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Implementation of an Evidence-based Feeding Protocol and Aspiration Risk Reduction Algorithm

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Aspiration pneumonia is a serious complication of mechanical ventilation and enteral tube feedings. It results in increased patient mortality, increased length of hospital stay, and increased healthcare costs. This article describes an evidence-based practice approach to the creation of an enteral feeding protocol and an aspiration risk reduction algorithm. These tools were piloted in a Medical Intensive Care Unit at a Midwest tertiary care center. Chart audits show an increase in the percentage of patients who reach their goal rate for enteral feedings from 78% to 85%. Reported aspiration pneumonias decreased from an average count of 4.8 patients per month to 4.3 per month and ventilator-associated pneumonia rates decreased from 6.8 to 3.2 per 1000 patient days.
Key words: *aspiration algorithm, aspiration reduction, feeding protocol*

MECHANICALLY VENTILATED PATIENTS are at risk for aspiration and nutritional compromise from a variety of reasons ranging from decreased level of consciousness to environmental barriers that impair normal mechanisms of swallowing and airway clearance. When possible, utilization of the gastrointestinal tract as a route for nutrition has been shown to provide many protective benefits to the patient.[1,2] Aspiration pneumonia is a serious complication arising from enteral feedings and a leading cause of pneumonia in the intensive care unit (ICU).[1,3] Although aspiration does not always lead to pneumonia, it is believed to be one of the underlying mechanisms of ventilator-associated pneumonia (VAP).[4] Aspiration is not an uncommon event. Some reported incidences of aspiration are as follow[3]:

- Up to 45% of normal patients during sleep
- Up to 70% of patients with altered levels of consciousness
- Up to 40% of patients receiving enteral feedings
- Between 50% and 75% of patients receiving mechanical ventilation

Intensive care unit patients usually have multiple risk factors for aspiration. Some risk factors for aspiration include decreased level of consciousness (from either sedation or underlying medical condition), presence of enteral feeding or endotracheal tubes, delayed gastric emptying, and need for supine positioning. The Medical Intensive Care Unit formed a multidisciplinary team to look at ways to reduce aspiration risk and standardize

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an enteral feeding protocol. Chart audits yielded greater than 2 risk factors for aspiration in 94% of our preimplementation group ($N = 18$) and 100% in our postimplementation group ($N = 13$). Given the prevalence of aspiration risk factors in this patient population, it is a challenge for the ICU clinician to provide optimal nutrition while minimizing the risk of aspiration.[1,3]

Our multidisciplinary group used the Iowa Model of Evidence-based Practice to Promote Quality Care[5] as a framework to institute the practice change. The Iowa Model calls for identification of clinical triggers for practice change. If change is identified as a priority for the organization, formation of a multidisciplinary team is recommended. The multidisciplinary team conducts a review of existing literature, and practice change is implemented as supported in the literature. If not enough evidence is available in the literature, a study is recommended to assess the effect of the proposed practice change. Changes in practice are then evaluated by their impact on measurable patient outcomes via the collection of quality improvement data.

FEEDING PROTOCOL

The clinical triggers associated with our feeding practice related to ways of detecting, preventing, or reducing the incidence of aspiration. Our multidisciplinary group searched the literature seeking evidence-based answers to these triggers. The group examined bedside methods to detect and prevent aspiration of feedings, management of gastric residual volumes (GRVs), and location of feeding tubes. Prevention of aspiration was a major concern, so the focus for teaching included not only management of enteral feedings, but also an algorithm on methods to decrease risk of aspiration (see Fig 1).

LITERATURE REVIEW

Methods to detect aspiration

Blue dye method

The blue food dye method of detecting aspiration is believed to give a visual clue to aspiration of feedings, that is, the pulmonary or oral secretions will show a blue color if the patient had regurgitated feedings. Many problem areas are identified in the literature with this method. Practice is noted to vary in the amount of dye used in feeds.[3,6] Also, use of multidose dye containers has been implicated in bacterial contamination of feedings.[7] Comparison of this blue dye method with the glucose oxidase method (plus the presence of clinical signs and symptoms of aspiration) shows low reliability.[7,8]

Anecdotal reports of skin, urine, and internal organ discoloration are found in the literature. This raises the concern that further study of the use of food coloring in the acutely ill patient is needed. Discoloration of other body fluids may interfere with pH and occult blood testing on those body fluids. Even more alarming reports of unexplained metabolic acidosis, and even death, associated with the addition of food dye to feedings have been published.[3] Blue dye method's poor reliability as a detector of aspiration, and the potential for patient harm, has led our institution to abandon this practice.[3,7,9,10]

