



Centre for Clinical Effectiveness

Enhancing patient outcomes through clinical application of the best available evidence

EVIDENCE CENTRE
CRITICAL APPRAISAL
Series 2002: Therapy

'Open' *versus* 'closed' systems for enteral feeding

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2002

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SUMMARY STATEMENT

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REQUEST

What are the benefits/disadvantages of using 'Ready to Hang' enteral feeding formula (enclosed feeding system), compared to the decanting system in an acute hospital environment?

REQUESTED BY

Elizabeth Frew, Manager, Dietetics, Dandenong Hospital, Dandenong.

METHODOLOGY

Search Strategy

The Centre for Clinical Effectiveness defines the 'best available evidence' as that research we can identify that is least susceptible to bias. We determine this according to pre-defined National Health and Medical Research Council (NHMRC, 2000) criteria (see Appendix 1).

First, we search for systematic reviews, evidence based clinical practice guidelines, health technology assessments and randomised controlled trials. If we identify sound, relevant material of this type, the search stops. Otherwise, our search strategy broadens to include studies that are more prone to bias, less generalisable or have other methodological difficulties. We include case-control and longitudinal cohort studies in our critical appraisal reports. While we cite observational and case series studies, and narrative reviews and consensus statements, in our reports we do not critically appraise them. Such studies can produce accurate results but they are generally too prone to bias to allow determination of their validity beyond their immediate setting.

Details of Evidence Request

Patients (Subjects): Patients in hospital requiring enteral feeding

Intervention: Closed enteral feeding systems

Comparisons: Open enteral feeding systems

Outcomes: Contamination, safety, wastage, labour time, cost effectiveness

Search terms

(see Appendix 2 for exact search strategy)

Patient (Subject):

Intervention: Enteral Nutrition, enteral feed\$, enteral formula\$, food, formulated, decant\$, pre-fill\$, ready adj hang

Comparison:

Outcome: Infection control, equipment contamination, bacteria\$ adj contaminat\$, costs and cost analysis, cost-benefit analysis, Hospital costs

Resources Searched

We searched the following databases and internet websites:

The Cochrane Library (CD-ROM) 2002 Issue 3

Medline (OVID)- 1966 to August Week 4 2002

CINAHL (OVID)- 1982 to July Week 4 2002

Current Contents (OVID)- 1993 Week 27 to 2001 Week 37

PREMEDLINE (OVID)- September 10, 2002

Biological Abstracts (OVID) – 1980 to June 2002

Australasian Medical Index (AMI) – accessed 11th September 2002

Refinements, Searching & Reporting Constraints

We included items of evidence that were available to us on the 11th and 23rd of September 2002. We only included articles published since 1998 (as requested). Critical appraisal was performed on the subset of studies published in English.

RESULTS

From our sources we identified 11 potentially relevant articles. We obtained the full text of these articles to determine their relevance.

After examination of the 11 articles, the following were excluded as follows:

Reason for exclusion	Number
Study examined systems in a home-based setting	1
Study assessed two ready to hang systems	1
Narrative reviews	3
Total	5

Six articles then remained for appraisal. These studies are classified as follows:

Study Design	Number included
Systematic reviews or meta-analyses	0
Evidence-based clinical practice guidelines	0
Randomised controlled trials	1
Pseudorandomised controlled trials	0
Comparative studies	3
Case study	1
Audit	1
Total	6

Based on our refinements, searching and reporting constraints we are reasonably confident these articles represent the most relevant findings published to date.

Brief summary of overall results of appraisal

Studies that have compared open versus closed enteral feeding systems for bacterial contamination found that contamination rates were lower in the closed enteral feeding systems. However, the relationship between lower contamination rates and a reduction in complications with improved patient outcomes has not yet been established. Three studies investigated the costs associated with open and closed enteral feeding systems. Two of these studies found there were significantly lower overall costs associated with the closed system. However, there were methodological limitations in both of these studies and the findings may not be applicable in an Australian setting.

EVIDENCE SUMMARIES

Format

Evidence summaries are presented as spreadsheets attached to this report. Each spreadsheet contains the article citation, details of the study design, patient description, scientific validity of the article, results, and pertinent remarks from the authors and Centre for Clinical Effectiveness reviewer.

