Factors Affecting Early Postoperative Feeding Following Elective Open Colon Resection

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Hypothesis: If factors accounting for the inability to tolerate early postoperative feeding after elective open colon resection can be identified, then perhaps these factors can be modified to decrease future failures.

Design: Consecutive case series.

Setting: Tertiary referral center.


Intervention: Early postoperative feeding protocol consisting of clear liquids on the evening of postoperative day 2, regular diet on postoperative day 3, and discharged home as tolerated. A subgroup of patients was treated with metoclopramide.

Main Outcome Measures: The ability to tolerate early feeding. Postoperative complications. Length of hospitalization.

Results: Twenty-seven (13.5%) of the 200 patients failed to tolerate early feeding. 16 patients (8.0%) were immediately unable to tolerate oral intake, whereas 11 patients (5.5%) initially tolerated early postoperative feeding but required hospital readmission due to emesis. There were no abdominal abscesses or anastomotic leaks. In patients who failed early feeding, no significant differences were noted for age, comorbid medical illness, operative time, or additional surgical procedures, when compared with patients who tolerated early oral intake. However, 18 (20.9%) of the 86 men failed early feeding, compared with 5 (6.8%) of the 73 women (P = .01). Additionally, patients undergoing total abdominal colectomy or total proctocolectomy (n = 11) failed 45.5% of the time, compared with 12.2% of the patients undergoing other types of colectomy (n = 189) (P = .01). The addition of metoclopramide therapy did not significantly improve the ability to tolerate early feeding.

Conclusions: In patients undergoing elective open colon resection, early postoperative feeding is safe and effective, and produces a brief hospital stay compared with patients fed by traditional means. However, men and patients undergoing total abdominal colectomy are more likely to be intolerant of early postoperative feeding.
PATIENTS AND METHODS

From 1993 to 1998, an early postoperative feeding protocol was used for patients undergoing elective, open colon resections at Kaiser Permanente Medical Center, Los Angeles, Calif. This protocol consisted of no routine use of a postoperative nasogastric (NG) tube, patient-controlled analgesia using morphine, and initiation of a clear liquid diet on the evening of postoperative day (POD) 2. If the patient tolerated clear liquids, a regular diet was provided on POD 3, the patient-controlled analgesia was discontinued, and the patient was given oral narcotic analgesics. Patients were discharged home after 3 regular meals were tolerated, regardless of the passage of flatus and/or bowel movements. The first 50 consecutive patients were operated on by a single senior surgeon (T.X.O'C.); however, in the subsequent 150 patients, the operations were performed by multiple surgeons. For all patients, immediate postoperative complications, the ability to tolerate early feeding, and length of hospitalization were recorded. Daily interviews and examinations of patients were performed with special attention to nausea, emesis, and other indications of intolerance of early postoperative diet. Patients who experienced 2 episodes of emesis underwent NG tube insertion. Any patient who initially tolerated early postoperative feeding, but returned to the hospital within 2 weeks of discharge with emesis that required bowel rest and intravenous hydration/nutrition, was defined as a hospital readmission.

The initial part of the cohort (41 patients) was designed to examine the feasibility and safety of early postoperative feeding after elective open colon resection. In the second phase of the study (159 patients), identifying the possible factors that might contribute to the inability to tolerate early postoperative feeding was emphasized. Finally, in the most recent phase of the study, 10 mg of metoclopramide, administered every 6 hours for the entire hospitalization, was incorporated into the early postoperative feeding protocol to determine if the addition of a gastrointestinal motility agent could increase the ability to tolerate early postoperative feeding.

The factors analyzed for possible correlation with the patient's ability to tolerate the early postoperative feeding protocol included the following: sex, age (in years), operative time (in minutes), presence of comorbid illness, presence of associated procedures, type of colectomy, and use of metoclopramide therapy. Each factor was initially tested in a univariate logistic regression model with failure to tolerate the early postoperative feeding protocol as the outcome variable. In addition, a multivariate logistic regression model with all factors included was employed to test the significance of each factor while adjusting for all other factors. The statistical software package of S-Plus 4.5 (MathSoft Inc, Seattle, Wash) was used for all logistic regression models. The χ² and Fisher exact tests in StatXact 2.05 (CYTEL Software Corporation, Cambridge, Mass) were also used to initially test for correlations between failure to tolerate the protocol and various categorical factors.

