7. Barriers and facilitators to implementation

Section key points

- Surveys indicate the majority of the public are concerned about climate change and support NHS net zero carbon ambitions.
- Many surgical teams are motivated to improve sustainability but perceived barriers to change include lack of awareness, lack of information, feeling disempowered, financial costs, lack of time, inadequate facilities or resources, and lack of leadership and guidance.
- Surgeons may look to Surgical Colleges, and specialty associations for guidance. Bottom-up leadership may be facilitated by sustainability champions and networks.
- Sustainability is now a GMC mandated core outcome for undergraduates.
- Few resources are available for postgraduate training e.g. the SusQI model enables sustainability to be integrated into Quality Improvement teaching and the Royal College of Anaesthetists has integrated sustainability into curricula and examinations.
- Infection prevention and control policy and practice is often perceived as a barrier to sustainability. More consistent and permissive policy is needed, without compromising safety.
- The medical supply chain is globalised, complex and fragmented, posing a challenge to enacting change to favour sustainability.
- Transition to sustainable models of surgical care requires appropriate supporting policy and infrastructure, including physical facilities and financial models.

7.1 Knowledge, attitudes, and behaviours

A YouGov survey of over 2,500 **healthcare staff** (2021) found **87% support NHS net zero carbon targets**.[392] However, surveys point to varying levels of awareness and engagement with sustainability issues amongst healthcare staff. For example:

- A 2022 survey of healthcare workers in the UK, revealed that 74% of staff were aware of the negative environmental impact of surgery[393]
- A 2022 study of Finnish perioperative nurses found they were aware of ecological sustainability, but most thought this unnecessary in hospital settings[394]
- A 2021 survey of UK surgeons found 82% were willing to make changes to their clinical practice to improve sustainability[395]
- A 2015 survey of nursing staff found sustainability was considered lower priority in daily work compared to issues relating to preventing infection[396]
- A 2012 study of anaesthetists from Australia, New Zealand and England found 93% would like to increase recycling rates in the operating room[397]

Other barriers to transitioning to sustainability identified by healthcare professionals include a lack of leadership or managerial support,[395] perceived economic cost,[396] and lack of time,[396] whilst enablers include development of leadership and education.[395] In a survey of surgical staff in 2022, 71% had not received any form of education on environmental sustainability in the workplace.[393]

To bring about change in behaviours to enable more sustainable models of surgical care, surgical teams and personnel within supporting services need appropriate knowledge about environmentally preferable models of care, alongside a shift in attitudes. This is illustrated in the COM-B model, whereby **change in behaviour (B) requires capability, opportunity, and motivation (COM)**.[398] This highlights that even where individuals are highly motivated, they may not feel they have permission or appropriate resources to facilitate such change.

A survey exploring attitudes and behaviours towards environmental sustainability of surgeons and surgical trainees in the UK and Ireland found that respondents expressed concern about climate change, and many were willing to engage in efforts to transition to more sustainable practices.[395] They reported that actions towards sustainability were greater in their personal lives than the surgical workplace,[395] aligning with findings from an older survey.[399] The finding that the majority (82%) of respondents were **willing to make changes in their clinical practice**[395] is supported by surveys of surgeons in the USA,[400] ophthalmologists in New Zealand,[401] disease control and prevention specialists in China,[402] anaesthetists in Australia and New Zealand,[397] and obstetricians and gynaecologists in the USA.[403] In the latter survey, **two-thirds support a shift to reusable surgical equipment where clinically equivalent**.[403]

Perceived barriers to change include lack of awareness, lack of information, feeling disempowered, financial costs, lack of time, and inadequate facilities or resources.[395,397,400] Surgeons surveyed would also welcome **greater support, guidance, and leadership**.[395] The growing engagement of surgeons in sustainability[395] (motivation) now needs to be matched with greater education (capability), guidance, leadership and support (opportunity) in pragmatic actions to reduce environmental harm. This may include protected time to work on improving sustainability (and quality) of care.

