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CLINICAL OBSERVATIONS

Implementing early feeding after liver transplant using implementation frameworks: A multimethod study

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Abstract

Background: Evidence-based guidelines (EBGs) in the nutrition management of advanced liver disease and enhanced recovery after surgery recommendations state that normal diet should recommence 12–24 h following liver transplantation. This study aimed to compare postoperative nutrition practices to guideline recommendations, explore clinician perceptions regarding feeding after transplant surgery, and implement and evaluate strategies to improve postoperative nutrition practices.

Methods: A pre-post multimethod implementation study was undertaken, guided by the knowledge-to-action framework. A retrospective chart audit of postoperative dietary practice and semistructured interviews with clinicians were undertaken. Implementation strategies were informed by the Consolidated Framework for Implementation Research–Expert Recommendations for Implementing Change matching tool and then evaluated.

Results: An evidence-practice gap was identified, with the median day to initiation of nutrition (free-fluid or full diet) on postoperative day (POD) 2 and only 25% of patients aligning with the EBGs. Clinician interviews identified belief in the importance of nutrition, with variation in surgical practice in relation to early nutrition, competing clinical priorities, and vulnerabilities in communication contributing to delays in returning to feeding. An endorsed postoperative nutrition protocol was implemented along with a suite of theory- and stakeholder-informed intervention strategies. Following implementation, the median time to

Abbreviations: BMI, body mass index; COREQ, consolidated criteria for reporting qualitative research checklist; EBG, evidence-based guideline; ERAS, enhanced recovery after surgery; IQR, interquartile range; KTA, knowledge to action; LOS, length of stay; MDT, multidisciplinary team; NUM, nurse unit manager; POD, postoperative day; TDF, Theoretical Domains Framework; QLTS, Queensland Liver Transplant Service.

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initiate nutrition reduced to POD1 and alignment with EBGs improved to 60%.

Conclusion: This study used implementation frameworks and strategies to understand, implement, and improve early feeding practices in line with EBGs after liver transplant. Ongoing sustainability of practice change as well as the impact on clinical outcomes have yet to be determined.

KEYWORDS
clinician perceptions, ERAS, evaluation, evidence-based practice, implementation science, knowledge gap, nutrition practice, liver transplantation, qualitative

INTRODUCTION

Enhanced recovery after surgery (ERAS) protocols have been shown to reduce length of stay, postoperative complications, and hospital costs after liver surgery.[1–3] Early feeding is recognized as an important component of ERAS protocols. Recent consensus ERAS recommendations after liver transplant provide strong support for commencing early postoperative feeding within 12–24 h of transplant.[4] This aligns with recommendations from evidence-based practice guidelines on the nutrition management of patients with advanced liver disease.[5,6] Studies investigating early oral feeding within ERAS protocols specifically after liver transplant are scarce, but the limited data available indicate good compliance with early feeding protocols and a reduced length of stay.[7–9]

The translation of evidence-based recommendations into routine clinical practice, such as the implementation of early postoperative feeding, can be challenging.[10–12] Previous studies have explored the challenges associated with implementing nutrition-related components of ERAS pathways and have shed light on perceived barriers and enablers.[13–16] Understanding these local barriers and enablers can help to better inform targeted strategies for practice change.[16]

Multifaceted approaches guided by implementation frameworks have been successful in improving and sustaining early feeding after surgery.[14,16] The aims of this study were to (1) audit local early feeding and diet upgrade practices after liver transplant compared with ERAS recommendations, (2) explore clinicians' perceptions and practices regarding the initiation of feeding after liver transplant to identify barriers and enablers to early oral feeding, (3) implement data-driven strategies to address any identified evidence-practice gaps, and (4) evaluate changes in early feeding practices following the implementation of these targeted strategies.

METHODS

Setting

The project was undertaken at a tertiary hospital that houses the Queensland Liver Transplant Service. This service provides a state-wide centralized service for liver transplant in Queensland, Australia.

Study design

This pre-post multimethod implementation study was guided by the knowledge-to-action cycle[17] and applied quantitative and qualitative methods to determine the know-do gap within the local context, identify barriers and facilitators to early feeding practice, and implement and evaluate strategies targeting early feeding practices after liver transplant surgery. This involved the following four phases: Phase 1 covers measuring the evidence-practice gap: a retrospective, cross-sectional audit of integrated electronic medical records to compare current practices regarding the initiation of nutrition and diet upgrade (defined as an upgrade from clear fluids to free fluids or clear/free fluids to full diet) after liver transplant to practice guidelines. Phase 2 covers adapting to the local context and assessing barriers and facilitators to knowledge use: qualitative, semistructured interviews with clinicians who provide inpatient care to liver transplant recipients within the first 30 days after surgery to explore influences on nutrition-related decisions and barriers to knowledge translation. Phase 3 covers selecting and implementing interventions: stakeholder engagement and targeted strategies to improve nutrition initiation and diet upgrade practices. Phase 4 covers monitoring, evaluating, and sustaining outcomes: a repeat retrospective chart audit to evaluate practice change and sustainability after intervention.

The chart audits of current nutrition practices were performed as a component of standard care and were

exempt from ethics committee review. The qualitative staff interviews conformed with the principles of the Declaration of Helsinki and were approved by the Metro South Human Research Ethics Committee (HREC/2020/QMS/64115). No organs from executed prisoners are used by the Queensland Liver Transplant Service.