REFERENCES

ARTICLES CRITICALLY APPRAISED FOR THIS REPORT

1. Beattie TK & Anderton A (2001). Decanting versus sterile pre-filled nutrient containers: The microbiological risks in enteral feeding. *International Journal of Environmental Health Research* **11**: 81-93.
2. Herlick SJ, Vogt C, Pangman V & Fallis W (2000). Comparison of open versus closed systems of intermittent enteral feeding in two long-term care facilities. *Nutrition in Clinical Practice* **15**: 287-298.
3. Vanek VW (2000). Closed versus open enteral delivery systems: a quality improvement study. *Nutrition in Clinical Practice* **15**: 234-243.
4. Lee CH & Hodgkiss IJ (1999). The effect of poor handling procedures on enteral feeding systems in Hong Kong. *Journal of Hospital Infection* **42**: 119-123.
5. Inman KJ, Davidson BC, Sibbald WJ & Rutledge FS (1998). Closed enteral systems in the intensive care unit: evaluating their economic impact... Proceedings of the Third Annual Ross Enteral Device Conference, Winston-Salem, NC, September 19-21, 1997. *Nutrition in Clinical Practice* **13**: S42-45 S50-41.
6. Silkroski M, Allen F & Storm H (1998). Clinical research. Tube feeding audit reveals hidden costs and risks of current practice. *Nutrition in Clinical Practice* **13**: 283-290.

ARTICLES NOT CRITICALLY APPRAISED

1. Bengmark S, Andersson R & Mangiante G (2001). Uninterrupted perioperative enteral nutrition. [Review] [98 refs]. *Clinical Nutrition* **20**: 11-19.
2. Bott L, Husson MO, Guimber D, Michaud L, Arnaud-Battandier F, Turck D & Gottrand F (2001). Contamination of gastrostomy feeding systems in children in a home-based enteral nutrition program. *Journal of Pediatric Gastroenterology & Nutrition* **33**: 266-270.
3. McKinlay J, Wildgoose A, Wood W, Gould IM & Anderton A (2001). The effect of system design on bacterial contamination of enteral tube feeds. *Journal of Hospital Infection* **47**: 138-142.
4. Marion ND & Rupp ME (2000). Infection control issues of enteral feeding systems. [Review] [12 refs]. *Current Opinion in Clinical Nutrition & Metabolic Care* **3**: 363-366.
5. Storm HM & Skipper A (2000). Clinical dilemmas. Closed-system enteral feedings: point-counterpoint. *Nutrition in Clinical Practice* **15**: 193-200.

APPENDIX 1

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Levels Of Evidence

Based on "How to use the evidence: assessment and application of scientific evidence" (National Health & Medical Research Council, Canberra, 2000):

Level I		Evidence obtained from a systematic review (or meta-analysis) of all relevant randomised controlled trials.
Level II		Evidence obtained from at least one randomised controlled trial.
Level III	-1	Evidence obtained from pseudo-randomised controlled trials (alternate allocation or some other method).
	-2	Evidence obtained from comparative studies (including systematic reviews of such studies) with concurrent controls and allocation not randomised, cohort studies, case control studies or interrupted time series with a control group.
	-3	Evidence obtained from comparative studies with historical control, two or more single-arm studies or interrupted time series without a parallel control group.
Level IV		Evidence obtained from case series, either post-test or pretest/post-test.

APPENDIX 2

Search strategy

	Search terms for MEDLINE, CINAHL, PREMEDLINE, Current Contents, Biological Abstracts
1	Enteral Nutrition/
2	(enteral adj5 (nutrition or feed\$ or formula\$)).mp.
3	Food, Formulated/
4	(decant\$ or pre-fill\$).mp.
5	(ready adj2 hang).mp.
6	Or/1-5
7	Infection Control/
8	Equipment Contamination/
9	(bacteria\$ or equipment adj contaminat\$).mp.
10	(infection adj control\$).mp.
11	Cost-Benefit analysis/ or Hospital Costs/
12	Cost\$.mp
13	Or/7-12
14	6 and 13
15	Limit 14 to (English language and yr=1998-2002)

