TOTAL PARENTERAL NUTRITION

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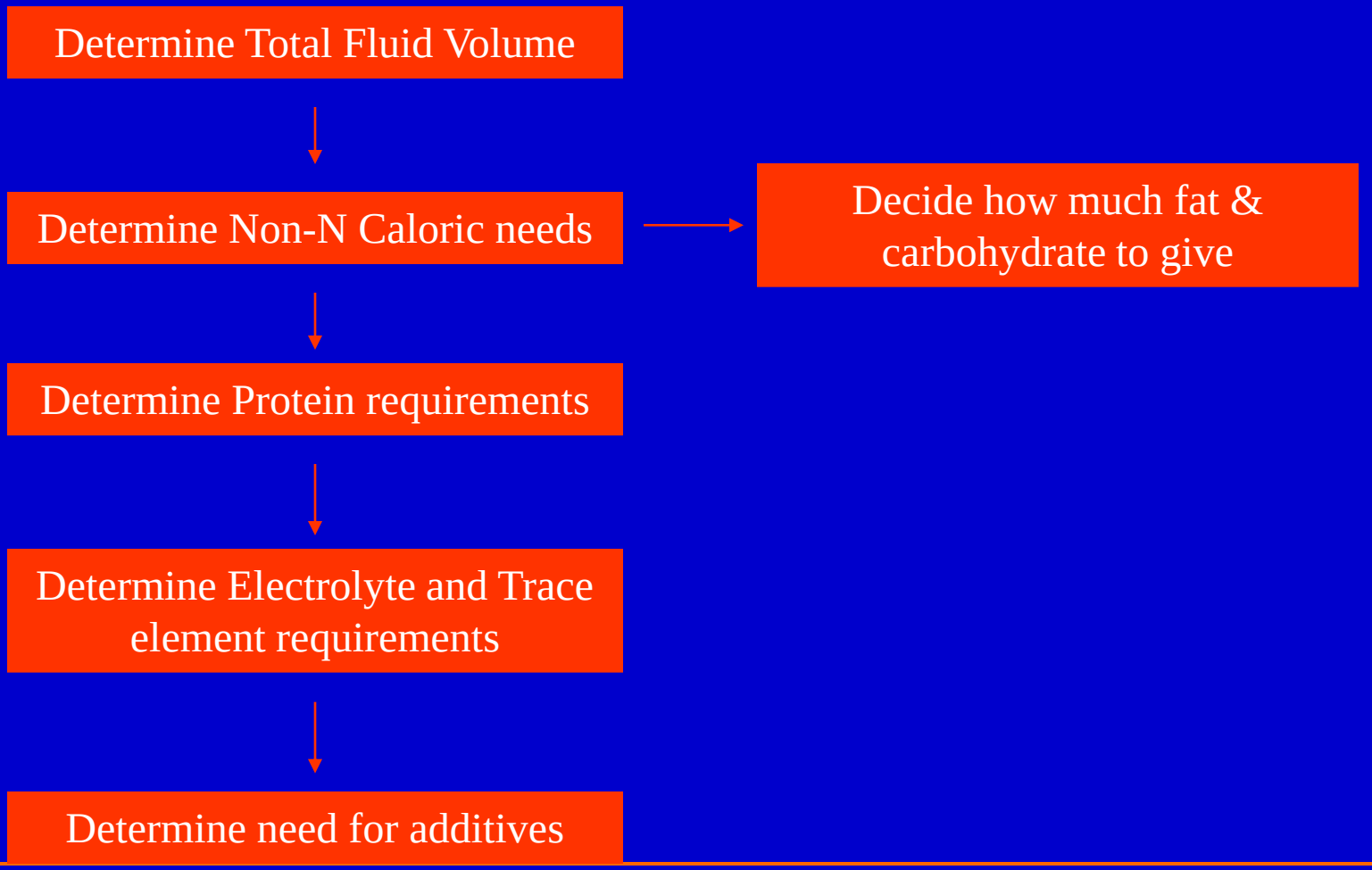
What to Do Before Starting TPN

- Nutritional Assessment
- Venous access evaluation
- Baseline weight
- Baseline lab investigations

Baseline Lab Investigations

- Full blood count
- Coagulation screen
- Screening Panel # 1
- Ca^{++}, Mg^{++}, PO_4^{2-}
- Lipid Panel # 1
- Other tests when indicated