Overall, 173 (86.5%) of the 200 patients tolerated the early postoperative feeding protocol. The mean hospital stay for these 173 patients was 3.4 days (range, 3-6 days), and 155 patients (89%) were discharged home by POD 4. Of the 27 patients who failed to tolerate early feeding, 16 patients (8.8%) experienced emesis and the inability to tolerate an early postoperative diet during the initial hospitalization. Five (31%) of these 16 patients required NG tube insertion. Their mean hospital stay was 7.5 days (range, 5-11 days); none were readmitted to the hospital. Eleven patients (5.3%) initially tolerated the early postoperative feeding protocol and were discharged home, but required later readmission due to emesis. Of these 11 patients, 6 (54.5%) required NG tube insertion. Three patients (1.5%) required 2 or more readmissions owing to persistent ileus. The mean duration of rehospitalization was 4.6 days (range, 1-9 days). The overall length of stay for these 11 patients, inclusive of all admissions, was 9.7 days (range, 4-13 days). Including the length of hospitalization time for readmissions, the mean hospital stay for all 200 patients was 4.2 days (range, 3-13 days).

Five patients (2.5%) developed wound infections. One patient (0.5%) developed pancreatitis requiring readmission, and 1 patient (0.5%) developed a perineal wound dehiscence after an abdominoperineal resection. Two patients (1.0%) experienced postoperative hemorrhage: 1 patient after an abdominoperineal resection developed pelvic hemorrhage requiring a 5-U blood transfusion, and 1 patient required immediate reexploration and vessel ligation for hemoperitoneum following a total proctocolectomy. One patient developed an early postoperative small-bowel obstruction requiring reexploration. No instances were noted of anastomotic leak, abdominal abscess, or aspiration pneumonia.

For the last 159 patients in the study, data were collected to identify the possible factors which might contribute to the inability to tolerate early postoperative feeding. In this group of patients, the mean operative time was 124 minutes (range, 65-305 minutes). Thirty-seven patients (23.2%) had at least 1 significant comorbid medical illness including the following: diabetes mellitus (17 patients), coronary artery disease/cardiovascular disease (10 patients), hypothyroidism (4 patients), end-stage renal disease (2 patients), and scleroderma (2 patients). Forty-three patients (27%) underwent 43 other surgical procedures simultaneously with colon resection including the following: adhesiolysis (21 patients), liver resection/wedge biopsy (10 patients), cholecystectomy (5 patients), enterectomy (2 patients), oophorectomy (2 patients), partial cystectomy (1 patient), radical nephrectomy (1 patient), and radical retropubic prostatectomy (1 patient).

When patients who tolerated early postoperative feeding were compared with those who did not, no significant differences were noted for age, comorbid medical illness, operative time, or additional surgical procedures. However, 18 (20.9%) of the 86 men failed early feeding, whereas only 5 (6.8%) of the 73 women did so (P = .01, χ² test). Additionally, 5 (45.5%) of the 11 patients undergoing total abdominal colectomy or total proc-
Factors Associated With Feeding Intolerance

<table>
<thead>
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<th>Factor</th>
<th>Early Feeding Protocol</th>
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<tr>
<td></td>
<td>Failed (n = 23)</td>
<td>Tolerated (n = 136)</td>
<td>Univariate</td>
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<td>Mean operative time, min</td>
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<td>132.2</td>
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<td>18/86 (20.9)</td>
<td>68/86 (79.1)</td>
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<td>5/73 (6.8)</td>
<td>68/73 (93.2)</td>
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<tr>
<td>TAC or TPC‡</td>
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<td>6/11 (54.5)</td>
<td>.006†</td>
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<tr>
<td>Other</td>
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<td>130/148 (87.8)</td>
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<td>Use of metoclopramide therapy</td>
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<td>Yes</td>
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<td>20/151 (13.2)</td>
<td>131/151 (86.8)</td>
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*Values are expressed as number (percentage) or number/total population (percentage) unless otherwise indicated. Ellipses indicate not applicable. †Boldfaced values indicate statistically significant factor. ‡TAC or TPC indicates total abdominal colectomy or total proctocolectomy.

