

Time Management in the Operating Room: An Analysis of the Dedicated Minimally Invasive Surgery Suite

Kenneth C. Hsiao, MD, Zurab Machaidze, MD, John G. Pattaras, MD

ABSTRACT

Background: Dedicated minimally invasive surgery suites are available that contain specialized equipment to facilitate endoscopic surgery. Laparoscopy performed in a general operating room is hampered by the multitude of additional equipment that must be transported into the room. The objective of this study was to compare the preparation times between procedures performed in traditional operating rooms versus dedicated minimally invasive surgery suites to see whether operating room efficiency is improved in the specialized room.

Methods: The records of 50 patients who underwent laparoscopic procedures between September 2000 and April 2002 were retrospectively reviewed. Twenty-three patients underwent surgery in a general operating room and 18 patients in an minimally invasive surgery suite. Nine patients were excluded because of cystoscopic procedures undergone prior to laparoscopy. Various time points were recorded from which various time intervals were derived, such as preanesthesia time, anesthesia induction time, and total preparation time. A 2-tailed, unpaired Student *t* test was used for statistical analysis.

Results: The mean preanesthesia time was significantly faster in the minimally invasive surgery suite (12.2 minutes) compared with that in the traditional operating room (17.8 minutes) ($P=0.013$). Mean anesthesia induction time in the minimally invasive surgery suite (47.5 minutes) was similar to time in the traditional operating room (45.7 minutes) ($P=0.734$). The average total preparation time for the minimally invasive surgery suite (59.6 minutes) was not significantly faster than that in the general operating room (63.5 minutes) ($P=0.481$).

Conclusion: The amount of time that elapses between the patient entering the room and anesthesia induction is

statically shorter in a dedicated minimally invasive surgery suite. Laparoscopic surgery is performed more efficiently in a dedicated minimally invasive surgery suite versus a traditional operating room.

Key Words: Laparoscopy, Operating room, Ergonomics, Efficiency, Minimally invasive surgery suite.

INTRODUCTION

Since completion of the first, successful, laparoscopic nephrectomy in 1990 by Clayman, Kavoussi, and colleagues,¹ laparoscopy and minimally invasive surgery (MIS) have become a mainstay of modern urological practice in the 21st century. Urologists have long championed the use of minimally invasive techniques for diagnostic and therapeutic purposes. Many advances have taken place since the German scientist Philip Bozzini first performed endoscopic examination of the lower urinary tract with his prototype "Lichtleiter" or light conductor in 1805.² Although material and technical limitations of the 19th century resulted in primitive instruments that were large and clumsy with poor visualization, modern day laparoscopy and endoscopy use a multitude of additional equipment that makes the traditional operating room an equally challenging environment.

The rapid proliferation of video equipment, tubes, wires, cables, cords, and monitors has in some cases been addressed with the adoption of a laparoscopic cart-based paradigm, in which mobile equipment carts can be wheeled from room to room.³ Although less expensive and transportable, the carts also consume precious operating room floor space, can be physically cumbersome, and may even create a hazardous working environment. As a result, some traditional operating rooms have been transformed into dedicated MIS suites at costs of \$200,000 to \$400,000 per suite. Advances include integration of the video, power, light, and insufflation systems onto ceiling-mounted columns, and a central, computerized, control station to coordinate these systems and provide for advanced telecommunications. These changes have simplified the operating room (OR) by decreasing clutter and

Emory University School of Medicine, Department of Urology, Atlanta, Georgia, USA (all authors).

Address reprint requests to: John G. Pattaras, MD, Emory University School of Medicine, Department of Urology, 1365 Clifton Rd NE, Ste 3225-A, Atlanta, GA 30322, USA. Telephone: 404 778 4260, Fax: 404 778 4006, E-mail: John_Pattaras@Emoryhealthcare.org

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crowding, and creating a safer working environment.⁴ In addition, the MIS suite may serve to facilitate operating room efficiency by reducing preparation and clean-up times.⁵

To date, however, few objective studies have measured the actual effect of these renovation projects. Because of the limited number of these specialized MIS suites at our institution, laparoscopic urological surgery is routinely performed in traditional operating rooms. We retrospectively examined various time points recorded as part of the standard surgical record to determine the impact of the dedicated MIS suite on operating room efficiency.