Phase 1: Identifying an evidence-practice gap

Chart audit data were sourced from the integrated electronic medical records for clinical data and a separate electronic foodservice system (CBORD) for the diet ordering data. Information on postoperative dietary practices was audited from the day of transplant (postoperative day [POD] 0) to the day a full diet was reached. At our facility, a full diet is defined as a normal diet including all foods and drinks, of any texture, without any restrictions; a free-fluid diet includes any liquids or foods that become liquid at room temperature (eg, pureed porridge, soups, or custard); and a clear-fluid diet includes all clear liquids that are see-through with a thin consistency at room temperature. All patients who underwent liver transplant surgery between June 2018 and June 2020 were included in the chart audit. Patients who developed an ileus or were managed for a suspected ileus postoperatively were excluded from the analysis of postoperative diet upgrade. Patients receiving alternative nutrition (parenteral or enteral tube feeding) after transplant were excluded. Nutrition outcomes included the diet code prescribed each day postoperatively, diet code ordered in the electronic foodservice system, diet ordered on POD 1, day of initiation of nutrition (considered as the commencement of a free-fluid diet or full diet), and the POD the patient received a full diet. The diet ordered in the electronic foodservice system before midday was deemed to be the diet received by the patient irrespective of diet documentation in the medical chart. Practice was considered to have met evidence-based guidelines (EBGs) if the initiation of nutrition occurred on POD1. The following data were extracted from patients' medical charts to inform outcome measures:

- Presence of ascites: the amount (in liters) identified in the operation note or identified by the medical team actively managing fluid overload (ascites/edema) and documented in the patient's chart.
- Estimated dry weight: a subjective estimation of weight after correcting for the presence of ascites or edema.[18] The volume of ascites was determined by the amount (in liters) identified in the operation note and subtracted from the patient's recorded weight on liver transplant admission. If these data were unavailable, dry weight was estimated by subtracting a percentage of weight for the degree of ascites as assessed by the treating team (ie, 5% for small-volume, 10% for moderate-volume, and 15% for large-volume ascites). A further 5% of weight was subtracted if the patient had bilateral edema documented on transplant admission.
- Obesity status: dry body mass index >30 kg/m^2 using the presurgical estimated dry weight.
- Grip strength: measured by handgrip strength (HGS), with a calibrated digital Jamar dynamometer using the highest of three readings from the dominant hand. Low HGS was determined by cutoffs of <27 kg for men and <16 kg for women.[19] HGS was obtained from the initial dietitian assessment as part of routine care in the pre–liver transplant clinic.[20]
- Primary etiology of liver disease: identified from the medical chart, with clarification sought from a transplant hepatologist (author GM) if this was unclear.
- Time on the transplant waiting list: determined by the difference in days between liver transplant surgery and the initial date of listing on the liver transplant waiting list.
- Postoperative infectious complications: infectious complications were defined as a medical diagnosis of infection documented in the chart along with biochemistry, blood/urine culture, or imaging confirmation.

Data analysis

The primary outcome of interest was the change in the proportion of patients that met the EBGs. Categorical data were analyzed descriptively using Microsoft Excel (V16.54) and presented as percentages. Statistical analysis was carried out using R Statistical Analysis and was presented as median and interquartile range (IQR) if not normally distributed and mean and SD if normally distributed. A difference in the median of categorical and proportional data was calculated via bootstrap sampling with 95% CIs. Bootstrap sampling overcomes any ambiguity in data distribution for CI calculation.[21] The Cohen kappa statistic was used to assess agreement between the diet code prescribed in the patient chart and the diet code ordered in the foodservice system.

Phase 2: Identifying local barriers and facilitators through clinician interviews

Individual, semistructured interviews were conducted to understand clinicians' perspectives of current practices regarding the initiation of nutrition and diet upgrade after liver transplant and to identify barriers and

facilitators to aligning practice with EBGs. Clinical staff involved in the first 30 days of posttransplant care of liver transplant recipients were eligible to participate, including all surgical/medical members of the liver transplant team, the liver transplant ward nursing staff, and all intensive care staff, including staff specialists, registrars, and nursing staff. To ensure the inclusion of relevant clinicians, participants were purposively recruited, and all potentially eligible clinicians were invited via email or face-to-face interaction to voluntarily participate by the principal investigator (PI, author TT). Interviewees were unaware of phase 1 audit results before their interviews.

A semistructured interview schedule (Table S1) was used to guide interviews with the questions informed by the Theoretical Domains Framework (TDF).[22] The interview schedule was piloted with a transplant hepatologist and refined before the commencement of data collection. Interviews were conducted individually, face to face or via telephone in the participant's workplace at a time convenient to each clinician. Interviews were audio-recorded and transcribed verbatim using an online transcription service (Temi) and cross checked by the study investigator for correction of errors. Analysis of the interviews used a qualitative description approach[23] and was designed and reported in accordance with the consolidated criteria for reporting qualitative research (COREQ) checklist[24] (Table S2).

For this approach, interview transcripts were transferred to Microsoft Excel then coded and analyzed thematically.[25] A deductive approach was adopted with the research questions forming the initial coding framework and identified themes being mapped to aligned domains of the TDF. An inductive approach was simultaneously used in the coding process, whereby codes were derived from line-by-line analysis of the participant responses with the research questions and TDF providing a lens. Additional investigators (IH and HM) read a sample of the transcripts for familiarization and to inform the coding framework. All interview transcripts were coded independently by the PI (TT) and then reviewed by a second investigator (IH) and amended to incorporate feedback. Themes and subthemes, mapped to the TDF, and illustrative quotes were identified before final review and triangulation by a third investigator (HM). Descriptive analysis was used to summarize participant characteristics as counts or median and IQR.

Phase 3: Stakeholder engagement, strategy selection, and implementation

The Consolidated Framework for Implementation Research–Expert Recommendations for Implementing Change (CFIR-ERIC) matching tool[26] was used to identify potential implementation strategies. The CFIR-ERIC matching tool is an instrument that can be used to match identified barriers with a list of potential strategies to address these barriers. The strategies generated by the matching tool have been drawn from the ERIC list of strategies. An output table is generated, highlighting the recommended strategies sorted by the highest level of endorsement.[26] The first step of the tool required input of key barriers, informed by the chart audit and interview data mapped against the TDF domains as well as feedback from clinicians involved in the care of liver transplant recipients. Once the priority implementation strategies were generated, the project team consulted stakeholders to select and prioritize strategies that were considered the most suitable for the local context.

