Intravenous Fluid Therapy

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Introduction

Can You Imagine life without water?

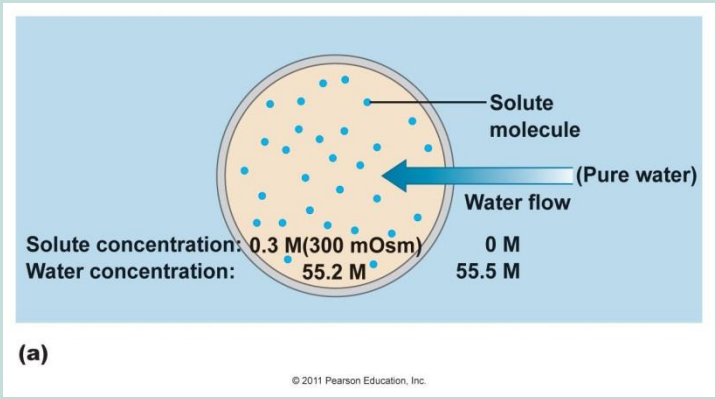
Of course not, because water is essential to sustain life. Likewise, body fluids are vital to maintain normal body functioning

Total body fluid (TBW), accounts for approximately 60% of total body weight (this can be 70% or higher in a newborn down to 50–55% in a mature woman).

Total Body Fluid can be divided into Intracellular and Extracellular

Intracellular Fluid

- ✓ 2/3 of the total body water .
- ✓ Found inside the plasma membrane of the body's cells. In humans (average 70 KG), the intracellular compartment contains on average about 28 liters of fluid .



Extracellular Fluid

Accounts for 1/3 of the TBW, either:

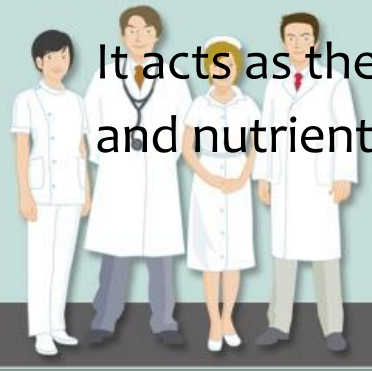
Interstitial, Intravascular and 3rd space

1- Interstitial compartment

- It the small, narrow spaces between tissues or parts of an organ. It is filled with what is called interstitial fluid

- When excessive fluid accumulates in the interstitial space, edema develops. In the average male (70 kg) human body, the interstitial space has approximately 10.5 liters of fluid (15% of the TBW)

Importance:

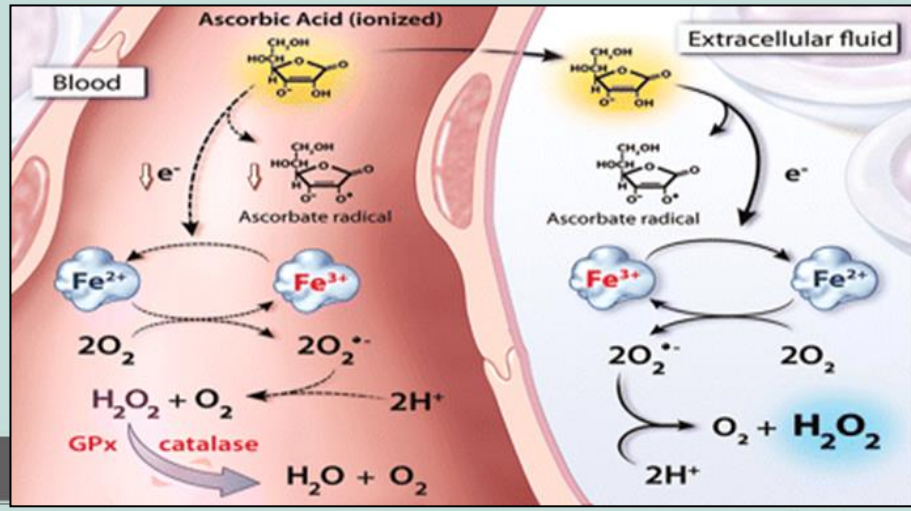


It acts as the microenvironment that allows movement of ions, proteins and nutrients across the cell barrier .