<p>Evidence Summary Therapy/Intervention</p> <p>'Closed' versus 'open' systems for enteral feeding</p>	<p>Study 1</p> <p>Herlick, S. J., C. Vogt, et al. (2000). "Comparison of open versus closed systems of intermittent enteral feeding in two long-term care facilities." <u>Nutrition in Clinical Practice</u> 15(6): 287-98.</p>	<p>Study 2</p> <p>Beattie, T. K. and A. Anderton (2001). "Decanting versus sterile pre-filled nutrient containers: The microbiological risks in enteral feeding." <u>International Journal of Environmental Health Research</u> 11(1): 81-93.</p>
<p>STUDY DESIGN & NHMRC LEVELS OF EVIDENCE</p>	<p>Level II – Randomised Controlled Trial</p>	<p>Level III – Comparative study</p>
<p>DESCRIPTION: Patients (subjects), Intervention, Comparisons, Outcomes, Inclusion & Exclusion Criteria</p>	<p>Patients (subjects): 36 patients from 4 chronic care units. Mean age 58 years, equal men and women. Intervention: Closed enteral feeding system Comparisons: Open enteral feeding system Study was conducted over 7 weeks. Data collection took place during weeks 2,3, 5 and 6 (week 4 was the cross-over period). Administration sets were changed every 48 hours. Outcomes: Bacterial contamination, nurse satisfaction (60 nurses data analysed), formula wasted, frequency of diarrhoea, nursing time (10 nurses analysed), costs Inclusion Criteria: Resident of long-term care nursing facility, be 18 years of age or older, receiving intermittent enteral gravity feeding, have been medically stable with no GI intolerance for 2 weeks before entering the study, be able to use a comparable enteral formula from a predetermined enteral formulary, be receiving a stable volume and type of enteral tube feeding throughout the trial period. Criteria for participant withdrawal: persistent diarrhoea or vomiting that compromised a patient's medical stability.</p>	<p>Patients (subjects): Not applicable Intervention: Ready-to-hang systems: Nutri bottle system and the Nutri Pack system. Comparisons: Decanted enteral feeding systems: Nutricia container system and the Ross Flexitainer system. The first was filled with Nutri feed (crown cap on glass bottle) and the latter filled with Paediasure (ring-pull can). Feed samples were taken from the distal end of the pump set of all systems. Systems were i) assembled according to the manufacturers' instructions, ii) assembled as above but with hands which had been deliberately contaminated with <i>Klebsiella aerogenes</i>, giving a concentration of approximately 10⁵ cfucm⁻², or iii) exposed to faulty handling procedures during assembly (touching both the nutrient container top and the pump set connector with hands deliberately contaminated with the test organism). All systems had a simulated feeding period of 24 hours, delivering 800mL of feed. Five samples were taken for each type of feeding system. Samples were taken from the feed cans and bottles to confirm that feed was supplied free from contamination. Outcomes: Bacterial contamination Inclusion Criteria: Not applicable</p>
<p>VALIDITY: Methodology, rigour, selection</p>	<p>Randomisation: Method of randomisation not stated. Randomised cross-over design. All patients accounted for: 41 patients enrolled in the study; 5 participants did not complete the study. Patients treated equally: Yes Similar groups: No separate analysis was conducted for different phases of the study (ie. closed vs. open in phase one (Weeks 2-3) or closed vs. open in phase two (weeks 5-6). That is, all closed enteral feedings or open system feedings were analysed together.</p>	<p>Randomisation: Study was not randomised All patients accounted for: No patients were treated Patients treated equally: Not applicable Similar groups: Not applicable</p>
<p>RESULTS: Generally favourable or unfavourable, specific outcomes of interest, estimate of experimental effect and precision if appropriate</p>	<p><u>Amount of formula infused and wasted:</u> There were no significant differences between the 2 enteral feeding systems. <u>Bacterial counts:</u> "No growth" of organisms was found in 20 (56%) of 36 of the formula samples from the closed system compared with only 1 (3%) of 36 of the formula samples from the open system. Coliform organisms were found in 28% of the formula samples from the open system compared with</p>	<p><u>Following manufacturers' instructions:</u> Organisms were only detected in one of the five samples from the feed decanted from cans (Ross Flexitainer) and at levels ≤20 cfumL⁻¹. <u>Following manufacturers' instructions but with contaminated hands:</u> No organisms were found in the ready-to-hang systems but average bacterial counts in samples from feeds decanted from bottles</p>

