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Reducing unnecessary coagulation screening in ambulatory patients in the emergency departments of a multi-site trust: a quality improvement project

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Abstract

Background Many Emergency Departments (EDs) front-load investigations, which can cause unnecessary over-investigation in ambulatory patients and has environmental and financial impacts. Coagulation screens often contribute little to patients' management and NHS England guidelines already exist regarding coagulation screening in the ED. Literature has demonstrated successful reductions in coagulation screening but have often lacked balancing measures.

Methods The number of coagulation and Full Blood Count (FBC) tests performed on ambulatory patients attending a multi-site Trust with 2 Emergency Departments were collected from 2023 to 2025. Total number of coagulation screens and coagulation: FBC ratio were measured and a proxy for repeat venepuncture measured. Interventions were introduced at the John Radcliffe, Oxford, a Major Trauma Centre and at the Horton General Hospital, a District General Hospital.

Interventions Interventions were implemented through PDSA cycles, including posters, moving the location of the coagulation bottles, other specialty involvement and a survey to highlight educational needs. The project was highlighted at regular nursing and medical meetings.

Results The decrease in the number of coagulation screens and the coagulation: FBC ratio was gradual and sustained: at 28 weeks, there was a decrease of 26.97% and 28.51%, respectively with no increase in the proxy measure for repeat coagulation or D-Dimer sampling, but there was an increase in the number of patients who had a D-Dimer retrospectively added to their previous sample. Projected annual cost savings were £81,700 - £86,400 and ~250 kg CO₂ per annum.

Conclusions Environmental and financial savings can be made by reducing coagulation screening in Major Trauma Centres and across EDs within the same Trust, in keeping with existing literature. This did not appear to be associated with increases in repeat phlebotomy.

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What is already known on this topic Multiple improvement projects have shown success in reducing coagulation screening in Emergency Departments, but high-quality balancing measures have been limited: previous studies have looked at blood transfusion requirements.

What this study adds This shows that coagulation screening can be decreased in a multi-site Trust with distinct nursing and medical staffing, with no apparent increase in repeat venepuncture, a key concern of staff when rationalising a reduction in testing.

How might this affect research, practice or policy In combination with existing literature, this demonstrates the feasibility of reductions in coagulation screenings in different sized Emergency Departments, and suggests substantial environmental and financial savings could be made by similar interventions elsewhere without impacting on patient care.

Introduction

To meet Key Performance Indicators, many Emergency Departments (ED) front-load investigations, especially pathology investigations, at triage. This may mean patients undergo unnecessary investigation, particularly if triage is performed by less experienced staff. When eliminated, these additional investigations seem to have no impact on patient care [1]. Unnecessary investigation can have a variety of impacts: environmental, opportunity and financial costs, potential impact on patient length of stay in the Department and risks from false positives or iatrogenic harm from incidental and benign findings. Waste from healthcare also contributes to climate change [2], which is likely to exacerbate health inequalities and increase need for healthcare [3].

As such, many NHS Trusts (organisations responsible for the delivery of local healthcare) have tried to reduce the number of unnecessary investigations undertaken in ED. There have been Quality Improvement initiatives looking at decreasing unnecessary routine coagulation screening (a single citrate tube) [4–6]. Many of these have included staff education, revising order sets on Electronic Patient Record systems and physically moving the location of blood bottles. Others have uncoupled coagulation screening in the lab to minimise unnecessary investigation [7]. All of these demonstrate success in reducing routine coagulation sampling in the ED, although there are a limited balancing measures in the literature, with no reported evidence regarding delays to patient care or the need for repeated phlebotomy during these initiatives. Some follow up literature suggests even after interventions, there are still many unnecessary coagulation samples sent [8].

Quantifying environmental impact of coagulation screening is difficult, due to variation in practice and complexity of materials and resources used. Studies in Australia and Canada have estimated a single coagulation screen to equate to 82 g [9] and 30 g [10] (excluding phlebotomy equipment) CO₂e respectively.

Oxford University Hospitals (OUH) Foundation Trust comprises 2 distinct Emergency Departments (EDs): the

John Radcliffe (JR), a Major Trauma Centre and the Horton General Hospital (HGH), a much smaller District General Hospital. In the 12 months prior to the project, 160,733 patients were seen in OUH EDs: 116,828 (72.68%) were walk-in attendances. 79,835 (68.34%) of these were at the JR, and 36,993 (31.66%) were at the HGH. The hospitals are staffed by the same Registrars and Consultants, but the nursing staff and more junior resident doctors are distinct at each hospital. This project was undertaken by the Chief Registrar in Emergency Medicine. In OUH, coagulation samples routinely run PT, APTT and INR (not targeted haemostasis investigations) and the laboratory cost per sample is £10.38. This was used to calculate cost savings but doesn't factor in time cost or equipment for phlebotomy. Analysing D-Dimers is coupled to coagulation screening.

