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Economic Impact of Laparoscopic Surgery

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Abstract

This report presents findings concerning the economic impacts of laparoscopic surgery. The study addresses hospital costs, physician costs and short-term disability costs. Specifically, the study addresses hospital costs, and not the hospital charges often reported by studies in the literature. The costs of four different laparoscopic procedures (laparoscopic cholecystectomy, laparoscopic inguinal herniorraphy, laparoscopically assisted vaginal hysterectomy, and thoracoscopic wedge resection) are examined relative to the costs of their "open" counterparts. The hospital cost analysis addresses the cost of equipment and instrumentation required for laparoscopic surgery, since these are important cost drivers for laparoscopic cases.

Data to determine hospital costs was obtained from nine hospitals throughout the United States. At each hospital site, the research team spent four to five days on-site interviewing surgeons, OR staff, hospital administrators and other personnel, as well as gathering additional data. Short-term disability cost and physician cost data were gathered from two large employers.

Findings show that laparoscopic approaches are a cost effective alternative to traditional open surgery. When total system costs are considered, each of the four procedures analyzed in this study is cost-effective. When the narrower view of hospital costs is taken, two of the laparoscopic approaches save money relative to their open counterparts, one is about equal in cost, and one is somewhat more expensive than its open counterpart. Analysis of operating room equipment and supplies indicates that single-use laparoscopic instruments are a cost effective alternative to reusable instruments. In addition, single-use instruments have many benefits that were not possible to quantify accurately in this study. Finally, laparoscopic cholecystectomy reduces disability costs relative to open cholecystectomy and potential exists to reduce disability costs further by ensuring that employees return to work soon after they resume normal activity.

Introduction

This report presents the findings of a study analyzing the economic impacts of laparoscopic* surgery on hospitals and the total health care system. Unlike many other studies published to date, this study addresses not only hospital ***charges***, but also hospital ***costs***, physician costs and short-term disability costs.

Nine hospitals throughout the country participated in the hospital portion of the study. Two Fortune 500 companies also participated in the study, supplying information on employee disability costs, hospitalization costs and physician costs. Preliminary results have been reviewed by both the American Medical Association and the American College of Surgeons. These organizations were involved primarily to comment on study methodology and to provide suggestions before the study was expanded to additional sites. They were not asked to endorse study findings.

This report contains three sections. The first section deals with the cost impacts of laparoscopic surgical approaches on hospitals. An important cost driver for laparoscopic approaches, costs of single-use and reusable surgical instrumentation, is addressed in the second section. The final section of the report analyzes the "total system" cost impact of laparoscopic surgery, including physician costs and disability costs that are incurred beyond the confines of the hospital.

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Hospital Cost Analysis

Study Participants

The participating hospitals represent a broad range of provider settings, including academic medical centers and community hospitals, urban and suburban locations in different states in New England, Mid Atlantic, Southeast, Mid West and West Coast. Profiles (with rounded totals for beds and cases) are shown below of the hospitals that participated in the study.

	HOSPITAL								
	A	B	C	D	E	F	G	H	I
Location	**New England**	**New England**	**Southeast**	**West Coast**	**Southeast**	**Mid West**	**Mid Atlantic**	**Mid Atlantic**	**Mid West**
Beds	**300**	**800**	**400**	**100**	**500**	**300**	**700**	**500**	**600**
No. of Surgical Cases	**7,000**	**10,000***	**11,000**	**4,000**	**12,000**	**15,000**	**12,000***	**10,000**	**7000***
Laparoscopy Set-ups	**5**	**6**	**9**	**4**	**4**	**6**	**6**	**4**	**7**

* Excludes Same Day Surgery cases

As demonstrated by the chart, the hospitals varied considerably in size, number of surgical cases relative to beds and number of laparoscopic equipment setups relative to surgical cases. Three of the hospitals viewed themselves as regional or national leaders in laparoscopic surgical approaches. Three other hospitals viewed themselves as being newer to laparoscopic approaches than other providers in their areas. The rest of the hospitals fell somewhere in the middle.

Overview of Hospital Cost Analysis

A detailed cost analysis was conducted to determine hospital costs for both laparoscopic and open surgical procedures. In order to provide focus for the study, four procedures were selected for analysis:

- Laparoscopic Cholecystectomy (LC)
- Laparoscopically Assisted Vaginal Hysterectomy (LAVH)
- Laparoscopic Inguinal Hernia Repair (LIHR)
- Thoracoscopic Wedge Resection (TWR)

These four procedures provide a view of the impacts of laparoscopic surgery on three different specialties: general surgery, gynecology and thoracic surgery. Each "closed" procedure was compared to its "open" counterpart. In the case of hysterectomy, the LAVH was compared to the total abdominal hysterectomy (TAH) because the majority of gynecology surgeons we interviewed regarded the LAVH as a replacement for the TAH in many situations, but did not view the LAVH as a replacement for the vaginal hysterectomy.

At each of the institutions, the vast majority of cholecystectomy cases were performed laparoscopically. Hospitals D, F, G and I had each performed in excess of 25 LAVHs in 1992. Hospitals C, D, and I had each performed in excess of 25 laparoscopic inguinal herniorraphies in 1992. Although many of the hospitals had performed in excess of 25 thoracoscopic procedures, case volumes of thoracoscopic wedge resections were relatively small. Comparisons were performed at hospitals C, E, G, H and I.

Approach and Methodology

Each hospital was visited for four to five days by the study team. The team was composed of experienced health care operations and financial consultants, including a registered nurse with related experience. The study approach contained three distinct thrusts. Qualitative and quantitative information was gathered from interviews with surgeons, operating room (OR) staff, finance staff and other key people throughout the hospital. In addition, observations were performed of the OR, equipment rooms, instrument processing areas and other key areas to help understand the impacts of laparoscopic approaches. Finally, quantitative data was collected in order to develop accurate cost comparisons. Data

for the relevant cases was collected from a number of sources, including the OR information system (procedure times, room times, procedure counts, etc.), clinical information system (diagnoses, procedures, comorbid conditions, lengths of stay (LOS), Diagnosis Related Groups (DRG), demographics, etc.), financial information systems (utilization of services by department) and hospital cost accounting systems (case costs, where such systems were in place). Data was also collected from Medicare Cost Reports, OR preference cards and other sources as appropriate.

Clinical data was used to normalize patient groups and minimize the impact of selection bias. A number of analyses were performed in this regard, including restricting groups based on primary and secondary diagnoses, DRG, multiple procedures, admission type, and length of preoperative stay. These techniques resulted in groups that were balanced in terms of age and other characteristics, unless otherwise indicated.

