We now come to the implementation part of the surgical nutrition training module. How do we deliver enteral (EN) and parenteral nutrition (PN) and what are the indications for choosing either EN or PN or both?

These are the objectives of this session:
- To discuss the different feeding pathways for surgical patients
- To define and discuss key points of enteral and parenteral nutrition
- To discuss the monitoring process and expected outcomes for surgical patients
We revisit the feeding algorithm which was discussed earlier in session 3 “The impact of nutrition care in surgery”. Here the priority is always the use of the gut (“If the gut works use it”) and when we fail to deliver 60% to 70% of the patient’s computed intake then that is the only time when we resort to parenteral nutrition. However one has to try always to give some degree of enteral nutrition whenever possible due to the role of the gut in immune function and other related metabolic functions.

Slide 4

We again re-emphasize the value of early enteral nutrition after surgery or when resuscitation from a critical care state is able to have stable vital signs for the patient.
Early enteral nutrition: definition

- Enteral nutrition that is initiated within 24 – 48 hours following hospitalization, trauma, or injury

Zaloga GP. Crit Care Med 1999; 27: 259

Early enteral nutrition is enteral nutrition that is initiated within 24 – 48 hours following hospitalization, trauma, or injury.
- Zaloga GP. Crit Care Med 1999; 27: 259
Why early enteral nutrition?

- The normal and designed route for nutrient intake, digestion, and absorption
- Immunocompetence is a major function of the gastrointestinal tract
- Non-utilization of the gastrointestinal tract even on a short term basis leads to complications in critical care or geriatric patient management
- Cost-effective

Why is early enteral nutrition important? These are the major reasons:

- The normal and designed route for nutrient intake, digestion, and absorption is the GIT
- Immune competence is a major function of the gastrointestinal tract and to sustain this the gut has to be used continually
- Non-utilization of the gastrointestinal tract even on a short term basis leads to complications in critical care or geriatric patient management secondary due to disuse, atrophy and reduction of function of the gut associated lymphoid tissue system (GALT)
- Cost-effective
Early enteral feeding: goal

- To maintain intestinal mucosal integrity
  - Normal microvilli
    - Height and number
  - Normal intestinal barrier
  - Intestinal mucosal immunity

This is the goal of early enteral feeding:
- To sustain the normal height and number of the microvilli
- This architecture sustains the normal intestinal barrier by the mucosal epithelium
- This set up also sustains intestinal mucosal immunity through the humoral immunity (=IgA secretion) and cellular immunity (=M cells, mucosal macrophages and T-lymphocytes)
Early enteral feeding: rationale

- Provide nutrients required during metabolic stress
- Maintain GI integrity
- Reduce morbidity compared with parenteral nutrition
- Reduce cost compared with parenteral nutrition

How does enteral feeding do all of the above?

- By providing nutrients required during metabolic stress
- By maintaining GI integrity
- By reducing morbidity which is higher with patients on long term parenteral nutrition
- By reduce cost compared with parenteral nutrition
Early enteral nutrition vs standard nutritional support on mortality

<table>
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<tr>
<th>Study</th>
<th>Treatment n/N</th>
<th>Control n/N</th>
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<tbody>
<tr>
<td>Cerra et al, 1990</td>
<td>1/11</td>
<td>1/9</td>
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<td>Gottschlich et al, 1990</td>
<td>2/17</td>
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<td>Brown et al, 1994</td>
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<td>Moore et al, 1994</td>
<td>1/51</td>
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<td>Bower et al, 1996</td>
<td>24/163</td>
<td>12/141</td>
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<td>Kubik et al, 1996</td>
<td>1/16</td>
<td>1/17</td>
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<td>Ross Products, 1996</td>
<td>20/87</td>
<td>8/83</td>
</tr>
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<td>Engel et al, 1997</td>
<td>7/18</td>
<td>5/18</td>
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<td>Mendez et al, 1997</td>
<td>1/22</td>
<td>1/21</td>
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<td>Rodrigo et al, 1997</td>
<td>2/16</td>
<td>2/13</td>
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<td>Weimann et al, 1998</td>
<td>2/16</td>
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<td>Atkinson et al, 1998</td>
<td>96/197</td>
<td>86/193</td>
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<tr>
<td>Galban et al, 2000</td>
<td>17/89</td>
<td>28/87</td>
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Pooled Risk Ratio

This meta-analysis done in 2001 shows the value of early enteral nutrition in reducing mortality in critical care patients compared to the standard NPO for more than three days.

- Heyland et al. JAMA, 2001

What are the access routes of enteral nutrition?
These are the access points through the stomach and jejunum.

