An analysis of set time, outcome indicators, and medicines of pediatric patients undergoing laparoscopic appendectomy
AN ANALYSIS OF SET TIME, OUTCOME INDICATORS, AND MEDICINES OF PEDIATRIC PATIENTS UNDERGOING LAPAROSCOPIC APPENDECTOMY

by

ERIC ROBERT CHUNG

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Submitted in partial fulfillment of the requirements for the degree of Master of Science 2016
Approved by

First Reader
Theresa A. Davies, Ph.D.
Assistant Professor of Medical Sciences & Education
Director, M.S. in Oral Health Sciences Program

Second Reader
Robert Brustowicz, M.D.
Senior Associate in Perioperative Anesthesia
Assistant Professor of Anesthesia
Boston Children’s Hospital of Harvard University
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AN ANALYSIS OF SET TIME, OUTCOME INDICATORS, AND MEDICINES OF PEDIATRIC PATIENTS UNDERGOING LAPAROSCOPIC APPENDECTOMY

ERIC ROBERT CHUNG

ABSTRACT

Introduction: There currently exists a wide variation in anesthesia perioperative management for pediatric patients undergoing laparoscopic appendectomy. The purpose of this retrospective chart review is to compare outcome indicators by using patient demographics. This study aims to establish evidence based guidelines for safe, efficient and effective anesthetic management for patients undergoing laparoscopic appendectomies by analyzing selected outcome indicators and metrics in relation to Surgical-End-to-Transport (SET) time: defined as the time from the end of surgical time until the patient is ready to exit the operating room.

Methods: After institutional review board approval, all laparoscopic appendectomies performed from 2012 through 2014 (n=790) were queried. Using the median SET time of 14 minutes, two groups were established as follows: Group A (n=431), SET time between 0 and 14 minutes, and Group B (n=338), SET time of 14 minutes and longer. Bivariate and multivariate logistic regression models were used to compare readmissions by American Society of Anesthesiologists (ASA) status and reports of high pain with PACU (Post-
Anesthesia Care Unit) duration, gender, age, and surgical duration using IBM SPSS Statistics (version 21.0, IBM, Armonk, NY).

**Results:** To limit confounding variables, patients over the age of 21 and those assigned an ASA Physical Status Classification 3 or 4 were excluded. Remaining cases (n=769) were then used to calculate readmission incidence. The median SET time for the study population was 14 minutes, while the median surgical and PACU durations were 58 minutes and 59 minutes, respectively. The readmission incidence rate was 300 per 10,000 (n=23, 3%). The study population consisted of 56% males and 44% females. Females had a higher incidence of readmission (n=13, 3.8%) than males (n=10, 2.3%), while males had longer SET times than females (Group A Males 52.33% vs. Group B Males 60.30%, p=0.0276). There was no difference in readmission incidence rates between ASA I (n=473) and ASA II (n=296) patients (ASA I readmits 3.2 % vs. ASA II readmits 2.7%, p=.711). Patients who reported high postoperative pain (n=75) were more than twice as likely to be readmitted than patients who did not report high pain (p=.071). Ethnicity frequencies were collected as follows: 60.3% White, 6.8% Black or African American, 3.6% Asian, and 29.1% Other.

**Discussion:** Males had significantly longer durations in SET times, and they experienced fewer readmissions than females. There were no significant findings related to the ethnic demographics. Further analysis identifying intraoperative
and postoperative anesthesia management for both groups will be performed.

This study was subject to the following limitations: retrospective design, incomplete data acquisition, and inconsistent EMR documentation. The correlations and results are preliminary in nature and will serve as a framework for future analyses.
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LIST OF ABBREVIATIONS

AMSD ........................... Appendix Maximum Short Diameter on Diagnostic Imaging
ASA ..................................................... American Society of Anesthesiologists
CRP .......................................................... C-reactive protein
EHR .......................................................... Electronic Health Record
FAQ .......................................................... Frequently Asked Questions
PACU .......................................................... Post-Anesthesia Care Unit
SET Time .................................................. Surgical-End-to-Transport Time
SPLA .......................................................... Single-Port Laparoscopic Appendectomy
WBC .......................................................... White Blood Cell
INTRODUCTION

Appendix

The appendix is an organ shaped as a tube that is closed on one end. It is attached to the cecum, a pouch-like structure that is considered to be the beginning of the large intestine (Figure 1). The appendix is, on average, 9 cm in length, and located in the lower right quadrant of the abdomen (Samaha, 2011).

