



Health Services Safety
Investigations Body

Investigation report

Invasive procedures for people with sickle cell disease

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Theme:

Long-term conditions, Communication and decision making

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Contents

[Show subheadings](#)

[Executive summary](#)

[1 Background and context](#)

[2 The reference event](#)

[3 Analysis and findings](#)

[4 Summary of findings and safety recommendations and safety observations](#)

[5 References](#)

[6 Appendix](#)

Executive summary

Background

HSIB launched two investigations which aimed to add to the understanding of the care provided to patients with sickle cell disease. This is the first of the two investigation reports.

Sickle cell disease is the name for a group of inherited red blood cell disorders that affect haemoglobin, which is a protein in red blood cells that carries oxygen through a person's body. Normally, red blood cells are disc shaped and flexible, enabling them to move easily through the blood vessels carrying oxygen. People with sickle cell disease have crescent or 'sickle' shaped red blood cells, which do not bend or move easily and can therefore block blood flow to the rest of their body. If this happens, it can cause a number of symptoms, including episodes of acute pain known as 'sickle cell crisis'.

Sickle cell disease mainly affects people from African or Caribbean backgrounds, though it can affect anyone. It affects approximately 15,000 people in the UK.

This investigation set out to review the care of patients with sickle cell disease who need to have an invasive procedure. Invasive procedures involve accessing the inside of a patient's body, either through an incision (cut) or one of the body's orifices.

Specifically, the investigation focused on:

how haematology teams – the specialists who treat people with blood disorders – are involved and informed when a patient with sickle cell disease is treated in another area of healthcare

how patients with sickle cell disease are prepared for invasive procedures

how and where clinical information relevant to the patient is shared.

In November 2021, the All-Party Parliamentary Group for Sickle Cell and Thalassaemia published a report detailing the issues that people with sickle cell disease experience in relation to their care. The report made 31 recommendations to organisations across the healthcare system to help address these issues. HSIB launched two investigations to find out what additional learning or knowledge could be added in this area and to provide further insights into the practical challenges that patients with sickle cell disease may face when receiving NHS care.

The investigation used a real patient safety incident to explore the issues identified. The case involved a woman who had an invasive procedure which resulted in her being admitted to hospital for sickle cell crisis. This incident is referred to as 'the reference event' and was used to examine national issues.

The reference event

The patient, who was 45 years old at the time of the incident, had a history of sickle cell disease that had led to her being admitted to hospital multiple times. For approximately 3 years she had been receiving regular exchange blood transfusions (transfusions that replaced her blood with donated blood) to help treat the symptoms of her sickle cell disease.

She had heavy, painful and frequent menstrual periods and was scheduled for a surgical procedure to help ease her symptoms. The procedure did not have the desired effect and about 16 months later the patient was scheduled to have a further procedure to again try to ease her symptoms.

The haematology team were made aware of the procedure but were not told when it was occurring, the procedure was conducted 1 week before the patient was due to have her regular exchange transfusion. Her haemoglobin levels were low.

The patient experienced a significant amount of pain during the procedure and was transferred to the haematology ward afterwards for treatment of a sickle cell crisis.

The national investigation

The national investigation sought to understand how patients with sickle cell disease are prepared for scheduled invasive procedures and how teams within hospitals communicate and share clinical information about patients with sickle cell disease. The investigation also looked at national networks and guidelines to understand how clinicians were supported in decision making and providing the best care available to patients with sickle cell disease. This was with the aim of generating additional information and action to that already identified in the All-Party Parliamentary Group report.

Findings

The treatment people with sickle cell disease receive varies depending on where they live and the number of patients that clinicians see.

Guidance on the treatment of sickle cell disease is limited to specific circumstances, such as sickle cell crisis or blood transfusion, with limited wider guidance available on the through-life management of sickle cell disease.

Compared to other conditions that affect similar numbers of people, there has been limited research into the lifelong management of sickle cell disease. This may indicate a health inequality.

There is no national information system for storing and sharing clinical information for patients with sickle cell disease.

Currently the main way in which haematology consultants are made aware that a patient with sickle cell disease is having treatment in another area of healthcare is when they are notified of this by the patient.

It may be possible to set up healthcare IT systems so that they alert haematology consultants when one of their patients accesses another type of healthcare. However, consultants in areas with a high prevalence of sickle cell disease may then receive so many alerts that such a system would be ineffective.

HSIB makes the following safety recommendations

Safety recommendation R/2023/230:

HSIB recommends that NHS England identifies and implements a system for sharing clinical information about patients with sickle cell disease to improve access to this information for clinicians, and reduce the risk of a patient's sickle cell disease not being treated consistently.

Safety recommendation R/2023/231:

HSIB recommends that the National Institute for Health and Care Research assesses the priority and feasibility of commissioning research into the management of patients with sickle cell disease, encompassing the requirements of patient-controlled-analgesia (pain relief) pumps. This will contribute towards building an evidence base for the generation of national clinical guidance and will reduce unnecessary variance in treatment for patients with sickle cell disease.

HSIB makes the following safety observations

Safety observation O/2023/224:

It may be beneficial if trusts included a sickle cell disease notification within their electronic patient record systems, to ensure that clinicians treating patients with the disease consider it and seek advice from haematology teams about the impact of any planned treatments, such as invasive procedures.

Safety observation O/2023/225:

It may be beneficial if the healthcare sector explores, researches and fully understands the care provision to all patients with sickle cell disease, at all points in their life, encompassing day-to-day treatment through to sickle cell crisis.

1 Background and context

HSIB launched two investigations focusing on the care provided to patients with sickle cell disease. This is the first of the two investigation reports; it explores the care of people with sickle cell disease who need to have an invasive procedure, such as surgery. The second investigation report examines the care of patients who experience sickle cell crisis (see 1.2.2) ([Healthcare Safety Investigation Branch, 2023](#)).

1.1 Haematology

1.1.1 Haematology is the study of disorders relating to the blood and bone marrow. This covers red and white blood cells, and the platelets and coagulation systems which cause blood to clot.

