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Assessing hydration status and measuring fluid balance can ensure optimal hydration

Measuring and managing fluid balance

In this article...

- What fluid balance is and how fluid moves around the body
- Causes and signs and symptoms of dehydration and overhydration
- How to assess fluid balance, including clinical assessment
- How to keep an accurate fluid balance chart

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Abstract Shepherd A (2011) Measuring and managing fluid balance. *Nursing Times;* 107: 28, 12-16.
Ensuring patients are adequately hydrated is an essential part of nursing care, yet a recent report from the Care Quality Commission found "appalling" levels of care in some NHS hospitals, with health professionals failing to manage dehydration.

This article discusses the importance of hydration, and the health implications of dehydration and overhydration. It also provides an overview of fluid balance, including how and why it should be measured, and discusses the importance of accurate fluid balance measurements.

Water is essential for life, and maintaining the correct balance of fluid in the body is crucial to health (Welch, 2010).

However, according to a recent report from the Care Quality Commission (2011), some hospital patients are not being given enough water to drink. The report suggests fluids are being left out of reach, or are not being given at all for long periods.

This article provides an overview of fluid balance, including what fluid balance is, and how and why it is measured. It also discusses the importance of measuring fluid balance accurately, and the health implications of dehydration and overhydration.

What is fluid balance?

Fluid balance is a term used to describe the balance of the input and output of fluids in the body to allow metabolic processes to function correctly (Welch, 2010).

Around 52% of total body weight in women and 60% in men is fluid. This consists of water and molecules containing, for example, sodium, chloride and potassium (Mooney, 2007). These compounds disassociate into particles which carry an electrical charge; these particles in solutions are called electrolytes. For example, sodium chloride (NaCl) dissolves in solution to form an equal number of positively charged sodium (Na^+) ions, and negatively charged chlorine (Cl^-) ions (Waugh, 2007).

Plasma electrolytes are balanced as it is important to have the correct concentration of ions in the blood, especially sodium, potassium and magnesium. Too much or too little of these electrolytes can cause cardiac arrhythmias (Docherty, 2006).

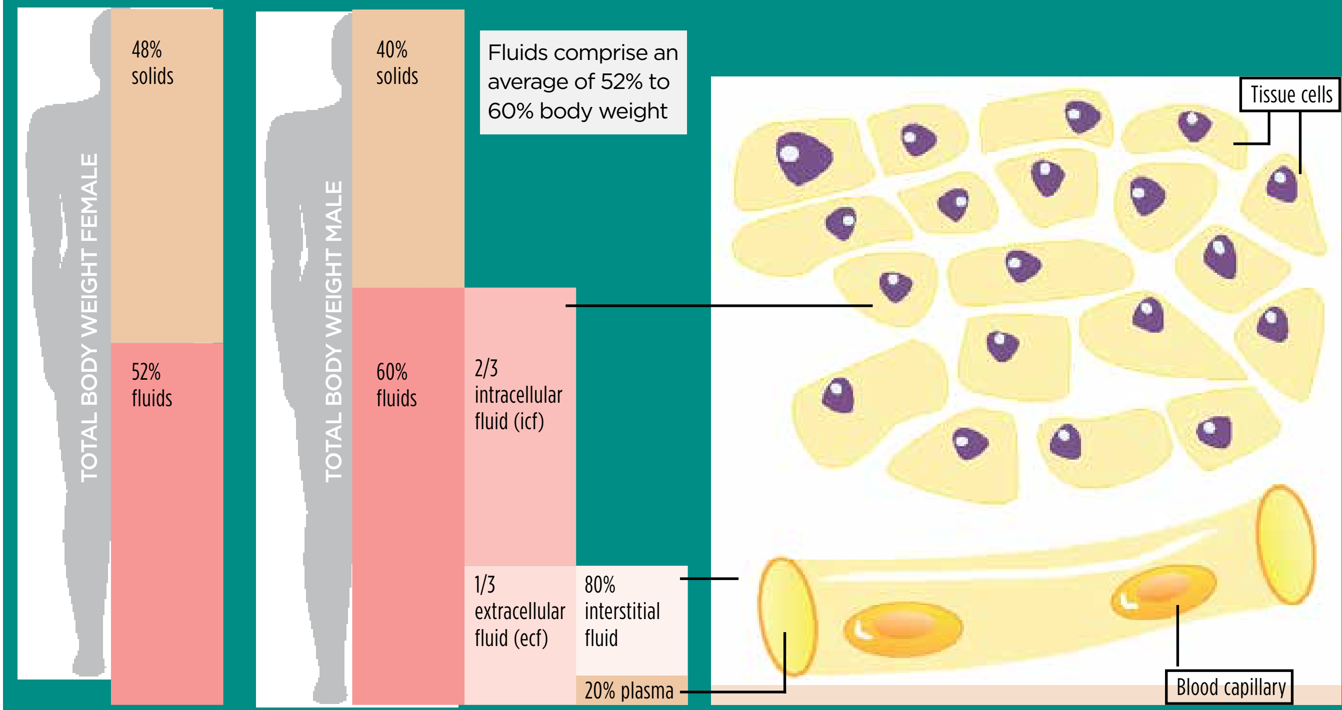
To make a competent assessment of fluid balance, nurses need to understand the fluid compartments within the body and how fluid moves between these

