Enteral Nutrition

COURSE: CHAPTER 3

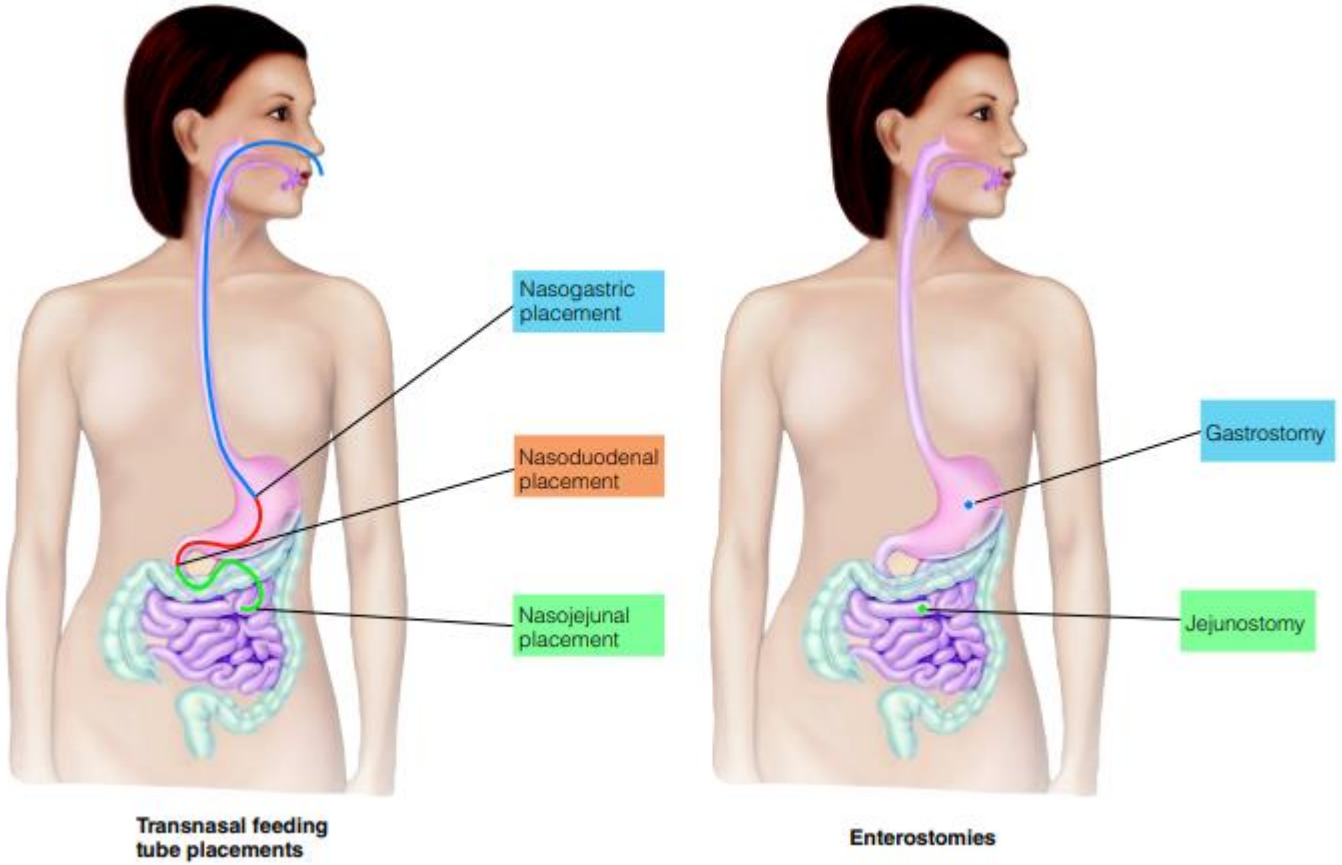
BOOK: CHAPTER 20

Introduction

- When illnesses interfere with eating, digestion, or absorption to a degree that conventional foods cannot supply the necessary nutrients, nutrition support can meet a patient's nutritional needs.

- Enteral Nutrition: the use of tube feedings, which supply nutrients directly to the stomach or intestine via a thin, flexible tube.

Feeding Routes



Left, A transnasal feeding tube accesses the GI tract via the nose. Right, In a gastrostomy, the feeding tube accesses the GI tract through the abdominal wall.

Ursula Markus/Science Source

Dr. P. Marazzi/Science Source

Feeding Routes

TABLE 20-1 Comparison of Tube-Feeding Routes[a]

Insertion Method or Feeding Site	Advantages	Disadvantages
Transnasal	Does not require surgery or incisions for placement; tubes can be placed by a nurse or trained dietitian.	Easy to remove by disoriented patients; long-term use may irritate the nasal passages, throat, and esophagus.
• Nasogastric	Easiest to insert and confirm placement; least expensive method; feedings can often be given intermittently and without an infusion pump.	Highest risk of aspiration in compromised patients[b]; risk of tube migration to the small intestine.
• Nasoduodenal and nasojejunal	Lower risk of aspiration in compromised patients[b]; allows for earlier tube feedings than gastric feedings during acute stress; may allow enteral feedings even when obstructions, fistulas, or other medical conditions prevent gastric feedings.	More difficult to insert and confirm placement; risk of tube migration to the stomach; feedings require an infusion pump for administration.
Tube enterostomies	Allow the lower esophageal sphincter to remain closed, reducing the risk of aspiration[b]; more comfortable than transnasal insertion for long-term use; site is not visible under clothing.	Tubes must be placed by a physician or surgeon; general anesthesia may be required for surgically placed tubes; risk of complications from the insertion procedure; risk of infection at the insertion site.
• Gastrostomy	Feedings can often be given intermittently and without a pump; easier insertion procedure than a jejunostomy.	Moderate risk of aspiration in high-risk patients[b]; for surgically placed tubes, feedings are often withheld for 12 to 24 hours before and 48 to 72 hours after the procedure.
• Jejunostomy	Lowest risk of aspiration[b]; allows for earlier tube feedings than gastrostomy during critical illness; may allow enteral feedings even when obstructions, fistulas, or medical conditions prevent gastric feedings.	Most difficult insertion procedure; most costly method; feedings require an infusion pump for administration.

