

SUSQI PROJECT REPORT

Reducing the carbon footprint in endoscopy using optical diagnosis in bowel cancer screening

Start date of Project: July 2026

Date of Report: September 2026

Team Members:

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Background:

Endoscopy departments are responsible for producing the second highest amount of waste in hospitals. Bowel cancer screening is a national screening programme where all adults 50-74 years of age are sent stool samples to test for blood. If the result is over a threshold, then patients are called for colonoscopy. This is carried out in the endoscopy department on a separate bowel cancer screening list, usually consisting of four patients. During colonoscopy, any polyps found are removed using biopsy forceps or a snare, retrieved and sent to histopathology for diagnosis. There is a financial, time and carbon cost of each polyp that is sent to histopathology. In most endoscopy cases, polyps are removed, placed in a formalin containing pot and sent to histopathology where they are processed into slides for review. The process of polyp removal in bowel cancer screening has recently changed with the introduction of optical diagnosis. This is a process by which expert endoscopists complete training in polyp recognition such that they can correctly identify small benign polyps (<5mm) that can be removed and discarded (into the bowel lumen) without needing to be sent for histological diagnosis. Training involves completing e-learning, passing a test to correctly identify polyps with high confidence and provide adequate photographic evidence of discarded polyps. This training ensures that current standards are maintained and that any larger polyps or those with concerning features are always sent to histopathology. Reducing the number of polyps sent to histopathology reduces the workload on endoscopy and histopathology staff in addition to reducing financial costs, time and the carbon involved in processing each polyp (Ahman *et al.*). Optical diagnosis is a national directive from NHS England which aims to 'significantly reduce the burden on histopathology services, promote green endoscopy by substantially reducing use of consumables and offer cost-savings at a screening and national level' ([*Optical diagnosis with resect and discard guidance September 2024 Version 4.0 NHS England*](#)).

Data will be collected at a national level, but I am unaware of this being done at local trust level. The endoscopy team is well suited to tackling this problem as they are involved at the start of this process (removing polyps and placing them into pots for analysis) and have the data available from endoscopy lists. The histopathology teams were involved to obtain further information about their procedures for processing polyps.

The ultimate goal would be to roll out optical diagnosis to other endoscopists (not just bowel cancer screening). This would need to be a national directive; however, our data may support a move towards this in the future or perhaps allow our trust to become a pilot site. Links to the British Society of Gastroenterology will allow this to be taken forward at a high level in the hope of implementing wider change nationally.

The project fits into practise position statement 2:7 of the Green endoscopy: British Society of Gastroenterology (BSG), Joint Accreditation Group (JAG) and Centre for Sustainable Health (CSH) joint consensus on practical measures for environmental sustainability in endoscopy 'we recommend that endoscopy departments should consider local protocols to minimise the use of histopathology in appropriate clinical pathways'.

Specific Aims:

To quantify the carbon footprint reduction and cost savings associated with optical diagnosis in bowel cancer screening endoscopy, compared with the previous approach of removing and sending all polyps for histopathological assessment.

Methods:

The endoscopy software (HICSS) was used to retrospectively identify all bowel cancer screening lists at the Royal Hampshire County Hospital for a full month since optical diagnosis implementation (May to June 2026). Endoscopy reports were viewed to calculate the number of polyps discarded which would previously have been processed by histopathology. Modelling was then used to calculate the cost saving and carbon reduction associated with this change across the service and over a longer period. An analysis of time saving was made in the endoscopy department based on average time needed to retrieve and send polyps to histopathology.

The standard pathway in endoscopy involves a polyp being removed by forceps or a snare and polyp trap before being placed in a formalin containing pot. A label is produced electronically, and the labelled pot is placed in a plastic sample bag, to be collected by porters and taken to the histopathology lab. Once in the histopathology lab, the sample is scanned and logged onto an electronic system, then cut using a scalpel and placed in a disposable cassette. From here the sample undergoes processing in specialised machinery overnight before being embedded in wax. After this the sample is cut into thin sections (microtomy), put onto a slide with a cover slip and then stained using specialist equipment. Slides are then scanned onto an electronic system and reviewed by a consultant histopathologist who produces a final report. Sometimes additional staining is required which makes the process longer and requires yet more equipment.

