SUSQI PROJECT REPORT: REDUCING THE CONSUMPTION OF UNNECESSARY BLOOD SAMPLES AND IDLE EQUIPMENT, HAEMATOLOGY LAB TEAM

TEAM MEMBERS:

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Project commenced in September 2022.

Report completed in January 2023

Background:

Sustainability in a laboratory setting

We are a 24-hour service providing pathology support to the hospital and GPs throughout the county which includes haematology, immunology and blood transfusion testing as well as issue of blood and blood products to patients across a wide range of specialties as well as in emergencies such as in ED, theatres and maternity. With regard to sample throughput, the haematology laboratory processes approx. 3000 samples a day for up to 6000 blood tests.

Laboratory sustainability is a difficult challenge. Before this project the haematology department was already making many green improvements. For example, we moved to sharing samples between chemistry and haematology to save blood bottles. However, due to the nature of our work as a containment level 2 lab, strict quality control and infection control procedures are required. This means we are running tests with many single use plastic items that must be disposed of to prevent cross-contamination. There is no scalable alternative to single use plastics for items such as gloves, transport bags, pipettes, aliquot tubes, blood tubes and paper blood forms. We also consume a large quantity of reagents as part of our testing. This is essential to provide assurance that our testing is controlled and accurate.

Coagulation sample waste

Each test we run needs the blood sample to be in a specific type of bottle. For coagulation tests, the bottle contains a chemical called sodium citrate, which stops the blood clotting. In our lab, our machine removes the sodium citrate and we initiate a reaction to measure how long it takes for blood to clot allowing us to identify clotting disorders indicating a variety of health disorders.

Sometimes clinicians will collect and send a sodium citrate bottle to the lab without requesting any tests. This is called a spare citrate, which we store for 24 hours, in case clinicians want to add a test on at a later time. Taking a spare sample at the same time as the other tests may a) prevent rebleeding of patient, which reduces patient discomfort, b) improve patient safety, c) save time because the clinician can phone or email the lab to add on the test, as opposed to waiting for new samples to be sent and d) save turnaround time for a test.

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Sodium citrate samples when received by the lab undergo a centrifugation process before being stored in a fridge. Tests must be performed within 24 hours of blood collection. If no further request is received, spare samples are placed in a Biobin and disposed of unused in clinical waste.

As a team we suspected that coagulation screens can be requested inappropriately, and that spare citrates were sent often without being used. Low value or unnecessary tests increase lab processing time and pressures on lab staff to meet turnaround deadlines, which may in turn impact waiting time for patient results. They also use blood bottles reagents, clinical equipment and disposal bins, all of which is incinerated, unnecessarily.

Energy Usage

Consumption of energy in the lab is substantial. We operate many machines that run a wide range of automated blood tests for our service users. We have many PCs that our team use to track testing and analyse results. We must be able to provide rapid and accurate test results to GPs, wards and emergency departments 24 hours a day, 365 days a year. To achieve this there are pieces of equipment that must remain switched on and active constantly. However, we believe that there is some equipment which is kept on primarily for ease of use, which may be able to get switched off or put on standby to improve sustainability and efficiency in the lab – especially out of hours (overnight and at weekends) as we run a reduced service during these hours. Moreover, this could be especially beneficial in a laboratory setting as some of our equipment has high energy consumption. If we can identify which equipment can be switched off when it is out of use, we can introduce an energy cost saving for the trust.

Specific Aims:

1) Reduce low clinical value samples sent to the haematology lab from the emergency department (ED) by targeting;
    a. Unused 'spare' citrate samples
    b. Inappropriate and 'just in case' sodium citrate samples
    c. Avoidable (low clinical value) samples
2) Reduce energy usage of electrical equipment in haematology, immunology and blood transfusion at GRH and CGH.

Methods:

Project 1: Reducing low value samples sent to the haematology lab from ED

We focused on emergency department (ED) requests on both sites due as ED as we have a steady flow of coagulation requests, and it is also is our main source of 'spare' citrates. We spoke to our ED colleagues to better understand their decision-making processes for these tests. The TrakCare Lite Environment (TCLE) system was used to show all lab episodes that had any of the most common coagulation tests on them (coagulation spare sample, coagulation screen, INR, D-Dimer, APTTH, Lupus screen, Thrombophilia screen). We were supported by the head of coagulopathies in haematology, Ceinwen Davies, in analysing our data and by head of IT in haematology, David Miles, who collected and organised the data from TrakCare Lite Environment for us to analyse. This allowed us to identify all coagulation screens and spare citrate samples.