Phase 4: Evaluation of outcomes

A retrospective chart audit was repeated for all patients who underwent liver transplant surgery (November 2021–June 2022) to evaluate outcomes following the implementation phase and stakeholder engagement. The repeat chart audit followed an identical process to phase 1. A further chart audit was conducted 12 months after the postimplementation audit to provide a snapshot of short-term sustainment and included patients who underwent a liver transplant in May and June 2023.

RESULTS

Phase 1: Identifying the evidence-practice gap

The initial chart audit was undertaken on patients who received a liver transplant between June 2018 and June 2020 ($n = 100$). Sixteen of these 100 patients met the exclusion criteria and were not included in the study. Patient characteristics are presented in Table 1, and main outcome measures are presented in Table 2.

Nutrition practices in 27% ($n = 23$) of patients were considered to have aligned with EBGs, with the initiation of nutrition by POD1 (19% were on free fluids and 8% were on full diet). The median time to initiation of both free fluids and of oral diet was 2 days (IQR = 1–2 and 1.25–3 days, respectively), whereas the median time to reach a full diet was 3 days (IQR = 3–4 days). On POD1, 25% met the EBGs and 43% of patients remained at nothing by mouth (NBM) status. Agreement between the diet ordered in the electronic foodservice system and the diet prescribed in the medical team's chart entry showed

TABLE 1 Characteristics of patients included in audit at study phases 1 and 4.

Characteristics	Preimplementation (phase 1), $n = 84$	Postimplementation (phase 4), $n = 20$	*P*
Age, median (IQR), years	54 (43–61)	54.5 (44–59)	0.58
Male sex, *n* (%)	61 (73)	13 (65)	0.85
Estimated dry weight, median (IQR), kg	80 (68.9–91.7)	78.7 (63.5–86.3)	0.34
BMI based on estimated dry weight, median, IQR), kg/m^2	25.9 (23.1–30.1)	24.3 (22.0–28.4)	0.24
Obese, *n* (%)	20 (24)	3 (15)	0.70
Primary etiology of liver disease, *n* (%)			
Alcohol-related liver disease	20 (24)	6 (30)	
MAFLD	10 (12)	1 (5)	
PSC/PBC	13 (15)	1 (5)	
Viral hepatitis (HBV/HCV)	14 (17)	2 (10)	
Autoimmune hepatitis	3 (4)	0 (0)	
Acute liver failure	1 (1)	1 (5)	
Cryptogenic liver disease	3 (4)	0 (0)	
Other	20 (24)	8 (40)	
HCC, *n* (%)	18 (21)	1 (5)	
Low HGS, *n* (%)	12 (15), $n = 79$	3 (17), $n = 18$	>0.99
Ascites, *n* (%)	39 (46)	9 (45)	>0.99
Time on waiting list, median (IQR), days	51 (13–138)	41 (23–74)	0.47
ICU LOS, median (IQR), days	1 (1–2)	1 (1–2)	0.83
Total LOS, median (IQR), days	12 (9–16)	10.5 (8–13)	0.08
Postoperative complication, *n* (%)	29 (40), $n = 81$	10 (48), $n = 21$	<0.01
Postoperative infectious complication, *n* (%)	7 (9), $n = 81$	1 (5), $n = 21$	0.25

Abbreviations: BMI, body mass index; HBV, hepatitis B virus; HCC, hepatocellular carcinoma; HCV, hepatitis C virus; HGS, handgrip strength; ICU, intensive care unit; IQR, interquartile range; LOS, length of stay; MAFLD, metabolic-associated fatty liver disease; PBC, primary biliary cholangitis; PSC, primary sclerosing cholangitis.

only fair agreement ($\kappa = 0.244$), indicating that diet codes prescribed by the team on morning rounds were not consistently actioned in the foodservice system by the patient's next meal.

Phase 2: Clinician interviews–identifying local barriers and enablers to early oral feeding

Nineteen liver transplant clinicians participated in the interviews: 4 transplant surgeons, 1 surgical fellow, 1 surgical registrar, 1 resident, 2 transplant hepatologists, 5 transplant nurses, 1 ward nurse unit manager (NUM), 2 intensivists, and 2 intensive care nurses (Table S3). Four overarching themes and 18 subthemes were identified from analysis of the interview transcripts. The link between themes, TDF domains, and illustrative quotes are summarized in Table 3.

Theme 1: Nutrition-related decisions are governed by surgeons

Surgeons are decision-makers for nutrition initiation and diet upgrades

All clinicians acknowledged that decisions about nutrition initiation and diet upgrades after transplant are directed by the surgeons. Transplant hepatologists indicated that although they might prompt discussion of diet upgrades on

TABLE 2 Primary nutrition outcomes before and after the implementation period.

Outcome measure	Preimplementation (phase 1), $n = 84$	Postimplementation (phase 4), $n = 20$	Difference in proportion (95% CI), %	Short-term sustainment audit, $n = 9$
Meeting evidence-based practice guidelines, *n* (%)	23 (27)	12 (60)	**0.34 (0.10 to 0.55)**	5 (62)
NBM on POD1, *n* (%)	36 (43)	5 (25)	−0.18 (−0.41 to 0.06)	—
CF diet on POD1, *n* (%)	25 (30)	3 (15)	−0.15 (−0.36 to 0.07)	—
FF diet on POD1, *n* (%)	16 (19)	10 (50)	**0.31 (0.11 to 0.51)**	—
Full diet POD1, *n* (%)	7 (8)	2 (10)	0.02 (−0.12 to 0.15)	—
			Difference in median (95% CI), days	
Time to initiation of nutrition, median (IQR)	2 (1.25–3)	1 (1–2)	**−1 (−1 to 0)**	1 (1–2)
Time to FF diet, median (IQR), days	2 (1–2), $n = 56$	1 (1–2), $n = 15$	−1 (−1 to 0.31)	1 (1–2)
Time to full diet, median (IQR), days	3 (3–4)	3 (2–3)	**0 (−1 to 0)**	2 (2–3)

Note: Bolded values represent statistically significant change.