Steps to Ordering TPN



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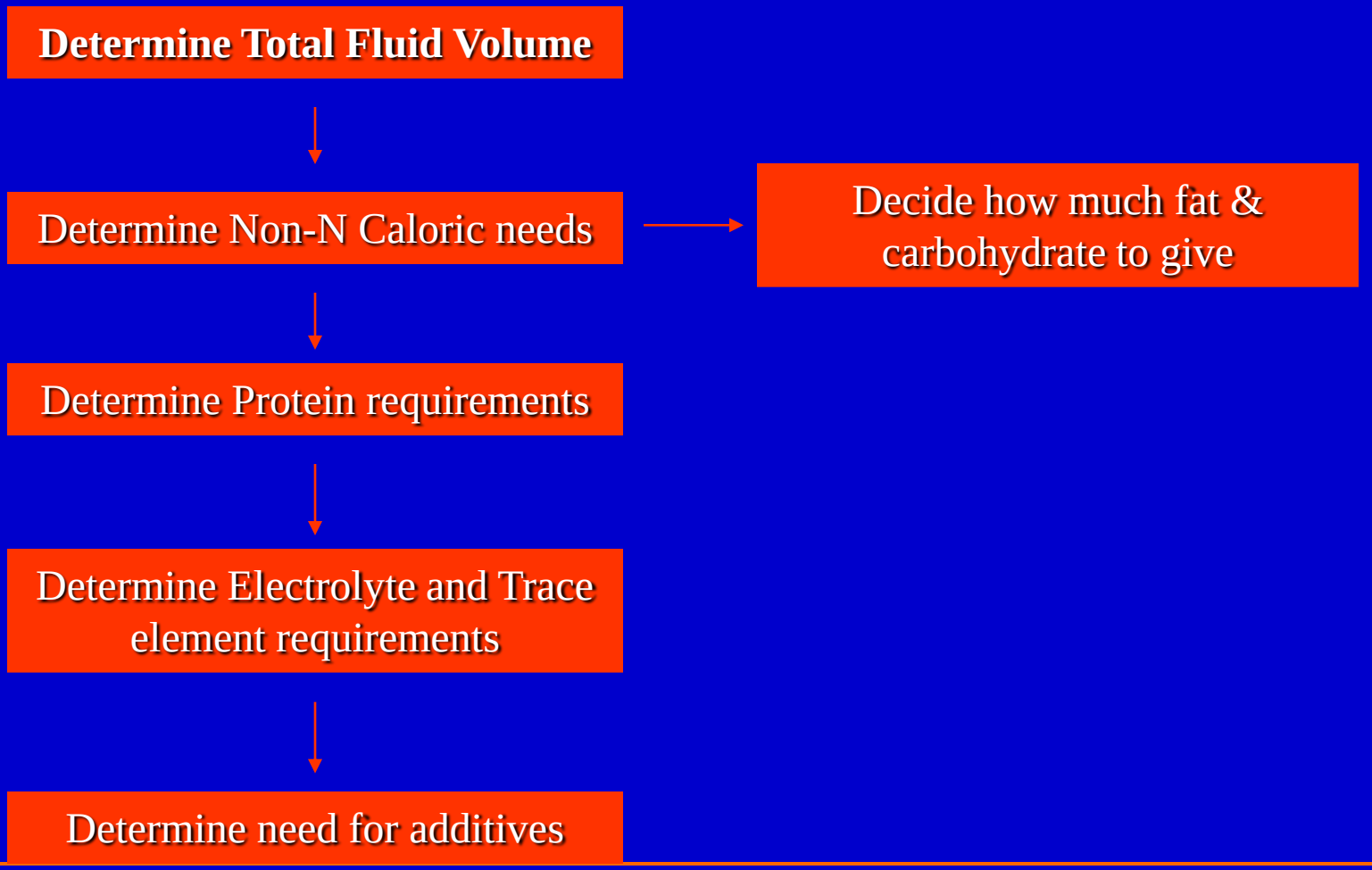
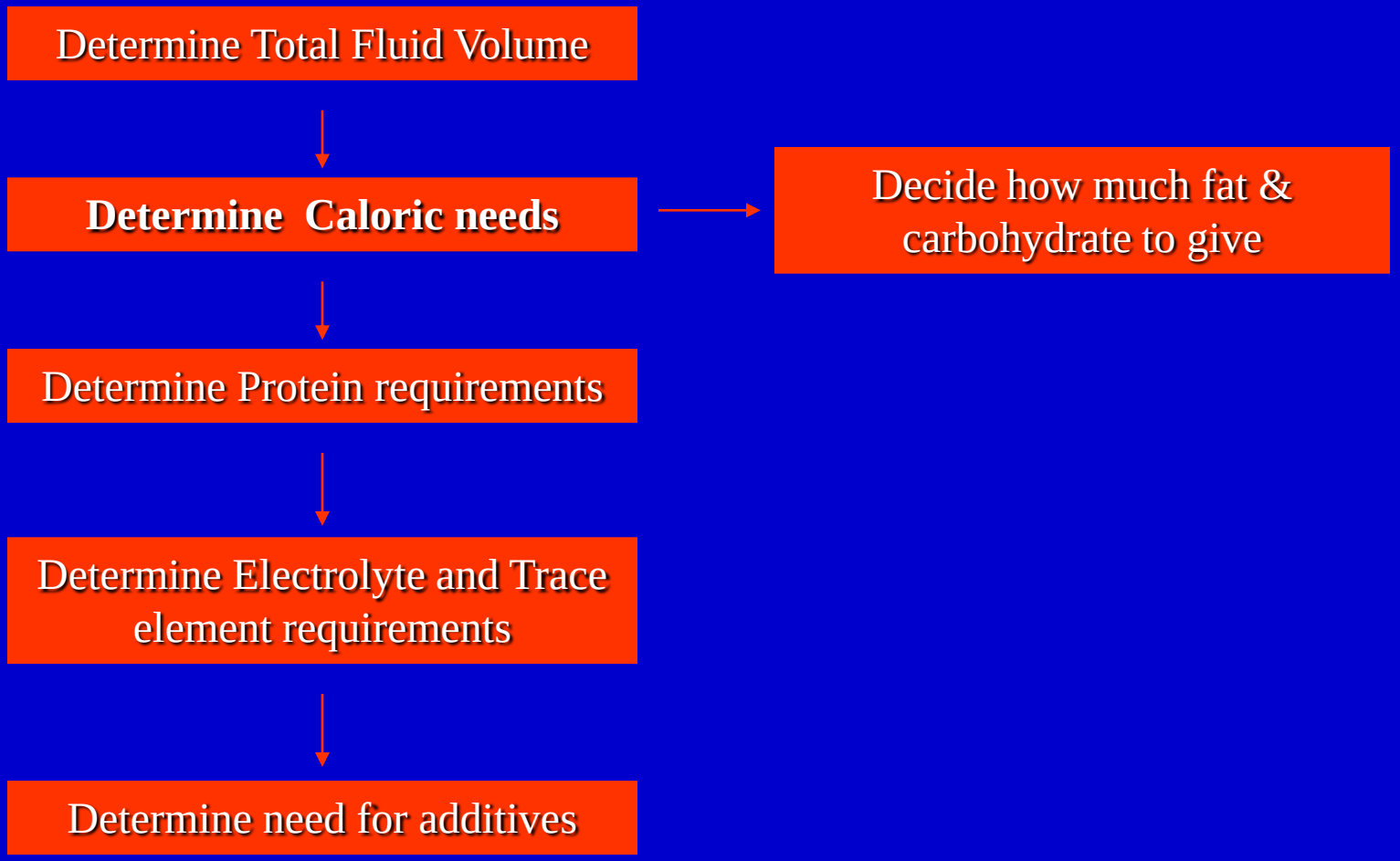