Red cells and white cells

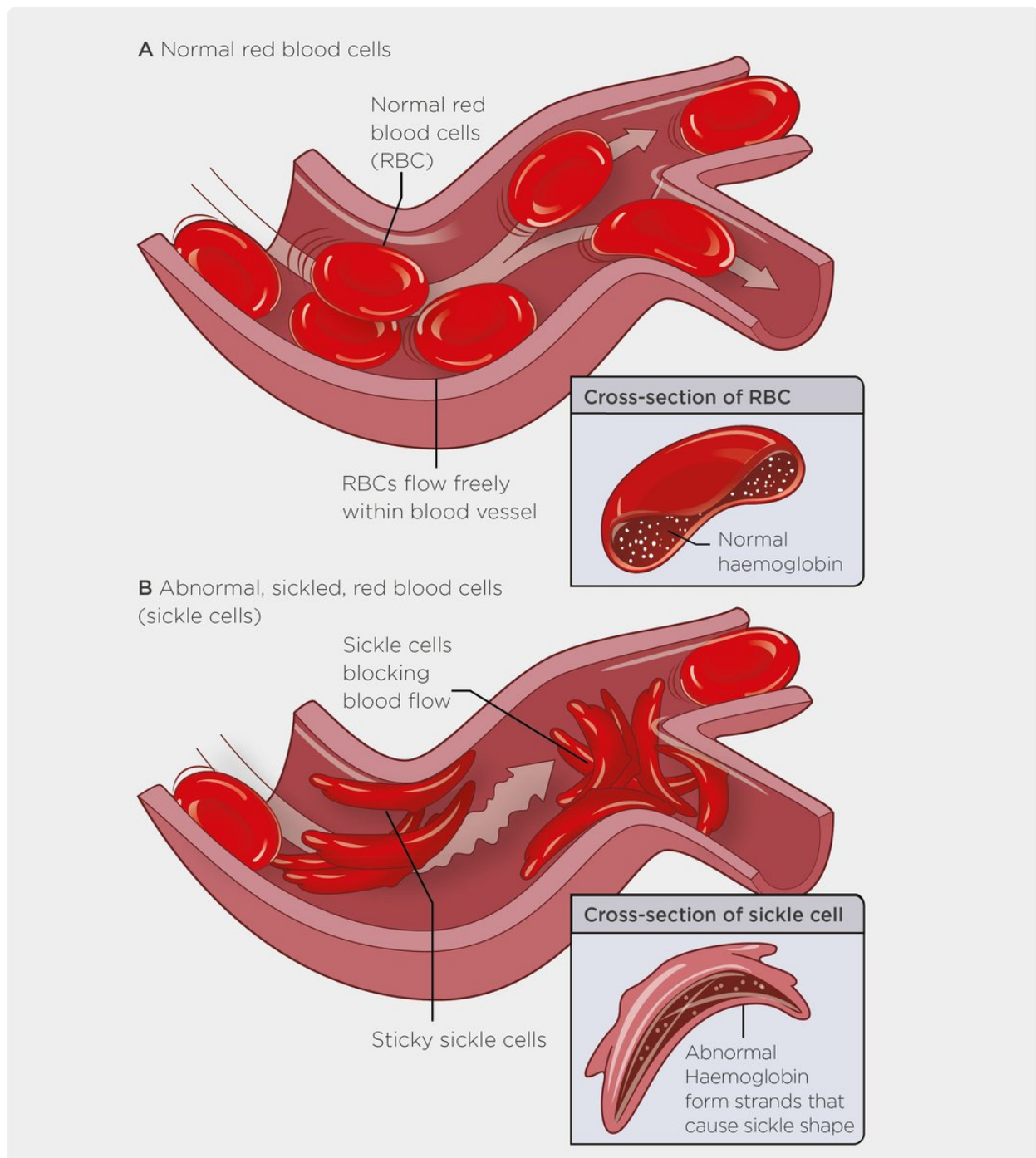
1.1.2 Red blood cells are the most common blood cells in the body. Their main function is to transport oxygen from the lungs to other parts of the body. Sickle cell disease is a red blood cell disease.

1.1.3 White blood cells help fight infections and other diseases as part of the body's immune system. White blood cell diseases include various types of blood cancer such as lymphoma and leukaemia.

1.2 Sickle cell disease

1.2.1 Sickle cell disease is the name for a group of inherited red blood cell disorders that affect haemoglobin, which is a protein in red blood cells that carries oxygen through a person's body (National Heart, Lung and Blood Institute, 2022). Normally, red blood cells are disc shaped and flexible, enabling them to move easily through the blood vessels carrying oxygen (see figure 1). People with sickle cell disease have crescent or 'sickle' shaped red blood cells, which do not bend or move easily and can therefore block blood flow to the rest of their body (National Heart, Lung and Blood Institute, 2022).

Figure 1 Normal and abnormal red blood cells (National Heart, Lung and Blood Institute, 2022)



1.2.2 Sickle cell disease can lead to a wide range of complications. These include:

- Sickle cell crisis or vaso-occlusive crisis – which are episodes of acute pain. These can affect a particular part of the body, often major joints (knee, shoulder, hip) and the torso including the stomach and chest. A sickle cell crisis can bring on reduced oxygen levels, and vice versa. People in sickle cell crisis require prompt treatment with pain relief, often opiate medication (morphine or similar medications), which should improve their symptoms.

- Sickle cell anaemia – a generic term covering all sickle cell disorders. Sickle cell disorders are a combination of vaso-occlusion (the blocking of the small blood vessels) and a chronic haemolytic anaemia.
- Acute chest syndrome – the sticky red blood cells can become stuck in a person's lungs, causing fever, breathlessness, coughing and wheezing.

Haemoglobin levels

1.2.3 People with sickle cell disease generally have lower haemoglobin levels than those without. A woman without sickle cell disease may have between 115 to 165 grams per litre (g/litre) of haemoglobin; a man may have 130 g/litre to 180 g/litre (Blood Cancer UK, n.d.). People with sickle cell disease have a variable haemoglobin level that may range from 70 g/litre to 110 g/litre in their routine daily condition (Marouf, 2011).

Sickle cell crisis triggers

1.2.4 Sickle cell crisis can be triggered by various factors, including:

low body temperature (including the impact of environmental factors, such as wind or rain)

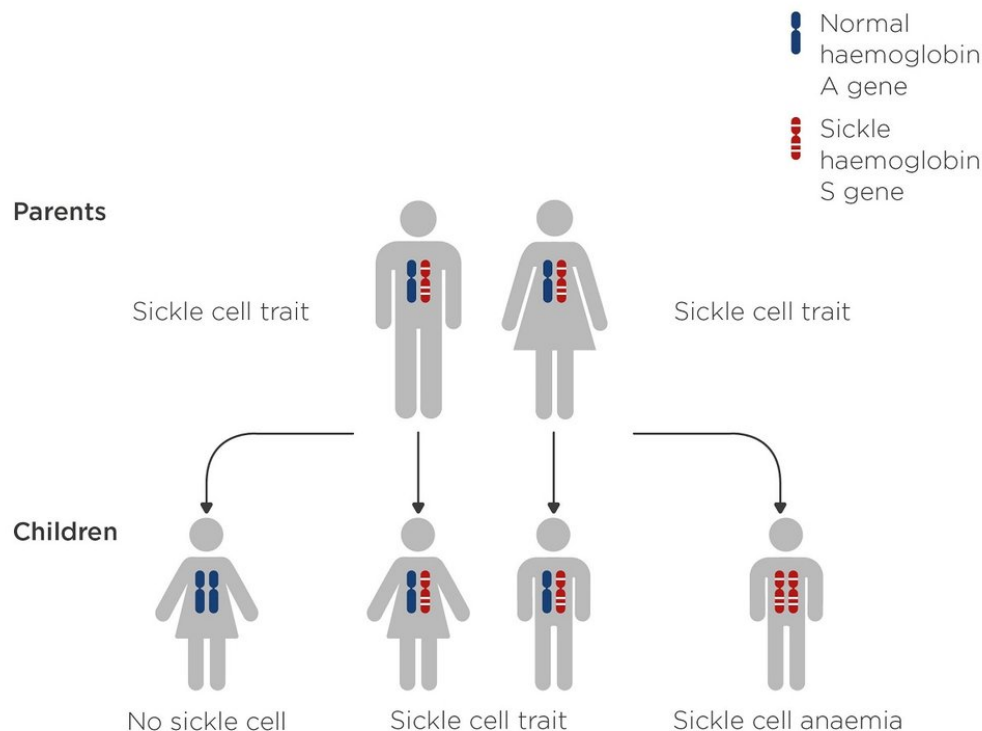
- dehydration
- stress
- strenuous exercise
- infection
- inflammation.

1.2.5 During and after medical procedures, efforts are made to maintain a patient's body temperature to try to reduce the risk of triggering a sickle cell crisis.

1.3 Cause and prevalence of sickle cell disease

1.3.1 Sickle cell disease is a genetic condition. People with sickle cell disease are born with it and will have it throughout their life. Sickle cell disease is inherited from a person's parents; both parents must have either sickle cell trait or sickle cell disease for their child to inherit the condition. A person has sickle cell trait when they inherit an abnormal haemoglobin gene (called haemoglobin S) from one parent, and a normal haemoglobin gene from the other (see figure 2). People who have sickle cell trait are generally healthy (National Heart, Lung and Blood Institute, 2022).

