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Original

Effect of Multidisciplinary Team Rounds on Postoperative Recovery and Nutrition Therapy for Patients After Cardiac Surgery in Intensive Care Unit: A Single-Center, Retrospective, Observational Study

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Background: Although early enteral nutrition (EN) plays a key role in managing patients after cardiac surgery, only a few studies have evaluated the effects of multidisciplinary team rounds (MDTR) in an intensive care unit (ICU) on the outcomes of cardiac surgery. We launched the MDTR in June 2020 and investigated its effect on clinical outcomes and nutritional management after cardiac surgery.

Methods: A retrospective observational study was conducted in a single ICU. This study included 160 patients admitted to the ICU. The patients were divided into the Conventional and MDTR groups according to their MDTR status. The postoperative hospital stay (PoHS) and EN initiation process were compared between the two groups.

Results: No significant difference was observed in the PoHS between the two groups (median: 15 days in the Conventional group and 14 days in the MDTR group). Multiple regression analysis indicated that MDTR was associated with shortened PoHS (regression coefficient: −4.65 days). The time to EN initiation was significantly shorter without increasing EN-related complications in the MDTR group (28.2 vs. 22.5 hours).

Conclusion: MDTR could be associated with the shortening of PoHS; it allows the early and safe provision of EN for patients after cardiac surgery.

The study was registered in the University Hospital Medical Information Network Clinical Trials Registry (UMIN 000044240).

Keywords: early enteral nutrition, multidisciplinary team rounds, cardiovascular surgery, intensive care unit

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Introduction

Nutritional support plays an essential role in the management of critically ill patients. Some studies have reported that early enteral nutrition (EN) in critically ill patients reduces the mortality rate and length of stay (LOS) in the intensive care unit (ICU).[1-5] Current clinical guidelines recommend that EN should be initiated within 24-48 hours after ICU admission in patients without contraindications, such as gastrointestinal problems and hemodynamic instability.[1,2] Therefore, a new reimbursement system for early EN in critically ill patients in the ICU was introduced in Japan in 2020. The reimbursement requires EN to be provided within 48 hours after ICU admission, nutritional assessment of critically ill patients, and evaluation of intestinal function by a multidisciplinary team (MDT) including physicians, dietitians, and pharmacists. With these requirements, multidisciplinary team rounds (MDTR) were conducted in the ICU, and EN was actively promoted in critically ill patients, including post-cardiac surgery patients.

The MDT is a team composed of various medical professionals who provide the best possible care to patients.[6,7] MDT is expected to improve the quality of medical care by strengthening inter-professional cooperation and emphasizing the advantages of having members with multiple specialties. A multicenter retrospective observational study reported that daily MDTR led by intensivists reduces the patient mortality rate.[8,9]

Patients undergoing cardiac surgery experience systemic inflammatory response syndrome.[10-12] Surgical stress activates immune cells and promotes the release of cytokines such as tumor necrosis factor-α and interleukin-1β.[10] Protein catabolism is increased by inflammatory reactions. After cardiac surgery, patients often experience malnutrition, which causes delayed wound healing and difficulty weaning from the ventilator.[10] Therefore, early EN in patients who have undergone cardiac surgery is recommended.

Although multidisciplinary collaboration is necessary for early EN in patients after cardiac surgery, only a few studies have reported the effects of multidisciplinary collaboration in the ICU on postoperative nutritional management. This study aimed to investigate the effect of MDTR in the ICU on the clinical outcomes and nutritional management of patients after cardiovascular surgery.

