A Balanced Solution

A review of the quality of the care in hospital provided to adults with abnormal levels of blood sodium

NCEPOD

Improving the quality of healthcare

A BALANCED SOLUTION

A review of the quality of care provided to adults in hospital identified as having hyponatraemia (low blood sodium levels) or hypernatraemia (high blood sodium levels)

A report published by the National Confidential Enquiry into Patient Outcome and Death (2025)

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Cohort: *All patients aged 18 or over who were admitted to hospital between 1st October 2023 and 31st December 2023 and identified as having hypernatraemia or hyponatraemia during their admission by retrospective ICD10 coding*.

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NOTES FOR READERS

Normal blood sodium levels range from **135-145 mmol/L**
Hyponatraemia is the term used to describe **low** blood sodium levels (<135 mmol/L)
Hypernatraemia is the term used to describe **high** blood sodium levels (>145 mmol/L)
This report relates to adults (18 years and over) only

LINKS TO ADDITIONAL REPORT SECTIONS

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INTRODUCTION FROM THE CHAIR

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The measurement of blood sodium levels is one of the most commonly requested pathology tests in the UK and levels outside the reference range are encountered regularly by a wide range of primary and secondary care specialties. The detection of an abnormal blood sodium level is often an incidental finding and may or may not be related to the condition being investigated. Hyponatraemia and hypernatraemia are not diagnoses on their own, and it is vital that the underlying cause of the abnormality is identified and treated. Hyponatraemia in particular can be more challenging as it has several causes, each requiring a different set of investigations and treatment.

The majority of blood sodium measurements are carried out in biochemistry laboratories, but a significant number are now done using point-of-care testing equipment, such as blood gas analysers, close to the patient's bedside. While this has many advantages, it does mean that the results of tests may not always be entered on the patient's laboratory record or filed in the patient's notes. Whichever technique is used, it is important that all results are recorded in the patient's record, and the same method is used when monitoring blood sodium levels, so sequential results are comparable. Thorough assessment and monitoring of patients' fluid status is not easy and may not be done well but is important to help guide both diagnosis and treatment. Accurate fluid balance records should be kept and reviewed regularly. The use of a care bundle, which is easily deliverable in different systems, could help ensure that appropriate ancillary tests are carried out in a timely manner.

There are many causes of abnormal blood sodium levels but one of the most easily identified and corrected is the effect of starting or changing the dose of a medication. An early, thorough medication review should be carried out for all patients, with changes made only after risk assessment and with specialist input if appropriate. It is particularly important that any changes to medications are communicated promptly to the patient's GP and other clinicians, with a rationale for the change, so that appropriate care continues after discharge and in the community.

The diagnosis of the cause of abnormal blood sodium level is not always straight forward, so specialist advice should be available and sought to help inform investigation and treatment decisions. Endocrinologists and clinical biochemists, in particular, have an important role to play in supporting clinicians to investigate and treat electrolyte disturbances such as abnormal blood sodium levels and undertake follow-up after discharge if required.

As always, my grateful thanks go to everyone involved in developing and carrying out this study and those involved in writing the report and its recommendations.

Dr Suzy Lishman CBE,NCEPOD Chair

TO IMPROVE THE CARE PROVIDED TO PEOPLE WITH ABNORMAL BLOOD SODIUM LEVELS…

Develop care bundles and training to reduce variation in the assessment and management of abnormal blood sodium levels.

Abnormal blood sodium levels were not always acted on as they should have been, leading to under investigation, inappropriate treatments and poor overall management.	116/265 (43.8%) emergency admission hyponatraemia patients should have had further investigations.	Training on hyponatraemia was provided to foundation doctors in most hospitals, but less so for other grades and specialties (37/100; 37.0%). Training on hypernatraemia was only provided in 14/99 (14.1%) hospitals.

Improve the clinical assessment of fluid status in all patients.

Patients do not have consistent assessment of their fluid status and monitoring and/or recording of their fluid balance.	57/270 (21.1%) patients with hyponatraemia did not have a fluid status assessment documented in their notes during their initial assessment. Furthermore, monitoring and documentation of fluid balance was inadequate in 85/205 (41.5%).	The accuracy of completion of fluid balance charts was only audited in 51/83 (61.4%) hospitals. In 73 hospitals this could not be answered.

Integrate test results into patient electronic records to help identify trends in blood sodium levels.

Frequently, results from point-of-care testing are not directly linked into the hospital laboratory electronic reporting system leading to delays in treatment.	Initial blood sodium results in patients with hyponatraemia (357/386; 92.5%) were from laboratory testing rather than point-of-care testing.	There were delays in the treatment of emergency admission hyponatraemia (64/255; 25.1%) and 17/64 (26.6%) were attributed to the impact of out-of-hours care with reduced staffing.

Standardise the use and the dosing of hypertonic saline solution.

Clinical staff are unsure when to use hypertonic saline and the dosage needed. This is hindered further by the variability in the concentrations stocked across all hospitals.	55/354 (15.5%) patients received hypertonic saline as part of their treatment. For seven patients, this was not indicated.	Of the 28/55 patients administered with hypertonic saline in an emergency department, only 11 were admitted to a critical care unit.

Document and communicate all medication changes to all healthcare providers and patients.

Medication changes were not always communicated which could lead to patients restarting medications that had caused their abnormal blood sodium.	225/270 (83.3%) patients admitted on an emergency basis with hyponatraemia were taking one or more medication that could have contributed to their hyponatraemia.	'Communication' to the GP that a medicine had been stopped, was commonly absent from the patient's medication list at discharge.