A 2021 survey of 1,858 members of the **UK general public**, commissioned by the Health Foundation,[404] found:

- The majority (82%) were concerned about **climate change**
- 94% supported NHS net zero carbon targets
- A quarter recognised **climate change** as one of the **biggest threats** to their health

A 2022 survey found that 41% of the public stated procedure duration did not matter to them and almost a third would be happy to undergo a more sustainable procedure even if twice as long in duration, whilst a quarter of surgical staff felt prolongation would be unacceptable.[393] There is little evidence to support the notion that performing an operation in a more sustainable manner will lengthen its duration, and on first principles a longer duration would tend to add to its environmental impact, not reduce it. The majority of both public and staff respondents (72% and 66% respectively) indicated patient outcomes were more important than sustainability, however the vast majority of both groups felt that financial cost is of equal importance to environmental sustainability. The majority of public (69%) and staff (79%) surveyed thought that sustainability should be a high spending priority for the NHS, and that choice of equipment should be driven by sustainability, even where these are associated with increased financial cost.[393] In contrast a 2021 study by the Health Foundation found that whilst the majority of public respondents (70%) were supportive of the NHS net zero carbon aim, they ranked minimising the NHS impact on climate change and the environment as low in priority (second least important out of 15 proposed priorities for the NHS, although the COVID-19 pandemic may have impacted these results).[405]

Surgical teams can engage with patients and the public to raise awareness of the inter-dependence of human and planetary health, and involve patients in promoting sustainable high quality surgical care.

7.2 Clinical leadership

One of the main perceived barriers to sustainability in surgery is a lack of leadership.[395] Effective, efficient, visionary and responsive leadership will be central to delivering the service provision changes necessary for sustainable healthcare. This may be facilitated by the Kotter model for leading innovation change:[406]

1. Establish a sense of urgency
2. Create a guiding coalition
3. Develop a vision and strategy
4. Communicate the change vision
5. Empower individuals for broad-based action
6. Generate short-term wins
7. Consolidate gains and produce more change
8. Anchor new approaches in the culture

It is important that healthcare leaders spearhead this challenge, with **top-down leadership both at national and local levels**, within surgery and across wider healthcare services, and with appropriate governmental support. There is a tendency towards a culture of siloed thinking and working within the NHS, and moving towards systems-level thinking and improving the coordination of leadership will be helpful in the transition to sustainable models of delivery of surgical care.

The UK Health Alliance on Climate Change brings together 46 national healthcare organisations (including medical and nursing Colleges, national associations, and leading medical journals) and advocates for action towards mitigating climate change and promoting public health.[407] The NHS was the first national health system in the world to commit to reaching carbon neutrality,[23,33] with endorsement from the NHS England Chief Executive providing a high level mandate for action. In 2022 NHS England integrated this commitment into legislation, by including components of the Climate Change Act and the Environment Act into the new Health and Care Act.[35]

The Roger's Diffusion of Innovation model predicts that once a critical mass has adopted a particular change in behaviour, the change will become self-sustaining and further adoption becomes inevitable.[408] National and regional bodies are well placed to promote engagement and to facilitate education enabling this. Whilst the Royal College of Anaesthetists paved the way with their Sustainability Strategy,[409] the Allied Health Professions (AHPs) five-year strategy now includes environmental sustainability as one of five key areas,[410] and the Royal College of Nursing have demonstrated leadership on sustainable nursing practice.[411] The British Society of Gastroenterology was one of the first specialist societies to publish a sustainability strategy,[412] and has supported development of consensus position statements in environmentally sustainable practice in endoscopy, looking at all stages of the patient pathway.[413]