Figure 1. Location of Appendix. Figure taken from Adam Images, n.d.
While the appendix is located within the digestive system in the human body, its true function is still being debated. The appendix is surrounded by gut-associated lymphoid tissue, drawing speculation that it may play a role in maintaining immune function and response. However, removal of the appendix does not seem to illicit side effects. Due to this reason, it is hypothesized that the appendix may actually be a vestigial structure; an organ that has lost its original function due to evolution over time. The appendix has been proposed to be the remnant of a structure found in a remote ancestor of humans (Glover, 1988).

Despite its lack of a function within the human body, a cause for concern occurs when the appendix becomes inflamed. This condition is called appendicitis.

**Appendicitis**

Inflammation of the appendix is due to a blockage in the proximal portion relative to the cecum (Figure 2). This condition is usually caused by an obstruction of calcified feces, or a fecalith. Hypotheses on the causes of appendicitis include the lack of dietary fiber (Walker, 1990). Other causes include infection of the surrounding lymphoid tissue. The blockage causes reduced blood flow to the area, resulting in increased pressures within the appendix, and ultimately bacteria inside of the appendix can grow and create an infection.
The lack of blood flow to the appendiceal area causes ischemia and results in tissue death and necrosis. Further growth leads to bacterial leakage through the walls, and pus forms. If the appendicitis is not treated at this point, it can lead to a rupture of the appendix, also known as a perforated appendix. This is a medical emergency due to the potential of sepsis and death. A perforated appendix causes infectious materials to be spilled all throughout the peritoneum, greatly increasing the risk of widespread abdominal infection. The latter condition is known as peritonitis and is fatal unless treated quickly with antibiotics (Craig and Brenner, n.d.).
In other cases, a pus-filled abscess is created, closing off the infection in a pocket-like structure. This infection is closed off from the rest of the abdominal cavity and requires drainage from a surgeon. Unfortunately this complication cannot be treated through the use of antibiotics and requires diagnostic surgery in order to determine the condition. Once the abscess is drained, the appendix is removed.

Because of these serious complications of appendicitis, urgent treatment is needed once the condition is diagnosed. In rare cases, the treatment involves the use of antibiotics. However, the majority of treatment is through surgery.

**Epidemiology**

Appendicitis is a highly common condition, and accounts for one of the main reasons for abdominal pain. One out of every 2,000 people have an appendectomy performed in their lifetime. 250,000 cases are reported in the United States annually, despite this number having been decreasing since the 1940s (Craig and Brenner, n.d.). The current annual rate is 10 cases per population of 100,000. Acute appendicitis tends to affect males more than females at about a 3:2 ratio. The most common age groups that are affected range from 5 to 40, while mean pediatric population age is 6 to 10.

Interestingly, cultures with a high intake of dietary fiber tend to have lower rates of acute appendicitis, such as countries in Asia and Africa. Dietary fiber decreases chances of solidification of feces within the bowels in addition to
increasing transit time. Thus, dietary fiber reduces the probability of a blockage in the lumen that may lead to the development of appendicitis. Historically, Western countries have poor fiber intake, which is thought to correlate with higher incidence of appendicitis. However in recent years, changes in fiber intake in these countries have decreased overall rates (Craig and Brenner, n.d.).

**Diagnosis**

Patients presenting with appendicitis most commonly report intense abdominal pain, nausea or vomiting, and fever. Growth and swelling of the appendix causes irritation to the abdominal wall, localizing the pain into the lower right quadrant. Less common symptoms include painful urination, diarrhea, loss of appetite, and severe cramps.

The diagnosis of appendicitis can be complicated due to the similar symptoms that are presented with other conditions such as Crohn’s Disease, gastritis, gall-bladder problems, and urinary tract infections. In order to accurately diagnose the problem as appendicitis, tests such as an ultrasound/CT scan are used. Additionally, abdominal and rectal exams are used to detect any inflammation. Urine tests are used to eliminate the possibility of a urinary tract infection (Marks and Stöppler, n.d.).

Early detection of appendicitis is necessary in order for the surgeon to prevent perforation of the appendix. In the case of acute appendicitis, the use of antibiotics is sufficient to eliminate the need for surgery. However, doctors are
cautious and are usually quick to remove the appendix through surgery to prevent any potential of a rupture.

**Treatment and Prognosis**

The incidence of acute appendicitis is considered a surgical emergency, due to the potential of perforation. Patients are given antibiotics 24 hours before the procedure in order to reduce the spread of infection during the operation and post-operative complications. Patients are given dietary restrictions the night leading up to surgery, to prevent any gastrointestinal blockage (Gordon, n.d.).