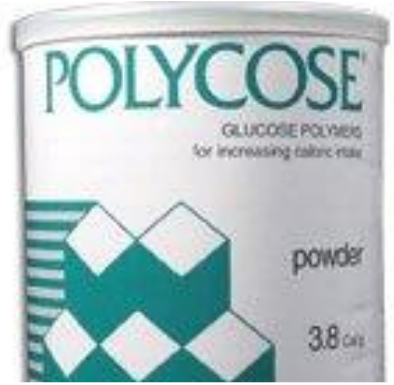
[a] Relative to other tube-feeding routes. The actual advantages and disadvantages of different insertion procedures depend on the person's medical condition.
[b] The risk of aspiration associated with the different feeding routes is controversial and still under investigation.

Types of Enteral Formulas

Standard Formulas

Elemental Formulas

Specialized Formulas



Modular Formulas

TABLE 20-2 Macronutrient Sources in Standard and Elemental Formulas

Type of Formula	Protein Sources	Carbohydrate Sources	Fat Sources
Standard formulas	Intact proteins, such as casein, whey, lactalbumin, and soy protein isolates Milk protein concentrate	Corn syrup solids Hydrolyzed cornstarch Maltodextrin Sucrose, fructose, sugar alcohols	Vegetable oils (such as corn oil, soybean oil, and canola oil) Fish oil MCT[a] Palm kernel oil
Elemental formulas	Hydrolyzed casein, whey, lactalbumin, or soy protein Crystalline amino acids	Hydrolyzed cornstarch Maltodextrin Fructose	Vegetable oils (such as corn oil, soybean oil, and canola oil) Fish oil MCT

[a]MCT = medium-chain triglycerides.

Macronutrient Composition

The amounts of protein, carbohydrate, and fat in enteral formulas vary substantially

Generally:

Protein: 12 - 20 %

Carbohydrate: 40 - 60 %

Fat: 30 - 40 %

See Appendix K

Energy Density

Range: 0.5 - 2.0 kcal/ml fluid

Standard formulas: 1.0 - 1.2 kcal/ml fluid (appropriate for patients with average fluid requirements.)

High energy density formulas: patients who have high nutrient needs or fluid restrictions.

Low energy density formulas: Individuals with high fluid needs

(OR additional water can be supplied via the feeding tube or intravenously)

Energy Density

Density = calories / volume

Volume = calories/density

If a patient needs 2000 calories, how much volume will he needs from:

1- A standard formula which provides 1.2 kcal/ml

2- A high density formula which provides 1.8 kcal/ml

Water needs

Adults require on average 2000 ml of water daily.

Fluid may be restricted in patients with kidney, liver, or heart disease

Fluid requirements may increase with fever, high urine output, diarrhea, excessive sweating, excessive vomiting, blood loss, or open wounds.

Standard formulas are 85% water

Nutrient dense formulas are 70-75% water

Water is also provided through feeding tube water flushes (≈ 30 ml)

Water needs

Estimation:

Adults: 30-40 ml/kg

Adults >65 years: 25-30 ml/kg

Children: 50-60 ml/kg

Infants: 100-150 ml/kg

Case Study

Ahmad is a 30 year-old adult. He weighs 75 kg and is 165 cm tall. Ahmad had just underwent surgery (stress factor 1.3), and is initiating tube feeding. He will be using a standard formula (1.0 kcal/ml). His physical activity factor 1.2.

1. Calculate his total energy requirements

2. How much volume will he need from the formula?

2. Calculate his fluid requirements

3. How many milliliters of fluid does the formula provide?

Fiber Content

Fiber-containing formulas:

✓ Improving fecal bulk and colonic function

✓ Treating diarrhea or constipation

✓ Maintaining blood glucose control.

Avoid in:

X Patients with acute intestinal conditions

X Before or after some intestinal examinations and surgeries

Osmolality

Osmolality: The moles of osmotically active solutes (or *osmoles*) per kilogram of solvent

isotonic formula: An enteral formula with an osmolality similar to that of blood serum (about 300 milliosmoles per kilogram)

hypertonic formula: formulas with an osmolality greater than that of blood serum.

Formulas osmolalities range between 300 and 700 milliosmoles per kilogram

Generally, elemental formulas and nutrient-dense formulas have higher osmolalities than standard formulas.

When medications are infused along with enteral feedings the **osmotic load** increases substantially and **may contribute to the diarrhea** experienced by many tube-fed patients.

Formulas

TABLE K-1 Standard Formulas

Product	Volume to Meet 100% RDI[a] (mL)	Energy (kcal/mL)	Protein or Amino Acids (g/L)	Carbohydrate (g/L)	Fat (g/L)	Notes
Lactose-Free, Standard Formulas						
Compleat	1313	1.07	48	128	40	Blenderized formula, 6 g fiber/L
Nutren 1.0	1500	1.00	40	127	38	25% fat from MCT
Osmolite 1 Cal	1321	1.06	44	144	35	20% fat from MCT
Lactose-Free, Fiber-Enhanced Formulas						
Jevity 1 Cal	1321	1.06	44	155	35	14 g fiber/L
Nutren 1.0 Fiber	1500	1.00	40	127	38	14 g fiber/L
Promote with Fiber	1000	1.00	63	138	28	14 g fiber/L
Lactose-Free, High-kCalorie Formulas						
Jevity 1.5 Cal	1500	1.50	64	216	50	22 g fiber/L
Nutren 1.5	1000	1.50	60	169	68	50% fat from MCT
Nutren 2.0	750	2.00	80	196	104	75% fat from MCT
Lactose-Free, High-Protein Formulas						
Fibersource HN	1165	1.20	53	160	39	20% fat from MCT, 10 g fiber/L
Isosource HN	1165	1.20	53	160	39	20% fat from MCT, low residue
Promote	1000	1.00	63	130	26	20% fat from MCT, low residue