	<p>5.6% from the closed system. The open system contained total colony counts $\geq 10^4$ in 78% of the formula samples compared with 39% from the closed system. When McNemar's test was applied to the total sample using $\geq 10^4$ as a bacterial count criterion for enteral formula, the formula from the open system contained significantly higher levels of bacteria than the closed ($p=0.003$).</p> <p><u>Gastrointestinal intolerance:</u> The number of liquid and semiliquid stools occurring for the participants receiving the open and closed system was minimal. There was no significant difference between the two systems in the total number of diarrhoea episodes or the number of episodes of diarrhoea (i.e. 1-4).</p> <p><u>Nursing time:</u> There were no significant differences in nursing time to deliver enteral feeding between the two feeding systems.</p> <p><u>Nursing satisfaction:</u> Overall response rate 48%. Nurses were more satisfied with the open system at $p<0.05$ for 8 of the 10 questions.</p> <p><u>Cost analysis (formula, formula waste during administration, and administration sets that were changed every 48 hours):</u> The open system cost CDN\$4.78/patient/day with sets changed every 48 hours and \$4.36/patient/day if the sets for the open system were changed every 72 hours. The closed system cost a total of \$7.85/patient/day.</p>	<p>(Nutricia container) were 1.8×10^3 cfumL⁻¹ at 24 hours and 9.3×10 cfumL⁻¹ for those where feed was decanted from cans (Flexitainer).</p> <p><u>Exposed to faulty handling procedures:</u> No organisms were detected in any feed samples from the pack system at 24 hours, while bacterial counts for the other 3 systems ranged from 10^1 to 10^5 cfumL⁻¹.</p>	
<p>AUTHOR(S) CONCLUSIONS: Limitations, implications for practice and research</p>	<p>"It seems reasonable to pursue further the feasibility of the closed system in long-term care settings. The potential complications of bacterial contamination in open systems must be considered in order to make decisions that reflect the best interests of patients."</p>	<p>"The difference in design (of the two decanted feeds) may therefore contribute to the higher rate of contamination of feed samples when both were assembled according to the manufacturers' instructions. In an ideal situation, sterile pre-filled ready-to-use enteral feeding systems with well-designed connectors should be the preferred choice. However, if it is considered essential to modify and decant feeds it is vital that carers are made aware, both by training and provision by the manufacturer of detailed instructions, of the correct handling procedures for each individual system."</p>	
<p>OUR COMMENTS: Opportunity for bias, weakness and strength</p>	<p>Potential for bias: Nurses recorded formula infused, formula wasted, frequency of diarrhoea. The nurses could bias the results if they favoured one system over the other. Method of randomisation not stated. Response rate for nurses (48%) is inadequate given that we do not know anything about the non-responders.</p> <p>Weakness/es: Power analysis was limited to 67% for the ability to detect large effects. Results may be applicable only to long-term care facilities. The authors acknowledge that nursing times have been sufficiently longer for open systems compared to closed systems in the intensive care unit. The authors also note that nurses may have been more satisfied with the open system as they were familiar with this system. The use of a closed system was new for many nurses and may have resulted in stress in becoming familiar with the new system. Costs may not be applicable to the Australian setting. The above results are only applicable for open systems are changed every 48 hours. With</p>	<p>Potential for bias: Blinding of investigators is not reported and could affect the observed results.</p> <p>Weakness/es: Results may not be applicable to settings that use different enteral feeding systems from the system tested in this study. The authors acknowledge that the high level of bacteria placed on the hands in this study would not normally be expected to be found on personnel assembling the systems. This was because the purpose of the study was to challenge the systems in order to compare the ease with which bacteria may be introduced into the feeding system. Therefore, the results may be less strong in the true hospital environment.</p> <p>Strength/s: Repeated measures were used to investigate bacterial contamination.</p>	

