Continuing Versus Withholding Enteral Feeding Among Critically Ill Patients Prior to Scheduled Extubation: A Prospective Study.

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Abstract

Introduction: Aspiration is a major risk factor for the development of pneumonia. Critically ill patients are at higher risk due to several factors. Many physicians routinely hold feeding prior to extubation due to usual practice, but evidence is scarce that *continuing* feeding increases the risk of aspiration. This study was designed to determine whether continuing enteral feeding prior to a scheduled extubation is associated with a higher risk of aspiration.

Study Design and Methods: This is a prospective, cohort study done in the critical units of Chong Hua Hospital. All intubated patients, (18 years and above) started on enteral feeding via nasogastric tube for at least 24 hours prior to planned extubation, were included. Patients were grouped into either *Continuous* or *Withold* Group (feeding withheld for at least 3 hours before and 2 hours after extubation). The following events were observed: aspiration of gastric contents during and after extubation, vomiting within 2 hours after extubation, and reintubation within 24 hours from extubation. In the event of reintubation, vomiting and aspiration of gastric content during the process of reintubation was documented.

Results: Seventy patients were included in the study. There was no documented aspiration in both groups. In the *Withhold* group, feeding was withheld with a mean average of 7.11 $\pm$ 2.35 hours and the amount of calories withheld ranged from as low as 166 calories to as high as 800 calories (320 $\pm$ 144.28).

Conclusion: Continuing nasogastric feeding during the peri-extubation period does not increase the risk of aspiration and allows for delivery of optimal nutrition to critically ill patient.

Keywords: *Continuous feeding, Withhold feeding, Aspiration, Critical Care, Extubation*

Introduction

Aspiration is a major risk factor for the development of pneumonia and is considered as one of the most feared complications of enteral feeding.[1-3] Critically ill patients are particularly at higher risk for aspiration due to several factors including mechanical ventilation, and presence of a nasogastric tube for enteral nutrition access.[3] Other factors include decreased level of consciousness, poor oral care, supine positioning, elevated gastric pH, self-extubation, intermittent bolus feeding and large-volume gastric residuals.[3,4]

Although evidence is lacking that continuing enteral feeding prior to a scheduled extubation increases the risk of aspiration, many physicians will routinely hold enteral feeding four to six hours before extubation to potentially minimize the risk for aspiration events.

Several studies have documented that inadequate nutrition in critically ill patients leads to poorer outcomes, greater likelihood for complications, longer hospital stay, and higher mortality.[5-8] In one study, the prevalence of baseline malnutrition among hospitalized patients was already as high as 30-50%, which is further aggravated by the patient's critical illness state, inadequate number of calories delivered, and feeding interruptions due to procedures (including scheduled extubation), leading to worsening of the patient's nutritional status.[5-8]

Although withholding feeding once may not be a significant contributor to the patient's decreased nutritional status, repeatedly holding feedings on days planned for possible extubation (or other procedures) might contribute to significant malnutrition in critically ill patients.[5-7]

This study is designed to examine whether continuing enteral feeding prior to scheduled extubation is associated with a higher risk of aspiration compared to

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withholding feeding. Among mechanically ventilated patients admitted in our critical care units, is there an increased risk of aspiration among patients whose enteral feeding are continued prior to scheduled extubation compared to patients whose feeding are withheld?

Methodology

This study is a prospective cohort study done in the adult critical care units of Chong Hua Hospital, a tertiary level hospital in Cebu City, Philippines.

The study included all patients, aged 18 years and above, admitted in the adult intensive care unit, intermediate care unit, neurocritical care unit and coronary care unit in Chong Hua Hospital who were intubated for more than 24 hours and were started on enteral feeding via nasogastric tube for at least 24 hours prior to a planned extubation. The duration of the study was from March 2019 to October 2019.

Patients who were extubated due to the family's decision to withdraw life support or due to self-extubation were excluded.