Blood sodium levels is one of the most requested pathology tests and levels outside the reference range are encountered regularly by a wide range of primary and secondary care specialties. The detection of an abnormal blood sodium is often an incidental finding and may or may not be related to the condition being investigated. Hyponatraemia and hypernatraemia are not diagnoses on their own, and it is vital that the underlying cause of the abnormality is identified and treated.

The care of patients in hospital between 1st Oct 2023 and 31st Dec 2023 with a diagnosis code of hyponatraemia or hypernatraemia was reviewed using 428 sets of case notes, 650 clinician questionnaires and 156 organisational questionnaires.

RECOMMENDATIONS

These recommendations have been formed by a consensus exercise involving all those listed in the acknowledgements. The recommendations have been independently edited by medical editors experienced in developing recommendations for healthcare audiences to act on.

The recommendations in this report support those made previously by other organisations, and for added value should be read alongside:

- Society for Endocrinology: Emergency management of severe and moderately severely symptomatic hyponatraemia in adult patients
- NICE Clinical Knowledge Summary: Hyponatraemia
- European Society of Endocrinology Clinical guideline for the management of hyponatraemia
- NICE Clinical Guideline CG174: Intravenous fluid therapy in adults in hospital

1	Implement processes to reduce variation in the assessment and management of abnormal blood sodium levels.* • Develop national care bundles. • Develop training for all healthcare professionals to be able to assess and treat patients with abnormal blood sodium levels and recognise when to escalate to specialists. **Promote existing information on hyponatraemia from the Society for Endocrinology and develop it into the care bundle*
FOR ACTION BY	Department of Health and Social Care/NHS England, Welsh NHS, Health Department of Northern Ireland, Government of Jersey
RATIONALE FOR THE RECOMMENDATION	The care and outcome of patients with an abnormal blood sodium may be improved through timely and appropriate identification and investigation. While there is guidance from the Society of Endocrinology and others on what investigations to do and how to manage hyponatraemia (low sodium), delays and omissions in the appropriate investigations being undertaken for patients were common in this study. Furthermore, patients admitted with conditions that might cause abnormal blood sodium levels should raise a concern and be investigated. There are currently no national guidelines for managing hypernatraemia (high sodium).
ASSOCIATED GUIDANCE	▪ RECOGNITION OF THE PATIENT PRESENTING WITH SEVERE AND MODERATELY SEVERE, SYMPTOMATIC HYPONATRAEMIA ▪ SOCIETY FOR ENDOCRINOLOGY: EMERGENCY MANAGEMENT OF SEVERE AND MODERATELY SEVERELY SYMPTOMATIC HYPONATRAEMIA IN ADULT PATIENTS ▪ NICE: HYPONATRAEMIA SCENARIO MANAGEMENT ▪ EUROPEAN SOCIETY OF ENDOCRINOLOGY CLINICAL GUIDELINE FOR THE MANAGEMENT OF HYPONATRAEMIA

ADDITIONAL STAKEHOLDERS	Society for Endocrinology, Royal College of Physicians, Royal College of Emergency Medicine, Royal College of Pathologists, Society for Acute Medicine, Royal College of Surgeons of England, Association of Surgeons of Great Britian and Ireland, Royal College of Anaesthetists, Association of Anaesthetists, Royal College of Nursing, Faculty for Intensive Care Medicine, Intensive Care Society, Association for Laboratory Medicine, Royal Pharmaceutical Society, UK Kidney Association
IMPLEMENTATION SUGGESTIONS: CLICK HERE	

2	Develop clear standards and tools for the assessment and recording of fluid status in all patients with abnormal blood sodium levels including, when appropriate, the use of point-of-care ultrasound.* **Point-of-care ultrasound is relatively new so should be considered as further research in its use is published and standards are developed*
FOR ACTION BY	Department of Health and Social Care/NHS England, Welsh NHS, Health Department of Northern Ireland, Government of Jersey
RATIONALE FOR THE RECOMMENDATION	Initial and subsequent clinical assessment of fluid status, along with ongoing monitoring of fluid balance after admission were not undertaken well or documented clearly. These assessments should be part of routine clinical care provided by all relevant healthcare professionals. Failure to do these can impact on the appropriateness of the hyponatraemia and hypernatraemia treatment. In addition, there is now interest in the use of point-of-care ultrasound (PoCUS) alongside clinical assessment to improve the quality of the fluid status assessment. Currently this is not widely used due to the lack of availability of technology and appropriately trained clinicians and the most appropriate way to use PoCUS has not been agreed amongst specialists.
ASSOCIATED GUIDANCE	▪ NICE CLINICAL KNOWLEDGE SUMMARY: HYPONATRAEMIA SCENARIO MANAGEMENT ▪ BRITISH MEDICAL ULTRASOUND SOCIETY: FOCUSED AND POINT-OF-CARE ULTRASOUND
ADDITIONAL STAKEHOLDERS	Royal College of Nursing, Royal College of Physicians, Royal College of Emergency Medicine, Royal College of Pathologists, Society for Acute Medicine, Royal College of Surgeons of England, Royal College of Anaesthetists, Association of Anaesthetists, Faculty for Intensive Care Medicine, Intensive Care Society, Society for Acute Medicine, Royal College of Radiologists, trusts/health boards, Royal Pharmaceutical Society, UK Kidney Association (clinical) British Society for Echocardiography, Intensive Care Society - Focused Ultrasound in Intensive Care (FUSIC), Consortium for the Accreditation of Sonographic Education and Medical Schools/Universities (training)

	National Institute for Healthcare Research (NIHR) (research into the use of point-of-care ultrasound).