Inappropriate and low clinical value tests

We focused on coagulation screens as there is a set list of clinical details and symptoms for accepting the test. Samples are received into the department and assessed by a biomedical scientist to see if they meet the criteria. We learned the indications guide was put together with joint input

from ED and haematology consultants, and senior management, and is used by ED as well as our lab, with the aim to minimise wasted samples[1]. We have investigated whether this is working.

We looked at all coagulation screens from September 2022 and patient records to obtain data on coagulation screen referrals and reasons given by clinicians for each request. We identified which samples continued to be processed despite being avoidable (low/no clinical value). Certain requests are routinely accepted by the lab but provide low clinical value to the requesting clinician. These were also grouped to try and identify a common request which could be targeted to reduce referrals. We identified several issues including.

- Referrals with vague clinical details/indications (e.g. 'trauma'; potential to bleed, and abnormal bleeding is a reason to request a coagulation screen)
- Inadequate samples (e.g. sample overfilled or underfilled – then wasted)
- Avoidable tests (no clinical indications and/or low clinical value such as pre-op testing)
- Tests are approved for more than the list of reasons that they should be requested for

While vague clinical referrals and inadequate samples may take additional time to process due to the need to confirm the clinical rationale with the requester or receive a new sample, we eliminated these from our further review as we assumed the test would still need to be completed. We therefore focused on identifying avoidable requests as these samples were being processed for low/no clinical value.

There may be a variation from the appropriate guidelines due to high staff turnover, new trainee doctors rotating in to ED, and high agency staff numbers. In addition to this, 'just in case' coagulation screens may be opted for because of the incredibly high pressure on our ED departments. The lab may be approving inappropriate requests in order to support ED while they remain so busy. On the other hand, if we could reduce the number of tests requested, then there is potential for ED patients to spend less time waiting on blood tests they don't need before reaching a treatment decision.

Spare citrate samples

We completed a process map from when spare sodium citrate samples are taken from ED to when they are disposed of in the lab (Appendix 1). We audited spare samples received across three months (August-October 2022). Episodes where the spare sample was a separate bottle to the one with any other coag tests were excluded and instead these separate spares were included in the unused spare samples data.

Potential change ideas:

We identified the following changes for consideration to reduce low clinical value samples sent to the haematology lab

- Haematology lab staff training for authorising and approving requests:
    - We found inconsistency among the team as some have lower thresholds to run tests than others
    - Encourage team to reject inappropriate coagulation screens
- Reduce clinician requesting test in first place via ED staff training:
    - Guidance on sunrise clinical manager may be an option for when a clinician requests a coagulation screen, enabling us to target the high turnover of staff in ED, where one off teaching sessions may prove ineffective.
- Changes to protocols/ paperwork used in ED
    - Reduce the number of wasted coagulation samples that never reach the lab by spreading education around wasted first draws, except for winged collection sets[3]
- Reduce the number of underfilled samples through similar raising of awareness[4]

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- Reduce the number of spare citrates being taken via a staff awareness campaign, "Spare a thought for spares". Or a prompt pop-up message when a clinician requests a spare citrate on sunrise clinical manager e.g. "Only 14% of spare citrates are ever used. Please consider whether you need one"

We are liaising with ED to explore these change options and reduce low value / unnecessary samples. We are working with the Sunrise EPR team to look at introducing a guidance message when a spare citrate is requested.

Project 2: Reduce energy usage in (Haematology, Immunology and Boof Transfusion) labs

We identified that the vast majority of the lab equipment stays on for 24 hours a day, 7 days a week. While we are a 24-hour service, in the evenings and overnight there are significantly less staff and less equipment required. We developed a list of all equipment used in the lab and identified when the equipment is used, and what equipment could be safely switched off at certain periods of the day.

Measurement:

Patient outcomes:

Project 1: While we have not directly measured patient outcomes, we have considered potential benefits and drawbacks to a change in the decision-making process for spare citrates and coagulation screens.

Project 2: In considering which equipment we could safely turn off our chief concern was patient safety. If any equipment may be needed for emergency blood testing or could not be reliably turned off and back on again then we have decided to keep it switched on.

