Assessing and documenting fluid balance


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Abstract

Concerns about inadequate patient hydration and suboptimal monitoring of fluid balance have been documented in recent reports. The Fluid Balance Improvement Project at Central Manchester University Hospitals NHS Foundation Trust was undertaken to identify risk factors influencing hydration and to implement a revised process to manage these risks, resulting in the development of a hydration pathway. This new approach to monitoring patient hydration, together with staff education and support, has resulted in improved compliance with fluid balance monitoring standards, as well as significant improvements in identifying patients at risk of dehydration, and an increase in patients with acute kidney injury commencing appropriate fluid balance monitoring.

Keywords

acute kidney injury, fluid balance, fluid balance assessment, hydration, hydration assessment, renal care, service improvement

WATER MAKES UP an average of 60% of total body mass in adult males and an average of 50-55% of total body mass in adult females (European Food Safety Agency Panel on Dietetic Products, Nutrition, and Allergies 2010). Water is necessary for various essential processes in the body; therefore, an adequate fluid balance is fundamental to maintaining metabolic processes (Welch 2010). Alterations to the fluid volume and subsequent changes to the body’s electrolyte levels resulting from fluid imbalance can have serious consequences. Mild to moderate dehydration may lead to physical and mental deterioration, while severe dehydration, where there is a decrease of more than 15-20% total body fluid, can be fatal (Madden 2000). By contrast, fluid overload occurs when there is an excessive circulating volume. This manifests as pulmonary oedema and peripheral oedema, and can cause acute deterioration, affecting patient outcomes and mortality (Bouchard et al 2009).

Accurate monitoring of a patient’s fluid balance status is an essential component of the National Institute for Health and Care Excellence (NICE) (2007) clinical guideline, Acutely Ill Adults in Hospital: Recognising and Responding to Deterioration. Timely and appropriate use of fluid balance observations is essential in determining adequate hydration (Scales and Pilsworth 2008). When patients are acutely ill, or have the potential to become acutely ill, they may show early warning signs that can be identified by accurate fluid balance measurement and documentation. A declining urine output may indicate initial signs of renal dysfunction, while a reduction in fluid intake may indicate issues such as changes in consciousness level, gastrointestinal problems or general ill health. In the absence of appropriate and accurate fluid balance monitoring, these signs may not be recognised, contributing to an increased length of stay in hospital and, in some cases, death (NICE 2007, Grams et al 2011).

Problems persist with monitoring fluid balance and ensuring patients are adequately hydrated, despite clinical guidance and evidence that demonstrate the importance of monitoring fluid balance in patient care. Cases of dehydration in hospitals have been reported in the national press (Sky News 2013, Disley 2014), bringing this
issue to public attention. Despite national initiatives intended to improve hydration in healthcare settings (Royal College of Nursing (RCN) et al 2007), there is limited evidence of success in preventing suboptimal recognition and response to fluid balance concerns. The causes of inadequate hydration and failure to monitor fluid balance are complex, with multiple influences. The Care Quality Commission (2011) identified central themes when discussing the dignity and nutrition inspection programme, because there was concern that patients were not receiving sufficient fluids. These themes included: the difficulty patients experienced obtaining fluids; inadequate monitoring of food and fluid intake; and lack of adequate assistance if a patient needed help with eating or drinking. Using a variety of measures, including a survey, knowledge quiz and observation, Reid et al (2004) found that the absence of appropriate training and a lack of understanding of daily fluid input and output targets affected the recognition of hydration issues and compliance with accurate monitoring in healthcare staff. Therefore, hydration and fluid monitoring should be prioritised in healthcare settings, to prevent unnecessary harm to patients.