Extracellular Fluid

2-Intravascular compartment

- The main intravascular fluid in humans is blood; the average volume of blood in humans is approximately 70-75 ml/kg



Extracellular Fluid

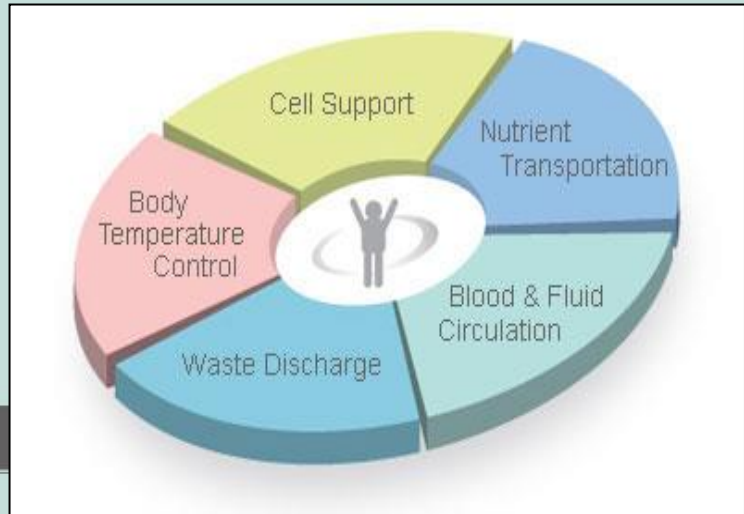
3- Third space

- The third space is space in the body where fluid does not normally collect in larger amounts.
- For examples the peritoneal cavity and pleural cavity are major examples of the third space.
- Small amount of fluid does exist normally in such spaces, and function for example as lubricant in the case of pleural fluid .

WATER

Water has many functions in the body !

- Essential for Cell life .
- Interfere in the Chemical and metabolic reactions .
- Nutrients absorption and transport .
- Regulate the Body temperature .
- Elimination of waste products through urine .



What are Solutes?

A substance dissolved in another substance

- There are many SOLUTES, for example:

✓ Plasma proteins (eg. albumin, globulins, fibrinogen)

✓ Ions (sodium chloride, magnesium, calcium, bicarbonates)

✓ Food molecules (eg. glucose, amino-acids), waste products as urea

What's Osmolality?

Term refers to the solute concentration in the body fluid by weight. The number of milliosmols (mOsm) in a kilogram (kg) of solution.

In humans normally the osmolality in plasma is about 275-295 mOsm/Kg

FLUIDTHERPY

Importance !

- Can be life-saving in certain conditions
- Loss of body water, whether acute or chronic, can cause a range of problems from mild headache to convulsions, coma, and in some cases, death.
- Though fluid therapy can be a lifesaver, it's never always safe, and can be very harmful.

Types of Fluid

The fluids used in clinical practice are usefully classified into **colloids, crystalloids** and **blood products**

1.Colloid

Solutions that contain large molecules that don't pass the cell membranes.

When infused, they remain in the intravascular compartment and expand the intravascular volume and they draw fluid from extravascular spaces via their higher oncotic pressure

Types of Fluid

2.Crystalloid

Solutions that contain small molecules that flow easily across the cell membranes, allowing for transfer from the bloodstream into the cells and body tissues.

This will increase fluid volume in both the interstitial and intravascular spaces (Extracellular)

It is subdivided into:

* Isotonic
* Hypotonic
* Hypertonic

Isotonic Fluids

When to consider a solution isotonic?

When the concentration of the particles (solutes) is similar to that of plasma, So it doesn't move into cells and remains within the extracellular compartment thus increasing intravascular volume.

Isotonic Fluids

Types of isotonic solutions include:

- ✓ 0.9% sodium chloride (0.9% NaCl)
- ✓ lactated Ringer's solution
- ✓ 5% dextrose in water (D5W)
- ✓ Ringer's solution

Isotonic Fluids

A- 0.9% sodium chloride (Normal Saline)

Solutions	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	HCO_3^-	Dextrose	mOsm/L
0.9% NaCl	154				154			308

- Simply salt water that contains only water, sodium (154 mEq/L), and chloride (154 mEq/L).
- It's called "normal saline solution" because the percentage of sodium chloride in the solution is similar to the concentration of sodium and chloride in the intravascular space.

A- 0.9% sodium chloride (Normal Saline)

When to be given?

