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SUSTAINABLE PRACTICE

Sustainable practice: Optimising surgical instrument trays

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What you need to know

- To provide environmental benefits, surgical instrument trays need to be optimised so that smaller or fewer trays are used, or individually wrapped instruments that are frequently opened are added to existing sets
- Inspect your surgical sets after an operation, looking for evidence of overage, single use instrument waste, and frequent opening of individually wrapped instruments
- Review surgical trays by auditing existing surgical trays using checklists to determine instrument usage, and/or hold stakeholder focus groups to rationalise trays

Medical equipment generates 10% of NHS England's carbon footprint.[1] Surgery, as a discipline, is particularly resource intensive, consuming three to six times more energy than other hospital departments.[2] Optimising surgical instrument trays (commonly referred to as "sets") to reduce carbon waste from sterilisation, handling, and procurement, is one of many strategies that can reduce the carbon impact of medical equipment. This article outlines the benefits and challenges of optimising surgical trays and explores how to achieve this using quality improvement methods.

Why change is needed

In most settings, pre-prepared sterile trays of surgical instruments are opened for every operation. Once opened, the entire tray needs to be re-sterilised before it can be used again. Frequently, however, only a small number of the sterilised instruments are used. For example, in a study that observed six surgeons in an American vascular surgery department over three months using two different vascular surgery sets, on average only 30 of 131 (22.9%) and 19 of 152 (12.5%) instruments were used.[3 4] This instrument excess is termed overage and generates resource wastage.

Research shows that financial savings are achieved by reducing excess instruments in trays. An American plastic surgery department saved $163 800 (£130 500) annually by reducing the number of instruments in two sets by 45.1% and 36.7%, respectively.[4] Furthermore, tray optimisation has been shown to provide additional clinical benefits for patients and clinicians, such as reduced operative time, by shortening the time taken for mandatory intra-operative instrument counts.[5]

In terms of carbon savings, however, the picture is more nuanced. A UK based assessment of the carbon footprint for the decontamination and packaging of reusable instruments found that reducing the number of instruments in each tray alone could, counterintuitively, increase carbon costs.[6] Surgical trays are sterilised using autoclaves with pre-defined slots, therefore simply removing instruments does not reduce the energy and water used for each autoclave cycle and thus does not reduce the instruments' carbon footprint. If instruments are then individually wrapped taking up entire slots in the autoclave, and frequently opened for use, this increases their environmental impact. Therefore, to provide environmental benefits, sets need to be optimised so that smaller or fewer trays are used, or instruments that are individually wrapped and frequently opened are added to existing sets.

Beyond surgical overage, when optimising trays, considerable carbon savings can be achieved by replacing single-use instruments with reusable alternatives. For example, a Swedish life cycle assessment of laparoscopic ports showed that single-use ports were at least twice as expensive over 500 surgical procedures (€37 567 versus €17 359) and had a carbon impact fourfold higher (565 kgCO2e *v* 118 kgCO2e) compared with their reusable counterparts.[7] The environmental benefits of adding reusable alternatives into instrument sets have been shown repeatedly in the literature.[8]

Evidence for the solution

A scoping review of methodologies applied to surgical tray optimisation found that most published studies audited existing surgical trays using checklists to determine instrument usage, or utilised stakeholder focus groups to rationalise trays.[5] Both approaches were highly effective, with most investigators reducing the total instrument number in sets by more than 50% (range 9.9-89.0%).

Along with reducing surgical set size, auditing instrument sets can provide an opportunity to introduce reusable alternatives into trays. This was demonstrated by a general surgical team in the UK, who optimised their laparoscopic appendicectomy trays by introducing reusable alternatives and rationalising existing instruments. They achieved savings of £31 350 and 432 kgCO2e annually in their hospital from this operation alone.[9]

Regular re-auditing is necessary to check for any unwanted increase in the use of individually wrapped sterilised instruments. Moreover, some instrument sets are used by multiple specialties, each with specific requirements, making it challenging to effectively optimise.

