascopic surgery) may improve patient care (Jackson, Wannares, Lancaster, Rattner, & Hutter, 2011). Other studies found that surgical team dynamics (as measured by action-team learning) and continuous quality improvement efforts can improve outcomes, patient safety, and quality of care (Vashdi, Bamberger, & Erez, 2013; Vetter, Ali, & Boudreaux, 2012)

5. POSTOPERATIVE CARE INITIATIVES

Data Sources and Search Strategy

The search terms and results for this topic included: "Post-procedural care initiatives" and "surgical home" which retrieved 2 results, "post-procedural" and "surgical home" which retrieved 33 results, and "care initiatives" and "surgical home" which retrieved 3 results. Search results were then each reviewed to determine their relevancy to the defined topic area. Only one of the findings from these searches was deemed relevant to the topic area so the general term "perioperative surgical" term was added; this search yielded 37 results, seven of which were relevant for a total of eight. These eight search results were added to the publications provided by ASA. Finally, the entire final collection of 228 included publications was then reviewed by researchers to determine which fit this topic area.

After a detailed review of these articles, we only selected those papers that focused on programs and initiatives related to best procedural care processes. The final number of peer-reviewed articles for this topic was 19. See Appendix E for a detailed description of these articles.

Leading Initiatives

Kehlet & Mogensen introduced fast-track surgery in 1999 to improve recovery and length of stay (Kehlet & Mogensen, 1999). The goal of fast-track protocols is to both quicken patient recovery and reduce morbidity; the former often results in shorter length of stay and thus decreased cost, but the primary aim is patient care (Aboulian, Hassan, Lin, Kaji, & Kumar, 2010). Enhanced recovery after surgery (ERAS) programs were developed around the fast-track surgery strategy to decrease complications and to hasten patient recovery, encouraging early discharge (Aarts et al., 2012). ERAS programs have been shown to reduce postoperative hospital stay (Knott et al., 2012; Ramirez et al., 2011; Ren et al., 2012; Sammour, Zargar-Shoshtari, Bhat, Kahokehr, & Hill, 2010).

The ERAS initiative has garnered increasing support since its introduction. A group comprised of surgeons that investigate best practices founded the ERAS society to support the initiative; they have recently published three new and updated surgery specific guidelines (Gustafsson et al., 2012; Kristoffer Lassen et al., 2012; Society, 2013). The ERAS society's research focus is stated well by Urbach & Baxter: "The immediate challenge to improving the quality of surgical care is not discovering new knowledge, but rather how to integrate what we already know into practice" (Urbach & Baxter, 2005).

Other initiatives relate to changes in types of anesthesia provided to manage postoperative pain. For example, one study investigated the effect of TAP (tranverse abdominis plane) blocks after laparoscopic surgery and found that the use of TAP reduced hospital stay by 1 day and the patient's need for narcotics (Favuzza, Brady, & Delaney, 2013).

Clinical Outcomes

The literature shows time and again that ERAS programs decrease hospital length of stay; this is achieved by faster recovery after procedures that adhere to ERAS protocols. A study of an enhanced recovery program for colorectal resections in five European cites showed that protocol adherence declined in the postoperative phase, suggesting that increased organization of care may improve adherence (Maessen et al., 2007). The University of Alabama Perioperative Surgical Home employs one anesthesia-intensivist to work with a group of mid-level providers to provide consistent, focused postoperative care as opposed to standard postoperative care provided twice a day by the surgical attending physician (Vetter, Goeddel, et al., 2013).

The Role of the Anesthesiologist

A team approach will improve the implementation of ERAS programs and associated outcomes (Kahokehr, Sammour, Zargar-Shoshtari, Thompson, & Hill, 2009). By increasing the role of the anesthesiologist in the perioperative process, efficiency and communication could be improved, decreasing morbidity and mortality that are caused by errors and insufficient care coordination (Warner, 2011).

6. REDUCED POSTOPERATIVE COMPLICATIONS

Data Sources and Search Strategy

The search terms and results for this topic included: "reduced complications" and "surgical home" retrieved 27 results and "efficiency" and "surgical home" retrieved 190 results. Search results were then each reviewed to determine their relevancy to the defined topic area. Six search results of the total 195 hits were added to the publications provided by ASA. The entire final collection of 228 publications was then reviewed by researchers to determine which fit this topic area.

After a detailed review of these articles, we only selected those papers that focused on programs and efforts to reduce postoperative complications. The final number of peer-reviewed articles for this topic was 31. See Appendix F for a detailed description of these articles.

Overview

This topic area looks to specific examples of improvements in postoperative complications. Hospital performance is increasingly being measured by rates of complication rates (Krupka, Sandberg, & Weeks, 2012). Surgical complications increase the cost of care and can reach up to $58,000 per case, depending on the associated severity; the average cost of surgical complications in 2010 dollars was $35,465, which was $17,000 more than for patients who did not experience complications (Krupka et al., 2012).

Clinical Outcomes

Collaborative efforts have been shown to reduce complications, mortality, and costs. Complications for those in the ERAS group of an elective colonic surgery were found to be significantly fewer (Sammour et al., 2010). The Blue Cross Blue Shield Cardiovascular Consortium of Michigan efforts decreased hospital mortality by 25 percent in the first four years, the Keystone Collaborative decreased blood-stream associated infections by 66 percent in two years (saving $160 million), and the Northern New England Cardiovascular Consortium reduced hospital mortality by 24 percent by holding an intervention focused on data feedback and quality improvement. (Campbell, 2009).

Two articles discuss the potential to manage postoperative delirium (POCD) through the PSH and similar programs (Crosby, Culley, & Dexter, 2014; Krenk et al., 2014). POCD is a common postoperative complication of geriatric

surgical patients. This complication is frequently overlooked and not well managed, so there are opportunities for the PSH to increase awareness and treatment for these patients (Crosby et al., 2014).

Factors Related to Complications

Better communication of details of procedures and postoperative patient responsibilities may improve complication factors contributing to postoperative complications, including perioperative feeding, mobilization, pain control, and respiratory hysiotherapy (Gustafsson et al., 2012). Counseling, printed materials, and multimedia information are common examples of patient educations tools.

While ERAS and other quality control programs can improve complication rates, there are other factors to consider. Fritsch et al. (2012) found that age, surgery type, and medical history are the best predictors of perioperative complications and that preoperative tests have a limited ability to predict perioperative complications (Fritsch et al., 2012). Similarly, Khuri and colleagues found that the greatest indicator of patient survival was the occurrence of a major postoperative complication within 30 days of the operation (S. Khuri, 2005). The geriatric population is prone to multiple comorbidities, putting elderly patients at higher risk of in-hospital complications, longer in-hospital recovery, and postoperative institutionalization (Batsis et al., 2007). Nutritional state can also predict postoperative complications; hand grip has been found to reliably indicate a patient's nutritional state (Guo, Zhang, Ma, Zhang, & Huang, 1996).

7. CARE COORDINATION AND TRANSITION PLANNING

Data Sources and Search Strategy

The search terms and results for this topic included: "care coordination" and "surgical home" which retrieved 13 results, "transition planning" and "surgical home" which retrieved 3 results, "inpatient procedures" and "surgical home" which retrieved 1 result, "skilled nursing facilities" and "surgical home" which retrieved 1 result, "rehabilitation centers" and "surgical home" which retrieved 2 results, "cost reduction" and "surgical home" which retrieved 12 results, "post surgery" and "care coordination", which retrieved 11 results, "post surgery" and "transition planning", which retrieved 3 results, "post surgery" and "discharge planning" which retrieved 26 results, "after surgery" and "transition planning", which retrieved 3 results, "after surgery" and "care coordination" which retrieved 65 results, and "after surgery" and "discharge planning", which retrieved 15 results . Search results were then each reviewed to determine their relevancy to the defined topic area. 9 of the 16 search results were added to the publications provided by ASA. Finally, the entire final collection of 228 included publications was then reviewed by researchers to determine which fit this topic area.

After a detailed review of these articles, we only selected those papers that focused on programs and efforts related to transition planning and care coordination after surgery. The final number of peer-reviewed articles for this topic was 57. See Appendix B for a detailed description of these articles.

Leading Initiatives – Surgical Home Example

The University of California, Irvine Health has developed a prospective Urology Surgical Home model that focuses on communication during transitions, pain management, patient education, and early problem detection. "The Urology Surgical Home seeks to establish a system of coordinated care that increases value for every dollar spent on the surgical care of the patient. This is achieved through standardization, improved clinical outcomes and appropriate resource utilization by providing patient-centered care throughout the entire surgical continuum" (Vakharia, Mentor, Kain, & MBA, 2013). Patient enrollment begins in October 2013 and the program will provide a higher degree of care coordination. This program is expected to decrease complications, thus decreasing length of stay and reducing readmissions (Vakharia et al., 2013).

Clinical Outcomes and Cost Reductions

A meta-analysis of randomized trials of colorectal surgery found that patients in ERAS programs were less prone to postoperative complications and shorter overall hospital length of stay (Eskicioglu et al., 2009). However, England's Enhanced Recovery Partnership Programme highlighted the necessity of consistent tracking measures of patient outcomes, as ERAS protocols are not standardized and not implemented consistently at all hospitals (Knott et al., 2012). Aarts and colleagues found the following ERAS elements to be most closely associated with improved clinical outcomes, particularly decreased length of stay: preoperative counseling, intraoperative fluid restriction, clear fluids on the day the procedure, and catheter discontinuation within one to three days depending on surgery type (Aarts et al., 2012). Hospitals participating in the Michigan Surgical Quality Collaborative, a quality-assurance program focused on improved data recording and sharing to improve perioperative surgical outcomes, saw decreased complications and morbidity after its implementation Campbell Jr et al. (2010). Furthermore, Kariv and colleagues found that fast-track colorectal surgery significantly decreased direct costs per patient almost $1,000 (Kariv et al., 2007), and in a similar study Roulin and colleagues calculated a reduced cost of €1,561 (Roulin et al., 2013).

One criticism of fast-track surgery is that the reduced length of stay results in negative postoperative outcome after discharge (Bardram, Funch-Jensen, Jensen, Kehlet, & Crawford, 1995). For example, one postoperative survey of coronary bypass surgery found significant deficiencies in the current state of postoperative care, including patient pain and patient and caretaker lifestyle adjustments (Theobald & McMurray, 2004). A similar survey of colorectal patients found that discharge protocol did not prepare patients for the extreme fatigue, bowel disturbances, nausea, and anxiety experienced after discharge (Wennström, Stomberg, Modin, & Skullman, 2010). Patients cite a lack of individualized information, inconsistent advice from healthcare professionals, a lack of predischarge assessment of home and work conditions, and a lack of provider follow up as major issues in post-discharge care (Mcmurray, Johnson, Wallis, Patterson, & Griffiths, 2007). Efforts to improve individualized discharge information and care improve both patient satisfaction and improved recovery after surgery (Cornell, Horton, Pamela Williams Russo MD, Paget, & Charlson, 2007; Ellison et al., 2004)

Care Coordination and Postoperative Education Initiatives

Postoperative care coordination may be lacking in many surgical settings (Toscan, Manderson, Santi, & Stolee, 2013). Some health care organizations have attempted to improve care coordination by the use of e-health platforms, where patients can self-report outcomes and interact with care plans. One study of such a program found that patients were able to effectively use the e-health platform and that self-reported data from this program accurately predicted length of stay and discharge home (Cook et al., 2013). Another program attempted to improve care coordination by using a nurse-led post-discharge telephone follow up program but had limited success (J. M. Young et al., 2013).

Other practices have attempted to improve postoperative medication adherence and care coordination by improving preoperative medication education documents. Preliminary results show that improved preoperative medication information may improve postoperative medication adherence and reduced pre- and postoperative anxiety (Miguel & Sagardoy, 2014; Vetter, Downing, Vanlandingham, Noles, & Boudreaux, 2014).

The Role of the Anesthesiologist

Not all clinicians are familiar with ERAS programs and care coordination. Successful ERAS implementation will require multidisciplinary support to avoid common hurdles (Melnyk, Casey, Black, & Koupparis, 2011). The anesthesiologist can coordinate services to improve communication and can address system issues that lead to suboptimal outcomes (Warner, 2011).

TABLE 3. ARTICLES BY SURGICAL SPECIALTY

Specialty	Preoperative	Intraoperative	Postoperative	Perioperative
Abdominal			Klidjian et al. (1980) Putwana et al. (2005) Schaefer et al. (1990)	
Colorectal	Levick et al. (2013) Mayo et al. (2011) Siddel (2013) Siriussawal et al. (2013) Sousa Soares et al. (2013) Thilen et al. (2013)	Hendren et al. (2011) Jackson et al. (2011) Vashdi et al. (2013) Vetter, Ali et al. (2012) Wongyingsinn et al. (2011)	Hendren et al. (2011) Leichtle et al. (2012) Wennstrōm et al. (2010)	Aarts et al. (2012) Aboulian et al. (2010) Abraham and Albayati et al. (2011) Adamina et al. (2013) Archibald et al. (2011) Bardram et al. (1995) Boothe and Finegan (1995) Boudreaux and Vetter (2013) Caplan et al. (1999) Carli et al. (2009) Clark and Spanswick (2013) Delaney et al. (2001) Eskicioglu et al. (2009) Favuzza et al. (2013) Gustafsson et al. (2012) Hardt et al. (2013) Joh et al. (2008) Kahokehr et al. (2009) Kariv et al. (2007) Kehlet (2011) Khuri (2006) Khuri et al. (1997) Khuri et al. (1998) Khuri et al. (2002) Kolozsvari et al. (2012) Kuntz and Vera (2005) Lassen et al. (2009) Lemmens et al. (2009) Lloyd et al. (2010) Maessen et al. (2007) Miller et al. (2014) Mohn et al. (2009) Nanavati and Prabhakar (2013) Nascimbeni et al. (2009) Pawa et al. (2012) Ramirez et al. (2011) Ren et al. (2012) Robinson et al. (2011) Roulin et al. (2013) Rowell et al. (2007)

				Sammour et al.(2010) Teeuwen et al. (2010) Varadhan et al. (2010) Vetter et al. (2012) Vetter et al. (2013) Wiklund and Rosenblaum (1997a) Wiklund and Rosenblaum (1997b) Wind et al. (2006) Young et al. (2013) Young et al. (2014)
General & Cosmetic	Bilku et al. (2014) Cooper et al. (2013) Fischer et al. (2014) Guo et al. (1996) Jones et al. (2011) Mantha et al. (2005) Miguel and Sagardoy (2014) Nepomnayshy et al. (2013) Nielsen et al. (2010) Sharareh et al. (2014) Sigmundsson et al. (2014) Swank et al. (2011) Topp et al. (2009) Trentman et al. (2010)	Ilfield et al. (2005) Ilfield et al. (2006) Ilfield et al. (2010) Nuelle and Mann (2007) Taicher et al. (2011) Trentman et al. (2010) Williams et al. (1998a) Williams et al. (1998b)	Cambell et al. (2010) Cornell et al. (2007) Graham et al. (2014) Holm et al. (2013) Krenk et al. (2014) McMurray et al. (2007) Miguel et al. (2014) Sharareh et al. (2014)	Batsis et al. (2007) Fink et al. (2007) Garson et al. (2014) Hebl et al. (2008) Henderson et al. (2007) Huddleston et al. (2004) Lassen et al. (2012) Macario et al. (1995) Prager et al. (2005) Raphael et al. (2011) Shyu et al. (2012) Toscan et al. (2013)
Pediatric	Holland et al. (2014) Pasquali et al. (2012)		Holland et al. (2014)	Tait et al. (1997)
Thoracic	Finegan et al. (2005) O'Brien et al. (2013) O'Doherty et al. (2013) Pattakos et al. (2013) Veronovici et al. (2013) Walters et al. (2014)	Lako et al. (2014)	Leandro-Merhi et al. (2011) Pattakos et al. (2013) Rinehart et al. (2012) Schaefer et al. (1990) Theobald and McMurray (2004) Walters et al. (2014)	Cook et al. (2013) Fearon et al. (2005) Huesch (2011) Huesch (2013) Lee et al. (2011) Prager et al. (2005) Veronovici et al. (2013)
Trauma	Pearse et al. (2001)	Cosgrove et al. (1998) Pearse et al. (2001)		
Transplant			Garonzik-Wang et al. (2012)	
Vascular				Campbell et al. (2010) Hutter et al. (2007) Johnson et al. (2007) Prager et al. (2005)
Urology			Ellison et al. (2004)	
Multi-Specialty	Bader et al. (2009) Badner et al. (1998) Baron et al. (2014) Brown and Brown (2011)	Cima et al. (2011) Dexter et al. (2014) Fernandez et al. (2014) Gillespie et al. (2012)	Ben-Ishay et al. (2011) Crosby et al. (2014) Kim et al. (2014) Vetter et al. (2014b)	Birkmeyer et al. (2012) Butterworth and Green (2014) Campbell (2009) Cannesson and Kain (2014)