Abbreviations: CF, clear fluid; FF, free fluid; IQR, interquartile range; NBM, nothing by mouth; POD1, postoperative day 1.

the ward, they considered it to be the role of the surgeon who performed the transplant to make diet-related decisions. The fellows and registrars acknowledged that although they may devise a preliminary plan and consider diet on their morning ward rounds, clearance from the surgeon was sought and they would "never do anything without asking the consultant first." It appeared that this approach could result in delays to the upgrade of diet, particularly if the surgeon was otherwise tied up.

Acceptance of individual variability

In relation to nutrition, a surgeon-dependent practice was described and accepted by clinicians across professional roles. Surgeons acknowledged that postoperative nutrition practices can differ between surgeons, and, despite describing some practices as "outdated,"—for example, use of clear fluids and cautious/slow upgrade of diet—these were not questioned. The lack of standardized practice for the type of diet commenced and the trajectory for upgrading diets was seen to lead to a "variable introduction to food" after transplant and created uncertainty among nurses, intensive care unit (ICU) doctors, and even transplant hepatologists on the ward about what to expect for patients.

Influence of experience, patient tolerance, and input from the clinical team

Diet-related decisions after liver transplant were influenced by multiple factors. For initiating nutrition, it appeared that surgeons' decisions were largely based on previous experience and preferences. It was widely agreed that nutrition is usually commenced after a patient is extubated. Surgical complexity, concerns about potential complications, and the patient's clinical status impacted decisions about commencing feeding. Diet upgrade practices were more variable and influenced by the same factors as the initiation of nutrition as well as input from other clinicians and clinical status. Gut function, nausea, vomiting, and "tolerance" were widely referenced as factors that impacted this decision making.

Theme 2: Early nutrition in a complex patient group

Mutual belief in benefits despite variable knowledge

There was acceptance of the importance of early initiation of nutrition, and it was evident that staff believed feeding is important in the postoperative period. Surgeons referred to evidence to support the benefits of early postoperative feeding; however, they were not aware of the actual guidelines for postoperative feeding after liver transplant. One surgeon mentioned ERAS guidelines in other surgeries and was aware that there were no ERAS guidelines specifically for liver transplant (at the time of interviews). Although nursing staff did not have knowledge about the evidence of early oral feeding, they still believed nutrition was important. This belief

TABLE 3 Selected quotations from 19 semistructured individual interviews of clinicians involved in the first 30 days of liver transplant care.

Theme/subtheme	TDF	Selected quotes
Nutrition-related decisions are governed by surgeons		
Surgeons are decision-makers for nutrition initiation and diet upgrades	• Social/professional role and identity • Social influences	"...we try and get patients on nutrition, but the final decision is left with the surgeon who did the operation and the surgical team working with him or her" – Transplant hepatologist "For this type of operation, yes. So anything, um, where... has been intra-abdominal access for surgical procedure, we would routinely defer, uh, decision making for, uh, enteral or oral feeds to the surgical team" – ICU consultant
Acceptance of individual variability	• Environmental context and resources • Beliefs about capabilities	"I do defer to the surgeons because individual surgeons have different, um, thresholds for when doing, uh, begin nutrition" – Transplant hepatologist "I think the overall message is it varies amongst different consultants. Everyone's got a bit of a different thing that they like done" – Transplant registrar
Influence of experience, patient tolerance, and input from the clinical team	• Skills • Memory, attention, and decision processes • Social/professional role and identity	"So, I think it's divided into two – it's surgeon preference and it's patient factors. So, surgeon preference might be someone that's used to doing something that they're regimented in their training...So that's one side of it. The other side of it is patient factors. So can they tolerate a diet yet?..." – Transplant fellow
Early nutrition in a complex patient group		
Mutual belief in benefits despite variable knowledge	• Knowledge • Beliefs about consequences • Environmental context and resources	"... if they're malnourished and you're not feeding them, then you risk having postoperative complications, so anastomotic leaks, wound breakdowns, your big concerns from a selfish, surgical perspective. But I think you generally want to have better patient outcomes. You should feed your patient pretty quickly" – Transplant registrar "Not just their length of stay in hospital, but their quality of life outside of hospital, which I think is highly dependent on good nutrition, you know, getting their fatigue, sorted out, getting their stamina back, everything like wounds, healing up, etc. Nutrition is like the foundation stone to this. So, if you don't put it in early, you're going to be a few steps back..." – Transplant fellow "I think that it could delay everything. It could delay the whole healing process. I mean, getting the nutrition level up to where it should be, is going to, um, assist with, you know, maybe their function, it's going to give them more energy, um, help with wound healing" – Transplant NUM
History of malnutrition before transplant	• Knowledge • Beliefs about consequence	"And I think in liver transplant patients, those of who are quite sick, and we know that they're malnourished, if we don't get on top of that early in some way, shape or form, we will prolong that, and their recovery will be longer" – Transplant fellow
Prioritization of nutrition with contemplation of risks vs benefits	• Beliefs about consequences • Memory attention and decision processes	"Um, so, um, and there lies some conservatism because, um, um, you do not want to push someone orally, if they're not ready. So, um, fear of aspiration, um, when you're thinking about the safety of your patient is, is a major consideration." – Transplant surgeon

(Continues)

TABLE 3 (Continued)