Appendectomies are performed either open or laparoscopically (Shushatovich, 2015). Once removed, the appendix is usually sent to a pathology lab for examination (Figure 2).
Figure 3. Removal of Inflamed Appendix.
Figure taken from Adam Images, n.d.

Recovery and post-operative complications can vary depending on many factors, but in general, patients recover very well from appendectomies. Recovery time usually depends on patient age, healthcare provider, and condition. Additionally, patient mortality is very rare, at a rate of less than 1% (Margenthaler, 2003).
Open versus Laparoscopic Appendectomy

Abdominal surgery has been utilized in the treatment of many pathologies associated with any organ located within the abdomen, such as the stomach, liver, pancreas and appendix (Florida Hospital, 2016). Traditionally, these surgeries are performed using an open technique, where the surgeon makes a large incision to provide direct access to the organs. The advantage with open surgery is that the surgeon is able to easily manipulate, view, and touch the organs that are located within the abdomen. However, the large incision requires a longer and more painful recovery. Therefore, a new technique, called laparoscopic surgery, has been utilized for many types of abdominal surgeries (Figure 3).

In recent years, laparoscopic surgery has been implemented for use in a wide variety of diagnoses. Laparoscopy is a technique that uses a tube in order to access the abdominal organs through the use of a small incision (or incisions). Surgeons use an instrument called a laparoscope that is placed through the tube and can act as a camera for viewing on an electronic screen. This technique can be used for diagnosing pelvic diseases and identifying adhesions, ovarian cysts, endometriosis, or even performing biopsies. It has become the preferred method for many surgeries, examples such as cholecystectomies and hysterectomies (Miles, 1992; Bijen 2011).

Advances in technology have made it possible to perform laparoscopic surgery on pediatric patients. One application is the treatment of appendicitis.
However, despite the theoretical advantages of this new technology, there are mixed results within the literature when comparing open to laparoscopic appendectomies (Figure 4). In one study, when compared to open procedures, laparoscopic appendectomies have been associated with fewer complications and shorter postoperative length of hospital stays, despite longer operating times (Tsai, 2012; Schmelzer, 2007, Werkgartner, 2015). Improvements in perioperative care can highly benefit the current body of research of anesthesia management. It is important to note that the opened approach is still the preferred method if the patient is diagnosed with a perforated or ruptured appendix.

Figure 4. Incision Types of Open vs Laparoscopic Appendectomy. Figure taken from Adam Images, n.d.
Mixed results within the current body of literature are apparent, with some papers citing comparable outcomes in patients of open and laparoscopic appendectomies. Specifically, post-operative complication rates of patients with perforated appendicitis who were treated with laparoscopic appendectomy were the same as those who were treated with open appendectomy (Vahdad, 2013). To complicate things even further, another study reports to have found similar operative times of laparoscopic and open appendectomy, while the laparoscopic technique was more costly than the open technique (Vernon, 2003). The inconsistencies found here may be attributed to varied surgical techniques, hospital practices, expertise, and experience. Moreover, patient population may have an effect on post-operative outcomes of laparoscopic appendectomy. One study attempted to elucidate any predictors of post-operative complications in patients with acute appendicitis. It was found that white blood cell (WBC) count, C-reactive protein (CRP) and appendix maximum short diameter on diagnostic imaging (AMSD) were all indicated in an increased risk of complications (Obayashi, 2015).

Overall, studies comparing the similarities and differences of laparoscopic and open appendectomies may be taken with a grain of salt, as the wide variation of surgical, anesthetic and hospital practice lead to mixed results, as seen in the current body of literature. Current studies tend to lean towards the use of laparoscopic surgery due to the comparable outcomes in length of hospital stay, operative time, and post-operative complications while reducing the need
for post-operative analgesics (Cipe, 2014). However, until a larger amount of consistency and standardization occur in order to minimize this variation, it may be difficult to elucidate the differences between the laparoscopic and open techniques.

**Operating Costs of Open versus Laparoscopic Appendectomy**

Optimization of hospital operating costs of appendectomies has been widely investigated. However, the superiority of laparoscopic appendectomy over open appendectomy is seldom agreed upon and is still being debated. As stated previously in this paper, Vernon et al. were able to find that laparoscopic appendectomies were costlier than open appendectomies. Interestingly, it was found that hospitals that preferred to perform laparoscopic appendectomies had higher complication rates as well (Tashiro, 2016).