How Much Volume to Give?

- Cater for maintenance & on going losses
- Normal maintenance requirements
  - By body weight
  - alternatively, 30 to 50 ml/kg/day
- Add on going losses based on I/O chart
- Consider insensible fluid losses also

  e.g. add 10% for every ^{o}C rise in temperature

Steps to Ordering TPN



Caloric Requirements

Based on Total Energy Expenditure

- Can be estimated using predictive equations

  TEE = REE + Stress Factor + Activity Factor

- Can be measured using metabolic cart

Caloric Requirements

REE Predictive equations

Harris-Benedict Equation

Males: REE = 66 + (13.7W) + (5H) - 6.8A

Females: REE= 655 + (9.6W) + 1.8H - 4.7A

Schofield Equation

Rule of Thumb - 25 to 30 kcal/kg/day

Caloric Requirements

Stress Factor

Malnutrition	*- 30%*	*Moderate infection*	*+ 20%*
Peritonitis	*+ 15%*	*Severe infection*	*+ 40%*
Soft tissue trauma	*+ 15%*	*<20% BSA burns*	*+ 50%*
Fracture	*+ 20%*	*20-40% BSA burns*	*+ 80%*
Fever (per ^{o}c rise)	*+ 13%*	*>40% BSA burns*	*+ 100%*

Caloric Requirements

Activity Factor

- Bed-bound + 20%
- Ambulant + 30%
- Active + 50%

Obesity

In obesity, energy expenditure must be calculated on ideal body weight.