**Context of the Fluid Balance Improvement Project**

The Fluid Balance Improvement Project was undertaken at Central Manchester University Hospitals NHS Foundation Trust in 2015. Anecdotal evidence had suggested that compliance with the organisation’s fluid balance policy was suboptimal. Four small-scale audits of documentation between August 2014 and October 2014 indicated that compliance with accurate recording of fluid balance was inconsistent and that inconsistencies were also evident in the escalation of hydration concerns by healthcare staff. The organisation’s professional practice forum made the decision to review the hydration pathway and identify issues affecting consistent implementation. Various information sources were analysed to scope the issues relating to hydration and monitoring of fluid balance in the Central Manchester University Hospitals NHS Foundation Trust.

**Acute kidney injury**

Development of acute kidney injury is closely linked to suboptimal fluid management. Acute kidney injury results from a rapid deterioration of renal function, leading to an inability to maintain fluid, electrolyte and acid-base balance (Bellomo et al 2012). The causes of acute kidney injury can be divided into three categories:

- Pre-renal, caused by reduced perfusion.
- Intrinsic renal, caused by damage to the kidney.
- Post-renal, caused by obstruction in the drainage of urine.

The causes of injury in each category, with the most common cause of injury listed first, are shown in Box 1.

Pre-renal causes account for approximately 70% of acute kidney injury cases in the community, and for up to 60% of inpatient cases (Godin et al 2013). Hypoperfusion resulting from volume depletion, reduced cardiac output and hypotension all lead to a reduction in renal perfusion pressure. Renal hypoperfusion reduces glomerular capillary pressure and the glomerular filtration rate, while prolonged hypoperfusion contributes to the development of acute tubular necrosis (Harty 2014). Pre-renal causes of acute kidney injury relate to circulatory volume insufficiency, emphasising the importance

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**BOX 1. Causes of acute kidney injury**

**Pre-renal:**
- Hypovolaemia, for example bleeding, gastrointestinal losses
- Sepsis
- Cardiac arrhythmias
- Myocardial infarction
- Renal artery stenosis

**Intrinsic renal:**
- Prolonged hypoperfusion, causing tubular injury
- Interstitial nephritis
- Nephrotoxins
- Infiltrative disease, for example myeloma
- Glomerulonephritis
- Rhabdomyolysis

**Post-renal:**
- Renal stone disease
- Blocked catheter
- Prostatic hypertrophy, prostate cancer
- Urethral stricture
- Pelvic masses, for example cervical cancer

(Adapted from The Royal College of Physicians of Edinburgh 2013)
A clinical diagnosis of acute kidney injury can be established by the onset of oliguria; anuria (urine output of less than 100 mL per day); or deteriorating creatinine levels (Rahman et al 2012). If acute kidney injury is not recognised and not treated in a timely manner, further deterioration results in the development of uraemia, acidosis and hyperkalaemia, which can be fatal (NICE 2013).

The presentation of acute kidney injury will depend on the underlying cause. There may be no signs or symptoms. However, oliguria (urine volume of less than 0.5 mL/kg/hour), is common (NICE 2013). A clinical diagnosis of acute kidney injury can be established by the onset of oliguria; anuria (urine output of less than 100 mL per day); or deteriorating creatinine levels (Rahman et al 2012). If acute kidney injury is not recognised and not treated in a timely manner, further deterioration results in the development of uraemia, acidosis and hyperkalaemia, which can be fatal (NICE 2013). In 2009 the report, Acute Kidney Injury: Adding Insult to Injury, carried out National Confidential Enquiry into Patients Outcomes and Death identified significant deficiencies in the recognition and management of acute kidney injury; suboptimal fluid balance monitoring was a recurring issue.

Data analysis at Central Manchester University Hospitals NHS Foundation Trust in 2014 concluded that approximately one in four acute patients (25% [185/745]) had clinical indications of acute kidney injury, with sepsis and dehydration being the most common causes (Challiner et al 2014). This equates to 4,000 new cases of acute kidney injury per year in the organisation. A retrospective unpublished study of 745 patient case notes undertaken in 2014 by the acute kidney injury specialist team found that dehydration accounted for 35% (260/745) of patients with acute kidney injury. Development of acute kidney injury resulted in a threefold-increase in the length of hospital stay. It also increased the number of critical care bed days and patient mortality in the organisation. The study identified that fluid balance charts had not been maintained for around 50% of acute kidney injury cases, leading to delays in recognising inadequate urine output and the risk of dehydration.