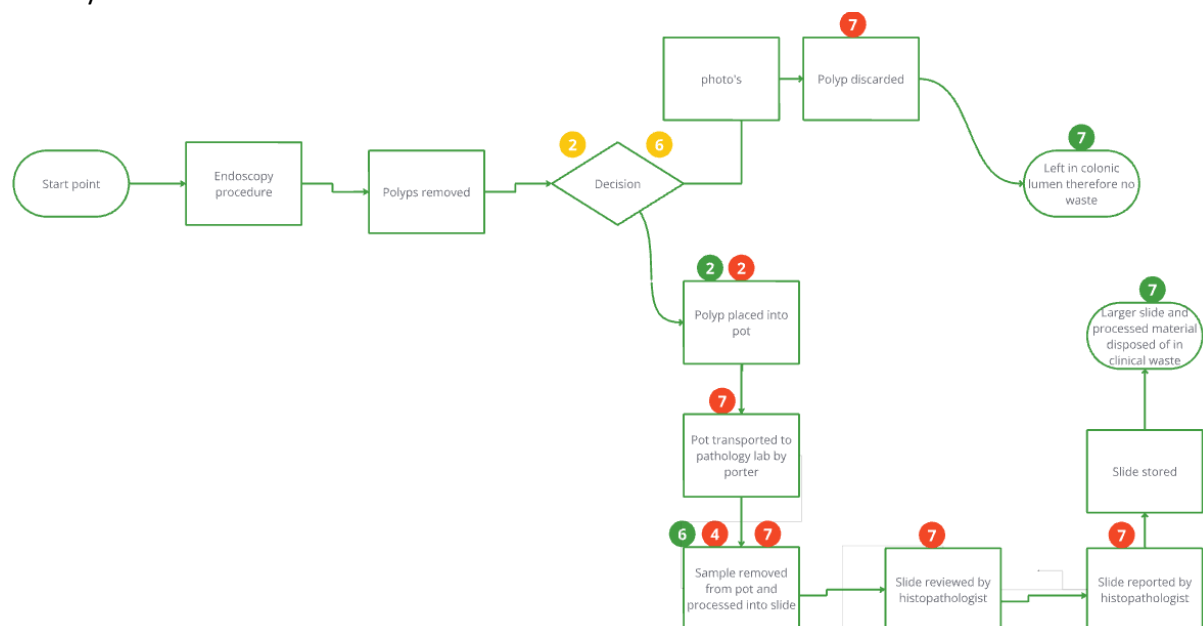
In the new pathway (see figure 1.), the process in endoscopy is initially the same (removal of the polyp using forceps or a snare) but the removed polyp is left in the bowel lumen so there is no need to collect it and send it the histopathology lab. As a result, the entire process in the lab is avoided.

The change has already been rolled out as part of the national bowel cancer screening programme but is a very recent change at Royal Hampshire County Hospital, with all relevant endoscopists completing training in April or May of this year. It therefore seemed an ideal time to assess this change, and it is open to further review in the coming months and years. It is also hoped that optical diagnosis may be extended to include all endoscopists in the future with an even greater impact on the carbon footprint associated with endoscopy.

As this has been implemented at a national level, no formal sign off was required locally and no additional staff or user education was required either.

This project involves reducing equipment use so no additional resources were required. Similarly, no financial investment was needed, with a plan for cost saving instead.

Image 1. Process Mapping – polyp removal to discarding or sending to histopathology with key to identify use of resources.



RESOURCE USE KEY		
Environmental resources	Social resources/impacts	Financial resources
1 Medications	1 Patient/carer time	1 Medications
2 Medical supplies	2 Patient/carer satisfaction	2 Medical supplies
3 Anaesthetic gases/nitrous oxide	3 Patient/carer relationships	3 Non-medical supplies
4 Propellant inhaler (MDI)	4 £ cost to patient/carer	4 Energy use
5 Non-medical supplies	5 Patient/carer wellbeing	5 Waste disposal
6 Energy use	6 Staff satisfaction	6 Water use
7 Waste disposal	7 Staff wellbeing	7 Staff time
8 Water use	8 Community impacts	8 Contracted services (e.g. cleaning, laundry)
9 Staff travel	9 Supply chain worker wellbeing	
10 Patient travel		

Measurement:

We planned to measure the reduction in the number of polyps sent to histopathology from bowel cancer screening endoscopy lists after the introduction of optical diagnosis. The number of consumables used prior to this change along with the financial and time savings for the trust and staff was measured.

