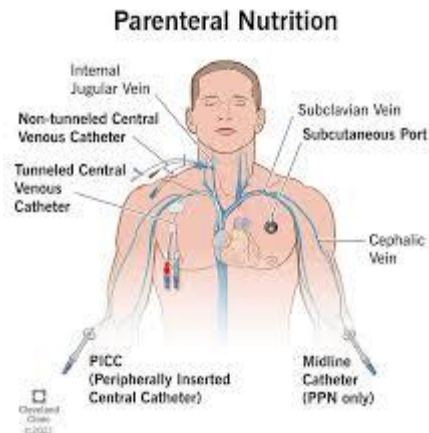


PARENTERAL NUTRITION SUPPORT



Course Name: Clinical Nutrition

Course Code: 0521422

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INTRODUCTION

- Because enteral formulas cannot be used if intestinal function is **inadequate**, the ability to meet nutrient needs intravenously is a **lifesaving** option for **critically ill persons**.
- The procedure is **costly**, however, and associated with a number of **potentially dangerous complications**.
 - *Therefore, enteral nutrition support is preferred over parenteral nutrition if the gastrointestinal (GI) tract is functional, partly to avoid the **expense and complications** associated with intravenous therapy and partly to preserve healthy GI function.*

INDICATIONS FOR PARENTERAL NUTRITION

Patients With The Following Conditions Are Often Considered Candidates For Parenteral Nutrition:

- Intestinal obstructions or fistulas
- Paralytic ileus (intestinal paralysis)
- Short bowel syndrome (a substantial portion of the small intestine has been removed)
- Intractable vomiting or diarrhea
- Bone marrow transplants
- Severe malnutrition and intolerance to enteral nutrition

THE ACCESS SITE OF PARENTRAL NUTRITION

- Once the decision to use parenteral nutrition has been made, the access site must be selected.
- *The **access sites** for intravenous feedings fall into two main categories:*
 - i- The Peripheral Veins** Located In The Arms And Legs.
 - ii- The Large-diameter Central Veins** Located Near The Heart.

I- Peripheral Parenteral Nutrition (PPN)

- In **peripheral parenteral nutrition (PPN)**, nutrients are delivered using only the **peripheral veins**.
- **Peripheral veins** can be **damaged** by **overly concentrated solutions**, however: phlebitis (inflammation of the vein) may result, characterized by redness, swelling, and tenderness at the infusion site.
- To prevent phlebitis, the **osmolarity of parenteral solutions used for PPN** is generally kept **below 900** milliosmoles per liter, a concentration that limits the amounts of energy and protein the solution can provide.
- PPN is used most often in patients who require **short-term nutrition support (about 7 to 10 days)** and who **do not have high nutrient needs or fluid restrictions**.
- The use of PPN is **not** possible if the **peripheral veins are too weak** to tolerate the procedure.
- **In many cases, clinicians must rotate venous access sites to avoid damaging veins.**

HOW TO Express the Osmolar Concentration of a Solution

- The movement of water across biological membranes (called **osmosis**) *is influenced by a solution's concentration of milliosmoles, the ions and molecules that contribute to water's osmotic pressure.*
- **The terms *osmolarity* and *osmolality* are both used to express the concentration of these types of solutes:**
 - *Osmolarity* refers to the milliosmoles per **liter** of solution (mOsm/**L**).
 - *Osmolality* refers to the milliosmoles per **kilogram** of solvent (mOsm/**kg**).
- Osmolarity and osmolality are roughly equivalent → 1 liter of water weighs 1 kilogram.

II- Total Parenteral Nutrition (TPN)

- Most patients meet their nutrient needs using the larger, central veins, where blood volume is greater and **nutrient concentrations do not need to be limited**. Because this method can reliably meet a person's complete nutrient requirements, it is called **total parenteral nutrition (TPN)**.
- Central veins lie close to the heart, where the large volume of blood rapidly dilutes parenteral solutions. Therefore, patients with **very high nutrient needs or fluid restrictions** are able to receive the nutrient-dense solutions they require.
- TPN is also preferred for patients who require **long-term parenteral nutrition**.

