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Early Oral Feeding After Bowel Resection

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EARLY ORAL FEEDING AFTER BOWEL RESECTION

by

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EARLY ORAL FEEDING AFTER BOWEL RESECTION

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University of the Incarnate Word, 2018

Research Focus: The primary purpose of this project was to determine if there was an association of factors with time to first solid meal in gastrointestinal (GI) surgery patients and the impact solid diet has on length of stay (LOS) in the hospital, GI symptoms, and incidence of post-operative ileus (POI). A secondary purpose was to observe and describe when an oral diet was started and the progression of diet after GI surgery.

Research Methods: This study was a cross-sectional, retrospective chart review of a convenience sample in a multi-centered hospital system conducted in 84 GI resection patients who were 18 years of age or older, and who underwent elective laparoscopic or open bowel resection. Primary outcome variables were postoperative LOS, return to bowel function, incidence of POI, overall complication rate, and presence of GI symptoms. Exploratory variables included pre-operative preparation techniques (pre-operative fasting, bowel preparation, and pre-medication), analgesic and anesthetic techniques used, laxative use, and nasogastric tube (NGT) reinsertion and time in situ, and time to mobilization. Demographic variables included age, sex, surgery type, incision type, and body mass index (BMI). International Business Machines Statistical Package for Social Sciences (IBM SPSS) and IBM Statistical Package for the Social Sciences Analysis of Moment Structures (IBM SPSS Amos) were used to analyze data. A correlation table and individual linear and binary logistic regressions in SPSS Statistics, and

pathway analysis in SPSS Amos were used to determine direct associations, indirect associations, and covariates.

Research Results/Findings: There were no significant associations between time to first solid meal and GI complications, sepsis, abscess, or other complications including hemorrhage, hypertensive thrombocytopenia, acute post-hemorrhagic anemia, hematochezia, leukocytosis, colovesical fistula, and prolapse of ileostomy. Time to first solid meal was significantly associated with allowing clear liquids 12 to 24 hours prior to surgery and time to mobilization. Both faster time to first solid diet and eating before bowel function return (BFR) were associated with decreased LOS. In this study, all except two patients received a clear liquid diet (CLD) as their first meal. Forty four percent of patients were not fed orally until after BFR. The NGT was not removed until after postoperative day 1 (POD1) in 25% of patients.

Conclusions from Research: The findings in this observational study concur with the findings of previous experimental research. Feeding an early solid meal is not associated with complications and is associated with decreased LOS.

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ABBREVIATIONS

AAT: advanced as tolerated

abd: abdominal

ACPC: feeding before and after BFR

AIC: Akaike information criteria

ASA: American Society of Anesthesiologists

BC: binary categorical variable

BFR: bowel function return

BIC: Bayesian information criterion

BM: bowel movement

BMI: body mass index

CFI: comparative fit index

CLD: clear liquid diet

CLG: clear liquid [diet] group

CMIN/DF: minimum discrepancy and degrees of freedom

CT: computed tomography

d: day

D/C: discontinue

d/c'ed: discontinued

DV: dependent variable

e1-e5: error terms of IBM SPSS endogenous variable

Abbreviations—Continued

EFG: early feeding group

EMR: electronic medical record

EOF: early oral feeding

ETF: enteral tube feeding

ERAS: enhanced recovery after surgery

FastingCLS: fasting clear liquids

freq: frequency

GI: gastrointestinal

h: hour

HIPAA: Health Insurance Portability and Accountability Act

IBM SPSS: International Business Machines Statistical Package for Social Sciences

i: incidence

ICU: intensive care unit

IRB: institutional review board

IV: independent variable

L&R: left and right

LI: large intestine

LOS: length of stay

LOSPO: length of stay post operation

LRD: low-residue diet

MD: medical doctor

NCM: Nutrition Care Manual

Abbreviations—Continued

NFI: normed fit index (Bentler-Bonett NFI in IBM SPSS Amos)

NGT: nasogastric tube

NPO: “nil per os” or “nothing by mouth”

NR: non-randomized

NS: not significant

N/V: nausea or vomiting

PC: patient-controlled

PCG: patient-controlled [feeding] group

PO: postoperative

POD: postoperative day

POI: postoperative ileus

PONV: postoperative nausea and vomiting

QOL: quality of life

RCT: random controlled trial

RD: registered dietitian

RDG: regular diet group

reg: regular

RMSEA: root mean square error of approximation

SBP: systolic blood pressure

SI: small intestine

TCG: traditional care group

Abbreviations—Continued

TT1stBFR: time to bowel function return

TT1stBM: time to first bowel movement

TT1stFlatus: time to first flatus

TT1stMealLiquid: time to first meal liquid

TT1stMealSolid: time to first meal solidTT1stMobil: time to first mobility

UIW: University of the Incarnate Word

UTI: urinary tract infection

WBC: white blood count

Chapter 1: Background and Purpose of This Study

Background

Currently, there are many inconsistencies in care after bowel resection surgery and the care is often not evidenced-based.[1-4] Reintroduction of an oral diet and the composition of the diet is often left to the beliefs of the surgeon and clinical tradition.[1-2] The traditional approach to feeding after bowel surgery is to rest the bowel until the resolution of postoperative ileus (POI), which is believed to be indicated by the absence of bowel sounds, passage of flatus, and/or bowel movement (BM), and absence of gastrointestinal (GI) symptoms. GI symptoms include postoperative nausea and vomiting (PONV), diarrhea, and abdominal distention. After flatus and/or BM has occurred, a clear liquid diet (CLD) is provided and progression of the diet is based on the patient's tolerance, which is defined as absence of PONV, diarrhea, or abdominal distention. The usual progression of diet is from CLD, to a full liquid diet, to a low-residue/low-fiber or mechanically soft diet, and to a regular diet.[1]

Statement of Problem

There is evidence that bowel resection and abdominal surgery patients who received early oral feeding (EOF) have decreased complication rates, faster recovery of bowel function and time to regular diet, decreased catabolism, and shorter length of stay (LOS) in the hospital, and, therefore, reduced healthcare costs.[5-11] In addition, researchers have taken this a step further by asking whether bowel rest, nasogastric tube (NGT) decompression, and diet progression starting with a CLD is evidenced-based and necessary.[1, 12-15] In fact, several studies suggest that EOF of a solid diet as the first meal is safe, well-tolerated, and preferred by patients.[12, 16-18]

There is scientific evidence which concludes that EOF immediately following GI and abdominal surgery is well tolerated and safe.[4, 5-11] However, many hospitals around the world

still use postoperative protocols that rest the bowel and keep NGTs in place until passage of flatus or bowel movement.[4] In 2006, a survey of 295 hospitals was conducted in Europe and the United States; the NGT was kept in place after surgery in 40% of patients who underwent colonic surgery in the US and 66% in Europe, and was used approximately three days postoperatively.[4]

Clear liquid diets are often provided after a period of NPO (“nil per os” or “nothing by mouth”) to “rest the bowel”, so GI and abdominal patients may go days without nourishment. In a study at the University of Louisville Hospital, the author sought to describe why patients were placed on NPO or CLD. A multidisciplinary team, including a registered dietitian (RD), decided unanimously what would be considered inappropriate reasons for patients to be placed NPO or CLD. They found 22% of patients continued to be NPO or on CLD for three days or more. Interestingly, they found two thirds of NPO orders and one third of CLD orders to be inappropriate and poorly justified.[19]

GI and abdominal surgery patients are at risk of malabsorption and malnutrition from inadequate nutritional intake, surgical stress, and increase in metabolic rate.[20-23] The metabolic changes that occur after surgery are well described in the literature and include increased neural sympathetic activity with increased catecholamine secretion, impaired immune function, increased inflammation, and a negative nitrogen balance caused by a hypermetabolic state.[24-26] Increased protein catabolism leads to poor wound healing, increased complications, and prolonged recovery and LOS.[4]

Surgical patients may be at an increased risk for poor clinical outcomes and increased morbidity and mortality if they are admitted for surgery already malnourished, due to their GI disease state. The nutritional status of pre- and post-elective GI surgery patients was examined at

admission and found 9% had a BMI of <20 and 8% of all participants were considered malnourished. At discharge, 32% had suffered significant weight loss, greater than 5% during their hospital course.[27] Studies have shown that 30-50% of patients admitted to a hospital are malnourished.[28] Malnutrition in surgical patients is known to decrease muscle, respiratory, cardiac, and immune functions, and wound healing, plus plays a role in increased development of postoperative complications and hospital LOS.[29-30] Post-surgical inflammation and the hypermetabolic state increases caloric and protein needs.[31] A CLD does not meet the increased nutritional needs of surgical patients.[20-23]

Purpose of the Study

The primary purpose of this project was to determine if there is an association of factors with time to first solid meal in GI surgery patients and to describe the association solid diet has with LOS, GI symptoms, and incidence of POI within a path analysis model. A secondary purpose was to describe the progression of diet after GI surgery.

Research Questions

Research questions were the following:

1. What type of diets are patients first given postoperatively?
2. When is solid food introduced in the postoperative GI patient?
3. What variables are significantly associated with time to solid diet?
4. Is an earlier solid diet associated with reduced LOS, decreased incidence of GI symptoms, ileus, and other complications?

Significance of the Study

The annual cost associated with treatment of POI and increased hospital LOS was found to be nearly one billion dollars.[26] Studies have demonstrated that EOF is related to earlier BFR

and decreased LOS. In addition, there have been many studies that linked EOF to better overall outcomes for patients.[9,32,33-36] These studies have defined "EOF" in different ways; starting EOF at various times and defining EOF as enteral with formula or oral feeding with liquid diets. Even fewer studies have started EOF of a solid diet as the first meal. Overall, the literature suggests that EOF, including EOF of a solid diet as the first meal, is safe and provides benefits for patients.[17,18,37-40] However, to the author's knowledge, there has not been a study that describes or analyzes time to first solid meal, whether early or not, and patient outcomes. This study aims to add to the body of knowledge that shows EOF of a solid diet is associated with reduced LOS and does not lead to increased incidence of GI symptoms, ileus, or other complications.

Summary of Methodology

This study is a cross-sectional, retrospective study. A retrospective chart review of a convenient sample was conducted in 84 GI patients. All patients who were 18 years of age or older who underwent elective laparoscopic or open bowel resection were considered eligible for the study. Included surgeries are left and right hemicolectomy, total colectomy, resection of transverse colon, sigmoid resection, segmental colonic resection, and any resection of the small and/or large bowel, excluding resections of greater than 100cm of ileum. The following patients were excluded: those with significant cardiopulmonary comorbidities with an American Society of Anesthesiologists (ASA) score greater than III, those who did not have a nutritional assessment completed within 48 hours of hospital arrival, pregnant or breast-feeding women, those younger than 18 years of age, those with emergency surgery, patients who were malnourished, those diagnosed with cancer, and patients who were held in the ICU for more than 24 hours.

Primary outcome variables were postoperative LOS, return to bowel function (flatus or bowel movement), incidence of POI, presence of GI symptoms and overall complication rate. Complications were only recorded during data collection if there was a diagnosis or mention in the physician's note. Exploratory variables (covariates) include pre-operative preparation techniques (pre-operative fasting, bowel preparation, and pre-medication), analgesic and anesthetic techniques used, fluid status and avoidance of fluid overload, bladder catheter and laxative use, and NGT reinsertion and time in situ, and time to mobilization. Demographic variables include age, sex, surgery type, incision type, and body mass index (BMI).

IBM SPSS Statistics and SPSS Amos were used to analyze data. A correlation table and individual linear and binary logistic regressions in SPSS and pathway analysis in Amos were used to determine direct associations, indirect associations, and covariates.

Summary of Limitations

The main limitation of this study is that it is an observational study involving retrospective EMR review where the author abstracted data and was not blinded to the aim of the study. Observational studies can only describe associations and not causations. While the author did review data abstracted for errors, there was not a second reviewer to examine abstraction data again. Data collected involving times may not reflect the actual time that the occurrence took place, e.g., first flatus/bowel movement, time to mobilization, or the time the care was provided, e.g., time to first liquid or solid meal. In addition, there were unmeasured confounders such as blood loss during surgery, length of surgery, extent of adhesiolysis, and total length of bowel resected (specimen length was not always noted by pathology). Total time until subject tolerated solid diet was not used. This study involved subjects from five different hospitals and each surgeon, as well as the clinical staff, had their way of handling their surgical patients and

documenting care. The ratio of sample size to number of parameters in the current study is 4.7:1, which is close to the generally accepted minimum of 5:1 for path analysis. Also, there were 84 cases used in this study, which is above the minimum acceptable sample size of 50. However, a sample size below one-hundred subjects increases the likelihood of estimation problems and decreased statistical power in some fit indices, and therefore, accepting a model that is unsatisfactory. Five types of GI surgeries were included in the study with various comorbidities and results are difficult to generalize for all GI surgical patients.

Chapter 2: Literature Review

The aim of the literature review was to explore studies comparing a solid diet to a CLD as the first meal postoperatively (under the heading “Solid diet as first meal studies”). In addition, EOF studies are examined, which compare an early feeding group (EFG) to a traditional care group (TCG). These studies are discussed under the heading, “Early Feeding Group Compared to a Traditional Care Group”. The EFGs were given a CLD on the first evening postoperatively or on POD1, and advanced as tolerated to a solid diet. The TCGs had the NGT in place and were given nothing by mouth until first flatus occurred. In each EOF study comparing an EFG to a TCG, the EFGs were advanced to a solid diet in less time than the TCGs. Ultimately, EOF studies comparing an EFG to a TCG explore whether an earlier solid diet is associated with reduced LOS, decreased incidence of GI symptoms, ileus, and other complications, and lead to faster BFR.

Methodological Approach

Primary studies reviewed were obtained from the following online databases: The Cumulative Index to Nursing and Allied Health Literature (CINAHL), MEDLINE, PubMed, and The Cochrane Library published during 1990-2016 in the English language. Search terms in various combinations were used, such as: ‘bowel resection’, ‘bowel’, ‘early oral feeding’, ‘diet’, ‘abdominal surgery’, ‘surgery’, ‘postoperative feeding’, ‘postoperative diet’, postoperative early oral feeding’, ‘solid versus liquid’, ‘enteral nutrition’, ‘nothing per os’, and ‘nothing by mouth’. The following criteria were used for study selection:

- Adult patients 18 years and older who underwent open or laparoscopic, elective abdominal and GI resection surgeries.

- The primary intervention under investigation was EOF after abdominal or GI resection surgery. A secondary intervention under investigation was a solid diet as the first diet after abdominal or GI resection surgery.
- Studies considered were primary research of experimental, quasi-experimental, or observational design. However, all studies chosen were randomized controlled trials.
- Outcome measures of interest were hospital LOS, complication rate and type, return to bowel function time, and presence of GI symptoms, such as nausea, vomiting, abdominal distention, or diarrhea, and NGT reinsertion.

