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RESEARCH ARTICLE

Nutritional Delivery and Adequacy during Bile Reinfusion in Post-Surgical Patients

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ABSTRACT:
Background: Bile acid and salts depletion from high output bile in post-gastrointestinal surgical patients can lead to fat malabsorption causing malnutrition, fat-soluble vitamin deficiencies, dehydration, acute kidney injury and electrolyte abnormalities. Bile reinfusion is a method for restoration of bile salts in the gut. However, there are no studies which describe feeding delivery and nutritional adequacy during bile reinfusion.
Methods: Patients undergoing gastrointestinal surgery and who have high bile output >500ml were included. Patients were started on oral, tube feeding and/or parenteral nutrition.
Results: Twenty post- gastrointestinal surgical patients with a mean age of 48±13.5years and body mass index of 23.94±4.0kg/m^2 had high output bile and in whom reinfusion was initiated. An average volume of 531±438ml/day of bile was reinfused for 9±4.99days along with oral diet or tube feeding and/or parenteral nutrition. Of the 20patients, 2 were exclusively on tube feeding, 5 on tube feeding and oral, 7 on oral and supplemental parenteral nutrition, and 6 on tube feeding with supplemental parenteral nutrition. Adequacy of energy and protein were categorized as ≥70% and <70%. Adequacy of protein and energy of ≥70% was achieved among 13patients (p=0.004, p=0.012). Although the adequacy was not statistically significant due to the small sample size, 18patients were discharged in clinically good condition and 2patients did not survive.
Conclusions: The improvement in the patient's nutrition, as in this study, is probably a significant contributing factor towards a positive postoperative outcome. Clinical benefits of this technique include fluid and electrolyte balance and optimal utilization of remaining absorptive capacity for enteral and/or oral nutrition.
Keywords: Bile reinfusion, GI surgery, adequacy, enteral nutrition, high output bile

Introduction:

Saliva, gastric juices, pancreatic, biliary, and intestinal secretions are produced daily within the gastrointestinal tract to aid digestion and maintain electrolyte balance[1]. Bile salts are essential for the transfer of digested lipids and fat-soluble vitamins across the intestinal mucosa and for the lipolysis of triglycerides by pancreatic lipase. Micellar solubilization is for the absorption of saturated fats and fat-soluble vitamins[2]. 97% of the fat that is consumed is effectively absorbed in the first 5 feet of the proximal small bowel- attributable to the joint actions of pancreatic enzymes and bile salts. Twice with each meal and up to 6-8 times each day, the whole bile salt pool is recycled. Within the final 100 cm of the ileum, extrahepatic circulation recycles 95% of the pool[3]. Bile salt deficiency results from ileum loss of greater than 100 cm because hepatic synthesis cannot compensate for the loss. Up to 40%–50% reduced fat absorption is seen when there is a deficit, impairment, or exclusion of bile salt from the intestines[4].

Potential factors causing bile deficiency or insufficiency include primary biliary cirrhosis, primary sclerosing cholangitis, cirrhosis, cholestatic processes, external biliary drains, gastric hypersecretion, bacterial overgrowth of the small bowel, obstruction distal to the common bile duct requiring decompression above the site, and disruption of the extrahepatic circulation of the bile salts (due to resection of the terminal ileum or small bowel enterocutaneous fistula). Due to the lack of an easily accessible bile salt replacement, patients will need a low-fat diet, enteral nutrition (tube feeding) if on nutrition support, or reinfusion of biliary secretions collected from an external drain that is in situ[5].

There have been several case studies of endoscopic methods to conserve biliary secretions by redirecting drainage systems. They include percutaneous endoscopic gastrostomy (PEG)[6,7], percutaneous endoscopic duodenostomy (PED)[8], external transhepatic biliary drainage tubes connected to PEG with jejunal extension (PEG/J) or PEG with duodenal extension tubes[9-11], external biliary drainage periodically bolus feeds into jejunal port of a PEG/J tube, gastrostomy along with separate jejunostomy[12,13], and a J-tube into the jejunum of a Roux-en-Y oesophagojejunostomy[14].

With functional or genuine blocking lesions, venting gastrostomies and jejunostomies have been employed in a variety of patient groups[15]. They give some patients leeway until their gastrointestinal tracts are surgically relieved or recover spontaneously, and they also offer the least intrusive treatment possible to improve quality of life in other individuals[16]. Although venting tubes are most frequently used for alleviating pain, nausea, vomiting and distention, in some patients they can also be used to collect extra secretions so that they can be refed. Regardless of the circumstance, hydration status will require monitoring depending on the total volume vented over 24 hrs.