Malnutrition

In malnutrition energy expenditure must be calculated on actual body weight.

How Much CHO & Fats?

"Too much of a good thing causes problems"

- Not more than 4 mg / kg / min Dextrose

  (less than 6 g / kg / day)

  Rosmarin et al, Nutr Clin Pract 1996,11:151-6

- Not more than 0.7 mg / kg / min Lipid

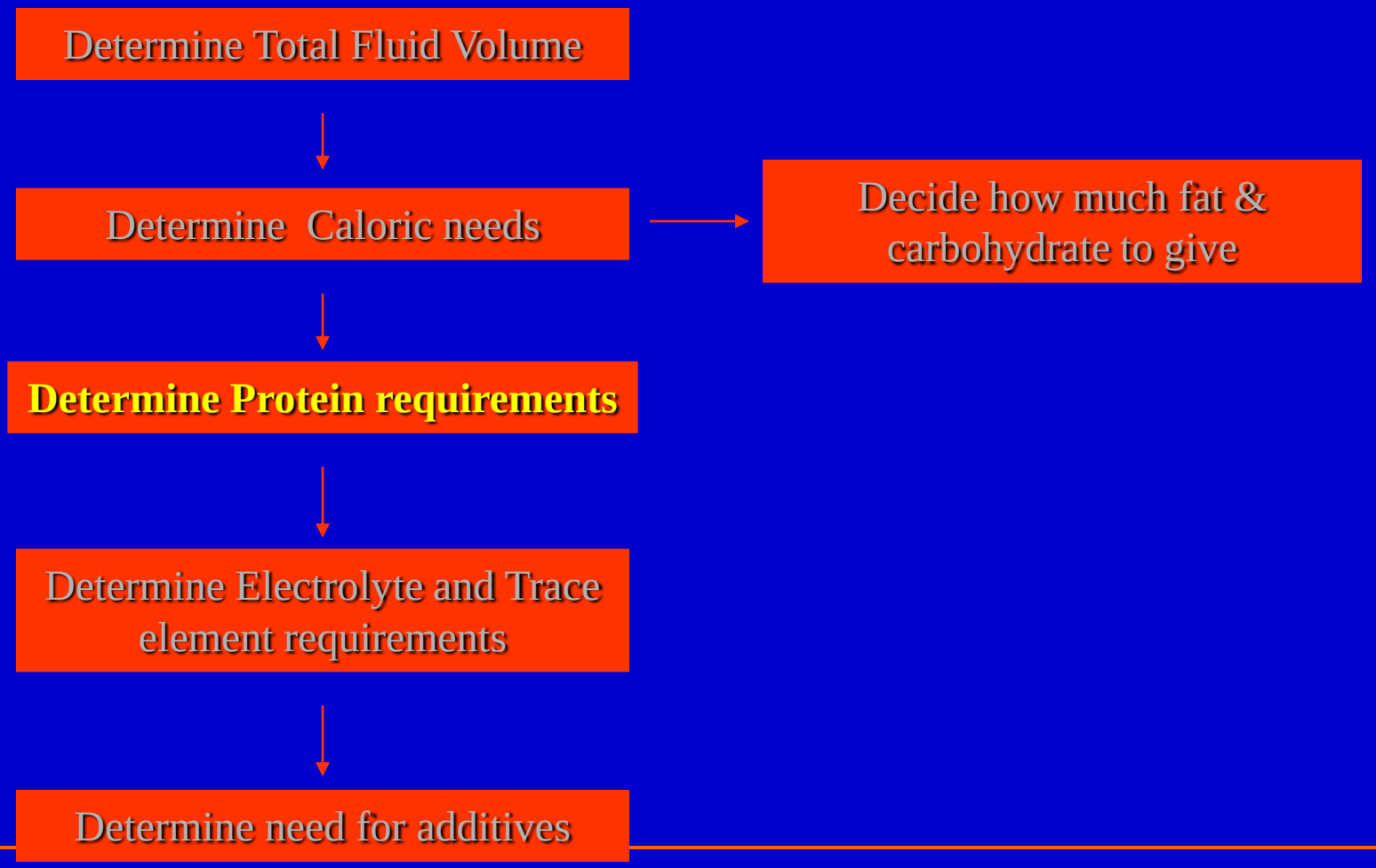
  (less than 1 g / kg / day)

  Moore & Cerra, 1991

How Much CHO & Fats?

