Inpatient Economic Burden of Postoperative Ileus Associated with Abdominal Surgery in the United States

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ABSTRACT

A study was conducted to estimate the economic burden of postoperative ileus (POI) to the U.S. hospital system. Using national data projected from a large, inpatient, service-level, comparative database and applying hospitalization costs, we determined direct inpatient costs attributable to POI. Our results indicated that hospitalization for coded POI, according to the International Classification of Diseases, ninth revision (ICD-9), was substantially more costly ($18,877 vs. $9,460) and longer (11.5 vs. 5.5 days) than hospitalization for non-coded POI. Total annual costs attributed to managing POI were $1.46 billion, a situation thus warranting increased attention.

INTRODUCTION

Postoperative ileus (POI) is a well-recognized complication of major abdominal and gynecological surgeries, but it may also occur with other procedures, including extraperitoneal surgery, joint replacement, and cardiovascular surgery.[1] Often considered an expected condition complicating postoperative care, some degree of POI occurs universally in patients who undergo major abdominal surgery.[2]

Clinically, POI is associated with significant patient discomfort, increased hospital length of stay (LOS), and high utilization of health care resources. It also has an impact on postoperative pain management. In fact, POI is the most common cause of delayed hospital discharge after abdominal surgery.[3]

Although the exact mechanism of POI is unclear, it is known to be multifactorial—neurogenic, metabolic, muscular, and inflammatory changes result in decreased gastrointestinal (GI) motility and inhibition of propulsive motion.[3] Opioid use during the perioperative surgical period also contributes to GI dysmotility by stimulating the opioid receptors in the bowel, leading to inertia in the gut.[3]

Regardless of the possible causative factors, the resulting clinical impairment associated with POI is characterized by a delay in return to normal bowel function, abdominal distention, pain, nausea, vomiting, and the inability to advance the diet during the postoperative period.[4] Complications of POI include atelectasis and pneumonia. If POI is prolonged, poor wound healing can result, in part, from nutritional deficits.[5]

Although the duration of POI is partially dependent on the extent of surgical manipulation, the surgical site, and patient characteristics, a delay in return to normal bowel function beyond three days after surgery is considered prolonged and, as such, is clinically relevant.[4]

Current management strategies consist of careful selection of anesthesia and analgesia before, during, and after surgery to minimize the duration of POI and the use of supportive therapies such as enteral nutrition, intravenous fluids, reversal of electrolyte or metabolic abnormalities, and pharmacological agents (e.g., laxatives and prokinetic drugs). However, these strategies are not uniformly successful, and patients are often slow to respond to them.

In addition to substantial patient morbidity, POI is a major cause of increased usage of hospital resources, because discharge after surgery is typically delayed until the patient can tolerate a regular diet and acceptable bowel function is restored.[1]

In a retrospective chart review of cystectomy procedures, almost 23% of patients had ileus lasting more than four days; 78% of these patients had prolonged POI lasting more than eight days.[6] In addition, a recent retrospective analysis demonstrated that patients with POI that was coded as such during their index hospitalization for various surgical procedures had a significantly longer LOS of two to three days than did patients without coded POI.[7]

Beyond prolonged hospital LOS during the index hospitalization, patients are also at higher risk for hospital readmission because of postoperative dysmotility. Based on recent publications, approximately 10% of patients undergoing major abdominal surgery were readmitted within 30 days, and one third were readmitted for small-bowel obstruction or ileus.[1,8]

Despite the substantial level of morbidity associated with POI, the aggregate clinical and economic consequences resulting from POI and its complications have not been well studied, possibly because of the lack of available therapeutic options

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that adequately address the problem. However, the development of prokinetic agents and novel agents such as peripherally active mu-opioid receptor antagonists and ghrelin receptor agonists may provide physicians and patients with new options for treating and preventing POI.[9,10]

Although some articles in the 1990s cited estimates of expenditures attributed to POI based on previous research coupled with *per diem* rates, the volume of procedures and newer surgical techniques influences these estimates.[2,11] For example, the number of inpatient surgical procedures performed increased from 22 million to more than 40 million in the past decade.[12] Such change makes it necessary to continuously update and reassess the economic burden of POI based on advances in technology and surgical practice.