5 key points

1. Fluid balance is the balance of the input and output of fluids in the body to allow metabolic processes to function
2. To assess fluid balance, nurses need to know about fluid compartments in the body and how fluid moves between these compartments
3. Dehydration is defined as a 1% or greater loss of body mass as a result of fluid loss. Symptoms include impaired cognitive function, headaches, fatigue and dry skin. Severe dehydration can lead to hypovolaemic shock, organ failure and death
4. The three elements to assessing fluid balance and hydration status are: clinical assessment, body weight and urine output; review of fluid balance charts; and review of blood chemistry
5. Fluid balance recording is often inadequate or inaccurate often because of staff shortages, lack of training or lack of time

Dehydration affects brain function

FIG 1. **TYPES OF FLUIDS**



compartments (Davies, 2010). Two-thirds of total body fluid is intracellular, and the remaining third is extracellular fluid, which is divided into plasma and interstitial fluid (Docherty and McIntyre, 2002) (Fig 1). There is also a third space, known as "transcellular fluid", which is contained in body cavities, such as cerebral spinal fluid and synovial, peritoneal and pleural fluids (Day et al, 2009).

It is important to remember that, although these fluid compartments are classed as separate areas, water and electrolytes continually circulate between them (Timby, 2008).

Movement of fluids

Fluid circulates between compartments by diffusion. This is "the random movement of particles from regions where they are highly concentrated to areas of low concentration. Movement continues until the concentration is equally distributed" (Casey, 2004).

This is normally a passive process but it can be facilitated by a carrier molecule, usually a specialist protein (Davies, 2010).

Fluid also moves by osmosis, defined by Montague et al (2005) as "the flow of water across a semipermeable membrane from a dilute solution to a more concentrated solution until stability is reached".

Formation of tissue fluid

Distribution and movement of water between the intracellular and interstitial spaces is determined by hydrostatic and osmotic pressures (Day et al, 2009):

- Hydrostatic pressure is created by the pumping action of the heart, and the effect of gravity on the blood within the blood vessels (Scales and Pilsworth, 2008);
- Osmotic pressure is generated by the molecules in a solution (Day et al, 2009). When generated by the presence of protein molecules in solution it is called colloid oncotic pressure. Osmotic pressure created by dissolved electrolytes in solution is called crystalloid oncotic pressure (Scales and Pilsworth, 2008).