Summary of Studies

There were four studies reviewed which compared an EFG to a TCG. Table 1 on pages 9-10 is a summary of EOF studies. All four randomized controlled trials (RCTs) compared patient outcomes in an EFG and a TCG. All four studies involved subjects undergoing laparoscopic (LAP) or open colorectal resection in addition to small intestine (SI) resections. The EFG began a CLD as the first meal POD1 and advanced as tolerated (AAT). The TCG in all four studies were NPO and the NGT was not removed until flatus occurred, then a CLD was given and was AAT. All four RCTs found that the EFG tolerated a solid diet in less time compared to the TCG. Reduction in LOS in the EFG was found in Fonseca et al. while two did not find a difference; Ortiz et al. did not measure LOS differences.[32-33] Three RCTs did not observe a difference between the groups in complications.[33-35] However, Ortiz et al. observed that the EFG did exhibit a higher incidence in complications; namely vomiting and reinsertion of NGT were more common.[32]

Six RCTs were reviewed to discover if an early oral diet of a solid meal as the first meal postoperatively leads to better patient outcomes compared to the typical step-wise progression of

Table 1. Summary of Early Oral Feeding Studies

Ref #	33	34	35	32
Author (Date)	Fonseca et al. (2011)	Reissman et al. (1995)	Feo et al. (2004)(2004)	Ortiz, et al. (1996)
Study Design	RCT	RCT	RCT	RCT
Sample Size	n=54	n=161	n=100	n=190
EOF Definition	EFG: POD1 TCG: NPO until 1st flatus	EFG: POD1 TCG: NPO until 1st flatus	POD1	EFG: POD1
Progression	EFG: POD1 oral liquid diet; advanced to regular diet w/i 24 hours as tolerated	POD1 EFG: oral liquid diet; advanced to regular diet w/i 24 hours as tolerated	EFG: no NGT, CLD POD1 → to soft-solid diet. TCG: NGT and fasting until flatus, then CLD advanced to semi-soft diet.	EFG: 1st evening PO CLD, then POD1 PC → to regular diet TCG: NPO; NGT d/c >POI resolved, then CLD; >24 hours → to solid diet
Discharge Criteria	Tolerated solid diet w/o N/V; had flatus and stool	Tolerated solid diet w/o N/V; had flatus and stool	Tolerated solid diet w/o N/V; had flatus and stool	Not described
Ileus Definition	Elimination of flatus and BM (indirect measurement)	Elimination of BM w/o emesis or abdominal distension	Not defined	Bowel sounds, no NV, and passage of flatus or stool
Outcome: EFG vs TCG — **↑ Tolerance**	√	√	√	√
↓ LOS	√	--	--	Ø
↓ Comps	--	--	--	X

Key: √ = yes; -- = no difference; X = no; Ø = not observed/measured or not described; NR = non-randomized

diet starting with a CLD.[17,18,37-40] Table 2 on pages 12-13 is a summary of diet progression studies. Two RCTs (Lau et al. & Pearl et al.) fed the experimental group either a low-residue diet (LRD) or regular diet as the first meal on POD1.[17,37] The control group received a CLD on POD1 and was AAT. Jeffrey et al. based diet resumption on BFR, and NGT use was not standardized. Jeffrey et al. did not find any difference between groups in incidence of complications, however, as expected, the regular diet group (RDG) did receive higher caloric intake compared to the CLD group.[18] Lau et al. found that the LRD group had BFR sooner, decreased GI complications, and decreased LOS.[17] Pearl et al. did not find groups to be significantly different in any of these variables.[37]

Three RCTs involved patients controlling their intake of solid food after elective abdominal, colonic, and upper GI surgeries.[38-40] Lassen et al. found that LOS and BFR was sooner in the patient-controlled group (PCG) compared with the enteral tube feeding (ETF) group, who did not achieve a solid meal until POD5.[38] There was not a difference in GI-related complications, however, after eight weeks the ETF group had significantly more wound infections and other complications after discharge.[38] In 2001, Han-Geurts did not find any difference in GI complications or LOS between the PCG and the TCG, who resumed a solid diet on POD5.[40] Similarly, in 2007 Han-Geurts et al. did not find any difference in BFR, GI complications, or LOS between the PCG and the TCG, which was progressed from a CLD on POD2 to a LRD on POD4.[39]

Table 2. Summary of Diet Progression Studies

Ref #	17	18	37	40	39	38
Author (Date)	Lau (2014)	Jeffery (1996)	Pearl (2002)	Han-Geurts (2001)	Han-Geurts (2007)	Lassen (2009)
Study Design	RCT	RCT	RCT	RCT	RCT	RCT
Study Aims	Compare POD1 safety/tolerance of CLD vs LRD	Determine if any difference in tolerance to CLD vs reg diet as 1st meal PO	Evaluate safety & effectiveness of reg diet as 1st meal PO vs CLD	Is PC feeding possible in colonic or aortic surgery patents?	Assess effects of EOF on GI function & QOL	Does normal diet at will ↑ morbidity/ mortality re NPO ETF PO?
Subjects	CLD: n=57 LRD: n=54	CLD: n=135 Reg: n=106	CLD: n=107 Reg: n=138	PCG: n=56 TCG: n=49	PCG: n=61 TCG: n=67	PCG: n=220 enteral tube feeding (ETF)=227
Surgery	Colorectal elective open	Abd, exc lap	Intra-abd, exc lap	Elective abd open, colonic aortic	Elective open colorectal or abd vascular	Upper GI
EOF Definition	POD1 of CL or LRD (CL advanced if no PONV)	Based on clinical criteria, usually BFR	POD1 of CLD & reg diet (CLD AAT)	PCG: POD1	PCG: AT. TCG: POD2 CLD, POD4 LRD	PCG: at will POD1. ETF: reg diet >POD5
ERAS Protocols Used	NGT (d/c immediately PO), early ambulation, catheters avoided	Ø	NGT d/c immediately PO	NGT D/C immediately PO, bowel prep	NGT D/C POD1 at latest, bowel prep, epidural anesthesia	Ø

Table 2. Summary of Diet Progression Studies (continued)

Results	POD2 emesis: CL=28%, LRD=14%. Days to flatus: CLD=4.8, LRD=3.7. No Δ in PO comps. Tolerance of LRD > in CLG (4.1 vs 2.0d) CLG POI 2x ↑ (NS). CLG wound infection 2x↑; intra-abd infection 3x↑.	8.1% of CLG intolerant. 7.5% of RDG intolerant (PONV or abd distention); six patients switched to NPO and two to CLD.	NS Δ in PO comps, GI symptoms, BFR, freq/dur of NGT use, toleration, or LOS. RDG tolerated 1d earlier (NS). Bowel sounds present POD1.	Median time to normal diet 3 days in PCG; 5 days in TCG. Reinsertion of NGT, comps, LOS similar for both groups. Median LOS in both 11d.	Comp and BFR rate similar. Normal diet tolerated a median of 2 days in PCG & 5 days in TCG. QOL similar in both groups.	Mortality, major/minor comps, TT1stBM, PO weight loss NS btw groups. PCG ↓TT1st flatus (2.6 vs 3d) & LOS (13.5 vs 16.7d).
↑BFR	√	Ø	--	--	--	√
↓GI comp	√	--	--	--	--	--
↓LOS	√	Ø	--	--	--	√
Conclusions	LRD compared w/ CLD on POD1 led to ↓ nausea, ↑ BFR, shorter LOS w/o ↑ of morbidity	No ↑ of GI morbidities in RDG compared to CLD. RDG received ↑ caloric intake.	Reg diet as the 1st meal PO is safe in gynecologic oncology patients	Patients can adequately determine their own diet tolerance.	Diet tolerance not influenced by BFR; no reason to delay or withhold reg diet PO	PC reg diet post major upper GI surgery did not Δ in morbidity or mortality

Key: √ = yes; -- = no difference; Ø = not observed/measured or not described; NS = not significant; Δ = change or difference; QOL= quality of life; CLG = clear liquid [diet] group

Gastrointestinal Resection

Adult patients require bowel resection to treat a variety of conditions including Crohn's disease and inflammatory bowel disease, ischemic necrosis due to trauma of the GI tract, removal of retroperitoneal malignancies, radiation enteritis, cancer, small bowel fistulas, mesenteric infarct, and volvulus.[42] The reason for the resection, along with other factors including age, the specific portion of the GI tract removed, and health of the GI tract that remains, affect digestive and absorptive capacity and add to the complexity of this population.[43] Based on the functionality of the respective anatomy of the bowel resected, there will be varying amounts of malabsorption after surgery. Differing lengths and portions of the jejunum and ileum may be resected along with the colon and ileocecal valve.[42] Each area and amount resected, in addition to the preservation of the colon and ileocecal valve, will affect the magnitude of macronutrient and micronutrient malabsorption.[42]

Short bowel syndrome. There are two somewhat different definitions of short bowel syndrome (SBS) used in the literature and clinical educational materials. Some material refers to SBS as the consequences resulting from resections of the small intestine, only referring to resections of the jejunum and ileum, without inclusion of the colon. However, a broader definition includes any loss of bowel length and function which results in decreased absorptive capacity. This definition includes all small intestine resections, and presence or absence of the ileocecal valve and colon. Some definitions also include a specific percentage of bowel remaining or a certain length. However, the impact of resection depends on many factors and defining SBS in those terms may not be sufficient.

Loss of bowel length and function refer to a loss of mucosal surface area and a negative change in motility and intestinal transit time. Common clinical symptoms include malnutrition

and malabsorption, weight loss, choleretic diarrhea, steatorrhea, and fluid and electrolyte imbalances.[42] The presence of symptoms depends on the length and specific portion resected, the underlying disease or condition that originally caused the resection, the health of the remaining bowel and other GI organs after resection, the ability for the remaining bowel to adapt, the presence or absence of the ileocecal valve or colon, and the overall condition of the patient.[42]

Impact of area resected. The percentage, length, and specific site of remaining bowel needed to avoid malabsorption and malnutrition after resection is somewhat controversial and sometimes conflicting. The ability of the patient to recover depends on what was resected and the ability of the remaining bowel to adapt. The ileum adapts to resection better than other portions of the GI tract.[41] Therefore, preservation of the ileum after resection often leads to a positive prognosis and ability to adapt to meet nutritional needs.[44] The ileum is the major contributor of absorption to intrinsic and extrinsic fluids that enter or are secreted into the GI tract, including bile salts, lipids bound to bile acids, fat-soluble vitamins, electrolytes, and vitamin B-12.[45] It is also the production site of gut hormones imperative to bowel motility and epithelial growth, such as glucagon-like peptides (GLP-1 and 2) and peptide YY.[45] However, a loss of more than 100cm of ileum results in severe malabsorption of lipids, bile salts, and fluid, resulting in diarrhea, steatorrhea, dehydration, increased motility, and decreased adaption of the remaining bowel.[44] Total ileal and distal ileal resections result in unabsorbed bile salts and lipids aggravating the lumen of the colon, and stimulating water secretion and an inability to absorb salt and water, resulting in diarrhea.[44]

Digestion begins in the duodenum with mixing of pancreatic enzymes and bile acids. Most carbohydrate and protein absorption occur in the duodenum and jejunum.[45] The duodenum is imperative to normal digestion, however, in the case of a complete resection of the duodenum,

the jejunum will recover the absorptive ability.[41] Total removal of the jejunum will cause malabsorption of calcium, folic acid, and iron.[44] However, total resection of the duodenum and jejunum is unusual and unlikely.[41] Due to mixing of lipids with bile acids, complete resection of the duodenum will cause some disruption of lipid absorption.[45]

The jejunum is the primary site for lipid absorption; however, after a complete resection of the jejunum, the ileum is capable of adapting.[44] Typically, malabsorption and malnutrition are not observed in resections of the jejunum.[44]

Postoperative complications. Following surgery, primary complications due to the physiological GI changes include diarrhea, choleric diarrhea, steatorrhea, a decrease in motility, and gastric hyper-secretion.[42] Secondary complications that can occur include anastomotic breakdown and leakage, wound infection, hemorrhage, aspiration pneumonia, venous thrombosis, urinary tract infection, abdominal abscess, intestinal obstruction, emesis, and POI.[46]

Postoperative ileus and bowel function return**.** POI occurs after GI surgery and is an expected, but temporary, impairment of intestinal motility which is viewed as non-preventable. The pathogenesis involves a complex interplay of surgical stress, manipulation of the bowel, and inhibitory neural reflexes.[46] POI affects normal GI motility patterns through altered hormone secretion, sympathetic hyperactivity, local and systemic inflammation, and use of opioid analgesia.[1] Entereg, a medication sometimes given before surgery to counteract POI, is an antagonist to opiate analgesia. POI results in abdominal distention, absence of bowel sounds, and decreased peristalsis that often leads to a buildup of gas and stool in the intestines. POI is clinically diagnosed based on cramping, bloating, PONV, and absence of bowel sounds, flatus, and bowel movement.[47]

There are many factors that affect the return to normal gut function after resection, including patient's co-morbidities and health of the remaining bowel.[42] The following factors are known to increase the incidence and length of POI: perception of pain and use of epidural opioid analgesia, preoperative fasting, type of surgery and incision, complications, use of NGTs, and excess fluid build-up. Thoracic epidural anesthetic, avoiding opioids, close monitoring of fluid levels, early feeding and early mobilization have been found to lower the incidence and duration of POI.[48-50] The presence of bowel sounds, flatus, and bowel movement are used to represent the end of POI and ability of the post-surgical patient to tolerate oral formula or food.

