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Intravenous Acetaminophen use in Postoperative Pain Management

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INTRAVENOUS ACETAMINOPHEN

USE IN POSTOPERATIVE PAIN MANAGEMENT

by

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Abstract

Surgery is a most common source of acute pain and effective postoperative pain management is crucial for wound healing and recovery. Opiods are the mainstay for acute pain management but have various adverse effects including death. The multimodal approach involves the use of multiple drugs with varying mechanism of action to achieve optimal pain relief with less adverse effects. Intravenous acetaminophen (IVAPAP) is a new addition to the multimodal approach that appears to afford effective pain relief with a low risk profile. The purpose of this research study was to examine the impact of IVAPAP use in multimodal pain management on decreased opioid consumption and decreased average length of hospital stay in the post colectomy population. A comparative two group retrospective chart review was conducted, with a total of 72 charts meeting the inclusion criteria. Group 1(n=36) study subjects who received IVAPAP for pain management were compared to Group 2(n=36) subjects who had not received IVAPAP after colectomy. Results demonstrated that Group 1, those who had received IVAPAP, used less opioids during the postoperative period as compared to those in Group 2 who had not received IVAPAP; there was no difference in length of stay between the groups. Further research related to the use of multimodal pain management strategies in general, and related to IVAPAP in particular, is indicated. Recommendations and implications for advanced practice nursing are presented and discussed.

Keywords: pain, postoperative pain, postoperative pain management, acetaminophen injection, abdominal surgery and IV acetaminophen, colectomy and postoperative pain.

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To conclude, I dedicate this research paper to my late father, Kuppuswamy - a strong and gentle soul, whose life was a testament to me, of that I could achieve whatever goals I sought to pursue, no matter what the challenges, if I believed in myself.

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Background and Statement of the Problem

Surgery is a most common and predictable source of pain in the hospital setting and postoperative pain is an expected outcome for people who undergo surgery. It has been estimated that more than 50 million inpatient surgeries are performed in the United States (US) annually (Centers for Disease Control [CDC], 2010). Fear of uncontrolled pain is one of the primary concerns of many patients who are undergoing surgery, and effective pain relief in the postoperative setting is a priority for patients and providers (Hutchison, 2007). Persistent acute pain unnecessarily taxes the body's physiologic reserves and contributes to pulmonary complications, impaired rehabilitation and functional outcomes, development of chronic pain, and long term disability (Hartrick, 2004). Unrelieved pain after surgery is highly prevalent and greatly impacts morbidity and mortality and can lead to an increase in readmission rates and length of stay, which contribute to higher healthcare costs (Hutchison). Effective pain control after surgery is important to prevent negative outcomes such as tachycardia, hypertension, myocardial ischemia, decrease in alveolar ventilation, immobility, deep vein thrombosis, and poor wound healing (Vadivelu, Mitra & Narayan, 2010).

In recent years, there has been an increased awareness of the importance of pain management in our society. It has been over a decade since the U.S. Congress declared the Decade of Pain Control and Research and pain was identified and encouraged as the "fifth vital sign" to be used by the healthcare providers. In 2001, The Joint Commission (TJC) introduced standards that require healthcare organizations to make pain

management a primary organizational priority and mandated pain assessment and treatment as part of patient routine care (TJC, 2001). Despite these efforts, effective pain management is still a major healthcare issue.

Treatment of acute postoperative pain remains suboptimal and approximately 50% of patients experience moderate to severe pain during the postoperative period (Polomano, Rathmell, Krenzischek, & Dunwoody, 2008). Despite considerable advancements in the field of pain management, research indicates that a large proportion of patients still experience extreme levels of pain after surgical intervention. This has been highlighted consistently in the literature for almost forty years, illustrating the significance of the problem. Multimodal or balanced analgesia was developed a decade ago to improve postoperative pain management and reduce opioid-related side effects; evidence suggests that multimodal analgesia is becoming a 'standard of care' for postoperative pain management (Elvir-Lazo & White, 2010).

The multimodal approach combines various analgesic techniques and different classes of drugs with varying mechanism of action to achieve additive or synergistic effects to provide superior pain relief (Pyati & Gan, 2007). This approach to postoperative pain management is associated with lower incidences of opioid related adverse effects, improved analgesia, shorter hospitalization times, and improved recovery and function (Buvanendran & Kroin, 2009). Opioids are very effective analgesics and a primary component of multimodal pain management approach in the postsurgical setting. However, they are associated with many undesirable side effects including nausea,

vomiting, sedation, constipation, physical dependence, tolerance, urinary retention, and respiratory depression (White, 2007).

The American Society of Anesthesiologists (2004) practice guidelines for acute pain management in the perioperative setting recommended that unless contraindicated, all patients should receive an around-the-clock regimen of a non-opioid agent such as a nonsteroidal anti-inflammatory drug (NSAIDs) or acetaminophen. Thus, postoperative pain management regimens often include the non-opioid agents as adjuvant to opioid agents since non-opioids alone are not sufficient to treat moderate to severe pain (Smith, 2011). In the US, there are a number of non-opioid oral analgesics that are approved and frequently used for acute pain treatment, either alone or in combination with opioids. Non-opioid analgesics include acetaminophen, aspirin, selective cyclo-oxygenase-2 inhibitors (COXIBs) and NSAIDs. When oral administration is not feasible, k*etorolac and ibuprofen* are the only two approved intravenous (IV) non-opioid agents that are available in the US for multimodal pain management. Both are NSAIDs and use is very limited in the perioperative settings due to their adverse effect profile (Smith).

Acetaminophen (APAP), known as paracetamol outside the US, has been available as an analgesic and antipyretic agent in the US since the 1950's. It has an established record of safety, efficacy, and tolerance in adults and children. In the US, APAP is the most widely used analgesic and antipyretic agent and it is a first-line drug of choice for pain in the World Health Organization (WHO) step ladder approach to pain management (Duggan & Scott, 2009). The IV formulation of APAP (IVAPAP) was introduced and has been used outside the US since 2002. Use in the US was approved by

the FDA in 2010 under a brand name of *Ofirmev* for mild to moderate pain and for use in severe pain in combination with opioid analgesics. Its safety and tolerability profile is a greater advantage over other analgesic agents used for the treatment of postoperative pain. In contrast to opioids, acetaminophen does not produce sedation, respiratory depression, ileus, and constipation, and is also not associated with dependence or misuse (Cadence Pharmaceuticals, 2011).