The traditional approach to postoperative feeding after colon resection required waiting for resolution of postoperative ileus, as evidenced by the passage of flatus and/or bowel movement. It was believed that early postoperative feeding might actually worsen and prolong postoperative ileus, by creating a vicious cycle of increasing intraluminal secretion, distention, and progressive motor dysfunction. Most important of all was the possibility of anastomotic leak, which could result from increased intraluminal pressure producing anastomotic tension, ischemia, and eventual disruption.

Based on the assumption that smaller incisions and decreased bowel manipulation would produce less ileus, laparoscopic and laparoscopic-assisted colectomy provided evidence that early postoperative feeding could be tolerated without a significant increase in complications. However, several recent trials have demonstrated the feasibility and safety of early postoperative feeding following open colon resection as well. In our 1996 study, we compared 41 patients who were managed by the early postoperative feeding protocol after elective colon surgery with 41 historical controls undergoing similar operations who were managed by traditional postoperative feeding criteria. Equivalent numbers of patients experienced postoperative ileus, yet the mean length of hospitalization was considerably shorter in the early postoperative feeding group (4.2 vs 6.7 days), and no differences were noted in postoperative complications.

Following open colectomy, Binderow et al also showed no difference in the duration of postoperative ileus between patients fed by an early postoperative feeding protocol vs traditional criteria, yet identified a trend toward decreased length of hospitalization (6.7 vs 8.0 days) in the early postoperative feeding group. Hawalsi et al demonstrated that in patients undergoing elective “conventional” colectomy who were given an early postoperative feeding 24 hours after the operation, their hospital stay was reduced from 8 to 4 days. Reissman et al compared 80 patients undergoing open colon resection who were managed by traditional postoperative feeding protocol with 80 patients undergoing similar open procedures but who were managed by an early postoperative feeding protocol. No significant differences were noted between the early postoperative and regular feeding groups for the rate of emesis, need for NG tube reinsertion, duration of ileus, or overall complications.

In our study, no patient developed an anastomotic leak or intra-abdominal abscess, confirming our previous findings that early postoperative feeding following open colectomy does not predispose patients to an increased incidence of complications. Other studies of early postoperative feeding after open colon resection have also shown no significant increase in infection rates, anastomotic leak, or other complications.

This protocol was designed to take advantage of well-recognized differences between the average time of return of gastric, small-bowel, and colonic motor activity following laparotomy. Because gastric and small-bowel motility...
normally return within 48 hours of operation, postoperative feeding was started then. Since colonic ileus generally lasts 3 to 5 days, solid food was given on POD 3. The proof of this protocol design is reflected in our results, with more than 80% of the patients discharged home by POD 4, and a mean initial hospital stay of only 3.8 days. Importantly, even when all readmissions were included in analyzing the overall length of hospitalization, the mean hospital stay was only 4.2 days—considerably shorter than when the traditional postoperative feeding criteria were used. More significantly, this hospital stay is shorter than that reported in more than 540 patients in multiple laparoscopic colectomy trials, in which the mean hospital stay was 6.7 days (range, 4.0-12.3 days).16

Although the results of our study were good, 13.5% of our patients were still unable to tolerate early postoperative feeding after elective open colon resection. In our study, we attempted to elicit the risk factors that might predispose patients to fail early postoperative feeding following open colon resection. If risk factors could be identified, perhaps appropriate alterations in management could be made to avoid feeding intolerance and, therefore, reduce the risk for potential complications, as well as costly hospital readmissions.

The risk factors associated with failure to tolerate early postoperative feeding were male gender and total abdominal colectomy or total proctocolectomy. We are uncertain why male patients were significantly more likely to fail early feeding. Possible mechanisms include anatomical differences, physiological differences (eg, hormone-dependence of gastrointestinal motility), or social/cultural differences between male and female perceptions of recovery and health. If anything, anatomical differences between men and women (increased mean colon length in women12) and physiological differences in gastric motility between men and women (slower gastric emptying in women13,14), would suggest an opposite effect than was observed.