Given many patients attending OUH ED are low acuity and low complexity, the ambulatory pathway was identified as an area where unnecessary coagulation samples were requested. This project aimed initially to decrease the total number of coagulation screens sent from walk-in patients in the John Radcliffe Emergency Department through a variety of measures. Prior to interventions, a mean of 76.3 coagulation samples were sent per day from OUH ambulatory patients.

Initial outcome measure: To reduce the number of coagulation screens sent from walk-in patients in the John Radcliffe ED by 20% in 3 months.

Methods

Many stakeholders were identified as crucial for the success to this project. Immediately, the laboratory team endorsed the project and sourced data. The Clinical Lead and Consultant body also supported the project, as well as Matron, other nursing staff and housekeeping.

3 principal measures were identified:

- **Total number of coagulation samples** (single citrate tube testing PT, APTT and INR only) sent

from adult OUH Ambulatory patients, as measured by the data analytics team on the Electronic Patient Record (EPR).

- **Coagulation: FBC (Full Blood Count) ratio** of the above patient group: this would help control for total number of attendances and total number of patients undergoing venepuncture, as every patient who had laboratory bloods sent would likely have an FBC. This would allow measurement of change in staff behaviour without total attendances or absolute phlebotomy frequency acting as confounders.
- **Incidence of repeat phlebotomy for citrate tube** to establish whether patients were inappropriately having investigations omitted. Given the difficulty measuring this, a proxy was used. EPR identified patients who had both an FBC and coagulation screen or D-Dimer requested more than 15 min apart in the same encounter. It was assumed ambulatory ED patients would only have a citrate measured for either a coagulation screen or D-Dimer. The timestamp of the request represents the time the test was ordered on EPR, which often coincides with when specimen labels were printed, which is often representative of when blood specimens were collected. This is distinct from when the sample was registered in the laboratory and so shouldn't be impacted by delays in using pneumatic tubes or porters to transport samples. Table 1 summarises this categorisation.
 - *If a coagulation screen or D-Dimer was requested within 15 min of the FBC, it was assumed the samples were collected together in the same phlebotomy encounter.*
 - *If a coagulation screen was requested more than 15 min after an FBC, it was assumed the patient underwent repeat venipuncture to obtain a citrate tube.*

- *If a coagulation screen was requested within 3 min of the FBC, and a D-Dimer after more than 15 min, it was assumed that the D-Dimer was added on retrospectively to the coagulation sample and the patient did not have to undergo repeat venepuncture. D-Dimers cannot be run independently in the Trust and mandate a pre-existing coagulation screen.*

A proxy for repeated venepuncture was calculated from EPR data:

1. Number of coagulation or D-Dimers requested > 15 min from FBC.
2. **Removal of duplicates** – D-Dimers mandate a coagulation screen and so if a D-Dimer was requested > 15 min after an FBC, so was a coagulation screen. To avoid duplicate counting of these patients, those who had a coagulation and D-Dimer requested at the same time > 15 min after FBC were only counted as repeated venepuncture for D-Dimer.
3. **Removal of retrospective add-ons** – cases where a coagulation sample was requested < 3 min of an FBC but a D-Dimer requested > 15 min after an FBC were classified as having had a coagulation screen analysed initially and a D-Dimer retrospectively added on without the need for repeat phlebotomy. This may result in an overestimate of those undergoing repeat venepuncture as previously discussed.
4. This left remaining incidence of repeat venepuncture for coagulation screening and D-Dimer.

This proxy is not totally accurate and it is possible that staff collected citrate samples from patients then clarified with senior staff whether coagulation screens should be analysed. It would not be possible to subsequently obtain a citrate sample and then adjust the timestamp to the previous collection time. As such, this may overestimate the true number of repeat venepuncture events. As this is the first time this balancing measure has been reported in the literature, and potential safety concerns regarding delays in investigation, it was deemed acceptable to potentially overestimate the frequency of repeat phlebotomy.

Cost savings, based on £10.38 per specimen analysed, and conservative estimates of Carbon savings at 30 g CO₂e per specimen, were used as secondary outcome measures and calculated based on observed statistically significant decreases in coagulation screening.