Theme/subtheme	TDF	Selected quotes
An evolving nutrition culture		
A fading legacy of awaiting physical signs of gut function to commence nutrition	• Knowledge • Beliefs about consequences	"I mean, I think historically people, you know, waited for flatus, and you know, bowel movements, and as far as I'm concerned, that's, that's what I referred to previously as surgical dogma. If the patient is not nauseated, then they should be able to drink" – Transplant surgeon
Increased acceptance for early nutrition	• Beliefs about consequences • Environmental context and resources	"I think overall the surgical culture with nutrition is shifting. I think the whole, you know, starve the patient for three days and then slowly feed them and that is, is shifting out because people are becoming aware of how important nutrition is in patients" – Transplant registrar
Patient preferences are valued in decision making	• Beliefs about consequences • Goals	"...patients will determine when they're ready to eat... just let them choose what they want and that they will either eat or they won't eat... I don't think we should restrict them particularly" – Transplant surgeon
System-related vulnerabilities in diet upgrades		
Processes to monitor diet code changes are lacking	• Environmental context and resources • Memory, attention, and decision processes	"The resident documents on iEMR and then the rest is magic" – Transplant surgeon "...if you were on the round as the in charge, they've, you've had a verbal order from the doctor. Um, and just because they forgot to write it in the notes, I would, would say to the nurse still upgrade it, and you might just go back to that doctor and just go, "Hey, can you just document that?" – Transplant nurse (04)
Multiple avenues for communication	• Environmental context and resources • Memory, attention, and decision process	"...documentation in the chart with diet communication —verbal and written. Yeah. That's what I think, I think, I think, you know, the written communication is as important as the verbal communication. It's one of the major aspects to assess in the postoperative setting...so therefore to record in the chart" – Transplant surgeon "If it's been written, hopefully the next in charge reviewing notes can pick it up and then that's an opportunity for a mistake to be missed, but if it's not noted and it's not been done off a verbal order by the first in charge, then it will get missed until at least the next day. Um, um, so that's quite a lot of barriers and a lot of sort of turns with, is we need to remember to, to do these upgrades" – Transplant nurse
Nurses action changes but are restricted by access to diet systems	• Environmental context and resources • Professional role	"Uh, well obviously we also have nursing on the ward round who action it usually" – Transplant surgeon "The truth is that access to that program is a bit frustrating, to be honest, the HBCIS, because to upgrade a diet we use the patient flow program, and that is one of the most frustrating programs. So, you need your HBCIS password, not all nurses on the floor get one" – Transplant NUM

Abbreviations: HBCIS, hospital based corporate information system; ICU, intensive care unit; iEMR, integrated electronic medical records; NUM, nurse unit manager; TDF, Theoretical Domains Framework.

around importance was informed by the "culture" on the ward and what they had been told by others, not based on an understanding of evidence.

History of malnutrition before transplant

It was acknowledged that because of advanced liver disease, patients are often nutritionally compromised before liver transplant and some patients require nutrition support preoperatively owing to issues with frailty, sarcopenia, and malnutrition. Because of this awareness, clinicians were able to recognize the importance of avoiding delays in facilitating nutrition after transplant to prevent further exacerbations of malnutrition risk and declines in nutrition status. This also appeared to be considered relevant for transplant recipients with obesity.

Prioritization of nutrition with contemplation of risks vs benefits

Although some clinicians referred to the prioritization of early initiation as both safe and acceptable, others considered whether it was reasonable and safe to do so. One surgeon stated that some colleagues followed a conservative approach to diet upgrade, and another indicated that they are not concerned about the "amount" of nutrition but rather getting "some type of nutrition started." In addition to this, the prioritization of nutrition tended to depend on the setting: in the ICU, doctors and nurses highlighted the prevention of aspiration as a factor that may influence their decision around diet upgrade. Some clinicians questioned whether "within 24 hours" was necessarily a concern, whereas other clinicians considered that starting nutrition as quickly as possible was both important and safe. ICU clinicians also acknowledged that there can be barriers to prioritizing nutrition because of the acuity of the critical care environment.

Theme 3: An evolving nutrition culture

A fading legacy of awaiting physical signs of gut function to commence nutrition

Some surgeons acknowledged the traditional practice of awaiting bowel sounds to start feeding was outdated and perceived that there was no need to keep patients at NBM status for extended periods. Although some surgeons clearly stated they "definitely won't wait for bowel sounds," other clinicians referred to signs of gut function as part of their clinical assessment of "tolerance" to guide how a patient's diet was upgraded after transplant surgery. Some ward nurses also believed that awaiting bowel sounds and motions influenced decisions for diet upgrades.

Increased acceptance for early nutrition

There appeared to have been a shift in culture from previous times, with some surgeons referring to the traditional stepwise and slow progression of diets as outdated practice. However, some were more conservative and employed a more gradual approach to starting and upgrading diets. Overall, nursing staff generally believed that there was a "pro-nutrition" culture for liver transplant recipients, with some acknowledging that the culture is improving. However, other clinicians reported room for an improved focus on the early nutrition care of patients, indicating that although it is important, it can come second to other tasks.

Patient preferences are valued in decision making

Patient-centered care was evident as a theme among various clinicians who stated that patient satisfaction, comfort, and a desire to eat were important factors to consider. Surgeons referred to the role of diet in providing a sense of "normality" for patients after transplant, which was also identified as important. Clinicians involved patients and stated that their motivation and degree of willingness, which was also seen to be a multifactorial indicator of alertness, gut function, and overall wellness, influenced nutrition-related decisions.

Theme 4: System-related vulnerabilities in diet upgrades

Processes to monitor diet code changes are lacking

It was apparent that doctors did not routinely refer to diet codes documented in the medical chart and were not consistently tracking patients' progress with diet upgrades or intake overall. Although some surgeons and hepatologists indicated that diet codes are discussed on surgical rounds each morning, it was generally acknowledged that at times this can be missed, and there are instances in which either the current diet code or change is not discussed by the team or documented in the notes. Additionally, the prescriber (surgeon) does not play a role in enacting the diet change. Surgeons give the direction to junior doctors to document the diet in notes or "tell the nursing staff," but they were not aware of how the diet code gets actioned or changed in the system. At times, surgeons may not be available to make these decisions, which could contribute to a logistical delay if registrars and fellows were awaiting the surgeon's confirmation before actioning any changes to diet.

Multiple avenues for communication

Clinicians indicated that there were multiple avenues for the communication of diet code changes, including both verbal communication and written documentation. Although nursing staff enact diet code changes based on a verbal order from the medical team to avoid delays, the preference is for written documentation in the medical chart. It was also apparent that diet upgrades can be delayed because of the process for changing diet codes, including the communication avenues, competing priorities, and system breakdowns.