	Chung et al. (2009) Correll et al. (2006) Dexter et al. (2014) Fernandez et al. (2014) Ferschl et al. (2005) Fischer (1996) Garcia et al. (2014) Gibbs et al. (1999) Glick et al. (2006) Holt et al. (2007) Hooper (2013) Huck and Lewandrowski (2014) Kastenberg et al. (2012) Kehlet (1997) Kim et al. (2014) Knox et al. (2009) Newman et al. (2013) Parker et al. (2010) Pasternak (2009) Pollard and Garnerin (1999) Procop et al. (2014) Qaseem et al. (2006) Raes and Poelaert (2014) Sear (2014) Vetter et al. (2014b) White et al. (2012) Wijeysundera et al. (2009) Wijeysundera et al. (2012)	Jacques et al. (2006) Kim et al. (2009) Lagasse et al. (1995) Rockall and Demartines (2014) Rotondi et al. (1997) Sandberg et al. (2005) Sear (2014) Segev et al. (2012)		Cheng (2013) Dasgupta et al. (2009) Dexter and Wachtel (2014) Ergina et al. (1993) Finks et al. (2011) Fleisher et al. (2007) Fried et al. (2001) Fried et al. (2004) Fritsch et al. (2012) Frost (2012) Goldhill et al. (2012) Grocott and Pearse (2012) Holt (2014) Huang and Schweitzer (2014) Hunt et al. (1985) Kain et al. (2014) Kaplan et al. (1985) Kehlet and Dahl (2003) Kehlet and Mythen (2011) Kilo and Wasson (2010) Knott et al. (2012) Krupka et al. (2012) Lee et al. (2011) Mackey (2012) Murphy et al. (2000) Mythen (2011) Mythen et al. (2012) Newman et al. (2006) Oates et al. (2000) Ryan et al. (2004) Seim and Sandberg (2010) Shafer and Donovan (2014) Share et al. (2011) Stenholm et al. (2008) Szokol and Stead (2014) Varadhan et al. (2010) Vazirani et al. (2012) Vetter et al. (2013) Vetter et al. (2014a) Vischer et al. (2012) Watters (2002) Webb et al. (1989)

PHASE 2: REVIEW OF NON-PEER-REVIEWED LITERATURE

Trends in Healthcare Improvement

Population demands for healthcare quality improvement are widespread and on the increase. Patients are demanding increased communication between providers, patients and families (Bakhtiari, 2010; Institute for Healthcare Improvement, 2003) and improved mechanisms for and incorporation of patient feedback (Bakhtiari, 2010). Furthermore, there is an increased demand for prehabilitation due to aging population, changing population expectations, and advances in healthcare technology and practice (Landry et al., 2006). All the while, as costs rise and continue to rise, particularly related to surgery, government, payors, and others demand increased OR efficiency (Bakhtiari, 2010). To respond to these pressures, many organizations, such as the ERAS society, the ASA, and the AAGBI (Association of Anaesthetists of Great Britain and Ireland), have developed surgical guidelines to enable members to follow best practices (Gustafsson et al., 2012; Smith, McWhinnie, & Jackson, 2011; The Association of Anaesthetists of Great Britain and Ireland, 2010).

Recently, the ASA has issued a report as part of the 'Choosing Wisely' campaign of the ABIM foundation to guide physicians and patients in the surgical decision making process. Topics discussed include recommendations against preoperative testing and certain blood management techniques for patients with no comorbidities undergoing low-risk surgery (Onuoha, 2013).

The Perioperative Surgical Home Overview

As a response to these increasing demands in the healthcare arena, the ASA and others have proposed the surgical home. In particular, the movement toward ACOs creates an opportunity for anesthesiologists to expand their practice through the perioperative surgical home (Johnstone, 2012a). According to previous ASA president Mark Warner (Warner, 2012), a successful surgical home must incorporate the following elements:

- Earlier anesthesiologist/hospitalist access to patients
- Increased preoperative counseling by anesthesiologists
- Increased communication between providers and patients
- Anesthesiologist involvement in protocol development
- Coordination of postoperative care to reduce pain, complications, morbidity, and mortality

The Committee for Future Models of Anesthesia Practice (CFMAP) of the ASA has recently compiled leading best practices for PSH programs in each of these areas. These best practices are augmented by specific recommendations, supporting published literature, and possible metrics to measure success (Commission for Surgical Anesthesia & Committee for Future Models of Anesthesia Practice, 2014).

Developing a PSH in a pre-existing surgical arena may be very difficult to implement. For many practices, developing a PSH may in fact be a consolidation of smaller existing teams, rather than an entirely new organization in many hospitals. Creating a preoperative clinic or anesthesiologist-based screening process may be a good place to start (Hertzberg, 2013). Research shows that many low-risk patients are receiving unnecessary preoperative testing, increasing costs and also risk to patient (S. Thilen et al., 2012), and anesthesiologists have already proven a valuable role in reducing preoperative testing and thus costs (Carrillo, 2012; Newswise.com, 2013).

The Role of the Anesthesiologist

Anesthesiologists are well suited for a perioperative management role due to unique position and knowledge of perioperative care requirements (Johnstone, 2012b) and the fact that many anesthesiologists also have business training (Johnstone, 2012b; Peterson, 2011). However, an anesthesiologist-led surgical home may require additional anesthesiologist training, particularly related to postoperative care (UC Irvine, 2013). One criticism of the surgical home is that it may 'step on toes' for other providers, particularly hospitalists. However, at least in some surgical homes, the concept of an anesthesiologist-led surgical home has been well received by hospitalists and other anesthesiologists (UC Irvine, 2013). For a surgical home to provide an improved patient experience, coordination between anesthesiologists and other providers, such as hospitalists, is not only possible but necessary (Adesanya & Joshi, 2007; Merli, 2005).

Payment Arrangements

The issue of payment is a primary barrier to the implementation of a PSH at many organizations, and yet is also an area where a PSH can have the most impact. Because a PSH may fit well into the ACO model, ACO regulations are of particular interest to those developing surgical homes.

The initial ACO regulations included two shared savings arrangements: the two-sided model, involving 65% shared savings with downside risk for three years, or the one-sided model, involving 52.5% shared savings with no downside risk for three years. A primary criticism of the original ACO program was that it would be costly to implement, with estimates ranging from $1.7 million up to $26.1 million, and receiving savings could be difficult due to the extensive quality reporting requirements (Byrd, 2011).

Several changes were made to most recent round of ACO regulations based on comments from the ASA and other organizations (American Society of Anesthesiologists, 2011), including :

- The delay of the first start date until April 1, 2012 and a second start date of July 1, 2012
- Beneficiaries will be identified prospectively with a retrospective reconciliation to improve provider's ability to deliver appropriate care
- Less stringent marketing guidelines and the provision of template language
- Reduction of the required reported quality measures from 65 to 33
- Elimination of downside risk in the one-sided model
- The withdrawal of the required 25% withholding of savings to offset future losses
- Increased caps on shared savings from 10% for the one-sided model and 15% for the two-sided model
- Grants for ACO startup costs for rural and physician-owned practices in shared savings programs

One additional criticism of ACOs and similar integrated health delivery systems was that such systems may violate antitrust laws. However, a recent ruling of the Office of the Inspector General found that integrated healthcare delivery programs do not necessarily violate antitrust provisions (Office of Inspector General, 2013). Generally speaking, even outside of the ACO, the general payment formula for all anesthesia services is shifting from the Relative Value Guide™ published by the ASA to a "base + time + outcome" formula, and the PSH is one way for anesthesiologists to accommodate and remain relevant in this new formula (Cohen, 2013).

Existing Surgical Homes: Featured Models

UAB Medicine:

The surgical home at UAB includes a pre-anesthesia care unit, general operating room services, cardiothoracic operating room services, and a post-anesthesia care unit (UAB Medicine Website, 2013). The general operating room services incorporate 32 operating rooms utilizing technology such as robotics, endovascular surgery, living-related transplants, and many other specialties. The cardiovascular operating room incorporates 8 ORs serving all patient populations and staffed by RNs in a 3-to-1 nurse-to-patient ratio. The post-anesthesia care unit also incorporates 45 preoperative prep holding areas, 47 postoperative care unit, as well as a specialized Women's Anesthesia Care Unit (UAB Medicine Website, 2013). The overall focus is on perioperative monitoring (Paloski, 2013), including preoperative anemia management (Vetter, 2013). All patient information is stored using an EHR to facilitate feedback and feed-forward of patient information (UC Irvine, 2013).

UC Irvine

The surgical home at UC Irvine focuses on joint replacement surgeries (Paloski, 2013), although plans to develop a similar surgical home for urology are in the works (Vakharia et al., 2013). The PSH was developed using a Lean Sigma approach, with input from relevant provider stakeholders, including surgeons, anesthesiologists, RNs, social workers, and respiratory therapists (UC Irvine, 2013). Many PSH functions at UC Irvine are carried out through the Center for Perioperative Care (UC Irvine Website, 2013). The goals of this center include surgery optimization, determination of needed pre-anesthesia testing, patient consultation on anesthetic choices, the ability to alert the OR of unusual circumstances or needs, to provide a consultation resource when needed, and to minimize cancellations and delays (UC Irvine Website, 2013). To meet these goals, the center provides anesthesiologist

consultation services, either in the clinic or over the phone; the anesthesiologist does not participate in the needed care (i.e. the preoperative testing) (UC Irvine Website, 2013).

FUTURE RESEARCH: THE PSH AS A HEALTHCARE MICROSYSTEM

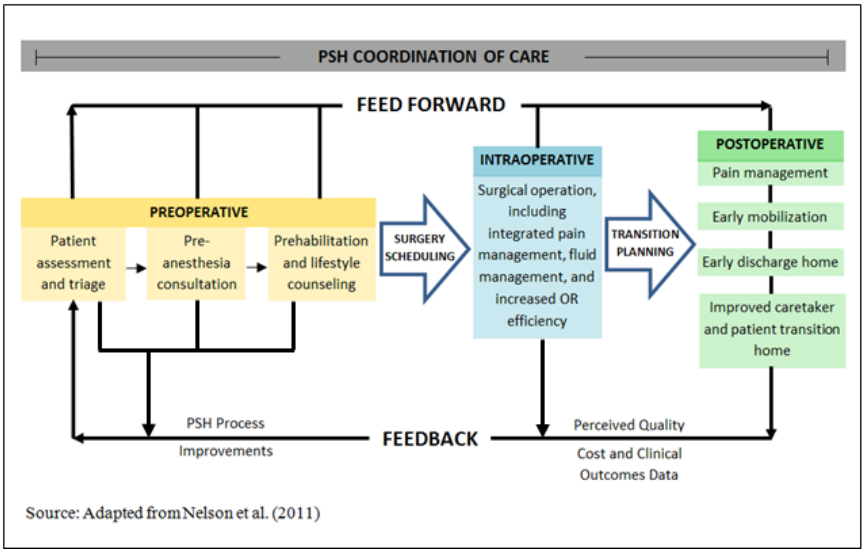
Clinical microsystems are "the places where patients, families, and caregivers meet – the places were care is delivered and where outcomes and costs are produced" (Nelson, Fisher, & Weinstein, 2011). The clinical microsystem becomes value added when feed-forward and feedback information is incorporated. Feed-forward information collects data in real time as care is delivered; this data moves with the patient in a useful, understandable way throughout the patient's healthcare experience (Nelson et al., 2011). Feedback information can be used for prospective management of this patient in future care episodes, evaluation and management of individual care. Feedback information simultaneously allows this individual-level data to be accumulated into subpopulations of similar patients to be used as a database for evidence-based practice (Nelson et al., 2011).

The essential process a patient undergoes in a clinical microsystem is as follows:

1. The patient enters and is oriented to the system.
2. The provider conducts an initial health assessment to create a plan of care that incorporates the patient's health status, health needs, and individual health preferences and values. This step builds off of feed-forward information from prior healthcare experiences, patient history, a physical examination, and diagnostic testing.
3. A patient care plan is created that includes all preventive, acute, chronic, and palliative care sensitive to the findings of the previous assessment.
4. As this care plan is carried out, longitudinal measures are collected to assess the patient's clinical status, functional status, patient perceptions of care, as well as direct and indirect cost tracking.
5. These longitudinal measures are used to improve future care for that individual patient and to improve overall care for the populations of similar patients in similar settings.

The perioperative surgical home fits the definition of a healthcare microsystem, as the PSH is where care is planned, delivered and managed, outcomes are achieved, and various providers meet patients and family. As clinical microsystem theory suggests, integrated information system management will be essential to the development of a successful perioperative surgical home. Applying the healthcare microsystems model developed by Nelson et al (2011), the perioperative surgical home as a microsystem could be modeled as follows:

Figure 1. PSH as a Microsystem



In future stages of research, we intend to expand on this model of the perioperative surgical home as a clinical microsystem using results from a national survey of PSH and PSH-like programs.

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Appendix A: Literature Charting for Topic 1 - The Surgical Home Concept

* Indicates a study conducted outside the United States

**LEGEND: SURGICAL SPECIALTIES	
Abbreviation	**Full name**
AS	Abdominal surgery
CS	Cosmetic surgery
CRS	Colorectal surgery
GS	General surgery
PDS	Pediatric surgery
TRS	Trauma surgery
VS	Vascular surgery
TS	Thoracic surgery
TTS	Transplant surgery

TOPIC 1: THE SURGICAL HOME CONCEPT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Abraham and Albayati (2011)*	Lit Review	N/A	CRS	N/A	ERAS	N/A	ERAS improves **length of stay** and reduction of **complications** in traditional open colorectal surgery, but findings do not show the same benefits for laparascopic surgeries. More research is needed.
Adamina, Gié, Demartines, and Ris (2013)*	Lit Review	N/A	Multiple	All	Perioperative care	N/A	Important elements of modern perioperative care: -Accelerated recovery pathways -Thromboembolism and antibiotic prophylaxis -Hyperoxygenation -Maintenance of normothermia -Avoidance of blood transfusions -Careful use of NSAIDs -Promotion of laparoscopic surgery -Chlorhexidine-alcohol skin preparations -Multidisciplinary meetings to facilitate care coordination
Boudreaux and Vetter (2013)	Editorial	N/A	Multiple	All	Efficiency & quality	N/A	This paper details the development, implementation, and results of a dedicated patient safety initiative within the UAB anesthesiology department (Section on Quality and Patient Safety). By adopting quality improvement and performance improvement techniques, the SQPS has initiated and completed more than 25 improvement projects and promoted a culture of patient safety in the department and health care system as a whole.
Butterworth and Green (2014)	Editorial	N/A	Multiple	N/A	Perioperative care	N/A	Anesthesiologists have the skill set and an opportunity to improve perioperative care in the US health system through PSH programs and similar initiatives. However, anesthesiologist training must be updated to reflect this emphasis, and anesthesiologists must be financially aligned to provide such care. To make this happen, anesthesiologists must provide evidence that they are best able to meet the need for perioperative care coordination.
Campbell (2009)	Editorial	N/A	Multiple	N/A	Improving surgical quality	N/A	**Nonpayment for error strategies** advocated by the Centers for Medicare and Medicaid Services are not supported by research and may actually undermine quality by stymying discussion about adverse outcomes. These 'never events' should be limited to a few

TOPIC 1: THE SURGICAL HOME CONCEPT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
							egregious errors. Instead, quality should be improved by following models like the Michigan Surgical Quality Collective.
Campbell Jr et al. (2008)	ACS-NSQIP database	n=33	Multiple	All patients	Perioperative care	N/A	Characteristics of high SSI outliers: **Higher trainee-to-bed ratios** (0.61 to 0,25, p<0.0001) **Operations took longer** (128.3 vs. 102.7, p<0.001) Characteristics of low SSI outliers: **Patients less likely to present anemic in OR**: (4.9% to 9.7%, p=0.007) **Patients less likely to receive a transfusion**: 5.1% vs. 8.0%, p=0.03 Generally **smaller**, more **efficient**, and had **lower staff turnover** Perioperative practices were similar between high and low **surgical site infection** outliers.
Cannesson and Kain (2014)	Editorial	N/A	Multiple	N/A	Perioperative care	N/A	ERAS and PSHs have similar goals (improved surgical outcomes and decreased costs). The key difference is that ERAS emphasizes a system of clinical protocols, while PSH programs encompass clinical protocols as well as care coordination across the entire perioperative spectrum.
Cheng (2013)*	Lit Review	N/A	All	N/A	Anesthesia	-Anesthesiologists should become familiar with **health economics** to be leaders in decision making in quality improvement processes	N/A
Clark and Spanswick (2013)*	Editorial	N/A	Multiple	All	Anesthesia	N/A	Key takeaways related to perioperative pain management: -Manage expectations and medication of patients presenting with preoperative pain -Manage patients with presurgical opioid dependence before surgery to minimize withdrawals and complications after surgery -Use multimodal analgesia when possible
Crosby et al. (2014)	Editorial	N/A	Multiple	N/A	Postoperative care	N/A	PSH programs aim to reduce postoperative complications, but postoperative cognitive dysfunction (POCD) and delirium, common complications of geriatric patients, may not be better managed under PSH programs, and programs that do formally diagnose and treat these complications may be penalized when compared to programs that do not.