Formulas

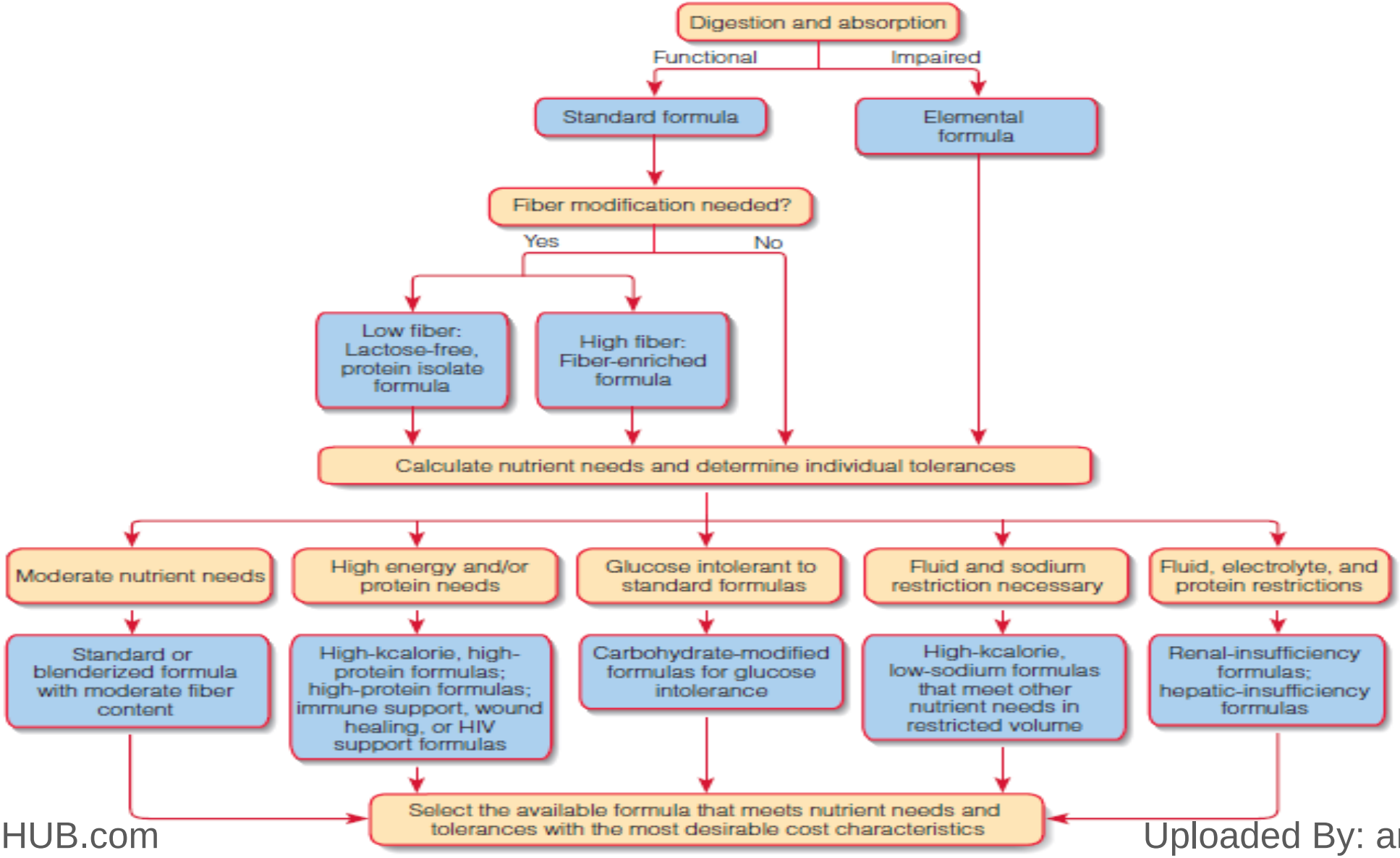
Specialized Formulas: Pediatric (1 to 10 years)						
Compleat Pediatric	Varies[b]	1.00	38	130	39	Blenderized formula, 7 g fiber/L
Nutren Junior	Varies[b]	1.00	30	110	50	21% fat from MCT
Specialized Formulas: Glucose Intolerance						
Diabetisource AC	1250	1.20	60	100	59	36% kcal from carbohydrate, 15 g fiber/L
Glucerna 1.0 Cal	1420	1.00	42	96	54	34% kcal from carbohydrate, 14 g fiber/L
Nutren Glytrol	1400	1.00	45	100	48	40% kcal from carbohydrate, 15 g fiber/L
Specialized Formulas: Immune System Support						
Impact	1500	1.00	56	130	28	Enriched with arginine, nucleic acids, and omega-3 fatty acids
Impact 1.5	1250	1.50	84	140	69	Same as above
Impact Glutamine	1000	1.30	78	150	43	Same as above, and enriched with glutamine
Specialized Formulas: Chronic Kidney Disease (CKD)						
Nepro with Carb Steady	948	1.80	81	167	96	Low potassium, low phosphorus; to be used after dialysis has been instituted
Novasource Renal	1000	2.00	74	200	100	Low in electrolytes; to be used after dialysis has been instituted
Suplena with Carb Steady	948	1.80	45	205	96	Low in protein and electrolytes; for patients with CKD (stage 3 or 4)

How to select a formula?

- The best formula is the one that meets both medical and nutritional needs with the:
  - ✓ Lowest risk of complications
  - ✓ Lowest cost

- Factors that influence formula selection:
  1. Adequate digestion and absorption
  2. Nutrient and energy needs
  3. Fluid requirements
  4. Fiber modifications
  5. Individual allergies and intolerances
  6. Availability of formulas

How to Select a Formula?