In healthy people, protein molecules are normally too large to pass out of the capillaries into the interstitial fluid. This is because of the tight intracellular junctions between adjacent endothelial cells in the capillary wall (Rassam and Counsell, 2005). Compromising the integrity of these tight intracellular junctions allows protein molecules to pass to the interstitial spaces. The subsequent accumulation of tissue fluid is known as oedema (Ganong, 2000).

Oedema can be caused by a number of pathological mechanisms, such as venous congestion. This increases venous hydrostatic pressure, common in disorders such as cardiac failure (Paulus et al, 2008). A decrease in plasma oncotic pressure causes the oedema associated with common renal disorders, such as glomerulo-nephritis, nephrotic syndrome and liver failure (Schrier, 2007; Waugh, 2007).

Maintaining fluid balance

Total fluid volume fluctuates by less than 1%, and fluid intake should be balanced by fluid loss (Scales and Pilsworth, 2008; Thomas and Bishop, 2007).

Water intake is obtained from fluid and food in the diet, and is mostly lost through urine output. It is also lost through the skin as sweat, through the respiratory tract, and in faecal matter (Waugh 2007). Fig 2 shows the normal balance of water intake and output.

Fluid intake is mainly regulated by thirst, a natural response to fluid depletion, and is accompanied by decreased secretion of saliva and dryness of the oral mucosa (Waugh, 2007).

As the osmotic concentration of the blood increases, this draws water from the cells into the blood. This dehydrates specific brain cells called osmoreceptors, which stimulate drinking and the release of antidiuretic hormone (ADH). ADH reduces water loss by lowering urine volume, producing urine that is more concentrated (Thornton, 2010). When water intake is high, less ADH is produced, so the kidneys produce large quantities of dilute urine (Scales and Pilsworth, 2008).

During times of fluid insufficiency, the adrenal glands produce the hormone aldosterone, which stimulates the reabsorption of sodium from the distal renal tubules and collecting ducts. This reabsorption of sodium causes the water in the collecting ducts to be reabsorbed, maintaining homeostasis.

Water lost through faeces, sweat and evaporation cannot be regulated in the same way by the body, and is influenced by dietary intake, illness and the environment (Scales and Pilsworth, 2008).

A fluctuation in fluid volume of just 5-10% can have an adverse effect on health (Large, 2005). A deficit in fluid volume is known as a negative fluid balance and, if fluid intake is greater than output, the body is in positive fluid balance (Scales and Pilsworth, 2008).

Dehydration

Dehydration is defined as a 1% or greater loss of body mass as a result of fluid loss, where the body has less water than it needs to function properly (Madden, 2000).

The physical symptoms of mild dehydration include:

- Impaired cognitive function;
- Reduced physical performance;
- Headaches, fatigue, sunken eyes and dry, less elastic skin (Welch, 2010).

If dehydration persists, the circulating volume of blood can drop. This leads to:

- Hypotension;
- Tachycardia;
- Weak, thready pulse;
- Cold hands and feet;
- Oliguria (reduced urine output) (Large, 2005).

These symptoms of dehydration are the beginnings of hypovolaemic shock which, if not corrected, can lead to organ failure and death. Allowing moderate dehydration to become chronic can cause a general deterioration in health (Mulryan, 2009; Thomas et al, 2008; Bennett et al, 2004).

Causes of dehydration:

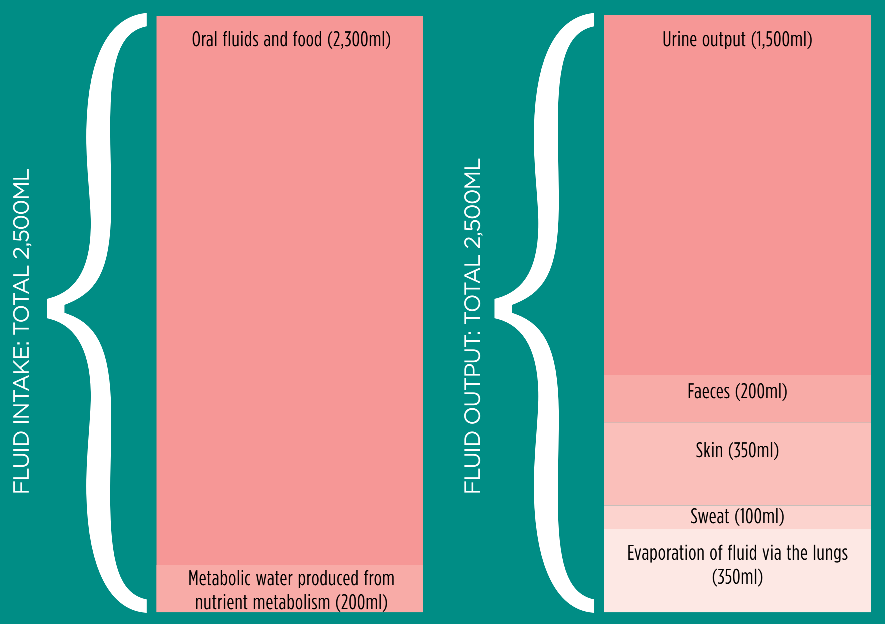
According to McMillen and Pitcher (2010), the main causes of dehydration are inadequate fluid intake, excessive fluid loss or both.

Inadequate fluid intake can be caused by a refusal to drink due to fear of incontinence, dementia or Alzheimer's disease, fluid restriction for conditions such as heart failure, and increased frailty (see Box 1).

Diarrhoea and vomiting are major causes of excessive fluid loss. Polyuria can also cause dehydration unless fluid intake is increased to compensate for such. Polyuria is usually caused by hyperglycaemia, diabetes or overuse of diuretic therapy (Large, 2005). Other causes of excess fluid loss include haemorrhage, sweating, fever and severe burns (Mooney, 2007).

FIG 2. **FLUID INTAKE AND LOSS**

Sources: McMillen and Pitcher (2010); Scales and Pilsworth (2008); Waugh (2007)



Fluid overload

Excessive fluid volume arises when there is retention of both electrolytes and water in proportion to the levels in the extracellular fluid. This may be caused, for example, by sodium retention that leads to the retention of water. As a result, excess fluid leaks into the interstitial spaces and forms oedema (Waugh, 2007). This normally happens in people with long-term conditions, such as renal impairment and liver disease (Large, 2005).

In patients with heart failure, the reduced cardiac output fails to maintain adequate systemic blood pressure, causing reduced renal perfusion. This stimulates thirst, which acts as a short-term compensatory mechanism to increase consumption of fluid. The fluid is then retained in an attempt to increase systemic blood pressure, leading to oedema (Scales and Pilsworth, 2008; Faris et al, 2006).

Symptoms vary, depending on the severity of fluid overload; patients with acute fluid overload may present with a sudden onset of acute dyspnoea secondary to pulmonary oedema (accumulation of fluid in the lungs).

The main symptoms exhibited by patients with a history of chronic fluid overload, such as those with heart failure, are fatigue, dyspnoea and pitting oedema (Khan and Heywood, 2010).

BOX 1. **INADEQUATE FLUID INTAKE CAUSES**

- Refusal to drink for fear of incontinence;
- Dementia, Alzheimer's disease or cognitive impairment;
- Reliance on health professionals to provide adequate fluids;
- Physical weakness or increased frailty;
- Pre-operative fasting;
- Medication, such as laxatives or diuretics;
- Illness causing physical and mental stress;
- Nausea;
- Reduced sensation of thirst in older people;
- Fluid restriction for conditions such as heart failure or renal disorders

Assessing fluid balance

Scales and Pilsworth (2008) identified three elements to assessing fluid balance and hydration status:

- Clinical assessment;
- Review of fluid balance charts;
- Review of blood chemistry.