There was a total of seventy (70) patients included in the study from a minimum sample size requirement of 66.
Sample Size: The sample size was determined using the formula

$$n = \left\{ z_{1-\alpha/2}\sqrt{\bar{p}\bar{q}\left(1+\frac{1}{k}\right)} + z_{1-\beta}\sqrt{p_1 q_1 + \frac{p_2 q_2}{k}} \right\} \Big/ \Delta^2$$

where q_1 = 1 - p_1, q_2 = 1 - p_2, $\bar{p} = \frac{p_1 + k p_2}{1+K}$, $\bar{q} = 1 - \bar{p}$, p_1 and p_2 are the proportion (or incidence) of the first and second group respectively, Δ is the absolute difference of the two proportions, K is the ratio of sample size for the second group to the first group, n is the sample size of the first group, α is the probability of Type I error, β is the probability of type II error, and z is the critical Z value for a given α or β. International studies show that aspiration incidence in ranges between 6% and 14%. Thus, by setting p_1 = 14%, p_2 = 45% (estimated), α = 0.05, β = 0.20, and $z_{1-\alpha/2}$ = 1.96 and $z_{1-\beta}$ = 0.84 (for 95% confidence level), then the minimum sample size

$$n = \left\{ 1.96\sqrt{(0.295)(0.705)\left(1+\frac{1}{1}\right)} + 0.84\sqrt{(0.14)(0.86) + \frac{(0.45)(0.55)}{1}} \right\} \Big/ 0.31^2$$

≈ 33 patients for the first group, and n=K*33=1(33) =33 patients for the second group

Patients eligible for the study were grouped into either *Continuous* or *Withhold* Group depending on whether feeding were continued or withheld prior to extubation. Patients in the continuous group had their feeding continued during the weaning, peri-extubation and post-extubation period, while patients in the withhold group had their feeding withheld for at least 3 hours prior to extubation and resumed at least 2 hours after extubation. The decision to continue or withhold feeding was based solely on the attending physician's preference.

Patients' demographic data, medical history, diagnosis, and indication for intubation was documented. Criteria for eligibility for extubation was based on attending physician's decision and the fulfillment of the weaning criteria. Once extubated, the following events were observed: witnessed aspiration of gastric contents during and after extubation, vomiting within 2 hours after extubation prior to resuming enteral feeding, and reintubation within 24 hours from extubation. In the event of reintubation, vomiting and aspiration of gastric content during the process of reintubation was documented. Total calories withheld in the *Withhold* group was also documented.

Grouping and Feeding Management:

Groups Formed: Continuous Group and Withhold Group.

Criteria for Grouping: Based on whether feeding was continued or withheld prior to extubation.

Feeding Management Details:

Continuous Group: Feeding continued during the weaning, peri-extubation, and post-extubation period.

Withhold Group: Feeding withheld for at least three hours before extubation and resumed at least two hours after extubation.

Outcomes:

Witnessed aspiration of gastric contents: Definition: Observation of the aspiration of gastric contents during and after extubation. Diagnostic criteria: Detailed documentation of the event in patient records.

Vomiting within two hours after extubation (prior to resuming enteral feeding): Definition: Occurrence of vomiting within the specified timeframe after extubation and before resuming enteral feeding. Diagnostic criteria: Clear documentation of the vomiting event in patient records.

Reintubation within 24 Hours from extubation: Definition: The need for reintubation within 24 hours after the initial extubation. Diagnostic criteria: Clearly defined criteria for the decision to reintubate, documented in patient records.

Vomiting and aspiration of gastric content during reintubation: Definition: Observation of vomiting and aspiration of gastric contents during the process of reintubation. Diagnostic criteria: Detailed documentation of these events during the reintubation process.

Total calories withheld in the Withhold Group: Definition: The total amount of calories withheld in the group where feeding was withheld. Diagnostic criteria: Documentation of the exact number of calories withheld for each patient in the Withhold Group.

Handling of quantitative variables: Data were analyzed using *IBMSPSS*™ software to ensure accuracy of computation.