Feeding Routes

Choosing a feeding route

- Oral feedings are preferred to tube feeding to avoid the stress, complications, and expenses associated with tube feeding

- Tube feeding is preferred to parenteral feeding because it:
  - ✓ Helps stimulate and maintain gut function
  - ✓ Causes fewer complications
  - ✓ Costs less

Help patients accept oral formulas

1. Sample different formulas that are appropriate and use only those that the patient enjoys.
2. Serve formulas attractively, and remind patients to drink them. (Ex: a glass on an attractive plate)
3. If the smell is unappealing, cover the top with plastic wrap or a lid, leaving room for a straw.
4. Provide easy access and within sight so that the patient is reminded to drink it.
5. Try keeping the formula in an ice bath so that it will be cool and refreshing.
6. For patients with little appetite, offer the formula in small frequent amounts.
7. If the patient stops enjoying the formula, recommend different flavors or try other formulas.

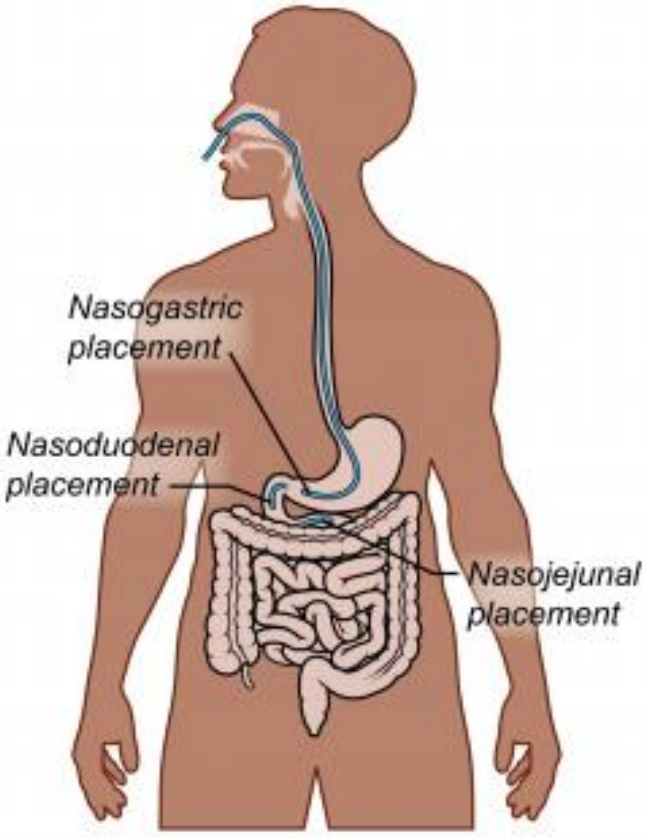
Indications for tube feeding

- Severe swallowing disorders
- Impaired motility in the upper GI tract
- Gastrointestinal obstructions and fistulas that can be bypassed with a feeding tube
- Certain types of intestinal surgeries
- Mechanical ventilation
- Extremely high nutrient requirements
- Little or no appetite for extended periods, especially if the patient is malnourished
- Mental incapacitation due to confusion, neurological disorders, or coma

Contradictions to tube feeding

- Severe GI bleeding
- Intractable vomiting or diarrhea
- Complete intestinal obstruction
- Severe malabsorption

Transnasal Routes



Transnasal Feeding Tube Placement

Transnasal

- Nasogastric, Nasoduodennal or nasojejunal

- When the patient is expected to be tube fed for less than 4 weeks.
- Tube is inserted into a nostril and passed into the stomach while the patient is in a slightly upright position with head tilted. The patient can swallow water to ease passage.

See: https://www.youtube.com/watch?v=en5ctZInOyA

Transnasal

Bypassing the stomach can be beneficial for:

1. Those whose stomachs don’t empty well
2. Who have chronic vomiting
3. Who inhale or aspirate stomach contents into the lungs.

Orogastric

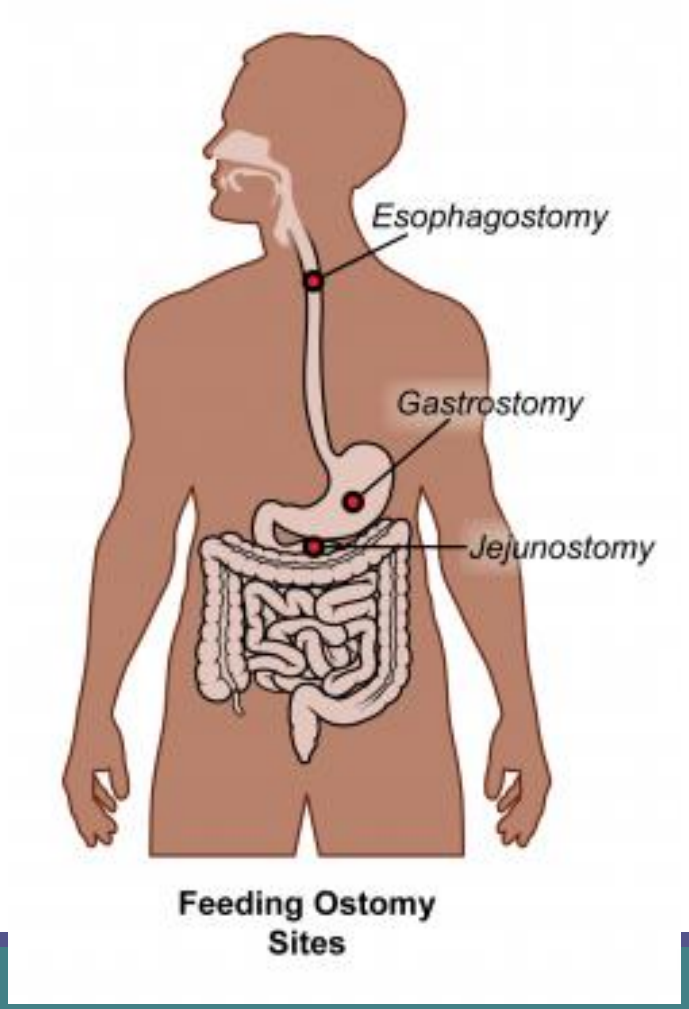
- In infants, the tube is passed to the stomach via the mouth

- Preferred over transnasal routes as it allows infant to breathe more normally during feedings

Nasogastric Tube

Orogastric Tube

Enterostomy



Enterostomy

A direct route to the stomach or intestine created by passing the tube through an **enterostomy**, an opening in the abdominal wall that leads to the stomach (**gastrostomy**) or jejunum (**jejunostomy**)

IF:

- ✓ Feedings longer than 4 weeks
- ✓ OR nasoenteric route is inaccessible

Made by either surgical incision or needle puncture.