METHODS

The records of 50 consecutive patients who underwent laparoscopic procedures by a single surgeon at the Emory University Hospital between September 2000 and April 2002 were retrospectively reviewed. Patients were separated based on whether surgery took place in a traditional OR or in a dedicated MIS surgery suite. Patients undergoing cystoscopic procedures prior to the start of laparoscopy were excluded from analysis because the records failed to provide adequate detail as to whether the start of surgery represented initiation of cystoscopy or laparoscopy. Laparoscopic surgery performed in a traditional OR used 2, floor-based, mobile equipment carts placed on opposite sides of the operating table (Figure 1). In the dedicated MIS suite, a single ceiling-mounted equipment column houses the video, light, insufflation, and electro-surgical generators that are remotely controlled by a computerized nursing control station. In addition, 2 ceiling-



Figure 1. Traditional operating room. Two, floor-based, mobile equipment carts are placed on opposite sides of the operating table.

mounted, flat-screen monitors on swivel arms provide horizontal and vertical motion (Figure 2).

Various time points are recorded as part of the standardized record for every case performed in the operating room. These include the “in-room time,” “anesthesia induction,” and “surgery start time.” The data were collected from the surgical records and 3 time intervals were subsequently generated from the time points. These time intervals were defined as the preanesthesia time (PAT), anesthesia induction time (AIT), and total preparation time (TPT). PAT was defined as the time elapsed in minutes between “in-room time” and “anesthesia induction.” AIT was defined as the time elapsed in minutes between the start of “anesthesia induction” to “surgery start time.” Finally, TPT was defined as the overall time elapsed between “in-room time” and “surgery start time.” AIT encompasses the multitude of tasks that are completed between the start of anesthesia induction to making of the surgical incision. These tasks included airway management, placement of central venous access, monitoring, patient positioning, skin preparation, and draping. The time intervals were compared for the laparoscopic suites versus traditional operating rooms.

A 2-tailed, unpaired *t* test was used for statistical analysis.



Figure 2. Dedicated minimally invasive surgery (MIS) suite. A single ceiling-mounted equipment column houses the video, light, insufflation, and electro-surgical generators that are remotely controlled by a computerized nursing control station. In addition, 2 ceiling-mounted, flat-screen monitors on swivel arms provide horizontal and vertical motion.

RESULTS

Of the 50 consecutive patients identified, 9 were excluded because of cystoscopic procedures performed before the start of the laparoscopic portion of the operation. A total of 23 patients underwent surgery in a traditional operating room, while the remaining 18 patients had surgery performed in a dedicated MIS suite. The operations performed are listed in **Table 1**. The mean PAT was significantly faster in the MIS suite (12.2 minutes) compared with that in the traditional OR (17.8 minutes, $P=0.013$). Mean AIT in the MIS suite (47.5 minutes) was similar to that in the traditional OR (45.7 minutes) ($P=0.734$). Although the mean total preparation time (TPT) for the MIS suite (59.6 minutes) was faster than that in the traditional OR (63.5 minutes), a statistically significant difference was not appreciated ($P=0.481$).

DISCUSSION

The field of ergonomics, also known as “human factors,” is a relatively new science that focuses on the design of machines and tools to optimize performance by the user.⁶ Many areas of industry have used ergonomic analyses to achieve optimal performance while minimizing error and injury. By comparison, the field of medicine has been slow to adopt ergonomic systems analysis. Beurguer⁷ has stated that more studies have been published about opti-

Table 1.

Breakdown of Procedures Performed in the Traditional OR and Dedicated MIS Suite

Laparoscopic Procedure	Minimally Invasive Surgery Suite (n = 18)	Traditional Operating Room (n = 23)
Nephrectomy	11	15
Spermatic cord ligation	2	1
Nephroureterectomy	1	1
Bilateral nephrectomy	1	1
Pyeloplasty	1	1
Cyst decortication	1	2
Renal tumor cryoablation	1	0
Mitrofanoff appendicovesicosty	0	1
Adrenalectomy	0	1

Table 2.