1- to treat low extracellular fluid, as in fluid volume deficit from

- Hemorrhage - Severe vomiting or diarrhea - Heavy drainage from GI suction, fistulas, or wounds

2- Shock

3- Mild hyponatremia

4- Metabolic acidosis (such as diabetic ketoacidosis)

5- It’s the fluid of choice for resuscitation efforts.

6- it's the only fluid used with administration of blood products.

B- Ringer's lactate or Hartmann solution

Solutions	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	HCO_3^-	Dextrose	mOsm/L
Lactated Ringer's	130	4	3		109	28		273

- is the most physiologically adaptable fluid because its electrolyte content is most closely related to the composition of the body's blood serum and plasma.
- Another choice for first-line fluid resuscitation for certain patients, such as those with burn injuries.

A- 0.9% sodium chloride (Normal Saline)

TAKE CARE:

Because 0.9% sodium chloride replaces extracellular fluid, it should be used cautiously in certain patients (those with cardiac or renal disease) for fear of fluid volume overload.

B- Ringer's lactate or Hartmann solution

When to be used?

- ✓ To replace GI tract fluid losses (Diarrhea or vomiting)
- ✓ Fistula drainage
- ✓ Fluid losses due to burns and trauma
- ✓ Patients experiencing acute blood loss or hypovolemia due to third-space fluid shifts.

B- Ringer's lactate or Hartmann solution

Notice. Both 0.9% sodium chloride and LR may be used in many clinical situations, but patients requiring electrolyte replacement (such as surgical or burn patients) will benefit more from an infusion of LR.

- LR is metabolized in the liver, which converts the lactate to bicarbonate. LR is often administered to patients who have metabolic acidosis not patients with lactic acidosis

- Don't give LR to patients with liver disease as they can't metabolize lactate

- used cautiously in patients with sever renal impairment because it contains some potassium

- LR shouldn't be given to a patient whose pH is greater than 7.5

C -Ringer's solution

Like LR, contains sodium, potassium, calcium, and chloride in similar. But it doesn't contain lactate. Ringer's solution is used in a similar fashion as LR, but doesn't have the contraindications related to lactate.

D- Dextrose 5%

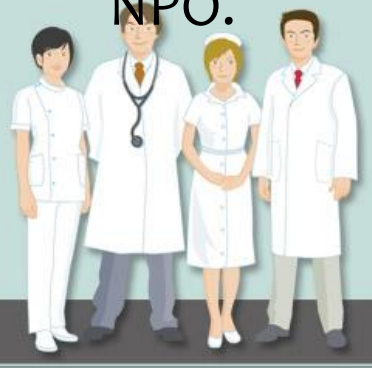
Solutions	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	HCO_3^-	Dextrose	mOsm/L
D5W							50gm/l	278

It is considered an isotonic solution, but when the dextrose is metabolized, the solution actually becomes hypotonic and causes fluid to shift into cells.

D- Dextrose 5%

How does it work?

- D5W provides free water that pass through membrane pores to both intracellular and extracellular spaces. Its smaller size allows the molecules to pass more freely between compartments, thus expanding both compartments simultaneously
- It provides 170 calories per liter, but it doesn't replace electrolytes.
- The supplied calories doesn't provide enough nutrition for prolonged use. But still can be added to provide some calories while the patient is NPO.



D- Dextrose 5%

Take Care !

- D5W is not good for patients with **renal failure** or cardiac problems since it could cause fluid overload.

- patients at risk for intracranial pressure should not receive D5W since it could increase **cerebral edema**

- D5W shouldn't be used in **isolation** to treat fluid volume deficit because it dilutes plasma electrolyte concentrations

- Never mix dextrose with blood as it causes blood to hemolyze.

- Not used for **resuscitation**, because the solution won't remain in the intravascular space.

- Not used in the **early postoperative** period, because the body's reaction to the surgical stress may cause an increase in antidiuretic hormone secretion

Precautions in usage of Isotonic solutions

- Be aware that patients being treated for hypovolemia can quickly develop hypervolemia (fluid volume overload) following rapid or overinfusion of isotonic fluids.

- Document baseline vital signs, edema status, lung sounds, and heart sounds before beginning the infusion, and continue monitoring during and after the infusion.