Surgeons will look to the **Colleges and national specialty organisations** for guidance and leadership to support individual members of the surgical team to embed sustainability into surgical practice. Many have now released sustainability strategies directed outwardly to action by members, including the Royal College of Surgeons of England,[414] Royal College of Surgeons of Edinburgh,[415] Royal College of Physicians and Surgeons of Glasgow,[416] and the Royal College of Surgeons of Ireland.[417] The declaration of climate emergency by these colleges, was aligned with the release of an **Intercollegiate Green Theatre Checklist** (Figure 14), designed to facilitate surgical teams to bring about change, and supported by an extensive compendium of relevant evidence.[110] A scorecard has been developed to evaluate action towards climate change by health organisations, and the Royal College of Surgeons of England was one of those piloted, highlighting areas for improvement including embedding sustainability within the postgraduate curriculum, developing an internal decarbonisation and divestment plan, and engaging with policy makers.[418]

At regional levels, the 2021/2022 NHS England Standard Contract mandated for the first time that all NHS Trusts (regional organisational units of healthcare providers) and Integrated Care Systems (partnerships bringing together healthcare commissioners, providers and partner organisations within a geographical region) must submit a **Green Plan** outlining local strategy for mitigating GHGs and should have a net zero board lead, in alignment with the NHS net zero carbon ambition.[419] NHS Wales published its Decarbonisation Strategic Delivery Plan in 2021, and NHS Scotland published its Climate Emergency and Sustainability Strategy in 2022. All NHS Trusts in England now have a Green Plan in place, representing over 1,000 healthcare organisations and facilities.[420] Surgical teams can identify members of the team involved at their local NHS Trust, as a starting point to join a local network of engaged individuals.

Bottom-up leadership from individual healthcare professionals is also required and could be fostered through the development of **sustainability champions and networks**, supported by platforms for dissemination of best practice. Such engagement is considered essential for delivering sustainable healthcare.[421] Surgeons and anaesthetists have expertise and authority in surgical care provision, and should be **ambassadors for change**, encouraging, supporting and collaborating with others in the surgical team, and colleagues in supporting services. This can include: staff in facilities and estates switching to renewable energy and heating; staff in sterile services increasing capacity or introducing/seeking systems for instrument repair and maintenance; and procurement teams integrating environmental sustainability into purchasing decisions (preferencing reusable options where possible). Improving disease prevention and health optimisation will require surgeons to engage with patients, and primary care and public health colleagues.

Figure 14: Intercollegiate Green Theatre Checklist[110]

THE ROYAL COLLEGE OF SURGEONS OF EDINBURGH

Royal College of Surgeons of England
ADVANCING SURGICAL CARE

ROYAL COLLEGE OF PHYSICIANS AND SURGEONS OF GLASGOW

RCSI

Intercollegiate Green Theatre Checklist

Below are a list of recommendations to reduce the environmental impact of operating theatres. All the relevant guidance and published evidence has been included in the Compendium of evidence, accessed via the QR code:

Anaesthesia		
1	Consider local/regional anaesthesia where appropriate (with targeted O_2 delivery only if necessary)	☐
2	Use TIVA whenever possible with high fresh gas flows (5-6 L) and, if appropriate, a low O_2 concentration	☐
3	Limit Nitrous Oxide (N_2O) to specific cases only and if using: ▸ check N_2O pipes for leaks or consider decommissioning the manifold and switching to cylinders at point of use; ▸ introduce N_2O crackers for patient-controlled delivery.	☐
4	If using inhalational anaesthesia: ▸ use lowest global warming potential (sevoflurane better than isoflurane better than desflurane); ▸ consider removing desflurane from formulary; ▸ use low-flow target controlled anaesthetic machines; ▸ consider Volatile Capture Technology.	☐
5	Switch to reusable equipment (e.g. laryngoscopes, underbody heaters, slide sheets, trays)	☐
6	Minimise drug waste (“*Don’t open it unless you need it”,* pre-empt propofol use)	☐
Preparing for Surgery		
7	Switch to reusable textiles, including theatre hats, sterile gowns, patient drapes, and trolley covers	☐
8	Reduce water and energy consumption: ▸ rub don’t scrub: after first water scrub of day, you can use alcohol rub for subsequent cases; ▸ install automatic or pedal-controlled water taps.	☐
9	Avoid clinically unnecessary interventions (e.g. antibiotics, catheterisation, histological examinations)	☐
Intraoperative Equipment		
10	REVIEW & RATIONALISE: ▸ surgeon preference lists for each operation - separate essential vs. optional items to have ready on side; ▸ single-use surgical packs - what can be reusable and added to instrument sets? what is surplus? (request suppliers remove these); ▸ instrument sets - open only what and when needed, integrate supplementary items into sets, and consolidate sets only if it allows smaller/fewer sets (please see guidance).	☐
11	REDUCE: avoid all unnecessary equipment (eg swabs, single-use gloves), “*Don’t open it unless you need it”*	☐
12	REUSE: opt for reusables, hybrid, or remanufactured equipment instead of single-use (e.g. diathermy, gallipots, kidney-dishes, light handles, quivers, staplers, energy devices)	☐
13	REPLACE: switch to low carbon alternatives (e.g. skin sutures vs. clips, loose prep in gallipots)	☐
After the Operation		
14	RECYCLE or use lowest carbon appropriate waste streams as appropriate: ▸ use domestic or recycling waste streams for all packaging; ▸ use non-infectious offensive waste (yellow/black tiger), unless clear risk of infection; ▸ ensure only appropriate contents in sharps bins (sharps/drugs); ▸ arrange metals/battery collection where possible.	☐
15	REPAIR: ensure damaged reusable equipment is repaired, encourage active maintenance	☐
16	POWER OFF: lights, computers, ventilation, AGSS, temperature control when theatre empty	☐

DISCLAIMER: These suggestions are based upon current evidence and broadly generisable, however, specific environmental impacts will depend upon local infrastructure and individual Trusts’ implementation strategies.

Intercollegiate Green Theatre Scorecard. November 2022

7.3 Education and support

Education on sustainable healthcare has been defined as, 'the process of equipping current and future health professionals with the knowledge, values, confidence and capacity to provide environmentally sustainable services through health professions education'.[422] The surgical workforce needs theoretical knowledge and theory on the environmental impacts of surgery and the principles of sustainable practice, to support their ability to drive change.[422,423]

Sustainability in Quality Improvement (SusQI)

The **SusQI model developed by the Centre for Sustainable Healthcare integrates sustainable healthcare with Quality Improvement** (QI) in patient care.[424] As QI is now a core requirement in undergraduate and postgraduate training for most healthcare professionals, this model can be effective in driving change. It can be used by multi-professional teams in a wide variety of settings, enabling staff to engage in greening surgery while achieving training and continuing professional development, and obtaining leadership and change management skills.[425] A multi-centre, multi-disciplinary evaluation found that use of SusQI in healthcare professional education increased engagement with QI, with learners describing a new sustainability 'lens' guiding their professional practice.[426]

Progress in undergraduate education

The requirement in the **2018 General Medical Council (GMC) Outcomes for Graduates** that: 'newly qualified doctors must be able to apply the principles of sustainable healthcare to medical practice'[427] marked a recognition of the importance of this topic in medical education and training. Although implementation across medical schools varies, educators are making efforts to connect sustainability to core curricular themes such as disease prevention, patient safety, and health systems design and operation.[428,429] A new Sustainable Healthcare curriculum, endorsed by the Medical Schools Council and the GMC, aims to support educators[430] to develop their capacity and confidence.[431] The Standards of Proficiency for midwives includes demonstration of 'knowledge and understanding of the principles and methods of sustainable healthcare'[432] and successful integration of QI has begun in several nursing and allied health professional undergraduate programmes.[433] Similar developments for nurses and operating department practitioners (ODPs) need to be developed.