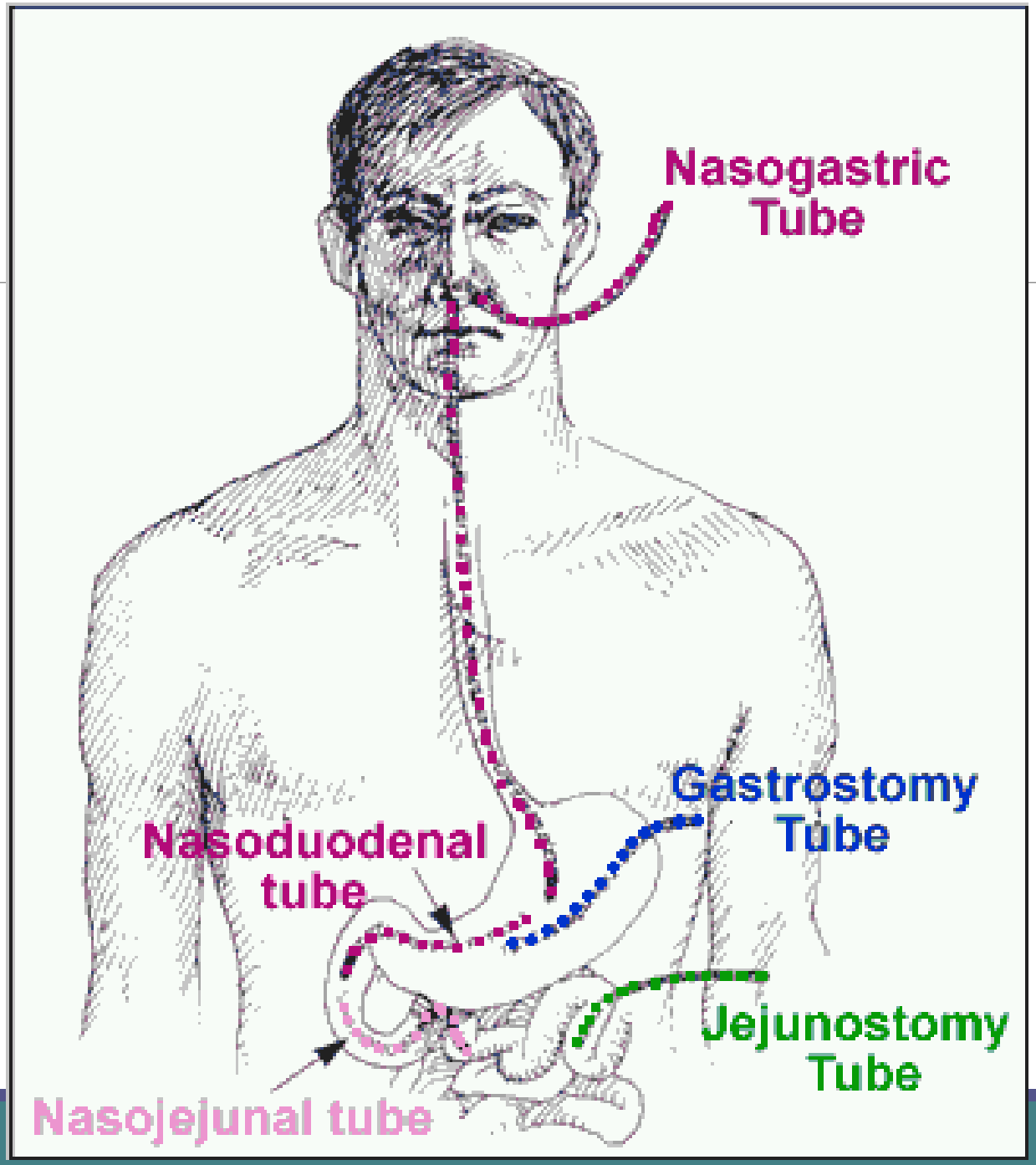
Choosing a route

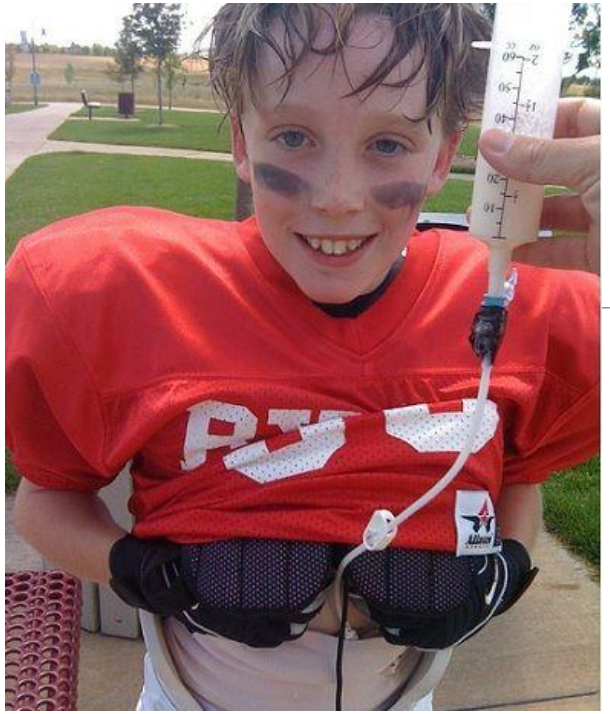
Gastric feedings (nasogastric and gastrostomy routes) are preferred whenever possible because they are:

✓ More easily tolerated

✓ Less complicated to deliver (the stomach controls the rate at which nutrients enter the intestine)