IMPLEMENTATION SUGGESTIONS: CLICK HERE	
3	Integrate point-of-care testing results into patient electronic records.
FOR ACTION BY	Commissioners/integrated care boards with the hospitals in their trusts/health boards
RATIONALE FOR THE RECOMMENDATION	Point-of-care analysis, such as blood gas analysers, can enable clinicians to have an initial blood sodium result more rapidly than laboratory results. This allows faster determination if additional investigations and/or specific treatment of hyponatraemia or hypernatraemia is required. Frequently, results from point-of-care testing are not directly linked into the hospital laboratory electronic reporting system and require clinicians to transcribe or include them in the patient's medical records. This may not happen, so they are 'lost', and therefore are not available for review during the current or subsequent admissions, which would allow trends in blood sodium levels to be determined. It is essential that testing done using point of care analysers is validated and quality controlled to ensure the validity and consistency of the reported results.
ASSOCIATED GUIDANCE	▪ INTEGRATING IN VITRO POINT-OF-CARE DIAGNOSTICS: GUIDANCE FOR URGENT COMMUNITY RESPONSE AND VIRTUAL WARD SERVICES ▪ ROYAL COLLEGE OF PATHOLOGISTS: THE RETENTION AND STORAGE OF PATHOLOGICAL RECORDS AND SPECIMENS (DRAFT 6TH EDITION) ▪ POINT OF CARE TESTING: NATIONAL STRATEGIC GUIDANCE FOR AT POINT OF NEED TESTING
ADDITIONAL STAKEHOLDERS	Royal College of Nursing, Royal College of Physicians, Royal College of Emergency Medicine, Royal College of Pathologists, Society for Acute Medicine, Royal College of Surgeons of England, Royal College of Anaesthetists, Association of Anaesthetists, Faculty for Intensive Care Medicine, Intensive Care Society, Society for Acute Medicine, Royal College of Radiologists, Association for Laboratory Medicine, Electronic Patient Record providers,
IMPLEMENTATION SUGGESTIONS: CLICK HERE	

4	Develop a national standard for the use of hypertonic saline in the management of hyponatraemia. This should include: ▪ The indications for its use ▪ The dose, route and location of administration ▪ Monitoring the blood sodium levels, including the rate of correction ▪ Actions to be taken if over-correction occurs ▪ A consensus on the strength of hypertonic saline stocked in hospitals.
FOR ACTION BY	Society for Endocrinology
RATIONALE FOR THE RECOMMENDATION	Many patients had clinical features of hyponatraemic encephalopathy but only half were administered hypertonic saline, and there were patients with no clinical indication who had it administered. When it was administered, there was variation in the rate, route, strength, and location of administration. Currently there is variability in the strength(s) of hypertonic saline stocked in hospitals, which increases risk as resident doctors rotate between hospitals. Additionally, a fifth of patients administered hypertonic saline had inappropriate subsequent monitoring of their blood sodium levels which increases the risk of too-rapid sodium correction, a risk factor for developing osmotic demyelination syndrome.
ASSOCIATED GUIDANCE	▪ SOCIETY FOR ENDOCRINOLOGY: EMERGENCY MANAGEMENT OF SEVERE AND MODERATELY SEVERELY SYMPTOMATIC HYPONATRAEMIA IN ADULT PATIENTS ▪ NICE: HYPONATRAEMIA SCENARIO MANAGEMENT ▪ EUROPEAN SOCIETY OF ENDOCRINOLOGY CLINICAL GUIDELINE FOR THE MANAGEMENT OF HYPONATRAEMIA
ADDITIONAL STAKEHOLDERS	Royal College of Physicians, Royal College of Emergency Medicine, Society for Acute Medicine, Royal College of Surgeons of England, Association of Surgeons of Great Britain and Ireland, Royal College of Anaesthetists, Association of Anaesthetists, Royal College of Nursing, Faculty for Intensive Care Medicine, Intensive Care Society, Royal Pharmaceutical Society
IMPLEMENTATION SUGGESTIONS: CLICK HERE	

5	Raise awareness of the importance of documenting and communicating all medication changes made in hospital to primary care as well as the patients and their family/carers.
FOR ACTION BY	Royal College of Physicians, Royal College of Emergency Medicine, Society for Acute Medicine, Royal College of Surgeons of England, Association of Surgeons of Great Britain and Ireland, Royal College of Anaesthetists, Association of Anaesthetists, Royal College of Nursing, Faculty for Intensive Care Medicine, Intensive Care Society, Royal College of General Practitioners, Royal Pharmaceutical Society.
RATIONALE FOR THE RECOMMENDATION	Most patients reviewed were taking one or more medicine that could be associated with the development of either hyponatraemia or hypernatraemia. Patients should have a thorough medication review (prescribed, over-the-counter and others) at the time an abnormal blood sodium is identified. As a result, many patients had changes to their prescribed medications during the admission to hospital (for example doses changed, switching to alternative medicines, and/or stopping of medication(s)). These changes were not clearly outlined at the point of discharge to the GP, other healthcare professionals involved in their care, patients and/or their family/carers.
ASSOCIATED GUIDANCE	▪ NICE CLINICAL KNOWLEDGE SUMMARY: HYPONATRAEMIA SCENARIO MANAGEMENT ▪ PROFESSIONAL RECORD STANDARD BODY: EDISCHARGE SUMMARY STANDARD ▪ ROYAL COLLEGE OF PHYSICIANS: ACUTE CARE TOOLKIT 17 MANAGING MULTIPLE MEDICATIONS
ADDITIONAL STAKEHOLDERS	Commissioners/integrated care boards, Department of Health and Social Care/NHS England, Welsh NHS, Health Department of Northern Ireland, Government of Jersey
IMPLEMENTATION SUGGESTIONS: CLICK HERE	

SUGGESTIONS FOR FUTURE RESEARCH

- Further work is needed to determine whether postoperative fluid protocols should be adjusted for weight and/or size, to reduce the risk of hyponatraemia and other electrolyte disturbances occurring.
- National guidelines or recommendations are needed on how quickly clinicians should act on abnormal blood sodium levels once reported and on the criteria for reporting rapidly dropping sodium results, as this may be a more important risk factor for the development of hyponatraemic encephalopathy than the absolute value.
- The use of point-of-care ultrasound in the assessment of blood sodium levels.