Glucose oxidase

The premise behind the glucose oxidase method as a detector of aspiration is the presence of glucose levels above 5 mg/dL in sputum *is* an abnormal finding.[10] The glucose oxidase method of testing sputum for contamination with enteral feedings showed more reliability than the blue dye method when compared with clinical signs and symptoms of aspiration.[6,10] However, it too had many areas for concern. Presence of blood in endotracheal aspirate would lead to glucose being detected in the aspirate. The manufacturer of the strips does not guarantee specificity for detecting glucose in sputum since they were designed to be used to detect glucose in blood. The use of low glucose formulas leads to difficulty detecting glucose presence in aspirate. Also, this method has a greater cost than the blue dye method, in both nursing time and supplies. Instances of elevated glucose in the sputum of patients not

Aspiration Risk Reduction Algorithm

Standard interventions for all patients receiving ventilation or enteral feedings
- Elevate HOB >30°
- Good oral care.
- Regular assessment of feeding tolerance and feeding tube

Does patient have one or more aspiration risk factors?

See risk factors

Aspiration risk factors
- Previous aspiration
- Decreased LOS
- Neuromuscular disease
- Structural abnormalities of the GI tract
- Endotracheal intubation
- Vomiting
- Persistent high gastric residuals
- Prolonged supine positioning
- Presence of feeding tube
- Bolus/intermittent feeding
- Abdominal/thoracic surgery or trauma
- Factors that delay gastric emptying (diabetes, hyperglycemia independent of diabetes, electrolyte abnormalities, and medications that delay gastric emptying like dopamine and propofol)
- Poor oral care
- Age
- Inadequate nursing staff
- Large bore feeding tube
- Malpositioned feeding tube
- Transport

Secondary interventions for patients with one or more risk factor
- Above interventions, plus
- Tight glycemic control
- Correct electrolyte abnormalities
- Minimize use of narcotics and sedatives
- Use continuous feeding

Documented aspiration or persistent feeding intolerance?

Interventions for patients with continued feeding intolerance
- All above intervention, **plus**
- Use prokinetic agents
- Small bowel feeding, potentially locate at or below Ligament of Treitz

Utilize below guidelines/protocols
- Sedation management for the mechanically ventilated patient
- Intravenous insulin management adult-dose adjustment table
- Oral care policy
- Intestinal feeding tube placement protocol (MICU & IPCU)
- Document in appropriate section within the SOC form

Feeding Protocol

Stop feeding if
1) Vomiting
2) Residual volumes > 250 cc
3) Residual volumes > 100 cc for PEG tubes
4) Abdominal distention
5) Abdominal pain

For residual 150–250 cc
1) return residual to patient
2) Maintain HOB >30°
3) Intervene systematically on risk factors that can delay gastric emptying:
   a. Avoid supine positioning
   b. Tight glycemic control, eg, goal blood sugar <150 mg/dl
   c. Assess and correct electrolyte abnormalities
   d. Minimize use of narcotics and sedation
   e. Minimize use of medications known to delay gastric emptying
   f. Assess bowel care needs
   g. Consider prokinetic agent

For residuals <150 cc
1) Return residual to patient and continue to monitor
2) Maintain HOB elevation >30°
3) Continue to assess tube placement and minimize risk factors

Restart feedings
1) Recheck residuals 2 h after stopped
2) Restart if volume less than 250
3) Resume at 1/2 previous rate and advance to goal as tolerated
4) Continue to assess and utilize interventions to decrease risk factors!

For patients with persistent inability to achieve goal feeds despite above interventions, consider placement of feeding tube into the jejunum.

Figure 1. Aspiration risk reduction algorithm and feeding protocol. HOB indicates head of bed; LOS, length of stay; GI, gastrointestinal; MICU, medical intensive care unit; IPCU, intermediate pulmonary care unit; SOC, standards of care; and PEG, percutaneous endoscopic gastrostomy. Copyright, Amy Bowman, BSN, RN, The University of Iowa Hospitals and Clinics.

receiving enteral feedings have occurred. These instances occurred without the presence of blood in the sputum and without systemic elevation of blood glucose.[8] The literature does not support the use of the glucose oxidase method to detect aspiration of feedings due to its cost (in time and supplies) and due to the potential for false positive results.[7,9,11]

Gastric residual volumes

The second clinical trigger for our practice change was the management and interpretation of GRVs. Review of the literature shows little standardization in practice related to GRVs. McClave and Snider report, "No aspect of the practice of GRV has been standardized."[12] Threshold volumes, at which feedings are being held, range from 30 to 500 cc. McClave and Snider[12] note that there is even inconsistency within institutions as to the acceptable threshold volume.