Clinical assessment

Patients should be asked if they are thirsty, although this is only effective for patients who are able to control their fluid intake.

"We need to think of new ways to construct courses and support students' learning"

Ieuan Ellis › p24

Patients with impaired ability to control fluid intake include those with speech difficulties, confusion or depression (McMillen and Pitcher, 2010). Thirst perception can also be impaired in older people (Cannella et al, 2009).

Dehydration will cause the mouth and mucous membranes to become dry, and the lips to become cracked so an assessment of the mouth and oral mucosa can be useful at this stage (McMillen and Pitcher, 2010; Scales and Pilsworth, 2008).

Observations

Vital signs, such as pulse, blood pressure and respiratory rate, will change when a patient becomes dehydrated.

Dehydrated patients may become tachycardic and, when a lying and standing blood pressure is recorded, they will show a postural drop, known as postural hypotension, which often accompanies a fluid deficit (Waugh, 2007). The respiratory rate may become rapid but only if fluid loss is severe.

These observations should be measured as part of the clinical assessment (Mooney, 2007; Large, 2005).

Capillary refill time

Capillary refill time (CRT) is a good measure of the fluid present in the intravascular fluid volume (Large, 2005). It is measured by holding the patient's hand at heart level and pressing on the pad of their middle finger for five seconds. The pressure is released and the time measured in seconds until normal colour returns. Normal filling time is usually less than two seconds (Resuscitation Council UK, 2006). It should be noted that CRT assessment can sometimes be misleading, particularly in patients with sepsis (Scales and Pilsworth, 2008).

Skin elasticity

The elasticity of skin, or turgor, is an indicator of fluid status in most patients (Scales and Pilsworth, 2008).

Assessing skin turgor is a quick and simple test performed by pinching a fold of skin. In a well-hydrated person, the skin will immediately fall back to its normal position when released. It is best practice to pinch the skin over the sternum or the inner thigh (Davies, 2010).

However, this assessment can be an unreliable indicator of dehydration in older people as skin elasticity reduces with age (Large, 2005).

A good alternative to skin turgor is tongue turgor, as this is not age-dependent. In a well-hydrated individual, the tongue has one longitudinal furrow, but a person with depleted fluids will have additional furrows (Metheny, 2000).

Body weight

Acute changes in body weight, after imposed fluid restrictions or exercise, is a good indicator of hydration status. However, this can be affected by bowel movements, as well as food and fluid, and would be difficult and unethical to measure in sick, immobile stroke patients (Vivanti et al, 2010). McMillen and Pitcher (2010) argued that to maximise the accuracy of weight assessment in fluid balance, the measurement should be performed at the same time of day using the same scales, which should be calibrated regularly.

Urine output

In healthy people, urine should be a pale straw colour. It should be clear, with no debris or odour (Smith and Roberts, 2011).

In dehydrated patients the kidneys conserve water, producing urine that is dark, concentrated and reduced in volume (Scales and Pilsworth, 2008). Normal urine output is around 1ml/kg of body weight per hour, in a range of 0.5-2ml/kg per hour. The minimum acceptable urine output for a patient with normal renal function is 0.5ml/kg per hour. Anything less should be reported (McMillen and Pitcher, 2010; Scales and Pilsworth, 2008).

QUICK FACT
5%
The fluctuation in fluid volume that can damage health

When recording urine output on a fluid balance chart, it is not acceptable practice to record it as "passed urine +++" or "up to the toilet". Notes such as these are uninformative and do not give a clear indication of the amount of urine passed (Mooney, 2007).

The colour of the urine should not be relied on as a marker of fluid balance as some drugs, such as tuberculosis medication, can alter urine colour and give a false indication of urine concentration (Scales and Pilsworth, 2008).

If a patient has a urinary catheter and the output is low, it is sensible to check whether the catheter or tubing is blocked or occluded in any way (McMillen and Pitcher, 2010).