TOPIC 1: THE SURGICAL HOME CONCEPT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Dexter and Wachtel (2014)	Editorial	N/A	Multiple	N/A	Perioperative care	N/A	This article discusses several net cost-reducing interventions common to PSH programs. The primary opportunities to reduce costs stem from the cessation of ineffective interventions and improving coordination of care and of personnel. Both of these opportunities require the use of informatics by anesthesiologists. Secondary opportunities that may reduce costs include improved preoperative assessment, faster surgery time, and faster postoperative recovery.
Ergina et al. (1993)*	Lit Review	N/A	Multiple	N/A	Perioperative care	N/A	This review proposes a general approach to the elderly surgical patient and applies it to the most significant sources of morbidity and mortality: pulmonary and cardiac complications.
Eskicioglu et al. (2009)*	Multiple	n=198	CRS	All	ERAS	N/A	**Length of stay**: 3 of 4 studies show reduced LOS (relative risk = 0.53, 95% CI .12 - 2.38) **Reduced complications**: 3 of 4 studies show reduced complications (relative risk = 0.61, 95% CI 0.42-0.88)
Fearon et al. (2005)*	Lit Review	N/A	AS	N/A	ERAS	N/A	Core protocol elements listed for **preoperative**, **intraoperative**, and **postoperative** care
Fink et al. (2007)	VA & university hospitals	n=32,624	GS	Female	Efficiency & quality	N/A	**Unadjusted 30-day mortality** was not significantly different in the VA and private sector hospitals, while **morbidity** was slightly higher in private sector hospitals compared to the VA, largely due to differences in rates of UTIs.
Fleisher et al. (2007)	Editorial	N/A	Multiple	All	Perioperative care	N/A	This report provides **guidelines for various patients and diseases**, as well as **surgery-specific issues,** preoperative testing, perioperative surveillance and therapies, anesthetic considerations, and postoperative and long-term care management.
Fried, Ferrucci, Darer, Williamson, and Anderson (2004)	Lit Review	N/A	Multiple	The elderly	Frailty	N/A	This article provides a narrative review of the current understanding of the definitions and distinguishing characteristics of each of disability, frailty, and comorbidity, including their clinical relevance, distinct prevention, therapeutic issues, and how these characteristics are related.

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Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Fritsch et al. (2012)*	Hospital of Schwarzach	n=1,363	Multiple	Elective patients	Perioperative care	N/A	Best predictors of **perioperative complications**: Age: OR 1.028, p=0.001 Invasiveness of procedure: OR=5.278, p<0.0001 History of renal disease: OR 4.987, p<0.001 History of anemia: OR 4.269, p=0.004 Abnormal ECG: OR 2.814, p=0.005
Furze et al. (2009)*	Hull and East Yorkshire Hospitals Trust	n=204	TS	First-time elective patients	Preoperative counseling	The program produced incremental cost savings of £288.83 per quality-adjusted life Year	No significant differences in **anxiety** or **length of stay** between routine preoperative counseling group and cognitive-behavior program group after 8 weeks but before surgery. Significant differences in: **depression** (7.79, p=0.008); **physical functioning** (0.82, p=0.001); **cardiac misconceptions** (2.56, p<0.001) after 8 weeks but before surgery.
Garson et al. (2014)	UC Irvine	n=146	GS	Hip and knee arthroplasty patients	Perioperative care	N/A	Results from implementation of a PSH program: **Incidence of complications**: 0.0% **Incidence of blood transfusion**: 6.2% **In-hospital mortality**: 0.0% **30-day readmission**: 0.7% **SCIP measures**: All 100% **Median LOS**: 3 days **Non-home discharge**: 48%
Goldhill et al. (2012)*	Editorial	N/A	Multiple	N/A	Perioperative care	N/A	A separate study showed that **levels of mortality** in non-cardiac surgery in the UK is 3 to 8 times of that in the US. This study shows that many process improvements, including the expansion of critical care beds, have been made since the time the underlying data was recorded and that the UK is significantly more cost effective at reducing mortality than the US. These changes have changed anesthesiology and will continue to.
Graham, Bowen, Strohecker, Irgit, and Smith (2014)	Geisinger Health System	n=194	GS	Hip fracture patients	Postoperative care	Mean costs for PCMH were lower, but not significantly different for pharmacy and non-pharmacy costs.	Patients whose postoperative care was managed by a patient-centered medical home (PCMH) had: Lower **6-month** and **12-month mortality** (11% vs. 26%, p<0.01 and 23% vs. 30%, p=0.12, respectively) Similar **quality of life scores**

TOPIC 1: THE SURGICAL HOME CONCEPT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
							Improved **Harris Hip scores** (73 vs. 64, p=0.04)
Gustafsson et al. (2012)	Lit Review	N/A	CRS	N/A	ERAS	N/A	Provides best practice recommendations for various items involved in ERAS programs, including preoperative counseling and recommendations, anesthesia, surgical prep, surgical procedures, postoperative fluid management and nutrition, and early mobilization.
Henderson et al. (2007)	VA & university hospitals	n=112,497	GS	Male	Efficiency & quality	N/A	**Unadjusted 30-day mortality** was higher in the VA than in the private sector, while **unadjusted morbidity** was lower in the VA. The higher mortality in the VA may be due to the increased frequency of complex procedures.
Hoff (2013)	Accredited medical homes	n=51	N/A	All	Efficiency & quality	N/A	In the implementation of a PCMH, the researchers identified hard implementation practices (normative activities and interventions) and soft best practice (practice social structure and everyday patient interactions). External stakeholders are less likely to value and encourage soft best practices.
Holt (2014)	Lit Review	N/A	Multiple	N/A	Perioperative care	N/A	The PSH is a potential solution to the problem of reducing costs and increasing quality in the face of an aging population and changing payment landscape, and anesthesiologists are well positioned to lead such initiatives.
Hooper (2013)	Editorial	N/A	Multiple	N/A	Preoperative testing	N/A	Discussion of various **models of preanesthesia care**, including programs staffed by RNs compared to programs staffed by RN anesthetists and nurse practitioners.
Huang and Schweitzer (2013)	Editorial	N/A	Multiple	N/A	Perioperative care	N/A	The PSH provides a means for anesthesiologists to adapt to the changing healthcare environment.
Huddleston et al. (2004)	Rochester Medical Hospital	n=526	GS	Elderly	Perioperative care	Total costs did not vary between hospitalist and non-hospitalist groups	**Complication rates**: lower in hospitalist-run group (61.6% vs. 49.8%) **Unadjusted length of stay**: no difference **Adjusted length of stay**: shorter in hospitalist-run group (5.1 vs. 5.6 days)

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Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Hutter et al. (2007)	VA & university hospitals	n=35,232	VS	Male	Efficiency & quality	N/A	**Unadjusted 30-day mortality** was lower in the VA than in the private sector, but virtually indistinguishable after risk adjustment. **Unadjusted moribidy** was also lower in the VA and remained lower after risk adjustment.
Ilfeld et al. (2010)	Alta Bates Summit Medical Center	n=81	GS	All	Anesthesia	N/A	**Readiness for discharge**: faster in cFNB than in control group - 47 hours vs. 62 hours (p=0.028) 4-day cFNB decreased time to discharge by 20%. Most of this decrease came from analgesia improvement.
Ilfeld et al. (2006)	University of Florida	n=32	GS	All	Anesthesia	N/A	**Time to discharge**: lower in CISB patients (12 hours vs. 51 hours, p<0.001) CISB required less **morphine** but reported less **pain** and tolerated more **external rotation**.
Ilfeld, Wright, Enneking, and Morey (2005)	Shands Hospital at the University of Florida, Gainesville	n=25	GS	All	Anesthesia	N/A	Median achievement of surgeon-defined goal for **shoulder elevation**: 85% with CISB, 33% without (p=0.048) Median achievement of surgeon-defined goal for **external rotation**: 100% with CISB, 17% without (p<0.001) Numeric rating **pain score**: 2.0 with CISB, 8.5 without (p<0.001) 24-hour post-operation numeric rating **pain score** least, median, and highest: 0.0, 1.0, and 3.0 with CISB, 2.0, 6.0, 8.0 without (p=0.030, p<0.001, p<0.001)
Johnson et al. (2007)	VA & university hospitals	n=3,993	VS	Female	Efficiency & quality	N/A	**Unadjusted 30-day mortality** was lower in the VA than in the prviate sectors, but virtually indistinguishable after risk adjustment. **Unadjusted morbidity** was also lower in the VA and remained lower after risk adjustment.
Kahokehr et al. (2009)*	Lit Review	N/A	CRS	N/A	ERAS	N/A	ERAS programs are highly unstandardized and not followed with consistency across countries, and practice is not keeping up with the most recent evidence. Compliance with ERAS protocol elements varied from 92% for epidural anesthesia to 40% for 3-day postoperative stay. Recommendations for practice specific to colorectal surgery included. See Lassen, Coolsen et al. (2012) for similar study on pancreatoduodenectomy

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Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Kain et al. (2014)	Editorial	N/A	Multiple	N/A	Perioperative care	N/A	Although conclusive evidence to support the effectiveness of the PSH does not yet exist, preliminary evidence for the success of PSH programs, combined with the established success of ERAS programs, indicate the PSH has promise as a solution that will potentially improve the quality of care and reduce costs. This article also discusses operational and fiscal barriers that may hinder PSH effectiveness.
H. Kehlet (1997)	Lit Review	N/A	Multiple	N/A	Postoperative care	N/A	**Preoperative factors contributing to postoperative morbidity:** pre-existing disease, malnutrition, alcohol abuse **Intraoperative factors contributing to postoperative morbidity**: surgical stress, blood transfusions, heat loss **Postoperative factors contributing to postoperative morbidity**: pain, immunosuppression, nausea, hypoxaemia, sleep disturbances, muscle loss, immobilization, drains
H. Kehlet (2011)*	Lit Review	N/A	CRS	N/A	ERAS	N/A	Fast-track colonic surgery can be successfully implemented in community hospitals. Two recent studies provide evidence of the benefits of this fast-track surgical approach on postoperative gastrointestinal recovery after laparoscopic and open procedures. The issue is no longer whether fast-track colonic surgery is better than standard care, but how to improve the approach and its implementation.
H. Kehlet and Mythen (2011)*	Editorial	N/A	Multiple	High-risk patients	Perioperative care	N/A	There is a general agreement that the preoperative high-risk patient still carries a high risk of postoperative morbidity and mortality. Many individual efforts have been made to improve this, but research indicates that combating this problem will require a multimodal approach. This will require further refinement of individual factors and development of research-based interventions to target these factors.
S. F. Khuri (2006)	Editorial	N/A	Multiple	All	Efficiency & quality	N/A	The NSQIP has reduced **postoperative complications** in the VA and has expanded to the private sector in recent years. The success

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Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
							of the NSQIP has been in part to its redefiniton of patient safety: (1) safety is an integral part of quality of care and cannot be separated; (2) patient safety is primarily determiend by quality of care; (3) reliable outcome data are necessary to identify and address systematic problems; and (4) QI efforts should aim to eliminate these systematic errors.
S. F. Khuri et al. (1997)	VA hospitals	n=87.078	Multiple	Major noncardiac surgical patients	Efficiency & quality	N/A	**Mortality rates** varied for all operations across the 44 hospitals studied. After **risk adjustment, observed-to-expected ratios** ranged from 0.49 to 1.53, and 93% of hospitals changed rank after adjustment, indicating that the VA system developed to compare risk-adjusted rates meaningfully ranked hospitals and could thus be a means to monitor and improve care.
(S. F. Khuri et al., 1998)	VA hospitals	n-417,944	Multiple	All	Efficiency & quality	N/A	Using risk **adjusted observed-to-expected mortality rates**, calculated using presurgical risk and process of care data, high and low outliers were more accurately identified, allowing improved comparative assessment of care and potentially enhanced quality of care for low outliers.
S. F. Khuri, Daley, and Henderson (2002)	Editorial	N/A	Multiple	All	Efficiency & quality	N/A	As mandated by Congress, the NSQIP collects data throughout the perioperative spectrum and uses this data to provide feedback to providers to improve the quality of care, particularly through the improvement of the system. In the future, NSQIP intends to promote measures beyond morbidity and mortality to include items such as long-term survival, functional outcomes, quality of life, patient satisfaction, and cost and process items in addition to outcome items.
Kuntz and Vera (2005)*	University Hospital Hamburg-Eppendorf	n=57,000	Multiple	All	Efficiency & quality	Physician effiiciency is improved when transfer pricing is used for anesthesia services.	N/A
K. Lassen et al. (2009)	Lit Review	N/A	CRS	All	Perioperative care	N/A	Most **ERAS protocols** have adequate support from good quality trials more meta-analyses.

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Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Lee, Kerridge et al. (2011)*	Lit Review	N/A	All	N/A	Perioperative care	**Benefits of perioperative systems**: Increased surgical volume and flow (20%-35%) Fewer cancellations of surgeries (1% - 8%) Reduction in number (23% - 55%) and costs (40%-59%) of preoperative cancellations Reduction in cost per patient (8%-18%)	Perioperative systems are the model of care in the North America, Australia, New Zealand, and increasingly in Europe **Benefits of perioperative systems**: Shorter preoperative length of stay (0.2 to 1.3 days) Lower risk of wound infection (relative risk 0.30, 95% CI 0.12–0.78)
Lloyd et al. (2010)*	Leicester Royal Infirmary and the Adelaide and Meath Hospital in Dublin	n=117	CRS	All	ERAS	N/A	Laparascopic: RAPID protocol group had significantly shorter median **stay** (6 vs. 9.5 days, p=0.01), **tolerance of full diet** (2 vs. 3 days, p=0.002), and reduction in **pain score** on days 1 and 3 (p=0.004, p<0.0001). Open resections: RAPID protocol group had significantly **shorter stay** (7.5 vs. 12 days, p=0.04) and **pain score** on day 3 (p=0.006).
M. F. Newman et al. (2013)	Editorial	N/A	All	N/A	Preoperative assessment	Key point: it is difficult to **implement preanesthesia screening guidelines** in the real world. One solution is perioperative clinics that do prescreening and coordinate care. This will be especially important as the focus shifts to long-term care and a value-based economy.	N/A
Nielsen, Jørgensen, Dahl, Pedersen, and Tønnesen (2010)*	Hospital	n=60	GS	All	Prehabilitation	N/A	**Postoperative stay**: 5 days for prehabilitation, 7 days for standard procedure (p=0.007) **Complications**: no significant difference **Functionality**: prehabilitation group had higher post-op function (p<0.001) based on Roland **Morris questionnaire**; reached recovery milestones faster (1-6 days vs. 3-13 days, p=0.001) **Pain**: no significant difference **Satisfaction**: higher in prehabilitation group than control group (15/28 in prehabilitation, 7/32 in traditional, p=0.02)

TOPIC 1: THE SURGICAL HOME CONCEPT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Nuelle and Mann (2007)	Single surgeon's practice	n=50	GS	All	Surgical procedures	N/A	**Time to walk 100 ft. with a walker**: 97.4 with standard protocol, 24.6 with minimally invasive protocol ($p<0.0001$) **Time to achieve bathroom independence**: standard 103, minimally invasive 29.3 ($p<0.0001$) **Time to get in/out of bed:** standard 97.9 hours, minimally invasive 27.2 ($p<0.0001$) **Time to achieve 90* of flexion**: standard 96, minimally invasive 25.6 ($p<0.001$) **Length of stay**: 5.4 days for standard, 2.8 for minimally invasive ($p<0.001$)
Oates et al. (2000)*	Primary care	n=39 physicians n=315 patients	All	Primary care patients	Patient-centered practice	**Medical care utilization**: patient perception of patient-centeredness associated with fewer diagnostic tests and referrals	**Patient perception of patient-centeredness**: patient-centered communication was correlated with patient perceptions of common ground with physician ($r=0.16$, $p=0.01$) **Patient symptom discomfort and concern**: patient perception of patient-centeredness associated with positive health outcomes and lower levels of post-encounter discomfort
Pasternak (2009)*	Editorial	N/A	Multiple	N/A	Preoperative testing	This excessive testing problem affects 30 million patient procedures with an estimated **cost** in excess of $18 billion.	Many studies have shown that preoperative testing is excessive and costly, but the problem has not improved. The profession should move toward a **policy of selective testing** instead.
Prager et al. (2005)	Hospitals participating in BCBS Michigan plans	n=60 participating hospitals	TS, VS, GS	N/A	Perioperative care	Improving quality requires the development of new **data registries** based on rigorous data collection systems, an explicitly platform for quality improvement, and a focus on data confidentiality and trust. The information in these registries is submitted to BCBS as evidence of quality improvement efforts, and BCBS reimburses them using a 'pay-for-participation' scheme, rather than pay-for-performance. This translates quality improvement efforts into reimbursement.	N/A
Rowell, Turrentine, Hutter, Khuri, and Henderson (2007)	VA & university hospitals		Multiple	All	Efficiency & quality		Using NSQIP data, each of the sites studied engaged in quality improvement efforts. The Salt Lake City VA hospital reduced **wound complication rates** by 47%; the Univeristy of Viriginia hospital reduced **SSIs** for abdominal surgery patients by 36%; Massachussetts