Our goals were to determine an updated incidence of POI in abdominal-related procedures in the U.S. and to quantify the economic impact of heath care resource usage associated with this condition. We conducted the economic analysis from a hospital perspective using direct inpatient costs from a large hospital alliance database.

METHODS

Data Source

Our study used data from Premier's Perspective Comparative Database. This hospital-based, service-level, comparative database included detailed information on the utilization of resources along with patients' primary and secondary diagnosis and procedure codes obtained from Uniform Billing form UB-92.

For this analysis, we limited the data to 160 hospitals. We used procedural cost-accounting systems that provided detailed and accurate costs associated with hospital stays instead of using hospital charge data or cost-to-charge ratios. These 160 hospitals were not randomly selected; they represented the entire pool of hospitals that used cost-accounting systems. Detailed service level information was available for each hospital day and included information on medications (i.e., drug name, dosage strength, quantity dispensed, and unit cost).

We collected patient information that included (but was not limited to):

- patient demographics (age, sex, race, and ethnicity).
- primary and secondary diagnoses.
- primary and secondary procedures.
- payer.
- LOS in the hospital.
- drug utilization.
- department charge detail.
- usage of resources according to day of stay.
- physician specialty.

Study Population

Initially, International Classification of Diseases, ninth revision (ICD-9), codes were used to select patients by surgical group. Five surgical categories were identified for inclusion in the study:

- open laparotomies (e.g., total abdominal hysterectomy and bowel resection)
- incisional laparoscopic procedures (e.g., laparoscopy, endoscopy)
- non-incisional laparoscopic procedures (e.g., vaginal hysterectomy, colonoscopic removal of polyps)
- orthopedic operations
- thoracic operations

Additional criteria for inclusion in the study were as follows:

- hospital discharge between January 1, 2002, and December 31, 2002
- LOS of 30 days or less in the hospital
- duration of time in the operating room of 12 hours or less (to eliminate outliers)
- a minimum total hospital cost of $500 to minimize the chance of capturing outpatient procedures

Following the initial selection of surgical procedures, we generated a list of the 100 most frequently performed primary or secondary surgical procedures with coded POI. Coded POI was identified using ICD-9 diagnostic codes 560.1 (paralytic ileus) and/or 997.4 (digestive complication, not elsewhere classified). From this list, we identified 61 four-digit ICD-9 codes based on the criteria that they would potentially involve open laparotomy and the disturbance or manipulation of the GI tract. We further refined the list by evaluating the overall volume (not limited to coded POI) for these 61 procedures.

Ultimately, we identified 50 surgical procedures of interest based on the potential involvement of open laparotomy, disturbance or manipulation of the GI tract, and overall volume of procedures (Table 1).

Methodology of Projection

We generated national volume projections for the 50 selected procedures by comparing the 160 hospitals used for this study with all acute-care hospitals in the U.S. To accomplish this, we stratified the 160 hospitals according to:

- geographic region.
- ownership type (profit, nonprofit, or government).
- population served (rural or urban).
- teaching status.
- number of beds.

We then compared these characteristics with those of similar hospitals from the 1999 American Hospital Association (AHA) Annual Survey.[13] This comparison generated two projection weights. The *mean discharge weight* adjusted for differences in the number of discharges between the 160 hospitals used for this study and the AHA survey. The *hospital weight* adjusted for differences in the number of hospitals.

Validation of this methodology indicated that the projection of 35.72 million annual discharges overall (not limited to 50 selected procedures) was approximately 0.5% less than the actual number of discharges of 35.85 million patients, as reported by the 1999 National Hospital Discharge Survey.[14]

Model for Attributing Costs of Postoperative Ileus

Because some degree of POI is expected in all patients undergoing major abdominal surgery,[2] we identified our study cohort of patients based on the presence of an ICD-9 code for

Table 1 **Fifty Selected Surgical Procedures Associated with the Development of Postoperative Ileus**