Environmental sustainability:

Project 1:

Calculating the wasted reagent and consumables used as part of unnecessary coagulation tests was outside the scope of this project. There are several reagents and quality control solutions, and some plastic consumables involved in a coagulation screen. Looking forward we hope to analyse this waste to determine more accurately the emissions factors for a coagulation screen.

To calculate potential carbon savings from a reduction in spare sodium citrate samples we collected data on the components of the blood tube used and applied emissions factors to each component. We calculated emissions from using a centrifuge, which spins samples at high speed to separate the blood components for testing. We weighed the waste and applied an emissions factor for waste. We calculated emissions factors for transport of citrate bottles and disposal bio-bins from the point of manufacture to the hospital. Equipment needed to take blood from the patient was excluded as this would be used anyway for other samples.

Project 2:

We assessed all equipment that uses electricity in the five departments within haematology. We estimated the power usage by the wattage of the machinery converted to kW and then the on/off time of each machine to get daily kWh figures. Each machine was assessed for whether it could be safely turned off, and for how long per day. "Safely turned off" was defined as would not affect patient outcomes. Reduced weekend usage was not calculated. We liaised with our Trust energy manager to obtain accurate measurement of machine energy usage (in kwh). Our Trust has a

renewable energy tariff, however energy is received from the Grid and therefore for carbon calculation purposes the Government Emission factor for energy (0.26155 per kWh) was used.

Economic sustainability:

Project 1: We collected data on cost of consumables used in collecting a spare citrate sample which included sodium citrate blood tubes (£0.0605 each), biobin and waste disposal (incineration) from the Trust procurement and waste team.

Sample processing time / running the test has no direct lab cost as the service contract for our coagulation machines includes all reagents and machine maintenance, and the number of coagulation screens doesn't affect our staffing requirement.

Project 2: We obtained energy costings for the trust via the Trust energy manager (£0.17-£0.27) and used the average cost for our calculation.

Social sustainability:

We have not measured social sustainability however have detailed potential impacts in results section below. We spoke to our team and we are aware that sustainable changes mustn't harm our patients. Our lab manager Alison said "Our Department is keen to be green and has felt first-hand the effects of supply problems but a lot of our consumables are difficult to reduce or change to degradable products without affecting the quality of our results."

Results:

Patient outcomes:

Project 1:

Inappropriate coagulations tests can make clinical management more difficult, as if they are abnormal, the medical team will be required to act, though this is unlikely to impact on clinical care or wellness of the patient. If coagulation screens are requested for inappropriate clinical reasons, a rejected sample will delay the patient's treatment, as the clinician queries this with the lab. A clinician can make faster decisions if they are waiting on fewer tests results to come back. If a clinician does require a coagulation screen and has an appropriate reason that they haven't stated, it will help the patient's outcome if they list this detail correctly. The lab will be able to process samples more confidently, and better analyse the results for that patient.

From a patient safety perspective, taking additional samples may be removing blood cells and fluids unnecessarily[2] and therefore detrimental to their health. This is especially true for anaemic patients. However, we also want to avoid rebleeding patients which may be a risk of reducing spare citrate samples at the time of an original test.

Project 2: A lot of machinery in our labs provides 24hr service to the hospital and mustn't be turned off. Clinicians require fast results to enable timely decision making, as illustrated by departmental turnaround targets for each test. These are monitored monthly at trust level. Primary machinery involved in our 24 hour service we have determined needs to be kept on.

Environmental and Economic sustainability:

Project 1:

We retrospectively analysed every coagulation screen request from ED GRH and CGH in September 2022. The results were split in two and analysed by two members of the team. Using clinical details

and patient history in the same way that a BMS would during initial screening, we recorded whether tests should have been approved or rejected and compared this to how many were approved and rejected in reality. We found that 21.45% of tests that were approved and definitely inappropriate. Tests of 'low clinical value' were listed as appropriate. Defining which tests should not have been requested has become beyond the scope of this project.

September 2022	CS screens group 1	CS screens group 2	Average
total	227	237	232
-rejected	10	8	9
-sample issue e.g. underfilled	31	28	29.5
-approved	186	201	193.5
appropriate	142	162	152
inappropriate	44	39	41.5
% inappropriate	23.66%	19.40%	21.45%
inappropriate tests kg CO2e	2.394	2.122	2.258

Reducing impropriate tests by 75% (31.12 tests per month) would be a CO2e saving of 1.68 kgCO2e, or **20.3 kgCO2e per year**. This is an underestimation as this does not take into account the CO2e associated with the processing of the test. Reducing the number of inappropriate coagulation screens by 75% could save an additional **£29.66 per year.**

Spare citrates: from August to October 2022, the average number of spare citrate samples received in the lab was 1,473.33. On average, 213.33 of these were used for a test, and 1,260 went unused each month. This equates to approximately 14.5% of these samples received ever being used (st dev 0.00264). The remaining 85.4% of samples were disposed of into bio-bins and incinerated without ever being used.