Figure 2 How sickle cell trait and sickle cell disease is inherited (National Heart, Lung and Blood Institute, 2022)



1.3.2 In the UK, approximately 1 in 79 babies carry the sickle cell trait, and around 300 babies are born with sickle cell disease each year. Approximately 15,000 people in the UK have sickle cell disease (Sickle Cell Society, n.d.).

1.3.3 Sickle cell disease can affect anyone; however, it mostly affects individuals from black African and Caribbean backgrounds. People from Central and South American, Middle Eastern, Asian, Indian and Mediterranean descent can also be affected.

1.4 Management of invasive procedures

1.4.1 Invasive procedures involve access to the inside of a patient's body, either through an incision (cut) or one of the body's orifices.

1.4.2 People with sickle cell disease are more likely to undergo surgery during their lifetime than the general population (Buck and Davies, 2005). Surgery exposes patients to many of the factors known to cause their red blood cells to sickle (become sickle shaped). Because of this, patients with sickle cell disease should be identified prior to surgery (Sickle Cell Society, 2018) and require meticulous care to prevent perioperative complications (complications that occur

during or after surgery) related to their sickle cell disease. Even with meticulous care, approximately 25% to 30% of patients with sickle cell disease will have postoperative complications (Buck and Davies, 2005).

1.4.3 The 'Standards for the clinical care of adults with sickle cell disease in the UK' (Sickle Cell Society, 2018) outline standards for the care of patients with the disease who undergo surgical procedures. The standards state that:

- 'All hospitals should have a protocol in place for preoperative screening for sickle cell disease.
- All hospitals should have a protocol in place for the perioperative management of patients with sickle cell disease, which will include recommendations for oxygenation, hydration, warmth, and surgical and anaesthetic techniques.
- Preoperative transfusion (simple transfusion [adding new blood cells] to Hb 100 g/l if Hb <90 g/l or partial exchange [removing existing blood cells and replacing with new] if Hb >90g/l) is recommended for patients with sickle cell anaemia undergoing low and medium risk surgery.
- Exchange transfusion [where a patient's blood or blood components are replaced with donated blood, rather than just 'topped up'] is recommended for all patients with sickle cell disease undergoing high risk surgery.
- Preoperative transfusion should be considered for patients with non-sickle cell anaemia genotypes undergoing low and moderate risk surgery taking into account previous history and complexity of surgery.'

1.5 Treatment of sickle cell disease

1.5.1 A blood and bone marrow transplant is currently the only cure for sickle cell disease but this is often not done because of the risks involved to the patients (NHS, 2022).

1.5.2 There are effective medications and treatments which can reduce the symptoms. These include:

- Penicillin: an antibiotic medication which is normally prescribed for children under 5 years of age.
- Hydroxycarbamide (hydroxyurea): an oral medication (taken by mouth) that has been shown in many clinical studies to reduce or prevent several sickle cell complications.
- Crizanlizumab: a new medication available to people aged 16 and over, who suffer from multiple sickle cell crises. Crizanlizumab can be taken on its own or alongside hydroxycarbamide.

- Blood transfusions: where a patient's blood is removed and replaced by a donor's blood, as described in 1.4.3.

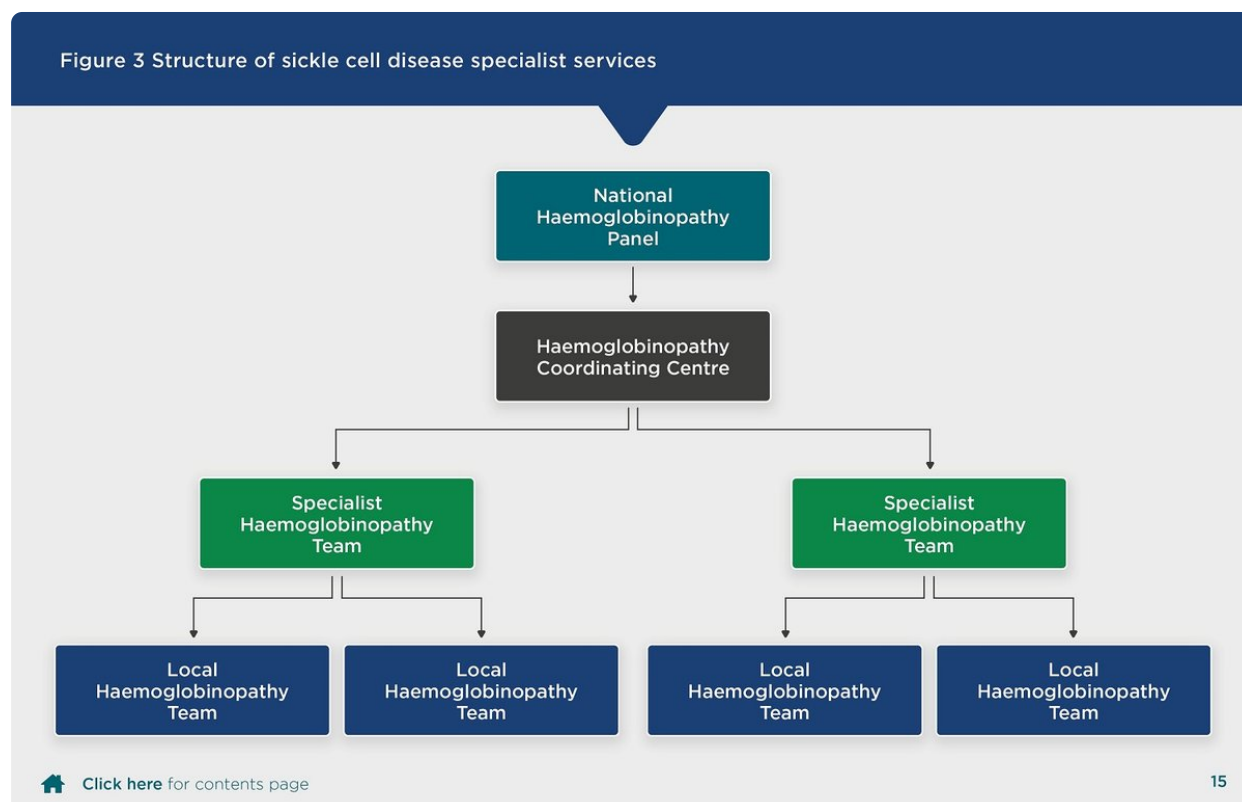
Patient-controlled analgesia (pain relief)

1.5.3 Patients experiencing sickle cell pain are often given patient-controlled analgesia (PCA) in a hospital. PCA is a method of delivering a set amount of pain-relieving (analgesic) medication, usually an opioid, from an electronically controlled infusion pump containing a reservoir of the medication. When the person presses a button on the PCA handset this activates the pump to deliver a small dose of analgesic. The analgesic is delivered either directly into the person's blood stream (intravenously) or under the person's skin (subcutaneously) through a thin flexible tube connected to the PCA pump. The amount of analgesic given when the patient presses the PCA button is known as a patient or 'bolus' demand or dose. There is also an option for continuous infusion of analgesic (that is, pain relief administered through a drip) to be given at the same time if needed, known as a background dose.