CHAPTER 1: METHODS

DETAILS ON THE METHOD ARE AVAILABLE HERE

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Study advisory group

A multidisciplinary group of clinicians was convened to steer the study from design to completion, define the objectives of the study and advise on the key questions. The group comprised lay and patient representatives and healthcare professionals in clinical biochemistry, emergency medicine, endocrinology, intensive care medicine, general surgery, neurology, pharmacy, renal medicine and specialist nursing.

Study aims and objectives

The objectives of the study were to identify and explore the avoidable and modifiable factors in the care of adults with abnormal levels of blood sodium levels in hospital.

Study population and case ascertainment

Inclusion criteria

All patients aged 18 or over were admitted to hospital between 1st October 2023 and 31st December 2023 and identified as having hyponatraemia or hypernatraemia during their admission by retrospective ICD10 coding. Patients who presented as an emergency and those who developed abnormal blood sodium levels after surgery were included.

Data collection

- A clinician questionnaire was sent to the named consultant for each patient in the sample. To collect data on the care provided throughout the admission, focusing on investigation and treatment of the patient's abnormal blood sodium level.

- An organisational questionnaire was sent to each hospital to collect data on the organisational structures, staffing provision and policies around the assessment and management of abnormalities in blood sodium levels.

- Copies of the case notes were requested for the included admission of each patient for peer review by a multidisciplinary group of case reviewers comprising consultants and trainees from acute medicine, anaesthetics, intensive care medicine, endocrinology, gastroenterology, general medicine, geriatric medicine, renal medicine and clinical biochemistry.

Data analysis rules

- Small numbers have been suppressed if they risk identifying an individual (usually <5)
- Any percentage under 1% has been presented in the report as <1%
- Percentages were not calculated if the denominator was less than 100 so as not to inflate the findings, unless to compare groups within the same analysis
- There will be variation in the denominator for different data sources and for each individual question as it is based on the number of answers given.

CHAPTER 2: DATA RETURNED AND THE STUDY POPULATION

DETAILS ON THE STUDY POPULATION ARE AVAILABLE HERE

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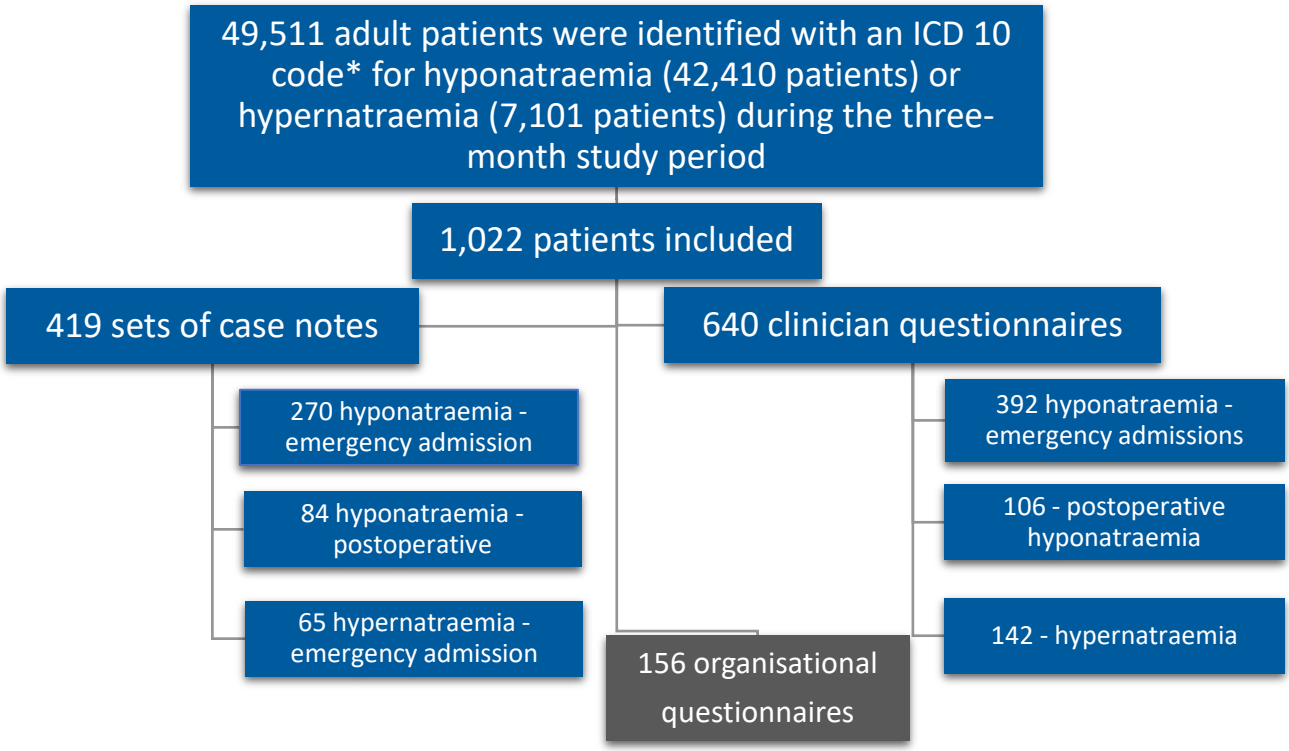
Data returned