The data analytics team provided the total number of each type of pathology investigation requested from ambulatory patients at OUH from August 2023 to November 2024 as a pre-intervention baseline. Our

Table 1 Calculating whether a patient experience repeat venipuncture based on timing of FBC and coagulation screen request

| | < 15 min | > 15 min |
|-------------------------|---|--|
| FBC to Coagulation time | Coagulation screen and FBC taken together. If < 3 min and D-Dimer requested > 15 min, added retrospectively and no repeat venepuncture | Patient underwent repeat phlebotomy for coagulation screen |
| FBC to D-Dimer time | D-Dimer (including coagulation screen) and FBC taken together in single phlebotomy encounter: no repeat venepuncture | If no coagulation sample within 3 min of FBC, patient underwent repeat phlebotomy for D-Dimer (and coagulation screen by necessity) |

interventions consisted of 2 PDSA cycles, with a multi-modal approach to each.

Consideration was given to waiting time and number of breaches due to awaiting investigations as potential balancing measures (as delay in ordering coagulation investigations may lead to delay in disposition). However, as both are highly multi-factorial and complex, it was felt that delays in coagulation screening, which would likely only affect a small proportion of patients, would have minimal impact on these measures and so weren't included. The most common presentations in this cohort were chest pain, shortness of breath, abdominal pain and palpitations, although there are a broad range of other very common presentations including fever, headache, diarrhoea and vaginal bleeding.

PDSA 1

This involved quantifying the baseline frequency of coagulation investigations sent from the patient population. Existing NHS guidance [11] was reviewed and offers clear guidance for the limited number of situations where coagulation screening should be investigated in the Emergency Department: bleeding and trauma presentations, patients on anti-coagulation, liver disorders, suspected sepsis and overdose patients. Many of these patient groups would be cared for in areas not designated for "Ambulatory" patients (i.e. allocated a Majors space on streaming or arrived by ambulance). A poster was designed and circulated to staff in November 2024, highlighting the above indications for coagulation sampling in ED. Simultaneous messaging was circulated via the Department's Microsoft Teams page.

To encourage behavioural change, citrate sample tubes were moved into a separate draw of the phlebotomy trolley to other pathology tubes. This change was communicated to the Housekeeping team, who ensured subsequent restocking of the trolley followed the new layout. Initially, staff moved sample tubes back to the drawer with other tubes, so a label was put on the draw of the trolley explaining the change.

In early December 2024, the Department hosted a "Green ED week", where messaging regarding sustainability was relayed at medical and nursing handovers daily. Each day featured a different way to reduce waste: one was to reduce unnecessary investigations, and coagulation sampling was highlighted.

PDSA 2

Given limited impact on the measures achieved, in January 2025 a staff survey was circulated by email and on Microsoft Teams to explore attitudes towards the project and highlight areas of concern. Questions focused on which indications and patient groups staff requested a coagulation screen on. The most common

clinical presentations to the JR Ambulatory area were included in these questions. This highlighted that staff often sent a coagulation screen for suspected General Surgery patients and those on Direct Oral Anticoagulants (DOACs). Following discussions with the Clinical Lead for General Surgery, it was relayed that for patients without liver involvement or significant comorbidities, coagulation screening was of very limited value in those undergoing laparoscopic surgery. Likewise, routine PT, APTT and INR often provide unreliable information regarding degree of anticoagulation in DOACs [12]. Further education highlighting these developments was delivered in Band 6 and Band 7 nursing meetings. Significant improvements in our measures were also celebrated at medical and nursing handovers.

By this cycle, there had been a significant decrease in coagulation sampling at the JR with minimal impact on repeat venepuncture. To spread the change, we introduced similar interventions at the HGH in March 2025. A poster was disseminated to staff and put in the Rapid Nursing Assessment cubicles (where venepuncture is performed), and this was highlighted at nursing handovers daily.

PDSA 3

PDSA 3 was aimed at the sustainability and spreading of project to include other blood results, however due to rotational nature of training, these were not achieved in the allocated time. Ideas included in PDSA 3 included:

- Alignment with the new Departmental Same Day Emergency Care Unit and Front Door Senior Decision Maker to reduce unnecessary investigations.
- Adjusting current investigation panels to not have coagulation screening selected as a default.
- Scale up to reduce other unnecessary blood tests, such as Liver Function Tests: initial research shows unless catastrophic, liver function did not impact on the dosing or regime of any of the stock discharge medication commonly prescribed by the Department. Drafts were made for daily nursing handover learning bites.
- Spread to other Departments: Surgical and Ambulatory Medical Units interested in replicating successes of ED.

Results

Initial audit

In January, a spot audit of JR Ambulatory patients showed 100% patients who underwent phlebotomy had coagulation investigated. Of those who had coagulation screening performed, 16% either met NICE criteria or clinical need, such as a Senior Doctor deciding

coagulation screening was necessary. This suggested that substantial reductions in coagulation screening without impacting on patient care were achievable.

When spot audits were repeated in April 2025, 50% patients who had bloods had coagulation tested. Only 25% of these met clinical need. In July, this improved further: 27.7% patients had coagulation screening and 60% of these met clinical need (Fig. 1).