TOPIC 1: THE SURGICAL HOME CONCEPT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
							General reduced **UTIs** for vascular surgery patients by 74%.
Ryan, Davoren, Grant, and Delbridge (2004)*	Royal North Shore Hospital	n=1,601	Multiple	All	Perioperative care	N/A	**23-hour discharge center discharge compliance**: 86% Only 3% needed **future unexpected medical care**
Shafer and Donovan (2014)	Editorial	N/A	Multiple	All	Perioperative care	N/A	This article details the vision of the ASA for the PSH as well as a summary of several articles appearing in this issue of Anesthesia and Analgesia. These articles are included in this review.
Stenholm et al. (2008)	Lit review	N/A	Multiple	Elderly obese patients	Frailty	N/A	Age-related **muscle weakness** is linked to changes in muscle composition and quality rather than muscle mass. This is especially important when studying older obese people.
Swank et al. (2011)	Hospital	n=71	GS	All	Prehabilitation	N/A	**Leg strength**: increased with prehabilitation treatment **Ability to perform functional tasks**: improved with prehabilitation treatment ($p<0.05$)
Szokol and Stead (2014)	Editorial	N/A	Multiple	All	Perioperative care	N/A	The Accountable Care Organization movement will require more of anesthesiologists in terms of perioperative care coordination and will change the way anesthesiologists are reimbursed. The PSH is one way for anesthesiologists to manage these demands.
Topp, Swank, Quesada, Nyland, and Malkani (2009)	Hospital	n=54	GS	All	Prehabilitation	N/A	3 months after surgery: both groups increased **strength** and decreased **pain**; treatment group increased **functional capacity**, while control group did not. Control group saw an increase **strength asymmetry** in quadriceps.
Varadhan, Lobo, and Ljungqvist (2010)*	Lit Review	N/A	Multiple	N/A	ERAS	See discussion of clinical outcomes.	This article goes through a history of ERAS, components of the ERAS system, the role of laparascopy based on randomized controlled trials, costs and savings of ERAS implementation, and implementation difficulties and best practices.
Krishna K Varadhan et al. (2010)*	Meta-analysis	n=6 studies n=452 patients	CRS	All	ERAS	N/A	**Length of stay**: 2.5 days less in ERAS, $p<0.0001$ **Risk of complications**: RR 0.53, $p<0.00001$ **Readmission rates**: no significant difference **Mortality**: no significant difference

TOPIC 1: THE SURGICAL HOME CONCEPT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Vetter, Boudreaux, et al. (2012)	UAB Medical Center	n=112	Multiple	All	Efficiency & quality	N/A	Significant disagreement exists among practitioners regarding the perioperative management of surgical patients with a coronary artery stent. 2 algorhithms were developed to (1) dictate which stent patients can have elective surgery without onsite cardiac catheterization laboratories and (2) identify emergent transfer of one of these patients who experiences a perioperative ST segment elevation MI.
Vetter, Boudreaux, Jones, Hunter Jr, and Pittet (2014)	Editorial	N/A	Multiple	N/A	Perioperative care	N/A	This article discusses the pressures leading to the development of the PSH, notably the PCMH and an emphasis on patient-centered care. The article then discusses how the PSH could achieve the 'Triple Aim' of improved quality for individual patients, improved population health, and reduced per capita costs. This article also addresses PSH staffing and suggestions for payment systems that incorporate the entire institution (i.e more than just anesthesia).
Vetter, Goeddel, et al. (2013)	Lit Review	N/A	Multiple	N/A	Perioperative care	N/A	The implementation of an anesthesiologist-run perioperative surgical home may improve clinical outcomes through process standardization and improved communication, while simultaneously reducing resource consumption by eliminating unnecessary testing, processes, and delays.
Vetter, Ivankova, et al. (2013)	Editorial	N/A	Multiple	All	Perioperative care	N/A	This article provides a basic model for a PSH, including key components of each phase of care and other key design elements. The authors then discuss the measures needed to validate PSH care as compared to traditional surgical care in terms of patient-centeredness, clinical adherence to guidelines, quality and safety, and cost. Finally, the authors discuss the optimal study design to investigate these measures.
Watters (2002)*	Editorial	N/A	Multiple	Elderly surgical patients	Perioperative care	N/A	Age is a proxy for many other social, biologic, and clinical factors, and the elderly are inherently heterogeneic. This must be considered when evaluating an individual elderly patient for a surgical process.

TOPIC 1: THE SURGICAL HOME CONCEPT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
D. N. Wijeysundera, Austin, Beattie, Hux, and Laupacis (2009)	79 hospitals in Ontario	n=204,819	Multiple	Non-cardiac elective surgery patients	Preoperative testing	N/A	**Preoperative testing**: performed on 38% of patients Patient- and surgery level factors explained on 5.9% of variation in **consultation rates** Consultation rate differences across hospitals varied greatly, from 1% to 89.7% but were not explained by surgical volume, teaching status, or patient- and surgery-level factors. Thus, the individual hospital is the primary explanatory variable as to whether patients will undergo preoperation testing.
Duminda N Wijeysundera et al. (2012)*	79 hospitals in Ontario	n=204,819	Multiple	All	Preoperative testing	N/A	**Preoperative testing**: performed on 38% of patients **Patient- and surgery level factors** explained on 5.9% of variation in consultation rates **Consultation rate differences** across hospitals varied greatly, from 1% to 89.7% but were not explained by surgical volume, teaching status, or patient- and surgery-level factors. Thus, the individual hospital is the primary explanatory variable as to whether patients will undergo preoperation testing.
Wiklund and Rosenbaum (1997a)	Editorial	N/A	Multiple	All	Preoperative care	N/A	In part 1 of this article, the authors discuss advances in the field of perioperative anesthesia in the last thirty years, including improvements in preoperative care, such as cardiac testing for noncardiac surgery, perioperative myocardial ischemia, and transfusion practice. The article also discusses advances in anesthetic agents, including muscle relaxants, opioids, inhalational anesthetics, and nonopioid intravenous anesthetics.
Wiklund and Rosenbaum (1997b)	Editorial	N/A	Multiple	All	Preoperative care	N/A	In part 2, the article continues to discuss advances in anesthetic agents, in particular local anesthetics. Changes in pain management are discussed, including mutlimodal anesthesia and preemptive analgesia, as well as new anesthetic techniques, such as pulse oximetry and capnography and airway managmeent. Finally, the article discusses changes in postoperative management of patients: treatment of nausuea and vomiting, aspiration pneumonitis, and renal failure/hepatic dysfunction.

TOPIC 1: THE SURGICAL HOME CONCEPT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Williams, DeRiso, Engel, et al. (1998)	Ambulatory surgery center in University of Pittsburgh Medical Center (UPMC),	n=503	GS	ASA physical status I and II patients who selected general anesthesia	ERAS	See discussion of clinical outcomes.	Clinical pathway regional anesthesia, compared to general anesthesia, led to increased **pharmacy and materials costs** and increased **turnover time** ($p<0.001$ for both), but **recovered** better ($p=0.003$), had lower **unexpected readmission** rates ($p=0.002$), and required **fewer nursing interventions** ($p<0.001$). **Postanesthesia care unit bypass** was more common in clinical pathway regional anesthesia ($p<0.001$).
Wind et al. (2006)*	Lit Review	n=6 studies n=512 patients	CRS	N/A	ERAS	N/A	**Hospital stay**: 1.56 days less for fast-track surgery programs than traditional **Morbidity**: RR 0.56 less than traditional **Readmission rates** and **mortality** not significantly different between fast-track and traditional programs.

*Indicates a study conducted outside the United States

Appendix B: Literature Charting for Topic 2 – Early Patient Engagement

* Indicates a study conducted outside the United States

**LEGEND: SURGICAL SPECIALTIES	
Abbreviation	**Full name**
AS	Abdominal surgery
CS	Cosmetic surgery
CRS	Colorectal surgery
GS	General surgery
PDS	Pediatric surgery
TRS	Trauma surgery
VS	Vascular surgery
TS	Thoracic surgery
TTS	Transplant surgery

TOPIC 2: EARLY PATIENT ENGAGEMENT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Aboulian et al. (2010)	County Hospital	n=54	CRS	All	ERAS	N/A	ERAS patients saw: Decrease in **intravenous fluids** during surgery (p=0.001) and over next 3 days (p=0.0017) Decrease in **hospital stay**: 4 days vs. 6 days, p=0.003 No difference in **complication** or **readmission rates**
Bader, Sweitzer, and Kumar (2009)	Preoperative assessment clinics	n=3	Multiple	N/a	Preoperative assessment	-Standardized preoperative assessment procedures helps ensure that payor, regulatory, and accreditation guidelines are met -Careful triage ensures that low-risk patients are not given unnecessary costly assessments and that high-risk patients receive all testing before the day of surgery -EHR reduce redundancy, provide a database for research, and create standardized patient information -Perioperative guidelines should be created, updated, and made available for various steps and surgeries	
Bilku, Dennison, Hall, Metcalfe, and Garcea (2014)	Lit Review	N/A	GS	Adults	Preoperative care		17 randomized controlled trials (RCTs) met inclusion criteria. Preoperative carbohydrate drinks improved patients' **insulin resistance** and **postoperative comfort**. There was no evidence to support improvement in **postoperative muscle mass**. No **adverse events** were reported as a result of use of preoperative carbohydrate drinks.
Carli et al. (2009)*	McGill University Health Centre	n=25	CRS	All	ERAS	N/A	**Length of stay**: median 3 days (95% CI 3-4 days); 16 patients discharged on day 3, 9 discharged later due to infection, pain, urinary retention, anemia, or social indicators. All patients recovered **bowel function** and **full diet** within 36 hours. 2 patients were **readmitted**.
Correll et al. (2006)	Weiner Center for Preoperative Evaluation, Boston, MA	n=5,083	Multiple	All	Preoperative assessment	12.7% of patients had medical issue identified in clinic visit. 647 cases required additional information and testing. If these issues had not been caught in the preoperative clinic, each delay would cost the hospital $1,500 on average, or a total of $970,500.	N/A

TOPIC 2: EARLY PATIENT ENGAGEMENT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Dasgupta, Rolfson, Stolee, Borrie, and Speechley (2009)*	Tertiary care teaching hospital (Canada)	n=125	Multiple	Noncancer patients 70 years or older	Frailty	N/A	**Postoperative complications**: increased with frailty (p=0.02); patients with EFS (Edmonton Frail Scale) greater than 7 associated with greater complications - OR 5.02 **Length of postoperative stay**: increased with frailty (p=0.004) **Inability to be discharged home**: increased with frailty (p=0.01); patients with EFS (Edmonton Frail Scale) greater than 7 had a 40% chance of not going home, p<0.002
Ferschl et al. (2005)	University of Chicago Hospitals	n=6.524	Multiple	All	Preoperative assessment	Reduction in **day surgeries cancelled-day of**: 8.4% in suites with preanesthesia clinic, 16.2% in traditional (p<0.001) Reduction in general **OR surgeries cancelled-day of**: 5.3% in suites with preanesthesia clinic, 13.0% in traditional (p<0.001) **Time in OR**: 3 minutes less for day surgery patients (p<0.001) and 2 minutes for general surgery patients (p=0.015)	N/A
Fritsch et al. (2012)*	Hospital of Schwarzach	n=1,363	Multiple	All	Preoperative assessment	N/A	Best predictors of perioperative complications: **Age**: OR 1.028, p=0.001 **Invasiveness of procedure**: OR=5.278, p<0.0001 **History of renal disease**: OR 4.987, p<0.001 **History of anemia**: OR 4.269, p=0.004 **Abnormal ECG**: OR 2.814, p=0.005
Glick et al. (2006)	Response letter	N/A	Multiple	N/A	Preoperative assessment	Preanesthesia medical clinics are beneficial to all, but in a world of constrained resources, should focus their attention on at-risk patients, such as the elderly and those with significant comorbidities. More work is needed to demonstrate the potential savings generated by a preanesthesia clinic in order to incentivize hospitals to fund them.	N/A
Hebl et al. (2008)	Mayo Clinic	n=200	GS	All patients	Anesthesia	N/A	TJRA patients had: Shorter **length of stay**:3.8 days vs. 5, p<0.001 Earlier **discharge eligibility**: 1.7 days p<0.0001 Improved **joint range of motion**: 90* vs. 85*, p=0.008 Lower **pain scores**, p<0.001 and **opioid requirements**, p=0.04 Lower **urine retention** (50% vs. 31%, p<0.001) and **ileus formation** (7% vs. 1%, p=0.01)

TOPIC 2: EARLY PATIENT ENGAGEMENT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Jones et al. (2011)*	Queen Elizabeth Hospital	n=472	GS	All	Preoperative education	N/A	**Length of stay**: 7 days in traditional, 5 in education treatment **Inpatient complications** **24-hour readmission rate** **3-month readmission rate**
Knox et al. (2009)*	Saint Luke's Hospital, Kilkenny, Ireland	n=2,826	Multiple	All	Preoperative assessment	**Reduction in case cancellations**: 114 after implementation of preoperative testing clinic vs. 256 before, p<0.001 **Reduction in case cancellations for medical reasons**: 10 vs. 31, p=0.013 **Reduction in case cancellations for hospital reasons**: 49 vs. 132, p<0.001	N/A
R. Lee et al. (2011)	Nationwide valve surgeries over past 15 years	n=623,039	TS	All in STS data set	Surgical procedures	N/A	**Unadjusted operative mortality**: highest for multiple valve surgery; but rates of all surgeries fell over 15 years (p<0.001) **Adjusted odds ratios for mortality**: decreased for all surgeries other than tricuspid (p<0.031). Composite of mortality and major complications: did not improve due to **increased rates of pulmonary/infectious death** and **complications** (increased 78% and 39%, respectively)
Leichtle et al. (2012)	Michigan Surgical Quality Collaborative	n=4,340	CRS	All	Postoperative care	N/A	Risk factors for anastomotic leakage: **Fecal contamination** (OR 2.51, p=0.02) **Intraoperative blood loss** more than 100 mL (1.62, p=0.02)
Mayo et al. (2011)*	McGill University Health Centre	n=95	CRS	All	Prehabilitation	N/A	Patients who improve during prehabilitation were more likely to **achieve baseline walking capacity** than those who showed no change or deteriorated (77% vs.59% and 32%, p=0.0007). **Complication risk** increased for those whose walking ability decreased in prehabilitation.
Mythen (2011)	Editorial	N/A	All	N/A	Perioperative care	N/A	As perioperative care has improved, the key question to consider for an elective surgical patient is, '**Is this patient ready for surgery**?' This is best answered by assessing risk based on age, comorbidities, and functional capacity
O'Brien, McKeough, and Abbasi (2013)*	The Alfred cardio surgical unit	n=118	TS	Elective cardiac patients	Preoperative education	Written pre-surgical education provides most patients with adequate understanding of what to expect post surgery. A small subset of patients indicated that they would prefer verbal preoperative education.	N/A