Fluid balance chart

Monitoring a patient's fluid balance to prevent dehydration or overhydration is a relatively simple task, but fluid balance recording is notorious for being inadequately or inaccurately completed (Bennett, 2010).

A study by Reid (2004), which audited the completion of fluid balance charts on different wards, found the major reasons fluid balance charts were not completed appropriately were staff shortages, lack of training, and lack of time.

According to the Nursing and Midwifery Council (2007), record keeping is an integral part of nursing care, not something to be "fitted in" where circumstances allow. It is the responsibility of the nurse caring for a patient to ensure observations and fluid balance are recorded in a timely manner, with any abnormal findings documented and reported to the nurse in charge (Scales and Pilsworth, 2008).

Smith and Roberts (2011) said that all fluid intake and output, whatever the source, must be documented using quantifiable amounts. This means it is important to know how many millilitres of fluid are in an intravenous medication, a glass of water or a cup of tea. How frequently the fluid balance chart data should be recorded – such as hourly or two hourly – should be clearly documented. It is not acceptable practice to use shorthand.

Fig 3 shows best practice when completing a fluid balance chart and Fig 4 shows an example of unacceptable practice (Smith and Roberts, 2011).

The use of fluid balance charts that show cumulative input and output is now being debated in the literature (Bennett, 2010). A recent study by Perren et al (2011) suggested that for a large proportion of patients, especially those in critical care, cumulative fluid balance charts are not accurate and their use should be questioned.

Blood chemistry and hydration status

While Scales and Pilsworth (2008) suggest that the analysis of blood chemistry may be useful in the assessment of hydration status, the evidence surrounding this is equivocal. According to Wolfson (2009) sodium, potassium, chloride, bicarbonate, blood urea nitrogen (BUN) are helpful blood electrolytes to measure when determining hydration status. Wolfson proposes that if any of these electrolytes are found to be outside normal parameters, their levels should be used to guide the prescription of intravenous fluids required to restore homeostatic fluid balance.

In contrast, Vivanti et al (2008) argue that there is limited value in the analysis of biochemical indicators such as these for less severe dehydration, particularly in

FIG 3. ACCURATE FLUID BALANCE CHART

Time	Oral input	IVI input	Cumulative input	Urine output	Bowels output	Vomit output	Cumulative output
08.00	Water 150ml	Normal saline 0.9% 100ml	250ml	550ml			550ml
09.00		100ml	350ml				
10.00	Coffee 150ml	100ml	600ml			250ml	800ml
11.00	Water 300ml	IVI tissued	900ml		150ml		950ml
12.00		Venflon sited		350ml			1,300
13.00		100ml	1,000ml				
14.00	Tea 150ml		1,150ml			100ml	1,400ml
15.00		100ml	1,250ml				
16.00	Water 75ml	100ml	1,425ml				
17.00		100ml	1,525ml	200ml			1,600ml
18.00	Tea 150ml	100ml	1,775ml		100		1,700ml

FIG 4. INACCURATE FLUID BALANCE CHART

Time	Oral input	IVI input	Cumulative input	Urine output	Bowels output	Vomit output	Cumulative output
08.00	Tea	100ml??		PU+++	Diarrhoea		?
09.00							
10.00	H20	50ml					
11.00		Tissued				+++	
12.00				Bed wet	Soiled bed linen		
13.00		Venflon sited					
14.00							
15.00	Tea	200ml?? Pump not working			BO+++		
16.00							
17.00	Juice						

older people, and suggest that physical signs may be more promising indicators.

Conclusion

Achieving optimal hydration is an essential part of holistic patient care. Maintaining fluid balance is important to avoid complications such as dehydration and overhydration, both of which can have serious clinical consequences.

The nurse caring for a particular patient is responsible for ensuring that fluid balance charts are recorded regularly and with accuracy, using the correct notation throughout. To promote adequate hydration, and safe and effective nursing care, nurses should always report any significant abnormalities identified in patients' fluid record. **NT**

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