Fluid and Electrolyte Balance

Water Balance in Infants

As already mentioned people of all age groups can be affected by fluid and electrolyte imbalance. However, infants and children are the group that is at most risk.

Because of several characteristics, infants and young children have a greater need for water than adults and are more susceptible to alterations in fluid and electrolyte balance.

New-born infants have a larger water content than older infants and children. This is partially because the new-born has less fat and a greater proportion of body mass composed of the visceral organs. Compared to older children and adults, infants have a greater fluid intake and output relative to size. Therefore water and electrolyte disturbances occur more frequently and more rapidly and infants adjust less promptly to these alterations.

The Extra Cellular Fluid (ECF) compartment comprises over half of the total body water at birth and contains a greater relative content of extracellular sodium and chloride. Most of this neo-natal "excess" ECF is lost in the first 10 days of life through insensible perspiration, which can amount to 5% to 10% of the infant's birth weight.

Until about 2 years of age, the infant maintains a larger ECF than the adult in terms of overall percentage of body water. This, combined with other anatomical and physiological differences between children and adults, means that the child is subject to greater and more rapid water loss and poorer adjustment to lack (or excess) of intake of fluids.

Depletion of the volume of ECF, often caused by gastro-enteritis, is one of the most common problems found in infants and younger children. In fact, until modern fluid replacement therapies were perfected, it was one of the major causes of infant mortality.

Surface Area

It is estimated that the body surface area of the premature neonate is proportionately five times as great, and that of the newborn is two to three times as great, as that of the older child or adult.

The infant's relatively greater surface area allows larger quantities of fluid to be lost in insensible perspiration from the skin. Estimates put the surface area of the premature neoneate at 5 times the surface area of the older child or adult. Even a full term neonate is estimated to have 2-3 times the surface area of an adult. The large surface area is an important factor in metabolism and heat production, which also influence fluid loss.

Metabolic rate.

The rate of metabolism in infancy is significantly higher than in adulthood because of the larger surface area in relation to the mass of active tissue. Consequently ther is a greater proportion of metabolic waste that must be excreted by the kidneys. Any condition that

increases metabolism causes a rise in heat production with it's concomitant insensible water loss and growingneed for water for secretion.

Kidney function.

The kidneys of the infant are functionally immature at birth and are therefore inefficient. Of particular importance for fluid balance is the inability of the infant's kidneys to concentrate or dilute urine, to conserve or excrete sodium, and to acidify urine. Therefore the infant is less able to handle large quantities of solute-free water than the older child and is more apt to become dehydrated when given concentrated baby milk formulas.

Fluid requirements.

As a result of these characteristics, infants ingest and excrete a proportionally greater amount of fluid per Kg of body weight than older children. The infant has little ability to conserve electrolytes and therefore they are excreted with the water. Thus daily maintenance requirements include both water and electrolytes. The daily exchane of ECF in the infant is much greater than that in older children, which leaves little fluid volume reserve in dehydration states.

Table 5: Problems with Water Levels

CAUSES	SIGNS	NURSING CARE
• Water depletion Failure to absorb or reabsorb water Complete sudden cessation of intake or prolonged diminished intake: Neglect of intake by self or caregiver- confused, psychotic, unconscious, or helpless Loss from gastrointestinal tract--vomiting, diarrhoea, nasogastric suction, fistula Disturbed body fluid chemistry: inappropriate ADH secretion Excessive renal excretion: glycosuria (diabetes) Loss through skin or lungs: Excessive perspiration or vaporisation- febrile states,	• General symptoms: Thirst Variable temperature- increased in infection. Dry skin and mucous membranes Poor skin turgor Poor perfusion (decreased pulse, slowed capillary refill time) Weight loss Fatigue Diminished urine output Irritability and lethargy Tachycardia (increased heart rate) Tachypnoea (increased breathing rate)	Provide replacement of fluid losses in keeping with volume depletion Provide maintenance fluids Determine and correct cause of water depletion Measure intake and output Monitor vital signs

hyperventilation, increased ambient temperature. Impaired skin integrity-transudate from injuries Haemorrhage Iatrogenic: Overzealous use of diuretics Improper postoperative fluid replacement	Altered level of consciousness Symptoms depend to some extent on proportion of electrolytes lost with water • Clinical Tests: High urine specific gravity Increased hematocrit Variable serum electrolytes Variable urine volume Increased blood urea nitrogen (BUN) Increased osmolality	
• Water excess Water intake in excess of output: Excessive oral intake Excessive intravenous infusion Hypertonic fluid overload Plain water enemas Failure to excrete water in presence of normal intake: Kidney disease Congestive heart failure Malnutrition	• General Symptoms Oedema: Generalised Pulmonary (moist rales) Intracutaneous (noted especially in loose areolar tissue) Elevated venous pressure Hepatomegaly (increase in liver size) Slow, bounding pulse Weight gain Lethargy Increased spinal fluid pressure Central nervous system manifestations (seizures, coma) • Clinical tests: Low urine specific gravity	Limit fluid intake Administer diuretics Monitor vital signs Determine and treat cause of water excess Analyse laboratory electrolyte measurements frequently

	Decreased serum electrolytes Decreased hematocrit Variable urine volume	

Go back to the main text at the point where you left if you linked to this table from there.