Patients undergoing total abdominal colectomy or total proctocolectomy demonstrated significant inability to tolerate an early postoperative diet. The logical explanation for this finding is the amount of bowel manipulation, the length of incision, and time of exposure associated with these more extensive operations. However, time as an independent variable was not significant in our analysis, and the mean operative time for total abdominal colectomy or total proctocolectomy in this study was 158 minutes (range, 105-235 minutes), not significantly different from the mean operative time for the other colectomies (122 minutes). Additionally, other extensive procedures such as adhesiolysis, which are time-consuming and also require extensive bowel retraction and manipulation, did not seem to affect the ability to tolerate early postoperative feeding. It remains unclear why patients having total abdominal colectomy or total proctocolectomy are more intolerant of early postoperative feeding.

We also hypothesized that the addition of metoclopramide therapy may speed the time to resolution of gastric ileus and allow more patients to tolerate an early postoperative diet. However, in the 49 patients receiving routine metoclopramide therapy, no difference was noted in the failure rates, length of hospitalization, or number of patients discharged home by POD 4. It seems as if the addition of metoclopramide therapy offers no advantage in the success of early postoperative feeding after elective open colectomy. In the future, however, further study with different motility agents, as well as the use of nonopiate analgesics, may be done to determine if they have any notable effect on the results of early postoperative feeding.

To the best of our knowledge, this study represents the largest series of patients undergoing early postoperative feeding after open colon resection. We believe our data clearly demonstrate that early postoperative feeding and early hospital discharge following colon resection are not limited to laparoscopic techniques alone. The ideal method to compare laparoscopy vs open techniques, however, is a randomized, controlled trial that carefully incorporates identical means of postoperative feeding. Although the Phase 3 Prospective Randomized Trial Comparing Laparoscopic-Assisted Colectomy vs Open Colectomy, currently underway and accruing subjects, aims primarily at comparing survival between the 2 operative approaches, quality of life and cost-effectiveness are also important study objectives.17 It is important to point out that in any randomized trial examining length of hospital stay and/or costs of medical treatment following laparoscopic vs open procedures, patients must be given an identical feeding protocol to make accurate and appropriate comparisons between the 2 techniques.

In patients undergoing elective open colon resection, early postoperative feeding is safe, with no evidence of increased morbidity. Early postoperative feeding is also highly effective in reducing hospital stay. For unknown reasons, men and patients undergoing total abdominal colectomy or total proctocolectomy are predisposed to feeding intolerance. Failure to tolerate early postoperative feeding does not result in increased complications or increase the overall length of hospitalization. We believe that early postoperative feeding can be safely and effectively performed in the vast majority of patients undergoing elective open colon resection.

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REFERENCES

I have a few final questions. Were epidural catheters used in any patients? If they were, how did their use influence tolerance of the early postoperative feeding protocol? Do the authors have any anecdotal experience with prokinetic agents other than metoclopramide that show promise in this particular setting? Finally, how can your early feeding and early discharge program with open colectomy influence your opinions regarding the appropriateness and cost effectiveness of laparoscopic or laparoscopic-assisted colon resection?

Theodore Schroock, MD, San Francisco, Calif: We have seen enough data in this and other papers to believe that this effect is genuine. We, too, have observed that patients who have had the entire colon resected are different. Bruce Stabile said it may be due to autonomic nerve disruption from extensive mesocolic dissection. I have thought it was loss of the main intestinal gas reservoir, namely, the colon, that is responsible for intolerance to small amounts of gas, but I am curious about the authors' view.

The second question is about postdischarge follow-up. Was there a protocol involving personal calls from surgeons or nurses to these patients, or were they simply advised to call if they were having any problems?

Thomas Russell, MD, San Francisco: We did a study similar to this a few years ago, and I agree completely with the authors' premise. Many surgeons are still using NG tubes after elective colon resections. To these surgeons early feeding is a foreign concept. To feed early a protocol needs to be developed and allow taking small amounts of fluid throughout the day as the patient desires. Hopefully improved prokinetic agents will further shorten the period of ileus.