Abdominal surgery tends to be the most painful among all surgery types, and 70% of patients who undergo upper abdominal surgery suffer from severe pain (Chen et al., 2009). Postoperative ileus is a persistent, gastrointestinal immobility that frequently occur three days post colorectal surgery (Chen et al.). Ileus results in nausea, vomiting, abdominal discomfort, delayed oral intake and increased length of hospitalization, which contributes to increased healthcare cost. Delayed bowel function is one of the most important and distressing side effects associated with opioid analgesic use in colorectal surgical patients (Chen, et al.). Recently, the study institution (The Miriam Hospital) added IVAPAP as additional non-opioid analgesic around the clock (1 gram q 6 hrs. for 48 hrs.) along with an opioid regimen initiated in the inpatient surgical unit for post operative pain management in the colectomy population. Nurses play a major role in the management of patients' pain following surgery as they are the healthcare professionals who provide 24-hour care at the bedside. Today, more than ever, RNs and APNs are challenged to provide high-quality and cost effective patient care. Nurses at the study institution had perceived a decrease in opioid consumption and average length of hospital stay among this surgical population since the use of IVAPAP for pain management. A

gap exists in research related to the relationship between effective postoperative pain management with IVAPAP and length of hospital stay.

Studying the effect of intravenous acetaminophen use in postoperative pain management of the post colectomy population is clinically relevant. The purpose of this research study was to examine the impact of IVAPAP use in multimodal pain management on decreased opioid consumption and decreased average length of hospital stay in post colectomy population.

Review and Critique of the Literature

An extensive literature review was conducted using the following databases: CINAHL; Ovid; Pub Med; Medline Plus, and Cochrane Library. The search was limited to articles published in the English language and from 1990 through the current year.

Pain

Melzack and Wall (2008) referred to pain as a puzzle and an exceptionally complex process for which one definition is not entirely satisfactory. The study of pain has evolved significantly in recent years and several distinguished contributions have been made toward an improved understanding of the nature of pain. Traditionally, pain was viewed solely in terms of the sensory component, whereby it was believed that pain was comprised only of a solitary sensory component that fluctuated only in intensity (Melzack & Wall). This hypothesis has been hugely modified and now we acknowledge and recognize that pain is a physiological manifestation that is significantly influenced by psychological components. The International Association for the Study of Pain defined pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage" (IASP, 2011). The existence and intensity of pain are measured by the patient's self-report. A clinical definition of pain states "Pain is whatever the experiencing person says it is, existing whenever he/she says it does" (McCaffery, 1968). Pain has been classified as nociceptive, inflammatory, and pathological based on its neurobiological perspective (Woolf, 2010).

Pain affects more Americans than diabetes, heart disease, and cancer combined and it is the most common reason Americans access healthcare (National Institutes of Health [NIH], 2010). According to the National Centers for Health Statistics (2006), approximately 76.2 million, one in every four Americans, have suffered from pain that lasts longer than 24 hours and millions more suffer from acute pain. It is a leading cause of disability and a major contributor to health care costs. Pain is a predictable experience after surgery due to tissue and nerve injury caused by the surgical procedure. Effective management of postoperative pain is a priority for patients and providers after surgery; the goal is to relive pain while keeping side effects to a minimum (Hutchison, 2007).

The Institute of Medicine (IOM, 2011) published a report on advancing pain research, care, and education, which was subsequently mandated by the Patient Protection and Affordable Care Act. The report stated that at least 116 million US adults are burdened by chronic pain alone and the national economic cost associated with this is estimated to be 560 to 635 million US dollars. It was noted that addressing pain will require a cultural transformation in the way pain is understood, assessed, and treated. In addition, it was emphasized that healthcare providers, patients, and our society should overcome the misconceptions and biases about pain. It was also recommended that health care providers should keep their knowledge current by engaging in continuing education programs. This report urged healthcare providers, insurers, and the public to understand that pain is more than a physical symptom and is not always resolved by curing the underlying condition. Persistent pain can cause changes in the nervous system and become a distinct chronic disease (IOM).

Prevalence of Postoperative Pain

Costantini, Viterbori, and Flego (2002) conducted a study aimed at determining the prevalence of pain among 4,709 eligible patients in 30 hospitals in Italy. Overall, 87% (4121 /4709) of in-patients were interviewed. At the time of the interview, 51.2% (*n* = 2412) of the eligible patients were on medical wards, 46.4% (*n* = 2183) were on surgical wards, and 2.4% (*n* = 114) were on rehabilitation units. Over 56% of patients (n = 2333) had experienced pain in the previous 24 hours and almost 30% (n = 1178) had experienced pain of severe intensity. Approximately 43% (n = 1750) of participants experienced pain during the interview and almost 12% of the pain experienced was severe in nature. The authors concluded that the pain prevalence was unacceptably high in most cases and age, sex, education, diagnosis, and days from surgery were significantly related to pain prevalence.

Apfelbaum, Chen, Mehta & Gan (2003) conducted a national survey to assess patients' postoperative pain experience and the status of acute pain management. The authors administered a questionnaire of patients' post operative pain experiences retrospectively. A total of 250 questionnaires were returned out of 666 requests for participation. Responders had undergone in-patient or out-patient surgery. More than half of these patients were concerned about postoperative pain (59%; n = 147), more than about success of surgery (51%; n =127). Approximately 80% (n =200) of patients experienced acute pain after surgery and about 75% (n =187) reported pain after discharge. Almost 82% (n =205) received pain medication and 27% (n = 68) experienced adverse effects, the most common of which were drowsiness, nausea, and constipation.

The authors concluded that there is a need for further changes in practice patterns, continued research, and development of newer analgesics with potent efficacy and minimal adverse effects. Use of balanced analgesia should enhance the potential to treat postoperative pain more successfully.

Sommer et al. (2008) conducted a study aimed to measure the prevalence of postoperative pain in in-patient surgical patients. A total of 1975 subjects were eligible, of whom 1663 (85%) agreed to participate. Of these participants, only 1490 patients met the inclusive criteria. There were no significant differences in age and gender distributions between the non-responders and the participants. After admission to the surgical ward, a trained research assistant explained the purpose and methods of the study to each eligible patient. Pain measurement scores on a visual analogue scale were obtained on the day before surgery and on days 0-4 postoperatively. Results revealed that despite the presence of an acute pain protocol, 41% (n =610) of patients had moderate-to-severe pain on the day of surgery, with almost 15% (n =223) experiencing moderate-to-severe pain on the fourth postoperative day. The authors concluded that the postoperative pain management was unsatisfactory in in-patient surgical patients, especially after intermediate and major surgical procedures on an extremity or on the spine.