The Planetary Health Report Card is an international initiative led by medical students, providing a scoring system for the integration of sustainability within the taught curriculum.[429] This initiative involves 96 medical schools across 12 countries, with 11 of the 25 UK medical schools included awarded the highest marks (A or B overall). This tool accounts for the integration of sustainability into the curriculum, research, community outreach and advocacy, support for student-led initiatives, and campus operations.[429]

Opportunities in Postgraduate training

Colleges can ensure sustainability is included in specialty training programmes by incorporating it into their **curricula and examinations**, alongside accreditation as part of continuing professional development. The Royal College of Anaesthetists pioneered requirements that a trainee 'applies principles of sustainability to clinical practice' and 'promotes strategies to support sustainable healthcare in clinical practice'.[434] There are no such requirements at present in the core or specialist surgical training curriculum, but there are many examples of trainees using SusQI projects in their training portfolios.

Three levels of training are also available through NHS England, including an entry level Environmentally Sustainable Healthcare programme (in partnership with the Centre for Sustainable Healthcare) which some NHS Trusts are using within induction and mandatory training,[435] intermediate level Sustainability Leadership for Greener Health via the NHS Leadership Academy,[436] and carbon literacy training to NHS leaders.[437] Useful resources are also available via the Greener NHS Knowledge Hub on the FutureNHS Collaboration Platform.[290]

Support

There are rising levels of climate and eco-anxiety, especially amongst children and young people.[438] Raising awareness of the impact of surgical care on planetary health could induce this amongst healthcare professionals. We encourage healthcare individuals and organisations to consider mechanisms to support members of the surgical team who may experience eco-anxiety.

7.4 Infection prevention and control

Infection prevention and control is often cited as a barrier in transitioning to reusable equipment use, but is often misunderstood.

Medical devices and equipment can become contaminated with microorganisms and subsequently transmit pathogens if used on another patient, and the requisite decontamination after use depends on the risk of the equipment transmitting infection. High-risk items are those which penetrate the skin/mucous membranes or have direct or indirect contact with sterile tissues.[439] These items must be decontaminated by sterilisation and sterility guaranteed until subsequent re-use. Medium-risk (or semi-critical) items are those that have contact with mucous membranes, where some pathogens but not bacterial spores present a risk of infection.[439] They include respiratory therapy and anaesthetic equipment such as endoscopes (and other body cavity scopes) and probes.[440] High-level disinfection is adequate for these items, although sterilisation is often preferred as it can provide a more reliable method, and can be safely re-processed using heat or chemicals and appropriate quality control systems.[440] Equipment used on intact skin presents a low risk and is unlikely to transmit infection, so cleaning is generally an adequate approach to decontamination, although disinfection using heat (e.g. for textiles) or chemicals (e.g. for surfaces) are sometimes appropriate.[439,440] We note lack of international consensus on classification for some items, for example laryngoscope blades are classified as semi-critical, and therefore do not require sterilisation,[441] whilst in the UK they are considered critical (due to regular contamination with blood implying penetration of mucous membranes), and therefore must undergo sterilisation.[442]

Prior to 2000 most NHS hospitals had their own sterile services departments (SSD) and reprocessed surgical instruments (and a large proportion of other theatre equipment) on-site. However, guidance published by the Department of Health in 2004 emphasised the need for purpose-built centralised departments to enhance quality control and support the development of an expert workforce.[443] The Health and Social Care Act 2008[63] formalised Quality Requirements, set out in a series of Health Technical Memoranda (HTM).[444]

This change was driven by concerns about the emergence of Creutzfeldt–Jakob disease (CJD) in

the early 2000s,[445] with fear from the ability of abnormal CJD prion proteins to adhere strongly to surgical instruments and withstand conventional sterilisation procedures.[446] As a result, stringent regulations for instrument reprocessing, especially those used on tissues at potential risk of accumulating high concentrations of prion proteins were introduced.[444] These included the requirement to ensure surgical instruments are kept moist until cleaned (to counteract protein adherence to the surface),[446] to track surgical instruments throughout the decontamination process, and (more recently) to reduce the protein load to 5µg or less prior to sterilisation.[444] Centralised SSDs were seen as key to enhancing quality, efficacy and safety of cleaning through the use of automated washer-disinfectors.[444] The logistics and costs associated with applying these controls and the perceived costs and risks associated with surgical equipment and its re-processing have been accompanied by increasing use of single-use disposable equipment in operating theatres.