X Avoid in patients with high risk of aspiration






NCSP

Safe Administration of Tube Feeding

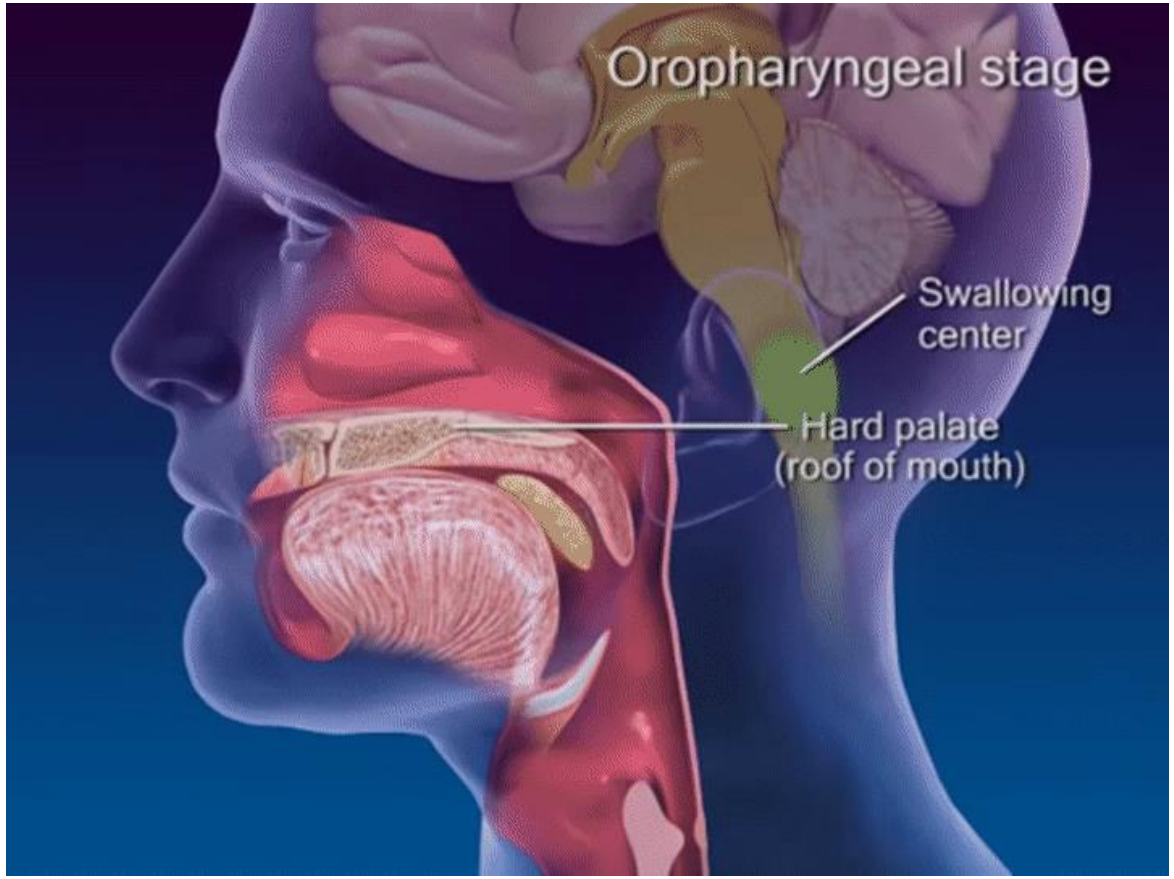
- Patients often have suppressed immune systems, making them vulnerable to infection from foodborne illness. Thus, the personnel should be aware of the specific protocols at their facility that prevent formula contamination. (HACCP System)
- Closed feeding systems are less likely to become contaminated, require less nursing time, and can hang for longer periods of time than open systems.
- Hands should be carefully washed before handling formulas and feeding containers.
- Before opening a can of formula, clean the lid with a disposable alcohol wipe and wash the can opener with detergent and hot water. If you do not use the entire can, label with the date and time it was opened.
- Store opened cans or mixed formulas in clean, closed containers. Refrigerate the unused portion of formula promptly.
- Discard unlabeled or improperly labeled containers and all opened containers of formula that are not used within 24 hours.
- The nurse should hang no more than an 8-hour supply of formula. For closed feeding systems, the hang time should be no longer than 24 to 48 hours.