Nasir, Howard, Joshi & Hill (2011) conducted a survey to describe the structure and function of the acute pain services (APS) in US hospitals. Acute pain services are aimed at alleviating postoperative pain by utilizing evidenced based approaches to pain management and providing a wider choice of analgesic techniques. A total of 108 questionnaires were returned out of 301 requests for participation (35.9%). Of these

responses, 55 hospitals were university based teaching hospitals, 40 were non-teaching hospitals, and 13 were VA hospitals. The questionnaire was completed by the person who was in charge of postoperative pain management. The size of the hospitals varied: 21 hospitals had fewer than 200 beds; 49 had 200-500 beds; 34 had 501-1000 beds; and four had more than 1000 beds. Results showed that 81 hospitals had an organized APS (75%) and 27 did not (25%). The likelihood of having an APS directly correlated with the hospital size, with the larger hospital having a better score on organized APS. Responding academic hospitals reported a higher rate of an organized APS (96%) when compared to private hospitals (47%), and VA hospitals (69%). These authors concluded that the structure and function of APS vary significantly among U.S hospitals. It further demonstrated that an organized APS with a written protocol adherence is more common in teaching hospitals than in either private or VA hospitals. This study emphasized pain intensity scores alone should not be used to evaluate improvement in pain management, and that the functional ability of patients and adverse effects of analgesic should be considered.

Despite the wealth of research and knowledge about postoperative pain management that has been conducted for more than four decades, it is apparent that postoperative pain remains an unresolved or under treated major healthcare issue.

Consequences of Unrelieved Postoperative Pain

Extended periods of unrelieved acute pain can result in physiologic changes that include pituitary-adrenal activation. This results in diminished immune response that interferes in wound healing and sympathetic activation, which in turn may result in

cardiovascular, gastrointestinal, and renal changes. In addition, unrelieved postoperative pain causes the avoidance of movement and ambulation in post surgical patients (Hutchison, 2007). Ability to move and ambulation are the key elements in early surgical recovery and this inability may contribute to longer hospital stays and readmissions after discharge.

Unrelieved acute pain affects the person's quality of life after surgery. Strassels, McNicol, Wagner, et al. (2004) conducted a study to assess patients who had undergone radical prostatectomy (RP), total hip replacement (THR), or total knee replacement (TKR) for pain, health-related quality of life, and physical social function at four weeks post hospital discharge. Participants completed the SF-36 and questions from the Treatment Outcomes of Pain Survey (TOPS) four weeks after leaving the hospital. Total number of participants were 30 (RP = 15, TKR = 8, THR = 7). Postoperative pain interfered with patients' ability to participate in desired activities (42.9% RP, 28.6% THR, 100% TKR), ability to sleep (21.4% RP, 71.4% THR, 75% TKR), and sexual functioning (50% RP, 28.6% THR, 25% TKR). During the first month after surgery, postoperative pain contributed to diminished health-related QOL and interfered with activities important to patients. Patients in each surgical group demonstrated worse mean pain scores compared with US norms: the complaints were bodily pain, impaired physical functioning, and social functioning. Acute pain also substantially impaired patients' sleep, sexual function, and ability to perform physical activities during the postoperative period.

Unrelieved and poorly controlled postoperative pain can negatively affect the perioperative outcome and risk for developing chronic pain (Yarnitsky, Crispel, Eisenberg et al., 2008). A greater proportion of patients who experienced acute postoperative pain developed chronic pain after surgery. Acute pain in the postoperative setting is a risk factor for developing chronic pain. Chronic post surgical pain is defined as patients' pain persisting for at least three months after a surgical intervention and with additional presence of a particular neuropathic pain. This pain has been also called persistent postsurgical pain (PPP) and it is estimated that about 50% of patients developing PPP after surgery (Cregg, Anwar, & Farquhar-Smith, 2013). Pain that persists well after surgical lesions have healed is prevalent and may occur after almost any surgery. While this was accepted as a negligible and normal phenomenon after surgery, it has now become recognized as an important clinical and perhaps social problem (Yarnitsky et al.). The one of many risk factors for developing PPP is the unrelieved postsurgical pain (Cregg et al.). Based on the described studies, it is evident that unrelieved postoperative pain greatly affects the post-surgical patients' physical and physiological functions. Effective postoperative pain management is important and necessary for improving quality of life and minimizing patient morbidity.

Intravenous Acetaminophen: Role in Postoperative Pain Management

Healthcare providers can facilitate better pain control after surgery by implementing and applying evidence-based analgesic practices. The ultimate goal of postoperative pain management is choosing an effective, safe drug regimen with minimal adverse effects and maximum pain relief for effective patient outcomes (Smith, 2011).

Multimodal analgesic approach was introduced and has become the practice for postoperative pain management. It involves the use of multiple agents that act at different regions of the pain pathway and opioids are the primary component in this regimen. The rational for this approach is that it reduces the use of opioids and their side effects (Elvir-Lazo & White, 2010). IVAPAP was first introduced in the U.S in 2010 under a brand name of *Ofirmev,* although it was widely available in Europe for more than a decade. Its' safety profile is supported by more than seven years of clinical post marketing safety experience outside the US and more than 60 years of clinical experience with oral and rectal acetaminophen (Wininger et al., 2010). The advantage of using IVAPAP in multimodal approach is that it is safe to use in conjunction with other drugs and has few clinically significant drug interactions.

The recommended dosage in adults and adolescents weighing more than 50 kilograms is one gram every six hours or 650 milligrams every four and a maximum daily dose of four grams. It is administered as a 15 minute infusion and may be given as single or repeated dose (Cadence Pharmaceuticals, 2011). The mechanism of acetaminophen-mediated pain relief is not well understood but research studies has been shown that it acts at both peripheral and central pain pathways (Smith, 2011). Intravenous APAP should be used with caution in patients with hepatic impairment or active hepatic disease, alcoholism, chronic malnutrition, severe hypovolemia or severe renal impairment and should not be used in patients with acetaminophen allergy (Cadence Pharmaceuticals, 2011).