We analyzed hospital costs from a number of different perspectives. It is important to distinguish hospital costs from hospital charges. The latter, often reported in the past, have typically been confused with costs. Most importantly, we analyzed total hospital costs, the most relevant indicator of costs over the long term. We also analyzed variable direct costs, which include salary costs for direct patient care providers as well as supply and pharmaceutical costs, all of which are useful indicators of short-term cost impacts. Finally, we looked at costs under "best practices" scenarios. Best practices analyses are important because of the relatively recent introduction of many laparoscopic techniques. By analyzing those hospitals and surgeons more advanced in specific laparoscopic approaches, it is possible to model the likely cost impacts once other hospitals and surgeons have gained more experience.

Overview of Findings

For each of the laparoscopic versus open procedure comparisons, several key cost drivers were responsible for the majority of the cost differences between the different approaches. These include:

- Length of Hospital Stay
- OR Procedure Time
- OR Supply and Equipment Utilization
- Ancillary Service Utilization

Laparoscopic procedures reduced the length of hospital stay and therefore reduced inpatient nursing costs. This impact was greatest for thoracoscopic wedge resection for which the number of ICU days was reduced and smallest for herniorraphy since the open procedure is typically done on an outpatient basis. Cost savings due to a faster recovery for laparoscopic patients after they leave the hospital have not been considered in the hospital cost analysis (see section on Total System Costs). OR procedure time varied both by hospital and by procedure. In general, laparoscopic cholecystectomy procedure times were shorter than for open times, but LAVH and laparoscopic inguinal herniorraphy procedure times were somewhat longer. The additional procedure time for these laparoscopic approaches was largely a function of the learning curve, and procedure times were shorter at hospitals where more had been performed. Thoracoscopic procedure times were approximately the same as thoracotomy times. OR supply and equipment costs were higher for each of the laparoscopic approaches. In order to understand these costs further, we conducted an analysis of the cost effectiveness of single-use and reusable instrumentation. Our findings, presented in a later section, indicate single-use instruments are a cost-effective alternative to reusables. Utilization of ancillary services such as pharmacy and respiratory therapy was higher for the open approaches with the exception of herniorraphy.

Total costs for laparoscopic cholecystectomy were lower than for the open approach at all hospitals. Total cost savings ranged from $100 to $3,600 per procedure, the median cost savings being $1,255. Variable direct costs were also lower for the laparoscopic approach. The length of stay savings ranged from 2.3 to 5.1 days.

Total costs for LAVH were higher than for TAH during the study period. Much of the cost increase can be attributed the learning curve, since more than 25 procedures had been performed at only four study hospitals. Total costs of LAVH and TAH are comparable when "best practices" are considered, which reflect anticipated reductions in LAVH average length of stay (ALOS), procedure time, and equipment and supply costs. If the LAVH is broadly adopted, it is possible that costs for LAVH will be less than those for TAH.

Total costs and variable direct costs for laparoscopic inguinal hernia repair were higher than for the open approach. While "best practices" will reduce costs for this relatively new procedure, it is unlikely that hospital costs for this procedure will be lower than for the open approach. When the broader perspective is taken, and health care and disability costs are included, the laparoscopic approach has considerable potential to reduce costs relative to the open approach.

Total cost savings for thoracoscopic procedures are $1,300 to $4,800 per case lower than for comparable open thoracotomy cases. Variable direct cost savings range from $700 to $2,600. The majority of the savings is due to fewer days per case in the ICU and savings in the total hospital length of stay.

When total system costs are considered, each of the four laparoscopic procedures analyzed in this study is cost-effective. When the narrower view of hospital costs is taken, two of the laparoscopic procedures reduce costs relative to their open counterparts; one is about equal in cost; and one is somewhat more expensive than its open counterpart. Given that laparoscopic cholecystectomy reduces costs an average of $1,500 per case and currently accounts for the majority of the laparoscopic procedures performed by each of these hospitals, the overall impact of laparoscopic surgery reduces hospital costs.

Detailed Findings - Cholecystectomy

The laparoscopic approach for cholecystectomy has become the standard of care at each of the hospitals studied, accounting for between 70% and 95% of cholecystectomy procedures in 1991 and 1992. At each institution, the laparoscopic approach reduced average length of stay and total costs. Key variables are shown below for each of the institutions.

COMPARISON OF CHOLECYSTECTOMY

		HOSPITAL								
	Average	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Open Cholecystectomy*										
Number of Procedures Analyzed	**30**	**33**	**68**	**23**	**10**	**5**	**24**	**69**	**29**	**12**
ALOS (Days)	**4.9**	**4.9**	**4.8**	**5.0**	**4.2**	**6.4**	**4.5**	**5.2**	**4.0**	**5.4**
Procedure Time (Min)	**104**	**102**	**96**	**73**	**80**	**163**	**80**	**118**	**117**	**110**
Laparoscopic Cholecystectomy										
Number of Procedures Analyzed	**202**	**303**	**390**	**175**	**177**	**186**	**244**	**138**	**85**	**116**
ALOS (Days)	**1.7**	**1.8**	**1.6**	**1.7**	**1.6**	**1.3**	**2.2**	**1.7**	**1.4**	**1.9**
Procedure Time (Min)	**93**	**88**	**129**	**73**	**84**	**91**	**80**	**104**	**93**	**98**
Savings Versus Open										
ALOS (Days)	**3.2**	**3.1**	**3.2**	**3.3**	**2.6**	**5.1**	**2.3**	**3.5**	**2.6**	**3.5**
Procedure Time (Min)	**11**	**14**	**-33**	**0**	**-4**	**72**	**0**	**14**	**24**	**12**
Variable Direct Cost	**$601**	**$79**	**$467**	**$613**	**$185**	**$2,652**	**$10**	**$466**	**($85)**	**$1,019**
Total Cost	**$1,545**	**$1,143**	**$1,567**	**$1,255**	**$1,228**	**$3,671**	**$111**	**$1,920**	**$693**	**$2,314**
Best Practices - Total Costs	**$1,957**	**$1,558**	**$1,978**	**$1,392**	**$1,557**	**$3,834**	**$1,429**	**$2,493**	**$981**	**$2,387**

* Where possible, 1989 and 1990 data were utilized

At each hospital, clinical data was used to adjust the laparoscopic and "open" groups to remove selection bias. Emergency cases and cases in which the primary diagnosis was not cholelithiasis were removed from both groups. Whenever possible, open cholecystectomy data was obtained for cases prior to the introduction of the laparoscopic technique (Hospitals F, G) or before the technique became the procedure of choice (All others except E).

As the data in the chart illustrates, LC reduces hospital costs relative to open cholecystectomy at all participating hospitals. A detailed cost comparison is shown below for Hospital G. This hospital was chosen because all open cholecystectomy cases analyzed were performed in 1989, prior to the introduction of the laparoscopic technique at that hospital.