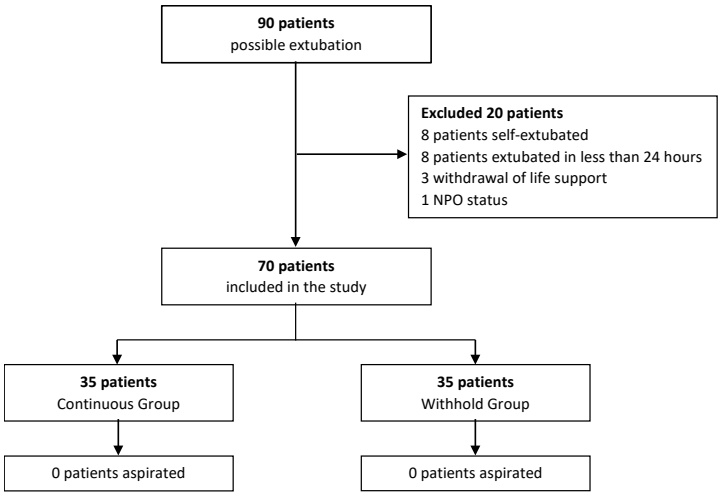

Figure 1. Study flowchart.

Group Stratification: For statistical analysis and data description, patients were stratified into two groups: *Continuous* or *Withhold* group. *t-test* was used for comparisons between independent variables while chi-square test was used between categorical variables. Results *were* considered significant at a $p \leq 0.05$.

The study only commenced after gaining approval from the Chong Hua Hospital Institution Review Board *(Ref code: 2419-02)*. All documents gathered were treated confidential, and were used for research purposes only.

Potential sources of bias may be in the decision-making for feeding management. The decision to continue or withhold feeding was based solely on the attending physician's preference, introducing a potential source of bias.

During our research, no missing data was noted since this was conducted in a prospective manner and data completeness is strictly practiced in the special care units.

Table I. The Demographic and Clinical Characteristics of Intubated Patients Admitted in the Critical Care Units, n = 70

Characteristics	Value n (%)
Age in years, mean (standard deviation)	61.59 (17.99)
21-30	4 (5.71)
31-40	5 (7.14)
41-50	10 (14.29)
51-60	14 (20.00)
61-70	13 (18.57)
71-80	12 (17.14)
81-90	10 (14.29)
91-100	2 (2.86)
Sex	
Male	36 (51.43)
Female	34 (48.57)
Days Intubated, mean (standard deviation)	6.87 (5.33)
Reason for Intubation	
Cardiovascular Disease	
Heart Failure	13 (18.57)
Myocardial Infarction	7 (10.00)
Fatal Arrythmia	6 (8.57)
Coronary Artery Bypass Graft	2 (2.86)
Cardiac Tamponade	1 (1.43)
Pulmonary Disease	
Pneumonia	14 (20.00)
Chronic Obstructive Pulmonary Disease	2 (2.86)
Upper Airway Obstruction	2 (2.86)
Acute Respiratory Distress Syndrome	1 (1.43)
Neurologic Disease	
Cerebrovascular Infarct/Bleed	8 (11.43)
Neuromuscular Disease	1 (1.43)
Others	
Sepsis	8 (11.43)
Massive Gastrointestinal Bleed	2 (2.86)
Chronic Kidney Disease	1 (1.43)
Post-operative (Spinal Surgery)	1 (1.43)
Trauma	1 (1.43)

Note: Values presented as Frequency (Percentage) unless otherwise stated

Limitations of the study are as follows. This study was conducted in a single center; thus, the findings may not be fully generalizable to other healthcare settings or time periods. The study included 70 patients, slightly exceeding the minimum sample size requirement of 66. Still, a small sample size may impact the generalizability of the findings, potentially limiting the ability to detect smaller but clinically relevant effects. The presence of a confounding factor as the decision to continue or withhold feeding was on physician preference the lack of standardized protocol may introduce a confounding bias, as other unmeasured factors could influence the outcomes studied. There is also a lack of long-term follow-up as the study was only limited to 6 months. Long term outcomes and potential complications beyond this time are not explored.

Results

Ninety patients were extubated in the critical care unit, and 70 patients were included in the study (35 Continuous Group and 35 Withhold Group). Twenty patients were excluded for the following reasons: (1) self-extubation (eight patients), (2) withdrawal of life support (three patients), (3) extubated in less than 24 hours (eigh8 patients), and (4) NPO status (one patient).

Table I shows the baseline demographic and clinical characteristics of intubated patients in the critical care units, while *Table II* shows the comparative analysis of the demographic and clinical characteristics of the *Continuous* group and the *Withhold* group. Both groups were comparable.