Materials and Methods

Setting and population

A retrospective single-center observational study was performed in the ICU of Komaki City Hospital. This study was approved by the Institutional Ethical Board of Komaki City Hospital (approval code: 211003) and was registered in the University Hospital Information Network Clinical Trials Registry (UMIN ID: 000044240). Patients aged 18 years and older and admitted to the ICU after cardiovascular surgery were enrolled. Patients 1) who died within 3 days after ICU admission, 2) who had undergone re-operation during the period of their hospitalization, 3) with contraindications for EN, 4) who did not receive EN during ICU admission, and 5) who received extracorporeal membrane oxygenation (ECMO) during ICU admission were excluded. MDTR was initiated in June 2020. The eligible patients were divided into two groups (Conventional and MDTR groups) according to their MDTR status. The MDTR group included patients admitted to the ICU after cardiac surgery during 10 months after MDTR initiated (between June 2020 and March 2021). By contrast, the Conventional group included those patients during 10 months before MDTR initiated (between June 2019 and March 2020). (**Figure 1**). **Figure 2** shows the process of initiating EN using MDTR.

Definition of MDTR

Our team comprised intensivists, nurses, dietitians, pharmacists, clinical engineers, and rehabilitation specialists. MDTR was defined as rounds held by intensivist-led MDTR members during weekday mornings in the ICU. The team members assessed the patients' condition, including nutritional status from the perspective of each professional, and shared each assessment in the MDT. Then, we held bedside conferences with the attending cardiovascular surgeons to discuss the patients' clinical issues, including nutrition therapy for patients after cardiac surgery. The criteria for EN initiation were based on several previous guidelines.[1,2] If contraindica-

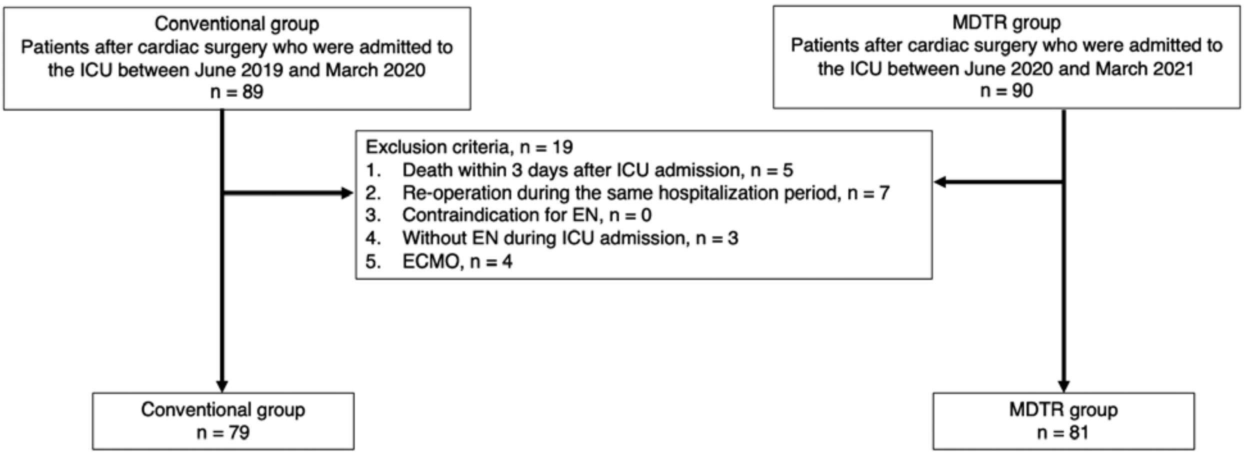

Figure 1. Flowchart of the study participant selection process.
EN, enteral nutrition; ECMO, extracorporeal membrane oxygenation; ICU, intensive care unit; MDTR, multidisciplinary team rounds.