Gastric residual volumes as a predictor of feeding intolerance

The beliefs that have led to the practice of obtaining gastric residual volumes are being challenged in the literature. The premises are as follows:

- The stomach holds a set volume.
- The stomach will overflow into the esophagus if more comes in than leaves in a given time.
- If we know the volume of the stomach at a given time, we can predict when it is going to overflow.

When interpreting gastric residual volumes, the practitioner must take into account the normal endogenous volumes of saliva and gastric juices. On average, a daily output for saliva can equal 1500 cc. Gastric secretions can average 3000 cc/d. This creates an average volume of 188 mL of endogenous secretions per hour.[12]

Lin and Van Citters used a mathematical model, typical feeding volumes, and gastric content emptying rates from 35% to 55%, to predict a normal plateau effect for gastric output that would occur between 232 and 464 mL within 3 to 6 hours of the initiation of feedings.[13] Therefore, based on this information, stopping feedings for GRVs less than 400 to 500 mL might not be physiologically sound or clinically appropriate.[12,13]

Further support that higher residual volumes are seen at the beginning of feedings, but decrease as the feedings continue, is provided in a study by McClave et al,[14] in which 80% of those with elevated GRVs responded with decreasing residuals as feedings continued. In most cases, the finding of an elevated gastric residual volume is an isolated event. McClave et al found that of 44 patients over 339 days of enteral feedings, only 4 patients showed a GRV more than 200 ml on 2 or more occasions.[15]

Other methods of assessing feeding tolerance include physical and radiographic examinations. In a study by McClave et al,[14] residual volume failed to correlate with physical and radiographic examinations. That is, there were times when high GRVs were noted in a patient with normal appearing physical and radiographic examinations, and times when low GRVs were noted, but the patient had abnormalities in physical or radiographic examinations. Thus, the study group concluded that a single high residual volume should not cause automatic cessation of tube feedings. Residual volumes should be interpreted in conjunction with physical examination and radiographic findings.[14]

Gastric residual volumes as a predictor of vomiting or aspiration

Knowledge of gastric residual volumes did not predict either aspiration or vomiting in the following studies. In a study by Lukan et al,[16] patients were randomly assigned to 2 groups—the first had feedings held for 200 cc and the second had feedings held for 400 cc GRV. This study showed no significant difference in incidence of aspiration between the 2 groups.[16] Another study,[17] examining small bore feeding tube occlusion after

residual checks, found no impact on the incidence of aspiration pneumonia when comparing groups that had residuals checked every 4 hours to those who had no residual checks done.[17]

Mentec et al used the term *upper digestive intolerance* to study the effect of elevated gastric residuals on aspiration pneumonia rates.[18] *Upper digestive intolerance* was defined as one of the following: vomiting, the presence of 2 consecutive GRVs between 150 and 500 cc, or 1 GRV more than 500 cc. The investigators demonstrated an increase in nosocomial pneumonia in the presence of UDI, as defined above. However, some concerns about the correlation between high GRV and vomiting arise from the data. In the study, 40 patients vomited, but 21 of those patients came from the normal GRV group. Of the 19 patients who vomited from the group with GRV more than 150 cc, the vomiting preceded the increased GRV in 6 of these patients. McClave and Snider[12] state,

> Increased GRVs were not shown to correlate with ICU mortality, hospital mortality, or pneumonia (occurring after the start of enteral tube feeding). However, when increased GRVs were combined with vomiting to define UDI, there was significant correlations to pneumonia ($P = .01$), ICU length of stay ($P = .007$), and ICU mortality ($P = .03$).[12]

Handling of gastric residual

In the literature, there is variability in practice for handling the gastric residual. A study by Booker et al[19] showed no increase in complications between the control group, which discarded gastric residual volumes, and the study group in which the residual volume was returned to the patient. Electrolyte balance and nutritional goals are enhanced with the return of gastric contents, and this study demonstrated no harm in returning the volume.[19]

Further studies need to be done in all areas of gastric residuals. In light of no absolute standard to guide practice, an algorithmic approach was developed to attempt to intervene on gastric residual volumes before they reached a level of potential concern. A higher level of reliability was placed on physical examination measures of poor gastric emptying (ie, abdominal distention, abdominal pain, and vomiting) as guides for feeding cessation. Although there were no consistent study findings to definitively guide threshold volumes for gastric residuals, there was significant support in the literature that feedings in our unit were being stopped for GRVs that were too small. The feeding protocol implemented in the Medical ICU set the threshold volume at 250 cc, based on study findings from the literature and unit consensus, with early algorithmic intervention starting at 150 cc.