Costs Per Case For Cholecystectomy
Hospital G

	Open	**Laparoscopic**	**Laparoscopic Savings**
Variable Direct Costs			
OR Costs	$959	$1,794	($835)
Inpatient Nursing	967	316	651
Ancillary Services	1,147	497	650
Total Variable Direct Costs	$3,073	$2,607	466
Fixed and Indirect Costs	3,518	2,064	1,454
Total Costs	**$6,591**	**$4,671**	**$1,920**

The data shows a savings for the laparoscopic approach in both variable direct costs and total costs. Note that the laparoscopic approach has higher operating room costs. These costs include: the costs for OR time (principally labor costs for operating room personnel), anesthesia and recovery, equipment such as video, camera and instrument systems, and operating room supplies such as trocars, clip appliers, scalpel blades, drapes, sutures, etc. The higher operating room costs are more than offset by lower inpatient nursing costs (principally inpatient nursing labor costs) and lower costs for ancillary services such as pharmacy, respiratory therapy, etc.

While the LC shows cost savings relative to open cholecystectomy (OC), further cost reductions are possible for the laparoscopic approach if hospitals reach "best practices" performance levels. For example, if Hospital G could reduce LC ALOS from 1.7 days to 1.2 days and reduce procedure time from 104 to 73 minutes additional cost savings of approximately $600 are possible, bringing the total cost savings for the laparoscopic approach to almost $2,500 per case. Given that a number of participating hospitals most recently began shifting laparoscopic cholecystectomy cases to outpatient surgery facilities, we believe cost savings represented by "best practices" performance levels are entirely achievable as providers manage ALOS, OR utilization and supply expenses.

Detailed Findings - Hysterectomy

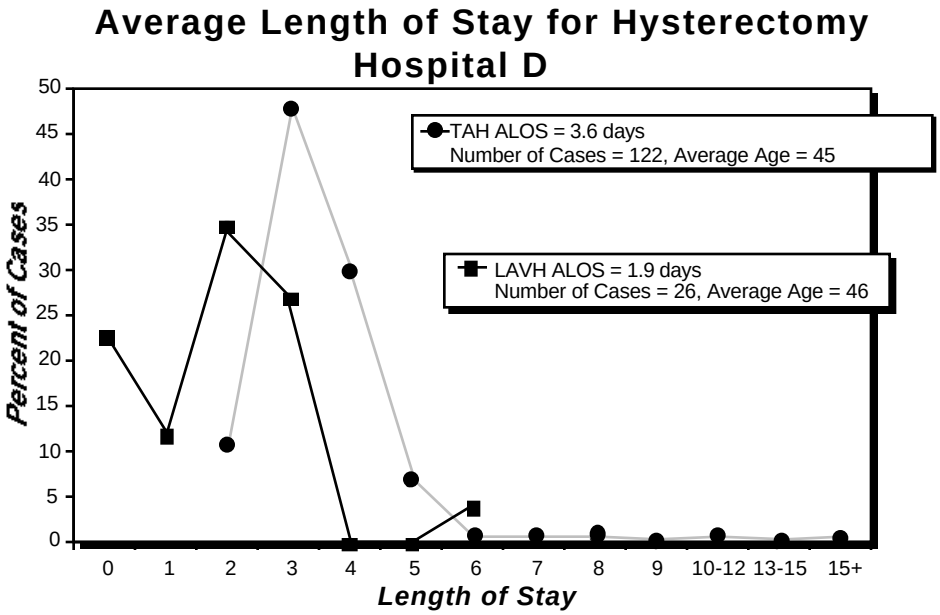
Because the technique for LAVH was developed and documented after the LC procedure, we found more variation across hospitals in their experience with the technique (majority of data in this study is for 1992). The table shows key data concerning the comparison of LAVH and TAH.

COMPARISON OF HYSTERECTOMY

		HOSPITAL								
	Average	A	B	C	D	E	F	G	H	I
TAH										
Number of Procedures Analyzed	304	97	1,130	155	122	200	263	270	235	263
ALOS (Days)	4.7	5.3	6.0	4.5	3.6	4.4	4.0	5.4	4.5	4.7
Procedure Time (Min)	111	101	117	115	98	127	102	117	118	108
LAVH										
Number of Procedures Analyzed	30	15	10	20	26	10	97	37	16	42
ALOS (Days)	2.7	3.0	3.4	2.2	1.9	2.1	2.8	2.7	3.1	3.5
Procedure Time (Min)	189	172	269	178	129	202	126	213	193	220
Savings Versus TAH										
ALOS (Days)	2.0	2.3	2.6	2.3	1.7	2.3	1.2	2.7	1.4	1.2
Procedure Time (Min)	-78	-71	-152	-63	-31	-75	-24	-96	-75	-112
Variable Direct Cost	($958)	($1,202)	($987)	($380)	($1,018)	($399)	($882)	($551)	($1,845)	($1,360)
Total Cost	($936)	($909)	($709)	($354)	($547)	($167)	($1,223)	($373)	($2,123)	($2,020)
Best Practices - Total Costs	$352	$342	$1,333	$358	($117)	$602	$279	$1,253	($495)	($390)

Four of the hospitals (D,F,G,I) had case series of LAVH that exceeded 25 cases. Note that the case series indicated is for the entire hospital as opposed to the individual physician, thus the surgeons in this report may have performed considerably fewer than 25 LAVH cases.

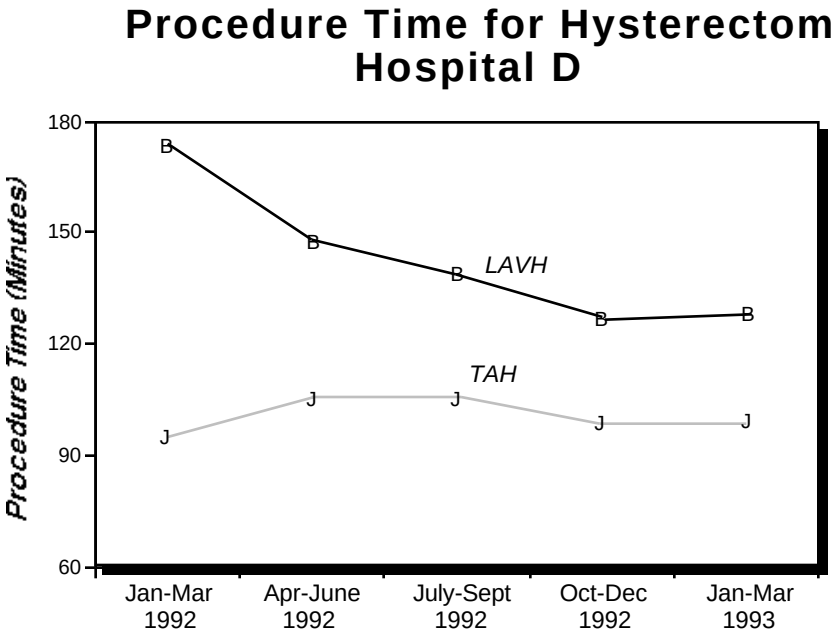
From a hospital cost perspective, the primary benefit of the LAVH is the reduction in length of hospital stay. The hospital length of stay distribution is shown below for Hospital D, which had considerable experience in using the technique.