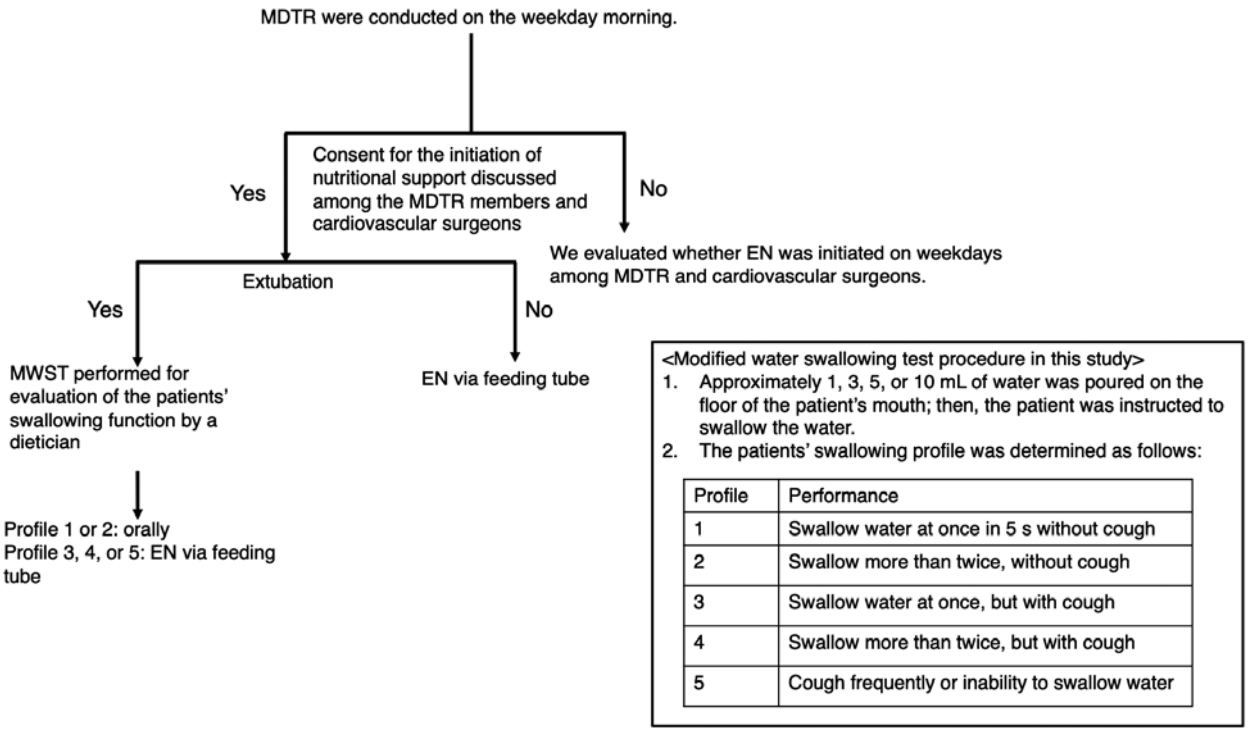

Figure 2. Enteral nutrition initiating procedure after MDTR implementation.
EN, enteral nutrition; MSWT, modified swallowing water test; MDTR, multidisciplinary team rounds.

tions to EN, such as high-dose catecholamine or large transfusions, were not present, we suggested to the attending surgeons that EN be initiated for the patients. In contrast, the initiation of nutrition in the Conventional group was judged only by the cardiovascular surgeons.

The route of EN and nutrients required were determined according to the procedure shown in **Figure 2** after discussion with the cardiovascular surgeons. Aquafan MD 100® (Aido, Yokkaichi, Japan) was preferred as an initiating nutrient owing to its low osmolarity and short gastric residual time.[13] Dietitians in our team performed the modified swallowing water test (MSWT), referring to previous studies on MSWT, and evaluated patients' swallowing function.[14, 15] During the MSWT, 1, 3, 5, or 10 mL of water was poured on the floor of the mouth, and the patient was instructed to swallow. The test was discontinued when the patient experienced aspiration. The profile was determined by a dietitian based on the swallowing function of the patient. In patients with tracheal intubation or MSWT profiles of 3, 4, or 5, nutritional administration via a nasogastric tube was selected. The nutrients were administered orally to patients with MSWT profiles 1 and 2.

Data collection

All data were collected from the patient's electronic medical records, including age, sex, body mass index, comorbidities, surgical procedures, duration of surgery, and duration of anesthesia. The additive and logistic European System for Cardiac Operative Risk Evaluation scoring systems were used to predict mortality after cardiac surgery.[16, 17] The Sequential Organ Failure Assessment and Acute Physiology and Chronic Health Evaluation II scores were calculated using the worst values obtained within 24 hours after ICU admission. The length of postoperative hospital stay (PoHS), ICU LOS, and time to extubation after ICU admission were also obtained. The time to initiate EN and the route of administration used for initial nutrition (oral or nasogastric tube) were recorded, and the reasons for tube feeding were investigated.