These are the different tubes currently used. The earlier and still commonly used tube type is polyvinyl chloride (PVC) but it tends to be uncomfortable for the patient. The better quality and acceptability for the patient is obtained with polyurethane and silicon tubes. Silicon tubes tend to be smaller in internal diameter compared with polyurethane tubes so care to avoid clogging is very important for these tube types.
Regarding gastrostomy:
- Gastric access may be obtained for short-term feeding via the nasogastric route using “blind” or manual placement at the bedside or with the use of radiologic guidance.
- For long-term use, gastric access may be obtained via a gastrostomy placement using endoscopic, radiologic, or surgical techniques.
- The technique used for gastric access is based on the expertise of the physician placing the tube as well as the patient’s condition. For example, if the patient has an esophageal tumor, the narrowed esophagus may prevent passage of the endoscope.

These are the different types of small bowel feeding where the end of the tube is in the small intestine. There is a short term use and long term use depending on the indication. If one foresees there will be slow recovery of oral intake in the post-operative period (beyond two weeks) it will be prudent to place a needle catheter jejunostomy and have it in place until the patient is able to achieve 70% oral intake of his requirements.

Enteral Formulas – what type?

• Polymeric formulas (80-90%)
  • Commercial (preferred)
  • Blenderized (If not critically ill, not severely malnourished)
• Oligomeric formulas
• Disease-specific formulas
• Modular formulas (concentrated protein and carbohydrate preparations)

What are the enteral nutrition formulas that are available?
• Enteral formula categories include polymeric, both commercial and blenderized, oligomeric, and disease-specific formulas.
• Modular formulas include concentrated protein and carbohydrate preparations to enhance protein and caloric content of enteral formulas.

Enteral nutrition delivery

These are the modes of tube feeding delivery to the patient. Note that the nurses have specific protocols on how to feed the patient from positioning to rate and volume of delivery.
Practical points: enteral nutrition

- If intake is within the range of 60% to 70% start oral supplement
  - Choose the product or preparation that meets all the daily requirements
- If oral intake is 50% or less
  - You may give parenteral nutrition to supplement (good for a week – expensive, but more comfortable for the patient)
  - Cost-effective: NGT
- If tube feeding duration will exceed 2 weeks and you are looking at long term (stroke or critical care) – gastrostomy is easier to maintain with lesser complications (aspiration)

Here are some practical points on enteral nutrition:

- If intake is within the range of 60% to 70% start oral supplement
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Practical points: enteral nutrition

- If patient will undergo surgery and you doubt patient will be able to have adequate intake for longer term:
  - Place gastrostomy during the surgery
- If gastric function return is in doubt for more than a week:
  - Gastrostomy with jejunostomy tube extension
  - Surgical Jejunostomy
- Main goal: adequate intake

More practical points in enteral nutrition:
- If patient will undergo surgery and you doubt the patient will be able to have adequate intake for longer term:
  - Place gastrostomy during the surgery
- If gastric function return is in doubt for more than a week:
  - Gastrostomy with jejunostomy tube extension
  - Surgical Jejunostomy
- Main goal: adequate intake
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Monitoring Gastric Residuals

- Monitor according to hospital protocol (e.g., every 3-4 hours)
- Volume not to exceed 50% of the amount infused


- High volume gastric residuals are associated with greater incidence of intolerance of enteral nutrition. Controlling gastric residuals before beginning nutrition and periodically after it has begun helps to reduce the possibility of bronchial aspiration.
- The presence of high volumes of gastric residuals indicates that close monitoring is required and that it may be necessary to hold tube feeding temporarily.
- Today, however, gastric residuals are managing by the following:
  - Use of enteral pumps with adjustments of the volume and rate of delivery
  - Use of prokinetics
  - Standardized protocol for feeding
- There is no more excuse of holding feeding and forgetting to resume feeding for 24 hours
Parenteral nutrition still needs to be utilized more. This session will give more time in discussing this mode of nutrient delivery.
Parenteral nutrition: Indications

- To avoid periods of starvation within 24 to 72 hours when oral or enteral intake are insufficient to achieve adequate intake in moderate to severe malnourished patients
- When unable to use the gut
  - Gut obstruction
  - Short bowel (intestinal failure)
  - High output enterocutaneous fistulae
  - Non-functional gastrointestinal tract


These are the indications for parenteral nutrition use:
- To avoid periods of starvation within 24 to 72 hours when oral or enteral intake are insufficient to achieve adequate intake in moderate to severe malnourished patients
- When unable to use the gut
  - Gut obstruction
  - Short bowel (intestinal failure)
  - High output enterocutaneous fistulae
  - Non-functional gastrointestinal tract

Contraindications to PN

- Gut can be used:
  - Ability to consume and absorb adequate nutrients orally or by enteral tube feeding
  - Hemodynamic instability
  - *Ineffective and probably harmful in non-aphagic oncological patients in whom there is no gastrointestinal reason for intestinal failure.


These are the contra-indications to parenteral nutrition use: when the gut is viable and can be used.