As the chart illustrates, LAVH provides a savings of 1.7 days in average length of stay versus the TAH. Note that six of the 26 LAVH cases were performed on an outpatient basis. Taken with other published studies in which 28 of the 29 LAVHs in the study[1] were performed on an outpatient basis, this would suggest that further reduction in LAVH ALOS is possible. For "best practices", we assumed an average length of stay of 1.5 days for LAVH. When experience levels approach the familiarity providers now have with laparoscopic cholecystectomy, ALOS may be lower than which we have called best practices, and the LAVH may indeed provide hospital cost savings relative to the open approach.

[1]Summitt, Robert L. Jr, MD, "Randomized Comparison of LAVH With Standard Vaginal Hysterectomy in an Outpatient Setting", Obstetrics and Gynecology, Vol. 80, No. 6, December, 1992.

The primary cost disadvantage of LAVH is OR time costs and OR supply costs. All hospitals related experiences of long procedure times for LAVH for their first cases. However, due to an apparently steep learning curve, procedure times have decreased considerably at the hospitals where the most LAVHs are performed. LAVH procedure times for Hospital D are shown in the chart below.



Note that the time decreased from nearly three hours to a little more than two hours during the course of a year. Because the first LAVH cases were performed at Hospital D prior to January 1992, the overall learning curve is actually steeper than indicated by the graph. Hospital F had only recently installed an automated OR management system, so the learning curve could not be tracked. For the last 23 LAVH cases that were analyzed, the average procedure time was 126 minutes, just 24 minutes longer than the average TAH procedure time at Hospital F. While the learning curve is beginning to flatten, it is likely that procedure times within 15 minutes of TAH are attainable in the future.

OR supplies and equipment also contribute substantially to the costs of LAVH. We noted considerable variation in OR supply costs for LAVH at different hospitals. Hospitals that had standardized supplies used for the procedures and had taken advantage of pricing discounts for buying supply "kits" (all instruments packaged and purchased together instead of purchasing each item individually) were able to substantially reduce costs for the procedure. Hospital F had taken this approach effectively. Lastly, several surgeons explained that there was a tradeoff between procedure time (OR time costs) and OR supply costs due to the fact that single-use laparoscopic stapling devices enabled the LAVH procedure to be performed more quickly. Although we did not study this point in detail, we did note that laparoscopic stapling devices were used in most cases at Hospitals F and D, where procedure times were shortest.

Detailed Findings - Inguinal Herniorraphy

The incidence of laparoscopic inguinal hernia repair varied across the participating hospitals to a greater extent than any of the other procedures studied. At some hospitals, this may have been due to the fact that most of the hernia repairs were performed at nearby outpatient surgery centers. At Hospital C, the laparoscopic inguinal herniorraphy eclipsed traditional open herniorraphy in number of procedures performed during the second half of 1992. At Hospitals D and I, LIHR also accounted for a relatively large percentage of all hernia repairs. Key data are shown below for comparison of laparoscopic and open hernia repair.

COMPARISON OF HERNIORRAPHY

		HOSPITAL								
	Average	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Open Hernia										
Number of Procedures Analyzed	**205**	**394**	**NO DATA**	**110**	**204**	**NO DATA**	**455**	**NO DATA**	**58**	**6**
ALOS (Days)	**0.4**	**0.4**		**0.3**	**0.2**		**0.3**		**1.3**	**0.0**
Procedure Time (Min)	**62**	**66**		**62**	**63**		**55**		**65**	**61**
Laparoscopic Hernia										
Number of Procedures Analyzed	**66**	**12**		**140**	**63**		**10**		**3**	**165**
ALOS (Days)	**0.3**	**0.2**		**0.2**	**0.0**		**0.4**		**1.0**	**0.0**
Procedure Time (Min)	**106**	**160**		**81**	**103**		**81**		**138**	**71**
Savings Versus Open										
ALOS (Days)	**0.1**	**0.2**		**0.1**	**0.2**		**-0.1**		**0.3**	**0.0**
Procedure Time (Min)	**-44**	**-94**		**-19**	**-40**		**-26**		**-73**	**-10**
Variable Direct Cost	**($1,149)**	**($989)**		**($1,306)**	**($980)**		**($1,015)**		**($1,457)**	**($1,145)**
Total Cost	**($1,518)**	**($1,411)**		**($1,530)**	**($1,311)**		**($1,483)**		**($1,907)**	**($1,463)**

The cost comparison between laparoscopic and open inguinal herniorraphy is different from that of the two preceding comparisons in one important way. For cholecystectomy and hysterectomy, the traditional open procedure was performed on an inpatient basis and the average length of stay was typically four to seven days. With herniorraphy, the traditional open procedure is done on an outpatient basis, so there is little potential to reduce length of stay driven costs. The benefits of faster recovery for the laparoscopic approach are reaped outside the confines of the hospital, and thus are not factored into the hospital cost analysis. Like other laparoscopic procedures, costs for OR time, equipment and supplies are higher for LIHR. Procedure times have decreased substantially over time at each hospital where a considerable number of procedures have been performed. Hospital I had the shortest average procedure time for LIHR at 71 minutes. This was only 10 minutes longer than the open procedure. The other potential levers for cost improvement are OR supply and equipment costs. As discussed with LAVH, standardizing the supplies required for the procedure and buying at discounted kit prices can improve LIHR cost performance.

Even when these “best practice” performance levels are considered, hospital costs for LIHR will be higher than for the open approach. However, it should be noted that if the horizon is expanded to view total system costs including disability (see section on Total System Costs), the laparoscopic approach may indeed prove to be more cost effective. While the existing compartmentalized structures for health care financing, disability financing and health care delivery do not typically encourage thinking in these broad terms, the overall system cost impacts are important to understand.

Detailed Findings - Thoracoscopy

At the first hospitals we studied, information was collected for open and thoracoscopic pulmonary
wedge resections. Because case volumes for wedge resections were small, we expanded this procedure comparison to include open and thoracosopic biopsies and wedge resections. As a result, a comparison of wedge resections was performed at some institutions, while a comparison of both biopsies and wedge resections was performed at others. Data for these procedures is shown in the table below.