Measurement of outcomes

The primary outcome was the post-cardiac surgery PoHS. The secondary outcomes were the time to initiate EN from ICU admission, the incidence of EN-related complications including non-occlusive mesenteric ischemia (NOMI), nausea, vomiting, diarrhea, abdominal pain, hospital mortality, ICU LOS, and incidence of infectious diseases diagnosed after ICU admission.

Statistical analysis

Continuous variables were assessed for normal distribution using the Kolmogorov-Smirnov test. Continuous data were expressed as medians and interquartile ranges (IQR) as all continuous data were non-normally distributed in this study. Categorical data were expressed as frequencies and percentages. Univariate comparisons of continuous variables between the Conventional and MDTR groups were performed using the Mann-Whitney U test, and categorical variables were analyzed using Fisher's exact test. Age, sex, chronic heart failure, chronic kidney disease, diabetes, surgical procedures (related to the prognosis of cardiac surgery), and MDTR intervention were determined as candidate variables affecting PoHS.[18] Multiple regression analysis was performed using these variables. The results of multiple regression analyses were expressed as unstandardized regression coefficients (β) and 95% confidence intervals (CI). A P-value of < 0.05 was considered significant. All statistical analyses were performed using the EZR software (version 1.54; Saitama Medical Center, Jichi Medical University, Saitama, Japan).

Results

One hundred seventy-nine patients were admitted to the ICU after cardiac surgery during the study period. Of them, 160 patients met the inclusion criteria. The patients were divided into the Conventional (79 patients) and MDTR groups (81 patients) (**Figure 1**). The patients' baseline characteristics are shown in **Table 1**. No significant differences were observed between the two groups. No significant differences were also found in the surgical procedures, operation duration, and anesthesia duration between the two groups (**Table 1**). Three (3.8%) and eight (9.9%) patients had undergone emergency surgery in the Conventional and MDTR group, respectively (P = 0.21).

Primary outcome

No significant differences were observed in PoHS after cardiac surgery between the two groups (Conventional group: 15 days, IQR: 12-23 days vs. MDTR group: 14 days, IQR: 11-17 days, P = 0.20) (**Table 2**). In a multiple regression analysis, MDTR was significantly associated with a shortened PoHS (β: −4.65 days, 95% CI: −8.82 to −0.49 days, P = 0.03) (**Table 3**). By contrast, aortic surgery and coronary artery bypass grafting (CABG) combined with other procedures were significantly associated with prolonged PoHS (aortic surgery = β: 12.7 days, 95% CI: 5.85 to 19.6 days, P < 0.001; CABG combined with other procedures = β: 12.7 days, 95% CI: 4.75 to 20.6 days, P = 0.002) (**Table 3**).

Table 1. Patient's baseline characteristics.

	Conventional (n = 79)	MDTR (n = 81)	P-value
Age, years	71 (60-77)	70 (62-74)	0.46
Male, n (%)	61 (77)	53 (65)	0.12
Body mass index, kg/m^2	24.3 (21.6-25.6)	24.1 (21.1-27.0)	0.99
APACHE II score	14 (12-16)	13 (10-16)	0.12
SOFA score	6 (4-8)	5 (4-7)	0.18
Additive EuroSCORE	6 (4-8)	6 (4-8)	0.39
Logistic EuroSCORE (%)	4.65 (2.86-9.20)	5.14 (3.23-10.2)	0.43
Comorbidities, n (%)			
Hypertension	48 (60.8)	42 (51.9)	
Diabetes	29 (36.7)	24 (29.6)	
Dyslipidemia	37 (46.8)	29 (35.8)	
Old myocardial infarction	4 (5.1)	5 (6.2)	
Vascular disease	2 (2.5)	7 (8.6)	
Chronic heart failure	9 (11.4)	9 (11.1)	
Chronic kidney disease	10 (12.7)	11 (13.6)	
Hemodialysis	6 (7.6)	6 (7.4)	
Old cerebral infarction	8 (10.1)	12 (14.8)	
Respiratory diseases	4 (5.1)	7 (8.6)	
Surgical procedures, n (%)			0.43
CABG	34 (43.0)	25 (30.9)	
Valvular	27 (34.2)	28 (34.6)	
Aortic	10 (12.7)	15 (18.5)	
CABG combined with other procedures	6 (7.6)	8 (9.9)	
Others	2 (2.5)	5 (6.2)	
Emergency/elective, emergency, n (%)	3 (3.8)	8 (9.9)	0.21
Duration of operation, hours	5.4 (4.3-6.7)	5.6 (4.4-6.8)	0.66
Duration of anesthesia, hours	6.7 (5.3-7.9)	6.8 (5.5-7.9)	0.59