Sinatra et al.(2005) conducted a randomized, double-blind, placebo-controlled multi dose study in seven US centers to evaluate the analgesic efficacy and safety of IVAPAP compared with its prodrug (Propacetamol) and placebo. One hundred one subjects were randomized to receive either placebo or IVAPAP one gram for pain management after major orthopedic surgery. An additional 50 patients were treated with Propacetamol; that data is not included here since the drug is not approved to use in the US. Patients were started on the trial medication on postoperative day one to allow for anesthesia washout and ensure a stable baseline. Patients were allowed to use morphine via patient-controlled analgesia (PCA) in addition to as needed (PRN) bolus doses of morphine as a rescue medication. End points measured were pain relief, pain intensity, patient satisfaction, quantity of morphine consumed, and time to first use of rescue medication.

Pain relief induced by IVAPAP one gram was significantly greater (79.6%) than with placebo (65.4%) and patients' pain intensity score and median time to rescue medication were also better. Morphine consumption in IVAPAP group was 46% lower after the first dose and 33% lower over 24 hours as compared to placebo. There were no differences between the groups in experience of adverse effects and no serious hepatic events were reported in the IVAPAP group. Ninety seven patients (64.2%) experienced at least one adverse effect after the first administration of the study medication: 32 in the IVAPAP group, 32 in the placebo group, and 33 in the propacetamol group. The most common adverse reactions reported with >5% incidence and higher than placebo were nausea, vomiting, enlarged abdomen, coughing, and pruritus. Based on the study results,

the authors concluded that IVAPAP 1gram administered over a 24 hour period in patients with moderate to severe pain after major orthopedic surgery provided rapid and effective analgesia and was well tolerated.

Macario and Royal (2010) performed a literature review of randomized clinical trials of IVAPAP for acute postoperative pain management to assess the analgesic outcomes of IVAPAP. This review included 16 articles from nine countries published between 2005 and 2010 and had a total of 1,464 patients. Twenty two study comparisons were analyzed: in eight studies IVAPAP was compared with active comparator (Parecoxib or Oral ibuprofen) and in 14 studies IVAPAP was compared with placebo. Of these participants, 780 patients received IVAPAP (n=1464). Seven out of eight comparator studies showed IVAPAP had similar analgesic outcomes as the comparator. The authors concluded that IVAPAP is an effective analgesic across a variety of surgical procedures. The limitations of the studies reviewed by the authors were the small sample size (in only five of 16 studies the IVAPAP group size exceeded 40 patients); small sample size studies are unlikely to identify clinically relevant side effects. Additionally, because the best analgesic approach needs to be individualized to the specific surgical procedure, results from a specific study may not be applicable to other surgery types or when other analgesic interventions are added to a multimodal approach (Macario & Royal).

Intravenous Acetaminophen: Role in Abdominal Surgeries

Wininger et al. (2010) conducted a randomized, double-blind, placebo-controlled, parallel-group study to evaluate the analgesic efficacy and safety of repeated doses of two

regimens of intravenous acetaminophen compared with placebo over 24 hours in subjects with moderate to severe pain after abdominal laparoscopic surgery. The study was conducted at 17 sites in the U.S. and 244 adult (aged 18-80 years) subjects were enrolled and randomized into four groups: IVAPAP 1000 mg (100ml) every six hrs; IVAPAP 650 mg (65ml) every four hrs; IV placebo 65 ml every four hrs; IV placebo 100ml every six hrs.). Intravenous or oral opioid rescue was available to all subjects. The end points were pain intensity differences between groups. Additional end points included overall patient satisfaction, time to first rescue medication use, and total consumption of rescue medication over 24 hours. Pain relief and pain intensity scores significantly higher (86.9%) in IVAPAP group compared with placebo (70.3%). Patient overall satisfaction was significantly higher (74%) in patients received IV acetaminophen. There was no significant difference in rescue medication consumption between groups. Intravenous APAP 1000 and 650 mg groups had median times to first rescue that were not significantly longer than combined placebo group (10.4 and 16.4 respectively vs. 9.3 hours). The most common adverse effects reported of any group were constipation, flatulence, nausea, and headache. This study concluded that both IVAPAP regimens (1 gram every six hours and 650 milligrams every four hours) were associated with significant pain relief compared with placebo and were well tolerated in abdominal laparoscopic surgical patients (Wininger et al., 2010).

Memis et al. (2010) conducted a study in patients undergoing major abdominal or pelvic surgery. The authors aimed to assess the analgesic efficacy, adverse effects, and time to extubation of IVAPAP after major surgery in an intensive care unit. They

randomized 40 ICU subjects into two groups: Group M, those receiving 100 ml of serum saline intravenous (IV) every 6 hours and IV meperidine (n = 20); or Group MP, who received IVAPAP 1 g every 6 hours and IV meperidine (n = 20, group MP). Both groups received the pain medications into a peripheral vein for 24 hours. Behavioral Pain Scale and VAS scores were significantly lower in group MP at 24 hours ($P < .05$). In group MP, postoperative meperidine consumption (76.75 ± 18.2 mg vs. 198 ± 66.4 mg) and extubation time (64.3 ± 40.6 min vs. 204.5 ± 112.7 min) were lower than in group M ($P < .01$). In addition, postoperative nausea-vomiting and sedation scores were significantly lower in group MP when compared with group M ($P < .05$). This data suggests that intravenous paracetamol is a useful component of the multimodal analgesia model, especially after major surgery.

In summary, postoperative pain management continues to be a healthcare issue. Numerous studies and surveys have demonstrated that many patients experience moderate to severe pain postoperatively. Multimodal analgesia is increasingly utilized in the perioperative settings and has become a standard of care. Intravenous APAP is a new addition to the multimodal regimen. Studies have demonstrated the improved efficacy and tolerability of IVAPAP in post surgical patients.

The purpose of this research study was to examine the impact of IVAPAP use in multimodal pain management on decreased opioid consumption and decreased average length of hospital stay in the post colectomy population.