Studies have discussed refeeding "succus entericus" in patients with multiple enterostomies, where the intestinal output has been collected from the proximal small intestine outlet and reinfused into the distal end. The authors concluded that when the intestinal secretions from the proximal end were reinfused distally, it resulted in a significant decrease in output from the proximal end and thereby decreased the overall fluid loss[17,18]. Refeeding of gastric secretions among patients treated with a PEG/J have been reported in studies. Refeeding of either gastric or biliary secretions into the jejunum is to protect hydration status, electrolyte balance and prevent malabsorption- avoiding the need for intravenous access[19].

There are a few studies regarding the route of nutrition support during distal chyme refeeding and demonstrated that oral and/or enteral feeding (tube feeding) can be achieved[20-25]. Rarely, though, have the papers cited explained how bile refeeding works in post-surgical patients, including the reinfusion procedure and feeding route. The methods of feeding post-surgery patients and the level of nutritional adequacy during bile refeeding was not included in any studies. Even with the best of intentions, providing appropriate enteral nutrition and/or oral diet and ensuring adequacy of calories and proteins may not always be possible due to interruptions. Providing nutritional therapy that is suitable for the patient's condition and improving the patient's outcome are the goals of nutritional delivery. Individualized assessments of timing, route, and quantity of nutrients, as well as protocolized feeding, are required for optimal nutrition support for patients during hospitalization and hence this study was taken up.

THE PRESENT STUDY IS TAKEN UP WITH THE FOLLOWING OBJECTIVES:

1. Monitor tolerance to feeding with bile refeeding.
2. Record nutritional adequacy during bile refeeding.
3. Identify the prevalence of malnutrition among post-surgical patients and record the outcome of hospital stay.

4. Understand the number of feeding interruptions with reasons.

Methodology:

This is a retrospective study of all post-surgical patients on bile refeeding. All patients who have undergone gastrointestinal surgery and who have high bile output of > 500ml were considered for the study. Those patients with high bile output and who tested negative for bacterial culture before initiation of the re-infusion were considered for the study.

The high output bile is either collected from the gastric secretions via an naso-gastric tube or from the proximal stoma. The collected bile is reinfused via a feeding jejunostomy tube or naso-jejunal tube into the distal end of the jejunum. A tube feeding catheter, 2 mm in diameter and 120 cm in length, was endoscopically inserted into the jejunum via the nostril. Bile secretions were collected into a drainage bag at 4-hour intervals and filtered through a 4-ply sterile gauze. The filtered bile was reinfused through the enteral feeding catheter 30 minutes after meals or along with the tube feeds at a rate of 75 mL/hr (i.e. 200 ml collection flushed at 75 ml/hr). Target reinfusion rate of at least 50-60% of the collected bile output was maintained.

Clinical Intervention methodology:

Routine clinical follow up was performed during the hospital stay by ward dietitian and telephonically by home care dietitian after discharge. Follow up included monitoring of weight and tolerance to bile refeeding, reinforcement of gastro-intestinal (GI) secretion infusion calculations and rates, enteral feeding volumes, rates and tolerance, tube site care education, tube clog and optimal flushing protocol and education, and oral diet advancement support. None of the patients were lost to follow-up during the study period.

Nutritional data collection methodology:

Evaluation of the nutritional status was performed using the subjective global assessment tool (SGA). Nutrition risk index (NRI) was also calculated as (1.519 × serum albumin (g/L) +41.7× (present weight/usual weight). The NRI scores were also solely completed in order to correlate with the SGA score findings, albeit this practice is no longer widely employed. The patients with NRI score of >100 were considered in no risk group, 97.5–100 mild risk, 83.5–97.5 moderate risk, and < 83.5 as severe risk groups[26,27]. The usual body weight was defined as stable body weight for the last 6 months, and the patient's weight was obtained through history or previous measurements, considered to be stable over time.