Sickle cell services

1.5.4 Sickle cell disease care is delivered by haemoglobinopathy teams – that is, teams specialising in the care of people with genetic haemoglobin disorders. These specialist teams were set up in 2019 and commissioned by NHS England. Services were set up in the structure shown in figure 3, with the National Haemoglobinopathy Panel sitting above the Haemoglobinopathy Coordinating Centres (HCCs), which in turn provide network support for one or more Specialist Haemoglobinopathy Teams (SHTs). These services are explored in more detail in our second report on the care of patients with sickle cell disease (Healthcare Safety Investigation Branch, 2023).

Figure 3 Structure of sickle cell disease specialist services



1.6 Interventional radiology

1.6.1 Interventional radiology is a sub-specialty of radiology. Clinicians who work in this sub-specialty will have completed training to become a radiologist and then undertaken additional training. Interventional radiology (IR) refers to 'a range of techniques which rely on the use radiological image guidance (X-ray fluoroscopy, ultrasound, computed tomography (CT) or magnetic resonance imaging (MRI) to precisely target therapy' (British Society of Radiology, n.d.).

1.7 'No one's listening' report

1.7.1 The All-Party Parliamentary Group (APPG) for Sickle Cell and Thalassaemia released a report detailing the issues people with sickle cell disease experience in relation to their care (Sickle Cell Society, 2021). The report highlights that 'awareness of sickle cell among healthcare professionals is low, with sickle cell patients regularly having to educate healthcare professionals about the basics of their condition at times of significant pain and distress'. Furthermore, the Sickle Cell Society produce standards for the clinical care of adults with sickle cell disease (Sickle Cell Society, 2018) which state that any surgical intervention should be planned for and managed with the haematology team.

1.7.2 The APPG report made 31 recommendations to organisations across the healthcare system. The Sickie Cell Society is monitoring the actions being taken to address these recommendations.

2 The reference event

This investigation used the following patient safety incident, referred to as 'the reference event', to examine the issue of care of people with sickle cell disease who have an invasive procedure.

2.1 The patient's story

The patient's medical history

2.1.1 The patient, who was 45 years old at the time of the reference event, had a history of sickle cell disease that had resulted in multiple hospital admissions. She was known to her local Trust's haematology department, which provided specialist care for the management of her condition, including exchange blood transfusions where her sickle haemoglobin was replaced with normal haemoglobin.

2.1.2 In 2018, the patient was referred to a consultant obstetrician and gynaecologist due to heavy, painful and frequent menstrual periods. The consultant identified that these were caused by adenomyosis (where the tissue that normally lines the uterus starts to grow within its muscular wall) and the presence of fibroids (non-cancerous growths in or around the uterus).

2.1.3 Hormonal treatment had not been effective in treating the patient's symptoms and a myomectomy (surgical removal of the fibroids) under general anaesthetic was scheduled for the last week of November 2019.

2.1.4 The risks associated with the myomectomy procedure, including the possibility of a sickle cell crisis, were explained to her as part of the process for taking informed consent.

2.1.5 Following the procedure, the patient was noted to have a pain score of 3 (trust pain scores range from 0 (no pain) to 3 (severe pain)). Her pain was managed using a combination of paracetamol and intravenous morphine. She was reviewed by the gynaecology and haematology teams and discharged home the following day.

The reference event: before the procedure

2.1.6 After the myomectomy, the patient's symptoms persisted, so a magnetic resonance imaging (MRI) scan was carried out in January 2021. This showed that her uterus had a further 20 small fibroids and an adenomyosis lesion (an area of tissue damaged by disease).

2.1.7 In March 2021, the consultant gynaecologist referred her to an interventional radiology consultant, asking whether an alternative procedure could be considered.

2.1.8 The referral letter included a brief medical history, making it known that the patient had sickle cell disease and was having exchange blood transfusions. The name of her consultant haematologist within the Trust was provided; the haematology consultant and her GP were sent copies of the referral letter, the letter contained no details of when the procedure was planned to take place.

2.1.9 The patient was seen by an interventional radiology consultant in early May 2021. In the referral response letter, the interventional radiology consultant stated that the patient did not want a further myomectomy or hysterectomy (the removal of the uterus) as she still wished to have a baby. The letter also detailed that the associated risks and benefits of an alternative procedure, uterine artery fibroid embolisation (a procedure to shrink uterine fibroids by depriving them of a blood supply), had been explained and the patient was 'keen to pursue this treatment'. The interventional radiology consultant acknowledged the patient's sickle cell disease and that she 'had many crises as a child and young adult, but has been well for the past 5 years', benefiting from exchange transfusions for 3 years.

2.1.10 The patient was given an information leaflet and she gave her signed consent for the procedure, which was booked for mid-May 2021. A letter outlining the consultation plan was sent to the consultant gynaecologist who referred her, and to her GP, but was not copied to the consultant haematologist.

2.1.11 Sickle cell disease was noted as part of a pre-operative risk assessment, which was completed by the interventional radiology team on the same day she saw the interventional radiology consultant in early May 2021. The risk assessment also identified that she was due to receive an exchange blood transfusion during the week after the procedure. The patient's haemoglobin levels were 79 grams per litre (g/litre), which was low for her. In relation to the consideration of any 'additional safety risks', she was documented to be 'safe'.

The procedure

2.1.12 When the patient arrived on the gynaecology ward in the morning, 11 days after her pre-operative assessment, she sent a text message to a nurse on the haematology ward, telling them that she was in hospital for the procedure.

2.1.13 Gynaecology staff noted that she had become "extremely short of breath" after walking a short distance from the waiting area, and that her haemoglobin levels had been recorded as low during her pre-operative assessment. Guidance was sought from the interventional radiology team, and staff were asked to retest her and continue preparing her for the procedure. The

patient's haemoglobin levels were lower than during her pre-operative assessment; this was escalated to the interventional radiology registrar. The registrar stated they would see her and assess her when she arrived at the interventional radiology department for the procedure.

2.1.14 Before the patient was brought into the interventional radiology suite she was given codeine, paracetamol and diclofenac (a non-steroid anti-inflammatory) for pain relief. She was also prescribed subcutaneous morphine and given a patient-controlled analgesia (PCA) device (see 1.4.3). In the interventional radiology suite, her haemoglobin levels were checked by the interventional radiology consultant and noted to be 60 g/litre, which was low but considered to be within the expected range for the patient by the interventional radiology registrar.

2.1.15 The procedure was carried out as planned by two interventional radiology registrars under the supervision of the consultant. During the procedure the patient was given fentanyl (an opioid pain relief medication) by intravenous injections. The PCA device allowed her to self-administer additional opioid medication during and after the procedure.

Procedure follow-up

2.1.16 After the procedure the patient was moved to the interventional radiology recovery bay, where it was documented that oral morphine liquid was administered and she had 'used her PCA to relieve the pain', which was 'decreasing'.

2.1.17 The patient arrived back on the gynaecology ward at 14:30 hours and was noted to have a pain score of 2 (moderate pain, based on local Trust guidance). It was noted she had used 23.3 milligrams (mg) of morphine (out of an initial 100 mg) from the PCA, since it had been set up at 10:35 hours.

2.1.18 An untimed entry in the clinical records documented that she remained 'in pain' as she had 'not managed to benefit from the increase in [morphine] dosage' from the PCA 'as [the] canula [the tube carrying the medication had] removed itself'.

2.1.19 At 15:20 hours a pain score of 3 (severe pain) was recorded. When the patient was assessed at 17:15 hours it was documented that she was 'utilising [her PCA] well', despite still having a pain score of 3. The haematology team was noted to be 'aware' of the situation and a plan was made for paracetamol to be given after intravenous fluids had been administered.