Between November 2014 and December 2014, audits of fluid balance charts were undertaken in 20 inpatient wards in the adult divisions within the organisation to assess healthcare staff compliance with fluid balance monitoring and the escalation of hydration concerns in accordance with local policy, using the policy standards to measure compliance. All of the audits demonstrated a lack of awareness of fluid balance policy, and there was 30% (72/242) overall compliance with chart completion and accurate recording and documentation of fluid balance. Where concerns were identified about the patient’s fluid balance, there was no escalation in most cases. Non-compliance with the fluid balance policy in adult inpatient areas and inadequacies in monitoring standards increased the risk of non-recognition and suboptimal response to the deteriorating adult, and heightened the possibility of mismanagement.

An electronic fluid balance monitoring system was available in Patientrack, the electronic observation and alerting system that had been used throughout the organisation to record clinical observations since 2009. Electronic documentation in Patientrack enables accurate calculations of fluid balance and automated reminders to undertake assessment. It is also possible to use alerts to automatically contact relevant healthcare staff in response to an elevated fluid balance and accurate recording and documentation of fluid balance. Where concerns were identified about the patient’s fluid balance, there was no escalation in most cases. Non-compliance with the fluid balance policy, using the policy standards to measure compliance. All of the audits demonstrated a lack of awareness of fluid balance policy, and there was 30% (72/242) overall compliance with chart completion and accurate recording and documentation of fluid balance. Where concerns were identified about the patient’s fluid balance, there was no escalation in most cases. Non-compliance with the fluid balance policy in adult inpatient areas and inadequacies in monitoring standards increased the risk of non-recognition and suboptimal response to the deteriorating adult, and heightened the possibility of mismanagement.

However, the authors identified that improvements were required in the current process and that it was necessary to investigate the reasons acute kidney injury was occurring before the implementation of the new electronic system, which could compound existing risks if these were not addressed. It was vital to improve the hydration assessment process to: ensure compliance with accurate and responsive fluid balance monitoring in adult inpatient areas; improve patient safety; and enable early recognition of acutely unwell patients.

**Fluid Balance Improvement Project**

The Fluid Balance Improvement Project team was established to undertake a programme of improvement work in relation to how nurses assess and record fluid balance in clinical care. The main objective was to ensure the safe assessment and management of patients at risk of fluid balance abnormalities,
ensuring that fluid balance monitoring was completed consistently and that any abnormalities were identified and responded to in a timely manner. The improvement work involved reviewing practice and ensuring this was evidence based and in accordance with relevant policies. Quality improvement methodology was used to support the process. Safety in the process was ascertained by using the Safer Clinical Systems approach developed by The Health Foundation (2009). Four plan, design, study, act (PDSA) cycles (NHS Institute for Innovation and Improvement 2010) were used to develop and implement various agreed changes and to evaluate the effects of the changes made in the identified clinical areas. This process will be discussed later in this article.

**Reviewing the process**

The Health Foundation (2009) Safer Clinical Systems tools were initially used in Central Manchester University Hospitals NHS Foundation Trust in 2009, working with Warwick University to test the methodology. These tools were used to review pathways and to assess, measure and ensure safety throughout the pathway. This approach was used at the start of the project in January 2015 to identify areas of risk in the process of fluid balance monitoring and to develop interventions that address or mitigate these hazards to reduce high-level risks. Process mapping identified the pathway as well as areas of risk and the potential for failure at all points in the fluid balance monitoring process (Figure 1).

Failure mode and effect analysis (Kelly 2011) was used to systematically analyse each stage of the patient journey, addressing any risk identified. This enabled the review of current practice and the calculation of the probability and severity of each identified area of risk on the trust risk matrix. This measured the effect or severity and likelihood of each risk identified. The severity, likelihood and risk score can be used to evaluate the overall level of the risk as very low, low, medium or high. High and medium-risk scores were associated with the identified areas of risk; assessment, documentation and escalation scored highest.