Nutritional intake (oral, enteral and parenteral) was expressed as kcal/kg actual body weight/day and g/kg actual body weight/day for energy and protein, respectively. Daily Oral intakes were quantified using the daily dietary record, from which nutritional intake (energy, proteins, carbohydrates, lipids) were calculated from meal orders and actual consumed from visual estimates of serving sizes consumed (25%, 33%, 50%, 75%, 100%). Volumes of enteral and parenteral nutrition delivered were recorded and the necessary nutrients and energy calculated. Adequacy of energy and protein were categorized as ≥70% and <70%. Three categories were used to group nutritional interruptions caused by medical, surgical, or procedural reasons namely, procedures requiring movement in and out of the critical care unit or ward, GI problems, and miscellaneous reasons. The volume of bile replaced, and the volume of externally drained bile, was monitored daily. Gastrointestinal disturbances like nausea, vomiting, abdominal distension and discomfort, diarrhoea were monitored to indicate intolerance to bile refeeding.

Outcome parameters:

The gathered data was analysed to determine the nutritional risk at admission and to show if bile refeeding and nutritional intervention were both achievable during the hospital stay. This in-turn demonstrates the patient's tolerance to feeding and bile refeeding.

Data is analysed to identify the length of hospital stay and identify if bile refeeding is linked to the enteral feeding tolerance, nutritional adequacy, and improvement in the medical condition. Patients were followed up after discharge and so the nutritional status and recovery post discharge were noted.

Statistical Analysis:

All categorical data were expressed as n (%) and were compared using the Fisher exact test. According to their normal or non- normal distributions, continuous variables were reported either as mean ± standard deviation (SD), and median with interquartile range, that are compared between groups using Student's paired t-test or Wilcoxon matched-pairs signed rank test as appropriate. P-values equal or less than 0.05 were considered as statistically significant.

Results:

According to the inclusion criteria, bile refeeding was performed on 20 consecutive post-surgical patients from May 2021 to May 2022. Of the 20 cases, 10 (50%) were male and 10 (50%) were female, with a mean age of (48 ± 13.5) years and body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) of 23.94 ± 4.0kg/m^2. Patient demographic details and other feeding characteristics are depicted in table 1. The etiological characteristics and surgical procedure of each of the patients is given in table 2.

Table 1: Patient Demographic and Feeding Characteristics

Parameter	Number
Number of patients	20
Gender Male number (%) Female number (%)	 10 (50) 10 (50)
Age years median (IQR)	46 (39-55)
BMI kg/m^2 median (IQR)	24 (21-26.8)
SGA scores mean ± SD	6.20 ± 2.38
No. of patients well nourished (%)	10 (50)
No. of patients malnourished (%)	10 (50)
Number of post-op days mean ± SD/ median (IQR)	15.3 ± 5.35/ 15 (10.3-19)
LOS ICU days mean ± SD/ median (IQR)	5.65 ± 4.66/ 5 (3.25-7.5)
LOS Ward days mean ± SD / median (IQR)	9.7 ± 5.52/ 10 (6-14.3)
No. of Comorbidities Nil number (%) 1 (%) > 1 (%)	 12 1 7
Post-operative day of Feeding / Oral diet initiation Day 0 Day 1 Day 2 Day 3 Day 4 Day 5	 2 (1-EN+PN, 1-Oral+ PN) 1 (1-Oral+PN) 10 3 3 1
Number of days of bile refeeding mean ± SD/ median (IQR)	9.3 ± 4.99/ 9 (5-11)
Average Bile output mean ± SD (ml)/ median (IQR)	9399 ± 6448 / 8200 (4272-12867)
Total volume of bile refeeding mean ± SD (ml) (%)/median (IQR)	4995 ± 4309 (~ 55%) /3237 (2011-7215)
Volume of bile refeeding/day mean ± SD (ml/day)/ median (IQR)	531 ± 438/ 419 (250-638)
Method of Feeding Exclusive Oral number (%) Exclusive Enteral number (%) Exclusive PN number (%) Mixed number (%)	 Nil 2 Nil 5 (EN + Oral) 7 (Oral + SPN) 6 (EN + SPN)
No. of Feed interruptions number	15
Cumulative Energy prescribed mean ± SD kcals/ median (IQR)	19490 ± 10086/ 18600 (11100-24900)
Cumulative Energy delivered mean ± SD kcals/ median (IQR)	15350 ± 9216 / 14250 (9175-18951)
Average energy delivered per day mean ± SD kcals/ median (IQR)	1417 ± 442/ 1446 (1065-1836)
Percentage of energy delivered mean ± SD/ median (IQR)	76 ± 20/ 75 (67-93)
Cumulative Protein prescribed mean ± SD gms/ median (IQR)	881 ± 477 / 816 (503-1134)
Cumulative Protein delivered mean ± SD gms/ median (IQR)	733 ± 462 / 678 (379-950)
Average protein delivered per day mean ± SD gms/ median (IQR)	66 ± 22 / 68 (49-83)
Percentage of protein delivered mean ± SD	79 ± 23 / 78 (61-100)
Survivors number (%)	16 (80)
Non-Survivors number (%)	2 (10)