There was no witnessed aspiration of gastric contents immediately post extubation in both *Continuous* and *Withhold* Group (*Table III*). In the *Withhold* group, feeding was withheld with a mean average of 7.11 $\pm$ 2.35 hours (ranging from 4 to 14 hours). There were 3 patients whose feeding was put on hold for more than 12 hours due to adverse events leading to termination or delay of the planned extubation. The number of calories withheld

Table II. The Comparative Analysis of the Demographic and Clinical Characteristics of Intubated Patients Admitted in the Critical Care Units, n = 70

Characteristics	Continuous, $N_1 = 35$	Withhold, $N_2 = 35$	Test Statistic (P-Value)
Age in years, mean (standard deviation)	65.00 (19.29)	58.17 (16.14)	1.61 (0.113) [A]
Sex			
Male	18 (51.43)	18 (51.43)	0.00 (1.000) [B]
Female	17 (48.57)	17 (48.57)	0.00 (1.000) [B]
Days Intubated, mean (standard deviation)	6.69 (5.14)	7.06 (5.58)	-0.29 (0.773) [A]
Reason for Intubation			
Cardiovascular Disease			
Heart Failure	6 (17.14)	7 (20.00)	0.06 (0.799) [B]
Myocardial Infarction	5 (14.29)	2 (5.71)	1.17 (0.279) [B]
Fatal Arrythmia	1 (2.86)	5 (14.29)	2.46 (0.117) [B]
Coronary Artery Bypass Graft	0 (0.00)	2 (5.71)	1.95 (0.163) [B]
Cardiac Tamponade	0 (0.00)	1 (2.86)	0.99 (0.321) [B]
Pulmonary Disease			
Pneumonia	8 (22.86)	6 (17.14)	0.24 (0.625) [B]
Chronic Obstructive Pulmonary Disease	1 (2.86)	1 (2.86)	0.00 (1.000) [B]
Upper Airway Obstruction	0 (0.00)	2 (5.71)	1.95 (0.163) [B]
Acute Respiratory Distress Syndrome	1 (2.86)	0 (0.00)	0.99 (0.321) [B]
Neurologic Disease			
Cerebrovascular Infarct/Bleed	5 (14.29)	3 (8.57)	0.45 (0.503) [B]
Neuromuscular Disease	0 (0.00)	1 (2.86)	0.99 (0.321) [B]
Others			
Sepsis	5 (14.29)	3 (8.57)	0.45 (0.503) [B]
Massive Gastrointestinal Bleed	1 (2.86)	1 (2.86)	0.00 (1.000) [B]
Chronic Kidney Disease	1 (2.86)	0 (0.00)	0.99 (0.321) [B]
Post-operative (Spinal Surgery)	0 (0.00)	1 (2.86)	0.99 (0.321) [B]
Trauma	1 (2.86)	0 (0.00)	0.99 (0.321) [B]
Calories per day, mean (standard deviation)	1382.86 (285.42)	1411.43 (373.00)	-0.36 (0.720) [A]

Note: Values presented as Frequency (Percentage) unless otherwise stated
** Significant at 0.05
[A] using t-test (or z-test) for two independent samples.
[B] using Test for Equality of population proportions (chi-square-based test)

Table III. Number of hours feeding withheld and number of calories not given in the *Withhold* Group.

Characteristics	Continuous, $N_1 = 35$	Withhold, $N_2 = 35$	Test Statistic (p-Value)[A]
Hours Feeding Withheld, mean (±SD)	0 (0.00)	7.11 (2.35)	N/A
Calories Withheld, mean (±SD)	0 (0.00)	320.51 (144.28)	N/A
Aspiration immediately after extubation	0 (0.00)	0 (0.00)	N/A
Reintubated	1 (2.86)	0 (0.00)	0.99 (0.321) [B]
Aspiration during Reintubation	0 (0.00)	N/A	N/A
Vomited	0 (0.00)	0 (0.00)	N/A

Note: Events observed post extubation on both *Continuous* and *Withhold* Group.
Values presented as Frequency (Percentage) unless otherwise stated
** Significant at $p < 0.05$
[A] using t-test (or z-test) for two independent samples
[B] using Test for Equality of population proportions (chi-square-based test)

in the *Withhold* group ranged from as low as 166 calories to as high as 800 calories (mean of 320.51 ± 144.28). One patient in the *Continuous* group was reintubated within 24 hours from extubation due to hypercarbia. There was no aspiration of gastric contents observed during reintubation. No patients vomited within 2 hours after extubation.