ICD-9 Procedure Code	Description	Total No. of Annual Projected Procedures in U.S.	Total No. of Annual Projected Coded POI Cases (% Incidence)
43.19	Other gastrostomy	10,683	488 (4.6%)
44.39	Other gastroenterostomy without gastrectomy	14,257	1,162 (8.1%)
45.62	Other partial resection of small intestine	48,824	9,364 (19.2%)
45.72	Cecectomy	12,343	2,041 (16.5%
45.73	Right hemicolectomy	86,825	12,406 (14.3%)
45.74	Resection of transverse colon	8,477	1,210 (14.3%)
45.75	Left hemicolectomy	30,858	5,381 (17.4%)
45.76	Sigmoidectomy	76,750	10,576 (13.8%)
45.79	Other partial excision of large intestine	14,966	2,570 (17.2%)
45.8	Total intra-abdominal colectomy	8,863	1,449 (16.3%)
45.91	Small-to-small intestinal anastomosis	2,397	328 (13.7%)
45.93	Other small-to-large intestinal anastomosis	2,875	801 (27.8%)
45.94	Large-to-large intestinal anastomosis	2,438	351 (14.4%)
46.10	Colostomy, not otherwise specified	3,775	568 (15.0%)
46.11	Temporary colostomy	2,483	414 (16.7%)
46.13	Permanent colostomy	3,372	366 (10.9%)
46.39	Other enterostomy	9,046	1,059 (11.7%)
46.51	Closure of stoma of small intestine	7,848	943 (12.0%)
46.52	Closure of stoma of large intestine	20,409	1,976 (9.7%)
46.73	Suture of laceration of small intestine, except duodenum	6,767	1,211 (17.9%)
46.75	Suture of laceration of large intestine	3,379	545 (16.1%)
47.09	Other appendectomy	175,946	10,936 (6.2%)
48.5	Abdominoperineal resection of rectum	8,730	1,435 (16.4%)
48.63	Other anterior resection of rectum	20,643	3,182 (15.4%)
48.69	Other resection of rectum	3,847	562 (14.6%)
50.12	Open biopsy of liver	6,565	452 (6.9%)
51.22	Cholecystectomy	81,013	6,893 (8.5%)
53.49	Other umbilical herniorrhaphy	21,101	983 (4.7%)
53.51	Incisional hernia repair	13,992	1,058 (7.6%)
53.59	Repair of other hernia of anterior abdominal wall	8,543	711 (8.3%)
53.61	Incisional hernia repair with prosthesis	46,215	3,798 (8.2%)
53.69	Repair of other hernia of anterior abdominal wall	13,873	807 (5.8%)
54.11	Exploratory laparotomy	20,548	1,933 (9.4%)
54.19	Other laparotomy	9,990	1,085 (10.9%)
54.23	Biopsy of peritoneum	6,158	487 (7.9%)
54.3	Excision or destruction of lesion/tissue of abdominal wall	6,305	319 (5.1%)
54.4	Excision or destruction of peritoneal tissue	14,090	1,210 (8.6%)
54.59	Other lysis of peritoneal adhesions	104,145	15,072 (14.5%)
55.51	Nephroureterectomy	44,808	3,979 (8.9%)
56.51	Formation of cutaneous uretero-ileostomy	2,066	322 (15.6%)
57.71	Radical cystectomy	7,791	1,443 (18.5%)
60.5	Radical prostatectomy	65,166	3,072 (4.7%)
65.39	Other unilateral oophorectomy	9,398	492 (5.2%)
65.49	Other unilateral salpingo-oophorectomy	36,340	1,596 (4.4%)
65.61	Other removal of both ovaries/tubes at same episode	63,384	2,997 (4.7%)
68.3	Subtotal abdominal hysterectomy	26,967	888 (3.3%)
68.4	Total abdominal hysterectomy	424,620	17,466 (4.1%)
68.6	Radical abdominal hysterectomy	4,705	442 (9.4%)
81.05	Dorsal and dorsolumbar fusion, posterior technique	11,884	1,057 (8.9%)
81.06	Lumbar and lumbosacral fusion, anterior technique	25,206	2,135 (8.5%)

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"paralytic ileus" (560.1) and/or "digestive system complications" (997.4). For purposes of this article, we classified this group of patients as having *coded POI*. Patients with no ICD-9 code for paralytic ileus or digestive system complications were classified as having *non-coded POI*.

Based on the use of hospitals with cost-accounting systems, our study included the entire cost associated with each hospitalization. It is noteworthy that this model did not include charges for physician billing. Costs attributed to POI in this model were then defined as the incremental cost differences between patients with coded POI and non-coded POI.