	systems with shorter hang times, labour time would be increased, thereby increasing costs. Strength/s: All data collection tools used in this study were pretested.	
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<p>Evidence Summary Therapy/Intervention</p> <p>'Closed' versus 'open' systems for enteral feeding</p>	<p>Study 3</p> <p>Vanek, V. W. (2000). "Closed versus open enteral delivery systems: a quality improvement study." <u>Nutrition in Clinical Practice</u> 15(5): 234-43.</p>	<p>Study 4</p> <p>Lee, C. H. and I. J. Hodgkiss (1999). "The effect of poor handling procedures on enteral feeding systems in Hong Kong." <u>Journal of Hospital Infection</u> 42(2): 119-123.</p>
<p>STUDY DESIGN & NHMRC LEVELS OF EVIDENCE</p>	<p>Level III – Comparative study</p>	<p>Level III – Comparative study</p>
<p>DESCRIPTION: Patients (subjects), Intervention, Comparisons, Outcomes, Inclusion & Exclusion Criteria</p>	<p>Patients (subjects): 138 patients requiring enteral feeding. Mean age 70.9 years±16.1, 50% males. Intervention: Closed system bags, Ultrapak, Nestle Nutrition. Recommended hang time of 48 hours. Seventy-seven percent of all tube fed patients were fed using closed systems. Comparisons: Open system bags are ready-to-use cans that are poured into sterile tube feeding bag and tubing sets on the nursing units. Recommended hang time of 24 hours, discarding residual solution every 8 hours. Outcomes: Bacterial contamination. In cases where the review determined that the hang time was >8 hours for the open system bags or >24 hours for the closed system, a 10mL specimen of the feeding bag solution was collected in a sterile fashion from the feeding bag for culture. Inclusion criteria: All patients on continuous or intermittent tube feedings (bolus tube feedings were excluded), were reviewed and included in the study. Exclusion criteria: Three nursing units (maternity, psychiatric, and paediatric) were excluded from the analysis because these units rarely have any tube fed patients.</p>	<p>Patients (subjects): Not applicable Intervention: System A – Isosource Closed System (Novartis Nutrition) Comparisons: System B – Compat Pumpset, filled with Isosource decanted from 4 x 0.25L cans. Each feeding system was assembled in accordance with manufacturer's instructions Whilst; i) wearing new, non-sterile latex surgical gloves ii) with bare hands and iii) with hands experimentally contaminated <i>E. coli</i>. Both systems were assembled i) with caution and ii) deliberately touching parts of each system deemed to be vulnerable to bacterial invasion. The flow rate was 40mL/ for 24 hours. Samples taken at 0, 4, 8, and 24 hours. Each experiment carried out in triplicate. Outcomes: Bacterial contamination Incl & Excl Criteria: Not applicable</p>
<p>VALIDITY: Methodology, rigour, selection</p>	<p>Randomisation: No randomisation All patients accounted for: Not reported Patients treated equally: In 127 (92%) of the tube fed patients, the date and time the bag as hung was properly noted. Two reviews of tube fed patients were carried out, in 1999 and 2000. In 2000, the maximum hang-time for closed systems was increased from 24 hours to 48 hours.</p>	<p>Randomisation: No randomisation All patients accounted for: No patients involved. Patients treated equally: As above</p>
<p>RESULTS: Generally favourable or unfavourable, specific outcomes of interest, estimate of experimental effect and precision if appropriate</p>	<p>The overall compliance with the maximum hang time was 85%. The closed system had a significantly higher maximum hang-time compliance rate compared with the open system (92% vs. 59%, p<0.001). Tube fed bag cultures were indicated (hang-time >8 hours for open systems and >24 hours in closed systems) in 13 open system (1 not cultured) and 21 (2 not cultured) closed system bags. In addition, 4 bags were cultured for open system bags hanging >6 hours but ≤8 hours, and 3 bags for the closed system hanging >20 hours but ≤24 hours. Of the 48 tube fed bag cultures only 3 were positive, 2 in the open system group and 1 in the closed system group. The two open system bags had been hanging for 23.9 and 26.6 hours (3000 cfu/mL, 70 cfu/mL). The only positive culture in the closed system</p>	<p><u>Wearing new, non-sterile gloves:</u> No bacterial contamination was detected in the feed from any of the systems assembled with wearing new gloves, even when systems were assembled using faulty handling procedures. <u>Using bare hands:</u> At 0 hours, no bacteria was detected for either system. After 4 hours, the viable count of 0.5 x 10¹ was detected in the open system, rising to 7.3 x 10³ after 24 hours. For the closed system, a viable count of 0.5 x 10¹ was detected after 4 hours, rising to 6.8 x 10³ after 24 hours. <u>Using experimentally contaminated hands:</u> For the open system, a viable count of 1.2 x 10¹ was detected at 4 hours, rising to 1.4 x 10⁸ after 24 hours. For the closed system, a viable count of 1.2 x 10¹ was detected after 4 hours, rising to 2.6 x 10⁸ after 24 hours.</p>