2.1.20 A haematology registrar and clinical nurse specialist arrived to see her at 17:38 hours, documenting that they had been unaware of her procedure or hospital admission. They informed the investigation that they had not seen the patient's earlier text messages until the late afternoon; seeing the messages had prompted them to visit her on the gynaecology ward.

2.1.21 The patient was then moved to the haematology ward for specialist care.

Post-procedure care

2.1.22 At 06:00 hours the following day, the patient was noted still to be in pain with a pain score of 3. It was documented she had likely suffered a combination of 'post-procedural pain' and a 'painful sickle cell crisis'.

2.1.23 The patient received an exchange blood transfusion and her condition continued to be managed with pain relief.

2.1.24 When she was seen by the gynaecology and interventional radiology teams 2 days after the procedure, an apology was offered, noting 'referral to the haematology team would have been best'. It was also documented 'no concerns were expressed [by the patient] during [the] clinic appointment'.

2.1.25 The patient's medications were reviewed and she was discharged home 6 days after the procedure, which had been planned as a day case.

3 Analysis and findings

This section describes the investigation's findings in relation to the reference event and the wider national investigation work. It includes a focus on the key factors that influenced the decisions made, and actions taken by staff resulting in the patient requiring an exchange transfusion. Information to support the reference event investigation was gathered from:

- an interview with the patient
- interviews with clinical staff
- a review of the patient's medical records
- observations of clinical practice.

To understand more about how information about patients with sickle cell disease is considered and shared among clinical professionals, and how pain may be managed during interventional procedures, the investigation spoke with a range of national stakeholders. This included in-depth interviews and conversations with colleagues from:

- the British Society for Haematology
- the National Sickle Pain Group
- NHS England's Sickle Cell Pathway Review Steering Group
- consultants from Haemoglobinopathy Coordinating Centres
- the Sickle Cell Society (including patient representation)

- the All-Party Parliamentary Group that produced the 'No one's listening' report (which captured a wide variety of patient experiences).

More information about how the investigation was carried out, who the investigation engaged with, and how evidence was analysed, is available in the appendix.

3.1 Information sharing

The reference event

3.1.1 The Trust had several policies for managing the treatment of patients with sickle cell disease, which included:

- 'Guideline for the management of surgery in adult patients with sickle cell disease'
- 'Interventional radiology procedure patient care plan'
- 'Standard operating procedure for nurse led radiology pre-op clinic'.

3.1.2 The Trust also had guidance for the care of patients with sickle cell disease being admitted for 'surgery'. The guidance set out planning steps to be taken to make sure the patients were prepared and ready for surgery, which included liaising with the haematology department. The guidance did not specify whether this guidance applied to an interventional radiology procedure where general anaesthetic was not being used. The patient's electronic patient record also had a sickle cell disease alert which highlighted this guidance as relevant for her care.

Initial review

3.1.3 The haematology consultant was copied into the letter referring the patient to interventional radiology. In previous experiences between the gynaecology team and the patient, the haematology consultant had waited to be approached by the operating gynaecologist regarding a plan of care for her. Once approached, they had worked collaboratively to optimise her for surgery. On this occasion, the haematology consultant had read the letter but did not take any further action as they were awaiting contact from the interventional radiology team.

3.1.4 The interventional radiology consultant had acknowledged the patient's sickle cell disease and that she had a named haematology consultant, but based on the information provided in the referral letter did not think they needed to engage further with the haematology team. The interventional radiology consultant told the investigation that they also assumed they would be informed by the haematology consultant if they needed to take any additional action to plan for the patient's procedure.

3.1.5 During her consultation the patient told the interventional radiology consultant that she had sickle cell disease and was on 6-weekly exchange transfusions. She added that she had not had any problems since she was a child. The consultant told the investigation that based on what the patient had told them, they were not concerned that her sickle cell disease would be an issue.

3.1.6 The interventional radiology consultant wrote back to the referring gynaecologist after seeing her in clinic. They noted the patient's sickle cell disease and that they planned to move forward with uterine artery fibroid embolisation. The investigation identified that this letter was not copied to her haematology consultant.

3.1.7 The only way the haematologist would have known that the consultation had taken place, and that the procedure had been planned, would have been if they had accessed the patient's electronic patient record and checked the clinical letters. Checking patients' clinical letters regularly, outside of appointments, was not an expected action for the haematology consultant. There was no system in place for the teams to discuss her care in a multidisciplinary way.

Pre-operative assessment

3.1.8 Traditionally, pre-operative assessments scheduled by the gynaecology team were done by a member of the gynaecology team. During the COVID-19 pandemic, when there was a need to reduce unnecessary hospital visits and exposure to infection, the interventional radiology team reviewed and streamlined the pre-operative assessment process. One element of this was that a member of the interventional radiology team did the pre-operative assessment, rather than a member of the gynaecology team. As a result, the pre-operative assessment paperwork was changed to only include information that was relevant to interventional radiology.

3.1.9 The patient was one of the first patients to go through the new process. The paperwork for the new process had not been finalised, but the Trust had stopped using the previous pre-operative assessment paperwork. As a result of the change in processes no pre-operative assessment paperwork was completed for her.

3.1.10 The nurse who undertook the pre-operative assessment told the investigation that they had assumed the interventional radiology consultant had made the necessary plans for the patient's sickle cell disease. No concerns were identified by the nursing staff regarding the patient's interventional radiology procedure.

3.1.11 The interventional radiology consultant told the investigation that they had experience of treating patients with sickle cell trait but could not recall having cared for someone with sickle cell disease. When the patient's consent was taken, the possible complications documented by the interventional radiologist included those known to occur from the procedure and did not

account for possible complications which a patient with sickle cell disease may experience. The possibility of her having a sickle cell crisis after the procedure was not discussed or documented as a result of the pre-operative assessment risks that had been identified.

Admission to hospital

3.1.12 On the patient's admission paperwork it was documented that she had sickle cell disease and was on anticoagulation medication. The investigation was informed that interventional radiologists could not admit patients to surgical beds in hospital as interventional radiology was not considered a surgical speciality. Patients requiring interventional radiological procedures were admitted by the surgical team, but may not be seen by them.

3.1.13 Because of this, the patient was admitted to the gynaecology ward under the care of a consultant gynaecologist. However, no consultant gynaecologist saw her, nor were they involved in the planning of the procedure, including post-procedure care and managing any complications as a result of the procedure. This was because the gynaecology teams were not specialists in uterine artery fibroid embolisation, and did not have expertise in the care of patients with sickle cell disease. Gynaecology staff informed the investigation that although they identified an alert for sickle cell disease on the patient's record in the Trust's electronic patient record (EPR) system, this was not noted in the patient agreement to investigation or treatment form as a potential risk of the procedure.

3.1.14 The interventional radiology consultant who carried out the procedure told the investigation that it was not usual practice to involve other specialties during the planning stage. They explained that they perform the procedure on behalf of the referring consultant (in this case, the gynaecology consultant), whom they saw as managing the overall care of the patient.

3.1.15 There was a difference of opinion about whether the Trust guidance for preparation of patients for surgery should apply to the patient's care. The interventional radiology consultant stated that as the procedure wasn't classed as surgery then the guidance did not apply; the consultant gynaecologist believed the guidance did apply.

3.1.16 The patient told the investigation she thought she had a good relationship with the haematology team and would usually contact them if she was in the hospital. She told the investigation that she had assumed the interventional radiology team had consulted with her haematology team and added that this was what happened when she had surgery previously. As a result, she felt she had no reason to ask if the same process was in place as "they are the doctors who look after you".

3.1.17 Patients with chronic conditions are often experts in their own care; however, they cannot be expected to know the significance or impact that every medical intervention may have. Therefore, the patient could not be expected to understand how uterine fibroid embolisation would affect her sickle cell disease.