Postoperative nausea and vomiting. PONV is a common occurrence after surgery and anesthesia, and is seen in 25-30% of all surgical patients.[51] PONV is related to several factors such as, surgical time and complexity, ASA score, and perceived pain.[52] PONV is very rarely fatal, however, avoiding it as much as possible is important for decreasing recovery time and increasing patient satisfaction.[53] Multimodal protocols such as use of high-flow oxygen, laxatives, and fluid management reduce PONV, as well as reduce the rate of wound infections and reduce overall morbidity.[49]

Anastomotic breakdown. Currently, EOF is avoided due to a fear that a food bolus would increase intraluminal pressure and cause anastomotic dehiscence. However, research has demonstrated that early enteral feeding is not only safe and leads to faster recovery, but improves blood flow and healing of the anastomosis.[54-56] In addition, animal studies have shown increased collagen deposition and hydroxyproline content in the healing anastomoses and increased bursting strength after EOF.[57]

Postoperative Diet Prescription

Current clinical practice. The traditional approach to feeding after bowel or abdominal surgery is to "rest the bowel" by keeping a NGT in situ, thus keeping the patient NPO, until the resolution of POI, which is believed to be indicated by the presence of bowel sounds, passage of flatus, and/or BM, and absence of GI symptoms, which include PONV, diarrhea, and abdominal distention. After flatus and/or BM has occurred, a CLD is provided and progression of the diet is based on the patient's tolerance, which is defined as absence of PONV, diarrhea, or abdominal distention. The usual progression of diet is from CLD, to a full liquid diet, to a low-residue/low-fiber or mechanically soft diet, and then to a regular diet.[58]

Current practice is based on the theory that nasogastric suction of the stomach and fasting by "resting the bowel" will prevent PONV and gastric dilation, treat POI, and allow the anastomosis to heal. [58] Clinicians have the fear that forcing food against an ileus will result in PONV with possible respiratory complications and increased tension that may rupture the anastomosis. However, research does not support these ideas and, in fact, suggests that nasogastric suction and NPO are associated with negative clinical outcomes.[59] Delaying initiation of food in surgical patients creates an energy deficit that places these patients at risk for slower recovery, increased infections, and increased LOS.[29-30,60-62] In addition, NGTs have their own complications and are associated with several clinical problems including respiratory complications, such as atelectasis and pneumonia, vocal cord paralysis, gastroesophageal reflux, discomfort and pain.[63-65]

Safety and tolerance. Safety and tolerance of diet are assessed by incidence of PONV or abdominal distention. Early enteral feeding has been shown to increase local blood flow and peristalsis, which stimulates intestinal motility, enhances mucosal hyperplasia and adaptation,

resolve POI, lessens immunosuppression, and attenuates the inflammatory response.[66] In addition, there is some scientific evidence that concludes that EOF is well tolerated and safe immediately following abdominal surgeries.[8,67-68] Resolution of POI and LOS are generally shorter, and complication rates do not differ in EOF compared to a traditional feeding protocol.[8,67-68] However, many hospitals still use postoperative protocols that rest the bowel and keep NGTs in place until passage of flatus or bowel movement.[4] A survey showed that only 16% of patients in the United States eat a normal diet by POD3.[4]

Resolution of ileus and recovery of intestinal function. Currently, resolution of POI and recovery of intestinal function (BFR) is said to occur after evacuation of first flatus and/or bowel movement. However, it has been found that the stomach regains function a few hours after surgery, followed by small intestinal function, which may explain why so many abdominal patients can eat an early oral and even solid or semi-solid diet immediately following resection, without passage of flatus or bowel movement.[14] Clinicians and the studies reviewed measure time to first flatus as an indication of return to bowel function. Some authors recognize these indications are not necessarily an indication of return of bowel function. However, bowel movement and flatus are observable and easy to document in the clinical setting.

Clear liquid diet versus solid diet. CLDs, when compared to solid diets, are thought to be easier to swallow, have faster gastric emptying, increased small intestinal absorption, and are tolerated better after surgery.[28,37] However, clear liquids are more easily aspirated due to rapid movement through the oropharynx.[37] In addition, glottic closure and the cough reflex is jeopardized after surgery due to pain and sedative medications.[37] In addition, CLDs are hyperosmolar, which could lead to osmotic diarrhea.[69]

Nutritional needs of surgical patients. A CLD does not meet the increased nutritional needs of surgical patients. In a survey of 299 United States hospitals, 82% of CLDs provided less than 1,000 kcal/d.[20] At the Eisenhower Army Medical Center in Georgia, a nutrient analysis was conducted in a small subset of the study population involving 25 subjects who underwent abdominal surgery where nursing staff recorded types and quantity of food consumed for three days; an average of 73.8% of caloric needs were met in patients who received a regular diet as the first postoperative meal, while only 42.3% of those who received a CLD met their caloric needs. In addition, 58.4% of regular diet subjects met their protein needs, while only 3.7% of the CLD subjects met their protein needs. The average CLD provided approximately 1200 kcal and 16 g protein, while the regular diet provided 2900 kcal and 100 g protein.[18] Other nutrient analysis sources calculate CLDs to provide 512 kcal to 600 kcal, 6 g to 19 g protein, and 0 g to 4 g of total fat.[22-23]

Caloric needs for post-surgical, non-obese patients can range from 25 kcal/kg/day to 35kcal/kg/day and protein needs range from 1.5 g/kg/day to 2.5 g/kg/day, depending on surgery complications, additional wounds present, and extent of inflammation and hypermetabolic state.[31,70] For a 75 kg post-operative abdominal surgery patient, this translates into caloric needs ranging from 1,875 kcal to 2,625 kcal and protein needs ranging from 112 g to 187 g of protein per day. Theoretically, this translates into a 1,275 kcal to 2,025 kcal deficit and a 106 g to 181 g protein deficit per day. A CLD as the first postoperative meal, before or after return of bowel function, provides a gross nutritional deficit for patients after GI and abdominal surgery.

Several studies showed that EOF of a regular, solid diet as the first meal is not only safe, but does not increase incidence of PONV or postoperative complications.[17-18,37-39,44] In addition, comparing an EFG to a TCG, where a CLD was given on POD1 and then advanced to a solid

diet within 24 hours, showed the EFG to have faster BFR and shorter hospital stay,[17,38] and decreased complications.[17]

Early Feeding Group Compared to Traditional Care Group.

There were four studies reviewed which compared an EFG to a TCG. Table 1 on pp 11-12 is a summary of EOF studies. All four randomized controlled trials (RCTs) compared patient outcomes in an EFG and a TCG. The four studies involved subjects undergoing laparoscopic (LAP) or open colorectal resection in addition to small intestine (SI) resection. In all four RCTs reviewed, the EFG was given a CLD on POD1 and AAT to regular diet within 24 hours (no emesis or abdominal distention). The TCG continued to have nasogastric suction while NPO until first passage of flatus, then a CLD was AAT within 24 hours. Reissman et al. included the same protocol as described above except that the NGT was discontinued immediately for both groups. NGT reinsertion occurred if the patient experienced at least two episodes of vomiting.[34]

Tolerance of solid diet. Tolerance of diet is defined as absence of PONV. All four studies found that approximately 80% of the EFG tolerated the first oral feeding on POD1 of clear liquids and were advanced to a solid diet within 24-48 hours, while the TCG did not receive a CLD until passage of flatus. Reissman et al., Feo et al., and Ortiz et al. all found a similar return to bowel function, represented by passage of flatus, of approximately 4 days.[32,34-35] Therefore, approximately 80% of the patients in these three studies were advanced to a solid diet by POD2, while the patients in the TCGs did not receive oral sustenance until two days later. In addition, Reissmann et al. found that the EFG tolerated a regular diet significantly earlier than in the TCG (2.6 days versus 5.0 days).[34] Fonseca et al. found that 95% of the EFG tolerated a solid diet while only 71% of the TCG tolerated the progression to a solid diet within 24 hours of the first meal, but this was not significant (p=0.093).[33]

Feo et al. was the only study that showed a significant increase in incidence of vomiting in the EFG compared to the TCG (14% vs. 32%).[35] It should be noted, however, that 20% of the EFG patients who experienced vomiting required NGT reinsertion due to repeated emesis.[35] Reissman et al. and Ortiz et al. did find an increase in the incidence of vomiting in the EFG, however, this was not significant when compared to the TCG. Nonetheless, Fonseca et al. found that all incidence of PONV that inhibited patients from eating a solid diet was found in the TCG.[35]

Complications. All four studies did not show a significant difference between groups in overall complication rate or readmission rate. Interestingly, Fonseca et al. also found that all readmissions were from the TCG and were due to anastomotic leak, abdominal pain and diarrhea, and deep vein thrombosis (DVT).[33] Reismann, et al. (1995) had two patients in the EFG develop wound infections and one developed aspiration pneumonia and died, while the TCG included two wound infections, one catheter-related infection, and one DVT.[34] Interestingly, Ortiz et al. showed that the only aspiration pneumonia patient was in the TCG and no anastomotic leak was found in the EFG.[32] In addition, the authors also found more patients experienced anastomotic breakdown and wound infection in the TCG versus the EFG (4.3% versus 2.1%, and 6.3 versus 5.3, respectively).[34]

Hospital length of stay (LOS). Fonseca et al. (2011) found that hospital LOS was significantly reduced in the EFG compared with the TCG (4.0 versus 7.6 days). However, there are two confounding factors: first, the patients were informed which feeding group they were in on POD1, which could have caused patients to recover more or less quickly; second, the physician was familiar with fast-track or multimodal care, and could have affected the difference of days between groups.[33]

Alternatively, Reissmann et al. and Feo et al. did not find any significant difference in LOS between groups (approximately 7 days in both groups).[34-35] However, this may have been due to discharge criteria: these studies required their patients to stay hospitalized until ileus was resolved (BFR) and they tolerated a solid diet. If patients in the EFG could discharge once they tolerated a solid diet regardless of BFR, then there would likely be a significant difference in LOS between the two groups. In addition, the physicians were not blinded to groups and awareness of trial may have led to earlier discharges in the TCG.[34-35]

In summary, all four RCTs found that the EFG tolerated a solid diet in less time compared to the TCG. Reduction in LOS in the EFG was found in Fonseca et al. while two did not find a difference; Ortiz et al. did not measure LOS differences.[32-33] Three RCTs did not observe a difference between the groups in complications.[33-35] However, Ortiz et al. observed that the EFG did exhibit a higher incidence in complications; namely vomiting and reinsertion of NGT were more common.[32]

Solid diet as first meal studies. Six RCTs were reviewed to discover if an early oral diet of a solid meal as the first meal postoperatively leads to better patient outcomes compared to the typical step-wise progression of diet starting with a CLD.[17-18,37-40] Three studies compared outcomes of a CLD on POD1 versus a solid diet on POD1[17,18,37] and three studies compared outcomes of a traditional care group versus a patient controlled group.[38-40] Both Jeffrey et al. and Pearl et al. fed the experimental groups a regular diet, while Lau et al. fed the experimental group a low-residue diet (LRD) as the first meal on POD1.[17,37] The control group received a CLD on POD1 and was AAT. Five studies fed both groups on POD 1 and used standardized NGT protocols. However, Jeffrey et al. based diet resumption on BFR, and NGT use was not standardized. Table 2 on pp 13-14 is a summary of diet progression studies.

A study published in 1996 by Jeffery et al. demonstrated that there is no difference in GI intolerance of 135 patients fed a CLD compared with 106 patients fed a regular diet as the first diet after open abdominal operations.[18] However, NGT use and resumption of diet was not standardized and left to the clinician's discretion based on BFR parameters, such as bowel sounds, flatus, and BM. Unlike most studies, a nutrient analysis in a small subset of 25 subjects was conducted for 3 days; an average of 73.8% of caloric needs were met in 13 subjects who received a regular diet as the first postoperative meal, while only 42.3% of those who received a CLD met their caloric needs. In addition, 58.4% of regular diet subjects met their protein needs, while only 3.7% of the CLD subjects met their protein needs.[18]

Alternatively, Lau et al. and Pearl et al. removed NGTs immediately after surgery. Both studies evaluated the safety and effectiveness of a solid meal (LRD or regular diet, respectively) on POD1 compared with a CLD on POD1. Lau et al. involved 111 subjects undergoing open, elective colorectal surgery and Pearl et al. involved 245 gynecologic oncology patients undergoing intra-abdominal surgeries. The latter group of patients are more complex due to having several serious medical issues and multiple procedures during surgery as compared to colorectal surgery patients. In both studies, the experimental group (LRD or RDG) received a regular diet as the first meal, and the control group (CLD group) received a clear liquid diet and was AAT. Lau et al. incorporated early ambulation and avoidance of catheters, which are known to increase BFR. However, Pearl et al. did not mention enhanced recovery after surgery (ERAS) protocols, other than immediate removal of the NGT.[17,37]

Lau et al. found that the LRD group did tolerate a LRD sooner than the CLD group (2.0 versus 4.1 days, respectively). Vomiting on POD2 was found more often in the CLD group (28% versus 14%), even though the CLD group had longer use of IV anti-emetics.[15] Pearl et al.,

however, found no significant difference in toleration or GI symptoms between the CLD and regular diet groups (RDGs). However, prophylactic anti-emetics were not used in their protocol and anti-emetics obviously play a significant role in toleration of diet.[37] Interestingly, 88% of patients who were fed a regular diet as the first meal on POD1 tolerated it on the first attempt.[37] In addition, bowel sounds were present on the first morning after surgery in both groups and 50% in both groups did not pass flatus before discharge.[37] Lau et al. showed significantly shorter days until flatus in the LRD group (3.7 versus 4.8 days).[15] However, Pearl et al. showed that both groups had passage of flatus in an average of 2.8 days.[37] This suggests that waiting for BFR, as defined by bowel sounds or flatus before giving a solid diet, is not necessary.

Neither study showed a significant difference in rate of complications between the groups.[15,37] Interestingly, Lau et al. did show that the CLD group had two times more incidence of POI, as defined as an inability to tolerate and resume solid diet for more than six days, but this was not significant. Wound infection and intra-abdominal infection was two and three times, respectively, more likely in the CLD group, but this was not found to be significant. Lau et al. did find that LOS was significantly longer for the CLD group (7 versus 5 days), however, Pearl did not find LOS to be significantly different between groups.[15,37]

The next three studies involve patient-controlled (PC) feeding as compared to a conventional, fixed regimen. Han-Geurts et al. conducted two RCTs; one study (2001) involved 105 patients undergoing elective, open abdominal or colonic aortic surgeries and one (2007) involved 128 patients undergoing elective, open colorectal or abdominal vascular surgeries.[39-40] In the earlier study, the NGT was removed immediately after surgery, however, in the later study the NGT was removed “on POD1 at the latest”.[39] In addition, bowel preparation was not avoided in both studies and epidural anesthesia was used in the later study, but not mentioned in the

earlier study. In both studies, the patient-controlled [feeding] group (PCG) was allowed a solid diet on POD1 at their discretion. However, the TCG was based on the usual step-wise progression of diet from liquid to solid; in the earlier study, the TCG was not progressed to a normal diet until POD5 and the later study progressed the TCG from sips of water on POD1 to a CLD on POD2, and finally a LRD on POD4.