Although vCJD controls were introduced in the UK in 1997, the outbreak of vCJD peaked in 2000, and only 2 of the 178 cases have been detected after 2012. Prevalence of vCJD is estimated to be 1-2 per 1 million population, although retrospective analysis of appendix specimens for prion proteins suggest prevalence may be higher, albeit with risk of developing clinical disease likely low.[445,447] Less than 1% of vCJD has been classified as iatrogenic and has predominantly been associated with historic blood or human products transfusions,[446] with only four known cases of surgically transmitted vCJD (3 UK; 1 France), potentially linked to contaminated neurosurgical instruments.[446] Some relevant infection prevention controls remain in place because of concerns about the long incubation period of prion disease,[445,446] although such controls are not applied elsewhere in the world.[439,440]

Meeting the obligations of current HTMs, depends on high performance washer disinfectors, tracking, validation and protein detection systems and a skilled workforce and is therefore only feasible within large-scale centralised SSDs. Whilst this might be interpreted as limiting flexibility for extending the reuse of surgical or endoscopy equipment (particularly semi-critical items) it is more correct to interpret this as a need for the NHS to prioritise and invest in reusable devices and sufficient capacity to manage increased reprocessing. Careful planning will also be required to ensure **effective integration of reusable equipment in current systems of work and logistics to support transportation to and from central reprocessing centres**.

There is also a need to explore opportunities for expanding point-of-care decontamination of medical equipment (that does not require sterilisation), for example through using detergent wipes or ultraviolet light exposure.

7.5 Medical supply chain

Medical supply chains are a major source of GHG emissions (almost two-thirds of the NHS carbon footprint),[22] but are not within the direct control of healthcare providers, posing a challenge. Health sector facilities, systems, and ministries will need to work with manufacturers and suppliers of healthcare goods and services, to encourage healthcare climate action. Making impactful change to reduce emissions upstream of the hospital requires alignment of actors across a highly **globalised, complex, and fragmented supply chain**. **Unified international action** will be important to apply collective pressure on industry, and may be facilitated, for example, by collaboration between the World Health Organization and the NHS, which can support policy alignment, shared learning, and coordinated procurement processes.[448] Given the globalised nature of healthcare supply chains, effective procurer engagement processes need to be similarly

harmonised, with substantive social and environmental value requirements also having global currency.[449]

An important first step is setting and implementing **measurement and action criteria for low-carbon or zero emissions** to drive supply chain decarbonisation. This strategy must involve policy, facility, procurement and clinical decision-makers so that approaches, and the messaging to supply chain industries, are coherent. Policy makers and regulators (such as Medicines and Healthcare Regulatory Agency) can assist clinical and procurement professionals **by integrating sustainability into product registration, funding approval processes, and product placement rules** to facilitate innovation in healthcare research, manufacture and supply chains. Such positive action can enable new ways of thinking about healthcare procurement, mirroring the impacts of value-based procurement with a sustainability focus.

Large-scale change is required and will need concerted time and effort, but has the potential for system-wide impacts, and is an opportunity for the healthcare industry to lead the way. There is a growing commitment from suppliers to join up along value chains.[450,451] **Annualised contracts** rather than spot-buying may facilitate building enduring supply chain relationships that enable holding a long-term strategic view alongside short-term contractual commitments, and building trust and commitment to common value-building. Only by engaging those deeper relationships can **whole chain stewardship**[452] reach all the way back through suppliers-of-suppliers to raw commodity producers and deliver deep and enduring results.