The authors’ review of the fluid balance policy confirmed there were gaps in the guidance provided and the procedures for escalation were complicated, demonstrating the necessity to change existing practice.

Hierarchical task analysis is a structured, objective approach that provides an understanding of the tasks that users should perform to achieve certain goals (Embrey 2000). The use of hierarchical task analysis enabled the fluid balance pathway to be broken down into progressively smaller component tasks that were required to complete the pathway. This method identifies any unnecessary tasks, steps or potential errors that might occur when performing each task, which enables the user to identify areas of the pathway that require improvement.

It was also important to consult clinical staff in the change process. Bevan (2010)
emphasised that if clinical staff are engaged with the process, they are often ideal to identify and support change, increasing the likelihood of its sustainability. Workshops and focus groups were held with healthcare staff involved in fluid balance monitoring, to ascertain the problems with existing practice and to ask for ideas for the improvement project. These confirmed there was a lack of ownership of and accountability in completing fluid balance charts, resulting in non-compliance with local documentation standards and the failure to monitor patients’ hydration status accurately. Many of the healthcare professionals did not know the correct indications for fluid balance monitoring. This could result in some at-risk patients being overlooked for fluid balance monitoring, increasing the risk of harm, while 56 patients without any risk factors that could influence hydration were monitored in the initial audits, increasing healthcare staff workload unnecessarily. The predominance of patients undergoing fluid balance monitoring unnecessarily reduced awareness of the vital role that comprehensive fluid balance monitoring can have in recognising patient deterioration.

The review process identified that assessment of patient fluid balance status and the documentation available for fluid balance monitoring were inadequate to ensure fluid balance was completed accurately and comprehensively. Documentation from Bedford Hospital NHS Trust provided a workable basis for what the authors aimed to achieve and they were given permission to adapt this for the pathway. The documentation bundle included the use of a daily hydration assessment tool and the use of a hydration chart alongside fluid balance charts. The project team adapted this approach and developed the new hydration pathway (Figure 2) and supporting documentation.

**Hydration pathway documentation bundle**

The new hydration pathway consists of a daily hydration assessment and a choice of two monitoring charts: the hydration chart and the fluid balance chart.

**Hydration assessment**

The implementation of a hydration assessment (Figure 3) enabled patients to be assessed for factors influencing hydration and ensured that at-risk patients were correctly identified and monitored accordingly. The predominance of patients undergoing fluid balance monitoring unnecessarily reduced awareness of the vital role that comprehensive fluid balance monitoring can have in recognising patient deterioration.

The review process identified that assessment of patient fluid balance status and the documentation available for fluid balance monitoring were inadequate to

**Hydration chart**

The hydration chart (available as Figure 4 online) is a simple-to-use chart for patients who do not require strict fluid balance monitoring, but who have one or more low-risk factors that could influence hydration, corresponding to the yellow section of the hydration assessment form. Regular assessment at intervals throughout the day enables early escalation of potential issues.

**Fluid balance chart**

The fluid balance chart is for patients who require strict fluid balance monitoring (available as Figure 5 online), who have one or more high-risk factors that could influence hydration, corresponding to the red section of the hydration assessment form. The fluid balance chart includes an area for documentation of special instructions, consideration of insensible loss and for 24-hour review of fluid balance.

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**Figure 2. Hydration pathway**

- Patient admitted to ward
- Hydration assessment within 6 hours
- Fluid balance chart
- Nurse-signed review every 6 hours. 24-hour signed review by nurse or doctor.
- Nurse-signed review 3 times a day.
- Hydration chart
- Any concerns escalate to the nurse in charge.
- Reassess need for fluid balance chart.
- No monitoring
- Daily hydration assessment until discharge (unless variance documented).
### Hydration assessment

#### Factors influencing hydration: any of the following:

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<td>Increased vomiting or high nasogastric output</td>
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<td>Dry mucous membranes, dry lips, skin turgor, sunken eyes</td>
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Quality improvement methodology was used to trial the new hydration pathway in three ward areas. These wards were chosen for their mix of patient acuity and high turnover of patients, to help demonstrate whether the new documentation was workable. Audits to measure the compliance, accuracy and escalation of monitoring were conducted in all three areas before the pilot trial. This provided a baseline measure by which improvements or shortfalls in hydration management could be shown, following implementation of the hydration pathway.