However, there were no differences found in anesthetic costs between the two appendectomy techniques in another study (Demirel, 2014). Moreover, Mantoğlu et al compared outcomes and cost effectiveness between the two techniques and found that laparoscopic appendectomy leads to less pain and faster recovery times as well as being the more cost-effective option due to reusable and cheaper vascular sealing devices (Mantoğlu, 2015).
Three-Port/Multi-Port versus Single-Port Laparoscopy

It is important to note that the type of laparoscopy technique used (i.e. three-port/multi-port or single-port) may influence these differences in cost of appendectomies. Traditional three-port, also called multi-port, laparoscopic technique uses three incisions; one at the patient’s navel, and two suprapubic. The latter two incisions can vary between providers; some surgeons prefer incisions in the lumbar or iliac areas. Trocars are inserted at each incision, and while the umbilical trocar is usually used as the camera viewport, the suprapubic trocars are used as ports for manipulation. Instruments such as grasping forceps, scissors and needle holders are used through these suprapubic incisions. The advantage of this technique is that it allows triangulation, is easily teachable and provides a good visual operative field (Figure 5) (Domene, 2014).
**Figure 5.** Traditional Three-Port Laparoscopic Appendectomy. Laparoscope is inserted through umbilical trocar, while surgical tools are inserted through iliac and suprapubic trocars. Figure from Sedlack, 2012.

Figure 6 depicts the removal of the appendix after creation of the pneumoperitoneum and trocar insertions.
Figure 6. Laparoscopic Removal of the Appendix. (a)(b)(c) Viewing of forcep instrument and stapler through laparoscope inserted through the umbilicus. Figure taken from TransMed Networks, (n.d.)
Conversely, single-port laparoscopic appendectomy refers to a surgery through the usage of a single incision, made at the navel, in which the surgeon accesses exclusively. This type of laparoscopic surgery leaves only a single scar when compared to the three-port technique. However, this technique is much more difficult to learn, due to its lack of triangulation and effective positioning. Thus, the operative field is less easily visualized and manipulated, creating a higher risk for any intra-operative complications. Safety is an important factor to consider for an operation that is as common as an appendectomy.

What cannot be denied, however, are the cosmetic benefits associated with a single-port laparoscopic appendectomy when compared to a multi-port operation. Efforts to maximize these cosmetic results are evident in a study that attempted to examine the feasibility of an appendectomy through a single suprapubic incision, as opposed to a single transumbilical incision. It was found that the suprapubic patients reported more favorable scar assessments in a patient consciousness questionnaire. This questionnaire provides assessment of patient satisfaction on the overall post-operative result after a full recovery. However, these patients who reported higher satisfaction experienced longer operative times and more postoperative analgesic use (Zhang, 2016). Clearly, while this method may yield more favorable results from a patient perspective, it is limited in its efficacy from a hospital cost perspective.
Operating Costs of Laparoscopic Appendectomy

In an attempt to further examine the similarities and differences in laparoscopic methods, one study compared the diagnosis and hospital costs between a transumbilical single-port and three-port laparoscopic appendectomy. No differences in total operative cost and operative time were found (Baik, 2013). However, these results are inconsistent to those of another study, where transumbilical laparoscopic-assisted appendectomy was associated with lowered costs and comparable rates of readmission, and post-operative complications (Kulayat, 2014). These apparent inconsistencies in results leaves room for further refined studies on operating costs in the future.

Other methods of cost cutting and optimizing recourse utilization involve reducing the personnel in the operating room. One study examined the safety and efficacy of a solo laparoscopic practitioner through the use of a single-port (Figure 7) (Kim, 2016). It was found that there were no differences in operating time between solo and non-solo single-port laparoscopic appendectomy (SPLA). Moreover, numerous variables such as the incidence of post-operative complications and the necessity for intravenous analgesic use were found to be no different between the two groups. Overall operating costs were reduced due to the lowered personnel expenses.
Anesthetic Management

Previously, multimodal regimens have been shown to significantly reduce the incidence of substantial pain after laparoscopic appendectomy (Liu, 2013). Lower pain scores are associated with shorter lengths of stays, benefiting both the patient and the hospital. Moreover, same-day discharges have been feasible for pediatric patients with acute appendicitis (Oyetunji, 2015). In outpatient settings, the use of narcotics and nonnarcotics as oral analgesics after laparoscopic appendectomies showed no differences in medication days and

Figure 7. Difference Between Non-Solo and Solo SPLA. A. Non-solo-SPLA. B. Solo-SPLA. Figure taken from Kim, 2016.
time returning to normal activity (Alkhoury, 2014). Hospital standardization on the type of appendectomy technique, i.e. laparoscopic, was associated with reduced cost, despite limitations in generalizability due to a small sample size (Skarda, 2015). Still, these results show promise to the potential benefits of standardization in hospital protocol. However, the variability in medication, ethnicity and hospital regions of these studies leaves much more to be investigated. Perhaps a larger review study or meta-analysis may help elucidate some of the mixed results that are seen within the current literature.