- Ability to consume and absorb adequate nutrients orally or by enteral tube feeding
- Hemodynamic instability
- *Ineffective and probably harmful in non-aphagic oncological patients (=able to have oral intake) in whom there is no gastrointestinal reason for intestinal failure.


Types of parenteral nutrition

<table>
<thead>
<tr>
<th>Central</th>
<th>Peripheral</th>
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<tbody>
<tr>
<td>- Amino acids (&gt; 5%)</td>
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<tr>
<td>- Dextrose (&gt; 20%)</td>
<td></td>
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<tr>
<td>- Lipids</td>
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<tr>
<td>- Includes vitamins, minerals, and trace elements</td>
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<tr>
<td>- Carrier of pharmaconutrients like glutamine or omega-3 fatty acids</td>
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<tr>
<td>- Osmolality (&gt; 700 mOsm/kg H₂O)</td>
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<tr>
<td>- Volume restriction</td>
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<tr>
<td>- Total kcal limited by concentration and ratio to volume being administered (usually delivers between 1000 to 1500 kcal/day)</td>
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<tr>
<td>- The current formulations can now deliver the daily requirements of macro and micronutrients</td>
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<tr>
<td>- Osmolality &lt; 700 mOsm/kg</td>
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<tr>
<td>- No volume restriction</td>
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</tbody>
</table>

These are the types of parenteral nutrition with their advantages and disadvantages.
Types of parenteral nutrition

- Central parenteral nutrition
- Peripheral central parenteral nutrition

PICC = peripherally inserted central catheter

Just to show how the central parenteral nutrition catheter is placed nowadays – there is now a peripherally inserted catheter, but the more frequently used is still the subclavian approach.

Catheters

Subclavian catheter (3 ports)

PICC line catheters

These are the catheters used.
Types of parenteral nutrition

• Peripheral parenteral nutrition

These are the more common areas where peripheral parenteral nutrition is inserted.
Central venous access

- Allows delivery of nutrients into the superior vena cava or right atrium
- Osmolarity - traditional cut off > 860 mOsm/L
- Catheter differences:
  - According to duration of use
  - Various lengths, gauges, and number of ports
  - Catheters treated with antibacterials
- Nutrient infusion via a dedicated catheter lumen


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Formulations

• Optimal nitrogen sparing is shown to be achieved when all components of the parenteral nutrition mix are administered simultaneously over 24 hours.
• The different forms of PN packaging and delivery:
  — Individualized
  — Compounded
  — "All in One"


How is parenteral nutrition formulated?

• Optimal nitrogen sparing is shown to be achieved when all components of the parenteral nutrition mix are administered simultaneously over 24 hours.
• The different forms of PN packaging and delivery:
  — Individualized
  — Compounded
  — "All in One"

This is how parenteral nutrition preparation, formulation and delivery evolved. Now from a separate two or three bottle system connected by Y-connectors there is now one bag that contains the three major macronutrients. This system is called the “3 in 1” or “All in One” preparations. The issue of contamination and frequency of infections through the parenteral nutrition formulation and route has been drastically reduced. Storage time is increased and the cost involved in mixing solutions has remarkably gone down. Technology has definitely improved patient safety in parenteral nutrition delivery.
These are the patient safety issues involved in parenteral nutrition preparation and delivery:

- Compounding in a clean room is required
- Three in one PN bags are preferred
- On line filters for lipid emulsions are considered best practice
These are the monitoring parameters for enteral and parenteral nutrition. The goal is to maintain normal status in both clinical and laboratory parameters.

Key monitoring points

- Fluid balance – avoid fluid accumulation within 4-5 days post op
- Calorie balance
- Gastric retention for enteral nutrition
- Blood tests:
  - BUN high – dialyze
  - High triglycerides – lower lipid flow
  - Hyperglycemia – insulin
- Weight once a week

These are the key monitoring points
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- Weight once a week
Outcome is dependent on the monitoring process especially on the patient’s nutrient intake.
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The recommended cut-off value to say the patient has inadequate intake through either enteral or parenteral nutrition or combined is 75%. It means monitoring for calorie and protein intake on a regular basis is mandatory.

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Calorie, protein, fluid balance form

This is the calorie, protein, and fluid balance form which is the standard data gathered by all members of the clinical nutrition service.
This is the final nutrient monitor form which is placed in the patient’s medical record – this will show the attending physician on the status of his patient’s nutrition care.

This is the sample data entry.
We will show again these local data to reinforce the value of monitoring intake for surgical patients either pre-operative or post-operative.
Adequate intake in surgery patients

When adequate intake was achieved in both calorie and protein intake improvement in mortality and morbidity outcomes in the surgical patients were noted whether they are nutritionally high risk or low risk. In this study no significant difference is seen in the mortality rate.

Finally the nutrition team is the best group that can achieve consistency in results. That is the goal of the surgical nutrition module – to create a team for the surgical nutrition care in the department of surgery and eventually in the hospital