Retrospective D-Dimers pre-intervention

Between January and October 2024, an average of 4.22 D-Dimers were added on retrospectively per day (not requested at triage but then added on to specimens already taken after review by a clinician). This represented 5.53% of the average daily number of coagulation screens taken pre-intervention, further supporting the argument that many were done unnecessarily.

Total coagulation screens sent

The median number of coagulation screens sent from JR Ambulatory alone decreased significantly, suggesting special-cause variation. By April, there had been a 19.6% decrease in the median (Fig. 2), representing a significant cost saving and sustainability impact.

When this was extended to include both the JR and HGH sites, there remained a significant and sustained decrease in the total number of coagulation screens sent (Fig. 3). The mean decreased from 560.2 to 409.1(26.97%), representing an annual saving of £81,762 if sustained at this level and a Carbon saving of ~230 kg CO₂e.

Coagulation: FBC ratio

Using coagulation: FBC ratio acted to control for patient attendances. Due to an IT error, there was a duplication of the number of FBC requests during July 2024, resulting in a false halving of the coagulation: FBC ratio. These data were deemed spurious with a clear cause identified and so discarded. Regardless, a 28.5% decrease was seen in the coagulation: FBC ratio (Fig. 4), with estimated annual savings of >£86,400 and using conservative estimates, ~250 kg, CO₂e if sustained. Using this measure, the weekly number of coagulation samples would decrease from 534.1 to 381.8.

Weekly repeat venepuncture

When modelling frequency of repeat venepuncture as described, there was no significant increase for coagulation. There appeared to be a slight upward trend towards the end of the period examined, but there were too few data points to represent a shift in the median (Fig. 5). There was a slight decrease in the median of repeat venepuncture for D-Dimer, but an increase in the number of retrospective D-Dimers added on (Fig. 6).

Staff survey

The staff survey was completed by 28 (~15%) staff, including both nurses and doctors. It is unclear why engagement was relatively low. It was designed to assess attitudes towards the project as of January – February 2025 and highlighted potential areas for improvement. Full findings can be found in Appendix 2. Key findings were:

Coagulation screening spot audits

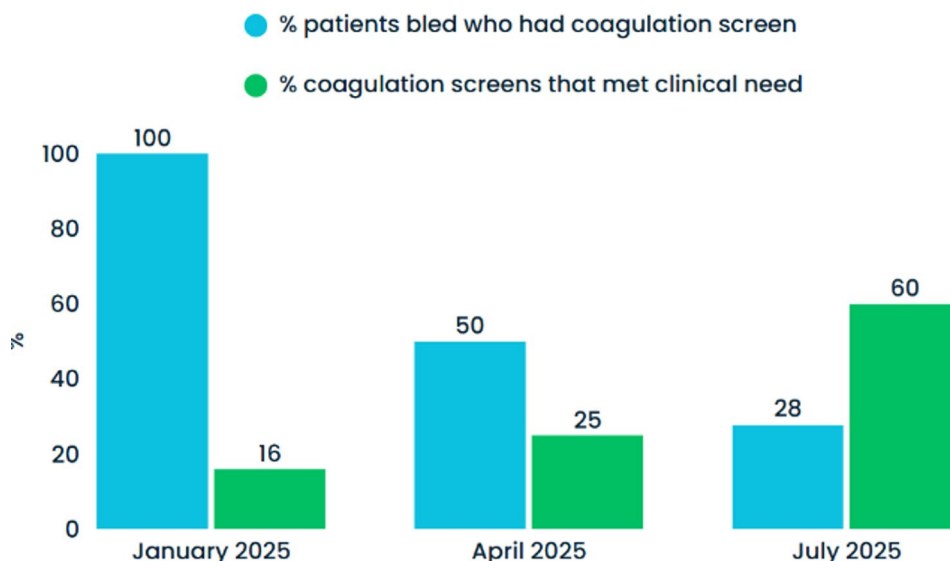


Fig. 1 Spot audits on frequency and appropriateness of coagulation screening

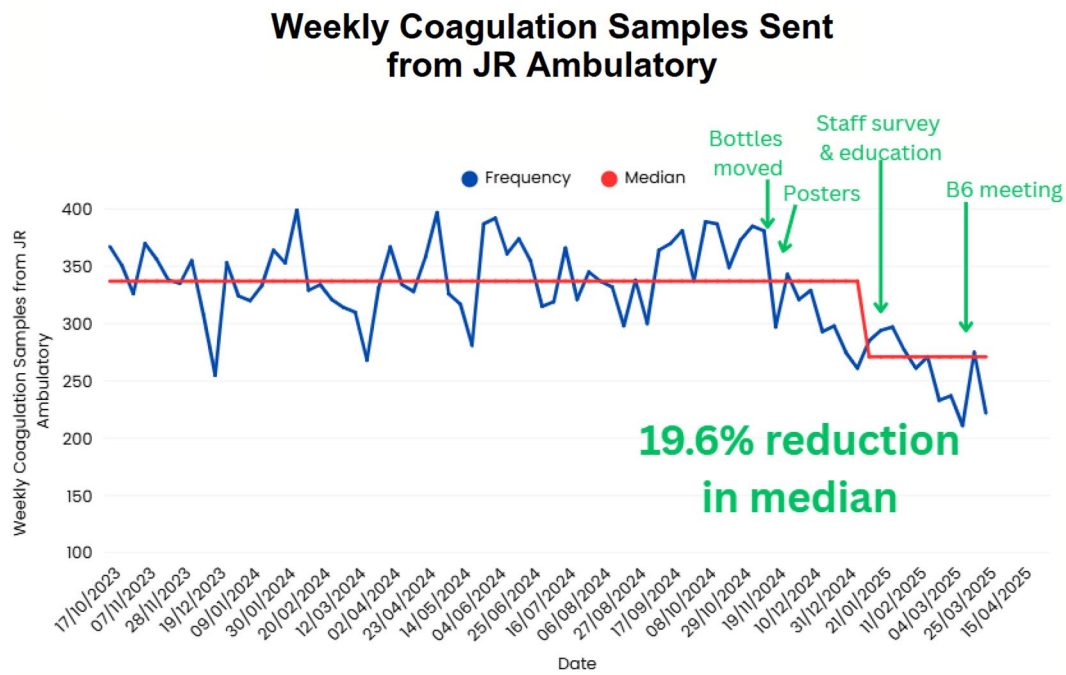


Fig. 2 Run chart of weekly number of coagulation screens sent from JR Ambulatory, October 2023-April 2025

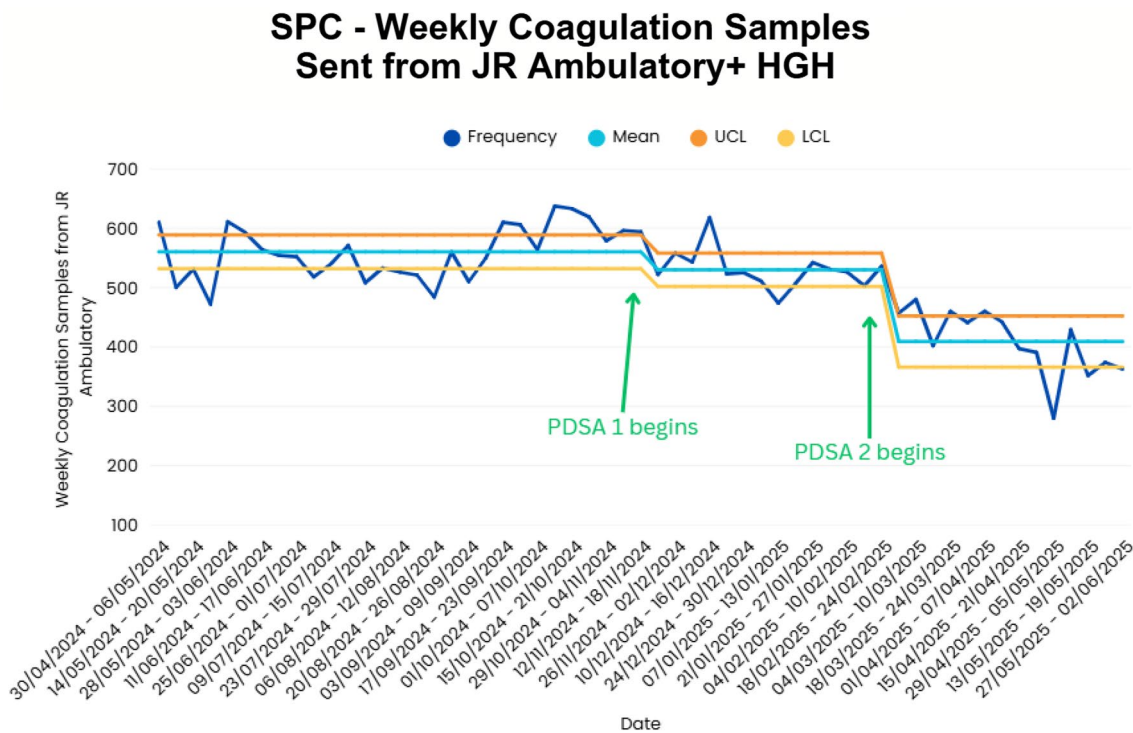


Fig. 3 Statistical Process Control Chart of total weekly number of coagulation screens for the JR and HGH sites combined, April 2024 - May 2025

- 78.6% respondents thought we do “too many” or “way too many” blood tests (Fig. 7) on ambulatory ED patients.
- Staff use a mix of caresets, free text and favourites to select the bloods to order.
- Knowledge of NICE guidance on when to request a coagulation screen was generally good, but there were multiple other reasons clotting was requested (Fig. 8), including taking apixaban (50%), chest pain (28.5%) and head injury (21.4%).