Patients with non-coded POI clearly incurred costs related to POI, but these costs could not be accurately captured with our methodology. Thus, this analysis reflects the costs associated with POI of great enough severity to warrant coding, despite little to no financial incentive to do so from a hospital reimbursement perspective.

We also included patient readmissions after the index surgical procedure in this analysis but only those patients with a primary or secondary diagnosis of paralytic ileus and/or digestive complications within 30 days of the index hospitalization discharge date. We viewed the total costs associated with these readmissions as "attributable" costs whether or not POI was coded on the index hospitalization. The Medical Consumer Price Index was used to inflate costs from 2001 dollars to 2006 dollars.[15]

Sensitivity Analysis

To measure how robust the model's results were to changes in base case inputs, we performed a sensitivity analysis. We conducted a univariate sensitivity analysis around each variable to estimate the relative importance of changing the base case estimate. The distribution of all variables used in the model was assumed to be normal across a range of reasonable values.

RESULTS

Incidence of Postoperative Ileus

Annual incidence rates of coded POI for the most common abdominal-related procedures are listed in Table 2. Hysterectomies were the most common procedure, followed by large-bowel resection. Large-bowel and small-bowel resections resulted in the highest rate of coded POI (14.9% and 19.2%, respectively).

The overall incidence of coded POI for the 50 selected abdominal-related procedures was 8.5%. Based on a total of 1,661,689 procedures that were expected to be performed annually in the U.S. for the 50 abdominal-related procedures of interest, we projected a total of 142,026 cases of coded POI to occur nationally as a result of these procedures.

Associated Use of Health Care Resources

Our analysis indicated that the average LOS was 11.5 days for patients with coded POI and 5.5 days for patients with non-coded POI (Table 3). By applying the length of stay of coded POI to the previously reported annual number of cases, we noted 1,633,299 hospital days for patients with coded POI each year (see Table 3, 3a). Of these, 852,156 days were likely to be attributable to coded POI (see Table 3, 3c). We obtained the figure of 852,156 by multiplying the incremental LOS of coded POI (six days) by the total number of procedures with coded POI (142,026).

Hospital Readmissions

We assessed the rate of readmission for primary or secondary coded POI for all patients in our data set. The rate of readmission for recurrent POI (i.e., for patients with coded POI at the initial hospitalization) was 3.6%, or 5,113 readmissions, within 30 days of the initial hospital discharge (see Table 3, 6a). By contrast, the readmission rate for patients with non-coded POI at the index hospitalization, but with coded POI on the second admission, was only about 0.02%, or 304 readmissions, within 30 days of initial hospital discharge (see Table 3, 6b).

Total Expenditures

When considering total hospital expenditures for a patient who developed POI after one of the 50 selected abdominal-related procedures, we found that the cost of an average hospital stay of 11.5 days was $18,877 (Table 3, 4a). Applying this cost nationally, we provided a projected total hospital cost of $2.7 billion annually in the U.S. (see Table 3, 5a) (determined by multiplying 1a by 4a).

The projected cost of readmissions for coded POI was an additional $122.2 million annually for patients with coded POI on the initial admission (see Table 3, 8a).

Hospital Cost Data

The projected incremental hospitalization cost of POI (i.e., costs associated with POI only) was $1.3 billion (see Table 3, 5c) (determined by multiplying 1a by 4c), with a further cost of $126.8 million for hospital readmissions (see Table 3, 8c) (determined by adding 8a and 8b). Therefore, the estimated total hospital cost in the U.S. attributable to coded POI was $1.46 billion annually (see Table 3, 9) (determined by adding 5c and 8c).

The cost of managing POI immediately after surgery

Table 2 Projected Incidence of Postoperative Ileus (POI) with Common Abdominal-Related Procedures

Procedure	Total No. of Annual Projected Procedures in U.S.	Total No. of Annual Projected Coded POI Cases (% Incidence)
Abdominal hysterectomy	456,292	18,796 (4.1%)
Large-bowel resection	257,336	38,243 (14.9%)
Small-bowel resection	48,824	9,364 (19.2%)
Appendectomy	175,964	10,936 (6.2%)
Cholecystectomy	81,013	6,893 (8.5%)
Nephroureterectomy	44,808	3,979 (8.9%)
Other related procedures*	597,452	53,815 (9.0%)
Total	**1,661,689**	**142,026 (8.5%)**

* See Table 1 for additional procedures.

accounted for 91% of the total and readmission within 30 days of initial hospital discharge accounted for 9% of the total costs.