Patient outcomes:

The aim of this project was to reduce samples sent to histopathology and there were no anticipated adverse impacts on patient outcomes associated with this project. It aims to deliver equivalent levels of safe and effective care, while achieving reductions in environmental and financial costs and contributing positively to social value. This is being done in conjunction with national guidance from the bowel cancer screening service. It has already been deemed to be an acceptable change in terms of patient care and has been rolled out nationally already. Any larger polyps that do not meet the criteria to be discarded or any polyps that the endoscopist is concerned about are still sent to histopathology.

Population outcomes:

The national bowel cancer screening service already collect data relating to population health and the value of a screening service is to improve health through early detection. The service is already able to provide more detailed and appropriate information for population groups so there is no perceived negative impact on such groups with this project.

Environmental sustainability:

Methodology

A cradle-to-grave carbon footprint analysis was used to estimate the items greenhouse gas (GHG) emissions. Data was provided on the equipment used to take and analyse a bowel polyp and were carbon footprinted using a process-based carbon footprint analysis. Items were weighed by the team and materials identified.

Data was obtained from previous studies by the Centre for Sustainable Healthcare and other references. Where data was not available, calculations were made based on the weight and material

of the product. Material weights were converted into GHG emissions using emission conversion factors taken from the Department of Energy Security and Net Zero (DESNZ)'s Greenhouse Gas Reporting Conversion Factors 2026 database, ICE V4.0 database and primary research papers and LCAs. The analysis included GHG emissions associated with primary materials production, transport, and disposal.

Determining emissions of reagent per test is complicated and precise data isn't available. Proxy data was considered from [Carbon footprint evaluation of routine anatomic pathology practices using eco-audit: Current status and mitigation strategies - ScienceDirect](#) and 'Use of histopathology multiwell cassettes to reduce waste in endoscopy procedures' [Endoscopy SusQI Report](#) from 2024.

For end-of-life treatment, disposable equipment was assumed to be disposed of as clinical waste, while the packaging waste was assumed to be dry mixed recyclable with the corresponding emission factors taken from [Rizan et al., 2020](#). The carbon footprint of waste disposal of the items was based on [Rizan et al., 2020](#) carbon footprint of high temperature incineration for clinical waste.

Materials

Material emissions were calculated by the weight of the material, emission factor of the material and number of items.

*Total emissions = weight of material * material emission factor*

Waste

Waste emissions were calculated by amount of waste (tonnes) and the UK emission factor of average emissions by waste stream.

*Total emissions = volume of waste * waste stream emission factor*

The emission factor for clinical waste is 1074 kgCO₂e, dry mixed recycling is 172 kgCO₂e and domestic waste is 172 kgCO₂e.

Activity

There was an average of 59 specimen pots avoided going to histopathology each month, or 708 per year through the new approach.

Economic sustainability:

Financial data for consumables was obtained from NHS supply chain and financial costs for staffing were obtained from nationally recognised figures ([2022 Personal Social Services Research Unit](#)). No investment costs were identified in this project. The financial cost of reduced disposal would be small and difficult to quantify in the confines of this project and has therefore been excluded from the project. There is a financial benefit in reducing the number of slides stored in again was difficult to quantify and has therefore been excluded.

Social sustainability:

Collecting patient surveys is beyond the scope of this project however, work has been done at a national level to ensure it is acceptable to patients and as the change is only within endoscopy itself, there will be no change to other factors such as patient travel to hospital, time off work for appointments etc.

From a staff perspective, this is considered a positive change as there are fewer processes in endoscopy and histopathology. This allows more time for other tasks to be completed, for endoscopy lists to finish more quickly and this may allow more patients to be booked onto lists resulting in efficiency savings. Although there will now be a little uncertainty about the histopathology of polyps, thorough training and testing ensures that staff feel supported to decide which polyps to discard. They are also able to send any polyps they are uncertain about to the histopathology laboratory ensuring that they are always able to act in the patient best interests without a negative impact on their care.

Results:

Environmental sustainability

Data collected for a 2024 Hampshire Green Team Competition ([Endoscopy SusQI Report](#)) was used with the emissions factor updated using the 2026 DESNZ figures. It was assumed components e.g. formalin pot, has not changed in shape, size or materials used. Calculations have excluded emissions associated with storage of slides, cassettes or digital storage as energy used per slide is not known in sufficient detail.

Table 1 describes the inventory and consumable items used at each stage of the process, along with the emissions per item.

Table 1. Consumables and energy used per slide with emissions per item and total emissions.