Both studies found a similar median time to toleration of a normal diet in the PCG versus TCG: three versus five days and two versus five days, respectively.[39-40] Time to bowel sounds, first flatus, and first BM were all similar between groups, however, time to toleration of a normal diet was significantly shorter in the PCG.[39] This demonstrates that waiting until BFR before feeding is not necessary. Interestingly, in the whole cohort, use of epidural anesthesia was associated with earlier BFR. Neither study found a significant difference in reinsertion of NGT, complication rates, or LOS between groups. The median duration of LOS was 11 days in both groups.[40] In addition, no difference in QOL scores was observed.[39]

Similarly, Lassen et al. researched if a solid diet at will would increase morbidity or mortality compared with ETF after upper GI surgery.[38] In the PCG, 220 patients chose their diet on POD1, while the ETF group (n=227) were not allowed solid food until POD5. NGT use and other protocols known to decrease BFR were not mentioned. Time to first bowel movement was not significantly different between groups. However, the PCG had shorter time to first flatus (2.6 versus 3.0 days). Mortality, minor and major complications, post-operative weight loss, and need for NGT re-insertion were not significantly different between groups. However, interestingly, at an 8-week follow-up, the ETF group had more wound infections and complications after discharge. LOS was significantly shorter in the PCG compared with ETF group (13.5 versus 16.7 days).[38]

In summary, Jeffrey et al. did not find any difference between groups in incidence of complications, however, as expected, the regular diet group did receive higher caloric intake compared to the CLD group.[18] Lau et al. found that the LRD group had BFR sooner, decreased GI complications, and decreased LOS.[17] Pearl et al. did not find groups to be significantly different in any of these variables.[37]

Lassen et al. found that LOS and BFR was sooner in the patient-controlled group compared with the enteral tube feeding group, who did not achieve a solid meal until POD5.[38] There was not a difference in GI-related complications, however, after eight weeks the ETF group had significantly more wound infections and other complications after discharge.[38] In 2001, Han-Geurts did not find any difference in GI complications or LOS between the PCG and the TCG, who resumed a solid diet on POD5.[40] Similarly, in 2007 Han-Geurts et al. did not find any difference in BFR, GI complications, or LOS between the PCG and the TCG, which was progressed from a CLD on POD2 to a LRD on POD4.[39]

Quality of Studies

All studies were RCTs. Feo et al. and Difronzo et al. did not describe the method by which they randomized patients. Jeffrey et al. did not describe differences between groups. Fonseca et al., Lassen et al., and Lau et al. did not mention blinding and Lau et al. was not blinded. Difronzo et al., Han-Guerts (2001), Jeffrey et al., and Ortiz et al. did not mention attrition. Feo et al. and Lau et al. were the only studies that included power analyses. There was a bias toward delayed feeding of open colectomy patients, and blinding and attrition were not mentioned. Due to the nature of the population being studied, consecutive convenience samples were used in all studies. However, all studies included homogenous groups. Table 3 on page 28 is a summary of quality of studies.

Table 3. Quality of Studies in Literature Review

Study	Randomized	Differences Between Groups	Blinded	Attrition Explained	Standard Protocols	Power Analysis	Observations
DiFronzo	?	X	?	?	√	X	X
Feo	X	X	√	√	√	√	X
Fonseca	√	X	X	√	√	√	X
Hans-Guerts (01)	√	X	?	?	√	X	X
Hans-Guerts (07)	√	X	?	√	√	√	X
Jeffery	√	X	√	?	X	X	X
Lassen	√	X	X	√	√	?	X
Lau	√	X	X	√	√	√	X
Ortiz	√	X	?	?	√	X	X
Pearl	√	X	?	√	√	X	X

Key: √ = yes; X = no; ? = not described/mentioned

Chapter 3: Research Methodology

Study Design

This study is a retrospective chart review of a convenience sample in a multi-centered hospital system conducted in 84 GI resection patients. This study was approved by the UIW (study #14-10-001) and the multi-centered hospital system institutional review boards. The UIW IRB form can be found in Appendix A. All patients who were 18 years of age or older and underwent elective laparoscopic or open bowel resection were considered eligible for study. Included surgeries are left and right hemicolectomy, total colectomy, resection of transverse colon, sigmoid resection, segmental colonic resection, and any resection of the small and/or large bowel, excluding resections of greater than 100 cm of ileum. The following patients were excluded: those with significant cardiopulmonary comorbidities with an ASA score greater than III, those who did not have a nutritional assessment completed within 48 hours of hospital arrival, pregnant or breast-feeding women, those younger than 18 years old, those with emergency surgery, patients who were malnourished, those diagnosed with cancer, and patients who were held in the intensive care unit (ICU) for more than 24 hours.

Data Collection

The chart review included 84 patients that had gastrointestinal resection between the years 2014 and 2015. Data was documented from each patient's EMR onto a data collection sheet. An example of the data collection sheet can be found in Appendix B. Outcome variables included LOS (in days) post operation (LOSPO), incidence of ileus, sepsis, and abscess and all other complications, and presence of GI symptoms including nausea, vomiting, diarrhea, and abdominal distention after surgery. Presence of GI symptoms (variable GI) was a binary categorical variable defined as a "yes/no" of occurrence at any point postoperatively. GI

symptoms were only documented on the data collection sheet if they were mentioned in the daily nursing notes or physician's note or if there was a diagnosis. Variables are described in Table 4 on pages 31-32. Complications (ileus, sepsis, intra-abdominal abscess, and "other complications") were only recorded during data collection if there was a diagnosis or mention in the physician's note. General definitions of complications are in Appendix C for reference. "Other complications" were grouped together (OtherComps) and included hemorrhage, hypertensive thrombocytopenia, acute post-hemorrhagic anemia, hematochezia, leukocytosis, colovesical fistula, and prolapse of ileostomy.

Continuous exploratory variables (covariates) included were time to first liquid meal (TT1stMealLiquid), time to first solid meal (TT1stMealSolid), time to first bowel function return (TT1stBFR), and time to first mobilization (TT1stMobil), all in hours. Time to first bowel function return (TT1stBFR) is defined as the first occurrence of either flatus or bowel movement. The time to flatus or bowel movement (in hours) was determined using the day and time the surgical procedure ended compared to day and time of first flatus and bowel movement.

Categorical binary covariates include pre-operative preparation techniques (pre-operative fasting, bowel preparation, and pre-medication), analgesic and anesthetic techniques used, and NGT in situ greater than postoperative day 1 (POD1). Medication use documented included laxatives, prokinetics, anti-emetics, and Entereg. Demographic variables included age, sex, surgery type, incision type, and BMI.

Table 4. Description of Variables

Variable	Type	Conceptual Definition	Operational Definition
ACPC	BC	Occurrence of first bowel function before/after first meal	0=before ACPC 1=after ACPC
FastingCLS	BC	Occurrence of patient receiving clear liquids 12-24 h < surgery	0=no; 1=yes
Fasting NPO	BC	Occurrence of patient being NPO < surgery	0= no; 1=yes
GI symptoms	BC	Overall tolerance of oral feeding	Includes incidence of any of the following GI symptoms postoperatively: nausea, vomiting, abdominal distention, or diarrhea 0=no; 1=yes
Ileus	BC	Occurrence of ileus after surgery	0=no; 1=yes
Incision_1 **Incision_2** **Incision_3**	Categorical	Type of surgical incision	Incision_1=laparoscopic Incision_2=midline incision Incision_3=off-midline incision
Laxative	BC	Use of laxative pre-operation	0=no; 1=yes
LOSPO	Continuous	Outcome reflects total time to recovery of bowel function, pain management, tolerance of diet, and ambulation	Number of days spent in the hospital after surgery until discharge
NGT	BC	NGT in situ beyond POD1	0=no; 1=yes
TT1stBFR	Continuous	Evidence of return of gut motility defined as flatus or bowel movement	Time in hours to BFR calculated by subtracting time to first BFR from day and time of surgery in total hours; rounded to nearest half hour.
TT1stMealLiquid	Continuous	Time in hours that patient received their first liquid meal after surgery.	Calculated by subtracting time to first liquid meal in hours from day and time of surgery in total hours; rounded to nearest half hour.
TT1stMealSolid	Continuous	Time in hours that patient received their first solid meal after surgery.	Calculated by subtracting time to first solid meal in hours from day and time of surgery in total hours; rounded to nearest half hour.
TT1stMobil	Continuous	Time to first unassisted ambulation	Calculated by subtracting time to first ambulation in hours from day and time of surgery in total hours; rounded to nearest half hour.

Table 4. Description of Variables (continued)

Prokinetic	BC	Use of prokinetic pre-op	0=no; 1=yes
Surgery_1 **Surgery_2** **Surgery_3** **Surgery_4** **Surgery_5**	Categorical	Type of surgery	Surgery 1=L&R hemicolectomy Surgery 2=total colectomy Surgery 3=partial resection of SI Surgery 4=sigmoid resection Surgery 5=partial resection of LI
Other Comps	BC	Hemorrhage, ↓platelets, anemia, ↑WBC, fistula, ileostomy prolapse, hematochezia, sepsis, abscess	0=no; 1=yes

BC: binary categorical variable

Data Protection

Health Insurance Portability and Accountability Act (HIPAA) regulations were followed at all times. Complete patient anonymity was maintained; names do not appear in any data collected and participants cannot be identified from the demographic data collected.

An experimental number was assigned to each subject's patient identifier number. Only the experimental number was documented on each data collection sheet. A master list of the patient identifier matched with an experimental subject number is kept in the nutrition advisor's office at UIW. The information was manually transferred to a spread sheet on a password-protected laptop that was always locked when not in use. No patient identifiers were saved to the laptop. The data collection sheets were kept in a locked safe until transfer to a locked file cabinet in a locked room at UIW. Each data collection sheet contains only the experimental subject number.

Data Analysis

IBM SPSS Statistics (version 24) and IBM SPSS Amos (version 24) were used to analyze data. Continuous patient characteristics, outcome variables, and covariates are described using basic descriptive statistics and are presented as means with standard deviations (SD) medians, and ranges. Categorical patient characteristics, outcome variables, and covariates are described using descriptive statistics as frequencies using percentages (%).

A linear model that quantifies the effect of each predictor (patient characteristics and covariates) on the final outcome variables (LOSPO, incidence of ileus, abscess, sepsis, other complications, and GI symptoms), and also how the predictors affect each other, was explored using path analysis. In addition, the data was divided into two groups according to whether

subjects where fed a meal before or after bowel function returned (variable ACPC). Using a correlation matrix of all variables, in the context of expected associations, a theoretical flow-chart was designed. Shown in figure 1 below. The SPSS correlation matrix is in Appendix D.

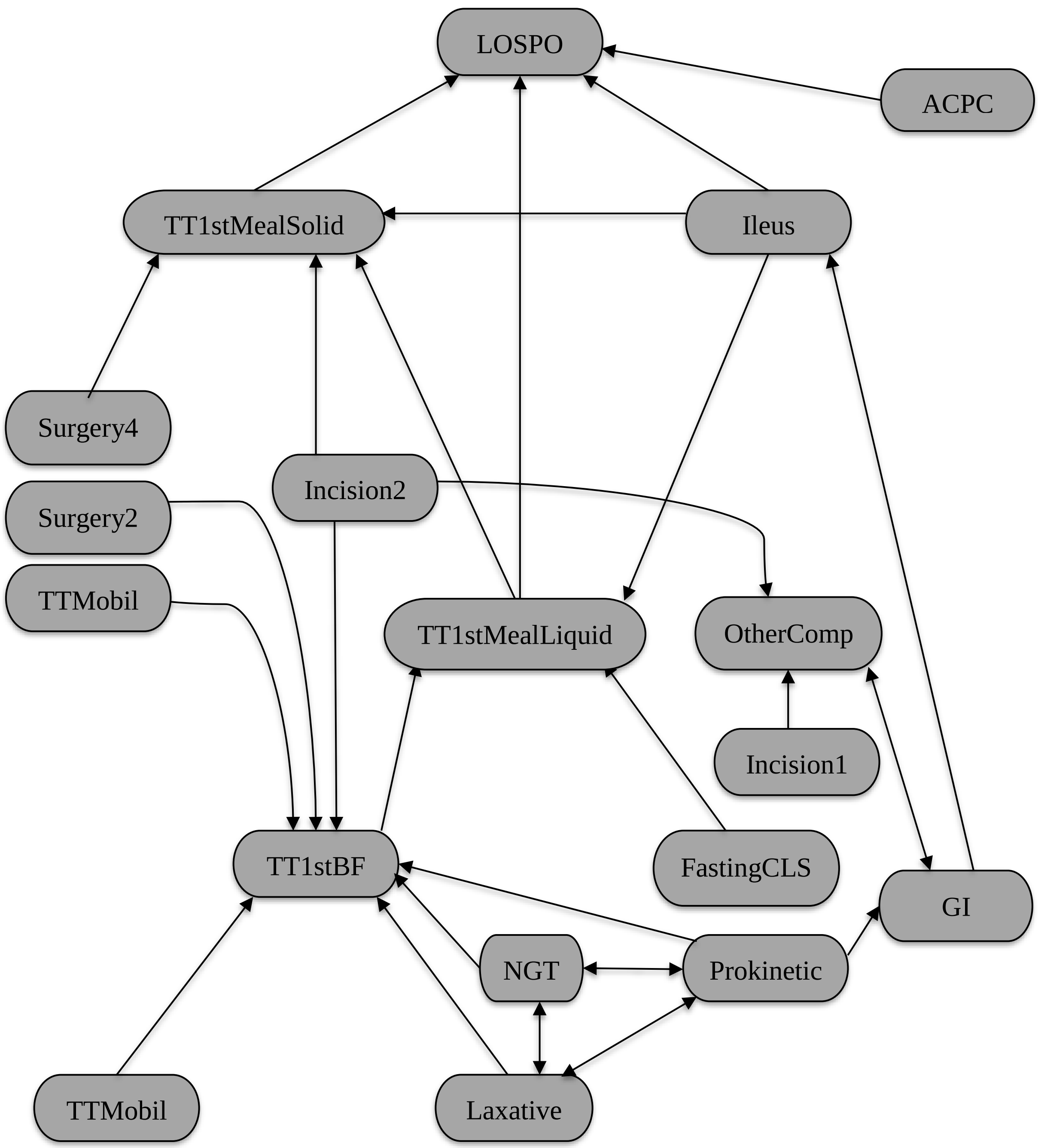

Figure 1. IBM SPSS Statistics Theoretical Variable Association Flow Chart.

Then, based on the theoretical associations, regressions were conducted to reinforce by what path the outcome variables were affected by the predictor variables and to ascertain if the associations were significant. Linear regression was used when the dependent variable was continuous and binary logistic regression was used for binary, categorical dependent variables. Individual regressions were conducted for the following sets of variables:

IBM SPSS Statistics linear regressions:
TT1stBFR as a function of NGT, Surgery_2, Incision_2, Laxative, TT1stMobil, and Prokinetic.
TT1stBFR as a function of TT1stMealLiquid and TT1stMealSolid.
TT1stMealLiquid as a function of FastingCLS, Ileus, and TT1stBFR.
TT1stMealSolid as a function of TT1stMealLiquid, Surgery_3, Surgery_4, Incision_2, and Ileus.
LOSPO as a function of TT1stMealLiquid, TT1stMealSolid, and Ileus.
LOSPO as a function of TT1stBFR.
LOSPO as a function of ACPC.
TT1stMobil as a function of Surgery_2

IBM SPSS Statistics logistic regressions:
Other Comps as a function of Incision_1 and GI.
Ileus as a function of Incision 1.
Ileus as a function of laxative, TT1stMobil, TT1stMealLiquid, and TT1stMealSolid.
GI as a function of ACPC.
Ileus as a function of ACPC.
Sepsis as a function of ACPC.
Abscess as a function of ACPC.
Other comps as a function of ACPC.

Finally, IBM SPSS Amos was used to conduct a path analysis.