TOPIC 2: EARLY PATIENT ENGAGEMENT							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
O'Doherty et al. (2013)*	Literature review	n=10	TS	All	Prehabilitation	N/A	Preoperative aerobic exercise was associated with reduced **postoperative and ICU stay**, and improved **postoperative physical fitness**. While the specific exercise interventions studied varied, adherence was generally strong.
Pattakos et al. (2012)	Cleveland Clinic	n=4,031	TS	All	Postoperative care	Nonhome discharge can be predicted using preoperative testing. Using this preoperative data to predict discharge could improve transition planning and shorten hospital stay.	N/A
Ramirez et al. (2011)*	Hospital	n=300	CRS	All	ERAS	N/A	**Compliance to ERAS protocol**: overall 65% but varied across components, ranging from 99% providing perioperative information to 40.6% taking early fluids by mouth. **Average LOS** 6 days; 3% readmission rate; most **complications** were surgical (24%)
Vazirani et al. (2012)	Veterans Administration Greater Los Angeles Healthcare System	n=5,223	Multiple	All	Preoperative assessment	N/A	**Length of stay** decreased for patients with ASA score of 3 or higher ($p<0.0001$) after addition of hospitalist-run preanesthesia clinic. **Reduction in same-day cancellations**: 8.5% to 4.9%, $p=0.065$ **Inpatient mortality reduced**: 1.27% to 0.36%, $p=0.0158$ **More perioperative beta blockers and stress tests** ($p<0.0001$, $p=0.012$)
D. N. Wijeysundera et al. (2009)*	Multiple research databases	n=271,082	Multiple	All	Preoperative assessment	N/A	**Assessment** increased 34% from 1993 to 2004 **Length of stay**: consultation decreased 0.35%, $p<0.001$ **Mortality**: consultation did not significantly reduce (0.98% difference, $p=0.20$)
Wong et al. (2012)*	Meta-analysis	n=25 studies	All	N/A	Postoperative care	N/A	Cessation of smoking more than 4 weeks before surgery reduced **risk of respiratory complications** by 23% compared to smokers; 8 weeks, 47%; more than 8-weeks, comparable to non-smoker risk Cessation of smoking 3-4 weeks before surgery reduced **wound-healing complications** than current smokers or those who ceased smoking less than 3 weeks prior to surgery

*Indicates a study conducted outside the United States

Appendix C: Literature Charting for Topic 3 – Reduced Preoperative Testing

* Indicates a study conducted outside the United States

**LEGEND: SURGICAL SPECIALTIES	
Abbreviation	**Full name**
AS	Abdominal surgery
CS	Cosmetic surgery
CRS	Colorectal surgery
GS	General surgery
PDS	Pediatric surgery
TRS	Trauma surgery
VS	Vascular surgery
TS	Thoracic surgery
TTS	Transplant surgery

TOPIC 3: REDUCED PREOPERATIVE TESTING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Badner, Craen, Paul, and Doyle (1998)*	Preadmission clinic	n=370	Multiple	All	Preoperative assessment	A screening assessment completed by the patient and screened by a preadmission clinic nurse anesthetist to determine further assessment needs. **The assessment resulted in the correct outcomes** 84% of the time, allowing for increased utilization of medical personnel.	N/A
Baron et al. (2014)*	Inpatient surgical patients in 28 European countries	n=39,309	Multiple	Non-cardiac and non-neurological patients over 16 years old	Preoperative assessment	N/A	Patients with severe anemia had higher **in-hospital mortality** than patients without anemia, longer **length of stay** ($p<0.0001$), and increased postoperative **admission to the ICU** ($p<0.0001$).
Brown and Brown (2011)	University of Arizona tertiary care hospital	n=19 physicians n=4 nurse administrators	Multiple	N/A	Preoperative assessment	N/A	An interview with 23 physicians and nurse administrators that unnecessary preoperative tests are ordered as a result of (1) practice tradition, (2) the belief that other physicians require them, (3) medicolegal worries, (4) concerns about surgical delays and cancellations, and (5) lack of guidelines.
Chung et al. (2009)*	Toronto Western Hospital	n=1,061	Multiple	All	Preoperative assessment	**1,558 tests were ordered and cancelled** for 480 patients resulting in a total savings of Canadian $18,447, or $38.50 per patient.	There was no significant difference in the **rate of adverse events** between the treatment and control groups.
Cooper et al. (2013)	Johns Hopkins Multidisciplinary Pancreas Cancer Clinic	n=101	GS	All	Efficiency & quality	Excessive preoperative testing on pancreas masses increased **cost** by $3,371 and extended **length of time to surgery.**	N/A
Finegan et al. (2005)*	Tertiary care preadmission clinic	n=938	TS	All	Preoperative assessment	The mean **cost of testing** was reduced to $73/patient.	More **complications** were noted in the group in which tests were ordered by the anesthesiologists, but this finding appears to be unrelated to the testing ordering practice being examined.
J. P. Fischer et al. (2014)	Lit Review	N/A	CS	All	Preoperative assessment	Patients with no comorbidities had a significantly lower rate of abnormal findings ($p<0.0001$), but 59.4% underwent preoperative testing.	Neither testing nor the presence of abnormal test results were associated with postoperative **adverse outcomes**

TOPIC 3: REDUCED PREOPERATIVE TESTING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Fritsch et al. (2012)*	Hospital of Schwarzach	n=1,363	Multiple	All	Preoperative assessment	N/A	Best predictors of perioperative complications: **Age**: OR 1.028, p=0.001 **Invasiveness of procedure**: OR=5.278, p<0.0001 **History of renal disease**: OR 4.987, p<0.001 **History of anemia**: OR 4.269, p=0.004 **Abnormal ECG**: OR 2.814, p=0.005
Frost (2012)	Lit Review	N/A	Multiple	N/A	Preoperative assessment	See discussion of clinical outcomes.	Integration of perioperative information is difficult and is confounded by a lack of computer infrastructure. This results in excessive and expensive testing. Guidelines for perioperative management have been developed but multiple specialties but have not been adequately communicated to practitioners.
Garcia, Pastorio, Nunes, Locks, and Almeida (2014)*	Hospital Universitáriodela Universidade Federalde Santa Catarina, Brazil	n=1,063	Mutliple	Adult non-cardiac elective surgery patients	Preoperative assessment	41.9% of tests on ASA I patients, 17.72% of tests on ASA II patients, 40% of tests on ASA II patients, and 22.5% of tests on ASA IV patients were not indicated. If these tests had not been ordered, the instution could generate a 13% annual **cost savings.**	N/A
Huck and Lewandrowski (2014)	Lit Review	N/A	Multiple	N/A	Preoperative testing	Utilization management of preoperative testing will require a team that is both clinical and non-clinical in nature, with a clear champion. Clinical pathologists may have an opportunity to become industry leaders in this area.	N/A
Kaplan, Sheiner, and Boeckmann (1985)	UC San Francisco Medical Center	n=2,000	Multiple	All elective patients	Preoperative testing	60% of **routinely ordered tests** were unnecessary based on recognizable indications Only 0.22% yielded abnormalities that might influence perioperative care	N/A
Levick, Stern, Meyerhoefer, Levick, and Pucklavage (2013)	Lehigh Valley Health System hospital	n=1	Multiple	All	OR system design	Use of a clinical decision support (CDS) system reduced the use of BNP testing by 21%, for an approximate **annual savings** of $92,000.	N/A
Mantha et al. (2005)*	Nizam's Institute of Medical Sciences	n=127	GS	All	Preoperative assessment	N/A	Although the **incidence of unindicated preoperative screening tests** is still more than 50%, no previously unidentified benefit was found to support this persistence of unwarranted testing.

TOPIC 3: REDUCED PREOPERATIVE TESTING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Nepomnayshy et al. (2013)	Lahey Clinic, Tufuts Medical School	n=882	GS	Morbidly obese patients	Preoperative testing	Bariatric morbidly obese patients are screened for sleep apnea; orthopedic patients are not. 25% of bariatric patients are diagnosed with sleep apnea as a result of this process. However, cardiopulmonary complication rates were not significantly different between the two groups, indicating that the sleep apnea diagnosis was unnecessary and led to unnecessary costs.	N/A
Parker, Tetzlaff, Litaker, and Maurer (2000)	The Cleveland Clinic	n=63,941	Multiple	All	Preoperative assessment	**Cost per evaluation** in clinic: $24.86 35.6% did not need to see anesthesiologist before surgery by using self-assessment **Preoperative surgical delay rate** decreased 49% **Patient interview time** and **dissatisfaction** both decreased	N/A
Procop et al. (2014)	The Cleveland Clinic	n=12,204 alerts	Multiple	All	Preoperative assessment	The use of a clinical decision support system in test ordering blocked 11,790 duplicate test orders over two years, yielding a savings of $183,586 with no adverse effects reported.	N/A
Siddel (2013)	Editorial	N/A	Multiple	All	Perioperative care	Preoperative testing conducted more than 3 days before inpatient admission will not be included in DRGs for Medicare patients and will send a red flag to auditors. Medicare is considering moving to a 14-day window in the move to bundled payment. Even if the provider will not be reimbursed for pre-operative care, it is best to submit the charge to Medicare for more accurate calculation of the cost-to-charge ratio.	N/A
Sigmundsson, Jönsson, and Strömqvist (2014)*	Swedish Spine Register	n=9.051	GS	Patients 50 years and older	Preoperative assessment	N/A	Patients with higher preoperative pain were associated with more postoperative self-reported **back and leg pain**, reduced **health-related quality of life** as measured by SF-36 and EuroQol, and lower **function** as measured by Oswestry Disability Index and self-reported walking distance.

TOPIC 3: REDUCED PREOPERATIVE TESTING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Siriussawakul et al. (2013)*	Siriraj Hospital	n=1,496	Multiple	Adults	Preoperative testing	Only 12.1% of patients had preoperative testing compliant with institutional guidelines, leading to **excess cost** of $200,000. Overinvestigations were more common for major surgery and younger patients.	N/A
Sousa Soares et al. (2013)*	Hospital Santo Antonio	n=800	Multiple	Elective non-major surgical patients aged 1-45 and ASA I	Preoperative testing	Only 68 of the 800 patients showed surgical **changes** in preoperative routine tests, and only 10 of those with abnormal tests had a **modified approach**. No surgeries were **suspended**.	N/A
Tait, Voepel-Lewis, Munro, Gutstein, and Reynolds (1997)	Large university children's hospital	n=127	PDS	Children	Efficiency vs. quality	**Parental costs of day-of cancellations**: 50.0% of fathers and 38.5% of mothers missed work; 53.3% and 42.1%, respectively, were unpaid. **Round trip miles driven**: 158.8 **Additional testing and appointments required** in 25.2% of cases	N/A
S. R. Thilen et al. (2013)	Integrated health care system	n=13,673	Multiple	All	Preoperative testing	22% of all surgical patients had preoperative testing. Ophthamalogic, orthopedic, or urologic surgery patients were more likely to undergo testing than general surgical patients.	N/A
Vazirani et al. (2012)	Veterans Administration Greater Los Angeles Healthcare System	n=5,223	Multiple	All	Preoperative assessment	N/A	**Length of stay** decreased for patients with ASA score of 3 or higher ($p<0.0001$) after addition of hospitalist-run preanesthesia clinic. **Reduction in same-day cancellations**: 8.5% to 4.9%, $p=0.065$ **Inpatient mortality** reduced: 1.27% to 0.36%, $p=0.0158$ **More perioperative beta blockers and stress tests** ($p<0.0001$, $p=0.012$)
White et al. (2012)	Editorial	N/A	Multiple	The elderly	Preoperative assessment	N/A	Ambulatory surgery on the elderly has increased and will continue to increase as the population ages. Age has physiologic and pharmacologic implications for medical treatment and may require differing anesthetic techniques and an increased focus on the effects of comorbidities. Best practices for managing common postoperative effects on the elderly are discussed, and future challenges mentioned.

*Indicates a study conducted outside the United States

Appendix D: Literature Charting for Topic 4 – Intraoperative Efforts Leading to Greater Efficiency

* Indicates a study conducted outside the United States

**LEGEND: SURGICAL SPECIALTIES	
Abbreviation	**Full name**
AS	Abdominal surgery
CS	Cosmetic surgery
CRS	Colorectal surgery
GS	General surgery
PDS	Pediatric surgery
TRS	Trauma surgery
VS	Vascular surgery
TS	Thoracic surgery
TTS	Transplant surgery

TOPIC 4: INTRAOPERATIVE EFFORTS LEADING TO GREATER EFFICIENCY							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Boothe and Finegan (1995)*	Hospital and outpatient clinic	n=64	CRS	All	Efficiency vs. quality	**Costs** for the same procedure were $360 less for outpatient surgery compared to inpatient surgery due to decreased nursing costs. **Total case flow** increased 12.2%.	N/A
Caplan et al. (1999)*	Prince of Wales Hospital	n=224	CRS	All	OR system design	The **cost savings** the hospital achieved outweighed increased post-discharge costs, netting a $200 savings in **overall treatment costs.**	The reengineered surgical service decreased **length of stay** (2.2 vs. 3.2 days, p<0.001) and accrued higher **patient satisfaction**. **Patient and caretaker burden** decreased following surgery.
Cima et al. (2011)	Mayo Clinic		Multiple	All	OR system redesign	OR processes were redesigned using Lean and Six Sigma methodologies by creating a value stream map depicting personnel, information processing, and time at each step. The newly designed process yielded -Fewer **patient wait times** greater than 10 minutes -Improved **on-time arrivals and starts** -Decreased **turnover and operating time** -Decreased **OR use after 5 P.M**. -Improved **OR operating margin** -Increased **OR capacity**	N/A
Cosgrove et al. (2008)*	Newcastle upon Tyne Hospital	n=839	TRS	All	Efficiency & quality	After an audit of emergency surgery efficiencies, findings were disseminated to related providers. A subsequent audit revealed a **decrease in delays** from 121 to 63 (p=0.001), an **increase in the availability of surgeons** (59 incidences of no available surgeon to 6, p=0.001), and a **decrease in the median waiting time** for emergency surgeries from 6.5 hours to 5 hours (p<0.01).	N/A
Dexter, Maxbauer, Stout, Archbold, and Epstein (2014)	22 academic and nonacademic hospitals in the US	n=13 weeks of data	Multiple	All	Efficiency & quality	Patients admitted to the hospital prior to the day of surgery make up only 8.1% of the scheduled surgical minutes non-academic surgical population (22.3% for the academic) but account for over half the minutes of surgical cancellations (over 70% for the academic).	N/A

TOPIC 4: INTRAOPERATIVE EFFORTS LEADING TO GREATER EFFICIENCY							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Fernández, Cronin, Greenberg, and Heitmiller (2014)	Johns Hopkins University Hospital	n=8.620	Multiple	Noncardiac pediatric surgical patients	Blood utilization	8.4% of patients who did not receive a blood transfusion underwent type and screen matching and 5% were crossmatched for red blood ceel products. Over a 13-month period, this **cost** $31,815 for the type and screens and $25,200 for the crossmatches.	N/A
Huesch (2011)	All state-regulated hospitals in Massachussetts	n=12,983	TS	All	Perioperative care	N/A	Increased hospital volume was associated with increased **discharge medication use** and decreased **intraoperative duration**. The variability in outcomes attributed to hospital/surgeon combination was small but significant in terms of **intraoperative practices**, **discharge destination**, and **medication use**, indicating an effect of surgeon/hospital 'fit'.
Jackson et al. (2011)	ACS-NSQIP data from 2005-2008	n=76,748	Multiple	Non-elective, non-same-day procedures	Intraoperative care	N/A	**Odds of complications** increased with increasing operating time for most laparoscopic surgeries, indicating that faster operations may improve patient outcomes.
Jacques, France, Pilla, Lai, and Higgins (2006)	Vanderbilt University Medical Center	n=22 anesthesiologists and n=30 nurses	Multiple	N/A	OR system design	Significantly faster **response rate** using VOIP technology compared to pagers (4 times faster) 70% of **nurses preferred** VOIP technology in feedback survey but only 50% **use** them due to greater reliability of pager technology (97.1% rated pagers more reliable)	N/A
Lako et al. (2013)	American Hospital, Albania	n=164	TS	CABG patients in a 2-year period	Blood utilization	N/A	Blood transfusion was required in 79.9% of patients. Factors contributing to the likelihood of transfusion include increased age, cardiopulmonary bypass, increased number of grafts, combined heart interventions, and preoperative hematocrit above 35%.
M. F. Newman et al. (2013)	Editorial	N/A	All	N/A	Preoperative testing	Key point: it is difficult to implement preanesthesia screening guidelines in the real world. One solution is perioperative clinics that do prescreening and coordinate care. This will be especially important as the focus shifts to long-term care and a value-based economy.	N/A

TOPIC 4: INTRAOPERATIVE EFFORTS LEADING TO GREATER EFFICIENCY							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Pollard and Garnerin (1999)	The Veterans Affairs Palo Alto Healthcare System	n=6,349	Multiple	All	Preoperative assessment	N/A	**Outpatient procedure share** increased after initiation of preoperative clinic (24.7% to 45.4%, p<0.0001) **Complication rates** remained stable for outpatient but increased for inpatient procedures (2.31% to 3.5%, p<0.05) **Mortality rate** unchanged for both
Prager et al. (2005)	Hospitals participating in BCBS Michigan plans	n=60 participating hospitals	TS, GS, VS	N/A	Efficiency & quality	Improving quality requires the development of new data registries based on rigorous data collection systems, an explicitly platform for quality improvement, and a focus on data confidentiality and trust. The information in these registries is submitted to BCBS as evidence of quality improvement efforts, and BCBS reimburses them using a 'pay-for-participation' scheme, rather than pay-for-performance. This translates quality improvement efforts into reimbursement.	N/A
Raes and Poelaert (2014)*	UZ Brussel, Belgium	n=2	Multiple	All	Preoperative assessment	N/A	Anecdotal evidence for preoperative consultation indicates its ability to correctly postpone surgery to improve patient safety. However, this is hard to prove on a large scale.
Rockall and Demartines (2013)	Editorial	N/A	Multiple	All	ERAS	N/A	Laparascopy is a widely accepted surgical technique and is fundamental the success of many ERAS programs. It may be that laparascopy should be included as a component of ERAS.
Rotondi et al. (1997)	University of Pittsburgh Medical Center (UPMC)	n=1,744	Multiple	All	OR system design	-**Raw and actual OR utilization** was less than 50% -High variation in **patient wait time** occurred in time of admit to time to OR, time from patient ready for OR to entry to OR, and time in the preoperative holding room	N/A
Sandberg et al. (2005)	Undisclosed OR	n =4	Multiple	N/A	OR system design	**Cases/day**: increased number of cases in new OR **Nonoperative time**: reduced from 67 minutes to 38 minutes (p<0.0001) **Operative time**: reduced 5 minutes **Hospital and anesthesia costs** increased (premium of 13%, p<0.005), but increased **throughput** offset costs (not significantly different)	N/A