All data are presented as medians (interquartile ranges) or n (%).

APACHE II, Acute Physiology and Chronic Health Evaluation II; CABG, coronary artery bypass grafting; EuroSCORE, European System for Cardiac Operative Risk Evaluation; MDTR, multidisciplinary team rounds; SOFA, Sequential Organ Failure Assessment.

Table 2. Clinical outcomes.

	Conventional (n = 79)	MDTR (n = 81)	P-value
Primary outcome			
Postoperative hospital stay, days	15 (12-23)	14 (11-17)	0.20
Secondary outcomes			
Time to initiate EN from ICU admission, hours	28.2 (24.9-40.1)	22.5 (19.5-27.7)	< 0.001
The number of patients who were initiated EN over 48 hours from ICU admission, n (%)	13 (16.5)	0 (0.0)	< 0.001
Route for initial nutrition (oral or feeding tube) feeding tube, n (%)	3 (3.8)	22 (27.2)	< 0.001
Reasons for tube feeding, n			
On mechanical ventilation	1	16	
Dysphagia	2	5	
Others	0	1	
ICU LOS, days	3.6 (2.8-4.7)	2.9 (1.9-4.0)	0.02
Hospital mortality, %	0	0	1.0
Time to extubation from ICU admission, hours	16.0 (12.7-18.1)	16.3 (13.3-23.0)	0.32

All data are presented as medians (interquartile ranges) or n (%).

EN, enteral nutrition; ICU, intensive care unit ; MDTR, multidisciplinary team rounds; LOS, length of stay.

Table 3. Multiple regression analysis of postoperative hospital stay.

	β (days)	95% CI (days)		P-value
		LCL	UCL	
Intercept	5.37	−10.1	20.8	0.49
Age, per 1 increase	0.14	−0.06	0.35	0.16
Male	1.33	−3.30	5.96	0.57
MDTR	−4.65	−8.82	−0.49	0.03
CHF	3.73	−2.92	10.4	0.27
CKD	5.48	−0.88	11.8	0.09
Diabetes	−0.53	−5.59	4.53	0.84
vs. CABG				
Valvular	2.55	−3.17	8.27	0.38
Aortic	12.7	5.85	19.6	<0.001
CABG combined with procedures	12.7	4.75	20.6	0.002
Others	3.34	−7.34	14.0	0.54

Age, sex, CHF, CKD, diabetes, surgical procedures, and MDTR were listed as explanatory variables for the multiple regression analysis on PoHS. β, unstandardized regression coefficient; CABG, coronary artery bypass grafting; CHF, chronic heart failure; CKD, chronic kidney disease; CI, confidence interval; LCL, lower confidence interval; MDTR, multidisciplinary team rounds; PoHS, postoperative hospital stay; UCL, upper confidence interval.