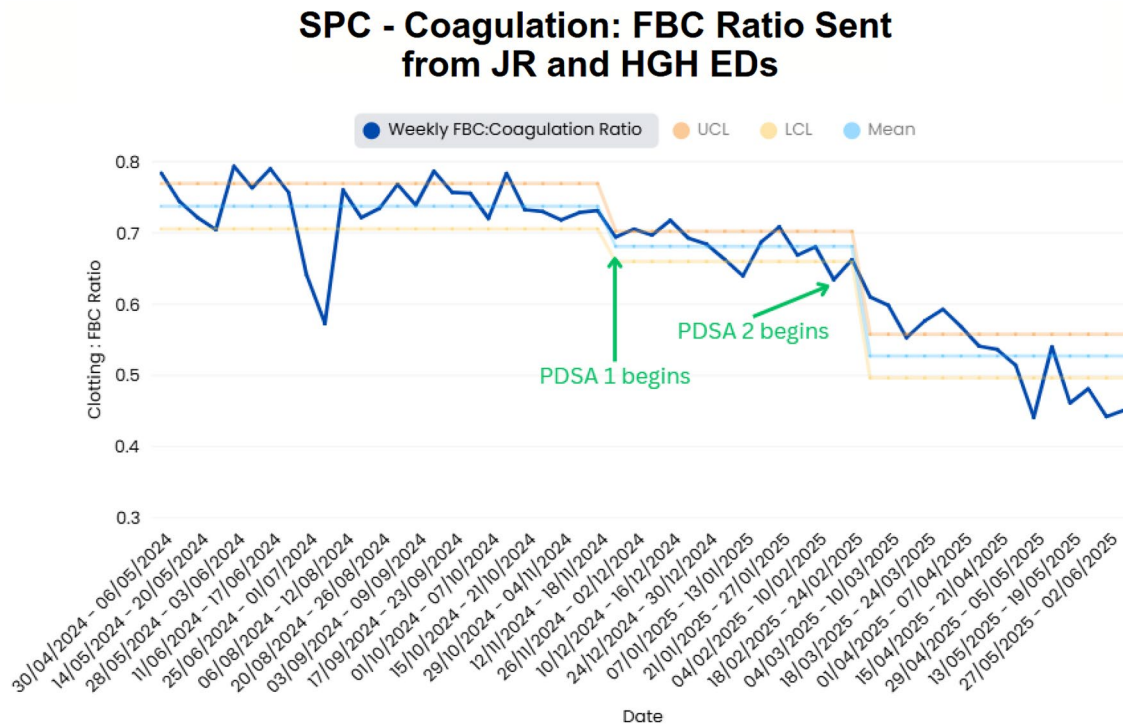


Fig. 4 Statistical Process Control Chart showing Coagulation: FBC Ratio from JR and HGH ED combined, April 2024-May 2025

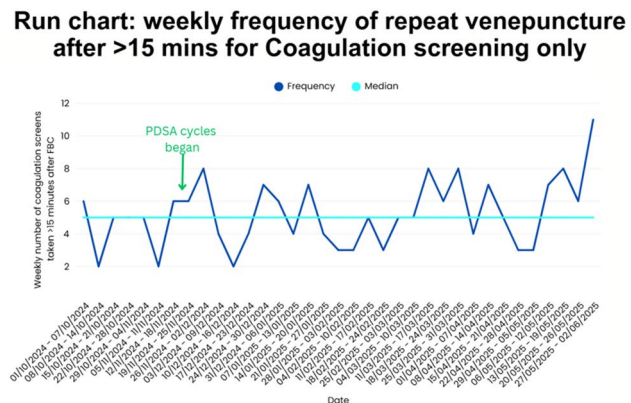
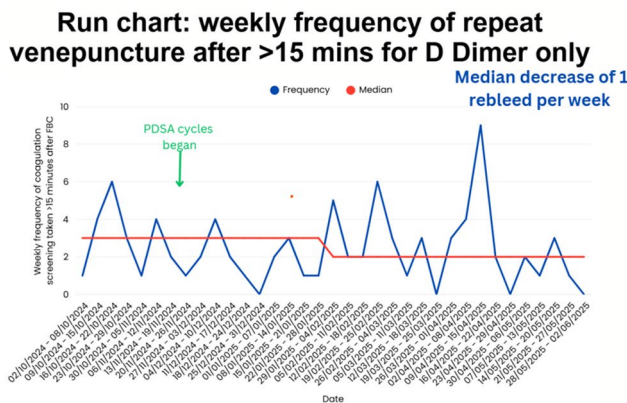