Comparison of Preanesthesia, Anesthesia Induction, and Total Preparation Time in an MIS Suite Versus Traditional OR

Time Interval*	Dedicated Minimally Invasive Surgery Suite (minutes)	Traditional Operating Room (minutes)
PAT	12.2 ($t = 0.013$)	17.8
AIT	47.5	45.7
TPT	59.6	63.5

*PAT (preanesthesia time) = time elapsed between “in room” and “anesthesia induction;” AIT (anesthesia induction time) = time elapsed between “anesthesia induction” and “surgery start time;” TPT (total preparation time) = time elapsed between “in room” and “surgery start time.”

mizing the work environment of a pilot, industrial welder, or computer terminal operator than about optimizing the work environment of surgeons in the operating room. The Food and Drug Administration has recognized the impact of ergonomics on patient safety, suggesting that up to half of the 1.3 million unintentional patient injuries in United States hospitals each year may be a result of poorly designed medical instruments.⁸

The emergence of laparoscopy and minimally invasive surgery in the operating room has made the modern-day urologist increasingly dependent on the optimal performance of highly advanced and complex technology for the successful and efficient completion of procedures. Kenyon and colleagues⁹ have previously demonstrated the improved efficiency of a dedicated laparoscopic operating team over a nonspecialized team. In addition to a decreased mean total anesthesia time of over 30 minutes, a significantly lower conversion rate (0%) was also documented with the dedicated laparoscopy personnel when compared with the conversion rate of the nonsurgical team (12%). The same group⁵ from Portland, Oregon, has also utilized a simulation model involving video set up and put away times to demonstrate a highly significant ($P=0.0001$) difference in operating room efficiency in a dedicated minimally invasive surgery suite versus a traditional OR.

In our retrospective analysis of the standardized operating room records from 50 consecutive patients undergoing laparoscopic urological procedures, the mean TPT in the MIS suite (59.6 minutes) was 4 minutes faster than the mean TPT in a traditional OR (63.5 minutes); however, a statistically significant difference could not be verified between the 2 groups ($P=0.481$). TPT includes both preanesthesia and anesthesia induction time. AIT encom-

passes the multitude of tasks required for proper patient airway management, placement of central venous lines for access or monitoring, and positioning that varied with each patient and procedure. The similar AIT for both the MIS suite (47.5 minutes) and traditional OR group (45.7 minutes) suggests that in spite of not being initially controlled for, any variables in anesthesia delivery and surgical preparation and positioning were adequately distributed between both groups. The differences in TPT in the MIS suite versus the traditional OR might have been diluted or masked by the length of time spent during anesthesia induction and positioning. Indeed, when AIT is removed from the equation and only preanesthesia time is analyzed, PAT is significantly shorter in the MIS suite (12.2 minutes) compared with that in the traditional OR (17.8 minutes, $P=0.013$). This translates into a cost savings of approximately \$100 based on the standard operating room charge at our institution of \$19/minute.

Although we were ultimately able to identify a small but significant difference in preparation times between the MIS suite and the traditional OR, operating room efficiency was not as profoundly affected by the advances of the MIS suite in our study as in others. One possible explanation is that we were unable to control for dedicated or nondedicated OR personnel in our study, a factor that has previously been described to decrease total anesthesia time.⁹ In addition, the video set up task utilized by Kenyon et al⁹ was a simulation model performed by 5 registered nurses in somewhat of an artificial setting. Our retrospective review, though with its own limitations, is an evaluation of the operating room environment and efficiency under the rigors of actual case conditions.

Aside from the practical concerns of reduced cost and improved efficiency is the notion that advances to the operative environment and surgeon's comfort achieved with the construction of MIS suites may also improve surgical performance. It has been suggested that the mental and physical workload is increased during laparoscopic surgery compared with that in open surgery.¹⁰ Indeed, some have described a 4-hour performance "wall" that is reached during prolonged laparoscopic procedures.¹¹ Experience from advanced laparoscopy trainers¹² have confirmed that many surgeons report exhaustion following 5 hours to 6 hours even under optimized conditions. It is clear that laparoscopic procedures require more equipment and result in more crowding than open operations do.⁴ This can adversely affect surgical performance by increasing time spent on "nonproductive" activities, thereby lengthening the procedure time and adversely affecting outcomes. The unmeasured benefits of

the MIS suite that include improved surgeon comfort and decreased fatigue cannot be underestimated and justify the initial capital expenditure for construction of the 21st century operating room.

The field of surgery and the operating room environment are ideally suited and clearly benefit from ergonomic analyses; however, relatively few objective studies have been published. As laparoscopy and minimally invasive surgery continue to become further integrated into the workplace of the 21st century urologist, further ergonomic studies are warranted to identify critical design elements in the operating room, and the surgeon's hands, that will further improve surgical efficiency, performance, and safety.

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