Theoretical Framework

Symptoms are of vital importance to healthcare professionals and are the central focus of the Theory of Unpleasant Symptoms (TUS) (1997) model. This theory was proposed as a means for integrating existing information about a variety of symptoms. The assumption behind this theory is that there are sufficient commonalities among symptoms to warrant a theory that is not limited to one symptom, but can explain and guide research and symptoms (Lenz, Pugh, Milligan, Gift, & Suppe, 1997). The Theory of Unpleasant Symptoms (TUS) proposes that the factors associated with a symptom may influence a number of different concurrent symptoms. Therefore, the use of therapeutic interventions aimed at lessening the severity of one symptom may be effective in alleviating other related symptoms.

The TUS includes three reciprocal components including the symptoms that the individual is experiencing, the influencing factors giving rise to or affect the nature of the symptom experience, and the consequences of the symptom experience (Lenz et al., 1997). Symptoms are described in dimensions of intensity, timing, level of perceived distress, and quality. These dimensions are influenced by three factors, including that of physiologic, psychological, and situational. The final component of the TUS is performance, the "outcome" or "effect" of the symptom experience. Performance is conceptualized to include functional and cognitive activities (Lenz et al.).

The variables described in the TUS provide insight into the pain characteristics of post surgical patients. Multiple symptoms can occur together as a result of a single event or one symptom can precede another. For example, surgery is a single event that can

cause pain, fatigue, and nausea. The occurrence of two or more symptoms at the same time are likely to increase the intensity of each; for example, in post surgical patients, pain seems worst when the patient is experiencing nausea or fatigue. Unpleasant symptoms are subjectively experienced indicators that affect performance (Liehr, 2005). Postoperative pain can in turn affect performance, such as mobility and effective breathing. The performance outcome, recovery, is likewise influenced by the symptoms experiences of pain, nausea and fatigue. This study will focus on the opioid consumption for effective pain symptom management and the performance outcome of LOS.

Using symptoms as a framework when caring for post-surgical patients can have a significant positive impact on post operative pain management.

Methods

Purpose

The aim of this research study was to examine the impact of intravenous acetaminophen use in multimodal pain management on decreased opioid consumption and decreased average length of hospital stay in the post colectomy population.

Research Design

This study employed a retrospective two group comparative chart review of adult patients who underwent colon resection. Group one (intervention) included subjects who received intravenous acetaminophen with opioid during the postoperative period. Group two (comparison) included subjects who did not receive intravenous acetaminophen. The independent variable was intravenous acetaminophen and dependent variables were the amount of opioid consumption and average length of stay. Key extraneous variables included age, BMI, laparoscopic vs. open surgical procedures, and gender.

Sample and Setting

The study sample was derived from a sample of 250 male and female patients 18 years and older who received postoperative pain management for colon resection (colectomy), including both laparoscopic and open colectomy surgical procedures, that had occurred between March 2012 to October 2013. Exclusion criteria included patients who had undergone multiple surgeries, who had long term opioid use for chronic pain, a history of substance or opioid abuse, or history of dementia. The medical records office at The Miriam Hospital in Providence, RI was the site of the data collection. The Miriam

Hospital is a 247- bed academic acute care hospital, part of the Lifespan system and also a Brown teaching facility.

Procedures

Permission to conduct this study was obtained from the Lifespan and Rhode Island College Institutional Review Boards. Permission was also obtained from the hospital's chief nursing officer. After approval, data were collected from February 2014 to April 2014 until the target sample size was met, which was a minimum of 36 complete records in each group. Colectomy procedures were identified by ICD 9 code and medical records were retrieved by the medical records management staff and placed on a shelf for the researcher to review. Paper records were examined for inclusion and exclusion criteria, and records meeting the inclusion criteria were reviewed further to extract the identified data.

Measurement

A researcher designed a data collection tool (Appendix A) was used, which included age, gender, body mass index, morphine or Dilaudid consumption, intravenous acetaminophen, morphine equivalent, and length of stay. The patients' medical record number was used to retrieve data but not recorded on the data collection tool. A total amount of intravenous narcotics used during inpatient surgical unit stay was obtained from the patients medication administration records (MAR) and Patient Controlled Analgesia (PCA) flow sheets. Amount of dilaudid used was converted to morphine equivalence by used the equianalgesic calculator provided within the American Pain Society guidelines (Anderson, Saiers, Abram et al., 2001). Based on this calculator, one

mg IV dilaudid is equivalent to three mg of IV morphine which includes a 25% cross tolerance reduction. Length of stay was calculated by subtracting day of admission from day of discharge as per hospital practice.

Upon completion of the research study, data will be stored for three years on an encrypted drive in a locked file on hospital premises to which only the PI has access and then will be destroyed.

Data analysis

Descriptive statistics were used to examine the study variables. The total amount of narcotics used was calculated, and morphine equivalence and LOS by group were compared using the T test.

Results

A total of 149 records were reviewed. Seventy seven records were excluded based on the exclusion criteria and secondary to incomplete information .Seventy two records that met the inclusion criteria were reviewed, with 36 from each group. The demographic profile of study subjects is illustrated in Figure 1.