Location of feeding tube

Most of the studies comparing gastric feeding to postpylorus feeding have been too small to generate significant findings. The results of these studies have been conflicting as to feeding intolerance and pneumonia rates.[20–29] Meta-analysis of a group of these randomized studies demonstrated a statistically significant decrease in pneumonia rates in the postpylorus group. However, positioning of the tube beyond the Ligament of Treitz (distal small bowel) is believed to be the most effective way to achieve this decrease in pneumonia rates.[3,23,29] Further studies using the control groups of jejunal feeding versus gastric feeding are needed to see if this hypothesis is borne out in practice.

Our ICU, which piloted the feeding protocol, already had a bedside method for duodenal placement of feeding tubes in place. Repeated attempts for duodenal placement are not attempted, but instead feedings may begin gastrically. The length of tubes used, along with the technique for placement, made bedside positioning into the jejunum not feasible. The 6-fold increase in risk of aspiration with transport off the unit[4] was weighed, along with the evidence supporting gastric feeding. Our multidisciplinary group chose to reserve endoscopic feeding tube placement beyond the Ligament of Treitz for those patients who have a history of aspiration and feeding intolerance.[3,25]

Methods to reduce risk of aspiration

Elevation of head of bed

Supine positioning of patients during the first 24 hours of mechanical ventilation has been shown to be an independent risk factor in the development of VAP and patient mortality.[30] A study by Drakulovic et al[31] demonstrated that supine body position and enteral nutrition were independent risk factors for nosocomial pneumonia. This study showed a lower frequency of nosocomial pneumonia in patients placed in the semirecumbent position. Studies demonstrate higher levels of pulmonary aspiration of radioactive-labeled gastric contents in the supine position than in the semirecumbent position. Gastroesophageal reflux occurred in both study groups, but pulmonary aspiration of those contents was lessened by the semirecumbent position.[32-34]

In a multivariate analysis of risk factors for VAP, Kollef found a higher mortality rate in study patients in the supine position than in those in the semirecumbent position—30.2% (supine) compared to 8.9% (semirecumbent).[30] Kollef also found that 32.1% of the ICU patients who were found to be in the supine position had no clear indication for supine positioning.[30]

A pilot study[35] supports this finding of overuse of the supine position in the ICU. The investigators[35] collected 2 months of data, comparing head of bed elevation to hemodynamic status and enteral feeding use, and found use of higher backrest positions (>30°) to be minimal and not related to use of enteral feedings or to patient blood pressure readings. The mean backrest position was 22.9°, and 86% of the patients were supine.[35] When possible, elevating the head of the bed is a simple, inexpensive way to reduce risk of aspiration in ventilated and enterally fed patients.[30-35]

Methods to promote gastric emptying

Interventions noted to promote gastric emptying are as follows:

- Maintain blood glucose less than 150 mg/dL because elevated blood sugars can cause disordered contractions throughout the gastrointestinal tract.[3,4,36]
- Minimize use of sedatives that alter level of consciousness and drugs that affect gastric emptying (eg, opioids, dopamine, and propofol can all negatively affect gastrointestinal motility).[1,3,4,36]
- Correct electrolyte abnormalities.[3]
- Assess bowel care needs.[37]
- Consider prokinetic agents.[3]

IMPLEMENTATION

Implementation of the evidence-based practice involved gathering information to identify baseline care processes and problem areas for teaching. This information was gathered by 2 methodologies: initial survey of the nursing staff to identify attitude and knowledge related to caring for patients receiving enteral feedings, and a quality improvement monitor used for chart audit to determine practice norms. After gathering initial quality improvement data, and developing an EBP protocol, teaching began. The protocol and algorithm were developed in a format that was available at the bedside. Teaching utilized a series of instructional posters and 1:1 peer teaching. Visual cues in the form of a brightly colored pictorial reminder to keep "Heads up, feedings!" were placed on all feeding pumps (see Fig 1). A unit resource book was developed. All the educational materials associated with the project were color-coded with a distinctive color and/or had the pictorial emblem on them to ease identification with the project.