COMPARISON OF PULMONARY WEDGE RESECTION

		HOSPITAL								
	Average	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Open Wedge Resection										
Number of Procedures Analyzed	**9**	**NO DATA**	**NO DATA**	**19**	**NO DATA**	**2**	**NO DATA**	**3**	**5**	**16**
ALOS - Med/Surg (Days)	**5.6**			**5.6**		**4.5**		**4.7**	**7.2**	**6.0**
ALOS - ICU (Days)	**1.2**			**2.6**		**0.0**		**1.0**	**1.6**	**0.8**
Procedure Time (Min)*	**107**			**203**		**95**		**98**	**79**	**156**
Thoracoscopic Wedge Resection										
Number of Procedures Analyzed	**4**			**3**		**3**		**2**	**4**	**8**
ALOS - Med/Surg (Days)	**3.7**			**3.0**		**3.0**		**5.0**	**4.7**	**2.7**
ALOS - ICU (Days)	**0.2**			**0.2**		**0.0**		**0.0**	**0.5**	**0.3**
Procedure Time (Min)*	**62**			**268**		**63**		**73**	**49**	**61**
Savings Versus Open										
ALOS - Med/Surg (Days)	**1.9**			**2.6**		**1.5**		**-0.3**	**2.5**	**3.3**
ALOS - ICU (Days)	**1.0**			**2.4**		**0.0**		**1.0**	**1.1**	**0.5**
Procedure Time (Min)*	**46**			**-65**		**32**		**25**	**30**	**95**
Variable Direct Cost	**$1,380**			**$2,619**		**$901**		**$735**	**$1,209**	**$1,436**
Total Cost	**$2,809**			**$4,746**		**$1,283**		**$1,756**	**$2,703**	**$3,558**
Best Practices - Total Costs	**$4,114**			**$6,009**		**$1,667**		**$3,426**	**$4,977**	**$4,492**

Pulmonary wedge resection and biopsy cases are included for Hospitals G, H, I

* For Hospital C, time indicated is room time

At each hospital, thoracoscopic approaches provided large savings in hospital length of stay and hospital costs. Savings in ICU days were an important contributor to the total cost savings. At Hospital C, patients who underwent open wedge resection stayed on average more than 2 days in the ICU. Of the 3 patients who underwent the thoracoscopic wedge resection, only one spent time in the ICU (1 day). Since ICU costs are very high ($800 to $1,500 per day for the study hospitals), the cost savings resulting from fewer ICU days amounts to thousands of dollars per case. Major savings were gained from reduced utilization of pharmaceuticals, respiratory therapy and other ancillary services.

At Hospital I, the comparison was based on both pulmonary wedge resections and biopsies. In this comparison, thoracoscopic approaches saved an average of 0.5 ICU days and 3.8 total hospital days per case. This translated into a total cost savings of more than $3,500 per case. Procedure times were shorter for the thoracoscopic approach.

While the sample sizes of thoracoscopic cases were small, a pattern emerged at five different hospitals that confirmed what surgeons related in interviews -- that thoracoscopic procedures reduce length of stay and have substantial patient benefits. As a result, we are confident in concluding that thoracoscopic procedures provide hospitals considerable cost savings relative to their open counterparts.

Summary of Procedure Comparisons

From a hospital cost perspective, two of the laparoscopic procedures reduce hospital costs, one has comparable costs, and the fourth increases hospital costs somewhat. Given that laparoscopic cholecystectomy currently accounts for the majority of the laparoscopic procedures performed by each of these hospitals, the overall impact of laparoscopic surgery reduces hospital costs. In addition, since the laparoscopic procedures are new relative to their open counterparts (open cholecystectomy has been performed for more than 100 years), the cost-effectiveness of laparoscopic procedures is likely to increase in the future as additional experience is gained. We would expect that learning curve impacts would further improve the cost savings benefits of LC and thoracoscopic procedures when compared to their open counterparts. "Best practices" scenarios indicate that LAVH hospital costs will be approximately equal to TAH costs. If sufficient experience is gained with LAVH, it may provide a hospital cost savings relative to TAH. Hospital costs for LIHR, even under "best practices" are likely to remain higher than for open herniorraphy. Broadening the perspective to acknowledge the cost savings resulting from an earlier return to work will provide a benefit to all laparoscopic procedures, particularly hernia repair, which are often work-related.

Single-Use Versus Reusable Laparoscopic Instrumentation

In the course of analyzing the cost of laparoscopic procedures, questions regarding the relative merits of single-use versus reusable laparoscopic instruments emerge as a focal issue. As a result, we conducted a separate study of this important issue.

In this analysis, the total cost-in-use of reusable instruments was compared with that of single-use instruments. Total cost-in-use includes not only the purchase cost of the instruments, but also labor and supply costs needed for cleaning and sterilization, costs for repair and maintenance, and other related costs. Each of the hospitals used a mixture of single-use and reusable instrumentation: primarily single-use trocars, clip appliers and scissors; and primarily reusable graspers, dissectors and suction irrigators. Our analysis was structured to address the following question: "What would the cost impact be if hospitals replaced the reusables they currently use with single-use instruments?". The question was approached in this way due to the fact that the majority of surgeons and OR personnel we interviewed expressed substantial concern regarding the performance of reusable trocars and scissors -- suggesting that a completely reusable scenario would prove unworkable in practice.

At each hospital, reusables generated relatively large costs that were "difficult to detect". These include cleaning and sterilization costs, repair and replacement costs and other costs which were generally buried in departmental expense budgets and often not quantified by hospital administrators. Single-use instruments generated essentially no "difficult to detect" costs but did generate greater purchased costs which were easier to detect because they were charged against a highly visible OR supply expense account.

The total cost-in-use comparison is shown below. We chose to perform the analysis for cholecystectomy because the LC is a widely accepted procedure and was performed in large numbers at each of the hospitals studied.

The "Current Mix" column shows the costs for laparoscopic instruments used during the study period. The "All Single-Use" column shows what the cost would be if no reusable instruments were used.

INSTRUMENT COSTS FOR LAPAROSCOPIC CHOLECYSTECTOMY

	CURRENT MIX		ALL SINGLE-USE
	Average	**Range**	**Best Practices**
Purchase Instrument Costs			
Single-Use Instruments	$545	$292-$861	$723
Reusable Instruments	117	53-187	-
Repairs/Replacement	30	13-49	-
Processing Costs			
Salary	31	10-54	-
Non-Salary	16	3-28	-
Disposal Costs	1	1	2
Total Costs	**$740**	**$501-$1,055***	**$725**

Purchase Instrument Costs

Purchase instrument costs represent the direct cost to the hospital of purchasing the instruments required to perform laparoscopic cholecystectomy. The cost of the reusable instruments on a per procedure basis was calculated for each institution based on the initial purchase costs of the instruments, the expected lifetime, the number of instrument sets owned by each hospital and the number of cases performed annually. The costs of back-up instrument sets as well as obsolete instrument sets were also included. At one of the hospitals, an instrument set was used only a few times because surgeons believed it became obsolete shortly after it was purchased.