	Consumable	Number	Emissions per item (kgCO ₂ e)	Emissions total (kgCO ₂ e)
In endoscopy	Polyp trap	1	0.365	0.365
	Formalin pot	1	0.120	0.120
	Transport bag	1	0.016	0.016
In histopathology	Disposable cassettes	1	0.021	0.021
	Scalpel blade			
	Gloves	2	0.026	0.052
Processing	Alcohol + xylene	1	0.007	0.007
	Tissue block and wax	1	0.027	0.027
Embedding	Gloves	2	0.026	0.052
Microtomy	Scalpel blade	1	0.000	0.000
	Gloves	2	0.026	0.052
	Glass slides and coverslip	1	0.024	0.024
	Reagents and stains (*)	1	0.014	0.018
Total				0.754

(* See Table 3)

The emissions from consumables are 0.754 kgCO₂e per slide.

Electricity

Details of the electricity used for each piece of equipment summarised in Table 1 are shown in Table 2, for each step of the histopathology process. They are taken from [Carbon footprint evaluation of routine anatomic pathology practices using eco-audit: Current status and mitigation strategies - ScienceDirect](#) and updated with 2026 UK electricity emission factors of 0.144 kgCO₂e per kWh.

Table 2. Electricity use and emissions from electrical equipment per slide

Item	kWh per slide	GHG emissions per slide (kgCO ₂ e)
Scanner	0.000269	0.000039
Cassette Printer	0.02304	0.003317
Label Printer	0.002462	0.000354
Printer	0.04378	0.006302
Computer Station	0.005	0.000720
Dehydration Machine	0.136	0.019577
Automated Embedding Machine	0.05867	0.008445
Hot Plate	0.010267	0.001478
Cold Plate	0.0767	0.011036
Blade Burner	0.02304	0.003317
Microtome	0.012267	0.001766
Computer Station	0.004	0.000576
Automated Slide Stainer	0.0207	0.002980
Glass Cover slipper	0.003312	0.000477
Microscope	0.023564	0.003392
Computer Station	0.030682	0.004417
Total		0.0682

The total emissions from electricity use are 0.0682 kgCO₂e per slide.

Reagents

Reagents in addition to ethanol and xylene are described in [Carbon footprint evaluation of routine anatomic pathology practices using eco-audit: Current status and mitigation strategies - ScienceDirect](#). Table 3 shows the reagents, volume used per slide, emission factor for the reagent and the emissions per slide.

Table 3. Emissions from reagents used per slide

Reagents	Weight per slide (kg)	Emission factor (kgCO ₂ e /kg)	GHG emissions per slide (kgCO ₂ e)
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Methylcyclohexane	0.005133333	2.12	0.0129
Lithium Carbonate	0.000028	2.12	0.0001
Hematoxylin	9.09E-05	6.4	0.0006
Total			0.0136

The total emissions from reagents used are 0.0136 kgCO₂e per slide.

Total emissions

Emissions per slide from

- consumables are 0.754 kgCO₂e.
- electricity use is 0.0682 kgCO₂e.
- reagents used are 0.0136 kgCO₂e.

The total emissions per slide are 0.852 kgCO₂e. Per month, if 59 specimens are no longer sent to histopathology, emissions are reduced by 59 * 0.852 kgCO₂e = 50.3 kgCO₂e. **Emissions avoided per year are 603 kgCO₂e.**

Economic sustainability

Staff time

Different staff are involved for different lengths of time throughout the process. These are summarised in Table 4.

Table 4. Sample pathway between endoscopy and histopathology and estimated length of time taken

Procedure	Staff time (mins)
Process in endoscopy	
Polyp trap used in most cases – additional approx. 5 minutes to add trap and search for polyp	5
Sample placed in pot. Additional 2 minutes to do this	2
Label printed out and attached to pot and request form printed – approx. 3 minutes	3
Pot placed in bag and sample checked by two members of staff – additional 1-2 minutes	1
Process in histopathology lab	
Reception/Booking	
Label is attached to pot and decision made about which stream is needed (3/4 minutes)	0.75
Booked onto management system and decide levels needed for downstream (single transfer if <5mm, bisecting if >5mm) – 5minutes per sample	5
Cut up	
Approx 5 minutes per sample	5
Processing	
Sample processing	

Embedding	
Approx 8 minutes per sample	8
Microtomy	
Approx 5 minutes per sample	5
Gloves used	Not known
Slide processing and staining	
Takes around 45 minutes for a rack of slides (up to 20)	2.5
Scanning	
Slides checked to match cassette and digital images viewed to check quality	?
Reporting	
Slides sent with request paperwork to histopathologist for reporting	?
Variable time depending on the individual	
Additional immunohistochemistry	
Separate machinery – high consumables – 3 hours to complete on machine	? Per sample

At least 37.25 mins are used per sample throughout the process. This does not include the reporting by the histopathologist, review of the results by the clinician, or any follow up appointment to discuss the results with the patient. Time saving on average band 5 (£41 per hour in scientific staff) x 37.25 minutes is £25.45 per sample processed in histopathology (excluding reporting, reviewing the results and follow-up with patients). This equates to modelled staff financial efficiency savings of £1,501.55 per month and £18,018.60 per year.