Other areas of change involved responding to initial survey data that stated staff felt that they had difficulty documenting interventions. Changes were made in the standards of care forms (care plans) to facilitate documentation of feeding tube position and nutrition status. Changes were made in the flow sheet to allow easier documentation of elevation of head of bed. The protocol and algorithm were incorporated into the unit-based competency review.

Initial chart audits were performed from July through October 2003. Information was

collected on a total of 18 patient feeding days occurring at least 24 to 48 hours after initiation of feeding. Areas of interest included documentation of elevation of head of bed, achievement of goal rate of feedings, residual volumes for which feedings were held/or not advanced, and presence of major and minor risk factors of aspiration. Staff education occurred between November 2003 and February 2004. Baseline staff surveys were distributed to 37 staff nurses.

EVALUATION

Evaluation on effectiveness of teaching occurred between February 2004 and April 2004. A follow-up (postimplementation) survey was distributed to evaluate changes in staff knowledge and attitudes. A follow-up (postimplementation) chart audit was performed on 13 patient feeding days following the same criteria as in the initial audit.

Chart audit results

On the basis of literature review, the following patient risk factors for aspiration were assessed: (1) history of aspiration/emesis, (2) vasoactive medications, (3) analgesics/sedatives, (4) poor glycemic control (glucose > 150), (5) electrolyte imbalance, (6) neuromuscular blockage, and (7) supine positioning. Presence of risk factors was compared to assure that the initial patient group was similar in risk for aspiration to the group that used the protocol. Comparison of the groups can be found in Table 1.

The preimplementation and postimplementation chart audits demonstrated improvements in head of bed 30° or more (pre = 2.2 times in 24 hours, post = 6.2 times in 24 hours); mean residuals for stopping or not advancing feedings (pre = 23.3 cc, post = 115 cc); percentage of patients at goal rate of feedings (pre = 78%, post = 85%); and feeding tube position documented (pre = 27%, post = 64%). The chart audit also revealed that the percentage of patients at risk for aspiration and/or feeding intolerance for reasons other than mechanical ventilation and presence of feeding tube were similar in the preimplementation (94%) and postimplementation (100%) groups.

Table 1. Assessment of patient risk factors for aspiration in chart audits

Risk factor	% of audited patients: Preimplementation (*N* = 17), %	% of audited patients: Postimplementation (*N* = 13), %
History of aspiration/emesis	11	23
Vasoactive medications	29	15
Analgesics/sedatives	71	77
Poor glycemic control (glucose > 150)	47	54
Electrolyte imbalance	65	62
Neuromuscular blockage	6	0
Supine positioning	45	15

Staff survey results

The staff survey was distributed to 37 members of the medical ICU nursing staff. The return rate was 92% and 62% for the baseline and follow-up survey, respectively. Knowledge was assessed using true/false and multiple-choice questions. Staff attitude and satisfaction were assessed using a Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*) and improved in all areas (see Table 2). Staff knowledge (see Table 3) improved in all areas except a slight decrease in the knowledge that addition of blue food coloring to feeds was not recommended. Blue food dye had been discontinued at our hospital while the project team was still reviewing the literature, so it was not strongly stressed during peer- and poster-based teaching. Variations in answers may also reflect staff turnover during the audit period.

Evaluation related to pneumonia occurrence

Evaluation of impact of these practice changes on pneumonia rates is difficult to assess. Since aspiration is thought to be a mechanism of VAP, trends for both diagnoses of

Table 2. Nursing staff attitude and satisfaction scores (Likert scale: 1 = Strongly Agree to 5 = Strongly Disagree)

Questions	Average	
	Preimplementation (N = 34)	Postimplementation (N = 23)
There is a systematic enteral feedings protocol in my unit?	2.9	1.4
I am satisfied with the enteral feeding protocol?	3.2	1.4
The enteral feeding protocol is easy to follow?	2.9	1.3
The process for documenting enteral feedings is clear?	3.0	2.0
I have adequate resources for nutrition management?	2.6	1.8
The method of charting is convenient?	3.0	2.0
I am able to assess the patient's residual volumes every 4 hours?	2.1	1.6
I document every time I assess feeding residuals?	1.7	1.3
Physician's orders are adequate to meet the nutritional needs in your unit?	3.0	2.5
Are you satisfied with the collaborative effort of nutrition management on your unit?	2.3	2.0
It is useful to evaluate the nutritional status of patients?	1.7	1.1
There is a place to document feeding tube position?	3.7	2.3
I am able to document HOB elevation?	1.6	1.2

aspiration pneumonia and VAP were used to capture this outcome. Average counts per month of patients with the listed diagnosis of aspiration pneumonia decreased from an average count of 4.8 patients per month before implementation to an average count of 4.3 patients per month after implementation of the feeding protocol and aspiration risk reduction algorithm. The rate of VAP also decreased from 6.8 (preprotocol) to 3.2/1000 patient days (postprotocol) (see Fig 2).