The incremental cost per abdominal-related procedure attributable to POI was $881 (see Table 3, 9) (determined by 9 divided by the sum of 1a and 1b). Of this amount, $805 was a result of the costs associated with the index hospitalization, and $76 was a result of readmissions for POI.

Sensitivity Analysis

We evaluated the effects of individual inputs on the total costs of POI using sensitivity analyses by varying each input by 20% around the mean.

As shown in Figure 1, the variables that most influenced the estimate of the total cost of POI included the incidence of coded POI, the cost per hospital stay for coded POI and non-coded POI, and the volume of abdominal-related procedures performed annually. However, the range of the incidence of coded POI reported in the literature was significantly greater than that determined by a 20% variation around the mean value (range, 6.3%–10.7%).

For example, rates of "prolonged" POI (indicating a prolonged LOS) as high as 20% have been reported in clinical trials.[6,16] Therefore, to arrive at parallel ranges found in the literature, we intentionally used an incidence of 20% as the upper bound.

When we applied a triangular distribution using this fixed endpoint, the sensitivity analysis ranged from 4.1% to 15.2%; this was a more realistic range of coded POI incidence.

If the incidence were increased to 15.2%, extrapolating from the model, the direct cost of illness would increase to $2.6 billion.

If the cost per hospital stay for coded POI were reduced from $18,877 to $15,102 (varying by 20% around the base case value) and if all other inputs remained constant, the total direct cost of illness would fall to $923 million.

Table 3 **Length of Hospital Stay (LOS) and Projected Annual Costs Associated with Postoperative Ileus (POI) from Hospital Cost Data**

Category	Value
1. *Total No. of procedures (%)*	
a. With coded POI	142,026 (8.5%)
b. Without coded POI	1,519,663 (91.5%)
2. *Average LOS (days)*	
a. With coded POI	11.5 days
b. Without coded POI	5.5 days
c. Incremental length of stay resulting from coded POI	6.0 days
3. *Total No. of LOS (days)* *(average LOS times No. of procedures)*	
a. With coded POI	1,633,299 days
b. Without coded POI	8,358,146 days
c. Incremental number of hospital days resulting from coded POI	852,156 days
4. *Cost per hospital stay*	
a. With coded POI	$18,877
b. Without coded POI	$9,460
c. Incremental cost per stay because of coded POI	$9,417
5. *Total hospitalization cost* *(cost per hospital stay times No. of procedures)*	
a. With coded POI	$2,681,024,802
b. Without coded POI	$14,376,011,980
c. Incremental total cost attributable to coded POI	$1,337,458,842
6. *No. of readmissions (%)*	
a. With coded POI	5,113 (3.6%)
b. Without coded POI	304 (0.02%)
7. *Cost per readmission*	
a. With coded POI	$23,907
b. Without coded POI	$14,710
8. *Total readmission costs** *(cost per readmission times No. of readmissions)*	
a. With coded POI	$122,236,491
b. Without coded POI	$4,471,840
c. Total readmission cost attributable to coded POI*	$126,708,331
9. *Cumulative costs for a coded POI* *(total hospitalization cost plus readmission cost)*	$1,464,167,173

* Readmissions documenting POI were viewed as coded POI costs whether or not POI was coded on the index hospitalization.

DISCUSSION

Postoperative ileus (POI) is typically perceived as a self-limiting condition that inevitably occurs after major surgery. Although the higher use of resources associated with POI has been recognized, the true economic burden to the health care system has not been quantified within the past decade.

As shown in this article, a hospital stay for coded POI is both substantially more costly ($18,877 vs. $9,460 per case) and of longer duration (11.5 days vs. 5.5 days per case) than a hospital stay for non-coded POI. The total annual national hospital costs attributed to managing coded POI is $1.46 billion for both the index hospitalization and any readmissions within 30 days. Given this high attributable economic burden of illness and the prospect of new therapies on the horizon, POI warrants increased attention from clinicians and health care decision makers.