Precautions in usage of Isotonic solutions

- Frequently assess the patient's response to I.V. therapy, monitoring for signs and symptoms of hypervolemia such as:

hypertension / bounding pulse / pulmonary crackles / peripheral edema / dyspnea/ shortness of breath / jugular venous distention (JVD)

- Monitor intake and output
- Elevate the head of bed at 35 to 45 degrees, unless contraindicated .
- If edema is present, elevate the patient's legs.

- monitor for signs and symptoms of continued hypovolemia, including:

  - urine output of less than 0.5 mL/kg /hour /
  - poor skin turgor
  - tachycardia
  - weak, thready pulse
  - hypotension
- Educate patients and their families about signs and symptoms of volume overload and dehydration
- instruct patients to notify if they have trouble breathing or notice any swelling.
- Instruct patients and families to keep the head of the bed elevated (unless contraindicated).

B- HYPOTONIC FLUIDS

- Compared with intracellular fluid (as well as compared with isotonic solutions), hypotonic solutions have a lower concentration of solutes (electrolytes). And osmolality less than 250 mOsm/L .
- Hypotonic crystalloid solutions lowers the serum osmolality within the vascular space, causing fluid to shift from the intravascular space to both the intracellular and interstitial spaces.
- These solutions will hydrate cells, although their use may deplete fluid within the circulatory system.

TYPES OF HYPOTONIC FLUIDS

- **0.45% sodium chloride** (0.45% NaCl), **0.33% sodium chloride, 0.2% sodium chloride, and 2.5% dextrose in water**

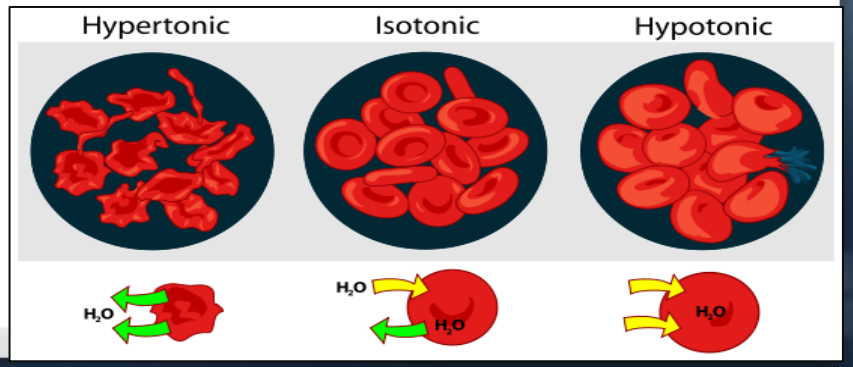
- Hypotonic fluids are used to treat patients with conditions causing intracellular dehydration, when fluid needs to be shifted into the cell , such as:

1. **Hypernatremia**
2. **Diabetic ketoacidosis**
3. **Hyperosmolar hyperglycemic state.**

HYPOTONIC FLUIDS

Precautions with hypotonic solutions

- ✓ Never give hypotonic solutions to patients who are at risk for **increased ICP** because it may exacerbate cerebral edema
- ✓ Don't use hypotonic solutions in patients with **liver disease, trauma,** or **burns** due to the potential for depletion of intravascular fluid volume



HYPOTONIC FLUIDS

Precautions with hypotonic solutions

- ✓ The decrease in vascular bed volume can worsen existing **hypovolemia** and **hypotension** and cause cardiovascular collapse
- ✓ Monitor patients for signs and symptoms of fluid volume deficit
- ✓ In older adult patients, **confusion** may be an indicator of a fluid volume deficit. Instruct patients to inform you if they feel **dizzy** or just "don't feel right."

C- HYPERTONIC SOLUTIONS

- What is hypertonic solutions?
- Solution that have a higher tonicity or solute concentration. Hypertonic fluids have an osmolarity of 375 mOsm/L or higher

- The osmotic pressure gradient **draws** water **out** of the intracellular space, increasing extracellular fluid volume, so they are used as **volume expanders.**

HYPERTONIC SOLUTIONS

Some examples and Indications:

1- 3% sodium chloride (3% **NaCl**):

- May be prescribed for patients in critical situations of severe hyponatremia.
- Patients with cerebral edema may benefit from an infusion of hypertonic sodium chloride

2- 5% Dextrose with normal saline (D5NS): which replaces sodium, chloride and some calories

Colloid solutions

How does it work?

- It expand the intravascular volume by drawing fluid from the interstitial spaces into the intravascular compartment through their **higher oncotic pressure**.