Open vs Closed System

Ed Eckstein/Photolake

Courtesy of Abbott Nutrition

Confirming Placement



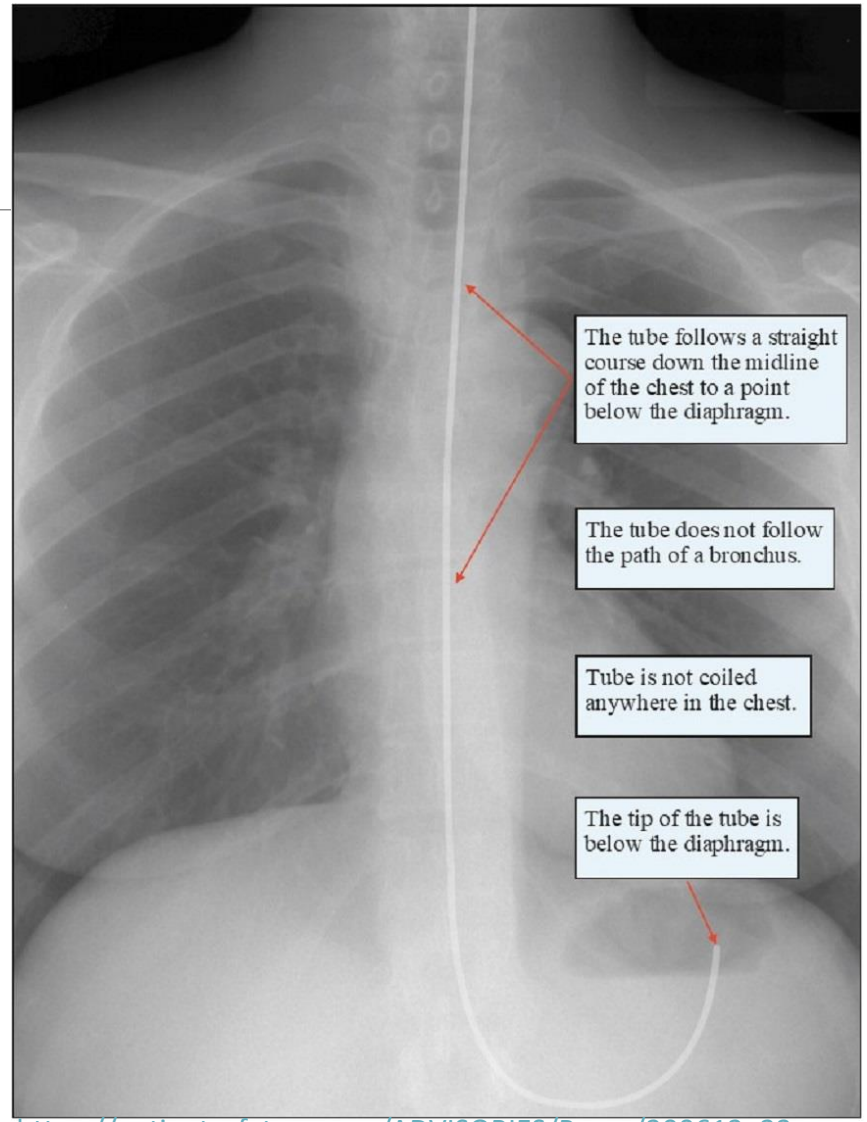
Confirming Placement

The gold standard for nasogastric feeding tube placement is radiographic confirmation with a chest x-ray.

Other traditional methods:

8:16

https://www.youtube.com/watch?app=desktop&v=yAyOVxAwm78



https://patientsafety.pa.gov/ADVISORIES/Pages/200612_23.aspx

Formula Delivery Methods

Intermittent Feeding

Continuous Feeding

Intermittent Feeding

- Best when delivered into the stomach
- 250-450 ml delivered over 30-45 min
- The required volume/ daily feeds= amount per feed
- Might be difficult to tolerate
- High risk of aspiration
- Similar to the patient's eating pattern
- Freedom of movement
- Allows mobile patients to enjoy an improved quality of life. It allows time for treatments, therapies, and activities.

Bolus feeding

- Rapid delivery of a large volume of formula into the stomach (250-500 ml) in less than 20 minutes
- Given every 3-4 hours using a syringe
- Cause abdominal discomfort, nausea, and cramping
- High risk of aspiration
- Use for patients who are not critically ill, clinically stable, and have adequate gastric emptying
- Administered over 5-20 minutes
- If patient develops discomfort, wait 10-15 minutes before infusing the remainder of the formula

Why choose bolus feeding?

1. Reduced time required for each feeding occasion
2. Often considered simpler to understand and administer
3. Allow more flexibility in feeding to allow for work/social outings
4. Timing of feeds can be arranged when carers and/or family are available
5. Easier to transport feed and syringe when feeding outside the home than carrying a pump and pack of feed
6. Administration of a concentrated protein bolus may support muscle growth and minimise muscle loss when compared to continuous feeding

Continuous Feeding

- Delivered slowly at a constant rate over 8-24 hours
- Starts with 10-40 ml/hour and raised by 10-20 ml/hour as tolerated
- Used for intestinal feedings
- Easier to tolerate, recommended for critically ill
- High osmolality formulas may require more time to achieve tolerance

Starting feeding

Intermittent:

may start with 60 to 120 milliliters at the initial feeding and be increased by 60 to 120 milliliters every 8 to 12 hours until the goal volume is reached.

Continuous:

may start at rates of about 10 to 40 milliliters per hour and be increased by 10 to 20 milliliters per hour every 8 to 12 hours until the goal rate is reached

Note: If the patient cannot tolerate an increased rate of delivery, the feeding rate is slowed until the person adapts. Goal rates can usually be achieved over 24 to 48 hours.

Water Flushes

Water flushes are conducted to prevent feeding tubes from clogging

The water used for flushes

- Intermittent feedings: before and after feedings
- Continuous feeding: Every 4 hours

This should be included when estimating fluid intakes.

Case Study

Consider a patient who needs 2000 kcalories daily and is receiving a standard formula that provides 1.0 kcalorie per milliliter.

1. If the patient is to receive intermittent feedings six times a day
2. If he is to receive intermittent feedings eight times a day
3. If the patient is to receive the formula continuously over 24 hours

4. For Case 1: estimate the total fluid intake

Gastric Residual Volume

Volume of formula remaining in the stomach after feeding. It is used to ensure that the stomach is emptying properly

Done by withdrawing gastric contents through the feeding tube using a syringe

Usually done before each intermittent feeding, and every 4 to 8 hours during continuous feedings in critically ill patients

If volume exceeds 200 ml, an evaluation needs to be conducted

If volume exceeds 500 ml feeding should be withheld. Intestinal feedings or drug therapy to stimulate gastric emptying may be recommended.

Tube Feeding Complications

Gastrointestinal Complications

1. Diarrhea
2. Constipation
3. Abdominal discomfort, nausea, and/or vomiting

Gastrointestinal Complications

1. Diarrhea

Possible causes & Corrective measures:

❖ Medication intolerance

Dilute hypertonic medications before administering; avoid using poorly tolerated medications

❖ Infection in GI tract

Consult physician about specific diagnosis and appropriate treatment

❖ Formula contamination

Review safety guidelines for formula preparation and delivery.

Gastrointestinal Complications

1. Diarrhea (Continued)

❖ Excessively rapid formula administration

Decrease formula delivery rate or use continuous feedings.

❖ Lactose or gluten intolerance

Use lactose-free or gluten-free formula in patients with intolerances

❖ Unknown cause

Review medical record for conditions that predispose to diarrhea; try an alternative formula that contains adequate fiber; consult physician about using antidiarrheal or antimotility medications.

Gastrointestinal Complications

2. Constipation

Possible causes & Corrective measures:

- Inadequate dietary fiber

  Use a formula with appropriate fiber content.

- Dehydration

  Provide additional fluids.