A factor contributing to the relative lack of attention given to POI is the paucity of therapies that can effectively address the condition. Current management of POI after surgery comprises a combination of primarily supportive strategies: nasogastric tube placement for decompression, intravenous hydration, early enteral feeding, early ambulation, and pharmacotherapy.[4]

Pharmacological agents for POI (e.g., prokinetic drugs, laxatives, and analgesics) have had only limited success in reducing the duration of POI.[3,4]

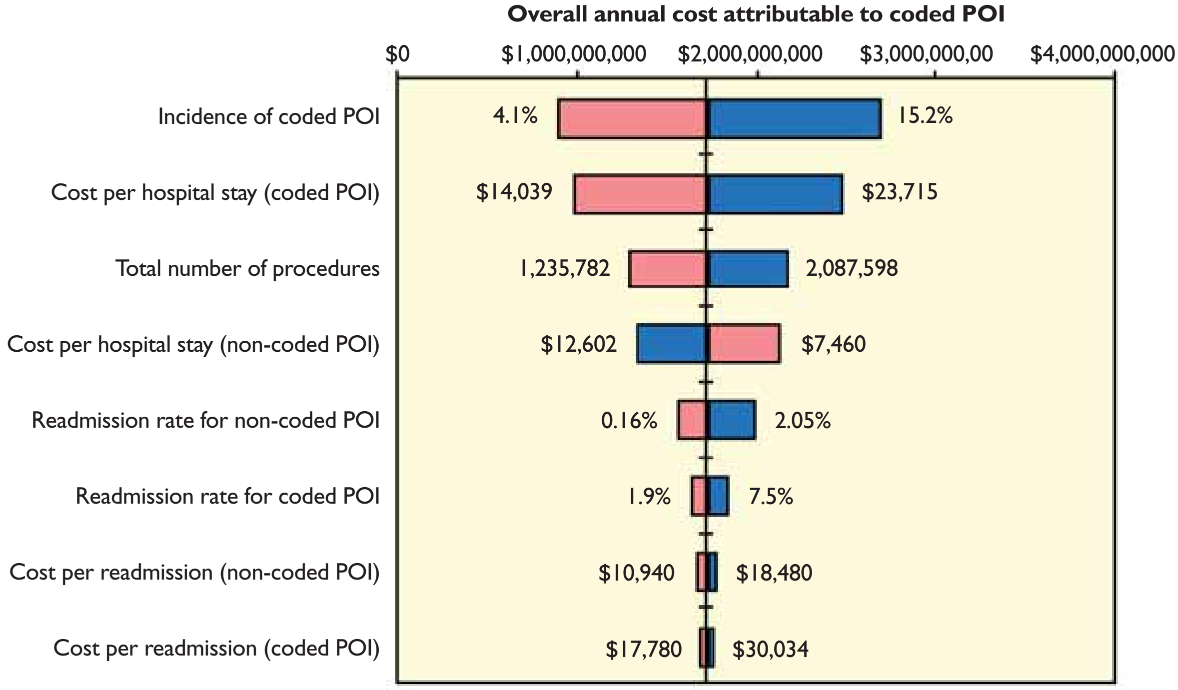

Figure 1 Univariate sensitivity analysis for postoperative ileus (POI). The upper and lower ranges evaluated for individual variables are shown at the ends of the horizontal bars.

Postoperative management is further complicated by the use of analgesic agents such as opioids, which may directly affect and worsen GI dysmotility associated with POI.

Although available treatment options may reduce the severity of POI, their impact on LOS and consumption of resources has not been well studied. As more efficacious therapies evolve, such as peripheral mu-opioid receptor antagonists and gastric ghrelin-receptor agonists, it will become more appropriate to quantify their impact on LOS and economic outcomes. For example, alvimopan (Entereg, Adolor), a peripheral mu-opioid receptor antagonist, has been shown in clinical trials to decrease LOS in the hospital.[9,10,17–19]

Historically, studies on POI have been limited, because no standardized nomenclature or grading system is available to objectively define the clinical scope and the clinical relevance of this common postoperative problem. As suggested by other authors, one approach would be to arbitrarily assign a three-day cut-off and to classify the condition as either (1) "primary ileus," an iatrogenic transient, self-limiting dysfunction of bowel motility lasting no more than three days, or (2) "prolonged" POI, lasting longer than three days after surgery and typically more severe than self-limiting.[1,4,20]

Although this division is arbitrary, patients with prolonged POI are expected to undergo a greater number of interventions and are at greater risk for complications associated with the prolonged hospital stay.