Secondary outcomes

The time to initiation of EN was significantly shorter in the MDTR group (22.5 hours, IQR: 19.5-27.7 hours) than in the Conventional group (28.2 hours, IQR: 24.9-40.1 hours) (P < 0.001) (**Table 2**). EN was initiated over 48 hours in 0 patients (0%) in the MDTR group and in 13 patients (16.5%) in the Conventional group (P < 0.001). The number of patients using feeding tubes was significantly higher in the MDTR group (22 patients, 27.2%) than in the Conventional group (3 patients, 3.8%) (P < 0.001), and tube feeding was the most common initial feeding administration method in patients under mechanical ventilation with tracheal intubation (16 of 22 patients received mechanical ventilation in the MDTR group). The incidence of EN-related complications was similar between the two groups (**Table 4**). Hospital mortality was 0% in both groups (P = 1.0). ICU LOS was significantly reduced in the MDTR group (2.9 days, IQR: 1.9-4.0 days) compared with the Conventional group (3.6 days, IQR: 2.8-4.7 days) (P = 0.02) (**Table 2**). No significant difference was observed in the time to extubation after ICU admission between the two groups. The incidence of pneumonia was significantly lower in the MDTR group (1 patient, 1.2%) than in the Conventional group (8 patients, 10.1%) (P = 0.02) (**Table 4**).

Table 4. Enteral nutrition-related complications and infectious diseases diagnosed after ICU admission.

	Conventional (n = 79)	MDTR (n = 81)	P-value
EN-related complications, n (%)			
NOMI	0 (0)	0 (0)	1.0
Nausea	2 (2.5)	3 (3.7)	1.0
Vomit	1 (1.2)	1 (1.2)	1.0
Diarrhea	1 (1.2)	0 (0)	1.0
Abdominal pain	0 (0)	0 (0)	1.0
Infectious diseases diagnosed after ICU admission, n (%)			
Bacteremia	3 (3.8)	0 (0)	0.12
Pneumonia	8 (10.1)	1 (1.2)	0.02
Surgical site infection	9 (11.4)	4 (4.9)	0.16
Urinary tract infection	4 (5.1)	7 (8.6)	0.53
Others	4 (5.1)	1 (1.2)	0.21

EN, enteral nutrition; ICU, intensive care unit; MDTR, multidisciplinary team rounds; NOMI, non-occlusive mesenteric ischemia.

Discussion

In this study, three important clinical observations were found. First, although MDTR implementation did not reduce the PoHS in patients after cardiac surgery, it was linked to the reduction in PoHS. Second, MDTR was associated with a shorter time to EN initiation without increasing the risk of EN-related gastrointestinal complications. Third, MDTR was associated with a reduction in the incidence of postoperative pneumonia.

Some previous studies have reported that MDTR was associated with lower mortality in noncardiac and nonsurgical patients admitted to the ICU and possibly improved the outcomes of surgical patients admitted to the ICU.[8, 9] A multidisciplinary nutritional support team has been associated with an increase in caloric intake and a shorter duration of mechanical ventilation in ICU patients.[19] Similarly, this study showed that MDTR was a significant factor associated with shorter PoHS in a multivariate analysis. However, MDTR implementation did not reduce the PoHS in this study. In addition to nutritional therapy in the ICU, patients' baseline characteristics, comorbidities, surgical procedures, perioperative management, and management after discharge from the ICU were the factors that may influence PoHS. Results of the multivariate analysis in this study demonstrated that complex surgeries, such as aortic surgery and CABG combined with other procedures, were associated with an increase in PoHS. These confounding factors may have masked the effect of MDTR implementation on clinical outcomes.