- Fats usually form 25 to 30% of calories
  - Not more than 40 to 50%
  - Increase usually in severe stress
  - Aim for serum TG levels < 350 mg/dl or 3.95 mmol/L
- CHO usually form 70-75 % of calories

Steps to Ordering TPN



How Much Protein to Give?

- Based on calorie : nitrogen ratio
- Based on degree of stress & body weight
- Based on Nitrogen Balance

Calorie : Nitrogen Ratio

Normal ratio is

150 cal : 1g Nitrogen

Critically ill patients

85 to 100 cal : 1 g Nitrogen in

Based on Stress & BW

Non-stress patients	0.8 g / kg / day
Mild stress	1.0 to 1.2 g / kg / day
Moderate stress	1.3 to 1.75 g / kg / day
Severe stress	2 to 2.5 g / kg / day

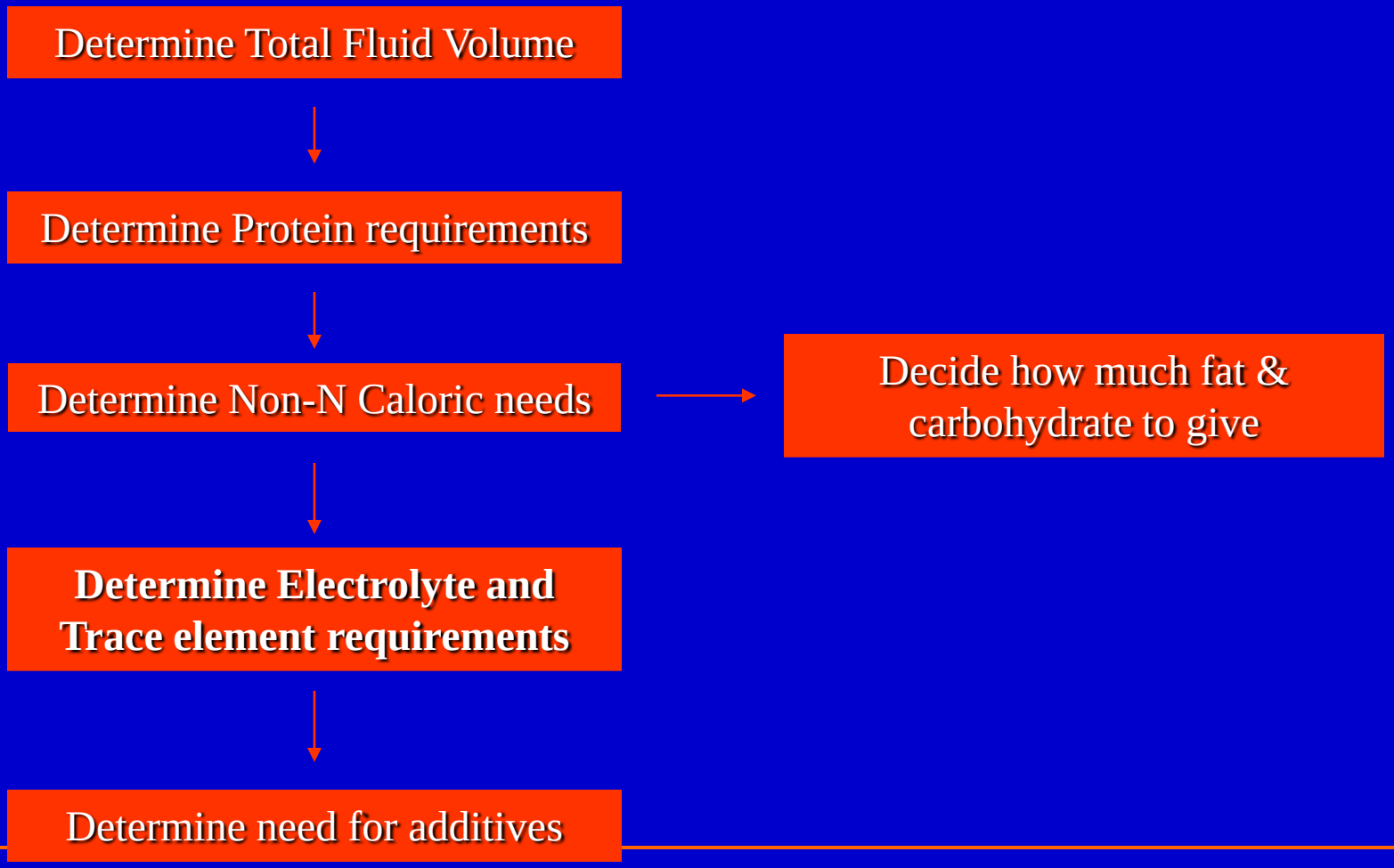
Protein Requirements

- 1.2 to 1.5 g protein/kg IBW
  mild or moderate stress
- Up to 2.5 g protein/kg IBW
  burns or severe trauma