An alternative approach is to incorporate more objective criteria for defining POI, such as ICD-9 coding for paralytic ileus and/or complications of the digestive system as proxy measures for POI, as used in this article. As such, coded POI was identified on the basis of more clinically recognized criteria, regardless of LOS.

Because the incidence of coded POI varied greatly among the 50 selected surgical procedures (see Table 1), we performed a sensitivity analysis to identify the most critical factors that affected the model results. As the analysis indicated, the burden of POI was highly dependent on the incidence of coded POI after surgery.

Although this model reported an incidence of 8.5% after selected major abdominal surgery, this rate was based on discharge coding of POI and was likely to be a significant underestimation of the true prevalence.

For example, based on prospectively collected data from clinical trials, the incidence of prolonged POI can range up to 15.2%, for a cost ranging as high as $2.6 billion. Moreover, in our model, we projected the economic burden to the U.S. on the basis of data from 160 hospitals from 2000 to 2001, which may affect the generalizability and timeliness of the results.

Notably, data from the 2002 National Hospital Discharge Survey (NHDS) suggests that the number of certain abdominal-related procedures in the nation might be significantly higher than we projected.[12] If the number of selected major abdominal procedures, estimated by the 2002 Survey, were used (669,000 hysterectomies; 329,000 appendectomies; 436,000 cholecystectomies), the total direct cost of coded POI would approach $1.26 billion instead of our projection of $1.46 billion. Similarly, when the total number of procedures varied by 20% around the base case of 1,661,689 procedures, the upper bound of total cost increased to $2.161 billion. Therefore, our results are probably a conservative estimate of the hospital costs of POI.

Additional causes of our conservative estimate of total costs included the following:

- The model assumed that patients without ICD-9-coded POI incurred no costs for the management of GI motility.
- The model captured only POI cases that occurred after abdominal-related procedures; however, ileus can also occur after other types of major surgery.[3]
- Even though other trials have reported readmission rates that are higher than those reported in our analysis, doubling the readmission rates still did not change the results significantly.[8,21]

A strength of this methodology in determining the economic impact of POI is the data source. Because the data set was limited to 160 hospitals with a procedural cost-accounting system that provided detailed costs associated with hospital stays versus hospital charge data or cost-to-charge ratios, the costs determined were a more accurate reflection of costs attributable to POI. Also, by using a hospital database instead of a managed care database population, we were more likely to incorporate data from a more diverse, cross-sectional population.

An additional strength was the accuracy of the projection methodology, which has been validated to differ from national data sets by only 0.5%.[14]

LIMITATIONS OF THE STUDY

As with all models, there were some inherent limitations to our results.

First, reliance on the accuracy of diagnostic coding is subject to underestimation or overestimation of actual incidence. According to the reimbursement structure within the health care system used in this analysis, we had no financial incentive to code for POI; as such, we believe that we minimized any potential effect of "upcoding."

Second, we calculated incremental costs of hospitalization based on the difference between patients with coded POI and non-coded POI. Embedded within this incremental difference are costs related to LOS specifically (room and board charges) and other costs of resource consumption.

Our model was limited in its ability to identify specific POI-related additional resource utilization because we used total costs per hospital stay. As such, the impact of POI on individual costs, such as nursing time, medication management of complications, and surgical management of complications, could not be isolated.

Determining important drivers of the economic burden of POI, such as these additional resources, may be of additional value to decision makers as more therapeutic options become available.

Finally, the conceptual framework of the economic model did not account for outpatient-related direct costs or indirect costs, such as lost productivity and wages. These costs are not insignificant. Sarawate et al. estimated a figure of $6.1 to $12 million annually in lost productivity resulting from POI, based on an additional hospital LOS of two to three days.[7]

CONCLUSION

This study presents a rigorous estimate of the economic impact of postoperative ileus, one of the most common complications of major surgery, to the U.S. inpatient hospital system. Not only is POI is important in terms of clinical morbidity; it also imposes a significant economic burden to the health care system. Although we provided a current cost estimate, further research is needed to quantify the indirect costs of POI and to address specific considerations of the economic burden.

As new therapeutic options for POI become available, it will be important for clinicians and health care decision makers to fully understand the clinical and economic outcomes of POI in order to evaluate the impact of such therapies.

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