



Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Review

The cost of intraoperative adverse events in abdominal and pelvic surgery: A systematic review

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ARTICLE INFO

Article history:

Received 21 March 2017

Received in revised form

30 May 2017

Accepted 13 June 2017

Keywords:

Healthcare costs

Abdominal surgery

Pelvic surgery

Intraoperative complications

Patient outcomes

ABSTRACT

Background: The assessment of intra-operative adverse events (iAEs) is a vastly under researched area with the potential to provide new methods on how to improve patient outcomes and hospital costs. Our objective was to determine the relationship between iAEs and total hospital costs in abdominal and pelvic surgery.

Data sources: We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. Embase, MEDLINE and EBM Reviews online databases were searched to identify all studies that reported iAE rates and total hospital costs. We then analyzed the costing approach used in each article using the Drummond tool and evaluated articles quality using the GRADE method.

Conclusions: In total, 1709 unique references were identified through our literature search. After review, 23 were included. All studies that reported iAE rates and cost as the primary outcome found that iAEs significantly increased total hospital costs.

We identified a relationship between iAEs and increased hospital costs. Future studies need to be performed to further evaluate the relationship between iAEs and cost as current studies are of low quality.

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1. Introduction

It is estimated that surgical procedures cost more than \$400 billion annually in the United States, with costs projected to increase over time.¹ The current political landscape has placed much focus on cost-effective healthcare, as the aging population will put a heavy strain on resources.² With most developed countries spending at least 10% their GDP on healthcare, many experts agree that current health care spending is not sustainable.^{3,4}

One health care cost saving strategy that physicians may directly affect is increasing healthcare efficiency. Surgery is a unique field of medicine where the technical skill of the operating surgeon can

have a direct impact on patient outcomes.⁵ This has recently become an area of growing interest, with a significant potential of developing interventions that may result in safer patient care. By improving patient care, hospitals may have fewer perioperative complications, fewer investigations and shorter length of stay, all of which lead to substantial cost savings.^{6–8} Many studies have looked at decreasing the rate of post-operative complications as a method of cost savings. However, the rate and cause of post-operative complications is multifactorial and can depend on the patients comorbidities, age and prior functional status.⁹ Intra-operative complications, also known as intra-operative adverse events (iAEs) can be the direct result of a surgeon's surgical technique and thus may be modified through performance enhancing strategies. Furthermore, the link between intra-operative adverse events (iAEs) and increased costs has only recently been explored and studies have shown that intraoperative adverse events (iAE) result increased health care costs^{10–13}

The objective of the present work was to perform a systematic review of the financial costs of iAEs in abdominal and pelvic surgery

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and identify areas for future research.

2. Methods

2.1. Research question

Do patients who have experienced an intra-operative adverse event during intra-abdominal or pelvic surgery incur higher overall hospital costs compared to those who do not have an intra-operative adverse event?

2.2. Protocol and eligibility criteria

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was used for reporting of the systematic review (see Appendix).^{14,15} Randomized controlled trials and observational studies were included. Editorials, review and opinion articles were excluded. Only full text articles, in English, from peer-reviewed journals that were published between January 2000–November 2015 were included as patient and health outcomes are a new field of research in surgery.

This review included studies that examined patients of any age who underwent an intra-abdominal surgery performed by general surgeons, urologists or gynecologists, regardless of operative technique (open, robotic or laparoscopic methods). Reports assessing endoluminal surgery (such as transurethral resection of prostate and colonoscopy) were excluded.

To be eligible for inclusion, studies had to report intra-operative complication or adverse event rate (iAE). We considered these terms interchangeable. An intra-operative adverse event was defined as any deviation from standard surgical practice that resulted in injury to tissues, vessels or organs during an operation. The intra-operative adverse event had to be a result of surgical technique. Adverse events due to other participating healthcare workers (eg. anesthesiologist) were excluded if they were reported separately. Intra-operative blood transfusion and insertion of additional trocars were not considered intra-operative adverse events if reported on their own, but were included if they were reported with iAEs as defined above.

All eligible studies had to report a total cost. Total cost was defined as all costs incurred or charged by the hospital or healthcare provider as a result of performing a specific procedure on a patient. Operative cost was defined as costs/charges incurred by the hospital (or healthcare provider) while the patient was in the operative theatre. This includes cost of the operative room, personnel and any materials used. We examined only direct costs, those borne by the healthcare system, and excluded indirect costs. Studies were included if they described the total direct costs of the hospital or healthcare provider of the procedure being performed. Costing data collected from large national databases were included. There was no restriction to type of currency. Costs could be divided into intra-operative and post-operative as long as the total cost could be calculated.

2.3. Information sources and search

Embase, MEDLINE and EBM Reviews online databases were searched from January 1, 2000 to November 12, 2015 with the assistance of a medical librarian specializing in medical literature reviews. Subject headings and text-word terms for “surgery”, “general surgery”, “gynecology”, “urology”, “adverse event”, “error”, “cost”, “financial cost”, “healthcare cost” in conjunction with exploded and related terms were searched. Keyword searching was also performed. Search results were limited to the English language and duplicate results were excluded. A manual cross-reference of

references from retrieved articles was performed for completeness and to identify any relevant studies not picked up by the initial search to be included.

In instances where data were incomplete, or additional information was required, primary authors from included studies were contacted.

2.4. Study selection and data collection process

Titles and abstracts were screened for inclusion criteria prior to full text selection. If articles could not be included/excluded based on abstract alone, the full text was reviewed. Two authors independently performed final full text article selection (A.G. and M.G.). Disagreements were resolved by consensus involving the senior author (T.G.).

The evidential quality of each selected article was assessed using the Grade of Recommendations Assessment, Development and Evaluation (GRADE) system and the 10-point Drummond checklist (for full economic evaluations only)^{16–18} by a single reviewer (A.G.). Risk of individual study bias was performed using the GRADE system. A second reviewer (M.G.) independently assessed a random selection of the articles to ensure accuracy. Agreement was assessed using inter-rater reliability (Cohen’s Kappa). One reviewer (A.G.) performed all data abstraction from the final full text articles.

For the data collection and study selection process, Distiller SR[®] (Evidence Partners) software was used. This allowed for simple access to abstract and eligibility criteria (as stated earlier) for all authors. One study author was contacted for further clarification on their data set.

2.5. Summary measures and synthesis of results

As studies are heterogeneous with regards to country of origin, type of surgery, hospital costs vs. charges and iAEs reported, summary measures will not be used. Tabulations and descriptive summaries will be used will be used to summarize major results.

3. Results

In total, 1709 unique references were identified through our literature search. After full text review of 122 articles, 23 were selected for data abstraction. The reasons for exclusion are provided in Fig. 1. The most common reason for exclusion was lack of reporting of intraoperative complications (n = 54).

3.1. Study quality

Studies were assessed for methodological quality using the GRADE system. There were no studies of high quality, 11 studies of medium quality, 7 studies of low quality and 5 studies of very low quality. The most common reason for lowering a GRADE score was imprecision. A detailed summary of GRADE quality assessment scoring can be seen in Table 1. All full text articles were critiqued on the type of economic evaluation used. As all included articles were either cost analyses or cost-descriptions (partial economic evaluations), the Drummond tool was not used. As both reviewers (A.G. and M.G.) agreed on GRADE and type of economic evaluation, Cohen’s Kappa was not calculated.

3.2. Study description and cost outcomes

Detailed description of the included studies can be seen in Table 2. Of the 23 studies included in final text review, 13 are retrospective population cohort studies, 6 are retrospective chart reviews, 2 are randomized controlled trails and 2 are prospective

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