*Reflects high and low total costs across hospital sample

The cost of the single-use instruments reflects prices specific to each institution. Single-use instrument cost in the "Current Mix" column reflects the costs for instruments used during the study period. In the "All Single-Use" column, the cost reflects all instruments required to perform a laparoscopic cholecystectomy without the use of reusables. At each hospital we visited, there was significant potential to improve the value obtained for a given cost by using “best practices” to reduce waste (for example, by using a single trocar to make two punctures for two sleeves rather than using a separate trocar for each sleeve) and to take advantage of supplier discounts for buying “kits” (buying a number of instruments packaged together rather than buying them separately). Such savings are reflected in the “All Single-Use” column[2].

Repair and Replacement Costs

There were relatively large costs at each institution related to repair and replacement of individual reusable instruments. These costs were difficult for the hospitals to identify because they were routinely tracked in accounts that captured all repair costs for the OR. It should be noted that despite the relatively high costs observed for repairs and replacement, none of the institutions we visited had effective processes for maintaining the instruments in working order. For example, scissors were only sent out for sharpening after they failed to cut during a case, causing delays in the OR. Such practices are entirely contradictory to the concepts of "doing it right the first time" and total quality management, and create the need for multiple backup instrument sets.

Processing Costs

At most hospitals, reusables had significant hidden costs related to cleaning and processing in both the OR and in Central Sterile Processing. At one academic medical center, all cleaning and processing was performed in the OR and no related costs were generated in the Central Sterile department. Processing costs include labor costs for decontaminating, cleaning and sterilizing the instruments. Processing

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[2]Laparoscopic Instruments required for Cholecystectomy - "All Single-Use":

5 MM Trocar w/ 2 radiolucent sleeves	Clip Applier	Dissector
10 MM Trocar w/ 2 radiolucent sleeves	Verres Needle	Graspers (2)
Suction Irrigator	Trocar Grips (2)	Shears
Converters (2)		

costs also include the cost of chemicals, sterile wraps, protective gloves, face shields, etc. needed for reusables. In addition, processing costs include the cost of equipment used in processing, such as Steris (peracetic acid sterilizer), steam and ethylene oxide sterilizers. Processing costs varied significantly both across hospitals and within a given hospital, due to the lack of a common process for sterilizing reusable instruments. As is discussed below, this lack of a consistent method has implications for the quality of patient care.

Disposal Costs

As shown in the comparison, disposal costs are not a significant consideration in the question of single-use versus reusable instruments. Disposal costs for reusables are zero because the chemicals used for processing are released untreated down the drain or vented directly to the atmosphere. The $1 to $2 disposal cost for single-use instruments reflects the cost of landfill or incineration. Many of the surgeons and OR personnel interviewed cited disposal concerns as a disadvantage of single-use instruments. This is a misperception and is inconsistent with the facts. Looking at the volume of waste as opposed to the disposal cost leads one to the same conclusion. According to estimates from the Environmental Protection Agency, regulated medical waste generated by hospitals represents less than 0.3% of total municipal waste generated annually in the country[3]. Thus, single-use laparoscopic instruments, which account for only a small portion of a hospital's waste stream, represent considerably less than one-third of one percent of the municipal waste in the country.

Total Costs

As the data indicates, the total costs-in-use for the “All Single-Use” scenario are very close to the costs of the “Current mix” that hospitals are using. Based on the nature of the cost comparison, we conclude that the two approaches have costs that are essentially equal.

Other Considerations

While cost considerations are a major factor in the question of single-use versus reusable laparoscopic instruments, there are a number of other factors that need to be considered. These are discussed below but have not been factored into the cost comparison because they are, by nature, difficult to accurately quantify.

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[3]EPA, May 1990 Report to Congress

Effectiveness of Cleaning and Sterilization Processes

The most important issue which is not addressed in the cost comparison is the cost of potential increased liability for patients and health care workers given questions about the efficacy of the process for cleaning and sterilizing reusable instruments. Other studies have suggested a greater risk for reusables in this regard given the difficulty of cleaning and sterilizing these instruments[4]. During the on-site visits at study hospitals, we obtained a thorough understanding of the cleaning and sterilization processes for laparoscopic instruments in order to determine the costs involved. Based upon numerous interviews and observations, a few of which are shared below, we believe it is highly unlikely that existing processes are producing reusable instruments that are being properly cleaned and sterilized 100% of the time. According to a 1993 General Accounting Office report, "FDA's laboratory tests found that a manufacturer's sterilant did not work as the manufacturer claimed. When the sterilant was used according to its labeling, it failed to kill all microorganisms in the samples tested."[5]

At one hospital we visited, three different processes were used for processing reusable laparoscopic instruments. The process used depended upon where the procedure was performed and upon the case sequence on the day that the case was performed. The processes in place for cleaning and sterilizing laparoscopic instruments appear to be born more out of constraints and expediency rather than out of the requirements to assure patient safety through proper sterilization. The anecdotes below support this view.

> *One OR supervisor responsible for processing laparoscopic instruments indicated that instruments were flashed before each case because there was not enough time for a full cycle steam or ethylene oxide sterilization for consecutive cases. As a result of their desire for a consistent level of patient care, they decided to flash the instruments for* ***all*** *cases rather than performing full cycle steam or ethylene oxide sterilization whenever possible. In essence, this hospital chose a lower standard of patient care in order to ensure consistency across all cases.*

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[4]Reichert, Marimargaret, "Laparoscopic Instruments - Patient Care, Cost Issues", AORN Journal, March, 1993.

[5]U.S. General Accounting Office, GAO/HRD - 93-79, June, 1993.

At a different hospital, the OR technician responsible for processing the laparoscopic instruments explained that the instruments are difficult to clean. Insulated instruments, she explained, are particularly difficult to clean because blood can get under the insulation in the space between the metal shaft and the insulation. In order to fully clean the instruments, they are first soaked in an enzyme solution, then manually decontaminated using a brush under running water. Instruments are then put into an ultrasonic machine and re-rinsed under running water. The instruments are then hung to drain over a sheet of white paper. If the water dripping from the instruments is discolored, the ultrasonic cleaning followed by manual cleaning is repeated and the instruments are again hung to dry. This process is repeated until there is no evidence of discoloration. The instruments are then sterilized. The OR tech explained that while the cleaning process generally needed to be repeated two to three times to ensure proper cleaning, it was impossible to run the instruments through the ultrasonic and manual wash more than once when the instruments were needed for the next case, which typically happened several times per day.