TOPIC 4: INTRAOPERATIVE EFFORTS LEADING TO GREATER EFFICIENCY							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Sear (2014)	Editorial	N/A	Multiple	Patients with comorbidities	Efficiency & quality	**N/A**	Whether or not patients should maintain a preoperative prescription drug to manage comorbidities is up for debate, as these drugs may interact with anesthesia. While the debate is not yet resolved, anesthesiologists must continue to be mindful of interactions with prescription drugs and anesthesia.
Trentman, Mueller, Gray, Pockaj, and Simula (2010)	Hospital, ambulatory surgical center at the Mayo Clinic	n=184	CS	Females	Perioperative care	**Preoperative time**, **OR entry to incision time**, and **total time** were significantly lower in the ambulatory surgical center compared to the hospital ($p<0.001$ for all).	N/A
Vashdi et al. (2013)*	Large, public tertiary care health care center	n=362 teams	Multiple	All	Efficiency & quality	N/A	Higher levels of action-team learning are associated with reduced **adverse events** in low complexity surgeries and s**horter operative time**, mediated by improved team helping and workload sharing, particularly in complex cases.
Vetter, Ali, et al. (2012)	UAB Medical Center	n=163,195	Multiple	All	Efficiency & quality	N/A	A continuous quality improvement effort to reduce intraoperative corneal injury was undertaken at UAB employing the Seven-Step Problem-Solving Model. This model standardized the method of ocular protection during surgery and required documentation. The program successfully reduced rate of corneal injury in the 45 month follow-up period.
Williams, DeRiso, Engel, et al. (1998)	Ambulatory surgery center in University of Pittsburgh Medical Center (UPMC)	n=503	GS	All	OR system design	See discussion of clinical outcomes.	Clinical pathway care reduced **pharmacy and materials cost variability** ($p<0.001$), increased **turnover time** (20.7 to 25.0, $p=0.042$), improved **intraoperative anesthesia and surgical efficiency** ($p<0.001$), improved **recovery times** ($p<0.001$), improved **unexpected readmission rates** (20.1% to 8.1%, $p=0.001$), and decreased the **number of required nursing interventions** (2.1 to 1, $p<0.001$).

*Indicates a study conducted outside the United States

Appendix E: Literature Charting for Topic 5 – Postoperative Care Initiatives

* Indicates a study conducted outside the United States

**LEGEND: SURGICAL SPECIALTIES	
Abbreviation	**Full name**
AS	Abdominal surgery
CS	Cosmetic surgery
CRS	Colorectal surgery
GS	General surgery
PDS	Pediatric surgery
TRS	Trauma surgery
VS	Vascular surgery
TS	Thoracic surgery
TTS	Transplant surgery

TOPIC 5: POSTOPERATIVE CARE INITIATIVES							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Aarts et al. (2012)*	7 hospitals	n=336	CRS	All	ERAS	N/A	Strategies associated with a length of stay of five days or less: **Preoperative counseling**: OR 1.26, 95% CI 1.15 - 1.37 Use of a **laparascopic** approach: OR 1.24, 95% CI 1.12 - 1.38 **Intraoperative fluid restriction**: OR 1.26, 95% CI 1.15 - 1.37 **Clear fluids on day of surgery**: OR 1.09, 95% CI 1 - 1.2 **Early discontinuation of the Foley catheter**: OR 1.13, 95% CI 1.01 - 1.27
Campbell Jr et al. (2010)	16 hospitals in Michigan Surgical Quality Collaborative (MSQC) and 126 non-MSQC hospitals	n=315,699	GS, VS	All	Perioperative care	N/A	**Morbidity** rates improved in MSQC hospitals over time (10.7% to 9.7%, p=0.002) but did not improve in non-MSQC hospitals over the same time period (12.4% vs. 12.4%, p=0.49). **Mortality** rates did not improve in either group. **Odds of experiencing a complication** were lower in the MSQC group (odds ratio 0.898) compared to the non-MSQC group (odds ratio 1.000), p=0.004.
Clark and Spanswick (2013)*	Editorial	N/A	Multiple	All	Anesthesia	N/A	Key takeaways related to perioperative pain management: -Manage expectations and medication of patients presenting with preoperative pain -Manage patients with presurgical opioid dependence before surgery to minimize withdrawals and complications after surgery -Use multimodal analgesia when possible
Favuzza et al. (2013)	University Hospitals Case Medical Center	n=70	CRS	N/A	Postoperative care	The use of TAP (transverse abdominis plane) blocks after laparoscopic surgery shortened hospital stay by 1 day, and patients who received TAP required fewer postoperative narcotics. Both could potentially reduce costs associated with laparoscopic surgery.	N/A
Kastenberg et al. (2012)	University-affiliated tertiary Veterans Affairs Medical Center	N/A	Multiple	All	Preanesthesia assessment	N/A	Unadjusted morbidity rates: decreased with intern home-call rather than hospital visit (12.14% vs. 10.19%, p=0.003) Risk-adjusted morbidity rates: decreased 6.03% (p<0.001) Unadjusted mortality rates: decreased (1.76% to 1.26%, p=0.05)

TOPIC 5: POSTOPERATIVE CARE INITIATIVES							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Knott et al. (2012)*	Survey	n=86	Multiple	N/A	ERAS	N/A	Recent developments in ERAS-related anesthesia: Increased use of intraoperative fluid management Cardio-pulmonary exercise testing Key factors in sustaining ERAS success: Clinical champions Dedicated ERAS facilitator
Kolozsvari et al. (2012)*	Clinical teaching unit in a university-based hospital	n = 433	CRS	All	ERAS	N/A	Primary: **Length of stay**: 4 for both groups ($p<0.01$) Secondary: **Operation performed by a colorectal surgeon?** More likely with ERP ($p = 0.01$) **Time to eating solids**: ERP patients earlier ($p<0.001$) **Time to catheter removal**: ERP patients earlier ($p<0.001$) **Discharge by planned POD**: ERP more often ($p<0.001$) **Complication rates**: not significantly different **ER visits**: ERP fewer ($p=0.02$) **Readmission rates**: not significantly different
Kuper et al. (2011)*	3 hospitals in the UK	n = 1,357	Multiple	All	Postoperative care quality	N/A	**Length of hospital stay**: 3.6 day reduction ($p=0.002$) **In-hospital mortality**: no significant difference **Readmission rates**: no significant difference **Reoperation rates**: 2.5% decrease, $p<0.08$
Lagasse, Steinberg, Katz, and Saubermann (1995)	Montefiore Medical Center-Albert Einstein College of Medicine	n=116	Multiple	N/A	Anesthesia	N/A	7.8% of **errors** were **human errors**; 92.2% of errors were **system errors**. This indicates that the primary determinant of care quality is the system, not the individual provider. All errors but one in statistic control, indicating a stable system.
Maessen et al. (2007)*	5 surgical centers	n=425	CRS	All	ERAS	N/A	Surgical centers with previous experience with fast-track surgery were associated with a shorter **hospital stay**. **Fast-track protocol adherence** was high before and during the operative phase but low in the postoperative phase.

TOPIC 5: POSTOPERATIVE CARE INITIATIVES							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
A. B. Newman et al. (2006)	Participants in the Health, Aging, and Body Composition Study	n=3,075	Multiple	Adults aged 70 to 79	Prehabilitation	N/A	Inability to complete walking test was associated with: **Mobility limitation**: 212.6 vs. 79.1 1000-person/years, p<0.001 **Mobility disability**: 85.2 vs. 28.8 1000-person/years, p<0.001 The longer the test took, the greater the risk for **mortality**, **incident cardiovascular disease**, and mobility limitation and disability.
Raphael, Jaeger, and van Vlymen (2011)*	Tertiary care and in community hospitals	n=200	GS	All	ERAS	Lower morphine utilization by fast-track patients (7.5 vs. 35 mg)	**Length of stay**: reduced in fast-track patients by 69 hours (95% CI 60 to 78) **Pain scores** lower in fast track patients (4 vs. 40 on postoperative day 2)
Rinehart, Merkel, Schulman, and Hutchens (2012)	Cardiac surgery ICU	n=3	TS	All	Postoperative care	N/A	**Predicted mortality** for these patients was 14.6% (13.3% one-way CI). However, all three were **discharged** and **no negative side effects** of therapeutic hypothermia were noted.
Sammour et al. (2010)*	Manukau Surgical Centre	n=100	CRS	All	ERAS	Does implementing an ERAS system offset implementation costs? Yes; costs were recouped after 15 patients	**Use of intravenous fluids**: lower in ERAS group (intraoperative -2 vs. 3, p<0.0001; 3 days postoperative - 2 vs. 6.5, p<0.0001) **Duration of anesthesia use**: lower in ERAS group (2 days vs. 3 days, p<0.0001) **Recovery time**: ERAS faster in days to full meal, passage of flatus and mobilization (p<0.0001 for all) **Length of stay shorter in pre-surgery days, postoperative days, and total days** (p<0.0001 for all)
Share et al. (2011)	Michigan regional collaborative improvement program; BCBS Michigan network	n=44 participating hospitals	Multiple	All	Efficiency & quality	**Return on investment** - reduction in complications and improvement in quality reduces future costs and implementation of cost-saving best practices -2.6% drop in vascular surgery complications translates to $20M in cost savings on a $5M investment cost of administering the program. -Reduction in use of problematic vena cava filters translates to savings of $4 million annually. -Implementation of risk-prediction tools has reduced kidney failure and need for dialysis translated to $1M annual cost savings.	General and vascular: **risk-adjusted 30-day morbidity rates** fell from 13.1% to 10.5% from 2005 to 2009 (p<0.001), **overall morbidity** in Michigan hospitals lower than other hospitals (10.5% to 11.5%, p<0.001) Bariatric: **overall complication rates** fell from 8.7% to 6.6% from 2007 to 2009, **risk-adjusted 30-day mortality rates** dropped from 2007 to 2009 (p=0.004); **rate of improvement** in Michigan exceeded other hospitals (p=0.045) Interventional cardiology: **serious complication rate** fell from 3.8% to 2.3% (p<0.001) between 1998 and 2002; fewer **complications** than non-participating hospitals (2.3% vs. 3.2%, p<0.001) Cardiac surgery: **composite quality scores**

TOPIC 5: POSTOPERATIVE CARE INITIATIVES							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
							including risk-adjusted mortality, complications, use of mammary artery as a graft, and other, went from national benchmark (2007-2008) to exceeding national to falling within top tenth percentile
Toscan et al. (2013)*	Community hospitals	n=1	GS	Elderly hip fracture patients	Postoperative care	N/A	Patient and family caregivers do not feel fully informed about home care after surgery and do not understand the role of the health care providers involved. These parties also report not knowing what to expect or what is expected of them, and feel that hospital rules hinder individualized care.
Veronovici, Lasiuk, Rempel, and Norris (2013)	Literature review	n=8	TS	All	Preoperative education	N/A	Education of cardiovascular patients preoperatively was associated with decreased self-reported anxiety and depression, increased self-reported health. No studies reported negative results of preoperative education.
Williams, DeRiso, Engel, et al. (1998)	Ambulatory surgery center in University of Pittsburgh Medical Center (UPMC)	n=503	GS	All	OR system design	See discussion of clinical outcomes.	Clinical pathway care reduced **pharmacy and materials cost variability** ($p<0.001$), increased **turnover time** (20.7 to 25.0, $p=0.042$), improved **intraoperative anesthesia and surgical efficiency** ($p<0.001$), improved **recovery times** ($p<0.001$), improved **unexpected readmission rates** (20.1% to 8.1%, $p=0.001$), and decreased the **number of required nursing interventions** (2.1 to 1, $p<0.001$).
Williams, DeRiso, Figallo, et al. (1998)	Ambulatory surgery center in University of Pittsburgh Medical Center (UPMC)	n=503	GS	All	OR system design	See discussion of clinical outcomes.	Clinical pathway regional anesthesia vs. general anesthesia led to increased **pharmacy and materials costs** and increased **turnover time** ($p<0.001$ for both), but **recovered** better ($p=0.003$), had lower **unexpected readmission rates** ($p=0.002$), and required **fewer nursing interventions** ($p<0.001$). **Postanesthesia care unit bypass** was more common in regional anesthesia ($p<0.001$).

*Indicates a study conducted outside the United States

Appendix F: Literature Charting for Topic 6 – Reduced Postoperative Complications

* Indicates a study conducted outside the United States

**LEGEND: SURGICAL SPECIALTIES	
Abbreviation	**Full name**
AS	Abdominal surgery
CS	Cosmetic surgery
CRS	Colorectal surgery
GS	General surgery
PDS	Pediatric surgery
TRS	Trauma surgery
VS	Vascular surgery
TS	Thoracic surgery
TTS	Transplant surgery

TOPIC 6: REDUCED POSTOPERATIVE COMPLICATIONS							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Archibald et al. (2011)	8 community hospitals	n=1,358	CRS	All	ERAS	**Hospital costs**: decreased by $1,763 (p=0.02)	**Length of stay**: decreased by 1.5 compared to 2-year baseline (p<0.0001) **Postoperative days**: decreased by 1.3 compared to 2-year baseline (p<0.0001) **30-day readmission rate**: remained stable (p>0.05) **Return to surgery**: remained stable (p>0.05)
Batsis et al. (2007)	Tertiary care center	n=466	GS	All	Perioperative care	N/A	Hospitalist care does not have a significant effect on patient **1-year mortality** (70.5% vs. 70.6%, p=0.36), despite **shortened length of stay** and **time of surgery** under hospitalist care.
Birkmeyer, Gust, Dimick, Birkmeyer, and Skinner (2012)	Multiple		Multiple	All	Efficiency & quality	CABG: Hospitals in highest complication quintile had **higher payments** than the lowest quintile ($5,353 higher, p<0.001). Colectomy, $2,719; AAA repair, $5,279; hip replacement, $2,436. **Payments higher to lower quality hospitals** due to higher payments for index hospitalizations, 30-day readmissions, post-discharge ancillary care, and physician services **Mortality** not associated with expenditures	N/A
Dasgupta et al. (2009)*	Tertiary care teaching hospital	n=125	Multiple	Noncancer patients 70 years or older	Frailty	N/A	**Postoperative complications**: increased with frailty (p=0.02); patients with EFS (Edmonton Frail Scale) greater than 7 associated with greater complications - OR 5.02 **Length of postoperative stay**: increased with frailty (p=0.004) **Inability to be discharged home**: increased with frailty (p=0.01); patients with EFS (Edmonton Frail Scale) greater than 7 had a 40% chance of not going home, p<0.002
Eskicioglu et al. (2009)*	Multiple	n=198	CRS	All	ERAS	N/A	**Length of stay**: 3 of 4 studies show reduced length of stay (relative risk = 0.53, 95% CI .12 - 2.38) **Reduced complications**: 3 of 4 studies show reduced complications (relative risk = 0.61, 95% CI 0.42-0.88)