Parameter	Number
Readmission of the survivors number (%)	2 (10)

SGA- subjective global assessment; LOS-length of stay; EN-enteral nutrition/ tube feeding; PN- Parenteral Nutrition; SPN-Supplementary parenteral nutrition

Table 2: Details of patient medical diagnosis, operative procedures and issue

Sl.no.	Underlying Disease	Surgical Procedure	Issue
1	Peritonitis secondary to prepyloric giant perforation	Distal gastrectomy +Truncal vagotomy + loop Gastrojejunostomy	Gastroparesis with high RT output
2	Duodenal Obstruction	Post Ladd's, Re-exploration + Failed NJ placement	Duodenal oedema with High RT output
3	Right Ovarian Mass with Sigmoid and Small bowel infiltration	Total abdominal hysterectomy + small bowel resection + double barrel stoma with Hartman's procedure	Anastomic odema with high RT output
4	Acute necrotizing pancreatitis with duodenal fistulisation + colonic communication	Necrosectomy + diversion ileostomy + feeding jejunostomy	Post op high output biliary leak
5	Duodenal D2 perforation, CCP	Exploratory laparotomy + perforation repair + Tube duodenostomy + FJ	Post op high T tube output
6	Obstructive jaundice - Distal cholangiocarcinoma	Whipple's Pancreaticoduodenectomy	Hepato-jejunostomy Leak
7	Carcinoma Stomach - pTN3a	Total gastrectomy with D2 lymphadenectomy	Duodenal stump blow out
8	Extensive Venous Thrombosis involving splenic vein, SMV and portal vein with venous gangrene of small bowel	S/p Exploratory Laparotomy + small bowel resection + double barrel stoma + distal feeding jejunostomy	High output proximal stoma
9	Groove Pancreatitis	Whipple's pancreaticoduodenectomy	Gastroparesis
10	Ampullary NET	Whipple's pancreaticoduodenectomy	HJ leak
11	Mesenteric ischemia secondary to celiac artery and SMA thrombosis	Exploratory laparotomy + small bowel resection + double barrel stoma	High output proximal stoma
12	Perforation peritonitis-Giant duodenal ulcer perforation	Exploratory laparotomy + pyloric exclusion procedure	High output bile leak
13	Entero atmospheric fistula	stomach perforation closure+ duodenal *diverticulization* procedure, left Thoracotomy	High T tube output
14	Mesenteric Ischemia with extensive small bowel gangrene, Bilateral lower limb peripheral vascular disease, Short bowel syndrome	Exploratory laparotomy + resection of gangrene segment + end jejunostomy + distal mucus fistula	High output proximal stoma
15	Subacute intestinal obstruction with mid-jejunal volvulus due to adhesions	Segmental resection of small bowel+ end jejunostomy+ distal ileostomy	High output proximal stoma
16	Small bowel obstruction	Segmental resection of small bowel + end jejunostomy + distal ileostomy	High output proximal stoma
17	Crohn's disease, Acute intestinal obstruction with ileal gangrene	Exploratory laparotomy with resection of gangrenous ileum and end jejunostomy with distal mucous fistula	High output proximal stoma
18	SMA + Aortic thrombosis & mesenteric ischemia	Double barrel ileostomy closure	High output enterocutaneous fistula
19	Post ERCP D2 perforation with controlled biliary fistula	ERCP+CBD Clearance and PD stenting	High output biliary fistula

Sl.no.	Underlying Disease	Surgical Procedure	Issue
20	Extensive Venous Thrombosis involving splenic vein, gangrene of small bowel	S/p Exploratory Laparotomy + small bowel resection + double barrel stoma + distal feeding jejunostomy	High output proximal stoma

RT- Ryle's tube; CCP-Chronic calcific pancreatitis; FJ- Feeding jejunostomy; HJ- Hepatic jejunostomy; SMA- Superior Mesenteric Artery; ERCP- Endoscopic retrograde cholangiopancreatography; CBD- Common bile duct; PD-Pancreatic Duct

The mean SGA score of all the patients was 6.20 ± 2.38, with 10 patients being malnourished (8.1± 0.99) , and 10 patients who were well nourished (4.3±1.7). According to the nutrition risk index, there were 2 patients with no nutritional risk. There were 11, 6 and 1 patients with severe, moderate and mild risk respectively according to the NRI scores. There were 12 patients with no comorbidities, seven patients with more than one comorbidity and one patient with single comorbidity.