Chapter 4: Results

Patient characteristics. The mean age of patients was 51 years old and ranged from 18 to 82 years of age; 47% were male and 52% were female. The average BMI was 27.0 and ranged from 19.4 to 40. Forty-four percent of patients had a laparoscopic procedure, 51.2% had an open midline incision, and only 4.8 had an off-midline incision. The most common procedure (75%) in this set of patients was a colon resection (hemicolectomy, total colectomy, or sigmoid resection) while 25.0% had a partial resection of the small intestine.

Table 5. Patient Characteristics

	N = 84	**%**
Sex, M/F	40/44	47/52
Age, years	51 (18-82)	
BMI	27.0 (19.4-40.0)	
ASA		
I	3	3.6
II	81	96.4
Incision		
Laparoscopic	37	44.0
Midline	43	51.2
Off-midline	4	4.8
Surgery		
L/R Hemicolectomy	19	22.6
Total colectomy	5	6.0
Partial resection of SI	21	25.0
Sigmoid resection	30	35.7
Partial resection of LI	9	10.7

Pre-operative practices. Fifty-six percent of patients were ordered to have nothing by mouth after midnight prior to surgery. Only 19% were ordered to have a clear liquid diet 12 to 24 hours pre-surgery.

Medication use. All patients received a thoracic epidural, general anesthesia, and opioid analgesics, however, only 20.4% received Entereg as a pre-medication before surgery. Anti-emetic use was found in 64.3% of patients after surgery. Laxatives were used in 32.1% of patients and a prokinetic was used in 27.4% of patients. Often, pre-operative orders for mechanical bowel preparation were not found in the documentation. However, a physician who worked in the hospital system confirmed that most, if not all, patients received mechanical bowel preparation before GI surgery, so it was assumed that all patients were mechanically prepped. Medication descriptions can be found in Appendix E for reference.

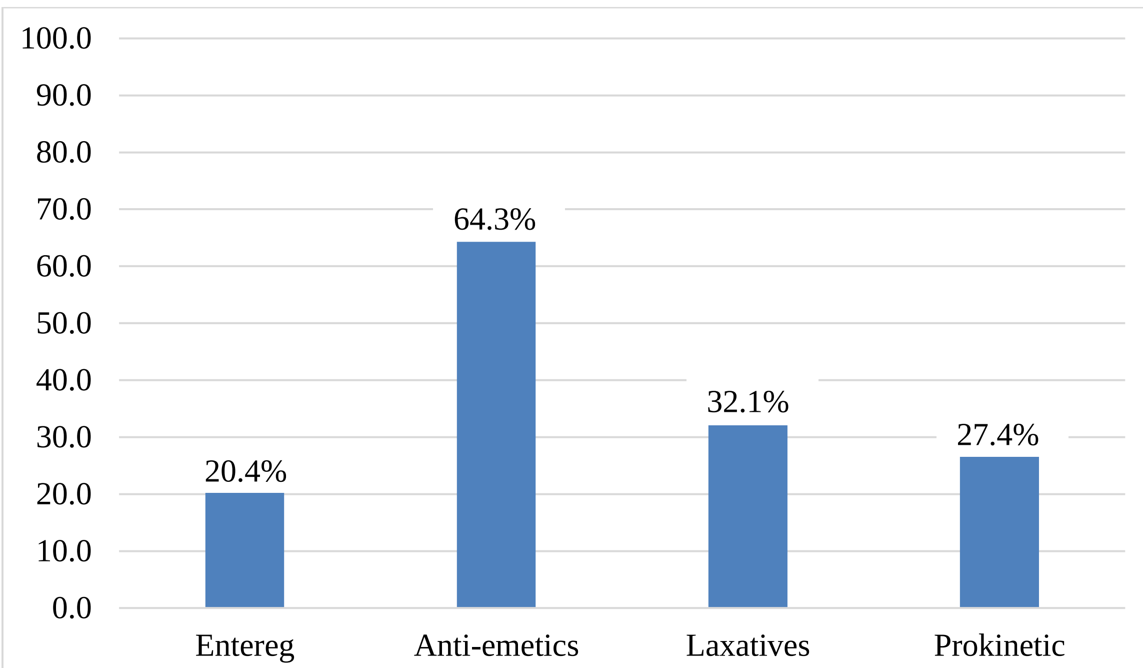

Figure 2. Percentage of Patients Receiving Types of Pre-Operative Medications

Post-surgical outcome variables and covariates. Average LOSPO was 4.9 +/- 2.4 days, and ranged from 2 to 13 days. GI symptoms, such as nausea, vomiting, diarrhea, and abdominal distention, occurred in 42.9% of patients post-operatively. Complications diagnosed in patients after surgery were ileus (14%), sepsis (2%), abscess (2%), and other complications (13%). The

NGT was kept in place beyond POD1 in 25% of patients. Forty-four percent of patients (n=37) were given a liquid or solid meal after BFR, and 56% (n=47) were fed before BFR.

Table 6. Post-Surgical Outcome Descriptive Statistics

Variable	**Mean (+/- SD)**	**Days**	**Min.**	**Max.**
TT1stBFR	51 hours (+/- 36)	2.1	2	211
TT1stMealLiquid	48 hours (+/- 38.3)	2.0	1	173.5
TT1stMealSolid	81 hours (+/- 49.6)	3.4	18	291
LOSPO	118 hours (+/- 57.6)	4.9	2	13

Linear and Logistic Regression Results

Tables 7 and 8 on pages 39-40 show the significant variables and beta (β) values for the individual regressions performed in SPSS. Whether patients were fed before or after BFR (ACPC) was found to be significantly associated with LOSPO, but not other variables. It was not included in the Amos model because it was not shown to have a significant effect on TT1stBFR when considered with the other predictors. It was found that subjects who ate before BFR stayed 1.5 days less than those who waited until after BFR to eat. Using linear regression, laxative use was originally found to positively and significantly be associated with TT1stBFR. However, the Amos model fit better without it included. ACPC was not significantly associated with incident of ileus, abscess, sepsis, or other complications.

Table 7. Initial Linear Regressions

Dependent Variable	**Independent Variables**	**Significant Variables**	**p**	**β**
TT1stBFR	NGT, Surgery_2 Incision_2 Laxative TT1stMobil Prokinetic TT1stMealSolid TT1stMealLiquid	TT1stMobil Incision_2 Laxative TT1stMealSolid	0.001 0.044 0.024 <0.001	0.289 16.58 -20.30 -0.46
TT1stMealLiquid	FastingCLS Ileus TT1stBFR	FastingCLS Ileus TT1stBFR	0.020 0.010 0.011	-24.19 28.7 0.29
TT1stMealSolid	TT1stMealLiquid Surgery_3 Surgery_4 Incision_2 Ileus	TT1stMealLiquid Surgery_4	<0.001 <0.001	1.15 22.27
LOSPO	TT1stMealSolid Ileus TT1stMealLiquid	TT1stMealSolid Ileus	<0.001 0.002	0.023 2.25
LOSPO	ACPC	ACPC	0.003	-1.52
LOSPO	TT1stBFR	TT1stBFR	0.009	0.019

Table 8. Initial Logistic Regressions

Dependent Variable	Independent Variables	Significant Variables	p	Exp(B)
Other Comps	Incision 1 GI	Incision 1 GI	0.042 0.040	(+) 0.24 (+) 3.60
Ileus	Incision 1 Laxative TT1stMealLiquid TT1stMealSolid TT1stMobil	Incision 1	0.055	(-) 0.21
GI	ACPC TT1stBFR	NS		
Ileus	ACPC TT1stBFR	NS		
Sepsis	ACPC TT1stBFR	NS		
Abscess	ACPC TT1stBFR	NS		
Other comps	ACPC TT1stBFR	NS		

NS = Not significant

IBM SPSS Amos Results

An estimates matrix of all dependent variables against predictors is in Appendix F. The model is considered a good fit; Minimum discrepancy and degrees of freedom (CMIN/DF) was less than 1.393 and normed fit index (NFI) was less than 0.9, which is the threshold for good fit. However, comparative fit index (CFI) is 0.961, CFI having the same general threshold as NFI of 0.9. Root mean square error of approximation (RMSEA) or absolute fit index is 0.069, which is within the range conventionally accepted as adequate fit. Akaike information criteria (AIC) and Bayesian information criterion (BIC) are both significantly less for the chosen model than for the saturated model, indicating that most if not all dropped paths were wisely dropped. These two statistics are also lower than they were for the previous model that does not include covariance between Surgery 4 and Incision 2 and the direct effect of FastingCLS on TT1stBFR. This shows that the covariance between Surgery 4 and Incision 2 and the direct effect of FastingCLS on TT1stBFR are appropriately added. Overall, the model fit is adequate. The reason that it is not a better fit is most likely that there may be paths that should have been included in the model. In addition, there is a dummy categorical variable, Ileus, as an intermediate endogenous variable, so that the error terms are not normally distributed. For some of the predictors, the relationship with the response variables may not be exactly linear. The error terms represent the variation in the endogenous variables (TT1stBFR, LOSPO, Ileus, etc.) that is not explained by the predictors. All Amos output, including values for the error terms, is included in Appendix G for reference. Definitions and use of the above-mentioned indices of fit are defined and described further in Appendix H.

Covariances defined were Incision_1 (laparoscopic), and Incision_2 (open surgery with midline incision) and Surgery_4, (sigmoid resection). Figure 3 below shows a graphical

representation of which variables and associations were included in the Amos model. The curved lines represent covariance associations between Incision_1 and Surgery_4, and Incision_1 and Incision_2. The numbers in Figure 3 on page 43 represent the beta values associated with each direct association.

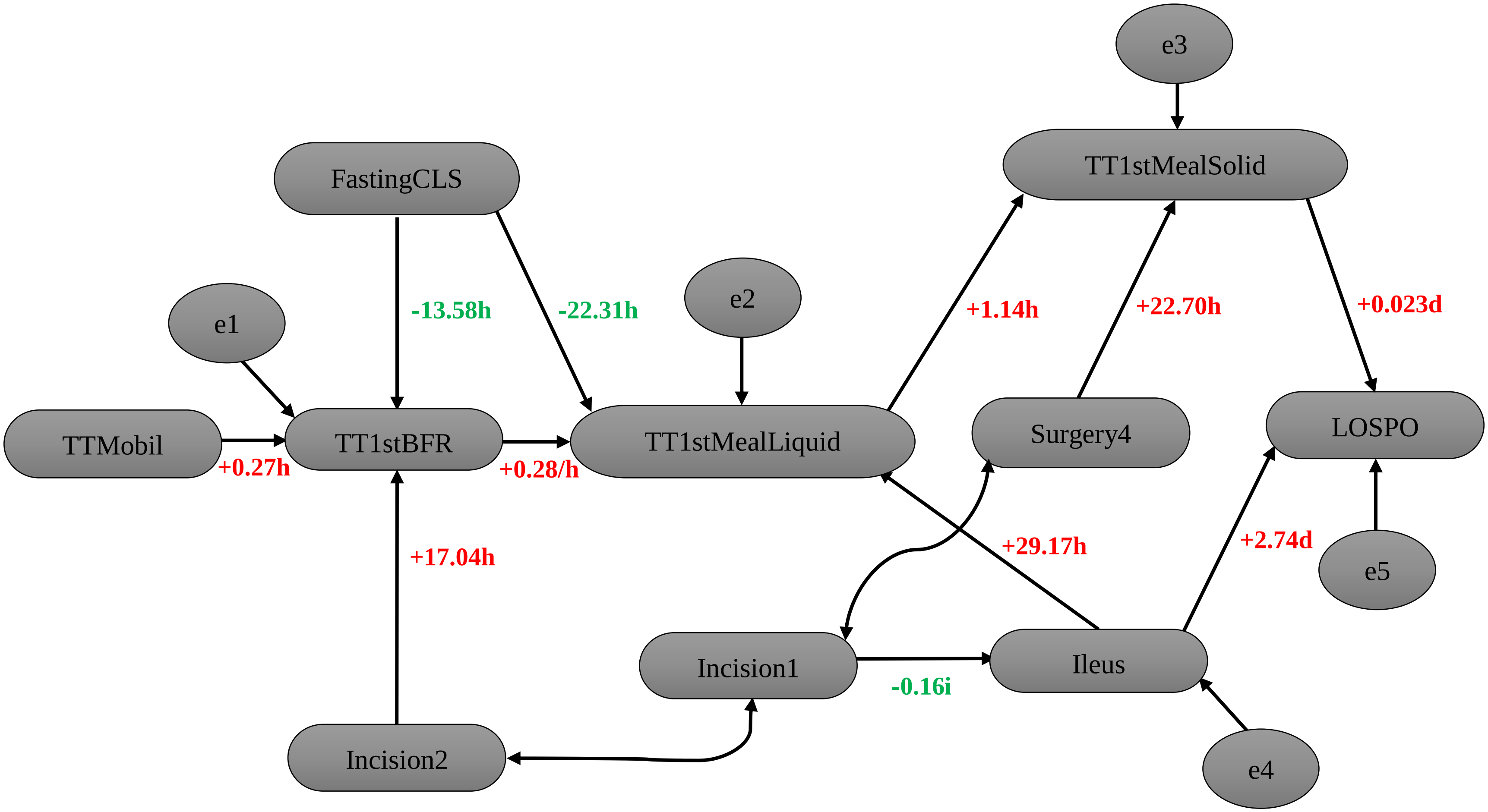

Figure 3. IBM SPSS Statistics Significant Variable Association Results Flow Chart.
Numbers represent β values of the direct associations between variables; Key: h = hours; d = days; i = incidence; green = decrease; red = increase; e1-e5 represent the error terms of each endogenous variable.

Time to first bowel function return. TT1st BFR was directly associated with TTMobil, Incision 2, and FastingCLS. Table 9 below lists the direction associations included in the Amos model. Patients who had an open surgery with midline incision delays BFR by 17 hours. Every hour mobilization was delayed is associated with delayed BFR by 0.27 hours or approximately 16 minutes.

Table 9. IBM SPSS Amos Direct Associations

DV		IV	β	Interpretation
TT1stBFR	←	TT1stMobil	+0.27	Every hour mobilization delayed = delayed BFR by 0.27 hours or approximately 16 minutes.
	←	Incision_2	+17.04	A midline incision delays BFR by 17 hours.
	←	FastingCLS	-13.58	Those who had clear liquids 12-24 hours prior to surgery= BFR 13 hours sooner than those who did not.
TT1stMealLiquid	←	TT1stBFR	+0.28	Every hour BFR is delayed = delayed liquid meal by 0.28 hours or 17 minutes.
	←	FastingCLS	-22.31	Those who had clear liquids 12-24 hours prior to surgery = liquid diet 22 hours sooner than those who did not.
	←	Ileus	+29.17	Presence of ileus delayed liquid meal by 29 hours.
TT1stMealSolid	←	TT1stMealLiquid	+1.14	A 1 hour delay in a liquid meal = 1.14 hour delay in a solid meal.
	←	Surgery_4	+22.70	A sigmoid resection = delay of solid meal by 22 hours.
Ileus	←	Incision_1	+29.17	Patients who had laparoscopic surgery were 15.9% less likely to develop ileus after surgery.
LOSPO	←	Ileus	+2.74	Presence of ileus increased LOS by 2.7 days.
	←	TT1stMealSolid	+0.023	A delay of one hour of a solid meal = increase in LOS by 0.023 days or approximately 33 minutes.