At a third hospital, where the central sterile processing department was responsible for cleaning and processing the laparoscopic instruments, the department manager explained that the reusable instrument sets were always sterilized using full cycle steam and were never flashed, citing the New Jersey prohibition on routine flash sterilization. However, the OR technician who actually processed the instruments was subsequently interviewed as the core areas of the OR were being toured. This person said that flash sterilization was used routinely, at least a few times per day.

Our findings suggest current procedures do not ensure that reusables are being properly cleaned and sterilized 100% of the time, suggesting a greater risk of post-operative infection and possible transfer of blood-borne pathogens with reusable laparoscopic instruments.

Reimbursement

Historically, hospitals have passed the costs of single-use instruments along to payors because instruments were patient-chargeable supplies. Indeed, at some of the hospitals studied, the hospital obtained more in net reimbursement from payors for these supplies than the instruments actually cost. We have not included reimbursement in the comparison because of the likely continued decline in the number of charge-based payors.

Other Costs, Instrument Performance and Intangibles

Other comparisons of single-use and disposable instruments have revealed additional costs for reusable laparoscopic instruments[6]. These include increased employee injury costs as a result of handling and reprocessing reusable laparoscopic instruments and increased in-service education costs related to training staff in how to clean and reprocess the reusable laparoscopic instruments. In addition, lost OR revenue has been cited as an opportunity cost of reusable laparoscopic instruments due to OR delays traced to reprocessing instruments for consecutive cases.

Interviews with numerous surgeons revealed performance differences between reusables and disposables that are not quantified in our analysis. The vast majority of surgeons expressed strong preferences for single-use shears because they were always sharp and reusable scissors were frequently dull. In addition, the majority of surgeons and nurses cited the safety shields and sharpness of single-use trocars as major advantages over reusables. Other surgeons remarked that single-use instruments were typically more technically advanced than the reusables available at their hospitals.

Finally, several OR managers raised questions regarding quality of work life for the nursing staff and quality of patient care. At one institution, laparoscopic instruments were cleaned exclusively by OR nurses, which caused a highly trained professional to be underutilized and reduced direct patient care nursing time. Such actions are contrary to many nursing management initiatives.

Single-Use Versus Reusable Instrument Summary

Clearly, the choice between single-use and reusable laparoscopic instruments involves a number of complex issues. Hospitals analyzed in this study could replace existing reusable instruments with disposable instruments without meaningful impacts on costs. This change would also have important benefits not quantified in the cost comparison. These include reduced risk of post-operative infection / transfer of blood-borne pathogens resulting from improper cleaning and sterilization, improved instrument performance, and reduced risk of employee injury.

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[6]Weatherly, Kathie S., "Reusable Laparoscopic Cholecystectomy Instrument Systems Cost Analysis", (in Press).

Given the importance of the single-use versus reusable decision, hospitals need to analyze their specific situation. With input from surgeons, OR staff, infection control staff, sterile processing staff and hospital administrators, each institution can make an informed decision consistent with its cost and patient care objectives.

Total Health Care System Costs

The economics of laparoscopic versus open cholecystectomy were also examined from the context of the total health care system - not just for the hospital. To do so, total health care and disability costs were analyzed for employees of two Fortune 500 companies who had undergone either laparoscopic or open cholecystectomy. Current coding limitations prevented us from performing the analysis for other procedures.

From the perspective of the employer, total heath care system costs for cholecystectomy include:

- Hospitalization Costs (payment to the hospital)
- Physician Costs (surgeon and anesthesiologist reimbursement)
- Short-term Disability Costs

Because companies do not typically link these three types of costs for employee illnesses, many are unaware of the cost impacts laparoscopic surgical approaches have had on employee benefit costs.

Profile of Participants

Over fifty Fortune 500 companies were contacted in an attempt to gather data on total system costs. The vast majority, however, did not maintain disability and health data in a form employable for the study. Profiles of the two company participants are shown below.

	Company A	**Company B**
Number of Employees*	5,800	65,000
Type of Business	Manufacturing	Diversified

*Employees with accessible medical and disability data for the study

Methodology

At each company, employee health care claims were reviewed to identify employees who had filed claims in 1991 or 1992 related to laparoscopic or open cholecystectomy. It was not possible to review claims related to the other three procedures in the hospital study because codes used in claims data bases do not distinguish which of these procedures were performed laparoscopically. Once employees were identified, all claims submitted for payment were reviewed, including physician costs for surgery and anesthesiology, and hospital costs. Short-term disability data was then collected for these employees.

Hospitalization Costs

Hospitalization costs paid by the employers for employees who underwent laparoscopic and open cholecystectomy are shown below.

	Company A	**Company B***
Open Cholecystectomy	$6,227	$11,170
Laparoscopic Cholecystectomy	$6,423	$10,490
Savings For Laparoscopic Approach	($196)	$680

*Figures include physician costs and hospitalization costs

For these two employers, hospitalization costs for employees undergoing laparoscopic cholecystectomy were about the same as for those undergoing the open approach. Based on the hospital study, where the majority of hospitals charged less for the laparoscopic approach, we expect that learning curve impacts would result in lower hospitalization costs for the laparoscopic approach.

Physician Costs

Data on physician costs was only available for Company A (physician costs are included in hospitalization costs for Company B). For employees undergoing laparoscopic cholecystectomy, physician costs were $1,448 versus $1,240 for those who underwent open surgery, for a cost increase of about $200 per case. More broadly, many payors in addition to Medicare are adopting RBRVS payment methodologies. Given that LC and OC have

nearly the same total RVUs, it is reasonable to conclude that physician costs for the two approaches will not be substantially different.

Short-Term Disability Costs

The table below shows the number of short-term disability days (STD) and costs for employees of both companies who underwent LC and OC.