Nurses action changes but is restricted by access to diet systems

The nurse in charge and/or ward nurses are responsible for enacting diet code changes advised by the transplant medical team. Nurses accepted this responsibility and doctors also acknowledged that this was a nursing role. The ward NUM indicated that nursing staff have a role in monitoring diet codes and identifying delays in diet upgrade. In addition to this, it was highlighted that nursing staff can actively prompt doctors about a patient's nutrition and act as a "safety net" against diet delays or changes being missed. Despite this role responsibility, not all nurses had access to the system required to make diet code changes. For example, in the ICU the senior nurses involved in shift management had access to make diet code changes directly, whereas other nurses relied on the administration officer to make diet changes in the system. It was also noted that there can be a delay in the nurse making the diet code change in the system because of time pressures and competing priorities, which could result in missing kitchen deadlines for changes to diet.

In summary, phases 1 and 2 highlighted that EBGs were not consistently met for multifactorial reasons, including variability in decision-makers' practice, knowledge of guidelines, and competing priorities and communication barriers. These findings formed the foundation for phase 3 in terms of consulting stakeholders and designing implementation strategies.

Phase 3: Stakeholder engagement and implementation

Following the phase 1 and 2 results and a stakeholder engagement process, key implementation strategies generated by the CFIR-ERIC matching tool included the following: capture and share knowledge, conduct local consensus discussions, inform local opinion leaders, identify and prepare champions, build a coalition, tailor strategies, provide ongoing consultation, audit and provide feedback, re-examine the implementation, conduct ongoing training, and develop and distribute education material. The local implementation strategies that align with the above ERIC strategies are described in detail below and are summarized in Table 4.

The results of the chart audit and interviews from phases 1 and 2 were disseminated through knowledge sharing with ICU staff, liver transplant surgeons, hepatologists, and nursing staff to stimulate interest and inform local consensus discussion. This involved sharing evidence for early oral feeding after liver transplant, outcomes from the local chart audit highlighting delays in the initiation of feeding and upgrade of diet, and key themes identified from staff interviews. Support for improving nutrition practices to align with EBGs was sought, and stakeholders agreed on a consensus feeding protocol for use after liver transplant (Figure S1). A postoperative nutrition protocol was codesigned with stakeholders and embedded into the existing ICU liver transplant protocol. This was distributed to staff in an electronic format with hard copies placed on the ward. The updated protocol was accessible to the broader healthcare workforce from the hospital intranet as required. Champions to facilitate implementation of this protocol were identified and included the ward NUM and clinical facilitator, nursing team leaders, and the directors of liver transplant and ICU, with support also obtained from the ICU nurse educator and the intensivist responsible for ICU policy management. The ward NUM continued to be engaged throughout the implementation process to assist in the distribution of resources and to reinforce protocols at nursing meetings and handovers.

Informal, one-on-one discussions with nursing staff and doctors took place to reinforce the protocol and answer questions. The PI (ward dietitian) reinforced the postoperative nutrition protocol during patients' transplant admission by advocating for and communicating the initiation of diet among the team postoperatively while the patient was in the ICU. However, this was not as prominent for diet upgrades (ie, upgrading to full diet for the next meal once the tolerance of free fluids was confirmed), because this generally occurred at the same time as the transition from the ICU to the ward. As part of the education and training, nursing leaders on the ward were encouraged to prompt discussion about diet upgrade when they attended rounds with the transplant surgical team.

As part of the process evaluation, an early audit of the first 10 liver transplant recipients after

TABLE 4 ERIC strategy selection and local implementation strategies.

ERIC strategy	Local implementation strategy
Assess for readiness, identify barriers and facilitators, and conduct local needs assessment	• Phase 1 and 2 of project, including chart audit and interviews with clinicians, identified evidence-practice gap and perceptions on early feeding
Capture and share knowledge Conduct local consensus discussions	• Group feedback session with ICU and liver transplant medical/surgical staff • Evidence for early feeding, chart audit, and interview findings presented and discussed among the group • Support sought, key implementation strategies and consensus on postoperative nutrition protocol agreed on
Inform local opinion leaders	• Surgeons, NUM, and Director of Liver Transplant engaged before implementation and kept informed with updates and communication throughout implementation process
Identify and prepare champions Build a coalition	• Champions identified to support, advocate, and endorse implementation of early feeding protocol included transplant NUM and clinical facilitator, Director of Liver Transplant and ICU, and ward nursing team leaders • Support obtained from ICU educator to disseminate protocol and arrange education sessions and intensivist responsible for ICU website management to facilitate approval and upload of protocol onto ICU website
Identify early adopters	• Ward nursing staff and team leaders who indicated interest in facilitated protocol implementation were recognized
Tailor strategies	• Selected implementation strategies informed by data from phase 1 and 2 and stakeholder driven following local consensus discussion
Conduct educational meetings	• Meetings conducted with ward NUM and clinical facilitator to inform of evidence for early feeding and new nutrition protocol. NUM and clinical facilitator reinforced protocol in their meetings and updates with nurses
Audit and provide feedback Purposely re-examine the implementation	• Process evaluation included chart audit of first 10 transplant recipients after implementation of protocol and in-services. Outcomes and key barriers to initiation of nutrition/diet upgrade fed back to surgeons and NUM (who distributed to ward nursing staff) and helped to inform PI on success of/issues with implementation • Process evaluation questions asked to fellow/registrar and ward nursing staff on (1) awareness of postop nutrition protocol, (2) when patients can commence nutrition after transplant, and (3) what diet patients can commence after transplant • Evaluation of postimplementation outcomes through chart audit was also conducted in phase 4
Conduct ongoing training	• A roll out of education with ward nursing staff took place, as well as one-on-one discussions on the ward. Ongoing opportunistic discussions and a plan for ongoing education sessions that will occur annually • Bedside training with ICU nursing staff took place with each new transplant admission and will continue to occur with each transplant admission • Multidisciplinary orientation sessions for transplant fellow/registrars were implemented, with a plan for ongoing continuation with each surgical rotation. These include the multidisciplinary team (Director of Liver Transplant, transplant hepatologist, and pharmacist and liver transplant coordinators)
Develop and distribute educational materials	• Postoperative nutrition protocol for nutrition after liver transplant was developed • Protocol was distributed via email to nursing staff, surgeons, and medical staff; hard copies were made available on ward and uploaded on ICU website and distributed among intensivists; and the protocol was uploaded to local ward folder that all ward nursing staff have easy access to online • Nutrition-related information and new postoperative nutrition protocol added to transplant handbook for medical staff and nursing orientation manual
Facilitation	• PI continued to facilitate and reinforce implementation of early feeding as per new protocol throughout implementation process