Based on Nitrogen Balance

Aim for positive balance of
1.5 to 2g / kg / day

Steps to Ordering TPN



Electrolyte Requirements

Cater for maintenance + replacement needs

Na^+	1 to 2 mmol/kg/d	(or 60-120 meq/d)
K^+	0.5 to 1 mmol/kg/d	(or 30 - 60 meq/d)
Mg^{++}	0.35 to 0.45 meq/kg/d	(or 10 to 20 meq /d)
Ca^{++}	0.2 to 0.3 meq/kg/d	(or 10 to 15 meq/d)
PO_4^{2-}	20 to 30 mmol/d	

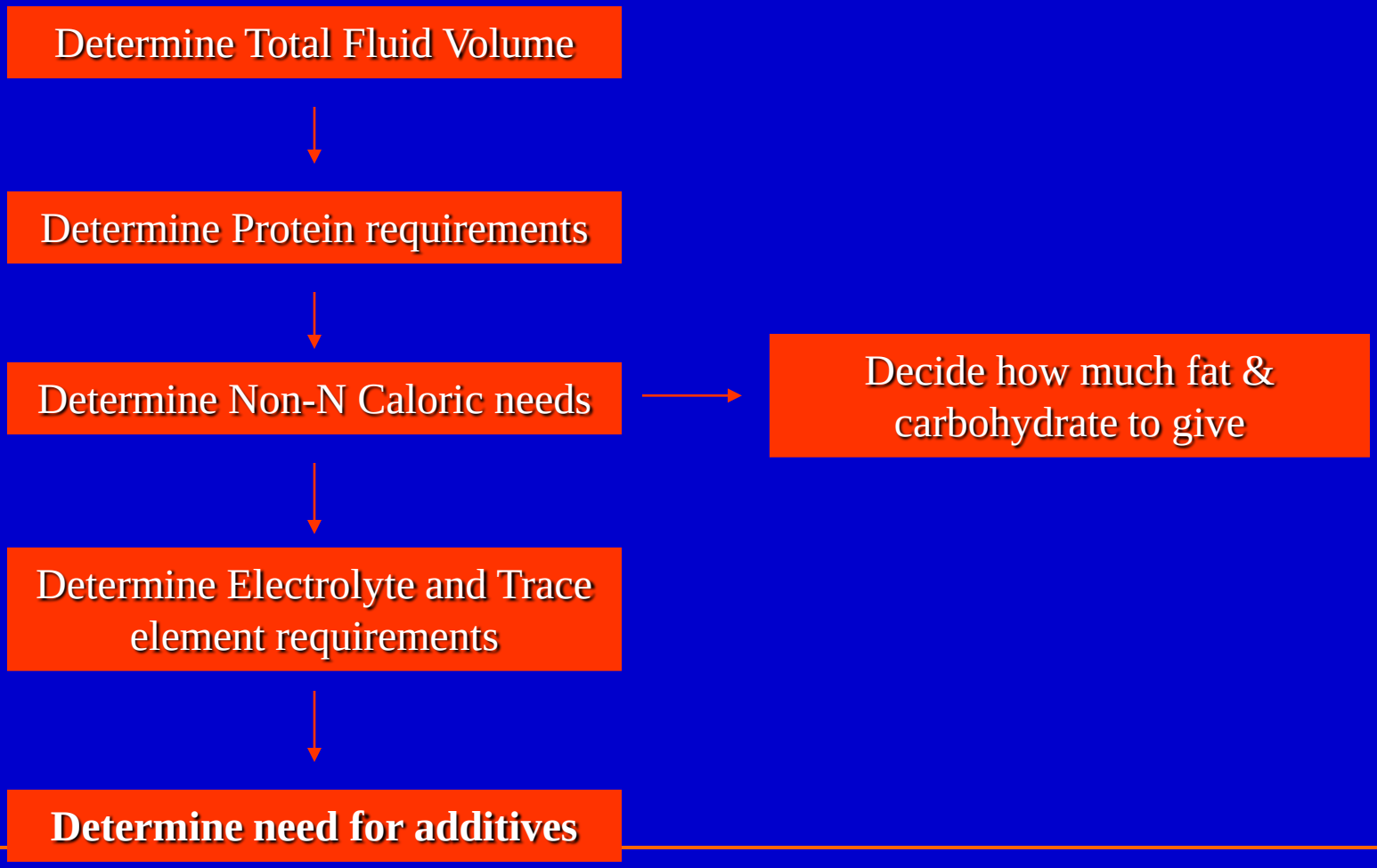
Trace Elements

Total requirements not well established

Commercial preparations exist to provide RDA

Zn	2-4 mg/day
Cr	10-15 ug/day
Cu	0.3 to 0.5 mg/day
Mn	0.4 to 0.8 mg/day

Steps to Ordering TPN



Other Additives

Vitamins

- Give 2-3x that recommended for oral intake
- us give 1 ampoule MultiVit per bag of TPN
- MultiVit does not include Vit K
  - can give 1 mg/day or 5-10 mg/wk

Other Additives

Medications

Insulin

- can give initial SI based on sliding scale according to hypocount q6h (keep <11 mmol/l)
- once stable, give 2/3 total requirements in TPN & review daily
- alternate regimes
  - 0.1 u per g dextrose in TPN
  - 10 u per litre TPN initial dose

Other medications

Different Ways of PN

- Multiple container system
- Two chamber bags
- Three chamber all in one system (3 in 1)

Multiple Container System

Allows simultaneous administration of amino acids, dextrose and lipid solutions in different concentrations.

Multiple Container System Disadvantages

- Errors in mixing causes incompatibilities
- Needs frequent bottle change, increasing risk of contamination

All in One System

- Amino acids, dextrose and lipid solutions in 3 different chambers
- Amino acids and dextrose to be mixed first
- Finally lipid solution is mixed