**The presence of an ICD-10 code would only have captured that hyponatraemia and/or hypernatraemia occurred during the admission but would not indicate the cause of the abnormal sodium level.*

- Of the patients admitted as an emergency, 93/392 (23.7%) had been an inpatient in the previous 30 days and this was due to hyponatraemia in 31. Therefore, 31/384 (8.1%) patients in this study with hyponatraemia had been in hospital in the previous 30 days for hyponatraemia.
- Patients with hypernatraemia were older (mean 76.9, median 81 years) than patients with hyponatraemia (mean 74.0, median 77 years) **(F2.1)**.
- A higher proportion of patients with both hyponatraemia and hypernatraemia were female.
- The ethnicity of the study population was similar to the population as a whole **(T2.1)**.
- There were 136/331 (41.1%) patients with hyponatraemia who had a high functional status (Rockwood Frailty Score 1-3) compared to 26/134 (19.4%) with hypernatraemia. This may reflect the greater proportion of patients with hypernatraemia who were admitted to hospital from a residential or nursing home (60/141; 42.6% vs 15/386; 3.9%) **(T2.2)** and that they were more likely to have a 'do not attempt cardiopulmonary resuscitation' (DNACPR) decision or treatment escalation plan (TEP) in place (hypernatraemia 39/61; 63.9% vs hyponatraemia 50/386; 13.0%) **(T2.3)**.

CHAPTER 3: IDENTIFICATION OF HYPONATRAEMIA AND HYPERNATRAEMIA

DETAILED FINDINGS ABOUT THIS AREA OF CARE ARE AVAILABLE HERE

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CASE STUDY – GOOD CARE

A 61-year-old patient presented with a sodium of 111 mmol/L. The low blood sodium result was recognised by the laboratory team and the clinical biochemist contacted the treating medical team to discuss investigations and treatment.

Reviewers considered that the recognition of severe hyponatraemia based on the blood result led to senior clinical feedback to the team, preventing any delays in the patient's treatment.

CASE STUDY – ROOM FOR IMPROVEMENT

A 75-year-old patient presented after a fall. Treatment was not started despite a blood gas sodium result of 109 mmol/L, and the patient had had a seizure by the time the laboratory called with a sodium result of 114 mmol/L.

Reviewers felt that the seizure may not have occurred if the blood gas sodium result had been used to initiate treatment. There were also further delays in calling through the formal results.

While hyponatraemia or hypernatraemia may be suspected based on clinical symptoms, underlying comorbidities and/or current medications, most patients are usually identified through blood tests.

- The majority (258/392; 65.8%) of patients with emergency admission-related hyponatraemia had their lowest sodium level on presentation to hospital (120 (IQR: 116 to 124) mmol/L) **(F3.1)**.
- Patients who developed hyponatraemia postoperatively had less severe hyponatraemia based on their lowest blood sodium results; median lowest blood sodium was 120 (IQR: 116 to 123) mmol/L for emergency admission-related hyponatraemia and 125 (IQR: 122 to 128.25) mmol/L for postoperative hyponatraemia **(F3.2 and F3.3)**.
- There were 90/183 (49.1%) first sodium results available for patients with hyponatraemia within an hour of time of arrival at hospital. This increased to 137/183 (74.9%) within 2.5 hours.
- Using point of care testing, such as blood gas analysers, can reduce the time to obtain blood sodium results as there is no need to transport the sample to the laboratory. Most of the initial sodium results in patients with hyponatraemia recorded in the clinician questionnaires (357/386; 92.5%) (unknown for 6) and reviewer assessment forms (169/263; 64.3%) (unknown for 7) were from laboratory testing rather than point-of-care testing (e.g. blood gas analyses).
- More initial sodium results from point-of-care testing may have been available to the treating clinicians than indicated in the questionnaire responses. This discrepancy could arise because such results are not always fully integrated into laboratory electronic reporting systems.
- Currently there are no national guidelines or recommendations on how quickly clinicians should act on abnormal blood sodium levels once reported. And there are no recommendations on the criteria for reporting rapidly dropping sodium results, which may be a more important risk factor for the development of hyponatraemic encephalopathy than the absolute value.
- The majority of hospitals (123/156; 78.8%) had guidelines for laboratory staff to escalate abnormal results and set values to trigger an alert **(T3.1)**.

CHAPTER 4: ASSESSMENT AND INVESTIGATION OF THE CAUSE OF HYPONATRAEMIA

DETAILED FINDINGS ABOUT THIS AREA OF CARE ARE AVAILABLE HERE

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CASE STUDY – GOOD CARE

A 78-year-old patient had hyponatraemia with a blood sodium level of 104 mmol/L due to excessive fluid intake. There was a clear assessment of the patient's fluid status on admission and the clinical team sent the appropriate investigations in a timely manner. The patient's fluid balance was monitored and documented very clearly throughout the admission.

Reviewers said that the clear documentation in the patient's notes of the initial and timely investigations ensured that the cause of the hyponatraemia was identified and the treatment was appropriate. During the admission there was good documentation of fluid balance.