The total average postoperative days in the hospital was 15.3 ± 5.35. The average length of stay was 5.65 ± 4.66 days in the ICU and 9.7 ± 5.52 days in the wards respectively. The mean number of days of bile refeeding of all the patients was 9.3 ± 4.99. The total average bile output for all the patients was 9399 ± 6448ml with the average volume of bile refed was 4995 ± 4309 ml, which is approximately more than 55% that was refed. The total average bile refeeding per day was 531 ± 438 ml/day. The total volume of bile output, total amount of bile refed, and average bile refed per day for patients is depicted in table 1. The bile was reinfused through the distal mucosal fistula, distal feeding jejunostomy, naso-jejunal tube and naso-gastric tube in 5, 8, 5, 2 patients respectively.

Most frequently, patients who required reinfusion of biliary secretions also required jejunal feeding. Patients who have received an external drainage tube and a collecting bag can start reinfusing bile secretions. Reinfusion is scheduled every 4 - 6 hours to coincide with their enteral feeding delivery and /or oral food intake for the maximal micelle formation required for fat absorption.

Of the 20 patients, two were on exclusive enteral nutrition, five patients were on enteral feeding and oral, seven patients on oral and supplementary parenteral nutrition, and six patients on enteral feeding and supplementary parenteral nutrition. There were no patients on exclusive oral or parenteral nutrition as shown in table 1. The mean cumulative energy prescribed was 19490 ± 10086 kcal, with mean cumulative energy delivered was 15350 ± 9216 kcals for all the patients. The daily average energy delivered was 1417 ± 442 kcals which accounts to 76 ± 20 percent of average adequacy of energy per day of all the patients. Similarly, The mean cumulative protein prescribed was 881 ± 477 grams, with mean cumulative protein delivered was 733 ± 462 grams for all the patients. The daily average protein delivered was 66 ± 22 grams which accounts to 79 ± 23 percent of average adequacy of protein per day for all the patients. Adequacy of protein and energy of ≥70% was achieved among 13 patients (p=0.004, and p=0.012). Although the adequacy was not statistically significant with outcome due to the small sample size, 18 patients were discharged in clinically good condition and 2 patients did not survive.

There were 15 interruptions to nutritional delivery among all the patients during the study period. Interruptions for medical procedures were 10 times, with GI disturbances 3 times and miscellaneous 2 times. The average duration of the interruption was 7 ± 5.52 hours. The total energy and protein lost was 615 ± 455 kcals and 28 ± 19 grams respectively.

The plasma albumin and serum total bilirubin values at admission and at discharge were 3.06 ± 0.75g/dL to 3.36 ± 0.55g/dL (p=0.77), and 2.69 ± 2.82 mg/dL to 1.6 ± 1.63mg/dL (p=0.04) respectively. The follow-up data of patients included in this study were collected from the out-patient clinic for a year. The mean change in weight, and BMI from the time of discharge up to one year were 62.9 ± 10.7 kgs to 62.2 ± 6.14 kgs (p=0.026), and 23.94 ± 4.0kg/m^2 to 23.9 ± 2.7kg/m^2 (p=0.044) respectively.

Discussion:

Water, inorganic electrolytes, and organic solutes like phospholipids, cholesterol, and bile pigments make up the complex solution known as bile[28]. In the digestive system, bile acids aid in the breakdown of fats in food and fat-soluble vitamins while also preserving cholesterol homeostasis. They function as surfactants and emulsify fats into micelles so that the small intestine's lipases may break them down. Steatorrhea is a result of impaired fat digestion brought on by excess bile acid loss. By allowing the stomach to replenish these lost bile acids, bile refeeding helps prevent malabsorptive diarrhoea and its associated consequences. The management of external biliary drainage is always fraught with difficulty due to the loss of electrolytes and bile salts. Refeeding the collected intestinal secretions through a jejunostomy tube, or using gastrostomy tubes with jejunal extensions or nasogastric tube are just a few of the approaches that have been documented[29]. Bile refeeding has demonstrated varying degrees of efficacy, according to a few case reports and limited trials that mostly targeted individuals with obstructive cholangiocarcinoma[30, 31].