Abbreviations: ERIC, Expert Recommendations for Implementing Change; ICU, intensive care unit; NUM, nurse unit manager; PI, principal investigator.

implementation was undertaken to identify barriers to early protocol adherence, and clinicians ($n = 7$) were asked about their awareness and knowledge of the protocol. Process evaluation was undertaken to assess awareness and showed that 85% were aware of the new postoperative protocol and day to commence nutrition after transplant, and 70% were aware of what diet code should be commenced. These results were communicated back to the surgeons, NUMs, and nursing staff (Table S4). A roll out of education with nursing staff took place, which involved engaging with ward and ICU educators and using existing in-service sessions to provide education in addition to opportunistic one-on-one bed side discussions. Multidisciplinary orientation sessions were implemented as a new initiative for transplant fellows/registrars as they rotated into the transplant workload. Liver transplant–specific nutrition-related information was added to the transplant handbook for medical staff and the nursing orientation manual, which also included the postoperative nutrition protocol.

Phase 4: Evaluation of outcomes

Chart audit data were collected on a total of 21 patients who underwent liver transplant surgery between November 2021 and June 2022 and mapped against implementation strategies (Table 2). In this audit, no patients were excluded because of postoperative ileus, but one patient was placed on alternative nutrition and excluded from analysis. The main outcomes after implementation are detailed in Table 2.

The proportion of patients meeting the EBGs increased by 30% (95% CI = 10%–55%). The median time to initiation of feeding improved by median of 1 day, from 2 days (IQR = 1–3 days) to 1 day (IQR = 1–2 days) postimplementation.

Compared with phase 1, there was a 30% (95% CI = 11%–51%) increase in patients who were on a free-fluid diet on POD1 during phase 4. Agreement between the diet ordered in the electronic food service system and diet prescribed in the chart remained "fair" in the postimplementation audit ($\kappa = 0.289$). The snapshot of nine patients taken 12 months after the postimplementation chart audit showed that these changes were sustained with improvements in the time to initiation of nutrition and free fluids both maintained, and the time to full diet improved to POD2 (IQR = 2–3 days).

In the postimplementation group, 5% ($n = 1$) had a postoperative infectious complication, compared with 9% ($n = 7$) in the preimplementation group.

DISCUSSION

This study provides novel insight into the application of a knowledge translation framework to implement nutrition components of the ERAS that have not previously been described in liver transplant recipients. There were improvements in the initiation of early oral feeding (defined in this study as a free-fluid or full diet by POD1); however, there is room for improvement in the progression to full diet postoperatively. The ongoing sustainment of practice change and the impact on clinical outcomes is yet to be determined.

Before implementation, fewer than one-third of patients met early feeding recommendations, with the median time to commencing a free-fluid or full diet being 2 and 3 days, respectively. On POD1, 73% remained NBM or on a clear-fluid diet with only 8% on a full diet. Only limited data on early oral feeding after liver transplant are available in the literature; however, our results are similar to what has previously been observed for ERAS in other surgical areas, highlighting a limited translation of knowledge into routine practice.[14,27] In a mixed methods study exploring feeding practices after colorectal surgery, preimplementation data showed that the median time to reach full diet was POD4.[14] In a systematic review by Rattray et al, <50% of studies reported a time to postoperative oral feeding that was in line with evidence-based recommendations, and more than half of the studies reported a median time of 3 (or more) days to commence a full diet.[28] In this study, interview data helped to enrich chart audit findings and highlighted factors influencing local postoperative nutrition practices. The idea that the complexity of surgery influenced diet-related decisions was an evident theme in clinician interviews. Historically, postsurgery feeding practices in which patients are kept at NBM status and are slow to progress to a full diet originate from fears of complications, such as vomiting and aspiration related to ileus.[29] The current evidence suggests that the early initiation of a full diet after liver transplant results in improved outcomes without increased complications.[4,7] Although slow diet initiation and using bowel sounds as an indicator of gut function were considered outdated by some of the surgeons in our study, references to bowel sounds and complications were consistently mentioned in interviews with nursing and junior clinicians, highlighting a discrepancy between perceived and actual practice. Individual surgical practice, complexity of surgery, concern about the risk of postoperative complications, and the patient's clinical status after transplant were reported to influence the decision to initiate oral intake. In other surgical cohorts, a decision-making hierarchy led by surgeons has also been described, with

this variation in practice among surgeons potentially impacting the initiation of nutrition for patient groups.[14,16,28,30] Obtaining support from surgeons as the lead decision-makers to endorse early feeding protocols is integral to streamlining and changing practice.

Compared with the initiation of nutrition, the process for diet upgrade was more variable and was usually based on clinical variables such as evidence of gut function, nausea/vomiting, and so-called tolerance, which is consistent with findings in colorectal and general surgical cohorts.[14,30] In practice, the tolerance of clear fluids usually leads to an upgrade to a free-fluid or full diet, and the tolerance of free fluids leads to an upgrade to a full diet.