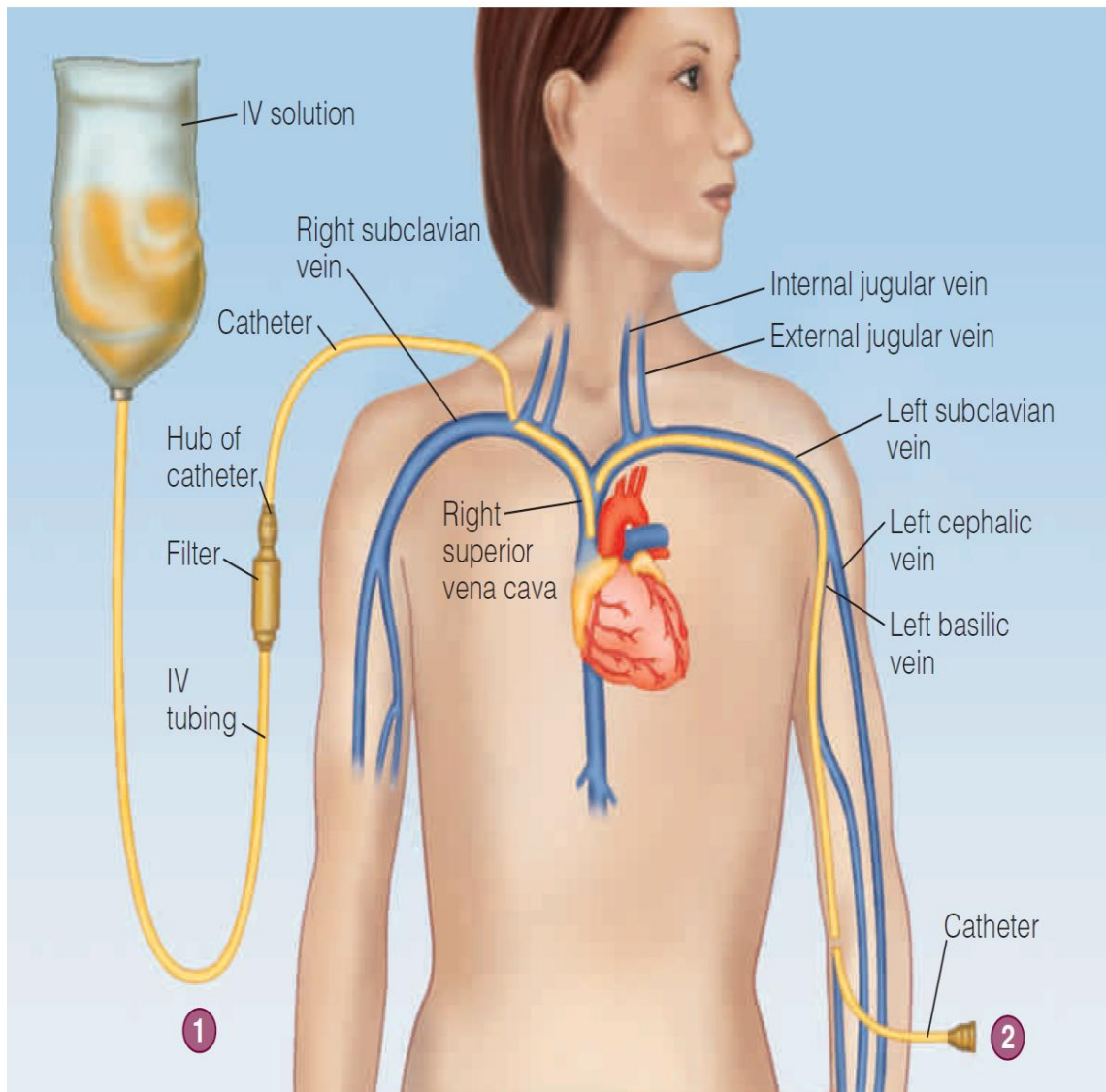
There are several ways to access central veins:

- The tip of a **central venous CATHETER** can be placed directly into a large-diameter central vein

OR

- Threaded into a central vein through a peripheral vein. **Peripheral insertion of central catheters** is less invasive and lower in cost than the direct insertion of catheters into central veins; this method is usually preferred for short-term venous access (about two months or less in duration)

FIGURE 21-2 Accessing Central Veins for Total Parenteral Nutrition



1 Traditionally, central catheters enter the circulation at the right subclavian vein and are threaded into the superior vena cava with the tip of the catheter lying close to the heart. Sometimes catheters are threaded into the superior vena cava from the left subclavian vein, the internal jugular vein, or the external jugular vein.