Discussion

Many physicians routinely hold feedings hours before a scheduled extubation to reduce the risk of aspiration during extubation and in the event of reintubation during extubation failure, which is a more pressing concern among physicians. Commonly, feedings are withheld 4 to 6 hours, however, practices differ among physicians, with others holding feeding as short as 2 hours.[17] While data regarding the safety of continuing enteral feeding during extubation is limited, data is also lacking on whether continuing enteral feeding increases the risk of aspiration. However, one study done among pediatric patients stated that continuing transpyloric feeding during tracheal extubation was safe and resulted in more

optimal nutrition delivered.[14] Correspondingly, in this study, there were no witnessed aspiration of gastric contents documented in both groups. Although there was 1 patient in the continuous group that required reintubation, the patient did not experience any adverse events (vomiting and aspiration of gastric contents during reintubation). Hence, it is safe to continue nasogastric feeding in patients during the peri-extubation period. This also avoids unnecessary delays in extubation when feedings are not withheld which can lead to longer ICU stay, and higher hospital costs. It is also important to take note that while physicians are concerned with the risk of aspiration in the event of reintubation during extubation failure, the rate of reintubation itself is very low with only one patient out of 70 reintubated in this study (1.4%).

On the other hand, several studies have already demonstrated that inadequate nutrition during critical illness leads to poorer outcomes.[5-8] Feeding interruption is a common occurrence among critically ill patients due to numerous reasons including extubation and this leads to inadequate calories delivered.[8,16] In this study, the average calories withheld in the withhold group was 320.51 $\pm$ 144.28 kilocalories (range from 166 to 800 kcal), with a mean total caloric intake per day of 1411.43 $\pm$ 373.00 (range from 900cal to 2500cal). This shows that on the day of extubation, approximately 23% of the total calories was not given. Of note, were 3 patients whose feeding were withheld for more than 12 hours (2 patients for 13 hours, 1 patient for 14 hours), with only half of the total calories delivered, making the patient undernourished for that day. Although withholding feeding once may not be significant to the patient's overall nutritional status, repeatedly holding feedings not only during planned extubation but including other reasons (procedures, large gastric residual volume, vomiting, diarrhea), can contribute to significant malnutrition in the critically ill patients. Therefore, continuing enteral feeding during the peri-extubation period allows patients to receive more optimal nutrition.

Conclusion

Continuing nasogastric feeding among critically ill patients during the peri-extubation period does not increase the risk of aspiration and is generally safe. Withholding feedings prior to a planned extubation is therefore an avoidable reason for interrupted feedings. Continuing feeding can help mitigate worsening of the patient's nutritional status by allowing delivery of optimal nutrition which is indispensable in the recovery of critically ill patients.

While the study provides valuable insights into feeding management strategies and outcomes post-extubation within its specific context, caution should be exercised when generalizing these findings to diverse patient populations, healthcare settings, and time periods. The study's applicability may be limited to patients with similar characteristics and may no fully generalize to populations with different clinical profiles. The Exclusion of patients extubated due to family decision or self extubation may enhance the internal validity. However, this exclusion criterion may limit the applicability of the findings to cases where extubation decisions are influenced by patients or family preference, which is common in clinical practice. The Observed variability in withholding duration and the reason for prolonged withholding may impact generalizability as these may differ in other healthcare settings. Being a single center study may limit the generalizability of results to a broader healthcare context.

Recommendation

The researchers would like to recommend the following:

1. This study be carried out in a prospective, randomized trial with a bigger population, and to include more objective measures of aspiration such as chest radiographs, and other clinical parameters suggestive of aspiration.
2. Further define continuous feeding into either continuous drip feeding and intermittent bolus feeding and compare.
3. Determine total caloric deficit based on the desired caloric requirement of the patient.

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Conflict of Interest: The authors have nothing to declare

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