**Patient involvement**

To support the new hydration pathway and to encourage patient involvement, urine colour chart posters were displayed in patient bathrooms and sluice areas (available as Figure 6 online), to serve as a guide to indicate whether a patient is adequately hydrated based on the colour of their urine. A patient information leaflet explains why it is necessary to monitor fluid balance, provides information about how to keep hydrated and encourages patient involvement in fluid balance monitoring, where they are able (available as Figure 7 online).

While the development stage of the project did not engage patient groups as partners in the process, the hydration pathway documentation was developed in response to healthcare professionals’ feedback and requirements, and their feedback in the initial documentation trial identified that changes were required to the documentation to enable patient participation in the improvement project. In retrospect, the inclusion of patient representation from the beginning of the project would have been beneficial. Close links have since been established with patient experience groups to improve patient participation and education.

**Pilot trial**

Quality improvement methodology was used to trial the new hydration pathway in three ward areas. These wards were chosen for their mix of patient acuity and high turnover of patients, to help demonstrate whether the new documentation was workable. Audits to measure the compliance, accuracy and escalation of monitoring were conducted in all three areas before the pilot trial. This provided a baseline measure by which improvements or shortfalls in hydration management could be shown, following implementation of the hydration pathway. The initial audits demonstrated 32% compliance with fluid balance monitoring standards (19/60 charts completed correctly), with 15 delays in escalation of concerns related to fluid balance.

The PDSA cycle is a method that helps to plan an intervention, test it on a small scale and review the effects of the change before deciding how to proceed or modify the intervention (NHS Institute for Innovation and Improvement 2010). Using PDSA cycles, the authors were able to assess the effect of the hydration pathway, enable modifications and identify elements that they had not considered in the initial development of the pathway. This led to further cycles, which considered documentation revision and educational needs analysis for all grades of healthcare staff. Following four PDSA cycles, the audits demonstrated a significant increase in compliance with fluid balance policy standards to 92% (55/60 charts completed correctly) and a significant increase in the recognition and escalation of hydration issues. This was reflected in the improvement in patients with acute kidney injury beginning appropriate fluid balance monitoring in the trial areas from 2/10 (20%) patients in the initial pre-trial audit to 10/11 (91%) patients in the post-trial audit, following implementation of the hydration pathway. This had a positive effect on acute kidney injury management standards, resulting in an ongoing reduction in the length of stay of patients with acute kidney injury in the trial areas.

**Implementation**

The resulting improvement in patient safety following the pilot trial led to the implementation of the hydration pathway throughout adult inpatient areas in Central Manchester University Hospitals NHS Foundation Trust. The hydration pathway was not deemed suitable for obstetric areas, because the majority of patients in this group are healthy. However, fluid balance charts from the hydration pathway are used if an obstetric patient requires fluid balance monitoring, ensuring that regular reviews are undertaken over a 24-hour period to enable early recognition and escalation of hydration issues.

Forty wards were included in the introduction of the hydration pathway and documentation. While the project team was involved in staff education and producing teaching materials, divisional educators were asked to support the introduction of the pathway in their ward areas. The
implementation took longer than initially anticipated, taking 6 months instead of 2-3 months, because of the competing demands of other mandatory training needs and local priorities. Compliance has been monitored through audits by the project team, and by including questions relating to the hydration pathway in the care quality rounds completed monthly by ward teams. Monitoring has shown consistent compliance of more than 80% with the organisation’s standards.