Reliance on just-in-time delivery or short lead times for **single-use disposable items leaves health systems vulnerable to supply chain interruptions**, for example, from pandemics such as COVID-19 or weather-related disasters.[453] There are global calls for reversion back to reusable medical devices, requiring re-evaluation of evidence for infection control practices, policy to facilitate better design to make it easier to clean and re-use devices, as well as procurement practices that prioritise reusable devices and avert greenwashing.[454] This may be supported by policies such as **extended producer responsibility**, whereby product manufacturers take on increased responsibility for products after the point of sale, including beyond use by the primary customer.

Where clinicians interact with industry partners, there may be opportunities to encourage the following:

- Streamline single-use sets
- Develop reusable and durable alternatives
- Design products which specifically enable repair and recycling
- Increase recycling potential of products through encouraging design of modular products (can be easily disassembled), with as few different material types as possible
- Clear labelling to facilitate waste segregation and recycling

7.6 Supporting policy and infrastructure

Supporting policy

In accordance with Procurement Policy Note PPN 06/21 (2021)[455] all major government contracts (> £5 million per year) are required to consider Carbon Reduction Plans in the procurement process.

NHS England has outlined an NHS Net Zero Supplier Roadmap which stipulates:[456]

- From April 2023, for all contracts above £5 million per annum, all suppliers to the NHS must publish a Carbon Reduction Plan for their UK scope 1 and 2 emissions and a subset of scope 3 emissions as a minimum
- From April 2024, this requirement will extend to a carbon reduction plan to cover all procurements
- From April 2027 all suppliers will be required to publicly report targets, emissions and publish a carbon reduction plan for scope 1, 2 and 3 emissions
- From 2028 new requirements will be introduced overseeing the provision of carbon foot printing for individual products supplied to the NHS

To support this, in 2022, NHS England adopted the UK Government Social Value Model for commissioning and purchase of NHS goods and services whereby a minimum of 10% weighting is applied to **net zero and social value** when evaluating tenders for NHS contracts,[457] and in 2023, launched the Evergreen Sustainable Supplier Assessment,[456] a tool to aid suppliers in this process. In Scotland, public procurement contracts must maximise environmental benefits, in line with the Procurement Reform (Scotland) Act 2014.[458]

The **National Institute for Health and Care Excellence** (NICE) provides evidence-based recommendations for healthcare in England, and in 2021 pledged to develop frameworks for evaluating environmental sustainability to inform future NICE guidance.[459] A handbook is available for the decarbonisation of operational Public Finance Initiative (PFI) projects.[460]

Supporting infrastructure

Alongside these policies and regulation, transition to sustainable models of surgical systems will require appropriate supporting infrastructure, including physical facilities and financial models.

To enable the shift towards reusable equipment, there will be increased demands placed on reprocessing infrastructure (such as sterilisation and laundering), and this will need to be anticipated with plans to expand capacity. There is also sometimes a need to link up with existing infrastructure. For example, plans are needed to enable areas which typically are less likely to use reusable equipment (such as Accident and Emergency, or outpatient departments) to access reprocessing systems that are used in operating theatres.

When the financial cost of products are estimated across the full product life span this enables the **total cost of ownership** to be determined, and the majority of evidence indicates financial costs reduce with reductions in carbon footprint. For example, financial savings have been demonstrated when switching from single-use to reusable laryngoscopes,[330] and when repairing surgical scissors.[374] Recycling companies sometimes do not charge for waste removal and processing of items including surgical products.[461] Surgical departments often underestimate the true financial cost of single-use products, for instance due to the cost of waste disposal being

centrally accounted for within the hospital, whilst the cost of reusables may be overestimated due to difficulties in accurately estimating the number of uses of reusable products over their lifespan.