TOPIC 6: REDUCED POSTOPERATIVE COMPLICATIONS							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Fried et al. (2001)	Cardiovascular Health Study data	n=5,317	Multiple	65 years and older	Frailty	N/A	Four criteria identified for frailty: **Unintentional weight loss (10 lbs. in past year)** **Self-reported exhaustion** **Weakness (grip strength)** **Slow walking speed** **Low physical activity** This definition of frailty was associated with being African American, lower education and income, poor health, and higher chronic morbidity (p<0.05 for all). Frailty was a predictor of **falls** (p=0.06), **disability** (p<0.05), **hospitalization** (p<0.05), and **death** (p<0.05).
Garonzik-Wang et al. (2012)	Johns Hopkins Hospital	n=183	TTS	All	Frailty	N/A	Delayed organ graft function; Preoperative frailty was independently associated with a 1.94-fold increased **risk for delayed graft function** (95% CI, 1.13-3.36; P = .02)
Graham et al. (2014)	Geisinger Health System	n=194	GS	Hip fracture patients	Postoperative care	Mean costs for PCMH were lower, but not significantly different for pharmacy and non-pharmacy costs.	Patients whose postoperative care was managed by a patient-centered medical home (PCMH) had: Lower **6-month** and **12-month mortality** (11% vs. 26%, p<0.01 and 23% vs. 30%, p=0.12, respectively) Similar **quality of life scores** Improved **Harris Hip scores** (73 vs. 64, p=0.04)
Holm, Thorborg, Husted, Kehlet, and Bandholm (2013)*	Copenhagen University Hospital	n=30	GS	All	ERAS	N/A	Hip muscle strength and leg press strength of patients was reduced at Day 2 compared to preoperative measures, but had begun to rebound at day 8. Self-reported symptoms also improved at day 8. Changes in hip pain, thigh swelling, and C-Reactive Protein levels were not associated with muscle strength or power loss.
Joh et al. (2008)	University Hospitals Case Medical Center	n=42	CRS	All	ERAS	N/A	**Median operative time**: 60 minutes **Median blood loss**: 17.5 mL **Median hospital stay**: 2 days 69% of patients **discharged** by day 2 **Complication rate**: 23.8% **30-day readmission rate**: 9.5%

TOPIC 6: REDUCED POSTOPERATIVE COMPLICATIONS							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
S. Khuri (2005)	NSQIP and VA databases	n=105,591	Multiple	Veterans	Postoperative care	N/A	Most important indicator of **post-operative survival** was 30-day postoperative occurrence of **22 NSQIP reported complications** Occurrence of one of these events reduced patient survival rates by 69%, independent of preoperative risk
S.-w. Kim et al. (2014)*	Seoul National University College of Medicine, South Korea	n=275	Multiple	Elective surgery patients older than 65	Frailty	N/A	10.5% of patients experienced at least one **complication** 8.7% were **discharged to skilled nursing facilities** Frailty score predicted mortality risk better than ASA. Higher frailty scores were associated with increased **mortality** rates and **length of stay.**
Klidjian, Foster, Kammerling, Cooper, and Karran (1980)*	Department of Surgery, University of Southampton	n=225	TS	All	Dynamometry	N/A	**Hand grip dynometry** predicted **complications** in 48 of 55 cases with complications (87%, $p<0.001$). **Arm muscle circumference** and forearm muscle circumference below 85% of the standard also predicted **complications** ($p<0.02$ and $p<0.01$)
Krenk et al. (2014)*	Rigshospitalet, Denmark	n=225	GS	Elderly joint replacement surgical patients	Postoperative care	N/A	The incidence of postoperative cognitive dysfunction (POCD) was 9.1% after 1-2 weeks and 8.0% at 3 months. Patients **with and without POCD** did not differ in terms of pain, opioid use, sleep quality, or C-reactive protein response, but did have a higher score on the Mini Mental State Examination.
Krupka et al. (2012)	University of Michigan Hospital	NSQIP data and hospital accounting data	Multiple	N/A	Efficiency & quality	Calculated **cost savings** for each complication avoided: $17,000 Calculated **change in reimbursement revenue** for each complication avoided: $13,000 If there is not another patient to fill the hospital bed, hospital incurs a **loss** of ($4,000). Thus, to incentivize hospitals not at capacity to avoid complications, these costs should be shared by payors.	N/A
Kristoffer Lassen et al. (2012)*	Standard database & personal data		GS	N/A	ERAS	N/A	See Kahokehr et al. (2009) for similar paper for colorectal surgery. Evidence and recommendations on ERAS best practices for pancreaticoduodenoctomy.

TOPIC 6: REDUCED POSTOPERATIVE COMPLICATIONS							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Lloyd et al. (2010)*	2 hospitals in Dublin	n=117	CRS	All	ERAS	N/A	Laparascopic: RAPID protocol group had significantly shorter **median stay** (6 vs 9.5 days, p=0.01**), tolerance of full diet** (2 vs. 3 days, p=0.002), and **reduction in pain score** on days 1 and 3 (p=0.004, p<0.0001). Open resections: RAPID protocol group had significantly shorter **stay** (7.5 vs. 12 days, p=0.04) and **pain score** on day 3 (p=0.006).
Miller et al. (2014)	Duke University Medical Center	n=241	CRS	All	ERAS	N/A	Median **length of stay** was lower in the ERAS group than in traditional care and rates of **UTI** and **readmission** were lower.
Mohn, Bernardshaw, Ristesund, Hovde Hansen, and Rokke (2009)*	Haukeland University Hospital and Haugesund Hospital	n=94	CRS	All	ERAS	N/A	**Length of stay**: 78% discharged within 5 days in ERAS patients, 5% with traditional program **Complication rate**: ERAS - 31% **Readmission rate**: ERAS - 15% **Time to resume daily activities**: ERAS - 57% within one week of discharge **Time to resume leisure activities**: ERAS - 65% within thirty days of discharge
Mythen et al. (2012)*	Best practice report	N/A	N/A	N/A	ERAS	N/A	Provides principles for each phase of surgery related to: -General principles of enhanced recovery fluid management and recommendations of the enhanced recovery partnership -Aims of ER fluid management (by the end of surgery) -Individualized goal directed fluid therapy
Nascimbeni, Di Fabio, Di Betta, and Salerni (2009)*	Brescia University Hospital	n=985	CRS	N/A	Postoperative care	N/A	Rate of cancer patients undergoing surgery increased significantly between 1975-1984 and 1995-2004. **Postoperative mortality**: 3.9% in 1975-1984, 0.6% in 1995-2004 (p=0.001). Most significant change in 74+ group. **5-year survival**: worse for 74+ group than younger group in both decades (p<0.001 and p=0.01, respectively). **Cancer-related survivals**: worse for 74+ group than younger group in both decades (p<0.0001 and p=0.04, respectively).
Pasquali et al. (2012)	14 surgical centers	n=546	PDS	Infants	Perioperative care	N/A	All preoperative care variables varied across the 14 sites (fetal diagnosis, preoperative intubation, enteral feeding). Some perioperative and operative variables varied, including **total**

TOPIC 6: REDUCED POSTOPERATIVE COMPLICATIONS							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
							support time and **intraoperative medication use**. Postoperative variables also varied, including **median ICU stay**, **type of feeding at discharge**, and a **home monitoring program**.
Qaseem et al. (2006)	Editorial	N/A	Multiple	N/A	Efficiency & quality	N/A	Patient-related factors (i.e. chronic disease, age above 60, ASA class II or higher) increase **risk of postoperative pulmonary complications**. Certain surgeries carry larger risk of postoperative pulmonary complications (prolonged, emergency, abdominal, aortic aneurysm, etc.) General anesthesia also brings a larger risk of postoperative pulmonary complications. Risk reduction strategies (spirometry, deep breathing exercises) reduce risk of postoperative pulmonary complications.
Ramirez et al. (2011)*	Hospital	n=300	CRS	All	ERAS	N/A	Compliance to ERAS protocol: overall 65% but varied across components, ranging from 99% providing perioperative information to 40.6% taking early fluids by mouth. **Average length of stay** 6 days; 3% required **readmission**; most **complications** were surgical (24%)
Raphael et al. (2011)*	Tertiary care and in community hospitals	n=200	GS	All	ERAS	Lower morphine utilization by fast-track patients (7.5 vs. 35 mg)	**Length of stay**: reduced in fast-track patients by 69 hours (95% CI 60 to 78) **Pain scores** lower in fast track patients (4 vs. 40 on postoperative day 2)
Ren et al. (2012)*	University hospital	n=597	CRS	N/A	ERAS	Postoperative expense lower for ERAS group ($p<0.001$)	**Nutritional status**: improved in ERAS group compared to control group (Insulin resistance index lower, $p<0.001$) **Reduced postoperative stress** in ERAS group **Accelerated gastrointestinal function** in ERAS group **Postoperative length of stay** lower in ERAS group ($p<0.001$) No significant difference in **complications**
Robinson, Wu, Stiegmann, and Moss (2011)	Denver Veterans Affairs Medical Center	n = 60	CRS	65 and older	Frailty	Does a preoperative assessment of frailty predict healthcare and hospitalization costs? Findings: as frailty advanced, so did **hospital costs** and **costs from discharge to 6 months** ($p<0.001$). Higher frailty associated with **discharge to an institution** ($p<.001$) and **readmission** ($p<0.044$)	N/A

TOPIC 6: REDUCED POSTOPERATIVE COMPLICATIONS							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Teeuwen et al. (2010)*	Outpatient clinic and a surgical center	n=62 n=246	CRS	All	ERAS	N/A	Primary: **Mortality**: no significant difference (p=0.55) **Morbidity**: lower in ERAS group (14.8% to 33.6%, p<0.01) Secondary: **Fluid intake**: ERAS patients received less fluid day of and postoperative days (p<0.0001) **Length of hospital stay**: 6 days vs. 9 days, p=0.032 **Number of relaprotomies**: no significant difference (p=0.85) **Number of readmissions in 30 days**: no significant difference (p=0.60)
Williams, DeRiso, Engel, et al. (1998)	Ambulatory surgery center in University of Pittsburgh Medical Center (UPMC)	n=503	GS	All	OR system design	See discussion of clinical outcomes.	Clinical pathway care reduced **pharmacy and materials cost variability** (p<0.001), increased **turnover time** (20.7 to 25.0, p=0.042), improved **intraoperative anesthesia and surgical efficiency** (p<0.001), improved **recovery times** (p<0.001), improved **unexpected readmission rates** (20.1% to 8.1%, p=0.001), and decreased the **number of required nursing interventions** (2.1 to 1, p<0.001).
Williams, DeRiso, Figallo, et al. (1998)	Ambulatory surgery center in University of Pittsburgh Medical Center (UPMC)	n=503	GS	All	OR system design	See discussion of clinical outcomes.	Clinical pathway regional anesthesia, compared to general anesthesia, led to increased **pharmacy and materials costs** and increased **turnover time** (p<0.001 for both), but **recovered** better (p=0.003), had lower **unexpected readmission rates** (p=0.002), and required fewer **nursing interventions** (p<0.001). **Postanesthesia care unit bypass** was more common in clinical pathway regional anesthesia (p<0.001).
J. M. Young et al. (2013)*	Public and private hospitals	n=775	CRS	Cancer patients	Postoperative care	N/A	Some patients were assigned to the CONNECT intervention in which nurses followed up with patients by phone at several intervals after discharge. CONNECT patients demonstrated no significant differences from non-CONNECT patient in terms of **unmet care needs**, **ED presentations**, **unplanned readmissions**, **experience of care coordination**, or **distress**.

*Indicates a study conducted outside the United States

Appendix G: Literature Charting for Topic 7 – Care Coordination and Transition Planning

* Indicates a study conducted outside the United States

**LEGEND: SURGICAL SPECIALTIES	
Abbreviation	**Full name**
AS	Abdominal surgery
CS	Cosmetic surgery
CRS	Colorectal surgery
GS	General surgery
PDS	Pediatric surgery
TRS	Trauma surgery
VS	Vascular surgery
TS	Thoracic surgery
TTS	Transplant surgery

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Aarts et al. (2012)*	7 hospitals in Canada	n=336	CRS	All	ERAS	N/A	Strategies associated with a length of stay of five days or less: **Preoperative counseling**: OR 1.26, 95% CI 1.15 - 1.37 **Use of a laparascopic approach**: OR 1.24, 95% CI 1.12 - 1.38 **Intraoperative fluid restriction**: OR 1.26, 95% CI 1.15 - 1.37 **Clear fluids on day of surgery**: OR 1.09, 95% CI 1 - 1.2 **Early discontinuation of the Foley catheter**: OR 1.13, 95% CI 1.01 - 1.27
Aboulian et al. (2010)	County Hospital	n=54	CRS	All	ERAS	N/A	ERAS patients saw: Decrease in **intravenous fluids during surgery** (p=0.001) and **over next 3 days** (p=0.0017) Decrease in **hospital stay**: 4 days vs. 6 days, p=0.003 No difference in **complication** or **readmission rates**
Anthony and Hudson-Barr (1998)	Healthcare agencies in Cleveland, Ohio	n=28	Multiple	All	Discharge planning	N/A	Factors affecting effective discharge: -**Communication** (or lack) between RN and physician -**Use of multidisciplinary teams** to facilitate communication -**Short staffing** resulting in inadequate teaching time and poor continuity -**Inability of families to meet post-discharge needs** -Limited LOS reduces **patient readiness for discharge** -**Tools for discharge** (i.e. care paths, clarity of discharge criteria) helpful
Archibald et al. (2011)	8 community hospitals in Utah	n=1,358	CRS	All	ERAS	**Hospital costs**: decreased by $1,763 (p=0.02)	**Length of stay**: decreased by 1.5 compared to 2-year baseline (p<0.0001) **Postoperative days**: decreased by 1.3 compared to 2-year baseline (p<0.0001) **30-day readmission rate**: remained stable (p>0.05) **Return to surgery**: remained stable (p>0.05)

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Bardram et al. (1995)*	University hospital	n=8	Colorectal	Elderly, high-risk	ERAS	N/A	**Early mobilization** in fast-track group due to effective pain relief **LOS**: reduced to 2 days without nausea, vomiting, or ilieus **Postoperative fatigue** reduced **Functional activity impairment** avoided
Ben-Ishay, Gertsenzon, Mashiach, Kluger, and Chermesh (2011)*	Rambam Medical Center, a tertiary 970-bed hospital	n=100	Multiple	All	Postoperative care quality	N/A	**Malnutrition risk**: 33% of patients were screened to be at a high malnutrition risk using MUST tool **Length of stay**: significantly longer for patients without malnutrition risk (18.8 days vs. 5.3 days, p=0.003) **Mortality**: higher in malnutrition risk group in hospital (9.4% to 0%, p=0.017), after 6 months (18.8% to 1.6%, p=0.006), and after 1 year (21.9% to 1.6%, p=0.002)
Birkmeyer et al. (2012)	All Medicare claims files for surgical specialties covered between 2005 and 2007		Multiple	All	Efficiency & quality	CABG: Hospitals in highest complication quintile had **higher payments** than the lowest quintile ($5,353 higher, p<0.001). Colectomy, $2,719; AAA repair, $5,279; hip replacement, $2,436. **Payments higher to lower quality hospitals** due to higher payments for index hospitalizations, 30-day readmissions, post-discharge ancillary care, and physician services **Mortality** not associated with expenditures	N/A
Campbell Jr et al. (2010)	16 hospitals in the Michigan Surgical Quality Collaborative (MSQC), 126 non-MSQC hospitals	n=315,699	GS, VS	All	Efficiency & quality	N/A	**Morbidity rates** improved in MSQC hospitals over time (10.7% to 9.7%, p=0.002) but did not improve in non-MSQC hospitals over the same time period (12.4% vs 12.4%, p=0.49). **Mortality rates** did not improve in either group. **Odds of experiencing a complication** were lower in the MSQC group (odds ratio 0.898) compared to the non-MSQC group (odds ratio 1.000), p=0.004.
Clark and Spanswick (2013)*	Editorial	N/A	Multiple	All	Anesthesia	N/A	Key takeaways related to perioperative pain management: -Manage expectations and medication of patients presenting with preoperative pain -Manage patients with presurgical opioid dependence before surgery to minimize

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
							withdrawals and complications after surgery -Use multimodal analgesia when possible
Cook et al. (2013)	Mayo Clinic	n=149	TS	Over 50	OR system design	N/A	Patients were able to effectively self-report and interact with a customized care plan using an e-health platform. Self-reported data were accurate predictors of length of stay and likelihood of discharge home.
Cornell et al. (2007)	3 New York hospitals	n=176	Hip fracture	65 and older	Post-discharge recovery	N/A	**Role-physical** domain of SF-36: significant improvement in group receiving peer counseling, strength training, and motivational video intervention compared to normal intervention (p=0.03)
Delaney et al. (2001)	Cleveland Clinic Foundation	n=60	CRS	All	ERAS	N/A	**LOS**: shorter for 'fast-track' patients, even those with comorbidities **Readmission rate**: 4 of the fast-track patients (4.7%) were readmitted for reasons unrelated to the fast-track process; as such, the fast-track process did not show higher readmission rates than the non-fast-track process
Ellison et al. (2004)	Brady Urological Institute, Baltimore	n=85	Urologic	All	Technology	N/A	Telerounding treatment: patient ratings of **examination thoroughness**, **quality of discussion**, **postoperative care coordination**, and **physician availability** improved Robotic telerounding treatment: patient ratings of **physician availability** improved
Eskicioglu et al. (2009)*	Multiple	n=198	CRS	All	ERAS	N/A	**Length of stay**: 3 of 4 studies show reduced length of stay (relative risk = 0.53, 95% CI .12 - 2.38) **Reduced complications**: 3 of 4 studies show reduced complications (relative risk = 0.61, 95% CI 0.42-0.88)
Hardt et al. (2013)*	Academic medical center	n=103	CRS	All	ERAS	N/A	This study compared clinical pathway outcomes to outcomes for patients in a previously existing enhanced postoperative recovery program. The clinical pathway patients **resumed regular diet** sooner, **passed stool** sooner, and reduced **LOS**. However, there was a higher **need for revisional surgery** in the clinical pathway group.