ALL IN ONE SYSTEM

Simultaneous Administration of all components

Simultaneous administration of amino acids and calories

- Less metabolic disturbance
- Gives a better N_2 balance

Decreased risk of catheter infection due to single connection

Permits Peripheral administration

ALL IN ONE SYSTEM

CANNOT PROVIDE FOR ALL TYPES OF PATIENTS ESPECIALLY PAEDIATRICS

CANNOT MANIPULATE VOLUME

STILL NEED ASEPTIC TECHNIQUES TO ADD VITAMINS AND TRACE ELEMENTS

General Principles for Administering TPN

- Hypertonic TPN should be administered through a central venous line
- Feeding line to be inserted by an experienced operator with all aseptic precautions
- Feeding line not to be used for any other purpose
- Solutions to be administered slowly (over 12 – 24 hrs)
- TPN bags to be changed using full aseptic techniques
- Once prepared, no other additions should be made
- The IV tubes can be changed with every bag
- No three way to be used

Safe Concentrations for Infusion

Nutrient	Central	Peripheral
Dextrose	25%,50%	5%, 10%
Amino acids	10%	5%
Lipids	10%,20%	10%,20%

Peripheral Line Solutions

- Osmolality < 700 mosm/kg
- Total Kcal limited by concentration and ratio to volume being administered

PN – Types of Infusion

- Continuous - Total volume administered over 24hrs
- Cyclic - Volume is administered in one period, with infusion adjustments and a period of rest
- Selection of infusion type depends on patients condition
- Use parenteral infusion pump

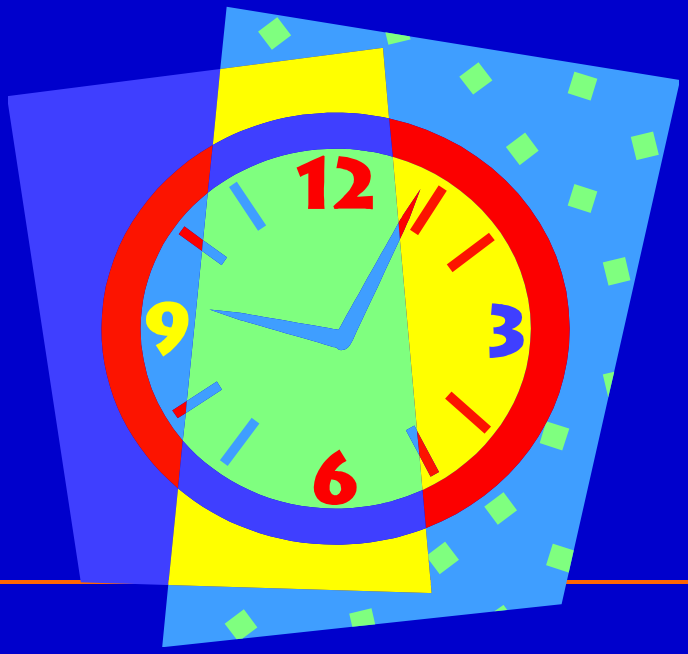
Parenteral Nutrition

Infusion Schedules

Infusion Schedules

- Continuous PN

  Non-interrupted infusion of a PN solution over 24 hours via a central or peripheral venous access