**Pediatric Anesthesia**

While previous studies have analyzed management of laparoscopic appendectomies, there is very limited data available on the anesthetic management in pediatric patient population of this diagnosis. However, one study was able to determine that pediatric laparoscopic appendectomy was associated with significantly higher surgical costs and charges than open appendectomy without any improvement in outcomes (Michailidou, 2015).

Another study that analyzed pediatric laparoscopic single-port appendectomies found that this technique was the preferred and standard procedure due to its safety and cost-effectiveness (Sesia, 2013). The treatment approach and diagnosis of the pediatric population becomes different when compared to the adults, due to the obvious differences in anatomy, physiology and size. Therefore, a closer examination into the treatment of pediatric patients
is required in order to maximize efficiency of utilization costs and outcomes for this population.

**Current Study**

The wide variability in the preparation and administration of anesthesia in pediatric laparoscopic appendectomies potentially provides room for improvement. Currently, anesthesia providers individually decide combinations of medications, which may cause variability in the emergence from anesthesia, post-operative pain control, and the total recovery time.

Surgical-End-to-Transport (SET) time refers to the duration at the end of surgery to the time the patient exits the operating room. SET time was chosen as the specific and central metric throughout this study due to its consistency, reliability, accessibility throughout all patient cases. Metrics such as emergence time can lend itself to become nebulous, as it often lacks specific starting and end points and thus the definition may vary from provider to provider. Additionally, SET time, a component of emergence time, is a readily calculated period of time, based on two consistently reported electronic health record (EHR) fields (end of surgery time and patient out-of-OR time).

Reduction of SET time is advantageous for the patient, hospital, and third-party-payer, saving time and money that can be used elsewhere. This study aims to establish evidence based recommendations for safe, efficient and effective anesthetic management for pediatric patients undergoing laparoscopic
appendectomies by analyzing selected outcome indicators and metrics in relation to are connected to the length of patient SET times, length of PACU stay, and frequency of complications.
METHODS

After institutional review board approval, all laparoscopic appendectomies performed from 2012 through 2014 (n=790) were queried. Exclusion criteria include: Patients over the age of 21 and those given an ASA Physical Status Classification of 3 or 4 (American Society of Anesthesiologists, 2014). The latter exclusions were used in order to limit confounding variables in the study.

Initially, the median SET time was calculated. The median SET time was found to be 14 minutes, and two groups were established as follows: Group A (n=431), SET time between 0-14 minutes, and Group B (n=338), SET time greater than 14 minutes (Table 1). Bivariate and multivariate logistic regression models were used to compare readmissions by ASA status and reports of high pain with PACU duration, gender, age, and surgical duration using IBM SPSS Statistics (version 21.0, IBM, Armonk, NY).

<table>
<thead>
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<td><strong>Group A</strong></td>
</tr>
<tr>
<td>0 to 14 min</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
</tr>
<tr>
<td>Greater than 14 min</td>
</tr>
</tbody>
</table>

*Table 1. Groups A and B Split by Median SET Time.*
RESULTS

The median SET time was found to be 14 minutes. The distribution of SET time ranged from 0 minutes to 60 minutes (Figure 8).

**Figure 8.** Distribution of Surgical-End-To-Transport Times for Laparoscopic Appendectomies N=790. Average weighted mean is 14.714 minutes with standard deviation of 7.626.
Median surgical and PACU durations were found to be 58 minutes and 59 minutes, respectively.

Males experienced longer SET times than females (Group A Males 52.33% vs. Group B Males 60.30%, p=0.0276). Group B was also found to have a longer average PACU Durations (Table 2).

<table>
<thead>
<tr>
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<th>Males</th>
<th>Females</th>
<th>Average PACU Duration (minutes)</th>
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<tr>
<td><strong>Group A</strong></td>
<td>52.33%</td>
<td>47.67%</td>
<td>67.9</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td>60.30%</td>
<td>39.70%</td>
<td>72.3</td>
</tr>
<tr>
<td><strong>p</strong></td>
<td><strong>0.0276</strong></td>
<td><strong>0.0452</strong></td>
<td></td>
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**Table 2.** Group A and Group B SET Time Differences. The longer SET time observed in Group B (Greater than 14 min) relative to Group A (0 to 14 min), was found to have a significantly greater percentage of males as well as a longer average PACU duration.
The readmission incidence rate was 300 per 10,000 (n=23, 3%). The study population consisted of 56% males (n=430) and 44% females (335). Females had a higher incidence of readmission (n=13, 3.8%) than males (n=10, 2.3%) (Table 3).