3.1.18 On the morning of her procedure, the patient sent a text message to a haematology nurse to let her know she was in the hospital to have a uterine artery fibroid embolisation. This was the first time that she had contacted any member of the haematology team about the procedure. She could not recall why she had not contacted the team earlier and thought she had assumed the doctors had “taken care of everything”.

3.1.19 On the day of her procedure, the nurse to whom the patient had sent the text message was on a ‘study day’ and not doing clinical work. This meant that the nurse did not check their mobile phone until around 16:00 hours. By this time the patient had had her procedure and had been admitted to the gynaecology ward in sickle cell crisis. The nurse contacted the haematology registrar to check if they were aware of the patient’s admission; they were not.

3.1.20 At the same time, the haematology consultant received an alert which notified them that the patient had been admitted to the hospital. The haematology registrar visited her on the gynaecology ward where they were able to assess the severity of her condition.

3.1.21 The ability to directly contact the nurse via text message, and the alert on her electronic patient record to notify them of her admission to hospital, appear to support sharing of information with the haematology team. However, these methods are dependent on the clinician being able to receive the information. There will be many occasions where a person receiving vital information may not be in a position to act on it immediately, for example study days, clinical emergencies, annual leave and sick leave.

The national investigation

Notification about patients with sickle cell disease

3.1.22 The All-Party Parliamentary Group report ‘No one’s listening’ recommended that:

‘All NHS Trusts to require that haematology teams are informed whenever a sickle cell patient accesses or is admitted to the hospital to ensure the patient’s clinical history is known and advice can be passed on regarding their care, with compliance reported via the NHS England and NHS Improvement Specialised Services Quality Dashboards.’

(Sickle Cell Society, 2021)

The section of the recommendation that particularly relates to this investigation is when a patient accesses the hospital to receive care.

3.1.23 The Sickle Cell Society also reported patients sharing with them that there was 'a lack of willingness to make contact with the relevant specialists to seek advice which resulted in severe prolonged pain and trauma'.

3.1.24 National organisations have written guidance on the preparation of patients with sickle cell disease before a general anaesthetic and surgery, including 'Peri-operative management of patients with sickle cell disease', published by the Association of Anaesthetists (Association of Anaesthetists, 2021). However, difficulty arises when patients are being prepared for procedures, such as uterine artery fibroid embolisation, that are not conducted under general anaesthetic and are not classed as surgical interventions.

3.1.25 A focus has been placed on notifying the haematology department when patients with sickle cell disease are admitted to hospital. However, haematology clinicians told the investigation that this would not give them enough time to respond in cases where patients were coming in for elective (planned) procedures, such as uterine artery embolisation. They also believed haematology departments should be advised and involved in the preparation of the patient before the procedure, not just notified on the day of the procedure.

3.1.26 Documents provided to the investigation by the NHS England Sickle Cell Pathway Review Steering Group refer to empowering patients by giving them the skills and knowledge to manage their own health and wellbeing. While empowering a patient to make decisions about their care is important, this is different to having a system that relies on them as the main method of alerting clinicians that the patient has sickle cell disease. Patients' ability to think clearly and remember to text or call their named consultant or remember to bring their care plan, when in pain or feeling anxious about an upcoming procedure, is unlikely to be a reliable method of notification. The current system places responsibility on the patient, rather than putting a robust system in place.

3.1.27 Haematology clinicians told the investigation that they were often informed too late, if at all, about their patients with sickle cell disease requiring non-haematology procedures.

3.1.28 Most haematology clinicians also told the investigation that they were notified by their patients and not the clinician who was treating the patient. A haematology consultant told the investigation that they advise their patients to inform them in advance about appointments and treatments with other departments, emphasising that informing them on arrival is too late. This was due to the lack of confidence that the system would be able to alert treating clinicians to the fact that a patient had sickle cell disease before they were seen and treated.

3.1.29 Haematology consultants also agreed that the logistics of notifying them each time a sickle cell patient has an interaction with the healthcare system were difficult. The main issues they identified were:

- the large number of patients that haematology consultants are responsible for, especially those working at the Specialist Haemoglobinopathy Teams (SHTs)
- a lack of clarity about which healthcare appointments/treatments would qualify as needing to trigger a notification to the haematology consultants.

3.1.30 Some trusts have identified the need to work in a multidisciplinary way and have requested notifications to be added to new electronic patient record systems. The notifications appear on the patient's electronic patient record, so all clinicians treating a patient with sickle cell disease would be aware that they had the disease. The purpose of the notification is to allow the treating clinician to decide whether there is a need to consult with the haematology department about the planned treatment, or at least take the patient's disease into account.

3.1.31 Decisions about any preparatory treatment that a patient may need before an invasive procedure could be made ahead of time and planned to align with any current haematology treatment, such as exchange transfusions.

HSIB makes the following safety observation

Safety observation O/2023/224:

It may be beneficial if trusts included a sickle cell disease notification within their electronic patient record systems, to ensure that clinicians treating patients with the disease consider it and seek advice from haematology teams about the impact of any planned treatments, such as invasive procedures.

Access to clinical information

3.1.32 The investigation spoke to many clinicians, who commented on the issue of access to pertinent sickle cell medical information. A specific comment heard was that there was no central (national) repository for this information, which was accessible to all clinicians. Several options for the sharing of key clinical information were highlighted to the investigation and discussed with the sponsors of those systems and clinicians to ascertain their usability, function, and future.

3.1.33 The National Haemoglobinopathy Register (NHR) was commissioned by the Department of Health and Social Care. The NHR is a database of patients with red cell disorders which, within the service specifications for Haemoglobinopathy Coordinating Centres, would be used to support the national sickle cell care networks by holding information such as:

- patient information
- guidelines and protocols
- education materials
- national sickle cell disease information, such as numbers of patients and the geographical spread of patients.

3.1.34 During discussions with haematology consultants, the investigation heard that there were factors that limited the usefulness of the National Haemoglobinopathy Register (NHR), including the following:

- Not all patients with sickle cell disease were on the NHR – historically all patients had to consent to be on it and some had either not consented or withdrawn consent.
- Some patients who were not on the NHR had become lost to the system (their name or whereabouts were not known to clinicians).
- Access to the NHR was limited to haematology clinicians/departments; it was not available to all clinicians who may provide care to patients with red cell disorders.
- The information held on the NHR was inconsistent and only a small number included patients' care plans.
- Patients were often unaware of the NHR.

3.1.35 The investigation was informed that after an update in 2021, patients are no longer required to consent to be on the register. Patients are automatically added once they are diagnosed or access healthcare, meaning that the numbers on the NHR are increasing. At the time of the investigation, this change of policy was not widely known.

3.1.36 The investigation considered whether it would be beneficial if other clinicians, such as emergency medicine consultants, could access the NHR if required. However, in response to this suggestion, an emergency medicine consultant stated, "I don't want another log on"; this was a common view among the clinicians the investigation spoke to. Clinicians commented that accessing another system would take time and would mean remembering another password, when there were already multiple systems and passwords to remember. The challenge of remembering where different types of information were stored was also cited as a reason why access to another patient information system would not be useful.

3.1.37 A consultant working in an area with a high prevalence of sickle cell disease told the investigation that they were using their trust's electronic patient record system to store information about registered patients with sickle cell disease. The information included patients' individualised care plans, and previous and current treatments. While this worked well for the trust, the information was not accessible to clinicians treating those patients when they were away from home, such as on holiday, resulting in a clinical information gap.