Continuous PN

Advantages

- Well tolerated by most patients
- Requires less manipulation
  - decreased nursing time
  - decreased potential for “touch” contamination

Continuous PN

Disadvantages

- Persistent anabolic state
  - altered insulin : glucagon ratios
  - increased lipid storage by the liver
- Reduces mobility in ambulatory patients

Infusion Schedules

- Cyclic PN
  - The intermittent administration of PN via a central or peripheral venous access, usually over a period of 12 – 18 hours
  - Patients on continuous therapy may be converted to cyclic PN over 24-48 hours

Cyclic PN

- Advantages
  - Approximates normal physiology of intermittent feeding
  - Maintains:
    - Nitrogen balance
    - Visceral proteins
  - Ideal for ambulatory patients
    - Allows normal activity
    - Improves quality of life

Cyclic PN

- Disadvantages
  - Incorporation of N_2 into muscle stores may be suboptimal
    - Nutrients administered when patient is less active
  - Not tolerated by critically ill patients
  - Requires more nursing manipulation
    - Increased potential for touch contamination
    - Increased nursing time

Stopping TPN

- Stop TPN when enteral feeding can restart
- Wean slowly to avoid hypoglycaemia
- Monitor hypocounts during wean
  - *Give IV Dextrose 10% solution at previous infusion rate for at least 4 to 6h*
  - *Alternatively, wean TPN while introducing enteral feeding and stop when enteral intake meets TEE*

TPN Monitoring

Clinical Review

Lab investigations

Adjust TPN order accordingly

Clinical Review

- Clinical examination
- Vital signs
- Fluid balance
- Catheter care
- Sepsis review
- Blood sugar profile
- Body weight

Lab investigations

Full Blood Count	weekly, unless indicated
Renal Panel # 1	daily until stable, then 2x/wk
Ca++, Mg++, PO42-	daily until stable, then 2x/wk
Liver Function Test	weekly
Iron Panel	weekly
Lipid Panel	1-2x/wk
Nitrogen Balance	weekly

Nutritional Balance

Nutritional Balance = N_{input} - N_{output}

1 g N = 6.25 g protein

N_{input} = (protein in g ÷ 6.25)

N_{output} = 24h urinary urea nitrogen + non-urinary N losses

(estimated normal non-urinary Nitrogen losses about 3-4g/d)

Complications Related to TPN

- Mechanical Complications
- Metabolic Complications
- Infectious Complications

Mechanical Complications

Related to catheter in situ

Venous thrombosis

Catheter occlusion

Metabolic Complications

Hepatic complications

- Biochemical abnormalities
- Cholestatic jaundice
  - *too much calories (carbohydrate intake)*
  - *too much fat*
- Acalculous cholecystitis

Metabolic Complications

Abnormalities related to excessive or inadequate administration

- hyper / hypoglycaemia
- electrolyte abnormalities
- acid-base disorders
- hyperlipidaemia

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Infectious Complications

- Insertion site contamination
- Catheter contamination
  - *improper insertion technique*
  - *use of catheter for non-feeding purposes*
  - *contaminated TPN solution*
  - *contaminated tubing*
- Secondary contamination
  - *septicaemia*

The most significant cause of morbidity during TPN is overfeeding.

Parenteral Nutrition

Home TPN

Home TPN

- Safety and efficacy

  depend on:

  - Proper selection of patients
  - Adequate discharge planning/education
  - Home monitoring protocols

Home TPN

- Patient selection
  - Reasonable life expectancy
  - Demonstrates motivation, competence, compliance
  - Home environment conducive to sterile technique

Home TPN: Discharge Planning

- Determination whether patient meets payer criteria for PN; completion of CMN forms
- Identification of home care provider and DME supplier
- Identification of monitoring team for home
- Conversion of 24-hour infusion schedule to cyclic infusion with monitoring of patient response

Home TPN

Cost effective

- Quicker discharge from hospital
- Improved rehabilitation in the home
- Reduced hospital readmissions

Summary

- PN can provide Partial or Total Nutrition
- Metabolic monitoring is a must

THANK YOU