Decisions about nutrition initiation and upgrade are made in a complex system with vulnerabilities identified at numerous stages of implementing action from these decisions. Discussions regarding diet code changes usually occur between the members of the liver transplant medical team, with junior doctors raising the issue with more senior colleagues, albeit not routinely. There are also communication issues and delays in (1) relaying decisions regarding diet changes to the intensive care team (medical and nursing), (2) changes being made in the foodservice system by nursing staff, and (3) the foodservice system receiving a notification of the upgrade with sufficient time to allow for a change in the diet being provided. When nutrition is not routinely discussed or documented on rounds, decisions to initiate or upgrade diet can be forgotten and patients can unnecessarily remain on a suboptimal diet code for a longer period. A lack of systematic tracking and vulnerability to communication breakdown is a barrier to implementing early feeding.[14] The multifactorial nature of the identified evidence-practice gap emphasized the need for multifaceted interventions that targeted the barriers and enablers specific to our context.

Overall, we saw an improvement in feeding practices after liver transplant after implementation, reducing the median time to initiate meaningful nutrition from POD2 to POD1 and markedly improving compliance with nutrition and ERAS guidelines following the implementation process. Stakeholder engagement, involving a range of multidisciplinary team (MDT) members across the ICU and ward setting and visibility of support from opinion leaders appeared to be a critical success factor. Biannual education sessions coincided with fellows/registrars rotating into the liver transplant unit, providing opportunities for knowledge sharing and education on the postoperative nutrition protocol. The director of liver transplant services attended these sessions, along with other MDT members, and played a crucial role in advocating for and supporting the new protocol.

Key enablers of success in implementing early feeding reported in previous studies include having a key member of the team as a "champion" taking an active role, multimodal and ongoing education strategies, opportunistic "in-services" with staff when patients are on the care path, leadership, and using an MDT approach.[13-15,30,31] Our experience aligns with this in that facilitation by the dietitian acting in the "champion" role was an important and ongoing strategy throughout the implementation process while the protocol was embedded into practice. Within our liver transplant unit, we do not have a formal ERAS protocol; however, many of the ERAS elements are employed. Nutrition-related ERAS components include preoperative optimization of nutrition in the pre–liver transplant multidisciplinary clinic and a preoperative carbohydrate-loading protocol that was implemented alongside the early feeding protocol. It is acknowledged that other components of ERAS may enable early feeding outcomes,[7] but monitoring other nutrition-related components was beyond the scope of this project.

Despite an indication of a positive shift in the time to full diet, the median time in days remained at POD3 postimplementation, and the agreement between the diet prescribed in the chart and the diet ordered in the electronic foodservice system remained only "fair." As per clinician interviews, unlike initiating feeding after extubation, diet upgrade is not necessarily a "standardized" process. The ongoing impacts of breakdown in communication and systems in addition to competing priorities in the acute postoperative period should be considered moving forward.[30] The vulnerabilities in the process for receiving appropriate meals based on surgically led decisions through to accurate and timely ordering and meal delivery act as barriers to achieving change and may require additional targeted strategies, such as integrated software for real-time updates, to improve the consistency between the written orders in the medical record and the action of orders in the foodservice system.

In the literature, adherence to postoperative diet upgrade recommendations has been reported to be >80%.[30,32] In the liver transplant space specifically, there have been three studies that demonstrated successful implementation of postoperative early oral feeding (>90% compliance), but these studies did not provide information on critical success factors or sustainment of practice change.[27,33,34] Although these studies reported on compliance to nutrition components of an ERAS protocol, other publications have described the application of theory-informed implementation frameworks to achieve early feeding initiatives in their cohorts. Byrnes et al used the integrated-promoting action on research implementation in health services (i-PARIHS) framework to guide and evaluate improved adherence to evidence-based diet guidelines (in line with ERAS) in older general surgical patients, including a similar study design with chart audit, interviews, facilitation, and evaluation of implementation

strategies.[16] However, they also included multilevel evaluation of facilitation strategies and clinical processes to develop an understanding of the complex interaction between context and environment. In their study, the proportion of patients receiving early nutrition increased from 53% to 79%. When observing the implementation strategies used, this group introduced facilitator attendance at weekly MDT "huddles" to encourage regular communication about postoperative nutrition. This represents more consistency in promoting the initiative and communicating with the team than occurred in our study, in which communication and education opportunities were more stagnant in comparison. This is potentially something to explore as part of an overall sustainment plan.

Short-term data indicate that practice change was maintained in the year after implementation. However, the persistence of long-term practice change is important, because the barriers to this likely differ from those of implementation.[35] Re-evaluation and assessment of how well change has been sustained in the longer term is necessary. The biannual MDT education sessions have been embedded as a process with sustainability in mind but may rely on facilitation by the ward dietitian and ongoing support from the director of liver transplant services. Strategies have been formulated with sustainment in mind, such as monitoring with annual audits of nutrition initiation and diet upgrade practice. Feedback of audit results to all key stakeholders should be part of this process.

Limitations of the current study include a smaller sample size in phase 4 resulting in the study potentially being underpowered to detect significant change in some outcomes, an inability to report on the sustainment of practice changes because of a short follow-up timeframe to date, and a lack of patient feedback as part of consumer engagement. The lead investigator (TT) who conducted the interviews and led the thematic analysis was the only dietitian working in the transplant service; hence, the interview data did not include any dietitians. We did not investigate the adequacy of nutrition intake or report on the influence of early oral feeding on clinical outcomes after liver transplant, which is an area with limited data to date. In conclusion, this study used implementation frameworks and strategies to improve early feeding practices to align with EBGs after liver transplant. Long-term sustainability of practice change as well as the impact on clinical outcomes should be established.

AUTHOR CONTRIBUTIONS

Tahnie G. Takefala, Hannah L. Mayr, Ingrid J. Hickman, Raeesa Doola, and Graeme A. Macdonald contributed to the conception and design of the research. Tahnie G. Takefala, Melita Andelkovic, and Heidi E. Johnston contributed to the acquisition of the data. Tahnie G. Takefala, Ingrid J. Hickman, Hannah L. Mayr, and Graeme A. Macdonald contributed to the analysis and interpretation of the data. Tahnie G. Takefala drafted the manuscript. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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