3.1.38 The NHS England Sickle Cell Pathway Review Steering Group has reviewed the sharing of information as part of its work. The different workstreams mentioned several options for information sharing, which include:

- the NHR
- the NHS app – an app owned and run by the NHS, used to store information and access services online. (NHS, n.d.b)
- the Summary Care Record – an electronic record of important patient information created from GP medical records. They can be seen and used in other areas of health. (NHS Digital, 2023)
- London network cloud-based app trial – a trial being conducted by a London network for sharing information, about patients with sickle cell disease, held in a secure cloud-based system.

3.1.39 There are advantages and disadvantages to each of the solutions mentioned. The investigation did not explore the advantages and disadvantages of each; however, it did review what clinicians said about information sharing and what any information sharing solution should consider.

3.1.40 All clinicians that the investigation spoke to agreed that a single, accessible source of information was required for both patients and any clinicians treating those patients. They stated that a solution should be accessible and easy to use, while not relying on the patient to interact with the information system, as this may be problematic if a patient is in crisis, for example.

3.1.41 The evidence showed that there was no method for providing clear, accessible clinical information to clinicians in all healthcare settings who may treat a patient with sickle cell disease. When combined with a system to alert clinicians that a patient has sickle cell disease, efficient sharing of patient information will enhance the opportunity for clinicians and multidisciplinary teams to make tailored, informed decisions about a patient's care.

HSIB makes the following safety recommendation

Safety recommendation R/2023/230:

HSIB recommends that NHS England identifies and implements a system for sharing clinical information about patients with sickle cell disease to improve access to this information for clinicians, and reduce the risk of a patient's sickle cell disease not being treated consistently.

3.2 Management of sickle cell disease during interventional procedures

The reference event

3.2.1 The patient's haemoglobin levels were noted to have been low on the pre-operative assessment, so the gynaecology nurse escalated this to the gynaecology on-call doctor. A repeat test showed that her haemoglobin levels were lower than the pre-operative assessment test.

3.2.2 The investigation was told by staff that patients having uterine artery fibroid embolisation typically needed the procedure because they experience heavy bleeding with their periods. The heavy bleeding causes their haemoglobin levels to be below the expected range; the patient's low haemoglobin level result did not therefore strike them as particularly unusual. The interventional radiology consultant said they had considered the haemoglobin result within this familiar context rather than seeing it as related to her sickle cell disease; therefore, the result did not prompt any actions to address the low level.

3.2.3 The gynaecology nurse who admitted the patient told the investigation that the patient had become "extremely short of breath" after walking a short distance from the waiting area. The nurse stated that the patient said "this was normal a week before her exchange transfusion". In addition, her haemoglobin level had been 79 grams per litre (g/litre) the week before, which was below the expected range for a patient with normal haemoglobin.

3.2.4 The nurse queried why this had not been 'flagged' by the gynaecology team as part of their pre-operative assessment. She was informed that the assessment had been carried out by the interventional radiology department.

3.2.5 The nurse also reported contacting an interventional radiology registrar, who checked the patient's haemoglobin levels and confirmed that they were "fairly normal" for her. The nurse was instructed to continue preparing her for the procedure, with reassurance that the team would "cast their own eyes" over her before the procedure took place.

3.2.6 Clinical records written by the interventional radiology consultant documented there had been 'no immediate complications' and concluded 'successful bilateral uterine artery embolisation' had been performed, requiring 'standard post procedural care'. A 'Bair Hugger' (a temperature management system) was used to maintain her core body temperature after the procedure, but not during it. A consultant haematologist suggested to the investigation that it is preferable to use a Bair Hugger during the procedure to help prevent the onset of sickle cell crisis.

3.2.7 It was noted by the interventional radiology nurse that the patient had 'experienced a lot of pain despite [the stated] medication' following her procedure. The patient informed the investigation that she was unable to "handle the pain" during the procedure, saying that the pain felt as if it was "constantly increasing". When she voiced concerns that she was still in pain, she was asked to press the patient-controlled analgesia (PCA) device again, which she stated was "ineffective", leaving her no option but to "endure the pain".

3.2.8 The investigation spoke with a consultant haematologist who stated that while pain is not classed as a trigger for a sickle cell crisis, the associated inflammation from the procedure could induce a crisis. Increased normal haemoglobin levels help reduce the risk of crisis, as well as optimising other variables such as keeping the patient warm, hydrated, and suitably managing the pain throughout the procedure.

The national investigation

3.2.9 The investigation found that there was variation in practice and limited agreement among clinicians about how to best treat patients with sickle cell disease, whether during a sickle cell crisis or for the day-to-day management of the disease. The investigation was told that patients received subtly different treatment depending on which hospital they went to or which clinician they saw.

3.2.10 The investigation heard from clinicians that this variation had resulted in patients feeling frustrated when they were accustomed to a certain method of treatment and then received an alternative plan or view. The 'No one's listening' report (Sickle Cell Society, 2021) also found that patients with sickle cell disease felt their quality of care varies 'from hospital to hospital' and 'ranges from very good to extremely patchy depending on where you live in the UK'.

3.2.11 Members of the National Sickle Pain Group, which is a multidisciplinary group of clinicians and healthcare staff, told the investigation that there is variation in practice when it comes to:

- the use of patient-controlled analgesia (pain relief) pumps, especially the use of a background delivery of morphine
- the use of morphine in hospitals

- whether patients are prescribed morphine for use at home.

3.2.12 NHS England has launched a Sickle Cell Whole Pathway Review, which is looking at patients with sickle cell disease care across every aspect of the healthcare system. This review has engaged with experts in sickle cell disease from across the country and was engaged by the investigation.

3.2.13 Current clinical guidance for sickle cell disease is limited to the following British Society for Haematology (BSH) and National Institute for Health and Care Excellence (NICE) guidance:

- 'Guidelines for the management of sickle cell disease in pregnancy' (BSH)
- 'Guidelines for the use of hydroxycarbamide in children and adults with sickle cell disease' (BSH)
- 'Red cell transfusion in sickle cell disease part I' (BSH)
- 'Red cell transfusion in sickle cell disease part II' (BSH)
- 'Management of acute chest syndrome in sickle cell disease' (BSH)
- 'Sickle cell disease – Quality Standard 58' (NICE)
- 'Sickle cell disease: managing acute painful episodes in hospital – Clinical Guideline 143' (NICE)

3.2.14 There are standards that have been produced by the Sickle Cell Society, 'Standards for the clinical care of adults with sickle cell disease in the UK' (Sickle Cell Society, 2018). These standards were authored by a multi-disciplinary team of healthcare professionals working with patients with sickle cell disease across the country. NICE clinical guidance requires a clinical evidence base to be produced, which is currently limited.

3.2.15 The investigation did not find any national guidance for the day-to-day management, treatment, or through-life care of people with sickle cell disease. Most guidance covers sickle cell crisis, transfusion, or certain other specific circumstances. The limited guidance resulted in trusts producing their own policies and having their own view on how best to treat patients with sickle cell disease, other than in those specific circumstances.

3.2.16 Clinicians the investigation spoke with perceived that there was a lack of research into sickle cell disease which meant there was limited evidence on which to base national clinical guidance. The National Sickle Pain Group has started work on a set of basic principles for managing and treating sickle cell disease, although the group itself also faces the challenge of agreement among its members about approaches.