The large volume output of bile and worsening clinical status led to the decision to pursue bile refeeding in these patients at our hospital. Our study demonstrates that the use of a continuous external reinfusion of bile into the distal gut along with oral and enteral nutrition yields a consistent, significant outcome. At least two clinical benefits result from using the bile refeeding procedure. First, during the early stages of therapy, when maintaining fluid and electrolyte balance is particularly difficult, intestinal losses can be decreased. When the post-surgery ebb phase is likely under control, it will be possible to use the remaining absorptive ability for nutrients to its fullest. In order to clarify the potential advantages of bile refeeding, Wang et al. randomly assigned patients to receive either bile refeeding or exclusive drainage and showed that bile refeeding accelerated the restoration of hepatic function and serum protein levels[31]. Using the patient's own bile for treatment is more economical than alternative therapies such exogenous bile salts along with intravenous (IV) fluid resuscitation, despite the fact that published research have observed varying success of bile refeeding. Our study reiterates that refeeding of bile is an effective, cost-free substitute for oral bile salts in patients as also reported in other studies[32]. Our study also demonstrated that there is an improvement in the plasma albumin and reduction in serum total bilirubin values from admission to discharge which were 3.06 ± 0.75g/dL to 3.36 ± 0.55g/dL (p=0.77), and 2.69 ± 2.82 mg/dL to 1.6 ± 1.63mg/dL (p=0.04) respectively, thus preventing malabsorptive diarrhoea and its associated consequences. This study also has shown that the number of interruptions due to GI disturbances is only 3 during the complete post-operative refeeding days among all the 20 patients. This proves that bile refeeding has improved tolerance to oral and tube feeding. It is not just the bile refeeding, that was focused during the intervention, but maintaining the nutritional adequacy for energy and protein were also monitored. Care was taken to follow the hospital feeding protocol along with bile refeeding to meet the nutrient adequacy. A 2017 study found a negative correlation between energy consumption and hospital and ICU length of stay[33]. Another study was able to demonstrate that guaranteeing enough protein and energy intake can decrease mortality, shorten the length of stay in the ICU, and hospital[34]. According to a global survey, just 62% of patients' nutritional requirements are being met by many hospitals[35]. Overall cumulative nutrition adequacy of energy and protein for patients at our centre in this study was 78%.

It is also to be noted that large volumes of bile output can lead to dehydration along with loose greasy stools. Patients may have worsening liver function tests and renal function tests. In our study, it was noted that the mean serum creatinine changed from 1.63± 1.1mg/dL before bile refeeding to 0.75±1.6 mg.dL after continuous bile refeeding indicating resolution of renal parameters, additional to the normalized liver function tests.

Conclusion:

This study proves that bile reinfusion is a sustainable and affordable method that may allow patients to go home more quickly. More and more of our patients are informed about and involved in the reinfusion process as we go along. Most patients may successfully finish the reinfusion process on their own with minimal help before their discharge. Reinfusion of upper GI secretions also enhances electrolyte and fluid balance, thus reducing the hassle, risk, or cost of IV fluids. It also corrects biliary secretion-related enteral formula intolerance or oral meal malabsorption. Additionally, reducing feed intolerance with bile reinfusion can improve nutrition adequacy which can impact the patients' outcomes.

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Conflict of Interest: None declared. No author in this study has any conflicts of interest to declare.

References:

1. Ma T, Verkman AS. Aquaporin water channels in gastrointestinal physiology. J Physiol. 1999;517 (Pt 2)(Pt 2):317-26. doi: 10.1111/j.1469-7793.1999.0317t.x. PMID: 10332084; PMCID: PMC2269340.
2. Macierzanka A, Torcello-Gómez A, Jungnickel C, Maldonado-Valderrama J. Bile salts in digestion and transport of lipids. Adv Colloid Interface Sci. 2019;274:102045. doi: 10.1016/j.cis.2019.102045. Epub 2019 Oct 17. PMID: 31689682.
3. Pierre F. Saldinger, Omar E. Bellorin-Marin. Anatomy, Embryology, Anomalies, and Physiology of the Biliary Tract, Shackelford's Surgery of the Alimentary Tract, Chapter 106, 1249-1266.
4. Bruno Szczygiel , Cora F. Jonkers-Schuitema , Ton Naber. Basics in Clinical Nutrition: Nutritional support in extensive gut resections (short bowel). e-SPEN, the European e-Journal of Clinical Nutrition and Metabolism. 2010;5 (1):e63–e68.
5. C.R. Parrish, Beth Quatrara. Reinfusion of intestinal secretions: A viable option for select patients. Practical Gastroenterology. 2010; 34(4):28-40.
6. Foutch PG, Sawyer RL, Sanowski RA. The biliogastric shunt: a method for simultaneous internal diversion of bile and enteric feeding in patients with cancer. Gastrointest Endosc. 1989;35(5):440-2. doi: 10.1016/s0016-5107(89)72853-4. PMID: 2507390.
7. Ponsky JL, Aszodi A. External biliary-gastric fistula: a simple method for recycling bile. Am J Gastroenterol. 1982;77(12):939-40. PMID: 7148797.
8. Shike M, Gerdes H, Botet J, Coit D, Ciaburri D. External biliary duodenal drainage through a percutaneous endoscopic duodenostomy. Gastrointest Endosc. 1989;35(2):104-5. doi: 10.1016/s0016-5107(89)72719-x. PMID: 2714591.
9. Cheong WY, Chua CL. Percutaneous biliary drainage into the jejunum via a tube gastrostomy in patients with complete biliary obstruction: a report of two cases. Ann Acad Med Singap. 1993;22(5):826-8. PMID: 7505540.
10. Morita S, Matsumoto S, Soejima T, Odani R, Yokota T. Biliary drainage: conversion of external to internal drainage. Radiology. 1988;167(1):267-8. doi: 10.1148/radiology.167.1.3347730. PMID: 3347730.
11. Mohandas KM, Swaroop VS, Desai DC, Nagral A, Jagannath P, Desouza LJ, Kamble M. Duodenal diversion of percutaneous biliary drain through a percutaneous endoscopic gastrostomy: report of a case. Hepatogastroenterology. 1991;38(5):462-3. PMID: 1722484.
12. Rumley TO, Lineaweaver W, Goff K, Vogel S. Self-administered bolus jejunostomy feeding and gastric fluid reinfusion in patients with gastric atony. JPEN J Parenter Enteral Nutr. 1985;9(5):626-9. doi: 10.1177/0148607185009005626. PMID: 3930772.
13. Wolfer JA. Jejunostomy with Jejunal Alimentation. Ann Surg. 1935;101(2):708-25. doi: 10.1097/00000658-193502000-00006. PMID: 17856506; PMCID: PMC1392051.
14. Akiyama H, Yukihiro N, Saeki S, Kin T, Nishimawari K, Sasao T, Iwamori S. A new method for internal biliary drainage in malignant obstructive jaundice. Intrahepatic cholangioenteric bypass via PTCD fistula. Acta Chir Scand. 1987;153(3):199-201. PMID: 2440212.
15. Piccinni G, Angrisano A, Testini M, Merlicco D, Nacchiero M. Venting direct percutaneous jejunostomy (DPEJ) for drainage of malignant bowel obstruction in patients operated on for gastric cancer. Support Care Cancer. 2005;13(7):535-9. doi: 10.1007/s00520-004-0749-4. Epub 2005 Feb 15. PMID: 15711947.
16. Thampy S, Najran P, Mullan D, Laasch HU. Safety and Efficacy of Venting Gastrostomy in Malignant Bowel Obstruction: A Systematic Review. J Palliat Care. 2020;35(2):93-102. doi: 10.1177/0825859719864915. Epub 2019 Aug 25. PMID: 31448682.
17. Calicis B, Parc Y, Caplin S, Frileux P, Dehni N, Ollivier JM, et al. Treatment of post- operative peritonitis of small-bowel origin with continuous enteral nutrition and succus entericus reinfusion. Archives of Surgery. 2002;137:296–300.
18. Lévy E, Cosnes J, Bloch P, Parc R, Huguet C, Loygue J. Reinfusion of the upper digestive secretions into the lower part of the intestine decreases stomal flow from temporary enterostomies. Gastroenterologie Clinique et Biologique. 1979;3:447–51.
19. Levy E, Palmer DL, Frileux P, Parc R, Huguet C, Loygue J. Inhibition of upper gas- trointestinal secretions by reinfusion of succus entericus into the distal small bowel. A clinical study of 30 patients with peritonitis and temporary enterostomy. Annals of Surgery. 1983;198 (5):596–600.
20. Nagar A, Mehrotra S, Yadav A, Mangla V, Lalwani S, Mehta N, Nundy S. Distal Bowel Re-feeding in Patients with Proximal Jejunostomy. J Gastrointest Surg. 2018;22(7):1251-1257. doi: 10.1007/s11605-018-3752-7. Epub 2018 May 18. PMID: 29777456.