The β value between TT1st BFR and FastingCLS was -13.58, meaning patients who were allowed clear liquids 12-24 hours prior to surgery had BFR 13 hours sooner than those who did not have clear liquids 12-24 hours prior to surgery. TT1stBFR is directly associated with TT1stLiquidMeal.

Time to first liquid meal. TT1stMealLiquid was directly associated with the incidence of ileus, FastingCLS, and TT1stBFR. Every hour BFR was delayed is associated with a delayed liquid meal by 0.28 hours or approximately 17 minutes. Patients who were allowed clear liquids 12-24 hours prior to surgery had a liquid diet 22 hours sooner. Presence of ileus delayed receiving a liquid meal by 29 hours. TT1stLiquidMeal is directly associated with TT1stMealSolid.

Time to first solid meal. TT1stMealSolid was directly associated with Surgery 4 (sigmoid resection) and TT1stMealLiquid. A one hour delay in a liquid meal was associated with a 1.14 hour delay in a solid meal. A sigmoid resection was associated with a delay of solid meal by 22 hours. Table 10 on page 46 describes factors that are associated with TT1stMealSolid, the associated beta values, and the interpretation of each beta value. Table 10 on page 46 describes the factors significantly associated with time to first solid meal.

Length of postoperative hospital stay. LOS was directly associated with Ileus and TT1stSolid Meal. Ileus was found only to be significantly associated with Incision 1 (laparoscopic surgery). Patients who had laparoscopic surgery were 15.9% less likely to develop ileus after surgery. Presence of ileus increased LOS by 2.7 days. A delay of one hour of a solid meal led to an increase in LOS by 0.023 days or approximately 33 minutes. Table 11 on page 46 describes the association TT1stMealSolid has with GI symptoms, POI, OtherComps, and LOS, the beta values, and the interpretation of each beta value.

Table 10. Factors Significantly Associated with Time to First Solid Meal

Variable/Covariate	Conceptual or Operational Definition	β	Interpretation
TTMobil	Time to 1st unassisted ambulation	0.09	Every hour delayed = delay of 0.09 hours to solid diet
Fasting CLS	CLS 12-24 hrs prior to surgery per MD	-29.80	CLS prior to surgery =↓ of 29.8 hrs to solid diet
TT1stBFR	Time in hrs to BFR	0.32	Delay of 1 hr of BFR = delay of solid diet by 0.32 hours
Ileus	Occurrence of ileus	33.28	Occurrence of ileus delayed solid diet by 33.28 hrs.
Incision 1	LAP surgery	-5.28	LAP surgery led to a ↓ of 5.28 hrs to solid diet
Incision 2	Midline incision	5.46	Open w/ midline incision = delay of 5.46 hours to solid diet
Surgery 4	Sigmoid resection	22.70	SI = delay of 22.70 h to solid diet
TT1stMealLiquid	Time in hrs to 1st liquid meal	1.14	Delay of 1 hour for liquid diet = delay of 1.14 h to solid diet

Table 11. Association of Time to First Solid Meal with GI Symptoms, POI, Other Comps, and LOS

Dependent Variable	Conceptual or Operational Definition	β	Interpretation
GI Symptoms	Includes incidence of PONV or abdominal distention	NS	NA
Ileus	Occurrence of POI	NS	NA
Other Comps	Hemorrhage, ↓platelets, anemia, ↑WBC, fistula, ileostomy prolapse, hematochezia, sepsis, abscess	NS	NA
LOS	# of days in hospital post-op	0.023	Delay of 1 hr. of a solid diet = > LOS by 0.023 days/33 minutes

Chapter 5: Discussion

A solid diet as the first meal on POD1 has been shown to be safe, to not cause increased GI complications or major complications[17-18,37-39,44], and to lead to decreased LOS.[17,38] However, in this study, only two patients (2%) were fed a solid diet as the first meal and the average time to first solid diet was 3.4 days. Post-surgical inflammation and the hypermetabolic state increases caloric and protein needs, and a CLD as the first postoperative meal consumed for an average of 3.4 days provides a gross nutritional deficit for patients after GI and abdominal surgery.

In the Amos model, time to first solid meal was positively associated directly with sigmoid resection surgery, and time to first liquid meal. Time to first solid meal was also indirectly associated with whether clear liquids were allowed 12 to 24 hours prior to surgery, time to mobilization, time to BFR, and incidence of ileus. As expected, delayed mobilization, delayed BFR, and incidence of ileus were associated with a delayed time to solid diet, and clear liquids prior to surgery versus those who did not receive clear liquids prior to surgery improved time to solid diet. These are individual interventions of ERAS protocols and have been shown to lead to earlier toleration of a regular diet, decreased LOS, and decreased complication rates when combined with other ERAS protocols.[47,53,71-72]

The aim of this study was to add to the body of knowledge that shows EOF of a solid diet as the first meal decreases LOS and is not associated with increased GI symptoms, ileus, or other complications. In the current study, when solid diet intake was delayed by one hour, there was an associated increase in LOS by 33 minutes. Theoretically, if a patient could have been fed a solid diet 16 hours after surgery, but was instead fed a solid diet at 81 hours (which was the average time to solid meal in the current study), then the LOS would be increased by approximately 1.5 days. This association is also shown in other studies. Four RCTs reviewed found that earlier oral

feeding led to a decreased LOS.[7,9,33,38] Fonseca et al. showed that EOF of a clear liquid diet (EFG) compared to subjects who were not fed a clear liquid diet until flatus (TCG) had significantly shorter LOS (4.0 versus 7.6 days, respectively).[33] The EFG received a CLD on POD1 and 83% were advanced to a solid diet within 24 hours while the TCG received a CLD on POD2 and 80% tolerated the meal and were advanced to a solid diet within 24 hours.[33] This suggests that intake of a solid diet earlier leads to a faster recovery and therefore, decreased LOS. Fonseca et al. excluded patients who underwent emergency surgery, those who received a stoma, patients who were in the ICU for greater than 24 hours, and patients with an ASA score greater than three.[33] Indeed, Lau et al. observed a significantly decreased LOS of two days in patients fed a solid meal (LRD) first compared with those fed a CLD first in colorectal surgery patients.[17] In addition, patients provided a LRD as the first meal tolerated the solid diet approximately two days sooner than those given a CLD as the first meal, and also PONV did not differ between groups.[17] This shows that eating a solid diet as the first meal on POD1 does not cause increased discomfort due to PONV and leads to faster recovery. Lau et al. excluded patients who were pregnant, those who had a pre-operative clinical diagnosis of intestinal obstruction, pre-operative use of total parenteral nutrition, and use of epidural analgesia.[17] There were no significant differences in baseline characteristics or demographics between the two groups in either study.

Similarly, the current study did not find any significant associations between time to first solid meal and GI complications, sepsis, abscess, or other complications. The results of the current study agree with the findings of RCTs reviewed. Lassen et al (2009) demonstrated that the need for NGT reinsertion and incidence of minor or major complications were not different between those who were NPO and those who had a solid meal at will. Interestingly, the authors did show that the enteral feeding group compared to the solid meal group had more

complications at an 8-week follow-up.[38] Lau et al. also did not find significant differences in complication rates between groups.[17] There were no significant differences between the CLD or LRD groups in wound infection or intra-abdominal infection, pneumonia, sepsis, bacteremia, or enteritis/colitis.[17] In addition, none of the 18 studies reviewed found that a solid diet as the first meal compared with CLD, or EOF of any type, led to increased complication rates.

In the current study, incidence of ileus was found to be significantly associated, indirectly, with time to first solid meal. It is to be expected that incidence of ileus would delay liquid and thus solid meals. It is important to note that in the current study, "ileus" is the incidence as specifically diagnosed by a doctor. Only 12 patients out of 84 cases were diagnosed with ileus. Generally, ileus is thought to be an unstoppable condition in all surgery patients. Most studies define resolution of ileus as the return of bowel function as evidenced by flatus and/or bowel function. Thus, resolution of ileus would be reflected in the time to first BFR. In this study, later BFR was associated with a delay in the patient receiving a liquid and solid diet. However, an association between later BFR and a delay in the patient eating is related to the fact that 44% of the patients were not fed until after BFR.

Early mobilization is used along with other ERAS protocols, and leads to earlier BFR, earlier oral intake, decreased complications, and decreased LOS.[49, 71-72] Interestingly, time to first mobilization and BFR did not have a significant effect on LOS, with beta values of 0.002 and 0.008, respectively. Based on these beta values, theoretically, if mobilization and BFR were delayed 24 hours, then LOS would be increased approximately 1 hour and 4.6 hours, respectively. The fact that the associated beta values are small may suggest that BFR is not as crucial to enhanced recovery as an earlier meal. Fifty six percent of patients in this study were fed before BFR and only two patients out of 84 cases were fed a solid diet as the first diet; all

other patients were fed a CLD. Indeed, studies have shown that feeding patients a liquid or solid diet early and before BFR is safe,[9,33-36] leads to faster recovery of bowel function [9, 17, 38] and decreased LOS.[9,17,33,38]

Twenty five percent of patients had an NGT in situ beyond POD1. Current practice of nasogastric suction of the stomach and fasting by resting the bowel until BFR is thought to prevent PONV, prevent gastric dilation, treat ileus, and allow the anastomosis to heal. However, physiologically, waiting until BFR to feed patients is not consistent with the return of GI motility. The motility of the small intestine resumes within 6 to 12 hours of surgery, the stomach resumes within 12 to 24 hours, and colonic motility resumes within 48 to 72 hours.[1,15] In addition, even when not being fed, the GI tract produces 500-1,000 ml/day of gastric secretions and 1L to 2L of biliary and pancreatic secretions per day.[1,15]

In open intra-abdominal surgery patients, the NGT was removed immediately and 107 patients were fed a CLD and 138 patients fed a regular diet on POD1.[37] This study did not see a significant difference in LOS, GI symptoms, BFR, frequency or duration of NGT use, or time to toleration between the groups.[37] However, it should be noted that 50% of patients in both groups did not pass flatus before discharge, demonstrating that it is not necessary to wait until BFR, defined as flatus and BM, to feed patients.[37] Along similar lines, other experimental studies comparing EOF of a solid diet to a CLD have shown a solid diet leading to faster BFR. In open colorectal surgical patients, the NGT was immediately discontinued and 57 patients were fed a CLD and 54 patients were fed a LRD on POD1. BFR occurred faster in the LRD group compared to the CLD group (4.8 days versus 3.7 days). In addition, time to tolerance of a LRD was significantly longer in the CLD group (4.1 days versus 2.0 days) and the CLD group had a 28% incidence of vomiting, while the LRD group had a 14% incidence of vomiting. In addition,

the CLD group had more days on anti-emetic medication.[17] In a study of patients having upper GI surgery, 220 patients resumed normal food at will on POD1; the control group (n=227) was fed an enteral tube formula on POD1 and advanced to normal food on POD5. The subjects that resumed normal food at will had significantly shorter time to first flatus (2.6 versus 3.0 days).[38]

Ultimately, the main limitation of this study is that it is an observational study involving retrospective EMR review where the author abstracted data and was not blinded to the aim of the study. Observational studies can only describe associations and not causations. The model is considered a good fit; minimum discrepancy and degrees of freedom (CMIN/DF) are less than 1.393, and normed fit index (NFI) is less than 0.9, which is the threshold for good fit. However, comparative fit index (CFI) is slightly higher than 0.9, CFI having the same general threshold as NFI of 0.9. Root mean square error of approximation (RMSEA) or absolute fit index is 0.069, which is within the range conventionally accepted as adequate fit. Overall, the model fit is adequate, however, the reason that it is not a better fit is most likely that there may be other associations that should have been included in the model. Also, it is possible that for some of the predictors, the relationship with the responses may not be linear.

There may have been errors in data abstraction since there was not a second abstractor or reviewer. Data collected included the time of events and may not reflect the actual time that the occurrence took place, e.g., first flatus/bowel movement, time to mobilization, or the time the care was provided, e.g., time to first liquid or solid meal. In the nurse’s daily assessments, only the exact time of first meal with regards to type of diet could be ascertained. If the first meal was not a solid diet (only two cases had a solid diet as the first meal), then the time to solid diet was calculated from the order date and time, and normalized to the time of meal service. In addition, there were unmeasured confounders such as blood loss during surgery, length of surgery, and

extent of adhesiolysis, and total length of bowel resected (specimen length was not always noted by pathology). All studies reviewed measured time, usually in days, to toleration of a solid diet. However, in the current study, time to toleration of a solid diet was not used, due to the way times were recorded in the reviewed patient EMRs. As a result, it was only possible to calculate the time to first solid diet; in almost all cases, patients tolerated a solid diet the first time it was consumed.

This study involved subjects from five different hospitals and each hospital, surgeon, and clinical staff had their own methodology of preoperative preparation, patient intake, pre- and postoperative care, and care documentation. The number of subjects collected were not large enough to analyze differences between hospitals. Five types of GI surgeries were included in the study with various comorbidities, so results are difficult to generalize for all GI surgical patients.

There are several rules of thumb used for determining the sample size to most accurately estimate the magnitude and significance of proposed associations among variables. Tanaka et al. suggest that a ratio of number of subjects to number of free parameters of 20:1 is best[73] and 5:1 is the absolute minimum.[74] Hoyle and Kenny suggest that a sample size of 200 is the goal for path analysis.[75] Hoyle and Gottfredson state that the fit and power of a path analysis model may be acceptable with a sample size of 50.[76] Similarly, Iacobucci et al. states, “shoot for a sample size of at least 50”.[77] However, it is difficult to use a single sample size rule of thumb due to the vast variability of complexity in each given structural equation model.[78-79] The ratio of sample size to number of parameters in the current study is 4.7:1, which is close to the generally accepted minimum of 5:1. Also, there were 84 cases used in this study, which is above the minimum acceptable sample size of 50. However, a sample size below one-hundred subjects

increases the likelihood of estimation problems and decreased statistical power in some fit indices, and therefore, accepting a model that is unsatisfactory.[76]

Chapter 6: Conclusions and Recommendations

In summary, EOF of a solid diet after GI resection surgery is safe, which agrees with randomized controlled trials reviewed. There were no significant associations between time to first solid meal and GI complications, sepsis, abscess, or other complications. Both earlier time to first solid diet and eating before BFR were associated with decreased LOS. In the model, time to first solid meal was directly associated with sigmoid resection surgery, and time to first liquid meal. Time to first solid meal was also indirectly associated with whether clear liquids were allowed 12 to 24 hours prior to surgery, time to mobilization, time to BFR, and incidence of ileus. All patients except two received a CLD as their first meal, 44% were fed after BFR, and the NGT was kept in place greater than POD1 in 25% of subjects.