3.2.17 The All-Party Parliamentary Group's 'No one's listening' report (Sickle Cell Society, 2021) also indicated that not enough research has been conducted. A common comparator for sickle cell disease noted in the research literature is cystic fibrosis, due to the number of people with the condition and the differing backgrounds of those it affects – cystic fibrosis mainly affects white people. In the UK, more people have sickle cell disease (approximately 15,000 (Sickle Cell Society, n.d.)) than cystic fibrosis (approximately 10,800 (Cystic Fibrosis Trust, 2023)). However, research comparisons from the National Institute for Health and Care Research (NIHR) showed there were 69 completed/ongoing research studies into cystic fibrosis (National Institute for Health and Care Research, 2023a), compared to 23 for sickle cell disease (National Institute for Health and Care Research, 2023b), indicating that there may be a health inequality related to sickle cell disease.

3.2.18 The 'No one's listening' report made the following recommendation to UK Research and Innovation and the NIHR:

'UK Research and Innovation and the National Institute for Health Research to launch dedicated sickle cell research opportunities, including supporting and funding research into genetic therapies to cure sickle cell disorder.'

(Sickle Cell Society, 2021)

3.2.19 The report also indicated that there is limited guidance on how to manage a sickle cell crisis from start to finish. The report made a further recommendation:

'NICE to revise clinical guideline around pain relief for sickle cell patients to set out standards relating to pain management in the entirety of a sickle cell crisis, not just delivery of the first dose.'

(Sickle Cell Society, 2021)

3.2.20 The recommendations from 'No one's listening', the data from the NIHR database and the evidence from clinicians and organisations, highlight that there is currently limited evidence and research into the through-life care and treatment of patients with sickle cell disease.

HSIB makes the following safety recommendation

Safety recommendation R/2023/231:

HSIB recommends that the National Institute for Health and Care Research assesses the priority and feasibility of commissioning research into the management of patients with sickle cell disease, encompassing the requirements of patient-controlled-analgesia

(pain relief) pumps. This will contribute towards building an evidence base for the generation of national clinical guidance and will reduce unnecessary variance in treatment for patients with sickle cell disease.

HSIB makes the following safety observation

Safety observation O/2023/225:

It may be beneficial if the healthcare sector explores, researches and fully understands the care provision to all patients with sickle cell disease, at all points in their life, encompassing day-to-day treatment through to sickle cell crisis.

4 Summary of findings and safety recommendations and safety observations

4.1 Findings

- The treatment people with sickle cell disease receive varies depending on where they live and the number of patients that clinicians see.
- Guidance on the treatment of sickle cell disease is limited to specific circumstances, such as sickle cell crisis or blood transfusion, with limited wider guidance available on the through-life management of sickle cell disease.
- Compared to other conditions that affect similar numbers of people, there has been limited research into the lifelong management of sickle cell disease. This may indicate a health inequality.
- There is no national information system for storing and sharing clinical information for patients with sickle cell disease.
- Currently the main way in which haematology consultants are made aware that a patient with sickle cell disease is having treatment in another area of healthcare is when they are notified of this by the patient.
- It may be possible to set up healthcare IT systems so that they alert haematology consultants when one of their patients accesses another type of healthcare. However, consultants in areas with a high prevalence of sickle cell disease may then receive so many alerts that such a system would be ineffective.

4.2 Safety recommendations and safety observations

HSIB makes the following safety recommendations

Safety recommendation R/2023/230:

HSIB recommends that NHS England identifies and implements a system for sharing clinical information about patients with sickle cell disease to improve access to this information for clinicians, and reduce the risk of a patient's sickle cell disease not being treated consistently.

Safety recommendation R/2023/231:

HSIB recommends that the National Institute for Health and Care Research assesses the priority and feasibility of commissioning research into the management of patients with sickle cell disease, encompassing the requirements of patient-controlled-analgesia (pain relief) pumps. This will contribute towards building an evidence base for the generation of national clinical guidance and will reduce unnecessary variance in treatment for patients with sickle cell disease.

HSIB makes the following safety observations

Safety observation O/2023/224:

It may be beneficial if trusts included a sickle cell disease notification within their electronic patient record systems, to ensure that clinicians treating patients with the disease consider it and seek advice from haematology teams about the impact of any planned treatments, such as invasive procedures.

Safety observation O/2023/225:

It may be beneficial if the healthcare sector explores, researches and fully understands the care provision to all patients with sickle cell disease, at all points in their life, encompassing day-to-day treatment through to sickle cell crisis.

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6 Appendix

Investigation approach

Decision to investigate

HSIB's Chief Investigator authorised a national investigation based on the following criteria.

Outcome impact – what was, or is, the impact of the safety issue on people and services across the healthcare system?

Patients who are not optimally prepared before an invasive procedure, or whose sickle cell disease is not considered as part of their pre-procedure assessment, may suffer complications such as a sickle cell crisis as a result.

Systemic risk – how widespread and how common a safety issue is this across the healthcare system?

Knowledge and awareness of sickle cell disease varies nationally depending on the prevalence of the disease within a region. This causes clinicians to take different approaches to the care and treatment of patients with sickle cell disease.

Learning potential – what is the potential for an HSIB investigation to lead to positive changes and improvements to patient safety across the healthcare system?

An HSIB investigation could help identify the issues across the healthcare system that relate to effective multidisciplinary communication and planning for this group of patients.

Evidence gathering and methods of analysis

Evidence gathering

Evidence gathered during the investigation included:

- a video interview with the patient, the patient involved in the reference event
- a review of the patient's clinical records, Trust policies, procedures, and observations of practice
- interviews with staff at the Trust where the reference event occurred
- a review of the Trust's internal serious incident investigation report
- a review of the literature relevant to the safety risk
- interviews, telephone calls and email correspondence with representatives from:

- Sickle Cell Society

- British Society for Haematology

- Royal College of Radiologists

- Department of Health and Social Care

- NHS England (Health Inequalities Steering Group, Haemoglobinopathies Clinical Reference Group, Specialised Commissioning)
- National Sickle Pain Group
- Sickle Cell Clinical Reference Group
- Multiple trusts from areas with high and low prevalence of sickle cell disease (including Haemoglobinopathy Coordinating Centres and Specialist Haemoglobinopathy Teams)
- National Institute for Health and Care Excellence
- NHS Race and Health Observatory
- National Institute for Health and Care Research

Methods of analysis

Analysis of this event was informed by the Australian Transport Safety Bureau (ATSB) model (Australian Transport Safety Bureau, 2008). The model is derived from the concept of organisational accidents, introduced by James Reason. This describes a hierarchy of organisational and local conditions that harbour latent risks, and unsafe acts which combine with these conditions and lead to accidents. It encompasses Reason's 'Swiss cheese' model of systemic defences or barriers at each level, which may be incomplete and fail when the 'holes' in the barriers line up (Reason, 1997).

These models capture the key concept which is that many of the causal factors leading to a failure at the 'sharp end' – in this case a procedure leading to sickle cell crisis – may lie well away from where the error occurred, within the organisation or the wider system. Further analysis was undertaken to understand the strengths and weaknesses of the barriers and whether they were sufficient to be effective.

A diagrammatic representation of ATSB model is shown in figure A.

Figure A ATSB investigation model



The AcciMap model was also used to analyse the reference event information and support the direction of the national investigation. AcciMap (Svedung and Rasmussen, 2002) is an incident analysis method that identifies factors within a system (in this case the healthcare system as a whole) that influence the occurrence of an incident. The analysis focuses on identifying relationships between the different levels of the system (see figure B), which include government policy and budgeting; regulatory bodies and associations; local area management; physical processes and actor activities (linked with staff, people, organisations and systems); equipment and surroundings (Stanton et al, 2013).

AcciMap is useful for visually representing contributory factors across the entire organisational system and their interrelationships. It removes the apportioning of blame to individuals and promotes the development of systematic countermeasures as opposed to countermeasures which focus on an individual (Salmon et al, 2011).

Figure B ACCIMAP investigation model