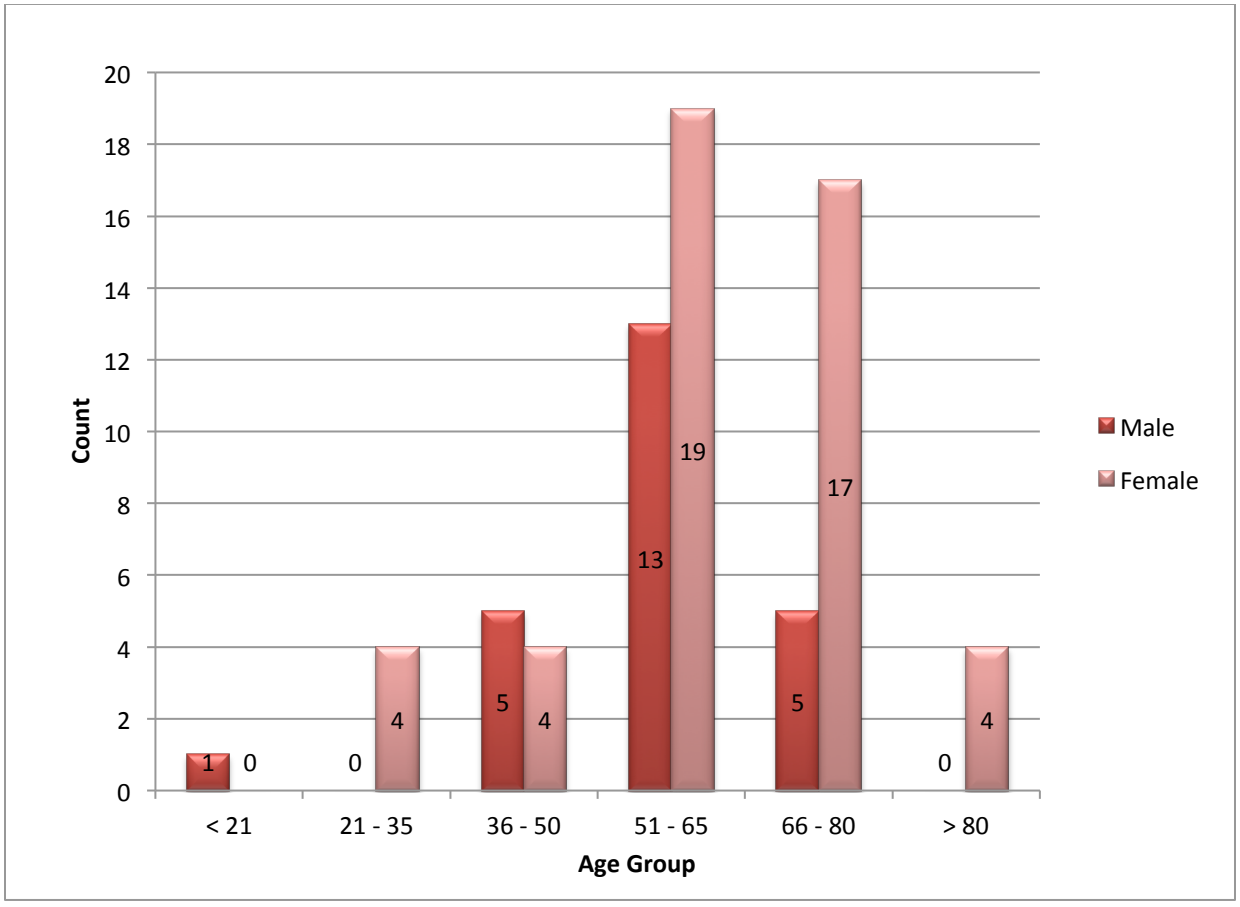

Figure1. Demographic distribution of study participants

Of the total number of study subjects (N=72), 62.5 % (n=45) were female and 37.5% (n=27) were male. Approximately 75% of subjects (n=54) were 51-80 years of

age, about 20% (n=14) were less than 50 years of age, and the remainder (n=4; 5%) were greater than 80 years of age.

Table 1 illustrates the range, average, and statistical significance of study variables between the IVAPAP group and the non IVAPAP group.

Table1. Range, Averages, and Significance Level of Selected Data by Group

	Group 1 (IVAPAP)		*Group 2 (non IVAPAP)*		*Significance*
	Range	*Average*	*Range*	*Average*	*(p)*
AGE(yrs.)	22 - 85	56.5	34 - 88	64	*0.015
BMI	17.5 - 45	26.1	18.9 - 42.6	25.75	0.973
MEQMS(mg)	6 - 150	36	7.2 - 160	38	0.324
LOS(days)	1-9	4	1-11	4	0.131

There was a statistically significant difference between ages of the groups (p=0.015), while average BMI was similar. The average use of morphine in Group 2 (non IVAPAP) was slightly higher (38 mg) as compared to Group 1 (IVAPAP) (36 mg), though the difference was not statistically significant. Average length of stay between the IVAPAP group and non IVAPAP group was the same, at four days.

All study subject received opioids, either morphine or dilaudid, for postoperative pain management. Figure 2 illustrates the distribution of opioid use in morphine equivalence between the two groups.

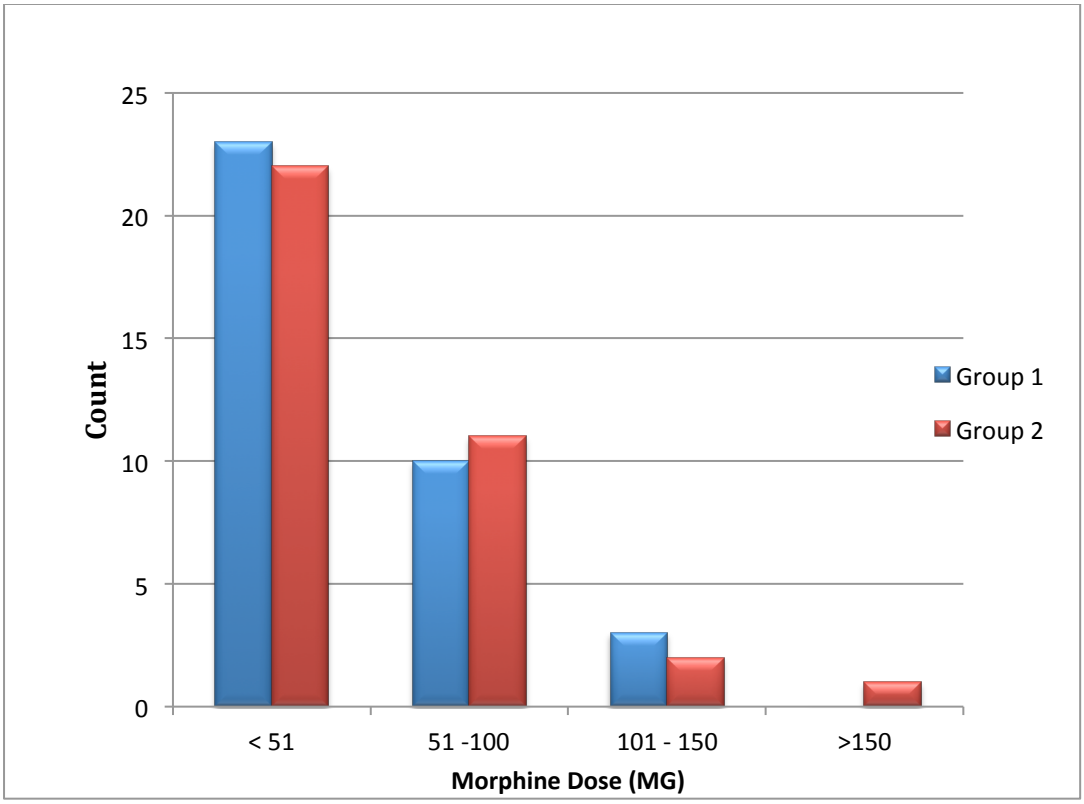

Figure 2. Distribution of opioid use in morphine equivalence by group

Morphine equivalence use is illustrated in Figure 2 by four categories: <51 mg; 51-100 mg; 101-150 mg; and >150 mg. Almost 90% of overall study subjects (n= 66) used less than 101 mg of morphine equivalence. Slightly more subjects in Group 1 (IVAPAP) used morphine equivalent doses in the lower range (< 51 mg); (23 vs. 22). Also, slightly more subjects in Group 2 (non IVAPAP) received doses within the 51-100 mg (11 vs. 10) category. Only one subject in group 2 received >150 mg of morphine equivalence, the highest dose morphine category.