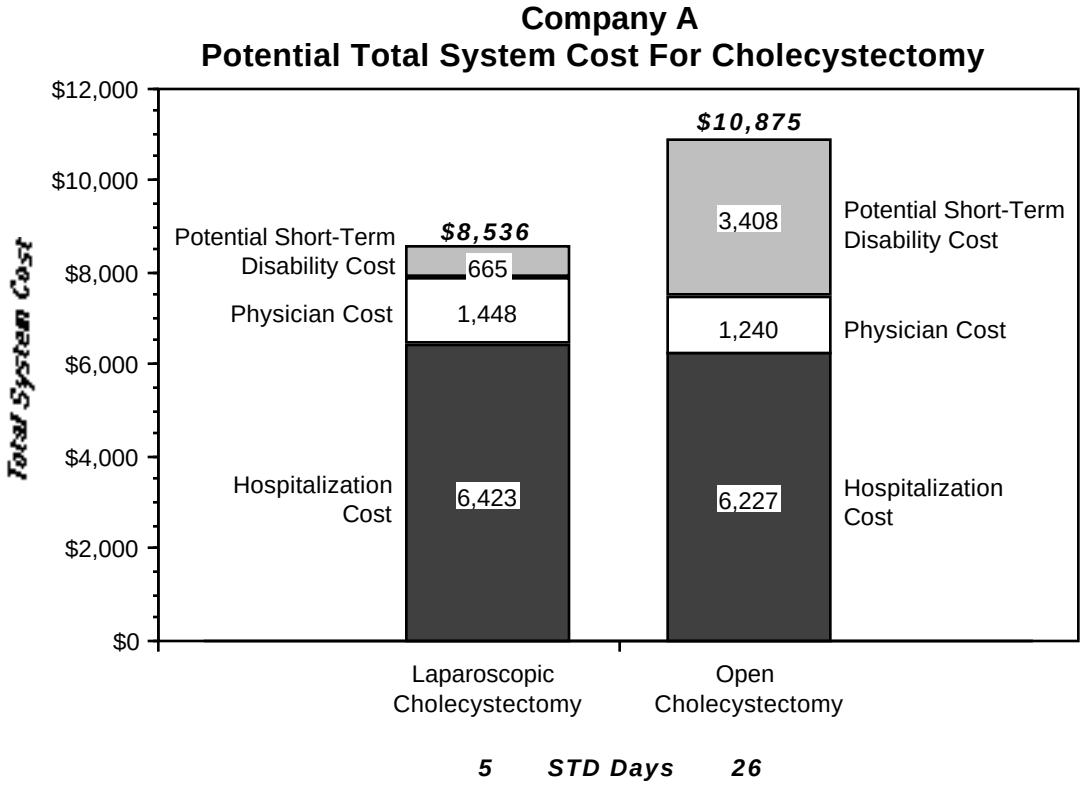
	Company A		Company B	
	Days	**Cost**	**Days**	**Cost**
Open	19	$2,490	18	$2,331
Laparoscopic	17	$2,228	14	$1,806
Savings	2	$262	4	$525

These results were notable in that, on average, employees who underwent laparoscopic cholecystectomy returned to work on average only 2 to 4 days earlier than those who underwent open cholecystectomy. Based on published research, we would have expected considerably larger savings in disability costs. Health and disability benefits managers at the companies indicated that they were not necessarily surprised with these findings. They explained their companies did not have any guidelines for length of short-term disability by illness nor did they communicate to employees what was typical for laparoscopic or open cholecystectomy in terms of short-term disability period. As a result, they were unable to help their companies effectively manage these costs.

Potential Short-Term Disability Cost Savings

The figure below, which shows the recovery period for LC and OC patients, gives an indication of the potential savings in short-term disability days due to the laparoscopic approach[7]. The patients in the LC group returned to normal activity in an average of 5 days as opposed to 26 days for the open group, for a savings of twenty days. If Company A was able to have LC patients return to work when the group in this study returned to normal activity, the total system costs for this company for cholecystectomy would be as shown below.

[7]Bailey, Robert W, MD, et. al., "Laparoscopic Cholecystectomy Experience with 375 Consecutive Patients", Annals of Surgery, October, 1991.



* Based on return to normal activity, see Bailey, Footnote 7

Given the average daily short-term disability cost of the companies studied, the potential savings represented by faster recovery is in excess of $2,500. As depicted by the graph, short-term disability costs account for about one third of total system costs for OC. As a result, the potential savings in disability costs alone for the laparoscopic approach translate into a cost savings of more than 25% in total health care costs for cholecystectomy.

Summary - Total System Cost

From the employer's perspective, laparoscopic surgery is cost-effective relative to open cholecystectomy. Hospitalization and physician costs are about the same for the laparoscopic approach, and disability costs are currently an average of $400 lower for the laparoscopic approach. If effective approaches are developed for managing short-term disability costs, the savings for the laparoscopic approach are potentially two thousand dollars per case. If extended nationwide, this level of savings would represent a truly significant source of potential health-related cost reductions.

Overall Conclusions

Taken together, the three aspects of the study provide a variety of important findings. Laparoscopic surgical procedures were definitively more cost effective for the hospital than open alternatives for cholecystectomy and thoracoscopic wedge resection. The evidence in support of this finding is quite compelling.

The third procedure, laparoscopically assisted vaginal hysterectomy (LAVH), produced somewhat higher costs than total abdominal hysterectomy (TAH) for hospitals in this study. As experience is gained and the learning curve is overcome, we believe hospital costs for LAVH will be about the same as for TAH. If the procedure becomes widely adopted, costs could potentially be somewhat lower than for TAH. Additional benefits of quicker return to normal activity, less physical disfigurement and less post operative pain, reported anecdotally by many surgeons, make LAVH an attractive alternative to TAH.

The fourth procedure we analyzed, laparoscopic inguinal herniorraphy (LIHR), proved somewhat more costly to hospitals than the open repair. The majority of surgeons interviewed reported benefits of more rapid post-surgical recovery for the laparoscopic approach. Provided LIHR patients are able to return to work two to three weeks earlier than their open counterparts, as many surgeons suggested, the LIHR will be at parity to the traditional open approach from a total system cost perspective.

Although data to analyze the total system cost (hospital costs, physician costs, disability costs) impacts of laparoscopic procedures proved to be limited, our evaluation of two large corporations indicated savings for laparoscopic approaches. Even though, due to current coding limitations, our analysis was restricted to total system costs for cholecystectomy, we found that hospitalization costs for LC were equal to or lower than for OC; physician costs were comparable; and disability costs were lower for LC. More importantly, qualitative findings from surgeons, benefits managers and others, supported by other published research, suggest that considerably greater cost savings for laparoscopic approaches are possible if disability is managed proactively.

Finally, we addressed the issue of laparoscopic instrumentation, a focal concern for laparoscopic approaches. Based on the sample of hospitals we studied, the cost of switching from the existing mix of instrumentation to all single use instruments was minimal. Furthermore, less quantifiable benefits related to infection control, technology and obsolescence, instrument performance, and instrument reliability make single-use instruments even more attractive.

This study was undertaken to address the concerns of hospitals, payors and physicians about the cost-effectiveness of laparoscopic surgery and single-use instrumentation. After a rigorous evaluation of total hospital costs and total costs to the health care system, we conclude that laparoscopic surgical approaches hold considerable advantages. In addition, single-use laparoscopic instruments are a cost-effective alternative to reusables. Hospitals should also consider the important, yet less quantifiable, benefits of single-use instrumentation when evaluating the impact of these new surgical technologies.