- the same effect as hypertonic crystalloids solutions but it requires administration of **less total volume** and have a **longer duration of action because** the molecules remain within the intravascular space longer.

- Its effect can last for several days if capillary wall linings are intact and working properly.

Colloid solutions

Examples:

1- 5% albumin (Human albumin solution)

- The most commonly utilized colloid solutions.

- It contains plasma protein fractions obtained from **human plasma** and works to rapidly expand the plasma volume used for:

- volume expansion
- moderate protein replacement
- achievement of hemodynamic stability in shock states.

- considered a blood transfusion product and requires all the same nursing precautions used when administering other blood products.

-It can be expensive and its availability is limited to the supply of human donors

What to do if you suspect transfusion reaction

- **Sings of transfusion reaction may include:**

fever, flank pain, vital sign changes, nausea, headache, urticaria, dyspnea, and broncho spasm.

- **If you suspect a transfusion reaction, take these immediate actions:**

1. Stop the transfusion.
2. Keep the I.V. line open with normal saline solution.
3. Notify the physician and blood bank.
4. Intervene for signs and symptoms as appropriate.
5. Monitor the patients vital signs.

Colloid solutions

2- Hydroxyethalstarches

- Another form of hypertonic synthetic colloids used for volume expansion
- Contain sodium and chloride and used for hemodynamic volume replacement following major surgery and to treat major burns
- Less expensive than albumin and their effects can last 24 to 36 hours

Components of fluid therapy

1. Maintenance therapy:

replaces normal ongoing losses

2. Fluid Resuscitation:

corrects any existing water and electrolyte deficits.

Components of fluid therapy

A. Maintenance therapy

Maintenance therapy is usually undertaken when the individual is not expected to eat or drink normally for a longer time (eg, perioperatively or patient on a ventilator)

Maintenance therapy

How to calculate maintenance fluid flow rates?

The most commonly used formula is (4/2/1) rule a.k.a (Weight+40), which is used for both adults and pediatrics.

4/2/1 rule

- **4** ml/kg/hr for first 10 kg (=40ml/hr)
- then **2** ml/kg/hr for next 10 kg (=20ml/hr)
- then **1** ml/kg/hr for any kgs over that

This always gives **60ml/hr** for first 20 kg

then you add **1 ml/kg/hr** for each kg **over 20 kg**

So: **Weight in kg + 40 = Maintenance IV rate/hour**

For any person weighing more than 20kg

Fluid Resuscitation

B) Fluid Resuscitation :

Correction of existing abnormalities in volume status or serum electrolytes (as in hypovolemic shock)

What is the Parameters used to assess volume deficit?

1- Blood pressure

2- Urine output

3- Jugular venous pressure

4- Urine sodium concentration

Fluid Resuscitation

How to know that the patient has Hypovolemic Shock?

The patient has the following sings and symptoms:

1- Anxiety or agitation

2- Cool, Pale skin

3- Confusion

4- Decreased or no urine output

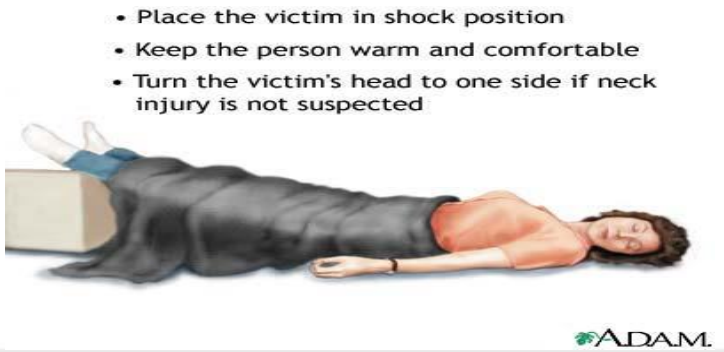
5- Rapid breathing

6- Disturbed consciousness

7- Low blood pressure

8- Low body temperature

9- Rapid pulse, often weak and thready



Fluid Resuscitation

Rate of Repletion of Fluid deficit:

1- Severe volume depletion or hypovolemic shock:

Rapid infusion of 1-2L of isotonic saline (0.9% NS) as rapidly as possible to restore tissue perfusion

2- Mild to moderate hypovolemia:

Choose a rate that is 50-100mL/h greater than estimated fluid losses. calculating fluid loss as follows:

- Urine output= 50ml/h
- Insensible losses = 30ml/h
- Additional loss such as Vomiting or Diarrhea or high fever (additional 100- 150 ml/day for each degree of temp >37 C)

IV Modes of administration

- ***Peripheral** IV* line placed into a peripheral vein
- ***PICC :*** Central line that is placed via the peripheral vasculature. Its tip terminates in the superior vena cava
- ***Peripheral midline catheters:*** Shorter version of the PICC, Its tip terminates in the axilla
- ***Hickman lines:*** Skin tunneled cuffed central catheters

How to calculate IV flow rates !