Total sum of morphine equivalent dose for each group was calculated. Group 2 (non IVAPAP) subjects received higher morphine equivalent (1869 mg) opiods as compared to group 1 (1625 mg). Most of the subjects in group 1 (n=23; 64%) were in the

lower dose (<51mg) morphine category and none of the study subject in group 1 (IVAPAP) were in the highest morphine equivalent (>151) range.

Figure 3 illustrates the length of hospital stay in days between Group 1 (IVAPAP) and Group 2 (non IVAPAP).

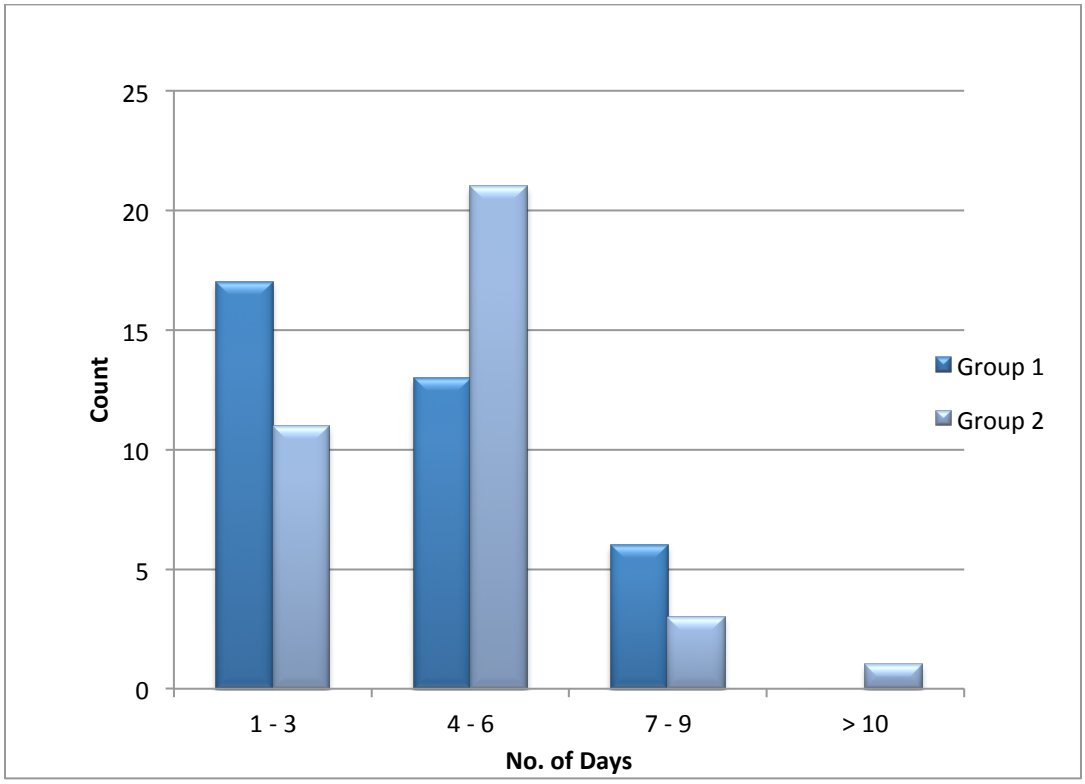

Figure 3. Distribution of length of stay

Approximately 47% (n=17) of study subjects from group 1 (IVAPAP) had a length of stay of one to three days, as compared to (n=11; 30%) in group 2 (non IVAPAP). Less subjects from Group 1 stayed more than three days overall (19 vs. 24). One study subject in group 2 (non IVAPAP) had a length of stay of more than ten days.

Summary and Conclusions

Surgery is a most common and predictable source of pain in the hospital setting (Smith, 2011) and postoperative pain is an expected outcome for people who undergo surgery. Fear of uncontrolled pain is one of the primary concerns of many patients who are undergoing surgery (Hutchison, 2007), and effective pain relief in the postoperative setting is a priority for patients and providers. Persistent acute pain unnecessarily taxes the body's physiologic reserves and contributes to pulmonary complications, impaired rehabilitation and functional outcomes, development of chronic pain, and long term disability (Hartrick, 2004). Insufficient pain control can contribute to various short-term and long-term complications, including low patient satisfaction, development of chronic pain syndromes, delayed postoperative rehabilitation and patient mobilization, atelectasis, deep vein thrombosis, and pulmonary embolism (Smith). Postoperative pain and its complications can be reduced with an appropriate postoperative analgesic regimen, and adequate pain relief reduces patients' anxiety, morbidity, and duration of hospitalization, along with the associated costs of care (Duggan & Scott, 2009).

In addition to postoperative opioid analgesics and NSAIDS, in recent years intravenous acetaminophen (IVAPAP) has been introduced and routinely administered in the inpatient postoperative period. The purpose of this study was to examine the impact of IVAPAP use in multimodal postoperative pain management on decreased opioid consumption and length of hospital stay in the post colectomy population.

This study included a two group design and retrospective chart review was used to gather the data. Inclusion criteria included 250 male and female study subjects were 18

years and older who received postoperative pain management for colon resection (colectomy). Group 1 included patients who had received IVAPAP during the postoperative period; Group 2 included patients who had not received IVAPAP. A total of 149 charts were reviewed, with 72 meeting the study criteria. Each group consisted of 36 subjects. Data were collected related to age, gender, body mass index, opioid use in morphine equivalent and length of stay; the latter two were the key outcome variables.