21. Liao Y, Tao S, Yao Z, Tian W, Xu X, Zhao R, Zhao Y, Huang Q. Chyme reinfusion improved outcomes after definitive surgery for small-intestinal enteroatmospheric fistula in patients with enteral nutrition. Nutr Clin Pract. 2022;37(3):634-644. doi: 10.1002/ncp.10823. Epub 2022 Jan 30. PMID: 35094427.
22. Sricharan, R., Chawla, A., Kumar, S. *et al.* Reinfusion Enteroclysis Can Successfully Replace Parenteral Feeding in Patients with High-Output Enteral Fistula or Ostomy Awaiting Definitive Surgery. Indian J Surg. 2020;82:848-854.
23. Picot D, Layec S, Dussaulx L, Trivin F, Thibault R. Chyme reinfusion in patients with intestinal failure due to temporary double enterostomy: A 15-year prospective cohort in a referral centre. Clin Nutr. 2017;36(2):593-600. doi: 10.1016/j.clnu.2016.04.020. Epub 2016 Apr 28. PMID: 27161895.
24. Coetzee E, Rahim Z, Boutall A, Goldberg P. Refeeding enteroclysis as an alternative to parenteral nutrition for enteric fistula. Colorectal Dis. 2014;16(10):823-30. doi: 10.1111/codi.12727. PMID: 25040941.
25. Picot D, Layec S, Seynhaeve E, Dussaulx L, Trivin F, Carsin-Mahe M. Chyme Reinfusion in Intestinal Failure Related to Temporary Double Enterostomies and Enteroatmospheric Fistulas. Nutrients. 2020;12(5):1376. doi: 10.3390/nu12051376. PMID: 32403450; PMCID: PMC7285017.
26. Cereda E, Pedrolli C. The geriatric nutritional risk index. Curr Opin Clin Nutr Metab Care. 2009;12:1–7. doi: 10.1097/MCO.0b013e3283186f59.
27. Perioperative total parenteral nutrition in surgical patients. The Veterans Affairs Total Parenteral Nutrition Cooperative Study Group. N Engl J Med. 1991;325:525–32.
28. Dawson PA. Bile secretion and the enterohepatic circulation. In: Feldman M, Friedman LS, Brandt LJ (eds). Sleisenger & Fordtran's Gastrointestinal and Liver Disease: Pathophysiology/Diagnosis/Management. 2016; 10th edn: chap 64. Elsevier Saunders: Philadelphia, PA.
29. Parrish CR, Quatrara B. The art of reinfusing intestinal secretions. J Support Oncol. 2010;8:92-6.
30. Song P, Mao L, Bian XJ, et al. Curative effect analysis of bile reinfusion combined with enteral nutrition support before surgery of hilar cholangiocarcinoma. Zhonghua Wai Ke Za Zhi. 2018;56(5):367–73.
31. Wang W, Chen X, He W, Liu Q, Wu Z. Effect of percutaneous transhepatic cholangial drainage with bile reinfusion and enteral nutrition via the nasojejunal tube on visceral protein and hepatic function. Nan Fang Yi Ke Da Xue Xue Bao. 2010;30(1):146–8.
32. Tripathy U, Dhiman RK, Attari A, Katariya RN, Ganguly NK, Chawla YK, Dilawari JB. Preoperative bile salt administration versus bile refeeding in obstructive jaundice. Natl Med J India. 1996;9(2):66-9. PMID: 8857040.
33. Mukhopadhyay A, Henry J, Ong V, et al. Association of modified NUTRIC score with 28-day mortality in critically ill patients. Clin Nutr. 2017; 36(4):1143-1148.
34. Chada RR, Chidrawar S, Goud BA, Maska A, Medanki R, Nagalla B. Association Between Nutrition Delivery, Modified Nutrition Risk In Critically Ill Score, and 28-Day Mortality. Nutr Clin Pract. 2021;36(5):1020-1033. doi: 10.1002/ncp.10673. Epub 2021 May 8. PMID: 33964049.
35. Cahill NE, Dhaliwal R, Day AG, Jiang X, Heyland DK. Nutrition therapy in the critical care setting: what is "best achievable" practice? an international multi-center observational study. Crit Care Med. 2010;38(2):395-401.