Currently, there are no clinical guidelines for postoperative feeding. Internet search engines will provide an array of GI surgeon and gastroenterologists private practice websites and blogs, which provide information on suggested postoperative feeding practices and each one is different. The Academy of Nutrition and Dietetics Nutrition Care Manual (NCM) is an internet-based diet manual and professional practice manual for registered dietitian nutritionists and allied health professionals. The NCM states that for bowel resection patients “research has shown that patients postoperatively had no difference in tolerance to a clear liquid diet or regular diet”, “significantly more energy and protein were consumed on a regular diet compared with a CLD”, and that “careful evaluation of diet progression is needed in patients with significant bowel resections, strictures, fistula, or motility disorders”. The NCM does suggest that advancing from a CLD to a full liquid diet may not be necessary due to high fat content. However, the nutrition intervention for bowel surgery suggested by the NCM is ambiguous and states “nutrition care depends entirely on the type of bowel surgery and can be a progression from CLD to a normal

meal plan or may require extensive nutrition support". However, in a different section describing what the clear liquid diet is and what it is used for, the NCM admits that the CLD is nutritionally inadequate for patients of all ages, that long-term use is thought to contribute to malnutrition, and should only be used when "absolutely necessary". It is recommended that a CLD should only be used for one to two meals.[42] The NCM also points out that the amount of time patients are on CLD postoperatively has declined because of the "new knowledge that return of bowel sounds is not a prerequisite for feeding" and admits that CLDs are unpalatable, causing patients to complain, and decreasing patient satisfaction scores.[31]

Bowel resection procedures cover a broad range of various surgery types, length, and type of bowel removed, and type of diagnoses and complications involved. Therefore, it is difficult to generalize postoperative feeding procedures. Based on the randomized controlled trials reviewed and the current study, it is recommended that surgeons and clinicians implement EOF of a solid diet on POD1 when appropriate. Postoperatively, patients should be given the choice of solid foods on POD1 and clinicians should discard the traditional step-wise progression of CLD, to full-liquid diet, to LRD after GI resection surgeries. However, a liquid diet may be appropriate for certain patients. Clinicians should continue to use clinical judgement to determine if a liquid diet is needed based on each patient's condition.

It is the responsibility of surgeons, nursing staff, and dietitians, working as an interdisciplinary team, to provide evidence-based care for GI and abdominal surgery patients. There are several ways the interdisciplinary team can use the evidence reviewed on feeding practices after surgery to improve patient care when a deficit in postoperative feeding practices is observed at their facility. First, surgical nurses or dietitians can begin encouragement of early feeding of a solid diet to patients and surgeons. Surgical nurses and dietitians can discuss the

evidence supporting EOF of a solid diet with nursing directors and chief of staff in order to advocate establishment of standard clinical guidelines. Dietitians can organize an educational in-service for nursing staff and a “lunch and learn” for surgeons. Dietitians can also collaborate with the interdisciplinary team and other hospital staff to design and implement educational handouts for surgical patients encouraging EOF of a solid diet on POD1.

Larger, multi-centered prospective, randomized controlled trials should be performed comparing a CLD to a solid diet as the first meal postoperatively. These studies would allow a direct comparison of time to first bowel function return, incidence of complications, GI symptoms, and LOS in subjects who were fed a CLD as the first meal on POD1 compared to a solid diet on POD1. According to the results of the current study, the following confounders need to be controlled: time to mobilization, preoperative practices, such as giving clear liquids preoperatively or fasting, incision type, and surgery type, among other factors. Since the Academy of Nutrition and Dietetics and reviewed studies suggest feeding before BFR is safe and early oral feeding of a solid diet is beneficial to the patient qualitative studies exploring clinician’s beliefs on early oral feeding of a solid diet and feeding before BFR are warranted.

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Appendices

Appendix A. UIW IRB Form.

DocuSign Envelope ID: 0D5CB230-F300-4DAA-8884-52451314678B

UIW Application for IRB Approval
Part I: Application Form

This application is to be used for initial application for IRB review only. Sufficient time must be allowed for review. Incomplete applications will be returned without review. For a list of application components, see the IRB Manual.

Submit this completed form as part of the application to the Office of Research Development electronically for IRB review. **Do not submit applications directly to the IRB representative**, as this form will be electronically routed to them for review after it has been checked for completion and logged into the IRB database. Signatures will be applied electronically once the application is approved.

Principal Investigator			
A Principal Investigator (PI) must be designated for any human subjects research. The PI is responsible for ensuring university and federal regulatory compliance for all research activities and research personnel associated with this protocol. For the responsibilities of the PI, refer to the UIW IRB Manual.			
Name: Jennifer Maycotte	Phone #: 210-787-8874	E-mail: kiehnhof@student.uiwtx.edu	Mailing Address: 4301 Broadway CPO# 100, San Antonio, TX 78209
College/School or Department: Department of Math, Science and Engineering/ Nutrition		CITI Training Date: September 2013	PIDM (UIW ID): 913937
Is the PI a student? ☐ NO ☒ If, YES, a faculty supervisor must be designated for this research protocol. Include a signed copy of the **Faculty Supervisor Agreement** with this application.			
Faculty Supervisor			
Name: Dr. Beth Senne-Duff	Phone #: 210-829-3165	E-mail: beths@uiwtx.edu	CPO: 311
College/School or Department: Nutrition		CITI Training Date: 12/11/2012	PIDM (UIW ID): Click here to enter text.

Other Project Personnel				
List all other project personnel, including co-investigators, research associates, and student researchers who will be recruiting, consenting, collecting data, or working with data collected from human subjects. Use "enter"/"return" key to list personnel on separate lines.				
Name: Click here to enter text.	Role in Research: Click here to enter text.	CITI Training Date: Click here to enter text.	Email: Click here to enter text.	PIDM (if student): Click here to enter text.

Research Information		
Title of Study: Early Oral Feeding After Bowel Resection		
Research Category: ☒Exempt ☐Expedited ☐Full Board		
This research will be conducted: ☐ On the UIW campus or UIW facilities ☒ Off campus (list all locations where research will be conducted): Baptist Health System		
Number of Subjects: 80	Number of Controls: N/A	Total Duration of Study Activities: 11 months
This research will involve the following (check all that apply): ☐ Inmates of penal institutions ☐ Institutionalized intellectually handicapped ☐ Institutionalized mentally disabled ☐ Committed patients ☐ Intellectually handicapped outpatient		

University of the Incarnate Word
IRB Approved
Application No. 14-10-001

- ☐ Mentally disabled outpatient
- ☐ Pregnant women
- ☐ Fetus in utero
- ☐ Viable fetus
- ☐ Nonviable fetus
- ☐ Dead fetus
- ☐ In Vitro fertilization
- ☐ Minors (under 18)

Funding Disclosures

Funding source(s): ☒Internal ☐External ☐Pending ☐None

List all funding sources (pending and awarded):
department

The funding provides for (select all that apply):

- ☐ Investigator release time or compensation
- ☒ Research materials
- ☐ Graduate assistants, student workers, or other project employees
- ☐ Travel
- ☐ Other:
  Click here to enter text.

Financial Conflict of Interest

Does any member of the project team hold financial interest in the funding organization or any similar organization (stocks, board membership, etc)?

- ☒ NO
- ☐ If YES, describe below:
  Click here to enter text.

This Section for Office of Research Development Use Only
Signatures will be applied electronically upon approval

Investigator Signature(s) & Assurances

I certify that the information above is accurate and complete. I will request prior IRB approval for any changes to the approved protocol and/or informed consent forms, and will not implement those changes until I receive IRB approval. I will report any adverse effects to the IRB immediately. I agree to comply fully with the ethical principles and regulations regarding the protection of human subjects in research.

Principal Investigator:

Name:	Signature:	Date:
Jennifer Maycotte	DocuSigned by: Jennifer Maycotte	10/1/2014

Faculty Supervisor (if Principal Investigator is a student):

Name:	Signature:	Date:
Beth Senne-Duff	DocuSigned by: Beth Senne-Duff	10/1/2014

Approval Signature(s)

IRB Representative/Reviewer:

Name:	Signature:	Date:
Kevin B. Vichcales	DocuSigned by:	10/1/2014

IRB Chair (or Chair's Designee):

Name:	Signature:	Date:

Appendix B. Blank Data Collection Form.

Early Oral Feeding After Bowel Resection Data Collection Form v2.0
UIW Research Study 14-10-001
Principal Investigator Jennifer Strang, UIW ID 913937

St. Luke's NCB MT BMC NEB

Subject age and sex: ______ Ht: _____ Wt: _____ BMI: _____

Diagnosis: ____diverticulitis w/o hemm

Comorbidities: ____

Previous surgeries: ____

Date of admission: __________ Date of surgery: __________ Time of surgery: __________

Date of discharge: __________ Total length of hospital stay (days): _____

Incision type: Laparoscopic Open Midline Open Off mid-line

Surgery:

- ▫ Left and right hemicolectomy
- ▫ Total colectomy
- ▫ Partial resection of SI
- ▫ Lap lysis of peritoneal adhesions
- ▫ Extensive adhesiolysis
- ▫ Sigmoid resection
- ▫ Multivisceral resection
- ▫ Abdominoperineal resection

Colostomy Ileostomy Benign Neoplasm

Pre-operative preparation techniques:

-Fasting: NPO >0000 CLS 12 hours CLS 24 hours Chew gum TID

-**Bowel preparation**: Yes Suprep Chloraprep Mechanical Anorectal

-Pre-medication: Invanz Midazolam Entereg Ancef (Cefazoin) Ertapenem Famotidine

Analgesic techniques: Morphine Hydromorphone Ketorolac Norco Codeine Dilaudid Mependine Tramadol

PRN meds: Ondansetron (Zofran) Phenergan Promethazine Docusate Metoclopramide (Reglan) Protonix Pantoprazole Senna

Anesthetic techniques: General Sevoflurane Fentanyl Desflurane

Bladder catheter: _________

Diet:

Type of post-operative diet (liquid or solid): __________

Date/time of first meal: ______________________ Time to first meal (hours): _____

First flatus (hours): _______________ **Time to mobilization** (hours): _____

First BM (hours): _____

Early Oral Feeding After Bowel Resection Data Collection Form v2.0
UIW Research Study 14-10-001
Principal Investigator Jennifer Strang, UIW ID 913937

Diet toleration

POD / **Symptom**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nausea								
Vomiting								
Diarrhea								
Abd distention								
NGT reinsertion								

Complications		
▫ Catheter infection	▫ Intra-abdominal abscess	▫ Renal Complications
▫ Pneumonia	▫ Fluid Overload	▫ Hemorrhage
▫ Urinary Tract Infection		▫ Post-operative Mechanical Ileus
▫ Primary Bacteremia	▫ Cardiovascular Complications	▫ Postoperative Paralytic ileus
▫ Sepsis	▫ Deep Vein Thrombosis	▫ Anastomotic leakage
▫ Surgical Wound Infection	▫ Pulmonary Embolism	

PATIENT EXCLUSION CRITERIA:

- ▫ Age <18
- ▫ ASA score >III
- ▫ CA diagnosis
- ▫ Emergency surgery
- ▫ ICU >24 hours (pre- or post-surgery)
- ▫ Malnutrition
- ▫ No nutritional assessment w/i 48 hours of surgery
- ▫ Pregnant/breast feeding

Appendix C. General and Local Complication Definitions.

Complication	**Definition**
Catheter Infection	Pathogen organisms isolated in culture and/or local signs of inflammation
Pneumonia	Clinical signs plus positive blood culture Clinical signs plus positive culture of brushing or biopsy or tracheal aspirate
Urinary Tract Infection	Clinical symptoms or >100,000 colony-forming units/ml were present in culture
Primary Bacteremia	Isolation of a known pathogen in blood culture not relation to another source of infection or fever >38ºC, chill, or hypotension (SBP <90 mm Hg)
Sepsis	Fever >38ºC, hypotension, or oliguria (<20 ml/h) without a known origin that is treated with sepsis antibiotics
Surgical Wound Infection	Purulent exudate in wound and isolation of pathogen organisms in culture
Intra-abdominal abscess	Fever, abdominal pain and either ultrasound, CT, or surgical evidence of abscess plus isolation of pathogen
Fluid Overload	Documented hypoxia, examination findings, or radiologic diagnosis requiring diuretic therapy
Ileus	Absence of flatus, bowel sounds, and passage of bowel movement, abdominal distention, nausea, or vomiting that prevents oral intake and/or require reinsertion of a nasogastric tube
Cardiovascular Complications	Ischemia, infarction, arrhythmia, or heart failure requiring an alteration in treatment
Deep Vein Thrombosis	Diagnosed by sonography and/or venography
Pulmonary Embolism	Diagnosed by CT scan or scintigraphy
Renal Complications	Elevated lab values requiring alteration in care.
Hemorrhage	Blood transfusion or reoperation required
Post-operative Mechanical Ileus	Reoperation needed
Postoperative Paralytic ileus	Abdominal distention with excessive vomiting requiring NGT re-insertion
Anastomotic leakage	Radiological or reoperation finding

Appendix D. IBM SPSS Statistics Correlation Matrix.

* = Pearson Correlation is significant at the 0.05 level (2-tailed).