CASE STUDY – ROOM FOR IMPROVEMENT

A 76-year-old patient with voiding issues and urinary retention was drinking lots of fluids and was admitted with a sodium of 123 mmol/L. No urine biochemistry was undertaken, and no diagnosis was made. Management alternated between intravenous fluids and fluid restriction. In addition, the patient's protein pump inhibitor was stopped with no clear reason why.

Reviewers thought this demonstrated a lack of understanding of the potential causes of hyponatraemia. Under-investigation of the cause of the hyponatraemia led to inappropriate 'trials' of treatments and stopping medication without clear causation.

Fluid status assessment

Assessment of fluid status in patients with hyponatraemia is essential for determining its cause. Delays in clinical teams not sending appropriate investigations and establishing the fluid status of the patient in a timely manner can lead to confusion in what treatment is required.

- In total, 57/270 (21.1%) patients with hyponatraemia did not have a fluid status assessment documented in their medical records during the initial assessment, with no indication that any assessment had been undertaken and 11/270 (4.1%) had incomplete or inadequate assessments.
- There were 85/205 (41.5%) patients admitted with hyponatraemia, and 14/62 (22.6%) who developed postoperative hyponatraemia who did not have evidence of appropriate monitoring (essential for determining the type of hyponatraemia) and documentation of fluid balance (T4.1).
- In 26/156 (16.7%) hospitals both electronic and paper charts were used (T4.2). This practice may increase the risk to patients due to the potential for duplicate recording, which can lead to over- or under-estimating a patient's actual fluid intake and/or output, resulting in inappropriate changes to oral or IV fluids.
- Accuracy of completion of fluid balance charts was audited in only 51/83 (61.4%) hospitals, and just 39/83 hospitals reported that any quality improvement projects had been undertaken in the previous five years related to fluid management. Where they had been completed, the improvement themes identified were around resident doctor training and support for the use of intravenous (IV) fluids in both general medicine and surgery, strategies to implement NICE

CG174 (Intravenous fluid therapy in adults in hospital and training and compliance with fluid balance documentation.

- It was reported from only 26/156 (16.7%) hospitals that there was an IV fluid lead in place as recommended by NICE and in 63/156 (40.4%) it was unknown, suggesting that the overall proportion of hospitals with an IV fluid lead was much lower.
- In this study point-of-care ultrasound (PoCUS) was only used to assess fluid status in three patients as it is an emerging application amongst non-radiologist clinicians, not currently widely used due to the lack of availability of technology and appropriately trained clinicians.

Imaging

- The majority (222/270; 82.2%) of patients admitted as an emergency had some form of imaging undertaken during their admission **(T4.3)** and this altered the management for only 11 patients with emergency admission-related hyponatraemia.

Blood tests

- Data from the clinical questionnaires showed that liver function tests were most commonly performed **(F4.1)**.
- A higher proportion of postoperative hyponatraemia patients required additional investigations compared to those admitted as an emergency (47/83; 56.6% vs 116/265; 43.8%). **Table 4.4** shows the other investigations that were indicated.

Plasma/serum osmolality

The measurement of plasma/serum and/or urine osmolality, along with urine sodium concentrations, are required to assist clinical teams in diagnosing the cause of the hyponatraemia, so results need to be made available as soon as possible.

- 48/270 (17.8%) emergency admission patients and 33/84 (39.3%) postoperative patients did not have paired (taken at the same time) urine and plasma/serum osmolality measured when it was indicated (**F4.2** and **F4.3**).
- There was no strong correlation between the serum and urine osmolality in an individual patient with hyponatraemia **(F4.4)**, which may reflect that urine and serum osmolalities were often not 'paired'; with the urine typically being sent later and so the result may be impacted by any treatment that has been given before the urine is collected.
- There was a delay in obtaining the results from the time of request of a urine osmolality compared to plasma/serum osmolality in emergency admission-related hyponatraemia. Obtaining the urine osmolality result rapidly may be helpful in making a diagnosis or determining what treatment is appropriate (**F4.5** and **T4.5**).
- Most hospitals had agreed turnaround times for urine osmolality (93/114; 81.6%), urine sodium (95/118; (80.5%) and serum/plasma osmolality (99/118; 83.9%) **(T4.6)**. However, the reported service level agreements for these turnaround times in a high proportion of hospitals exceed what the reviewers considered to be clinically acceptable **(T4.7)**. In addition, regular audit of the turnaround times for these tests occurred in only 30/73 (41.1%) hospitals where it was known **(T4.8)**.

Serum cortisol

Measurement of serum cortisol in patients with hyponatraemia should be undertaken if the suspected cause of the hyponatraemia is thought to be adrenal insufficiency. Ideally, the serum cortisol should be measured between 8:00am and 9:00am to facilitate the interpretation of the result, as there is variation in cortisol with higher levels in the morning and lower levels in the evening. Although, outside of these hours a low serum cortisol in patients with severe hyponatraemia may alert clinicians to suspect adrenal insufficiency.

- Only 25/150 (16.7%) patients had cortisol samples collected between 8:00am and 9:00am. The presence of an abnormal cortisol outside of 08:00am and 10:00am, should lead clinicians to repeat the test utilising additional resources (F4.6).

Duration and severity of emergency admission-related hyponatraemia

Acute hyponatraemia is defined as occurring in the previous 48 hours.

- Where the time of onset could be determined, 184/306 (60.1%) patients admitted as an emergency had acute hyponatraemia (T4.9).
- The severity of hyponatraemia was determined by the local treating clinician. However, as the severity gradings were not defined for the clinicians, their assessment could have been made based on biochemical severity, clinical severity or a combination of both (T4.10).
- Severe hyponatraemia was more common in patients with hypotonic (true) hyponatraemia (60/118; 50.8%) and hypervolaemic (volume overload) hyponatraemia (23/45; 51.1%) than in those with euvolaemic hyponatraemia (52/129; 40.3%).