Fig. 5 Left: Run chart showing weekly number of patients undergoing repeat phlebotomy for Coagulation screening only, calculated as described in Methods, October 2024-May 2025. Right: Run chart showing weekly number of patients undergoing repeat phlebotomy for D-Dimer screening only, calculated as described in Methods, October 2024-May 2025

- In addition to the presentations detailed above, staff report requesting a coagulation screen for a multitude of reasons, including but not limited to:
 - Being unsure when to request clotting.
 - Habit.
 - Fear of prolonging patient length of stay in case a clotting is required upon subsequent review by a clinician.

- Extra work and patient dissatisfaction generated by repeated phlebotomy after a clinician has reviewed the patient.
- Perception that other clinical teams, especially surgical specialties, prefer a coagulation screen result.

Discussion

Resource and financial allocations are 2 key challenges currently facing the NHS, especially with regards to growing pressure on Urgent and Emergency Care service

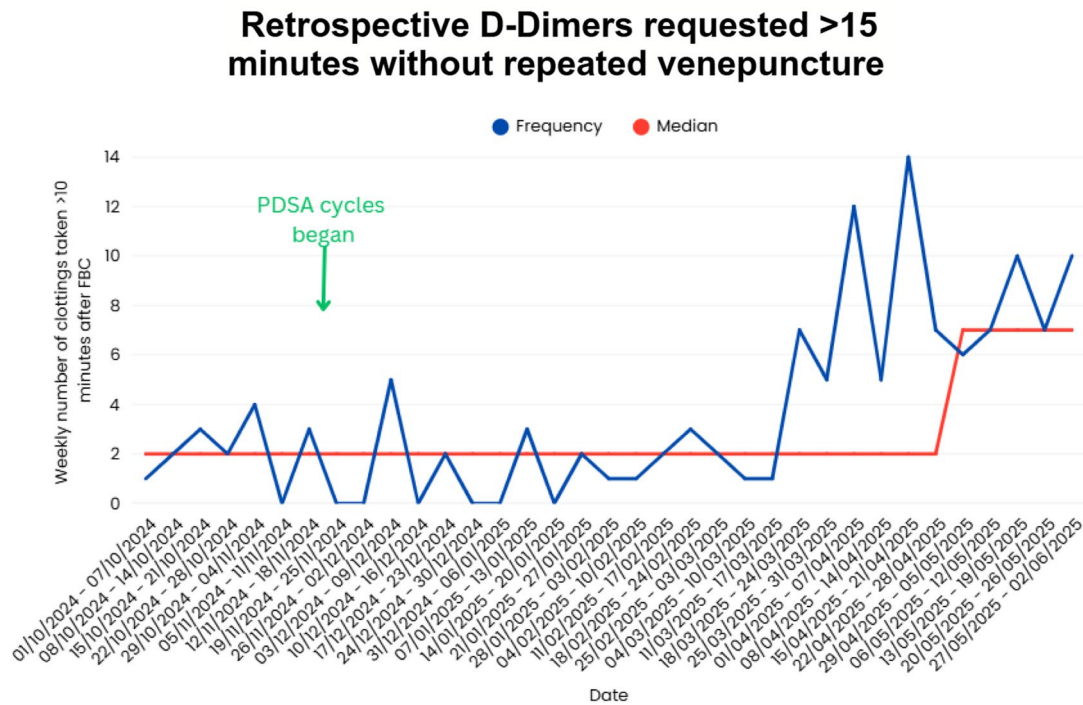


Fig. 6 Run chart showing frequency of retrospective D-Dimers added on to previously collected coagulation sample after > 15 min (no repeated venepuncture), October 2024-May 2025

3. Do you feel we do the correct amount of blood tests?

● We do way too few ● We do too few ● We do the perfect amount ● We do too many ● We do way too many

Do we do the correct amount of blood tests?