Table 6: Problems with Sodium Levels

CAUSES	SIGNS	NURSING CARE
• Sodium depletion (hyponatremia) Prolonged low-sodium diet Fever Excess sweating Tachypnoea (infants) Cystic fibrosis Burns and wounds Vomiting, diarrhoea, nasogastric suction, fistulas Adrenal insufficiency Renal disease Diabetic acidosis	• General symptoms Associated with water loss: Same as with water loss: dehydration, weakness, dizziness, nausea, abdominal cramps, apprehension Mild - apathy, weakness, nausea, soft pulse Moderate - decreased blood pressure • Clinical tests Sodium concentration <130 mEq/L (may be normal if volume low) Specific gravity depends on water deficit or excess	Determine and treat cause. Administer IV fluids with appropriate saline concentration
• Sodium excess (hypernatremia) High salt intake (either by mouth, nasogastric or IV Renal disease	• General symptoms Intense thirst Dry, sticky mucous membranes Flushed skin Temperature may be increased	Determine and treat cause Administer fluids as prescribed Measure intake and output Monitor laboratory data

	Hoarseness Oliguria (lowered urine output) Nausea and vomiting Irritability and possible progression to disorientation, convulsions • Clinical tests: Serum sodium concentration <150 mEq/l High plasma volume Alkalosis	

Click here to go back to the main text

Table 7: Problems with Potassium Levels

CAUSES	SIGNS	NURSING CARE
• Potassium depletion (hypokalemia) Starvation Clinical conditions associated with poor food intake Malabsorption IV fluid without added potassium Diarrhoea, vomiting, fistulas, nasogastric suction Diuresis Administration of diuretics Administration of cortiocosteroids Diuretic phase of nephrotic syndrome Healing stage of burns	• General symptoms Muscle weakness, cramping, stiffness, paralysis, hyporeflexia Hypotension Cardiac arrhythmias, gallop rhythm Tachycardia or bradycardia Ileus Apathy. drowsiness Irritability Fatigue • Clinical tests Decreased serum potassium concentration 13.5 mEq/L Abnormal ECG, flat, notched or	Determine and treat cause Monitor vital signs, including ECG Administer supplemental potassium Assess for adequate renal output before administration IV: administer slowly Oral: offer high potassium fluids and foods

Healing stage of burns Potassium-losing nephritis Hyperglycaemic diuresis (e.g. diabetes mellitus) Familial periodic paralysis IV administration of insulin in ketoacidosis Alkalosis	Abnormal EGG--flat, notched, or inverted T waves, prolonged ST segment	
• Potassium excess (hyperkalemia) Renal disease Renal shutdown Adrenal insufficiency (Addison's disease) Associated with metabolic acidosis Too rapid administration of IV potassium chloride Transfusion with old donor blood Severe dehydration Crushing injuries Burns Haemolysis from sudden massive water intake Dehydration	• General symptoms Muscle weakness, flaccid paralysis Twitching Hyperreflexia Bradycardia Ventricular fibrillation and cardiac arrest Oliguria Apnoea--respiratory arrest • Clinical tests High serum potassium concentration >5.5mEq/L Variable urine volume Flat P wave on EGG, peaked T waves	Determine and treat cause Monitor vital signs, including ECG Administer exchange resin, if prescribed Administer IV fluids as prescribed Administer insulin (if ordered) to facilitate movement of potassium into cells Monitor serum potassium levels

Click here to go back to the main text

Table 8: Problems with Calcium Levels

CAUSE	SIGNS	NURSING CARE
• Calcium depletion (hypocalcemia) Inadequate dietary calcium Vitamin D deficiency Rapid transit through gastrointestinal tract Advanced renal insufficiency Administration of diuretics Hypoparathyroidism Alkalosis Trapped in diseased tissues Increased serum protein (albumin) Cow's milk baby formula tetany of the new-born Exchange transfusion with citrated blood	• General symptoms Neuromuscular irritability Tingling of nose, ears, fingertips, toes Tetany Laryngospasm Generalised convulsions May be changes in clotting Positive Chvostek sign Hypotension Cardiac arrest • Clinical tests Decreased serum calcium concentration (8.8 - 10.8 mEq/L) Or Increased serum protein	Determine and treat cause Administer calcium supplements as prescribed; administer slowly Monitor IV site; calcium may cause vascular irritation Monitor serum calcium levels Monitor serum protein levels
• Calcium excess (hypercalcemia) Acidosis Prolonged immobilisation Conditions associated with increased bone catabolism Hypoproteinemia Kidney disease Hypervitaminosis D Hyperparathyroidism	• General symptoms Few problems (ordinarily) Constipation Anorexia Dryness of mouth (thirst) Muscle hypotonicity Bradycardia/cardiac arrest Increased calcium concentration in urine may cause formation of kidney stones	Determine and treat cause Monitor serum calcium levels Monitor ECG

	• Clinical tests Increased serum calcium levels Or Decreased serum protein levels	

Click here to go back to the main text

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email comments or queries to johnross[redacted]