The estimated saving due to reduction in procurement of medical equipment per slide of retrieval at endoscopy in a polyp trap to processing in histopathology is £8.32 (£0.93 per slide processed, £7.21 per polyp trap and £0.18 in gloves). See table 5.

Table 5. Poly retrieval and processing costs

Equipment	Items per year	Cost per item/slide	Saving per year
Polyp trap	708	£7.21	£5,104.68
Gloves	708 pairs	£0.18	£127.44
1 Slide processed	708	£0.93	£658.44
Total		£8.32	£5,890.56

The total saving per slide including consumables and staff time is therefore £33.77. Based on the average saving of 59 slides per month at £33.77 per slide, this would result in a monthly saving of £1,992.43, equating to an **annual saving of £23,909.16**.

Patient outcomes:

The project has maintained standard levels of care with a reduction in carbon emissions, time and financial costs. No adverse outcomes have been reported via our Inphase system since the new pathway implementation. The reduced burden on the histopathology lab could result in other patients receiving their results more quickly, leading to early diagnosis however this is not quantifiable within the scope of this project.

Population outcomes:

As this is part of the national screening service, changes will be applicable in all trusts therefore having an immediate effect at population level. There are no predicted negative population outcomes.

Social sustainability:

The implementation of optical diagnosis is estimated to save **37.25 minutes per slide**. Based on a workload of **59 slides per month**, this equates to approximately **36.6 hours saved a month**. Over a year, with **708 slides avoided**, the total time saving is approximately **439.6 hours (55 working days)**, based on an 8-hour working day).

This substantial reduction in histopathology workload allows skilled laboratory staff to redirect their time towards higher-value activities, including the processing and reporting of more complex or urgent specimens. As a result, laboratory capacity can be used more efficiently, potentially improving turnaround times for higher-priority results and supporting more timely patient care

By streamlining the bowel cancer screening pathway using optical diagnosis, the service becomes both more efficient and more environmentally sustainable. Reducing unnecessary histopathology processing eliminates waste, lowers the carbon footprint associated with diagnostic pathways, and supports the wider healthcare sustainability agenda. Importantly, this aligns with values that many healthcare professionals identify as important, including delivering high-quality patient care while minimising environmental impact. Empowering staff to contribute to a more sustainable service can increase engagement and job satisfaction by demonstrating that their work supports both clinical and environmental objectives. In turn, a more efficient and values-driven pathway can help foster a more motivated and productive workforce, with greater capacity to focus on activities that add the highest value to patient care.

Discussion:

This project assessed the impact of optical diagnosis in bowel cancer screening endoscopy with a focus on environmental, financial and social savings. The project was limited to working within the confines of a nationally driven screening programme, but this does mean that savings would be applicable to all trusts involved in the screening service. The project aimed to maintain current clinical standards as the endoscopists are highly trained and able to send any polyps they want to histopathology if they feel it is needed. The savings made will be applicable to the whole population as this is already part of the national screening programme, so it has a far-reaching effect. The overall results indicate that 603 kgCO₂e emissions are avoided annually, representing a meaningful environmental benefit. In addition, the annual financial saving of £23,909.16 is significant. If similar savings were achieved across all NHS trusts in England, the cumulative financial impact would be substantial, delivering considerable cost efficiencies alongside environmental gains.

From a social savings aspect, there is a time saving of 439.6 hours (55 working days based on an 8-hour working day), freeing up time for other work and allowing other results to be obtained more quickly.

Maintaining clinical care standards was an important consideration throughout implementation. However, the national screening programme supports optical diagnosis and ensures that endoscopists are appropriately trained to identify polyps suitable for a discard strategy. As part of routine practice, photographs are taken of polyps that are not sent for histopathological analysis, allowing for review if required. In cases where there is any uncertainty, endoscopists are encouraged to submit polyps for histopathology. These safeguards ensure that high standards of patient care and diagnostic accuracy are maintained. Staff within the department were highly supportive of the initiative, recognising the environmental, financial and social benefits associated with optical diagnosis.