	BMI	Incision=1	Incision=2	Incision=3	Surgery=1	Surgery=2	Surgery=3	Surgery=4	TT1stMealLiquid	TT1stMealSolid	HoursNPO	TT1stBFR	ACPC	TTMobile	LOSPO	FastingNPO	FastingCLS	Entereg	Laxative	Prokinetic	GI	NGT	Ileus
BMI	1	-0.025	0.025	0.001	-0.135	0.026	-0.199	.383**	0.034	0.104	0.031	0.149	-0.052	0.210	-0.077	-0.091	-0.211	0.117	-0.041	-0.045	-0.048	-0.097	-0.039
Incision=1	-0.025	1	-.909**	-0.198	.323**	-0.122	-0.014	-0.211	-0.067	-0.175	-0.058	-0.173	-0.091	0.024	-0.189	.256*	0.180	0.063	0.006	0.208	0.007	0.042	-.225*
Incision=2	0.025	-.909**	1	-.229*	-.269*	0.145	-0.151	.280**	0.132	.265*	0.123	.250*	0.053	-0.003	.263*	-0.147	-0.133	-0.012	-0.042	-0.202	0.028	0.014	0.194
Incision=3	0.001	-0.198	-.229*	1	-0.121	-0.056	.387**	-0.167	-0.152	-0.219	-0.153	-0.180	0.085	-0.061	-0.178	-.252*	-0.108	-0.117	0.085	-0.012	-0.081	-0.129	0.068
Surgery=1	-0.135	.323**	-.269*	-0.121	1	-0.136	-.312**	-.403**	-0.133	-0.103	-0.126	-0.158	-0.026	-0.111	-0.105	0.021	0.173	0.064	0.054	0.179	-0.066	0.016	-0.139
Surgery=3	-0.199	-0.014	-0.151	.387**	-.312**	-0.145	1	-.430**	-0.091	-.260*	-0.082	-0.190	-0.036	-0.142	-0.204	-0.042	0.140	0.034	0.132	0.077	0.000	-0.206	0.157
Surgery=4	.383*	-0.211	.280**	-0.167	-.403**	-0.188	-.430**	1	0.032	.280*	0.026	0.191	0.164	0.114	0.080	-0.039	-.235*	-0.147	-0.141	-0.179	0.007	-0.029	-0.020
TT1stMealLiquid	0.034	-0.067	0.132	-0.152	-0.133	0.160	-0.091	0.032	1	.880**	1.000**	.364**	-.570**	0.147	.531**	-0.095	-.296**	-0.123	-.349**	-.280*	-0.067	.494**	.329**
TT1stMealSolid	0.104	-0.175	.265*	-0.219	-0.103	-0.019	-.260*	.280*	.880**	1	.867**	.346**	-.395**	0.261	.538**	-0.140	-.353**	-0.187	-.300*	-0.201	0.064	.382**	.254*
HoursNPO	0.031	-0.058	0.123	-0.153	-0.126	0.158	-0.082	0.026	1.000**	.867**	1	.351**	-.571**	0.145	.522**	-0.094	-.273*	-0.107	-.332**	-.262*	-0.058	.486**	.324**
TT1stBFR	0.149	-0.173	.250*	-0.180	-0.158	.245*	-0.190	0.191	.364**	.346**	.351**	1	0.111	.364**	.287**	0.002	-0.180	0.018	-0.190	-0.122	-0.020	0.184	0.202
TTMobile	0.210	0.024	-0.003	-0.061	-0.111	-0.071	-0.142	0.114	0.147	0.261	0.145	.364**	-0.128	1	.324**	-0.005	-0.039	0.005	0.030	0.182	-0.007	-0.125	-0.035
LOSPO	-0.077	-0.189	.263*	-0.178	-0.105	0.140	-0.204	0.080	.531**	.538**	.522**	.287**	-.291**	.324**	1	-0.177	-.219*	-0.133	-0.149	-0.150	0.196	.215*	.409**
FastingNPO	-0.091	.256*	-0.147	-.252*	0.021	0.021	-0.042	-0.039	-0.095	-0.140	-0.094	0.002	0.074	-0.005	-0.177	1	.308**	0.171	0.097	.276*	0.042	-0.097	-0.117
FastingCLS	-0.211	0.180	-0.133	-0.108	0.173	0.134	0.140	-.235*	-.296**	-.353**	-.273*	-0.180	0.102	-0.039	-.219*	.308**	1	.338**	.445**	.586**	0.070	-0.210	-0.025
Entereg	0.117	0.063	-0.012	-0.117	0.064	.236*	0.034	-0.147	-0.123	-0.187	-0.107	0.018	0.057	0.005	-0.133	0.171	.338**	1	.386**	.330**	-0.042	-0.101	-0.047
Laxative	-0.041	0.006	-0.042	0.085	0.054	0.042	0.132	-0.141	-.349**	-.300*	-.332**	-0.190	0.151	0.030	-0.149	0.097	.445**	.386**	1	.492**	0.125	-.280**	-0.062
Prokinetic	-0.045	0.208	-0.202	-0.012	0.179	0.071	0.077	-0.179	-.280*	-0.201	-.262*	-0.122	0.148	0.182	-0.150	.276*	.586**	.330**	.492**	1	.331**	-.293**	-0.098
GI	-0.048	0.007	0.028	-0.081	-0.066	0.087	0.000	0.007	-0.067	0.064	-0.058	-0.020	-0.021	-0.007	0.196	0.042	0.070	-0.042	0.125	.331**	1	-0.111	0.059
NGT	-0.097	0.042	0.014	-0.129	0.016	0.203	-0.206	-0.029	.494**	.382**	.486**	0.184	-.281*	-0.125	.215*	-0.097	-0.210	-0.101	-.280**	-.293**	-0.111	1	0.157
Ileus	-0.039	-.225*	0.194	0.068	-0.139	0.041	0.157	-0.020	.329**	.254*	.324**	0.202	-0.178	-0.035	.409**	-0.117	-0.025	-0.047	-0.062	-0.098	0.059	0.157	1

** = Pearson Correlation is significant at the 0.01 level (2-tailed).

Appendix E. Description of Medications.

Class	Generic Name, Brand Name	Use	Basic Mechanism of Action	GI-Related Considerations
Opioid	Codeine sulfate	Analgesic	Opioid analgesic; not established.	Avoid w/ GI obstruction, especially paralytic ileus; may obscure diagnosis or clinical course w/ acute abdominal conditions.
	Hydromorphone HCL, Dilaudid	Analgesic	Opioid analgesic; pure opioid agonist. Has not been established.	May cause N/V
	Meperidine HCL, Demerol	Analgesic	Opioid analgesic; has multiple actions qualitatively like morphine.	May cause N/V
	Morphine sulfate	Analgesic	Opioid analgesic; not established.	Avoid w/ GI obstruction, especially paralytic ileus; may prolong obstruction. May obscure diagnosis or clinical course w/ acute abdominal conditions. N/V and constipation.
	Acetaminophen/ hydrocodone bitartrate, Norco	Analgesic	Hydrocodone: Opioid analgesic and antitussive; has not been established.	May cause N/V
	Alvimopan, Entereg	PO GI recovery	Opioid antagonist; selective antagonist of μ-opioid receptor. Antagonizes the peripheral effects of opioids on GI motility and secretion by competitively binding to GI tract μ-opioid receptors.	Dyspepsia

Appendix E. Description of Medications (continued).

Class	Generic Name, Brand Name	Use	Basic Mechanism of Action	GI-Related Considerations
Laxative	Docusate sodium Colace	Constipation	Stool softener	Caution w/ stomach pain, N/V, and sudden change in bowel habits >2 weeks. Consider D/C if rectal bleeding occurs, if no bowel movement after use, or if laxative req'd for >1 week.
	Magnesium hydroxide, Phillips' Milk of Magnesia	Constipation	Saline laxative	Caution w/ stomach pain, N/V, and sudden change in bowel habits that lasts >14 days. D/C if rectal bleeding occurs, no BM after use, or if needed for >1 week.
	Psyllium, Metamucil	Constipation	Bulk forming laxative	May cause N/V
Prokinetic	Metoclopramide, Reglan	PONV	Dopamine antagonist/prokinetic; not established. Appears to sensitize tissues to the action of acetylcholine; stimulates motility of upper GI tract w/o stimulating gastric, biliary, or pancreatic secretions and accelerates gastric emptying and intestinal transit. Increases resting tone of the lower esophageal sphincter. Antiemetic.	GI motility effect antagonized by anticholinergics and narcotic analgesics.

Appendix E. Description of Medications (continued).

Class	**Generic Name, Brand Name**	**Use**	**Basic Mechanism of Action**	**GI-Related Considerations**
Anti-emetic	Ondansetron, Zofran	PONV	Selective 5HT3 receptor antagonist; has not been established.	Diarrhea, constipation. Use > abdominal surgery may mask ileus and/or distension. Does not stimulate gastric/intestinal peristalsis; do not use instead of NG suction.
	Promethazine HCL (Phenergan d/c'ed)	PONV	Phenothiazine derivative; H1 receptor antagonist (does not block release of histamine). Possesses antiemetic effects.	May cause N/V

Source:

1. Various drug data sheets. PDR.net website. http://www.pdr.net/drugsummary. Updated 2016. Accessed October 26, 2016.

2. Psyllium. MedlinePlus website. https://medlineplus.gov/druginfo/meds/a601104.html. Updated 2016. Accessed November 03, 2016.

Appendix F. IBM SPSS Amos Total Effect Estimates Matrix.

	Incision_2	TTMobile	FastingCLS	Incision_1	TT1stBFR	Ileus	Surgery_4	TT1stMealLiquid	TT1stMealSolid
TT1stBFR	17.039	.273	-13.577	.000	.000	.000	.000	.000	.000
Ileus	.000	.000	.000	-.159	.000	.000	.000	.000	.000
TT1stMealLiquid	4.786	.077	-26.121	-4.629	.281	29.165	.000	.000	.000
TT1stMealSolid	5.460	.087	-29.804	-5.281	.320	33.276	22.700	1.141	.000
LOSPO	.128	.002	-.699	-.435	.008	2.741	.533	.027	.023

An estimates matrix describing total effects of all dependent variables against predictors are shown above. The dependent terms are listed on the left side and the predictors are across the top.

Appendix G. IBM SPSS Amos Path Analysis Raw Data Output.

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	33	44.591	32	.069	1.393
Saturated model	65	.000	0		
Independence model	10	381.552	55	.000	6.937

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.883	.799	.964	.934	.961
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.582	.514	.559
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	12.591	.000	34.299
Saturated model	.000	.000	.000
Independence model	326.552	268.353	392.242

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	.537	.152	.000	.413
Saturated model	.000	.000	.000	.000
Independence model	4.597	3.934	3.233	4.726

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.069	.000	.114	.250
Independence model	.267	.242	.293	.000

Appendix G. IBM SPSS Amos Path Analysis Raw Data Output (continued).

AIC

Model	AIC	BCC	BIC	CAIC
Default model	110.591	120.674		
Saturated model	130.000	149.861		
Independence model	401.552	404.607		

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	1.332	1.181	1.594	1.454
Saturated model	1.566	1.566	1.566	1.806
Independence model	4.838	4.137	5.629	4.875

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	86	100
Independence model	16	18

Appendix G. IBM SPSS Amos Path Analysis Raw Data Output (continued).

Estimates (Group number 1 - Default model)

Scalar Estimates (Group number 1 - Default model)

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Ileus	<---	Incision_1	-.159	.074	-2.131	.033	par_1
TT1stBFR	<---	TTMobile	.273	.081	3.365	***	par_6
TT1stBFR	<---	Incision_2	17.039	7.167	2.377	.017	par_9
TT1stBFR	<---	FastingCLS	-13.577	9.124	-1.488	.137	par_12
TT1stMealLiquid	<---	TT1stBFR	.281	.103	2.721	.007	par_2
TT1stMealLiquid	<---	FastingCLS	-22.308	9.244	-2.413	.016	par_3
TT1stMealLiquid	<---	Ileus	29.165	10.259	2.843	.004	par_13
TT1stMealSolid	<---	TT1stMealLiquid	1.141	.072	15.932	***	par_4
TT1stMealSolid	<---	Surgery_4	22.700	5.541	4.096	***	par_5
LOSPO	<---	Ileus	1.961	.601	3.263	.001	par_7
LOSPO	<---	TT1stMealSolid	.023	.004	5.285	***	par_8

Means: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Incision_1	.440	.055	7.985	***	par_17
FastingCLS	.190	.043	4.419	***	par_20
TTMobile	42.915	5.624	7.630	***	par_22
Incision_2	.512	.055	9.330	***	par_23
Surgery_4	.357	.053	6.791	***	par_18

Intercepts: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Ileus	.213	.050	4.275	***	par_16
TT1stBFR	32.473	6.440	5.042	***	par_21
TT1stMealLiquid	33.831	6.859	4.932	***	par_19
TT1stMealSolid	19.752	4.776	4.136	***	par_15
LOSPO	2.666	.409	6.521	***	par_14

Covariances: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Incision_1	<-->	Incision_2	-.229	.037	-6.139	***	par_10
Surgery_4	<-->	Incision_1	.011	.011	1.033	.301	par_11

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Incision_1	.253	.039	6.454	***	par_24
FastingCLS	.154	.024	6.442	***	par_25
TTMobile	2209.193	377.749	5.848	***	par_26
Incision_2	.250	.039	6.442	***	par_27
e1	1005.004	163.134	6.161	***	par_28
e4	.116	.018	6.442	***	par_29
e2	1056.235	165.684	6.375	***	par_30
Surgery_4	.230	.036	6.442	***	par_31
e3	439.164	79.841	5.500	***	par_32
e5	3.381	.534	6.337	***	par_33

Matrices (Group number 1 - Default model)

Total Effects (Group number 1 - Default model)

	Incision_2	TTMobile	FastingCLS	Incision_1	TT1stBFR	Ileus	Surgery_4	TT1stMealLiquid	TT1stMealSolid
TT1stBFR	17.039	.273	-13.577	.000	.000	.000	.000	.000	.000
Ileus	.000	.000	.000	-.159	.000	.000	.000	.000	.000
TT1stMealLiquid	4.786	.077	-26.121	-4.629	.281	29.165	.000	.000	.000
TT1stMealSolid	5.460	.087	-29.804	-5.281	.320	33.276	22.700	1.141	.000
LOSPO	.128	.002	-.699	-.435	.008	2.741	.533	.027	.023

Appendix G**.** IBM SPSS Amos Path Analysis Raw Data Output (continued).

Direct Effects (Group number 1 - Default model)

	Incision_2	TTMobile	FastingCLS	Incision_1	TT1stBFR	Ileus	Surgery_4	TT1stMealLiquid	TT1stMealSo
TT1stBFR	17.039	.273	-13.577	.000	.000	.000	.000	.000	.0
Ileus	.000	.000	.000	-.159	.000	.000	.000	.000	.0
TT1stMealLiquid	.000	.000	-22.308	.000	.281	29.165	.000	.000	.0
TT1stMealSolid	.000	.000	.000	.000	.000	.000	22.700	1.141	.0
LOSPO	.000	.000	.000	.000	.000	1.961	.000	.000	.0

Indirect Effects (Group number 1 - Default model)

	Incision_2	TTMobile	FastingCLS	Incision_1	TT1stBFR	Ileus	Surgery_4	TT1stMealLiquid	TT1stMealSo
TT1stBFR	.000	.000	.000	.000	.000	.000	.000	.000	.0
Ileus	.000	.000	.000	.000	.000	.000	.000	.000	.0
TT1stMealLiquid	4.786	.077	-3.813	-4.629	.000	.000	.000	.000	.0
TT1stMealSolid	5.460	.087	-29.804	-5.281	.320	33.276	.000	.000	.0
LOSPO	.128	.002	-.699	-.435	.008	.781	.533	.027	.0

Appendix H. IBM SPSS Amos Goodness of Fit Indices.

Abbreviation	**Definition**	**Use**
CMIN/DF	Minimum discrepancy/degrees of freedom	Measure of fit of independent model
NFI	Normed fit index	Fit of independent model compared to fit of saturated model (percentage)
CFI	Comparative fit index	CFI value near 1 = good model
RMSEA	Root mean square error of approximation (absolute fit index)	Measures extent to which model reproduces sample covariance matrix
AIC	Akaike information criteria	Comparative measure; ↓ value = better fit
BIC	Bayesian information criterion	Comparative measure of fit; More sensitive than AIC to complex models

Source:

1. Pui-wa Lei 2007

2. http://Amosdevelopment.com/webhelp/cmindf1.htm; http://davidakenny.net/cm/fit.htm.

Updated 2015. Accessed April 8, 2017.