	Spare Citrates	Used Spares	unused spares	% used	Co2e (unused spares)
August	1348	192	1156	14.24%	62.9 kg CO2e
September	1425	205	1220	14.39%	66.4 kg CO2e
October	1647	243	1404	14.75%	76.4 kg CO2e
Average	1473.33	213.33	1,260.00	14.46%	68.5 kg CO2e

Projected across a year, reducing spare citrates sent to pathology by 80% would save **658 kgCO2e**, equivalent to driving 1,895 miles in an average car.

Each sodium citrate bottle costs £0.0605. Each bio-bin costs £4.79. If we could reduce the number of unused spare citrates by 80%, we could reduce discarded samples by 1,008 bottles per month – 12,096 bottles per year! This would reduce the bio-bins needed by 17.7. The cost saving of bottles and bio-bins would be **£816.64 per year**.

Project 2: The table below summarises our energy usage for all equipment used across both sites for routine haematology, blood transfusion and immunology testing. Our potential savings have been calculated by identifying how many hours equipment could be turned off for. We have assumed that an 80% reduction in this time would be realistic as equipment being turned off consistently is dependent on a number of staff.

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Per day					
Area	Total Consumption (kWh)	Total emissions (kgCO2e)	Potential Saving (kWh)	Potential Saving (kgCO2e)	Potential Saving (£)
CGH				*0.26155kg CO2e per kWh*	*£0.02 per kWh*
Routine Haematology	1006.02	263.12	199.76	52.25	43.95
Blood Transfusion	691.53	180.87	122.16	31.95	26.88
GRH					
Routine Haematology	1288.61	337.04	138.98	36.35	30.58
Immunology	481.54	125.95	264.99	69.31	58.30
Blood Transfusion	542.86	141.99	97.96	25.62	21.55
TOTAL	4,010.55	1,048.96	823.85	215.48	181.25

Per Year Totals	**1,463,850.99**	**382,870.23**	**300,706.56**	**78,649.80**	**66,155.44**

Target: 80% of potential	Total Consumption (kWh)	Total emissions (kgCO2e)	Potential Saving (kWh)	Potential Saving (kgCO2e)	Potential Saving (£)
Daily	3,208.44	839.17	659.08	**172.38**	**145.00**
Yearly	1,171,080.79	306,296.18	240,565.25	**62,919.84**	**52,924.36**

It is estimated that if 80% of potential power usage reductions are implemented, **240,565kWh, £52,924.30 and 62,919.8 kgCO2e could be saved per year**. This CO2e reduction is equivalent to driving 181,220.6 miles in an average car.

Social sustainability:

Spare citrates potential benefits:

- The lab have a turnaround time of 1 hour. We are currently not consistently meeting this target. Lab staff will gain time from reduced vetting and processing of low value samples. This may increase turnaround time of other tests. ED will receive results of other tests more quickly.

Potential disbenefits:

- Rebleeding a patient may be required because a spare citrate wasn't taken at the time of bleeding for other tests. This should be avoided as it may cause discomfort to the patient and will delay results. Based on only 15% of spare samples being used for tests, we assume this would be an infrequent issue.

Discussion:

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Summary:

As we progressed with this project we found that it became more complicated than initially thought, especially with regard to inappropriate coagulation screen requests. It is difficult to categorise the reasons given for the requests, and the requestor may be asking for a coagulation screen for an appropriate reason that hasn't been provided with the request itself. Further analysis is required in collaboration with ED, perhaps in the form of audits to identify how often clinical details are left off of requests, and to expand this over several months. We suspect that in reality there is a significantly higher proportion of coagulation screens being run that are inappropriate, but to confirm this we will need further investigation.

It was more straightforward to investigate how often spare citrate tests are unused, and this would be an excellent target for reducing sample numbers sent to the lab. Each spare citrate sample must be spun, to prepare it for testing, and must be checked by a biomedical scientist. If we could free up these lab resources, we could free up time to better assess coagulation screens before running them. On the clinical side, if the sample isn't required, time and resources will be saved bleeding the patient.