Classification and the causes of hyponatraemia for patients admitted as an emergency

- Hyponatraemia is a descriptive term indicating that the patient has a low blood sodium concentration; it does not provide an indication of the actual cause of the sodium abnormality. Of note, 22/251 (8.8%) emergency admission patients with a low blood sodium level had only 'hyponatraemia' listed a cause of the low blood sodium in their notes, without any further clarification on the potential cause(s) for this.
- The reviewers agreed with the working diagnosis in 200/270 (74.1%) cases reviewed. In the cases where the reviewer did not agree, their reason was either that the clinicians had only documented 'low sodium' or 'hyponatraemia' as the diagnosis, or there were insufficient investigations undertaken for the reviewer to be able to support the clinical teams working diagnosis.

Hyponatraemic encephalopathy

- The reviewers determined that 105/260 (39.5%) patients should have had a diagnosis of hyponatraemic encephalopathy based on their symptoms (unknown for 10).
- Of the 63 patients who the treating clinicians documented as having a diagnosis of hyponatraemic encephalopathy, 38 were treated with hypertonic saline. In the additional 43 patients the reviewers believed should have been diagnosed with hyponatraemic encephalopathy, 11 were given hypertonic saline, suggesting that some patients were treated without the treating clinical team documenting that the patient had encephalopathy related to the hyponatraemia.

CHAPTER 5: MANAGEMENT OF HYPONATRAEMIA

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CASE STUDY – GOOD CARE

A 59-year-old patient with alcohol excess and mental health issues was found collapsed with an initial blood sodium level of 95 mmol/L. The patient was admitted to critical care, treated with hypertonic saline with good monitoring of subsequent sodium levels and recovered well.

Reviewers considered that the rapid commencement of hypertonic saline, admission to critical care and careful monitoring and treatment of the patient's blood sodium level prevented over-correction and the development of any complications.

CASE STUDY – ROOM FOR IMPROVEMENT

A 70-year-old patient had diuretic-related hyponatraemia (119 mmol/L), and the diuretics were stopped during their admission to hospital. There was no full medication review for other causes, nor was the GP informed of the stoppage at discharge.

Reviewers noted that the failure to inform the GP about stopping the diuretic could lead to re-prescription and the risk of recurrence of the hyponatraemia.

Location of admission

- In total, 219/270 (81.1%) patients admitted as an emergency were admitted to an acute/general medicine/elderly care ward area and 31/270 (11.5%) were admitted to a critical care (level 2 or 3) area (T5.1).

Treatment of hyponatraemia

- The treatments provided in both the emergency admission-related and postoperative hyponatraemia groups are shown in T5.2.
- Overall, the choice of treatment was deemed to be inappropriate for a quarter of both emergency admission patients (63/256; 24.6%) and postoperative hyponatraemia (22/74; 29.7%) (T5.3).
- The issues with the treatment(s) undertaken in both groups were broadly similar (T5.4). A total of 45 emergency admission-related hyponatraemia patients had both 0.9% sodium chloride and fluid restriction. This was inappropriate in only 10 patients; this reflects not only the challenge in the diagnosis of the cause of hyponatraemia, but also that on subsequent clinical assessment it may be appropriate to consider fluid restriction after a period of intravenous fluids or vice versa.
- A 2.7% sodium chloride solution was the most commonly administered hypertonic saline (2.7% alone in 38 patients or combined 1.8% and 2.7% sodium chloride solution in 12 patients (T5.5).
- Previous work has shown that administration of boluses of hypertonic saline is associated with better clinical outcomes. Bolus administration occurred in 33 patients (bolus alone in 31, combined boluses and IV infusion in two) (T5.6). Typically, hypertonic saline was administered in a critical care area for 44 patients (ED resuscitation or level 2 or 3 critical care) (T5.7).

- Of the 28 patients administered with hypertonic saline in an emergency department, only 11 were admitted to a critical care unit. The reviewers felt that five other patients were inappropriately admitted to a general ward area rather than critical care.

Monitoring

- When monitoring blood sodium levels, particularly after the administration of hypertonic saline, it is important that the same analytical method (either point-of-care or laboratory) is used to prevent differences in results between the analytical methodology impacting on the 'reported' rise in blood sodium levels.
- Blood sodium levels were monitored appropriately in 185/234 (79.1%) patients admitted as an emergency and 61/75 (81.3%) patients with postoperative hyponatraemia (T5.8).
- When hypertonic saline was administered, blood sodium levels were not monitored appropriately in 9/44 (20.5%) patients (T5.9).
- The issues with monitoring were due to blood sodium levels not being rechecked soon enough and/or inappropriate frequency of monitoring after administration of hypertonic saline solution.

Medication interactions

- The majority of patients admitted on an emergency basis with hyponatraemia were taking one or more medications prior to admission that could have contributed to their hyponatraemia (225/270; 83.3%) (T5.10).
- Given the potential relationship between certain medicines and the development of hyponatraemia 157/247 (63.6%) patients with emergency admission-related hyponatraemia had one or more changes to the medications they were taking on admission that may have contributed to the development of the condition. These changes may have occurred at the time of admission, at any point during the admission, or at the point of discharge.
- The most common changes made were discontinuation of a medication likely to cause hyponatraemia (141 patients) or dose adjustments to reduce risk of recurrence of the hyponatraemia (12).
- Where medications were changed, most changes were communicated to the GP on discharge (140/151; 92.7%). Commonly the 'communication' to the GP that a medicine has been stopped is its absence from the patient's medication list at discharge. It can therefore be unclear whether this is an intentional discontinuation or an omission on discharge prescribing.
- In those patients where no changes were made to medications during their hospital admission, reviewers identified that changes should have been made in 14/67 patients. These changes primarily involved stopping medicines associated with hyponatraemia (seven patients) and wider longer-term medication/disease management reviews (four patients).