The hydration pathway was not integrated immediately during the introduction period. However, the project team were able to identify this through staff feedback and audits of compliance, and were able to respond to difficulties with implementation in a timely manner. Reluctance to accept the change was evident in specialist areas where the hydration assessment tool did not meet the requirements of the specific patient groups fully, for example patients with renal failure or heart failure. Discussion with the ward teams enabled the authors to adapt the hydration pathway to support the assessment and appropriate monitoring of these specialised patient groups. This has included the addition of risk categories for fluid balance monitoring for patients with dementia or receiving chemotherapy. There have also been additions to the requirement for no hydration monitoring, and for patients with long-term renal failure or heart failure, where daily weight measurements are deemed sufficient for monitoring hydration.

A needs assessment and gap analysis (Watkins et al 2012) enabled the team to determine the requirements for appropriate and effective educational programmes for staff. Education about the hydration pathway has been added to induction and mandatory training for all clinical staff, with the project team providing bespoke teaching to specific ward areas as required. The education package has been included in training for the Care Certificate (Health Education England et al 2015), which sets standards that are covered in the induction training of new nursing assistants, and the subsequent apprenticeship course to ensure all staff involved in monitoring and maintaining patients’ fluid balance status have received formal training. Junior doctors have requested further training on hydration risks, fluid balance interpretation and fluid management, using staff feedback. This training is included in their weekly teaching programme.

Staff education is vital to help reduce the risk of suboptimal hydration and to improve the recognition of fluid balance issues. It is also important to educate patients and the general public to empower them, ensure ownership of hydration issues and enable a move towards self-care or towards a shared approach to healthcare. Several community settings have begun to display urine colour charts (available as Figure 6 online). The project team aim to develop education tools that can be used in community, preoperative and outpatient settings to increase awareness of the necessity of adequate hydration. This may help to reduce the number of patients presenting with conditions related to dehydration, such as acute kidney injury, urinary tract infections and pressure ulcers (RCN et al 2007). Targeted education for the public combined with robust staff education could help reduce unnecessary harm, and could also reduce the cost of dehydration to the NHS.

Using the Safer Clinical Systems tools (The Health Foundation 2009), the project team was able to identify areas of risk in the fluid balance monitoring process and develop an improved process of assessment and escalation to address and reduce these risks. The new hydration pathway has led to improvement in fluid balance monitoring, evident in the improved recognition and management of patients with acute kidney injury and enhanced recognition and escalation of patients found to have hydration issues, resulting from more robust monitoring and assessment.

**Future developments**
The authors acknowledge that ongoing work is required to ensure the improved level of safety is sustained, and that changes to the documentation and processes may be required to meet the specifications for specialist areas or as new developments arise. The Fluid Balance Improvement Project has addressed compliance issues.
related to fluid balance monitoring. With the implementation of the new hydration pathway, it may be suggested that the process is acceptably safe, thus improving patient safety. The aim is that, with the implementation of the electronic chart in the Patientrack system, which has been developed to mirror the new pathway, compliance with policy standards will improve and fluid balance observations will be more accessible and responsive.

Conclusion
Problems with hydration are long-standing in healthcare settings. Audits conducted in Central Manchester University Hospitals NHS Foundation Trust identified problems with the process and the lack of understanding of the complicated policy in place to support fluid balance monitoring.

The authors analysed these issues using the reference values for water: EFSA Journal, 8, 3, 1459-1506.


Health Foundations Safer Clinical Systems approach to gain an accurate understanding of problems with the process and the barriers that prevented compliance with local standards. The Fluid Balance Improvement Project emphasised the requirement for a simple pathway to ensure all patients were assessed and monitored according to their individual needs. Throughout the organisation, this project has resulted in improvements to the appropriate monitoring and timely escalation of hydration issues, improving patient safety and reducing the risks associated with the previous pathway. The authors aim to further improve compliance, using the new process and appropriate educational support, to ensure adequate hydration for all patients and timely identification and escalation of hydration issues.

Figures 4 to 7 are available online at http://rcni.com/fluid-balance

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