The energy reduction project identified immunology as a department to target for machine switch off, as the immunology service is run only during normal working hours. There are several large analysers in immunology which are unused during the evening and night. Fridges and freezers must be kept on for sample and reagent storage, however machinery like water baths could potentially be turned off while not in use. However, this will need an assessment of how quickly each water bath can return to temperature and how stable they are after this.

Some machinery which goes into limited use during out of hours is kept on because of issues with connectivity to the lab requesting system, TCLE, and various blood test analysis software. We may be able to safely power down some equipment during out of hours if we can ensure that the connection will remain reliable when powered back up.

Limitations:

Changes to practice that affect ED must be made very carefully because ED is under such enormous pressure. When weighing sustainability against department performance, the challenges the ED department face, such as high patient numbers, lack of beds, high numbers of patients requiring admission, get first priority. It has been hard to contact staff through the short project period as they are so busy. As we progressed and better understood the issues around coagulation screen requesting, the project expanded beyond our scope. A second stage of the project would be useful to investigate more thoroughly.

Due to the increased complexity of the project, we were unable to implement any of our desired changes within the timeframe of the project. High demand on staff time during working hours within our lab also slowed our progress.

In our energy project, we used estimated power usage figures to determine current consumption. We considered using energy monitor plugs, but decided there were too many pieces of machinery, and these could not be unplugged safely.

Interpretations:

Deciding whether to request a coagulation screen is far more complex than was initially thought when we started this project. There are defined guidelines for when a coagulation screen should be requested, however for departments like ED where there is such a high demand on the workforce due to patient numbers, it may improve patient safety to pre-emptively request tests like

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coagulation screens where there is ongoing bleeding, even though there is no clinical suspicion of a bleeding disorder, because the delay to patient treatment when deciding later that a coagulation screen is required negatively affects the performance of the whole department and so the treatment of other patients. The same may be true of spare citrate samples. At the time of initial venepuncture, a spare citrate can be taken to save time, reduce risk to the patient and improve department workflow, even when it is likely the sample will go unused. It is likely that this is current practice, as so many unused samples currently reach the lab from ED.

Future aims

As a team we examined possibilities of reducing energy usage of electrical equipment, and reducing low clinical value samples, in order to be a more sustainable laboratory. However, there is still much room for improvement and far more areas of the laboratory to target to move towards sustainability, but which were beyond the scope of this project. For the clotting screens requests, we could look at revising and updating the requesting criteria for clotting screens. This is due to relaxed test acceptance towards low clinical value reasons for coagulation screen testing. It is important we differentiate what is considered an appropriate or inappropriate request for CS testing; as well as improving sustainability, we want to be a high-quality laboratory that is able to work closely and proactively with other hospital departments.

Moreover, another future project could entail researching how many spare citrate tests or coagulation screens are requested on their own (with no other blood bottles on that episode). The proportion of these that are unused or inappropriate would include wasted venepuncture equipment and supplies in their CO2e calculations.

Similar to the clotting screen investigation, we could set up similar studies into inappropriate haematinics requests from GP surgeries, or unused group and save samples in blood transfusion. These are just two tests we have identified as tests with high waste, and further analysis could be done to select other tests worth exploring. These projects will enable us to save costs, reduce waste and be a greener lab. If our project is successful, then other departments could reproduce the projects with tests they identify.

The next steps for this project are to implement support for ED in deciding whether to request a coagulation screen, and to improve laboratory procedure around accepting or rejecting coagulation screens. However, any changes must be made with patient safety as the number one priority, so further discussion is needed with ED and haematology leaders.

Conclusions:

There is a good opportunity to improve the sustainability of the haematology laboratory, although the implementation, and measurement of this, has not formed part of this project. Our current blood booking system was ideal for data extraction, however was limited by the information input by requesting clinicians. Staff engagement should be a goal of improving the hospitals utilisation of coagulation screens. With test requesting and equipment use, patient care must be the priority in any changes considered to current practice. Colleagues have been encouraged to switch off tertiary