<table>
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<tr>
<th></th>
<th>n</th>
<th>Readmissions</th>
<th>Rate</th>
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<tr>
<td>Males</td>
<td>430</td>
<td>10</td>
<td>2.3%</td>
</tr>
<tr>
<td>Females</td>
<td>335</td>
<td>13</td>
<td>3.8%</td>
</tr>
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Table 3. Readmissions Incidence Rate Among Male and Female Populations. Males had a larger group with fewer readmissions. Females had a smaller group with more readmissions.

Reasons for readmission include: post-operative abdominal or pelvic pain, nausea and vomiting, bowel obstruction, fever, chest pain, and umbilical hernia (Table 4).
Table 4. Reasons for Readmission. Highest frequency reported include abdominal or pelvic pain at n=18.

<table>
<thead>
<tr>
<th>Reason for Readmission</th>
<th>n</th>
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</thead>
<tbody>
<tr>
<td>Abdominal or Pelvic Pain</td>
<td>18</td>
</tr>
<tr>
<td>Nausea and Vomiting</td>
<td>2</td>
</tr>
<tr>
<td>Bowel Obstruction</td>
<td>1</td>
</tr>
<tr>
<td>Umbilical Hernia</td>
<td>1</td>
</tr>
<tr>
<td>Chest Pain</td>
<td>1</td>
</tr>
</tbody>
</table>

There was no difference in readmission incidence rates between ASA I (n=473) and ASA II (n=296) patients (ASA I readmits 3.2 % vs. ASA II readmits 2.7%, p=.711) (Table 5).

Table 5. Frequencies and Percentages of Patient Post-Operative Pain Scores.
Patients who reported high postoperative pain (n=80, 6.3%) experienced twice as many readmissions than patients who did not report high pain (n=689, 2.6%) p=0.071 (Table 6).

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Not Readmitted</th>
<th>Readmitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not report High Pain (i.e. Medium/Low Pain)</td>
<td>689</td>
<td>97.4%</td>
<td>2.6%</td>
</tr>
<tr>
<td>High Pain</td>
<td>80</td>
<td>93.8%</td>
<td>6.3%</td>
</tr>
</tbody>
</table>

**Table 6.** Readmissions Rates Comparisons. Patients who reported high pain and those who did not report high pain are shown. Reports of high pain more than doubles the chance of readmission (p=0.071). Most common reason for a high pain score is due to abdominal or pelvic pain.
The ethnicities of patients were collected as follows: 60.3% White, 6.8% Black or African American, 3.6% Asian, and 29.1% Other. No significant differences were found between ethnicities.

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>60.3%</td>
</tr>
<tr>
<td>Black or African American</td>
<td>6.8%</td>
</tr>
<tr>
<td>Asian</td>
<td>3.6%</td>
</tr>
<tr>
<td>Other</td>
<td>29.1%</td>
</tr>
</tbody>
</table>

*Table 7*. Population Ethnicities. Note the high percentage reported as Other.


DISCUSSION

This study showed that SET time ranged from 0 to 60 minutes. Important findings include that SET time was associated with differences between males and females, where the former group experienced longer SET times than the latter. SET time was also found to bear influence on PACU duration. Interestingly, patient cases with longer SET times experienced longer durations in the PACU. Additionally, readmission rates, while overall very low, were found to be higher in female than male patients. Readmission incidence increases at a rate of more than double if the patient reported high pain within the PACU. No significant differences were found when comparing SET time to readmissions.

SET Time

SET time is a useful metric for measuring operating room utilization and can be indicative of speed of recovery from anesthesia. PACU duration and pain score in the PACU were also used as indicators of post-operative recovery. The connection between SET time and PACU duration/pain score in the PACU was tested in order to assess whether decreasing time in the OR would adversely impact post-operative recovery. Evidently based on this study, the longer the SET time experienced by a patient, the longer their PACU duration was. Therefore, efforts to minimize SET time may lead to shorter PACU times as well, cutting the overall operating costs on multiple fronts.
Males experienced longer SET times than females, which bears the question of whether or not healthcare is delivered differently based on gender. One hypothesis is that perhaps males were given more analgesics than females, and thus remained anesthetized longer once the surgery was completed. Another hypothesis is that there may be a different perception to pain between males and females. However, this finding requires further investigation.

No associations between SET time and surgical duration were found, suggesting research is needed that analyzes, in a more detailed and specific fashion, if there are correlations that can be revealed (i.e. patient data, provider preferences, medications given, etc.). Additionally, SET time was not found to have an influence on pain scores or readmissions. Overall, decreasing patient SET times will reduce costly minutes in the hospital.