- Lack of exercise

  Encourage walking and other activities, if appropriate.

- Medication side effect

  Consult physician about minimizing or replacing medications that cause constipation

Gastrointestinal Complications

3. **Abdominal discomfort, nausea, and/or vomiting**

Possible causes & Corrective measures:

- Delayed stomach emptying

  Decrease formula delivery rate or use continuous feedings; halt feeding if gastric residual volume is excessive (>500 mL); evaluate for obstruction; consider use of medications to improve emptying rate.

- Formula intolerance

  Ensure that formula is at room temperature, delivery rate is appropriate, and formula odor is not objectionable; consider using formula that is low in fat, low in fiber, or elemental.

Gastrointestinal Complications

3. **Abdominal discomfort, nausea, and/or vomiting** (Continued)

- Medication intolerance

  Consult physician about replacing medications that are poorly tolerated.

- Response to disease or disease treatment

  Consider use of medications that control nausea and vomiting.

Metabolic Complications

1. Fluid imbalances
2. Electrolyte imbalances
3. Glucose intolerance

Metabolic Complications

Possible causes & Corrective measures:

- Diarrhea

  See previous slides

- Inappropriate fluid intake or excessive losses

  Monitor daily weights, intake and output records, serum electrolyte levels, and clinical signs that indicate dehydration or overhydration; ensure that water intake and formula delivery rates are appropriate.

Metabolic Complications

(Continued)

- Inappropriate insulin, diuretic, or other therapy

  Ensure that medication doses are appropriate.

- Inappropriate nutrient intake

  Use a formula with appropriate nutrient content

Mechanical Complications

1. Clogged feeding tubes
2. Malfunctioning feeding pumps
3. Dislodged tubes
4. Leakage of gastrointestinal secretions

Monitoring Tube Feedings

Many complications of tube feeding can be prevented by choosing the most appropriate feeding route, formula, and delivery method.

Setting a monitoring schedule that may help with the early detection of common tube feeding problems.

TABLE 20-4 Monitoring Patients on Tube Feedings[a]

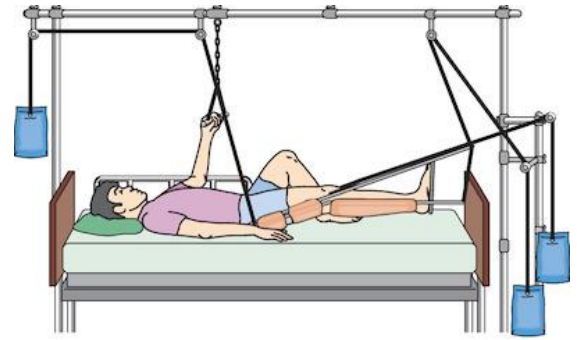
Before starting a new feeding:	• Conduct a complete nutrition assessment. • Check tube placement.
Before each intermittent feeding:	• Check patient's position. • Check tube placement. • Check gastric residual volume (gastric feedings only). • Flush feeding tube with water.
After each intermittent feeding:	• Flush feeding tube with water.
Every hour:	• Check infusion pump rate, when applicable.
Every 4 to 6 hours:	• Check vital signs, including blood pressure, temperature, pulse, and respiration. • Check blood glucose; once stable, check blood glucose daily (individuals without diabetes).
Every 4 to 6 hours of continuous feeding:	• Check patient's position. • Check gastric residual volume (gastric feedings only). • Flush feeding tube with water.
Every 8 hours of continuous feeding:	• Check tube placement.
Every 24 hours:	• Check intake and output, stool patterns, and hydration status. • Check skin condition at the tube insertion site. • Change feeding container and attached tubing. • Clean feeding equipment.
Twice weekly:	• Check body weight (check daily if patient is nutritionally unstable).
As necessary:	• Observe patient for undesirable responses to tube feeding, such as delayed gastric emptying, nausea, vomiting, or diarrhea. • Check results of laboratory tests. • Check nitrogen balance.

[a]Guidelines vary among institutions. Monitoring frequency depends on the patient's medical condition. Patients beginning tube feedings and patients who are medically or nutritionally unstable need more intense monitoring.

Transition to Table Foods

- After the patient's condition improves, the volume of formula can be tapered off as the patient gradually shifts to an oral diet. (Evaluate swallowing function)
- Individuals using continuous feedings are often switched to intermittent feedings initially.
- Patients receiving elemental formulas may begin the transition by using a standard formula, either orally or via tube feeding.
- A low lactose diet may be better tolerated at first.
- Oral intake should supply about **two-thirds of estimated nutrient needs** before the tube feeding is discontinued completely.

Case Study (See page 635)



Sharyn Bartell is a 24-year-old student who suffered multiple fractures when she fell from a cliff while hiking. She also developed gastroparesis (delayed stomach emptying), a possible result of damage to the vagus nerve, which controls stomach muscles. Because of her injuries, she is in traction and is immobile, although the head of her bed can be elevated 45 degrees. Sharyn weighed 63.5 kg upon her arrival in the hospital 2 weeks ago, but she has lost 3.6 kg over the course of her hospitalization. The health care team agrees that nasoduodenal tube feeding should be instituted before her nutrition status deteriorates further. A standard formula is selected for the feeding, and Sharyn's nutrient requirements can be met with 2200 milliliters of the formula per day.

… Continued

1. What steps can be taken to prepare Sharyn for tube feeding? What are some reasons why nasoduodenal placement of the feeding tube might be preferred over nasogastric placement?

2. The physician's orders specify that the feeding should be given continuously over 18 hours. Determine an appropriate tube-feeding schedule.

3. Estimate Sharyn's fluid needs using the recommended intake range of 30 to 40 milliliters of water per kilogram body weight. If Sharyn's formula is 80 percent water, will she receive enough water from the formula? If not, estimate the additional fluid she would need and explain how it could be provided.

4. What steps can the health care team take to prevent aspiration? Describe precautions that should be taken if Sharyn is to receive medications through the feeding tube.

5. After 3 days of tube feedings, Sharyn develops diarrhea. What are the possible causes? What measures can be taken to correct the diarrhea?