The time to EN initiation was significantly shortened without an increase in the incidence of EN-related gastrointestinal complications after the MDTR implementation. In addition, EN was initiated within 48 hours in all patients after MDTR implementation, as recommended by the guidelines. A previous study showed that EN initiation was likely to be delayed in patients after cardiac and gastrointestinal surgery compared with other surgical and medical ICU patients.[20] In critically ill patients with unstable hemodynamics, such as those who have just undergone cardiac surgery, the increased energy and oxygen consumption associated with EN cannot be accommodated, resulting in relative intestinal ischemia, which leads to NOMI.[21] Therefore, malnutrition is often a problem in patients after cardiac surgery. However, some desirable effects on hemodynamics were reported in a previous study. A study addressing the hemodynamic and metabolic adaptation to EN revealed that EN increased the cardiac index and splanchnic blood flow, decreased the catecholamine dose required, and reduced the incidence of gastrointestinal adverse effects in patients undergoing cardiopulmonary bypass and requiring postoperative catecholamines.[22] Moreover, a previous prospective observational study demonstrated that patients who had undergone cardiac surgery requiring two or more vasopressors and mechanical circulatory support did not present with mesenteric ischemia and significant adverse effects of EN.[23] Considering that 24.3% of the patients had difficulty continuing ENs due to the occurrence of EN-related complications, monitoring of hemodynamics after cardiac surgery is considered pivotal for the early and safe initiation of EN.[23] Our intensivist-led MDTR enabled the assessment of patients' nutritional status and discussion of patients' conditions among team members, including circulatory status and bedside conferences with cardiovascular surgeons. These efforts by our MDTR may have contributed to the earlier and safe introduction of EN. In addition, nutrition therapy was not appropriately managed due to understaffing of surgeons, which might have affected the timing of EN initiation. MDTR could complement the management of postoperative cardiac surgery patients.

The incidence of pneumonia significantly reduced after the implementation of MDTR. Previous meta-analyses have reported that early EN is associated with a substantially lower incidence of infectious diseases.[1] A randomized controlled trial also reported that early EN reduced the incidence of pneumonia.[4] In addition, a retrospective cohort study showed that MSWT is useful in predicting the occurrence of pneumonia after extubation in patients who had undergone cardiac surgery.[15] In this study, to assess the swallowing function after extubation, our MSWT could help select an appropriate route of nutritional administration and reduce the incidence of pneumonia.

Our study has several limitations. First, because this study was performed at a single institution, it is difficult to generalize our results. However, the results of this study were comparable to those of previous studies evaluating the effectiveness of MDTR in critically ill patients. Second, owing to the before-and-after design of this study, bias in both groups and confounding factors could not be excluded. However, the patients' baseline characteristics were comparable between the two groups, and a multiple regression analysis was performed as a sensitivity analysis. Third, the low detection power was due to the small sample size. The exploratory and retrospective design of this study makes it difficult to obtain a sufficient number of patients. In addition, the difference in the effect of MDTR by surgical procedures was not fully investigated. Fourth, the number of explanatory variables in the multiple regression analysis was limited due to the number of enrolled patients; therefore, several comorbidities were chosen as explanatory variables. Fifth, although emergency surgery cases were not excluded from this study, only a few emergency cases were noted. In general, emergency surgery cases have higher severity and hemodynamic instability compared to elective surgery cases. Patients receiving ECMO were excluded from this study. Thus, the efficacy of MDTR in critically ill patients remains unclear. Sixth, this study did not examine the effect of MDTR on healthcare costs. We speculated that MDTR might contribute to the reduction of healthcare costs in cardiac surgery patients because of the shorter ICU LOS and the lower incidence of pneumonia in the MDTR groups in this study. Therefore, further studies on healthcare costs are warranted to demonstrate the importance of the MDTR and to promote the induction of MDTR for cardiac surgery patients in the ICU. Although the results of this study should be interpreted carefully due to these limitations, it could help promote MDTR and early EN in patients who have undergone cardiac surgery in the ICU.

Conclusion

Although MDTR implementation did not reduce PoHS in patients after cardiac surgery, it was related to the reduction in PoHS. In addition, MDTR was associated with a reduced time to initiate EN without increasing the incidence of EN-related gastrointestinal complications; moreover, EN was initiated within 48 hours in all patients after MDTR implementation. MDTR has also been associated with a reduction in the incidence of postoperative pneumonia.

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Conflicts of Interest: The authors declare that they have no conflicts of interest.

Author Contributions: TY designed the study, collected and analyzed the data, conducted the literature review, and wrote the original draft of the manuscript. AK collected the data. MO, MI, and YS prepared the manuscript and reviewed the drafts. YS and TN designed the study, supported the writing of the manuscript, and reviewed the original manuscript. All authors have read and approved the final manuscript.

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Ethical Approval: This study was approved by the institutional ethical board of Komaki City Hospital (approval code: 211003).

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