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Holland et al. (2014)	Mayo Clinic	n=197	PDS	All English-speaking pediatric surgical patients	Discharge planning	N/A	A decision support tool was designed to identify patients in greatest need of discharge planning. 62% of the patients identified through this system had substantial post-acute care needs, whereas just 3% of the population not identified through this system had **substantial post-acute care needs**.
Huddleston et al. (2004)	Rochester Medical Hospital	n=526	GS	Elderly	Perioperative care	**Total costs** did not vary between hospitalist and non-hospitalist groups	**Complication rates**: lower in hospitalist-run group (61.6% vs. 49.8%) **Unadjusted length of stay**: no difference **Adjusted length of stay**: shorter in hospitalist-run group (5.1 vs. 5.6 days)
Huesch (2011)	All state-regulated hospitals in Massachus etts	n=12,983	TS	All	Efficiency & quality	N/A	Increased hospital volume was associated with increased **discharge medication use** and decreased **intraoperative duration**. The variability in outcomes attributed to hospital/surgeon combination was small but significant in terms of **intraoperative practices**, **discharge destination**, and **medication use**, indicating an effect of surgeon/hospital 'fit'.
H. Kehlet and Dahl (2003)*	Lit Review	N/A	Multiple	All	ERAS	N/A	Discusses pertinent literature on perioperative care, including **preoperative assessment**, **effects of general anesthetics**, **prevention of surgical stress**, **anesthetic techniques** for prevention and treatment of pain, fluid management, and the **role of surgeons and anesthesiologists** in care coordination
Kariv et al. (2007)	Cleveland hospital	n=97	Colorectal	All	ERAS	Median direct costs per patient within 30 days were lower with fast-track surgery ($5,692 vs. $6,672, p=0.001)	Fast-track patients had: Shorter **LOS**: 5 vs. 5.9 days, p=0.012 **Readmission rates**: no significant difference **Recurrent operation rates**: no significant difference **Complication rates**: no significant difference **Early discharge** associated with fast-track group

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Kolozsvari et al. (2012)*	Clinical teaching unit in a university-based institution	n=433	CRS	All	ERAS	N/A	Primary: **Length of stay**: 4 for both groups (p<0.01) Secondary: **Operation performed by a colorectal surgeon?** More likely with ERP (p = 0.01) **Time to eating solids**: ERP patients earlier (p<0.001) **Time to catheter removal**: ERP patients earlier (p<0.001) **Discharge by planned POD**: ERP more often (p<0.001) **Complication rates**: not significantly different **ER visits**: ERP fewer (p=0.02) **Readmission rates**: not significantly different
Kristoffer Lassen et al. (2012)*	Standard database & personal data		GS	N/A	ERAS	N/A	See Kahokehr et al. (2009) for similar paper for colorectal surgery. Evidence and recommendations on ERAS best practices for pancreaticoduodenoctomy.
Leandro-Merhi, de Aquino, and Sales Chagas (2011)*	Hospital e Maternidad e Celso Pierro, , Sao Paulo, Brazil	n=350	GS, TS	All	Efficiency & quality	N/A	Disease was the most prevalent factor in determining **length of stay** (p<0.0001), with neoplasm and vascular surgery patients having the longest stays. Well-nourished patients more likely to be **discharged** sooner than malnourished patients (RR 3.3, p=0.0002)
Lemmens, Van Zelm, van Hillegersberg, and Kerkkamp (2009)*	Lit review	n=13	Colorectal	All	Clinical pathways	N/A	Most common clinical pathway interventions to improve postoperative outcomes: **-Nutritional management** **-Pain management** **-Mobilization** **-Education** **-Discharge planning**
Macario, Vitez, Dunn, and McDonald (1995)	Stanford University Medical Center	n=715	Multiple	Not disclosed	Perioperative care	49% of total hospital costs are **variable**, 57% are **direct** to patient costs, 33% relate to the OR, and 31% relate to the **inpatient ward**. **Intraoperative anesthesia costs** are 5.6% of the total hospital costs. **Overall cost-to-charge ratio** was 0.42 across all surgical operations but varied threefold among departments. Patient anesthesia charges **overestimated resources use**d by 48%, but patient ward charges **underestimated resource use** by 23%.	N/A

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Mackey (2012)	Editorial	N/A	Multiple	N/A	Efficiency & quality	N/A	Integrated databases are necessary to eliminate negative variations in clinical practices nationwide. Anesthesiologists are in a unique position as perioperative specialists to help facilitate this information exchange.
Maessen et al. (2007)*	5 surgical centers	n=425	CRS	All	ERAS	N/A	Surgical centers with previous experience with fast-track surgery were associated with a **shorter hospital stay**. **Fast-track protocol adherence** was high before and during the operative phase but low in the postoperative phase.
Mcmurray et al. (2007)*	3 hospitals	n=13	GS	All	Discharge planning	N/A	Patients cited the following **issues with discharge protocol**: -'One-size-fits-all' approach to providing information -Inconsistent advice from health professionals -Lack of predischarge assessment of home & work conditions -Need for follow-up patient and carer needs assessment
Miguel and Sagardoy (2014)*	Miguel Servet Hospital, Spain	n=100	GS	All	Postoperative care	N/A	**Preoperative and postoperative anxiety** were less in the group receiving an anesthesia information leaflet (p=0.023). Preoperative anxiety was a predictor of postoperative pain (p=0.001).
Mohn et al. (2009)*	2 hospitals	n=94	CRS	All	ERAS	N/A	**Length of stay**: 78% discharged within 5 days in ERAS patients, 5% with traditional program **Complication rate**: ERAS - 31% **Readmission rate**: ERAS - 15% **Time to resume daily activities**: ERAS - 57% within one week of discharge **Time to resume leisure activities**: ERAS - 65% within thirty days of discharge
Mythen et al. (2012)*	Best practice report	N/A	All	N/A	ERAS	N/A	Provides principles for each phase of surgery related to: -General principles of enhanced recovery fluid management and recommendations of the enhanced recovery partnership -Aims of ER fluid management (by the end of surgery) -Individualized goal directed fluid therapy

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Nanavati and Prabhakar (2013)*	Public sector municipal hospital	n=60	CRS	Adults without significant comorbidities	ERAS	N/A	Fast track patients required less **analgesia**, had earlier **ambulation**, earlier **return of motility**, and had reduced **LOS.**
Pattakos et al. (2012)	Cleveland Clinic	n=4,031	TS	All	Postoperative care	Nonhome discharge can be predicted using preoperative testing. Using this preoperative data to predict discharge could **improve transition planning** and **shorten hospital stay.**	N/A
Prager et al. (2005)	Hospitals participating in BCBS Michigan plans	n=60 participating hospitals	TS, VS, GS	N/A	Efficiency & quality	Improving quality requires the development of new data registries based on rigorous data collection systems, an explicitly platform for quality improvement, and a focus on data confidentiality and trust. The information in these registries is submitted to BCBS as evidence of quality improvement efforts, and BCBS reimburses them using a 'pay-for-participation' scheme, rather than pay-for-performance. This translates quality improvement efforts into reimbursement.	N/A
Qaseem et al. (2006)	Editorial	N/A	Multiple	N/A	Efficiency & quality	N/A	Patient-related factors (i.e. chronic disease, age above 60, ASA class II or higher) increase **risk of postoperative pulmonary complications**. Certain surgeries carry larger risk of postoperative pulmonary complications (prolonged, emergency, abdominal, aortic aneurysm, etc.) General anesthesia also brings a larger risk of postoperative pulmonary complications. Risk reduction strategies (spirometry, deep breathing exercises) reduce risk of postoperative pulmonary complications.
Ramirez et al. (2011)*	Hospital	n=300	CRS	All	ERAS	N/A	**Compliance to ERAS protocol**: overall 65% but varied across components, ranging from 99% providing perioperative information to 40.6% taking early fluids by mouth. Average **length of stay** 6 days; 3% required **readmission**; most **complications** were surgical (24%)
Raphael et al. (2011)*	Tertiary care and in community hospitals	n=200	GS	All	ERAS	Lower morphine utilization by fast-track patients (7.5 vs. 35 mg)	**Length of stay**: reduced in fast-track patients by 69 hours (95% CI 60 to 78) **Pain scores** lower in fast track patients (4 vs. 40 on postoperative day 2)

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Ren et al. (2012)*	University hospital	n=597	CRS	N/A	ERAS	Postoperative expense lower for ERAS group ($p<0.001$)	**Nutritional status**: improved in ERAS group compared to control group (Insulin resistance index lower, $p<0.001$) Reduced **postoperative stress** in ERAS group Accelerated **gastrointestinal function** in ERAS group **Postoperative length of stay** lower in ERAS group ($p<0.001$) No significant difference in **complications**
Roulin et al. (2013)*	University Hospital of Lausanne	n=100	CRS	All	ERAS	Mean **savings** per ERAS patient was €1,561.	ERAS reduced **hospital stay** without increasing **readmissions**. ERAS patients also had a lower **rate of severe complications**, but no change in **morbidity**.
Ryan et al. (2004)*	Royal North Shore Hospital	n=1,601	Multiple	All	Perioperative care	N/A	**23-hour discharge center discharge compliance**: 86% Only 3% needed **future unexpected medical care**
Sammour et al. (2010)*	Manukau Surgical Centre	n=100	CRS	All	ERAS	Does implementing an ERAS system offset implementation costs? Yes; costs were recouped after 15 patients	**Use of intravenous fluids**: lower in ERAS group (intraoperative -2 supplements vs. 3, $p<0.0001$; 3 days postoperative - 2 supplements vs. 6.5, $p<0.0001$) **Duration of anesthesia use**: lower in ERAS group (2 days vs. 3 days, $p<0.0001$) **Recovery time**: ERAS faster in days to full meal, passage of flatus and mobilization ($p<0.0001$ for all) **Length of stay** shorter in pre-surgery admitted days, postoperative days, and total days ($p<0.0001$ for all)
Sandberg et al. (2005))	One OR	n = 4	Multiple	N/A	Perioperative care	**Cases/day**: higher number of cases in new OR **Nonoperative time**: reduced from 67 minutes to 38 minutes ($p<0.0001$) **Operative time**: reduced 5 minutes **Hospital and anesthesia costs** increased (premium of 13%, $p<0.005$), but increased **throughput** offset costs (not significantly different)	N/A
Schaefer, Anderson, and Simms (1990)	Michigan hospital	n=45	Thoracic and abdominal	Elderly	Post-discharge recovery	N/A	Significant difference in patient-assessed discharge readiness pre-discharge and post-discharge in the following areas: **Functional ability**: patients assessed better ability to perform functional tasks at home post-discharge

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Sharareh, Le, Hoang, and Schwarzkopf (2014)	UC Irvine Hospital	n=100	GS	All	Post-discharge recovery	N/A	Patients who were **discharged to skilled nursing facilities (SNFs) rather than home** had slower preoperative Get Up and Go and EQ-5D scores and higher ASA scores, length of stay, postoperative pain, as well as decreased physical therapy achievements. This can help guide discharge planning.
Shyu et al. (2012)*	Medical center in Taiwan	n=299	Hip fracture	Elderly	Clinical pathways	N/A	Subacute care (geriatric consultation, continuous rehabiligation, and discharge planning): improved more than usual care in **physical function**, **role physical**, **vitality**, and **social function** components of the SF-36 measure Comprehensive care (subacute care plus health maintenance interventions): improved more than usual care in **physical function**, **role physical**, **general health**, and **mental health** components of the SF-36 measure
Taicher, Alam, Berman, and Epstein (2011)	Thomas Jefferson University Hospital, Philadelphia	n = 25	GS	All	OR system design	Use of computers to convey surgical information to recipients not familiar with anesthesiologists' native language. 83% of subjects agreed that native language communication made them **more relaxed** (LCL = 73%) and 96% (LCL = 83%) would **refer friends** based on availability of this device.	N/A
Teeuwen et al. (2010)*	Outpatient clinic and a surgical center	n=146	CRS	All	ERAS	N/A	Primary: **Mortality**: no significant difference (p=0.55) **Morbidity**: lower in ERAS group (14.8% to 33.6%, p<0.01) Secondary: **Fluid intake**: ERAS patients received less fluid day of and postoperative days (p<0.0001) **Length of hospital stay**: 6 days vs. 9 days, p=0.032 **Number of relaprotomies**: no significant difference (p=0.85) **Number of readmissions in 30 days**: no significant difference (p=0.60)

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Theobald and McMurray (2004)*	Tertiary care hospital in Brisbane	n=30	Coronary	All	Discharge planning	Financial consequences of surgery a major burden to patients	After surgical discharge, patients experienced; -**pain** -heightened **body awareness** -**lifestyle adjustments** that would be helped by support services such as telephone support or patient networks -need for more accurate and informative **discharge planning**
Toscan et al. (2013)*	Community hospitals	n=1	GS	Elderly hip fracture patients	Postoperative care	N/A	Patient and family caregivers do not feel fully informed about home care after surgery and do not understand the role of the health care providers involved. These parties also report not knowing what to expect or what is expected of them, and feel that hospital rules hinder individualized care.
Veronovici et al. (2013)*	Literature review	n=8	TS	All	Preoperative education	N/A	Education of cardiovascular patients preoperatively was associated with decreased self-reported anxiety and depression, increased self-reported health. No studies reported negative results of preoperative education.
Vetter, Downing, et al. (2014)	UAB Hospital	n=1,052	Multiple	All	Preoperative education	N/A	The use of a standardized, simplified, multicolor medication instruction sheet increased postoperative medication compliance compared to previous nonstandardized education.
Walters et al. (2014)	University of Virginia Hospital	n=1,646	TS	Patients with LOS greater than 1 day	Post-discharge receovery	N/A	Age, lower preoperative albumin, and increased preoperative Zubrod score predicated **discharge to extended care facilities.**
Wennström et al. (2010)*	Hospital	n=32	Colorectal	Elderly	Post-discharge recovery	N/A	**LOS**: 6 days **Readmission rate**: 10% **Serious complications**: none reported **Pain** not reported as troublesome symptom Extreme fatigue, bowel disturbances, nausea, and anxiety reported as most impactful **post-discharge effects**
Williams, DeRiso, Engel, et al. (1998)	Ambulatory surgery center in University of Pittsburgh Medical Center (UPMC)	n=503	GS	All	OR system design	See discussion of clinical outcomes.	Clinical pathway care reduced **pharmacy and materials cost variability** ($p<0.001$), increased **turnover time** (20.7 to 25.0, $p=0.042$), improved **intraoperative anesthesia and surgical efficiency** ($p<0.001$), **recovery times** ($p<0.001$), and **unexpected readmission rates** (20.1% to 8.1%, $p=0.001$), and decreased the **number of nursing interventions** (2.1 to 1, $p<0.001$).

TOPIC 7: CARE COORDINATION AND TRANSITION PLANNING							
Source	**Setting**	**Scale of Study**	**Surgical Specialties Covered****	**Patient Population Segments**	**Elements of PSH studied**	**Cost Savings studied and captured**	**Clinical Outcomes measured**
Williams, DeRiso, Figallo, et al. (1998)	Ambulatory surgery center in University of Pittsburgh Medical Center (UPMC)	n=503	GS	All	OR system design	See discussion of clinical outcomes.	Clinical pathway regional anesthesia, compared to general anesthesia, led to increased **pharmacy and materials costs** and increased **turnover time** ($p<0.001$ for both), but **recovered** better ($p=0.003$), had lower **unexpected readmission rates** ($p=0.002$), and required **fewer nursing interventions** ($p<0.001$). **Postanesthesia care unit bypass** was more common in clinical pathway regional anesthesia ($p<0.001$).
J. M. Young et al. (2013)*	Public and private hospitals	n=775	CRS	Cancer patients	Postoperative care	N/A	Some patients were assigned to the CONNECT intervention in which nurses followed up with patients by phone at several intervals after discharge. CONNECT patients demonstrated no significant differences from non-CONNECT patient in terms of unmet care needs, ED presentations, unplanned readmissions, experience of care coordination, or distress.
J. Young, Masya, Solomon, and Shepherd (2014)*	Colorectal cancer experts	n=20	CRS	Cancer patients	Perioperative care	N/A	Core measures that are valid indicators of colorectal cancer care coordination relate to appropriateness of treatment, adherence to clinical pathway, communication, multidisciplinary care, and care planning.

*Indicates a study conducted outside the United States