	<p>bag had been hanging for 47.3 hours, that had also had methylene blue added to it. This bag was heavily contaminated with <i>Enterococcus faecium</i> (>3000 cfu/mL). Further in vitro analysis of the methylene blue procedure was investigated and it was found that the contamination in the closed system would have been due to poor technique and contamination either at the time of original injection or possibly subsequent injections.</p>	
<p>AUTHOR(S) CONCLUSIONS: Limitations, implications for practice and research</p>	<p>"Closed enteral delivery systems should be used whenever possible because it results in decreased incidence of tube feeding contamination compared with the traditional open enteral delivery systems. To decrease the risk of tube feeding contamination (in open systems) tube feeding solutions and bag/tubing administration sets should not be allowed to hang for >8 to 12 hours."</p>	<p>"It should be noted... that the requirement for decanting feed into a system such as the bag system constitutes an additional potential source of contamination. We postulate that the reason for the difference between our observations and the previous study (Anderton and Aidoo) is due to variations in the design of the systems available in Hong Kong." The authors noted that their systems had a reduced number of potential entry routes for bacteria.</p>
<p>OUR COMMENTS: Opportunity for bias, weakness and strength</p>	<p>Potential for bias: Thirteen bags that were hanging close to the recommended hanging time were not cultured to examine contamination (11 of these were closed system bags). The investigator carrying out the culture analysis may not have been blind to the intervention status, thereby allowing investigator bias.</p> <p>Weakness/es: Overall compliance rate for the closed systems is not meaningful given that the recommended hang time for closed systems changed between the two reviews.</p> <p>Strength/s: For the bags where hang time was not recorded, hang time was estimated and cultures were carried out on the majority where hang time was estimated to be above the allowable maximum time. In vitro analysis was conducted to investigate the possible reason for contamination when methylene blue was added.</p>	<p>Potential for bias: Investigators examining the feeds for contamination may have influenced the results if they favoured one system over the other.</p> <p>Weakness/es: The entire process of the open system was not measured, i.e. decanting of the feed from the can. The results may not be applicable in institutions that do not use the specified design systems.</p> <p>Strength/s: Each experiment carried out in triplicate.</p>