This project assessed the impact of optical diagnosis on one site in the trust. Optical diagnosis has now been rolled out nationally so the savings we have seen will be multiplied many times already. In terms of moving forwards, the aim would be to eventually roll this out to all endoscopists (with appropriate experience and training) who perform colonoscopy and all relevant patient groups, which will reduce the burden on histopathology services even more dramatically with associated savings environmentally, financially and socially. Links with the BSG will allow these discussions to start and the first steps to hopefully be made soon.

Conclusions:

This project has indicated that there is the potential for financial savings of £23,909.16 per year, just for the implementation of this change at one site. Basingstoke hospital is the other main site in our trust, and they perform a similar number of bowel cancer screening lists. This means that across the trust, there is a potential £47,818.32 savings per year and a saving of 1,206 kgCO₂e emissions. Work has already started in Basingstoke as optical diagnosis has been rolled out nationally as part of the bowel cancer screening programme. Patients will see benefits from these improvements by reducing the workload on histopathology and allowing a faster turnaround for other samples. Staff benefits include improved efficiency and staff time saving from reduced samples being sent to histopathology with a reduced workload on laboratory staff and consultant time for reporting samples.

The environmental impact/ carbon saving for implementing this change on our site is an estimated annual saving of 603 kgCO₂e. This will be further increased if we are able to roll this out to all endoscopy lists at some stage in the future.

The key elements that contributed to successes/learning in this project were working collaboratively with laboratory staff and gaining a deeper understanding of the processes involved in the laboratory. Key learning included recognising the importance of having clear training and guidance for bowel cancer screening endoscopists to ensure only very low risk polyps were discarded with optical diagnosis. Additionally, recognising that there are significant environmental, financial and social savings even through a relatively modest reduction in polyps being sent to the lab. This change benefits from being part of a national screening programme so will continue indefinitely and has an impact on a national level. This is all essential for ensuring lasting change and to spread learning to others for further benefits.

References and Resources

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Kinchen J, Rajest R and Lamar E. Use of histopathology multiwell cassettes to reduce waste in endoscopy procedures SUSQI Project Report 2024 [Endoscopy SusQI Report](#)

Optical Diagnosis with Resect & Discard Guidance – September 2024 Version 4.0 NHS England 2024 [Optical Diagnosis with Resect & Discard Guidance – September 2024 Version 4.0](#)

Rizan, C., Bhutta, M.F. and Reed, M. et al. The carbon footprint of waste streams in a UK hospital *Journal of Cleaner Production* 2021;**286**: p. 125446. [Rizan et al., 2020](#)

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Trecourt, A., Cottinet, P.-J. and Donzel, M. et al. Carbon footprint evaluation of routine anatomic pathology practices using eco-audit: Current status and mitigation strategies *Annals of Diagnostic Pathology* 2023;**67**:152210. [Carbon footprint evaluation of routine anatomic pathology practices using eco-audit: Current status and mitigation strategies - ScienceDirect.](#)

[2022 Personal Social Services Research Unit](#)

Critical success factors

Please select **one or two** of the below factors that you believe were most essential to ensure the success of your project changes.

People	Process	Resources	Context
☐ Patient involvement and/or appropriate information for patients - to raise awareness and understanding of intervention ☐ Staff engagement ☐ MDT / Cross-department communication ☐ Skills and capability of staff ☐ Team/service agreement that there is a problem and changes are suitable to trial (Knowledge and understanding of the issue) ☐ Support from senior organisational or system leaders	X clear guidance / evidence / policy to support the intervention. ☐ Incentivisation of the strategy – e.g., QOF in general practice ☐ systematic and coordinated approach ☐ clear, measurable targets ☐ long-term strategy for sustaining and embedding change developed in planning phase ☐ integrating the intervention into the natural workflow, team functions, technology systems, and incentive structures of the team/service/organisation	☐ Dedicated time ☐ QI training / information resources and organisation process / support ☐ Infrastructure capable of providing teams with information, data and equipment needed ☐ Research / evidence of change successfully implemented elsewhere ☐ Financial investment	X aims aligned with wider service, organisational or system goals. ☐ Links to patient benefits / clinical outcomes ☐ Links to staff benefits ☐ 'Permission' given through the organisational context, capacity and positive change culture.