Delays in treatment

- Delays occurred in the investigation or management of hyponatraemia in 17/64 (26.6%) emergency presentations and 5/18 (27.8%) postoperative hyponatraemia patients (T5.11). These delays were attributed to the impact of out-of-hours care where typically there was reduced medical, nursing and laboratory staff.

CHAPTER 6: ASSESSMENT AND MANAGEMENT OF HYPERNATRAEMIA

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CASE STUDY – GOOD CARE

A 70-year-old patient with poor oral intake and constipation was admitted with acute kidney injury and hypernatraemia (165 mmol/L). Their constipation was treated, and they were rehydrated with intravenous fluids. The patient's sodium level had normalised (143 mmol/L) by the time of discharge.

Reviewers said that this case of hypernatraemia was managed well with good documentation of fluid balance, and the patient was treated with appropriate intravenous fluids.

CASE STUDY – ROOM FOR IMPROVEMENT

A 76-year-old patient with dehydration had acute kidney injury but a normal blood sodium level on admission. They were not reviewed for many days and blood tests were not repeated, with worsening of their acute kidney injury and hypernatraemia (160 mmol/L). The patient died on the intensive care unit.

Reviewers felt that the failure to review and repeat bloods to detect worsening acute kidney injury and hypernatraemia meant that interventions to prevent deterioration were not put in place.

Timely identification of poor oral intake may allow interventions to prevent the development and/or worsening of hypernatraemia

- The most common cause of hypernatraemia was poor oral intake (77/142 (54.2%) **(T6.1)**.
- There were 11/53 (unknown in 12) patients with hypernatraemia where appropriate monitoring of fluid balance was not undertaken which if improved could have detected ongoing poor oral intake **(F6.1)**.
- The majority of hypernatraemia treatment involved rehydration (intravenous: 105 patients; oral/nasogastric rehydration: nine patients and combined oral/intravenous treatment: seven patients) **(T6.2)**.
- For most patients, the treatment(s) administered were appropriate (61/65). Overall, the themes for improvement included not fluid restricting in hypernatraemia and appropriateness of fluid choice for IV rehydration.
- Despite the lack of organisational focus on the assessment and management of hypernatraemia, 38/65 (58.5%) patients with hypernatraemia had their overall care graded as 'good practice'. This was better than for those patients with emergency admission hyponatraemia (111/265; 41.9%) or postoperative hyponatraemia (26/183; 31.3%). This higher grading of 'good practice' may reflect that the diagnosis of the cause is usually less complex than hyponatraemia and does not require the interpretation of blood and urine osmolalities, urine sodium, other blood test or investigations.

CHAPTER 7: SUPPORT FOR CLINICIANS TREATING PATIENTS WITH ABNORMAL BLOOD SODIUM LEVELS

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CASE STUDY – GOOD CARE

A 35-year-old patient with an eating disorder and alcohol excess presented with a seizure and initial sodium concentration of 115 mmol/L. A locally available clinical guideline provided advice on the management and specialist support that was available for managing the blood sodium levels. They were treated promptly, and the blood sodium levels were normalised.

Reviewers said that the multidisciplinary drafting of the guideline meant that there was appropriate support to resident medical staff out of hours, along with information on how to access specialist advice if needed.

CASE STUDY – ROOM FOR IMPROVEMENT

A 79-year-old patient had vomiting after an elective total knee replacement, which resulted in the sodium level dropping to 128 mmol/L. The orthopaedic team did not seek advice from medical specialists and restricted the patient's fluids. Blood sodium levels only improved once the patient was able to eat and drink.

Reviewers noted that if the orthopaedic team had asked for advice and/or a clinical review, the patient would have been treated with IV fluids instead of being inappropriately fluid restricted, as it was likely that the patient had hypovolaemic hyponatraemia.

Training

- Training on hyponatraemia and/or fluid management was commonly provided to foundation doctors (97/115; 84.3%), although it was only part of mandatory training in 30/90 hospitals. Training for other grade and specialties was less common (37/100; 37.0%). Training for staff on the management of hypernatraemia was only provided in 14/99 (14.1%) hospitals.

Audit and quality improvement projects

- Quality improvement projects on hyponatraemia been undertaken in only 46/103 (44.7%) hospitals (unknown in 53), and only eight in hypernatraemia, in the previous five years. Where undertaken positive actions included dedicated training for resident doctors, hyponatraemia investigation order sets/bundles, hyponatraemia assessment and management guidelines and protocols, guidance on use of hypertonic saline solution and development of electronic referral systems to specialist services for advice/clinical reviews and updating local guidelines on hypernatraemia management.

Specialist input and support

- Specialist advice for clinicians treating patients with hyponatraemia was available in 140/156 (89.7%) hospitals and was largely provided by services within the hospital or with a network.
- The advice could be provided by more than one specialty; endocrinology provided most of the advice (126/140; 90.0%) while clinical biochemistry only provided advice in 24/140 (17.1%) hospitals (T7.1).
- Specialist advice for clinicians treating patients with hypernatraemia was available in 126/156 (80.8%) hospitals and largely provided by services within the hospital.