The preparation of contracts with instrument suppliers can also incentivise companies to adopt these principles. Where surgical products are leased rather than owned by hospitals, and where these are associated with managed service contracts (also known as **servitisation**), companies can be nudged to design products that are durable and modular by design, and potentially increase the incentive to actively maintain and repair rather than replace them where appropriate. Such initiatives may confer environmental savings.

Section recommendations

Recommendation	Short term	Long term	Stakeholders
R7.1 Bolster top-down sustainability leadership		Increase time and investment in leadership[a,b,c,d] Develop sustainability strategy[a,b,c,d] Work collaboratively across national organisations to minimise duplication and to learn from one another[a,b,d] Provide a forum for shared learning and to celebrate successes[d] Advocate for sustainability, signalling the demand for sustainable products and services from industry, encouraging wider systems change towards disease prevention and health promotion, and equitable access[a,b]	Surgical Royal Colleges[a] Surgical and anaesthetic specialty associations[b] Greener NHS[c] Healthcare provider management teams[d]

R7.2 Foster bottom-up sustainability leadership	Become a green champion in local Trust (or equivalent, where scheme exists)[e] Look to existing resources including collegiate sustainability strategies and the Intercollegiate Green Surgery Checklist[e]	Develop sustainability champions for each specialty and geographical region[a,b] Develop sustainability champions locally within each department[d] Ensure ring-fenced time and resources are allocated to support individuals in driving sustainability initiatives[d] Invite representatives from surgical teams to be part of organisational decarbonisation planning[d]	Surgical and anaesthetic teams[e] Surgical Royal Colleges[a] Surgical and anaesthetic specialty associations[b] Healthcare provider management teams[d]
R7.3 Develop surgical sustainability networks	Healthcare professionals can act as ambassadors or leaders for change[e] Join local sustainability network (where these exist)[e]	Develop sustainability networks for scaling of initiatives and dissemination of knowledge[a,b]	Surgical and anaesthetic teams[e] Surgical Royal Colleges[a] Surgical and anaesthetic specialty associations[b]

R7.4 Develop effective education in sustainable surgery	Draw on existing resources when teaching, including the SusQI, Intercollegiate Green Theatre Checklist[f]	Integrate sustainability into undergraduate and postgraduate specialty curricula and examinations[a,b,f] Develop resources to teach principles of sustainable surgery[a,b] Develop case study repositories, and feature within specialty conferences enabling shared learning[a,b] Develop educational opportunities including leadership programmes, fellowships[a,b,f] Address the capacity of educators and trainers to teach this using a train the trainer approach[f]	Surgical Royal Colleges[a] Surgical and anaesthetic specialty associations[b] Educators[f]
R7.5 Provide support for those experiencing eco-anxiety	Signpost appropriate existing resources and support groups[d]	Develop support services for those with eco-anxiety[d]	Healthcare provider management teams[d]
R7.6 Address infection prevention and control (IPC) concerns	Work alongside surgical groups to consider opportunities for improving sustainability whilst addressing IPC concerns[g] Use evidence-based approach and avoid acting on hypothetic risk[g]	Develop research to evaluate evidence-based infection risk associated with reusable equipment[g,h] Design products enabling safe decontamination, with clear instructions for reprocessing[i]	Infection Prevention and Control Teams[g] Academics[h] Industry[i]

R7.7 Coordinate international action relating to supply chains		Develop unified international action towards whole chain stewardship across globalised supply chains[c,i,j]	Greener NHS[c] International partner organisations with net zero ambitions[j] Industry[i]
R7.8 Develop policies and infrastructure that supports transition to sustainable surgery		Develop regulations and policies for medical device and pharmaceuticals (end to end full life cycle processes)[k] Evaluate likely requirements to increase capacity of reprocessing facilities and plans to meet this demand[c,d,k] Evaluate ways to integrate environmental impact into healthcare product and pharmaceuticals procurement decisions[c,d,k,l]	Policy makers[k] Greener NHS[c] Academics[h] Pharmacists[l]