John Owings, MD, Sacramento, Calif: Patients' autonomic function is subject to suggestion by physicians. We, in a prospective study, previously demonstrated that ileus was similarly subject to perioperative suggestion by the physicians. My question then for the authors is what sort of suggestion were these patients given, namely, were the patients given clear liquids at POD 2 and told to take them and regular diet at POD 3 and told to take that, or were they simply offered up to clear liquids on POD 2 and up to regular diet on POD 3?

Edward Phillips, MD, Los Angeles, Calif: I have a question regarding protocols for nausea or nausea prevention. Were protocols in place prior to nausea, or was an aggressive protocol in place to treat nausea with Zofran (ondansetron hydrochloride), droperidol, or Compazine (prochlorperazine maleate) in your patients?

Ronald V. Maier, MD, Seattle, Wash: Since I agree with the authors' conclusions, it must be a good paper. Two questions. One of the important issues is how soon and how much the patients ambulate postoperatively. My impression is that men are more resistant than women. Did the authors notice if women ambulated earlier and whether that had a significant impact on their ability to eat sooner. The second is, as we are driven by medical economics and efficiency to force human physiology to fit a time clock, might the authors comment on what is an acceptable failure rate? A near 10% incidence of vomiting and a 5% readmission rate is not unreasonable, but should we start giving liquids on POD 1, send them home on POD 3 and accept an increased readmission rate and emesis rate? Do the authors have any thoughts on what are acceptable failure rates rather than waiting for objective evidence that the colon has returned to normal function?

Laurence F. Yee, MD, San Francisco: I congratulate the authors on a well-designed, controlled study, and I agree with their conclusions. I have a question regarding how you decide when to advance these patients' diets. Are there certain criteria regarding the amount patients have to tolerate on POD 2 to have a regular diet by POD 3? Second, what is your discharge criteria? Do your patients have to pass flatus or have a bowel movement prior to discharge?

Mark L. Welton, MD, San Francisco: We have been feed-

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ing our patients early now for 4 or 5 years, and Dr Schrock mentioned our lack of success. I agree with the authors’ discussion about men not doing as well. I think it comes down to intelligence. Women are smarter than men, and when you tell a woman to take it easy, she will start out with a postsurgical diet (tea, toast, crackers, juice, English muffins), and they nibble at it, drink a little bit, and they do okay. If you tell a man to start out light, he has 3 cheeseburgers and a pizza and then vomits. I specifically recommend that they just go real slow, and it works best if the wife is there to control them.

John E. Connolly, MD, Orange, Calif.: Having had the pleasure of being a visiting professor in various parts of the world, particularly the United Kingdom, going back many years, I was always amazed and somewhat aghast to see that they did not use NG tubes and fed patients earlier than we. Thus, finally we have a well-conducted study that questions a long accepted habit at least in the United States. I predict that many nonbelievers will change their ways.

Dr O’Connell: This is probably the first time that I had so much support in anything that I have ever presented, even at home, especially at home. But I think maybe I am preaching to the choir. I actually thought there would be a lot of objections since this is such a paradigm shift and a real change in our traditional methods. Surgeons are slow to change from their traditional methods. This study started with me watching people do laparoscopic colectomy a few years ago. They would look through the scope for 2 or 3 hours and, since these were usually laparoscopic assisted, they would make an incision, take the colon out, resect it, and anastomose it, drop it back in, and then feed them early. They said it was because of the laparoscopic technique. I really thought that this was Dumbo’s magic feather, that they thought it was laparoscopic technique but they could always do it. They could always fly. They just didn’t know it. They thought they needed the crutch of the laparoscopic technique. We can learn from these kinds of things just like we learn from laparoscopic herniorrhaphy, the use of the mesh. We don’t have to use laparoscopy, but use of mesh is the way that herniorrhaphy is done increasingly in the world.

I have answers to several of the questions. First of all, Dr Stabile, essentially we don’t use an NG tube unless the patient vomits and vomits repeatedly which means 2 emeses. There are no other factors that really make us put in the NG tube routinely.