<p>Evidence Summary Therapy/Intervention</p> <p>'Closed' versus 'open' systems for enteral feeding</p>	<p>Study 5</p> <p>Silkroski M, Allen F & Storm H (1998). Clinical research. Tube feeding audit reveals hidden costs and risks of current practice. <i>Nutrition in Clinical Practice</i> 13: 283-290.</p>	<p>Study 6</p> <p>Inman KJ, Davidson BC, Sibbald WJ & Rutledge FS (1998). Closed enteral systems in the intensive care unit: evaluating their economic impact... Proceedings of the Third Annual Ross Enteral Device Conference, Winston-Salem, NC, September 19-21, 1997. <i>Nutrition in Clinical Practice</i> 13: S42-45 S50-41.</p>
<p>STUDY DESIGN & NHMRC LEVELS OF EVIDENCE</p>	<p>Audit</p>	<p>Level IV – Case study</p>
<p>DESCRIPTION: Patients (subjects), Intervention, Comparisons, Outcomes, Inclusion & Exclusion Criteria</p>	<p>Patients (subjects): An audit of 11 major teaching hospitals in the United States. Data was collected on 417 tube-fed patients. An average tube feeding duration of 8.1 days (range 4-10).</p> <p>Intervention: Ninety-two percent of tube-fed patients received formula from an open system, in which formula is poured into bags before administration to the patient (type or name of system is not described)</p> <p>Comparisons: Eight percent received formula from a closed system in which commercially filled bags are spiked and hung for administration (type or name of system is not described)</p> <p>Outcomes: Costs (labour, formula), tube feeding preparation times, wastage of formula. Data collection occurred from October 1996 through to July 1997.</p> <p>Incl & Excl Criteria: All adult (>17years) patients for whom tube feedings provided all or some of the nutritional needs.</p>	<p>Patients (subjects): One multidisciplinary teaching intensive care unit (ICU). Approximately 20 patients received tube feedings each day, receiving an average 2 litres per day.</p> <p>Intervention: Closed enteral feeding system, 24 hour hang times (name and type of system not described)</p> <p>Comparisons: Open enteral feeding system, 8 hour hang time (name and type of system not described)</p> <p>Outcomes: Costs (total of formula, wastage, supplies (ancillary products – spikes and sets), and labour). Wastage was determined during a trial period during which all residual enteral feeding solutions were saved. No details of this pilot project are reported.</p> <p>Inclusion and exclusion criteria: Not described</p>
<p>VALIDITY: Methodology, rigour, selection</p>	<p>Randomisation: Not applicable</p> <p>All patients accounted for: The audit database was used to identify all patients who were tube-fed.</p> <p>Patients treated equally: The number of different formulas used per hospital ranged from 10 to 21, with mean of 13.</p>	<p>Randomisation: Not applicable</p> <p>All patients accounted for: Not reported</p> <p>Baseline utilisation data: Yearly product volumes, patient summaries, and their associated costs were compiled from both hospital records and chart abstraction. However, no details are reported on the date of collection of this data or how many investigators collected this data. Baseline wastage was 20% with open systems compared to 3% with closed systems.</p>
<p>RESULTS: Generally favourable or unfavourable, specific outcomes of interest, estimate of experimental effect and precision if appropriate</p>	<p><u>Labour time:</u> Open systems required an average labour time of 14.6 minutes per patient per day to manage compared to only 2 minutes per patient per day for the closed system delivery. The greatest labour savings were attributed to systems with ≥24 hour hang times. The predicted savings amounted to approximately USD\$43,000 per facility per year. Usage and cost of additional sets were higher for patients on open systems than for patients on closed systems.</p> <p><u>Total costs (formulas, labour, bags and sets):</u> Costs were reduced with closed systems, approximating USD\$71,000.</p> <p>On average, patients on open systems received only 70% of their prescribed tube feeding volume because of frequent</p>	<p><u>Costs:</u> Although direct product costs were substantially higher for the closed system, the cost of supplies, labour, and wastage was significantly less. The yearly ICU savings that would be accrued by using the closed system was approximately CDN\$23,000 to \$35,000.</p>

	<p>discontinuations and delays in refilling feeding bags.</p> <p><u>Contamination:</u> No quantitative analysis of contaminations issues was undertaken.</p>	
<p>AUTHOR(S) CONCLUSIONS: Limitations, implications for practice and research</p>	<p>“Although specific associations between contamination and costly clinical complications were not examined in this study, the identification of potentially hazardous sanitation practices provides a platform for improving general infection control procedures. Detecting and alleviating unnecessary expenses and risks of tube feeding processes are mandatory to optimise clinical and financial outcomes.”</p>	<p>“Intuitively, some may question the validity of this conclusion on the basis of a number of points, including the amount of waste in each system, the attribution of labour costs, and the hang time of our closed system. We believe that even without data in regard to improvements in patient outcomes, it is reasonable to use the closed system rather than the open system in the ICU on the basis of economic impact.”</p>
<p>OUR COMMENTS: Opportunity for bias, weakness and strength</p>	<p>Potential for bias: As there was a mean of 13 different formulas used per hospital it is difficult to compare any one open system versus one closed system.</p> <p>Weakness/es: Contamination of feeding bags was not assessed. Design of open and closed systems is not described.</p> <p>Strength/s: An external registered dietician consultant spent an average of 50 hours at each facility gathering the required data. Validity of data was confirmed by administrators at each hospital before analysis.</p>	<p>Potential for bias: No details are reported on the pilot study used to collect the baseline utilisation data. Therefore, it is impossible to determine the validity of the above findings.</p> <p>Weakness/es: Contamination issues were not assessed. Hang times for open systems were very short. Results may not be applicable to hospitals that use longer hang times. Costs in Canadian dollars may not be applicable to the Australian setting.</p>