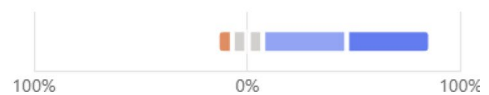


Fig. 7 Staff opinions on blood specimen testing, February 2025

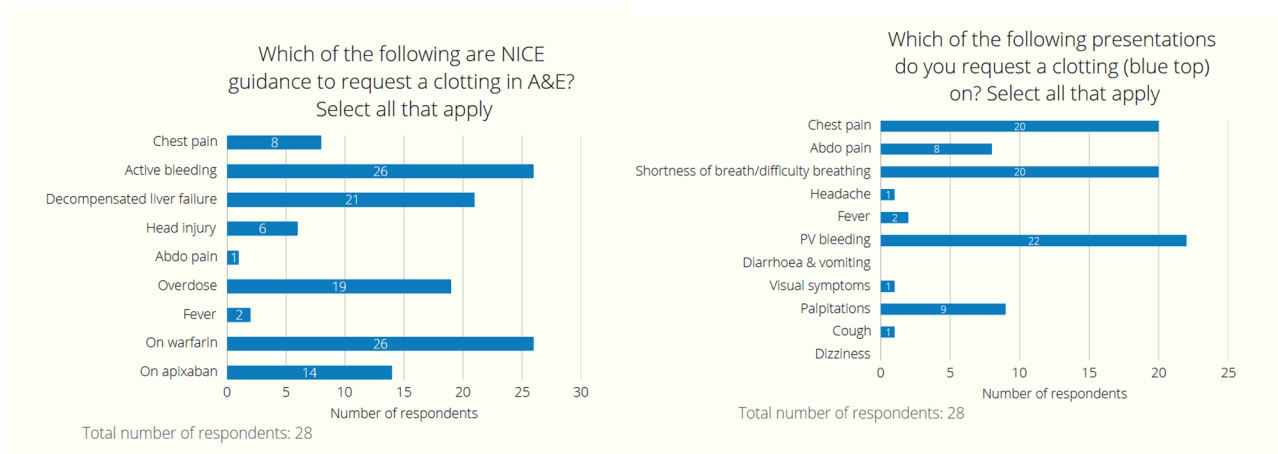


Fig. 8 Staff responses to survey Left: Knowledge of NHS England guidance Right: Individual preference for when to request a coagulation screen

provision. Reducing unnecessary investigations has many benefits: environmental, financial and minimising over-investigation and subsequent potential iatrogenic harm. This project demonstrates reducing unnecessary coagulation across a multi-site Trust in the NHS is achievable. Whereas other projects have demonstrated similar findings, both in the NHS and abroad, this is the first to include a proxy measure for repeated venepuncture. As seen in our staff survey, a key step to reducing coagulation screening in the Emergency Department is to address the concerns of staff that it will lead to prolonged length of stay, extra work and a less positive experience overall for patients. This project suggests a reduction in unnecessary pathology investigation isn't always associated with increasing repeated venepuncture, although there were limitations to how this measure was calculated. As expected in a large hospital, the changes implemented seem to demonstrate gradual results with continuous improvement over time, rather than immediate.

It is unclear why the retrospective D-Dimers added increased in April 2025, especially given there is a substantial delay between multiple interventions and this increase. The most recent intervention was launching the project at HGH, and it may be that this represents uncertainty in the face of recent change or is due to a cause not examined. Repeated venepuncture for coagulation only also showed an upward trend during this time, although the trend did not meet criteria to significantly shift the median.

The changes implemented account for very little opportunity cost and once embedded in culture, seem to be sustained with continuous improvement over 6 months. As coagulation: FBC ratio was measured to control for total volume of phlebotomy and in the absence of other similar interventions in the Department, it seems plausible that the gradual decline in coagulation screening was due to the implementations made and not due to confounding factors, for example absolute patient attendances. However, in the context of highly complex healthcare systems, these should be regarded as temporal associations rather than definitive causality. Reviewing associations between clinical pressures, such as waiting times, breach performance or clinical acuity is beyond the scope of this review. These may have impacted our measures, for example by adjusting staff perception or risk of delay if not ordering a coagulation screening.

Next steps for this project include scaling up the project to include other investigations which often have minimal effect on patient care in ED and translating this to other areas of the Trust, for example Ambulatory Medical and Surgical Units. Given there has been demonstrable improvement in both sites across distinct staff groups, it would suggest these findings are possibly translatable

to Emergency Departments in both major trauma centres and smaller district hospitals, although some specific interventions, such as phlebotomy equipment location, streaming and triage processes and information dissemination may be context-specific with variable results elsewhere. Given this is the first project to examine repeated venepuncture in the context of routine coagulation screening in ED, further corroborating literature would be beneficial when assessing potential generalisability and safety concerns.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12962-026-00726-z>.

Supplementary Material 1

Author contributions

RC - led and designed project, data interpretation, wrote manuscript NS - data acquisition for all measures involved in project.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Human ethics and consent to participate

Not applicable.

Competing interests

The authors declare no competing interests.

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