2 Peripherally inserted central catheters usually enter the circulation at the basilic or cephalic vein and are guided up toward the heart so that the catheter tip rests in the superior vena cava.

PARENTERAL SOLUTIONS **Nutrients**

- Parenteral solutions provide the combinations of amino acids, carbohydrate, lipids, vitamins, and minerals that are best suited to meet patients' requirements.
- Because the nutrients are provided intravenously, they must be given in forms that are **safe** to inject directly into the bloodstream.

PARENTERAL SOLUTIONS

AMINO ACIDS

- Parenteral solutions contain all of the **essential** amino acids and various combinations of the **nonessential** amino acids.
- Amino acid concentrations range from 3.5 to 15 percent; the more concentrated solutions are used only for TPN.
- Just as in regular foods, the amino acids provide 4 kcalories per gram.
- Disease-specific amino acid solutions are available for patients with liver failure, kidney failure, and metabolic stress.

PARENTERAL SOLUTIONS

CARBOHYDRATE

- Glucose is the main source of energy in parenteral feedings. It is provided in the form dextrose monohydrate, in which each glucose molecule is associated with a single water molecule.
- Dextrose monohydrate provides 3.4 kcalories per gram, slightly less than pure glucose, which provides 4 kcalories per gram.
- Dextrose solutions are available in concentrations between 2.5 and 70 percent.
- Concentrations greater than 12.5 percent are used only in TPN solutions.
- In parenteral solutions, the dextrose concentration is indicated by a “D” followed by its concentration in water (W) or normal saline (NS).
- For example, D5 or D5W indicates that a solution contains 5 percent dextrose in water. Similarly, D5/NS means that a solution contains 5 percent dextrose in normal saline.

PARENTERAL SOLUTIONS

LIPIDS

- Lipid emulsions supply **essential** fatty acids and are a significant **source of** energy.
- The emulsions usually contain **triglycerides**, **phospholipids** to serve as emulsifying agents, and **glycerol** to make the solutions isotonic.
- In the United States, the 30 percent lipid emulsion can be used for preparing mixed parenteral solutions but cannot be directly infused into patients.
- Lipid emulsions are often provided daily and may supply 20 to 30 percent of total kcalories.
- Including lipids as an energy source reduces the need for energy from dextrose and lowers the risk of hyperglycemia in glucose-intolerant patients.
- Lipid infusions must be **restricted** in patients with hypertriglyceridemia, however.
- There is also some concern that lipid emulsions that contain excessive linoleic acid can suppress some aspects of the immune response.

PARENTERAL SOLUTIONS

FLUIDS AND ELECTROLYTES

- Daily fluid needs usually range from 30 to 40 milliliters per kilogram of body weight in young adults and 25 to 30 milliliters per kilogram of body weight in adults who are 65 years and older, averaging between 1500 and 2500 milliliters for most people.
- The amounts are adjusted according to daily fluid losses and the results of hydration assessment.
- The electrolytes added to parenteral solutions include sodium, potassium, chloride, calcium, magnesium, and phosphate.
- The body's fluids and parenteral solutions are **neutral solutions** that contain equal numbers of positive and negative charges.
- The amounts in parenteral solutions **differ** from DRI values because the nutrients are **infused directly into the blood** and are not influenced by absorption, as they are when consumed orally.
- Because electrolyte imbalances can be **lethal**, electrolyte management by experienced professionals is necessary whenever intravenous therapies are used. **Blood tests are administered daily** to monitor electrolyte levels until patients have stabilized.

PARENTERAL SOLUTIONS

VITAMINS AND TRACE MINERALS

- Commercial multivitamin and trace mineral preparations are added to parenteral solutions to meet micronutrient needs.
- All of the vitamins are usually included, although a preparation **without** vitamin K is available for patients using [warfarin](#) therapy.
 - *The anticoagulant warfarin works by interfering with vitamin K's blood-clotting function.*
- The trace minerals typically added to parenteral solutions include **zinc, copper, chromium, selenium, and manganese**.
- **Iron** is **excluded** because it alters the stability of other ingredients in parenteral mixtures; therefore, special forms of iron need to be injected separately.