**Readmissions**

Overall, readmission incidence rate was very low (n=23, 3%). The differences in gender readmissions are particularly interesting, as females experienced more readmissions than males. While this value was not found to be statistically significant, this is likely limited due to the small frequency of readmissions. A larger sample size will likely generate more robust and significant results on the differences in gender readmissions.

Not surprisingly, reports of high pain in the PACU will more than double the likelihood of being readmitted. This p-value was approaching significance
Once again, this is likely due to the small frequency in overall readmissions and calls for a re-analysis using larger sample sizes. This result is significant clinically, however, because healthcare providers must realize the importance of pain scores and its influence on readmission.

The overwhelming majority of readmissions were due to abdominal and pelvic pain. Improvements in pain management in these areas may result in an overall decrease in readmissions. These results leave more to be desired and pave way for new avenues of research.

**Limitations**

This study was conducted as a retrospective chart review. Based on this study design, controlling for variables becomes more difficult to achieve. However, given this approach, variables such as ASA status and patient age were controlled in order to minimize confounding variables and create as clean of a data set as possible.

One central variable that was analyzed in this study, readmissions (n=23), had a very low frequency relative to the total sample size (N=769). While clinically advantageous and favorable, this poses some problems when attempting to analyze statistically. The low frequencies may generate large confidence intervals and low p values, which can potentially nullify the validity of the results that are reported, and ultimately lead to a loss of information.
Data Collection

As this study is retrospective in nature, most, if not all of the data was collected through the use of electronic health records. This presents issues in acquiring consistent, accurate and complete documentation. Before patient data was entered into an electronic system, records were made on paper. The act of transcribing these paper records into an electronic format requires tedious work and accurate interpretation of handwriting. This is the reason why within this study, laparoscopic appendectomies that date before 2012 were excluded; 2012 was the year when Boston Children’s Hospital required all patient data to be recorded in an electronic format.

Despite the transition from paper to computer, issues such as provider preference, experience or lack thereof with a computer, and inconsistent documentation lends to the incomplete data collection. This fact is particularly apparent when analyzing the ethnicity frequencies. The percentages are skewed due to the 29.1% Other that is reported. The category “Other” actually refers to a few subcategories such as “Did not report”, “Unable to collect”, or a truly “Other ethnicity”.

The inconsistencies of patient data documentation lead to issues during analysis. Statistical programs such as SPSS or SAS require specific inputs that may become difficult to use if data sets are very large. In general, the greater the inaccuracies, the more difficult it will be to statistically analyze.
When encountering errors in documentation, our research team frequently turned to manual chart review to determine the source. This method, while effective, is incredibly tedious and lengthy. These efforts can be put elsewhere had the documentation been consistent and accurate to begin with.

Sources of error were typically derived from where the data was obtained, and what the data output options were. For example, output options of Patient Airway Device status can include, “Endotracheal Tube”, “Laryngeal Mask Airway”, or “None”. However, data that is pulled as “None”, may actually mean one of two things: either the patient truly had no airway device during the operation, or the patient chart did not have the information filled out.

Thus, consistency in data reporting and documentation is paramount when performing statistical analyses on large sample sizes in order to generate accurate and meaningful results. Consistent methodology of documentation can be achieved if healthcare providers function cohesively and practice similarly.

**Future Directions**

Recently it has been found that genetics may be heavily involved with drug response. Termed pharmacogenetics, the genetic makeup of an individual may determine the metabolism of a drug that is delivered, and thus responses are heavily variable. For example, if a patient can metabolize a drug very rapidly, they may require higher and more frequent doses to maintain the same response as a patient that metabolizes the same drug slower. The latter patient will need
less amounts of the drug in order to avoid toxicity. Providers must be cautious with potent drugs with a narrow margin of safety. Additionally, many environmental factors can interact with the genetic makeup of an individual, and thus play a role in drug metabolism and response (Figure 9).

Figure 9. Environmental Interactions on Genetic Constitution. Figure taken from Goodman and Gilman’s The Pharmacological Basis of Therapeutics, 12ed.
This study was preliminary in nature and serves as a framework for future analyses. SET time is a metric that can be utilized across any institution with electronic health records and a target for cost optimization. This study focuses primarily on laparoscopic appendectomies, a diagnosis common among pediatric patients. However, many other procedures are very common among children, such as circumcisions, direct laryngoscopies and bronchoscopies, etc. Future analyses that include these procedures can help elucidate mediators of SET time in addition to the variables that SET time may bear influence on. The results that are found between SET time and pediatric laparoscopic appendectomy may differ from a different procedure. Hence, this study is a subset of a larger umbrella study that includes additional procedures within the pediatric population. Ultimately if patterns are found between procedures in relation to SET time, a larger-scale analysis may prove to be fruitful and productive.