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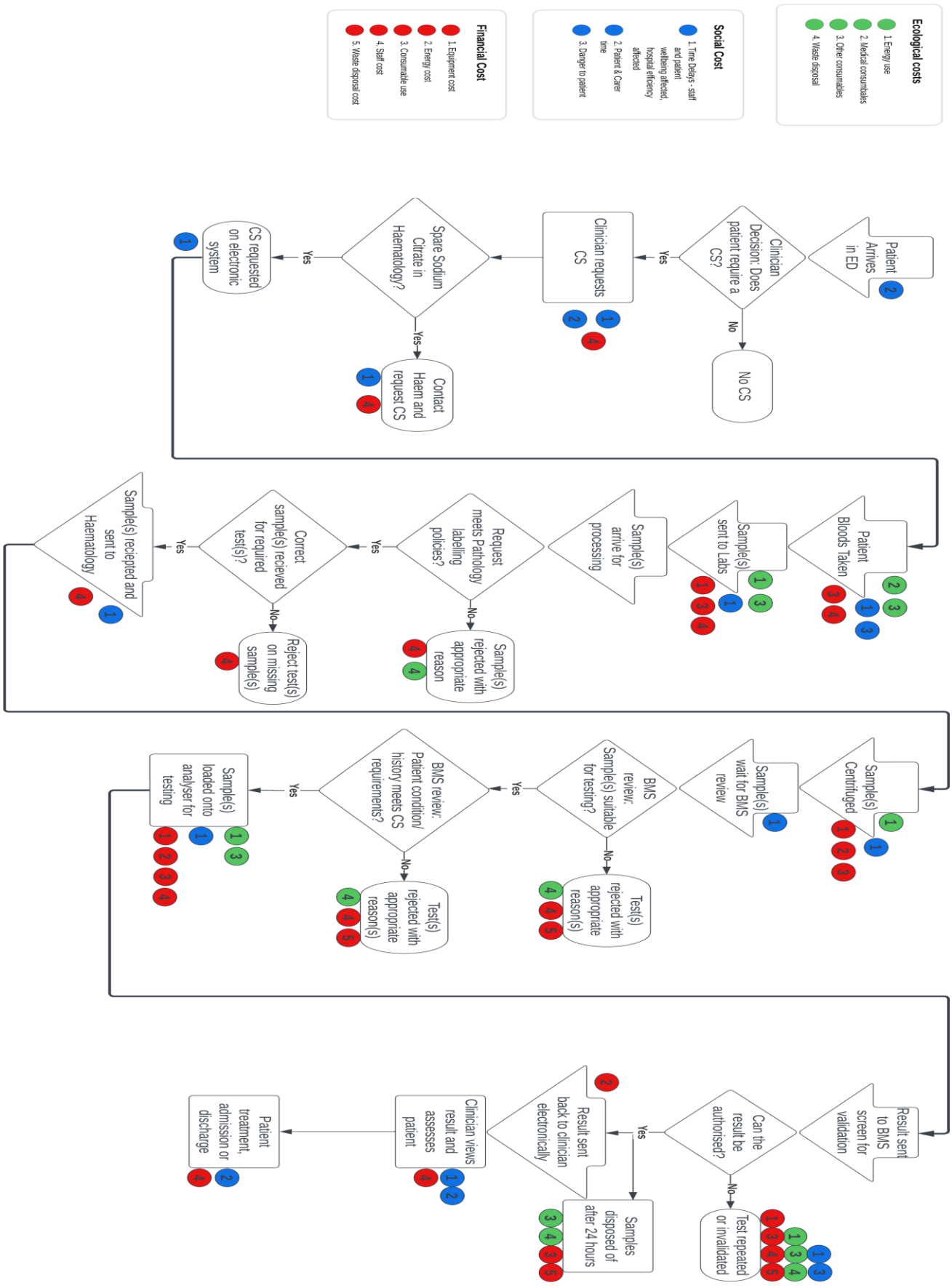
equipment e.g. PCs and monitors when out of use, but for primary testing equipment, further investigation is required before any changes can be made safely. Overall, the project provided a clear proof of concept for the changes we want to make in our lab, and provides a good template for future projects in our department and hopefully others in pathology.

References:

1. guide to indications for coagulation screens: https://www.gloshospitals.nhs.uk/our-services/services-we-offer/pathology/haematology/coagulation/
2. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0243782
3. **https://www.labcorp.com/resource/blood-specimens-coagulation**
4. **https://files.labcorp.com/labcorp-d8/inline-files/Volume_Guide_For_Coag_Testing.pdf**

Appendix 1 – Coagulation screen request flowchart



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