There was a difference between the groups on average morphine use, as determined by morphine equivalence; the IVAPAP group (Group 1) used less morphine as compared to the non IVAPAP group (Group 2) but differences were not statistically significant (36 mg vs. 38 mg: p=0.324). However, Group 2 (non IVAPAP) subjects overall received higher morphine equivalence (1869 mg) of opiods as compared to Group 1 (1625 mg). While it appeared that IVAPAP provided effective postoperative pain management, and the IVAPAP group tended to have lower opioid use, this study was not able to demonstrate a significant difference on opioid use. It is likely that the relatively small sample size lacked the power needed to demonstrate a significant difference.

The overall length of hospital stay was the same for each group, at four days. Further analysis revealed that approximately 50% (n = 17) of the IVAPAP group had a length of stay less than three days, whereas only 30% (n = 11) of non IVAPAP subjects had a length of stay less than three days. It is also acknowledged that the length of hospital stay is controlled by many other factors like insurance coverage, provider preferences, and the availability of other outpatient services.

This study was limited by the relatively small sample size and the choice of retrospective design. Other limitations were encountered by the researcher during the data collection process. First, some data, particularly height and weight, were not recorded; since that data was needed to calculate BMI, those records without this data were excluded from the study. Also, all study subjects used Patient Controlled Analgesia pump (PCA) within the first 24 hours after surgery for pain control. Either morphine or dilaudid were used, and dosages were ideally totaled and hand recorded by the registered nurses every four hours on the PCA flow sheet exclusively. The subjects' knowledge about using the PCA pump was unknown, and may have had an impact on opioid use. Missing or unclear amounts of opioid use were recorded, and it was very challenging for the researcher to obtain this data. Length of surgery is one of many factors that influence postoperative pain intensity (Ruiz-Suarez & Barber, 2008); it may have been helpful to collect data related to the length of surgery. Pain is a very subjective feeling; patients' individual tolerance may have impacted the results. Though data related to gender was collected, there was no attempt to analyze data by gender. While recognizing that ethnicity impacts pain expression and tolerance, data related to ethnic status was not gathered.

Postoperative pain is a common problem with serious potential adverse effects in terms of patient outcomes and healthcare costs. Opioid mono therapy is inadequate to treat postoperative pain, and NSAIDS have many adverse effects that limit their use in postoperative settings. Based on this study, it is concluded that using IVAPAP as a part of multimodal pain management can provide effective pain control and may contribute to less opioid use during the postoperative period in colectomy patients. Suggestions for the

study site included that further reinforcement related to the importance the recording of height and weight be considered, as well as the current method for recording PCA opioid consumption. Further research is needed to determine if IVAPAP is effective in reducing overall opioid consumption in a diverse sample of postoperative patients overall.

Recommendations and Implications

Unrelieved pain is a major health care issue and one of the primary reasons that people seek health care. Pain after surgery is expected and it must be the healthcare providers' priority to effectively manage that pain. The Joint Commission (2012) published a sentinel event alert; this report was a collection of opioid adverse effects including death that occurred between 2001 and 2011 in U.S. hospitals. The Joint Commission suggested that hospitals utilize evidence based practice to prevent opioid-related adverse effects.

Alleviating suffering is an essential part of nursing, which also has the responsibility to advocate for care needed by individuals, families, and communities. Nurses must be knowledgeable and skilled in assessment and management of pain because they are the healthcare providers with the most frequent patient contact and are in the best position to identity patients in pain. Advanced practice nurses, including NPs, have the advanced knowledge and skills to conduct comprehensive pain assessment and establish refined treatment plans for effective pain management. A primary recommendation for practice is that APRNs support and utilize multimodal analgesia approaches to achieve effective postoperative pain management. Nurse practitioners as members and leaders of the interdisciplinary team can be influential in advocating for effective pain management in general and for the use of emerging methods such as intravenous acetaminophen (IVAPAP) in particular.

Acetaminophen has a proven safety and efficacy profile and IVAPAP is a safe addition to the currently available analgesics for pain management. Advanced practice

nurses have an important opportunity to educate nurses and members of the interdisciplinary team regarding the adverse effects and dosage information about IVAPAP. Before administering IVAPAP, nurse should be aware of the patients' use of both prescription and nonprescription medications that contain acetaminophen in order to avoid exceeding the maximum daily dose. With proper use, the benefits of IVAPAP may reduce opioid consumption, minimize the incidence of opioid-related adverse events, improve pain relief, increase patient satisfaction, expedite mobilization and rehabilitation, and reduce health care costs.

Undergraduate and graduate nursing programs need to enhance and expand teaching related to the complex pathophysiology of pain as well as comprehensive pain management strategies, both pharmacologic and non-pharmacologic. Nursing students must understand the highly individualized expression of pain and how pain is influenced by such factors as gender as ethnic background. Students as well as practicing nurses and other health care professionals should be supported and encouraged to participate in educational program and conferences to gain knowledge about emerging new interventions for effective pain management. In the past decade, improving health care quality is a major focus of healthcare reform efforts. Pain management has become a key outcome that is reflective of patient satisfaction within hospitals. The HCAHPS is a survey instrument and data collection methodology used to measure patients' perceptions of their hospital experience, and in 2008 pain management questions were added in to this survey. Policy efforts at the national level need to continue to focus on enhancement of multimodal pain management strategies. Advanced practice nurse, in the leadership

role, have the ability to lobby national professional and policy making organizations to continue to advance research and evidence based guidelines related to effective pain management. As members of the interdisciplinary team, APRNs can be influential in ensuring that the most effective pain management strategies are implemented.

Postoperative pain is still a major healthcare issue even with all these efforts and policies in place. Future research on analgesics, adjuvant, and holistic approached for pain management is crucial to achieve quality and effective pain management. While there is growing support in the literature for use of IVAPAP, further research, particularly nursing research, is needed, with larger samples and different target groups.

In summary, the intense drive to measure quality is a concern for payers, regulators, and increasingly consumers. It will be imperative that APRNs are involved in the development of quality measures and evidence based practice. This study has established a foundation for further research opportunities in postoperative pain management. It may create awareness among nurses and the APRNs that there is still a need for new innovations and strategies to manage postoperative pain effectively.

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Appendix A

Data Collection Tool

NO	AGE	SEX	BMI	TOS	LOS	DILAUDID	MORPHINE	IVA	MEQ

No. = Subject ID #; BMI= Body Mass Index; TOS= Type of Surgery; LOS= Length of Stay; IVA = Intravenous Acetaminophen; MEQ = Morphine Equivalent;