PARENTERAL SOLUTIONS

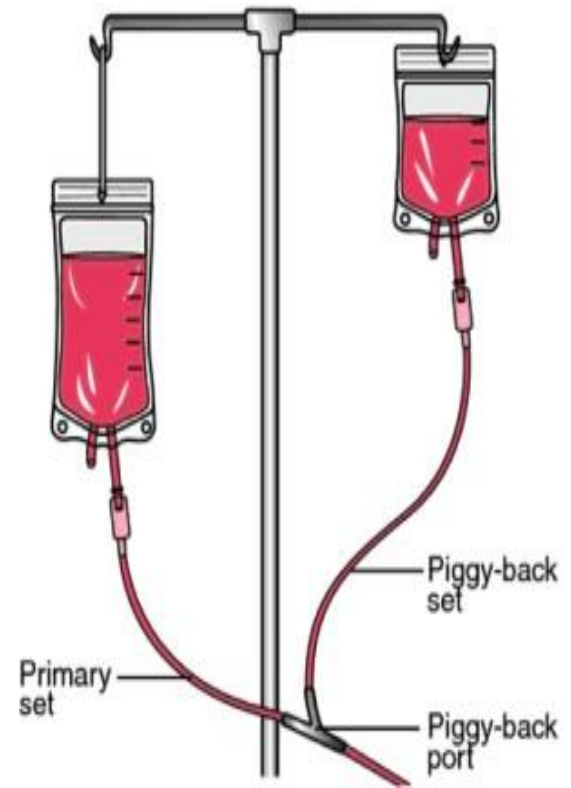
OSMOLARITY

- Recall that the osmolarity of PPN solutions is limited to 900 milliosmoles per liter because peripheral veins are **sensitive** to high nutrient concentrations, whereas TPN solutions may be as nutrient dense as necessary.
- The components of a solution that **contribute most** to its osmolarity are **amino acids, dextrose, and electrolytes**; as concentrations of these nutrients increase, the osmolarity of a solution increases.
- Because **lipids** contribute **little** to osmolarity, lipid emulsions are used to increase the energy provided in PPN solutions.

PARENTERAL SOLUTIONS

MEDICATIONS

- To avoid the need for a separate infusion site, medications are occasionally added **directly** to parenteral solutions or **infused** through a separate port in the catheter (attached via a Y-connector). The administration of a second solution using a separate port is called a **piggyback**.
- **Insulin**, for example, is sometimes added by piggyback to improve glucose tolerance.
- **Heparin** (an anticoagulant) may be added to prevent clotting at the catheter tip.
- In practice, **few** medications are added to parenteral solutions so that potential drug-nutrient **interactions** can be **avoided**.



SOLUTION PREPARATION

- The prescription for a parenteral solution must take into account the patient's **medical condition** and **nutrition status** and the **method of venous access**.
- Parenteral solutions are highly **individualized** and may need to be recalculated daily until the patient's condition is stable.
- The solutions are compounded in hospital pharmacies using commercial nutrient preparations and include amino acids, dextrose, electrolytes, vitamins, and trace minerals.
- **Few medications are added to parenteral solutions due to the potential for drug-nutrient interactions.**
- Parenteral solutions are prepared and handled using **aseptic** techniques to prevent contamination.

DEFINITIONS

- **Total Nutrient Admixture (TNA):** a parenteral solution that contains dextrose, amino acids, and lipids; also called a **3-in-1 solution** or an **all-in-one solution**.
- **2-in-1 solution:** a parenteral solution that contains dextrose and amino acids, but excludes lipids.

FIGURE 21-3 Sample Parenteral Nutrition Order Form

Physician Orders **PARENTERAL NUTRITION (PN) – ADULT**

Primary Diagnosis: _____ **Ht:** _____ cm **Dosing Wt:** _____ kg

PN Indication: _____ **Allergies** _____

Instructions: This form must be completed for a new order or continuation of PN and faxed to the Pharmacy by [Insert Time] to receive same day preparation. PN administration begins at [Insert Time]. Contact the Nutrition Support Service at (XXX) XXX-XXXX for additional information.