The second question was, were the patients forced to eat, even if they were anorexic? Do we suggest to them beforehand? First of all these patients are prepared before they come into the hospital of what our protocol would be. So they already have an idea of when they are going to be fed and accept that, buy into it, and when they are going to be discharged, buy into it. We don’t force them to feed on the night of POD 2. A clear liquid diet is offered to them. I tell them that this is a test and if they feel sick, if they feel nauseated, don’t drink it. They are not forced to. We are interested to see if they pass that test. Then the next day they go on to a regular diet. Again, the sex influence may come in. That was brought up. Women will abide by that and still have a lot of their tray left, but they say it went down pretty well. For men, you come in 5 minutes later, and it’s all gone. They are ready to move on to the next step. Maybe that is part of the difference. The sex difference was really quite surprising to me. I thought it would be the time of surgery, comorbid illnesses such as diabetes, hypothyroidism, or associated operations that would add to the ileus, and what we really came up with was sex was one of the big factors. I was surprised by that. You would think that women actually would fail more often because various physiological studies have shown that they are slower to get over an ileus, they have a longer colon to body size, and they have delayed gastric emptying compared with men. So you would think physiologically they would fail. Why don’t they fail? I think there are several factors. Maybe they go along with the protocol, they don’t try to force the feeding as much as men. I think the other thing which we didn’t look at, and several people brought it up, is the amount of morphine used. This is patient controlled, and men may not have the same pain tolerance as women. Women have already been through childbirth, many of them and so forth, and perhaps a little ileus and a little incision doesn’t bother them a bit. I think they may use less morphine, but we have to examine that in further studies.

As far as the total abdominal colectomy is concerned, I agree with Dr Stabile. I think this is because of the extensive mesenteric and retroperitoneal nerve manipulation. We have abandoned total proctocolectomy from the early feeding protocol. However, these patients also failed the traditional method. After total proctocolectomy, patients fail no matter whether you do early or late feeding. There were no epidurals used in this study. Epidurals were really introduced after the study was running and I didn’t want to add another variable. But, again, maybe one future direction is to use epidurals rather than morphine. We have dropped metoclopramide; it didn’t seem to be of any benefit. So our next variable that we recently added was cisapride.

As far as laparoscopic and its cost effectiveness, what are we really saying is that any study that is done in the future really has to keep the variables of the feeding protocol the same, otherwise you are not really comparing open colectomy with laparoscopic. You are maybe comparing 2 different feeding protocols, traditional vs early feeding protocol.

As far as Dr Schrock’s question, we do not do routine calls to these patients. We don’t want to suggest that they should be sick or vomiting at home. We just tell them to call us if there is a problem. Most don’t. Five percent did come in because they did have nausea or emesis.

It is important to have a protocol and stick with it and not vary it to have a proper protocol. If you feed them too early, you are going to fail. What we did, and I am not saying this is the ideal one, is to come up with this protocol because most studies have shown that after 24 hours the small intestine is back. After 48 hours the stomach is back, and then it takes 3 to 5 days for the colon to get over its ileus. So we didn’t want to feed the patient before the stomach ileus was over. That’s why we waited for 48 hours. Could you push it and get another 6 or 8 hours off or 12 hours? Maybe, but this was a rationale of the protocol and it was a physiologically thought out protocol. As far as Dr Phillips’ question, we don’t use anti-emetics in general, either in traditional or early feeding protocol as far as Zofran, Compazine, etc. I don’t think anti-emetics should probably be used in most surgical patients. I don’t think their vomiting is due to central mediated problems. That’s fine for chemotherapy and sea sickness, but I don’t think it is right for surgical patients.

I do agree that early ambulation is very important. The patients are essentially up that evening of surgery and walking. Again, what is the acceptable rate of failure? I can’t tell you what the acceptable rate is, but I have shown you that whether we are using the traditional method or the early feeding protocol method, about 12% of the patients fail. Some people get prolonged ileuses even though you wait forever for them to get over them. I think not using the NG tube and early feeding is actually a good method. There have been multiple studies that show that the intestines do better with solutions and food in them, etc. We used to question years ago when people would actually put jejunostomy tubes in and start feeding the patient immediately after the surgery. But this may be right. Enterocytes do better when there is food in contact with them, and it may actually help them get over the ileus.

The discharge criteria: We do not wait for them to pass gas or have a bowel movement. Most people can do that at home like they have been doing for centuries and do not have to do that in the hospital. The idea that you have to keep the patient in the hospital hovering over them and asking them, have you passed gas, is really not necessary for the proper care of these patients.

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