Intravenous fluid must be given at a specific rate, neither too fast nor too slow. The specific rate may be measured as ml/hour, L/hour or drops/min. To control or adjust the flow rate only drops per minute are used.

How to calculate IV flow rates !

What is a drop factor?

Drop factor is the number of drops in one milliliter used in IV fluid administration (also called drip factor). A number of different drop factors are available but the Commonest are:

1- 10 drops/ml (blood set)

2- 15 drops / ml (regular set)

3- 60 drops / ml (microdrop, burette)

How to calculate IV flow rates ?

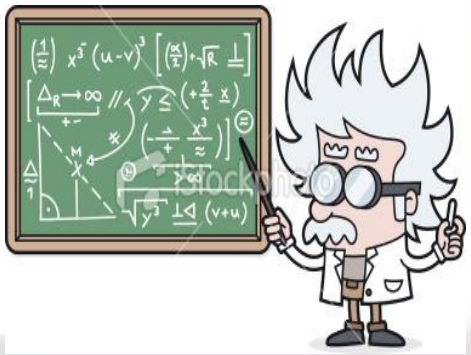
The formula for working out flow rates is:

$$\frac{\text{volume (ml) X drop factor (gtts / ml)}}{\text{time (min)}} = \text{gtts / min (flow rate)}$$

Example:

1500 ml IV Saline is ordered over 12 hours. Using a drop factor of 15 drops / ml, how many drops per minute need to be delivered?

$$\frac{\text{1500 (ml) X 15 (drop / ml)}}{\text{12 x 60 (gives us total minutes)}} = \text{31 drop/ minute}$$



IV lines common Problems

A. Infiltration

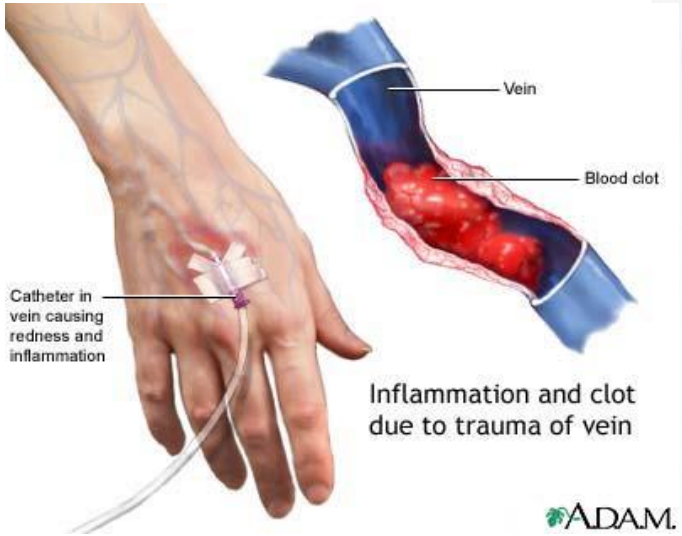
when the catheter unintentionally enters the tissue surrounding the blood vessel and the IV fluid go into the tissues.

B. Phlebitis

Inflammation of a blood vessel

C. Hypothermia

When large amounts of cold fluids are infused rapidly



D. Local infection (Abscess)

A microscopic organism may use the tiny hole in the skin created by the IV catheter to find its way into the body, and cause an infection

Remember !

I. Treat IV fluids as "prescription" like any other medication

II. Determine if patient needs maintenance or resuscitation

III. Choose fluid type based on co-existing electrolyte disturbances

IV. Don't forget about additional IV medications patient is receiving

V. Choose rate of fluid administration based on weight and minimal daily requirements

VI. Avoid fluids in patients with ECF volume excess

VII. Always reassess whether the patient continues to require IV fluid

Last Slide

It's Over

THANK YOU !