Administration Route: CVC or PICC *Note: Proper tip placement of the CVC or PICC must be confirmed prior to PN infusion*

Peripheral IV (PIV) (Final PN Osmolarity $\leq$ _____ mOsm/L)

Monitoring: Daily weights, Strict input & output, Bedside glucose monitoring every _____ hours

Na, K, Cl, CO₂, Glucose, BUN, Scr, Mg, PO₄ every _____

T, Bili, Alk Phos, AST, ALT, Albumin, Triglycerides, Calcium every _____

Base Solution: Parenteral nutrition <i>MUST</i> be administered through a dedicated infusion port and filtered with a 1.2-micron in-line filter at all times. Discard any unused volume after 24 hours. Select one		
PERIPHERAL 2-in-1 Dextrose _____ g Amino Acids (Brand _____) _____ g <i>For patients with PIV and established glucose tolerance; Provides _____ kcal; Maximum Rate not to exceed _____ mL/hour</i>	CENTRAL 2-in-1 Dextrose _____ g Amino Acids (Brand _____) _____ g <i>For patients with CVC or PICC and established glucose tolerance; Provides _____ kcal; Maximum Rate not to exceed _____ mL/hour</i>	CENTRAL 3-in-1 Dextrose _____ g Amino Acids (Brand _____) _____ g Fat Emulsion (Brand _____) _____ g <i>For patients with CVC or PICC and established glucose/fat emulsion tolerance; Provides _____ kcal; Maximum Rate not to exceed _____ mL/hour</i> <i>Use of additional fat emulsion not required with 3-in-1 base solution</i>
RATE & VOLUME: _____ mL/hour for _____ hours = _____ mL/day <i>Must specify</i>		
or CYCLIC INFUSION: _____ mL/hour for _____ hours, then _____ mL/hour for _____ hours = _____ mL/day		
Fat Emulsion (Brand _____) – via PIV or CVC with 2-in-1 base solutions (Select caloric density & volume)		
10% 250 mL 20% 500 mL	Infuse at _____ mL/hour over _____ hours (Note: infusions < 4 or > 12 hours not recommended)	Frequency _____ Discard any unused volume after 12 hours.
Additives: (per day) Sodium Chloride _____ mEq as Acetate _____ mEq as Phosphate _____ mmol of PO ₄ Potassium Chloride _____ mEq as Acetate _____ mEq as Phosphate _____ mmol of PO ₄ Calcium Gluconate _____ mEq Magnesium Sulfate _____ mEq Adult Multivitamins _____ mL/day Adult Trace Elements _____ mL/day H ₂ Antagonist _____ mg Other: _____	Normal Dosages 1-2 mEq Sodium/kg/day pH or CO ₂ dependent Consider if hyperkalemic 1-2 mEq Potassium/kg/day pH or CO ₂ dependent 20-40 mmol/day (1 mmol Phos = 1.5 mEq K) 5-15 mEq/day 8-24 mEq/day Contains Vitamin K 150 mcg Zn _____ mg, Cu _____ mg, Mn _____ mg, Cr _____ mcg, Se _____ mcg (with normal hepatic function) _____ mg/day with normal renal function	Additives: (per day) Regular Insulin _____ units Recommend if hyperglycemic, start with 1 unit for every 10 g of dextrose Pharmacy Use Only: Ca/PO₄ Limit Checked _____ (Note: Some brands of amino acids contain phosphate)

Physician's Signature: _____ **Pager Number:** _____ **Date/time:** _____

Orders transcribed by: _____ **Date/time:** _____ **Orders verified by:** _____ **Date/time:** _____

SEND COMPLETED ORDERS TO PHARMACY

ADMINISTERING PARENTERAL NUTRITION

- A *nutrition support team* is a **multidisciplinary** team of health care professionals who are responsible for the provision of nutrients by tube feeding or intravenous infusion.