Future research will include the analysis of anesthetic medicines and gases, their method of delivery and metabolic breakdown, and the influence on SET time, surgical duration, and PACU duration. Perhaps there is a “cocktail” of medications, that, when used perioperatively, may be associated with these lengths of times.
REFERENCES


CURRICULUM VITAE

ERIC ROBERT CHUNG

Born 1992  erchung@bu.edu  32 Paddock Lane
Bedford, NY10506

EDUCATION

Boston University School of Medicine, MA
September 2014 – May 2016
• Master of Science
• Major: Medical Sciences, 2016

University of Rochester, NY
September 2010 – May 2014
• Bachelor’s of Science, 2014
• Major: Neuroscience

Roslyn High School, Roslyn, NY
September 2006 – June 2010

RESEARCH EXPERIENCE

Research Assistant, Clinical Andrology, Weill Cornell Center for Reproductive Medicine
June 2014 – August 2014
Mentor: Gianpiero Palermo, M.D. Ph.D.
• Performed Semen Analyses, Intrauterine Inseminations (IUI), and assisted in Intracytoplasmic Sperm Injection (ICSI)
• Processed Extensive Sperm Search in low spermatozoa count samples as well as Testicular Biopsies
• Observed common laboratory assays such as Fluorescent In-Situ Hybridization (FISH) as well as Terminal deoxynucleotidyl transferase dUTP nick end labeling (TUNEL) to measure DNA Fragmentation Index (DFI)
• Maintained stem cell cultures by preventing differentiation using Mouse Embryonic Fibroblasts in a controlled environment
• Gained experience in handling laboratory materials, such as embryo dishes and ICSI Micromanipulators
• Assisted in data management

Research Assistant, Chapman Laboratory, University of Rochester, NY
May 2013 – May 2014
Mentor: Robert Chapman, Ph.D.
- Guided elderly and subjects with Mild Cognitive Impairment (MCI) through experimental paradigms while gathering electroencephalogram brain recordings
- Assisted in data management, statistical analyses, literature research, publication preparation, computer maintenance, and overall laboratory upkeep
- The laboratory goal is to study Event-Related Potentials (ERPs) in visual information processing in order to better understand how the brain is affected by Alzheimer’s Disease and associated memory disorders
- Performed neuropsychological evaluations to measure psychological function and diagnosis of deficits

**Research Assistant, PGD (Pre-implantation Genetic Diagnosis) Laboratory, Weill Cornell Center for Reproductive Medicine**

Mentor: Kangpu Xu, Ph.D.

- Assisted in embryo biopsy for PGD in one of the largest and most successful in vitro fertilization (IVF) programs in the nation
- Assisted in analyzing the cell or blastomere for aneuploidy through FISH and CGH
- Performed PCR for the detection of single gene defects

**PUBLICATIONS**

1. Pereira N, Chung ER, Irani M, Chung PH, Zarnegar R, Rosenwaks Z. Incarcerated omental hernia at a 5-mm trocar site after laparoscopy: case report and review of the literature. *Journal of Reproductive Medicine* (Accepted for publication)


**ABSTRACTS**


TEACHING EXPERIENCE

Teaching Assistant, Laboratory in Neurobiology, Department of Neuroscience, University of Rochester, NY January 2014 – May 2014
Course Directors: Dr. Kathy Nordeen, Dr. David Kornack
• Selected to supervise undergraduate laboratory sections
• Ran workshops, experience with laboratory preparations
• Led behavioral tests on rats in a controlled setting

Teaching Assistant, Organic Chemistry Laboratory, Department of Chemistry, University of Rochester, NY September 2012 – 2013
Course Directors: Dr. Bruce Toder, Dr. Benjamin Hafensteiner
• Selected to run individual laboratory sections for undergraduates
• Graded reports, prepared, oversaw experiments, conducted office hours

WORK EXPERIENCE

Medical Assistant, Plastic Surgery July – August 2012
Mentor: Danny Fong, M.D.
• Assisted in patient intake, taking history, physical examination, pre-operative and post-operative assessment
• Assisted in various in-office procedures related to plastic and hand surgery

Dental Assistant, Floral Park Dental Clinic, New York July – August 2010
Mentor: Michael Lang, D.D.S.
• Assisted in various dental procedures/surgeries whilst interacting with patients
• Managed main desk and handled clerical work