CONCLUSION

Evidence-based clinical practice protocols, when implemented, have a benefit to patient care by minimizing variations in practice,

Table 3. Knowledge-based question scores

Questions	Answer	% Correct	
		Preimplementation	Postimplementation
Feeding should be held for gastric residuals >250 cc or vomiting?	True	42	96
What HOB positions protect against aspiration of feedings?	30° or greater	74	83
Coloring feeds with food dye is a safe and effective way to detect aspiration?	False	100	96
Residuals should be checked 2 hours after they have been stopped for elevated gastric residual?	True	52	83
Correctly lists risk factors for aspiration	Multiple choice	90	100
Higher residuals are common at the start of feeding?	True	74	100
Identifying factors which delay gastric emptying	Multiple choice	93	100

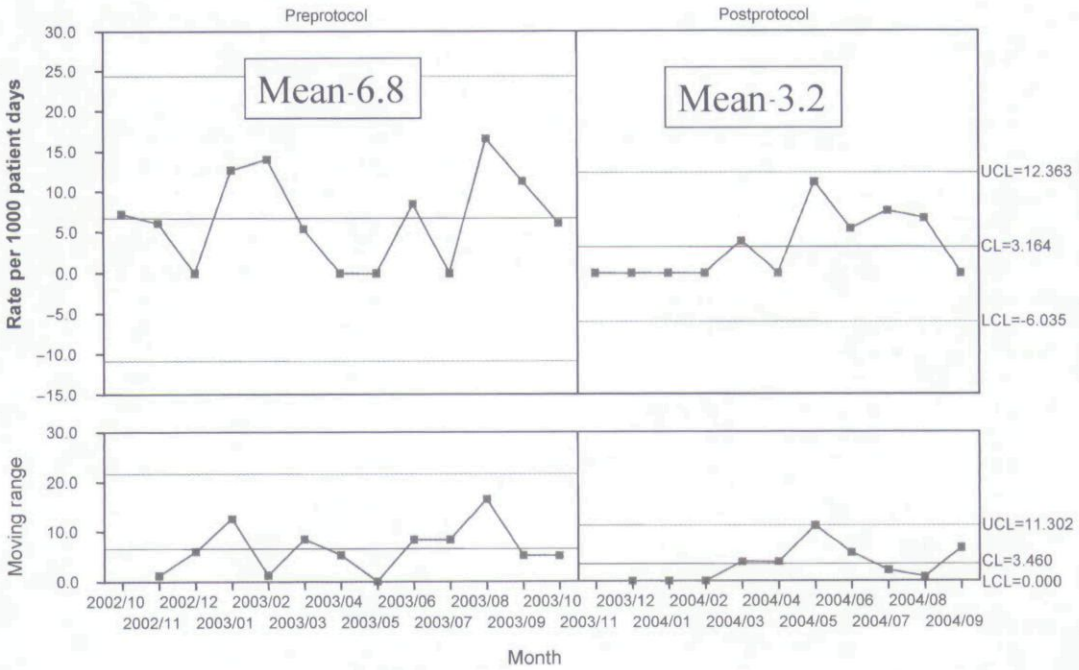

Figure 2. VAP rates per 1000 patient days: Preenteral and postenteral feeding protocol.

and improving patient outcomes.[38] Evidence-based guidelines use empirical research findings along with other types of evidence to standardize practice patterns.[2] The "best practice" goal is identified, and a practice standard is developed to help move practice toward that goal. Cooperation, and input, between multidisciplinary team members is essential to the achievement of these best practice goals. Our enteral feeding protocol and aspiration risk reduction algorithm achieved its goal of improvement in key areas of interest—namely, increase in percentage of patients at goal rate of feedings and decrease in incidence of pneumonia. Improvement has been shown in nursing knowledge and satisfaction relating to the care of patients at risk for aspiration and nutritional compromise. Continued assessment of practice, via quality improvement monitors, is needed to guide interventions to maintain these improvements in practice and to promote enhanced patient outcomes.

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