FIGURE 21-4 The Nutrition Support Team

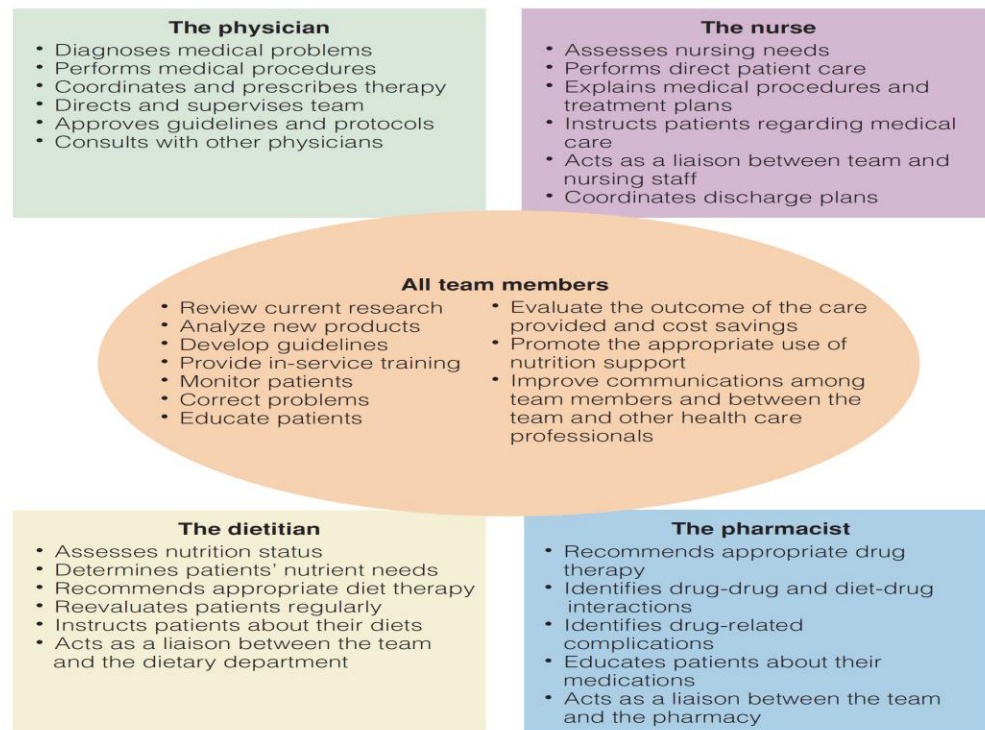


TABLE 21-1 Potential Complications of Parenteral Nutrition

Catheter-Related

Air embolism
Blood clotting at catheter tip
Clogging of catheter
Dislodgment of catheter
Improper placement
Infection, sepsis
Phlebitis
Tissue injury

Metabolic

Abnormal liver function
Electrolyte imbalances
Gallbladder disease
Hyperglycemia, hypoglycemia
Hypertriglyceridemia
Metabolic bone disease
Nutrient deficiencies
Refeeding syndrome

PATIENT MONITORING DURING PARENTERAL NUTRITION

BEFORE STARTING:

- Perform a nutrition assessment
- Record body height, weight, and body mass index
- Confirm catheter placement by X-ray
- Check laboratory values

EVERY 4 TO 8 HRS:

- Check vital signs, including body temperature
- Inspect catheter site for signs of inflammation or infection (frequency depends on patient condition)
- Check pump infusion rate and appearance of parenteral solution and tubing
- Check blood glucose levels (once stabilized, check daily)

DAILY:

- Replace parenteral solution and tubing
- Monitor weight changes
- Record fluid intake and output
- Check blood glucose levels, blood urea nitrogen, serum creatinine, and serum electrolytes until stabilized

SEVERAL TIMES WEEKLY (OR AS NEEDED)

- Reassess nutrition status
- Check laboratory values to monitor blood chemistry

Transition To Table Food AFTER Parenteral And Enteral Nutrition

The transition to table food requires a **gradual** and **patient-centered approach**, considering the following:

- **Gastrointestinal tolerance** → Start with liquids or purees then introduce small, frequent meals (easy-to-digest).
 - **Nutritional adequacy** → Maintain supplemental nutrition
 - **The ability to safely swallow and digest food.**
-

Key Considerations

- **Pediatric vs. Adult Populations:** Guidelines vary significantly based on age; **children** often require additional developmental and growth considerations.
- **Chronic Illness:** Patients with chronic GI or metabolic disorders may need long-term adjustments in their diets.
- **Psychological Support:** Eating can be stressful for patients after prolonged non-oral feeding; involve mental health professionals if necessary.