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Fortunately, automated machine learning systems are emerging to rationalise and monitor instrument usage. One study, in which machine learning was applied clinically, showed a reduction in total instrument numbers by 45.8% and 62.5% for the two operations studied.[3] However, while these innovations are shown to be cost efficient and effective at streamlining sets, published data on their environmental impact remain sparse.

What you can do

The sustainability in quality improvement framework offers simple solutions to reduce your carbon footprint.[10] Inspect your surgical sets after an operation, looking for evidence of overage, single-use instrument waste, and frequent opening of individually wrapped instruments. Set up a focus group comprising key stakeholders from the surgical team, including consultants, junior doctors, scrub nurses, and theatre managers to review instrument usage. Start by targeting common and relatively simple operations within a specialty, for example, a general surgical team could select appendicectomy or cholecystectomy. Next, gather data by distributing user surveys to stakeholders for their views on essential equipment for that operation, and simultaneously audit instrument usage through a checklist. The focus group should meet to review the findings, with the aim to remove unnecessary instruments (unless required for emergencies), integrate frequently opened and individually wrapped instruments into established sets, and consider reusable alternatives for single use instruments.

If enough instruments can be removed to reduce the tray size or opportunities arise to introduce reusable alternatives, engage procurement managers, sterilisation services, and instrument providers to enact these changes. This group should also review the tray container itself and opt for single-use tray wraps with an appropriate recycling pathway.[6] Whilst working with supporting services, request instrument repair whenever possible,[11] optimal autoclave loading, and sourcing of low carbon energy for decontamination processes.[12]

Once the new tray has been established, the group should re-audit to assess the environmental and financial outcomes. When successful, the audit can be expanded to more complex operations and the group can aim to integrate trays across specialties.

Education into practice

- Compile a list of stakeholders who you will engage with to optimise surgical instrument trays
- What challenges might you face in engaging colleagues in this work?
- Have you noticed lots of unused instruments at the end of an operation?
- What single-use instruments do you use in your surgical practice?

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1 Tennison I, Roschnik S, Ashby B, etal. Health care's response to climate change: a carbon footprint assessment of the NHS in England. *Lancet Planet Health* 2021;5:-92. doi: 10.1016/S2542-5196(20)30271-0 pmid: 33581070

2 MacNeill AJ, Lillywhite R, Brown CJ. The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems. *Lancet Planet Health* 2017;1:-8. doi: 10.1016/S2542-5196(17)30162-6 pmid: 29851650

3 Knowles M, Gay SS, Konchan SK, etal. Data analysis of vascular surgery instrument trays yielded large cost and efficiency savings. *J Vasc Surg* 2021;73:-53. doi: 10.1016/j.jvs.2020.09.043 pmid: 33359847

4 Wood BC, Konchan S, Gay S, Rath S, Deshpande V, Knowles M. Data analysis of plastic surgery instrument trays yields significant cost savings and efficiency gains. *Ann Plast Surg* 2021;86(Suppl 5):-9. doi: 10.1097/SAP.0000000000002913 pmid: 34100825

5 Dos Santos BM, Fogliatto FS, Zani CM, Peres FAP. Approaches to the rationalization of surgical instrument trays: scoping review and research agenda. *BMC Health Serv Res* 2021;21:. doi: 10.1186/s12913-021-06142-8 pmid: 33610192

6 Rizan C, Lillywhite R, Reed M, Bhutta MF. Minimising carbon and financial costs of steam sterilisation and packaging of reusable surgical instruments. *Br J Surg* 2022;109:-10. doi: 10.1093/bjs/znab406 pmid: 34849606

7 Boberg L, Singh J, Montgomery A, Bentzer P. Environmental impact of single-use, reusable, and mixed trocar systems used for laparoscopic cholecystectomies. *PLoS One* 2022;17:e0271601. doi: 10.1371/journal.pone.0271601 pmid: 35839237

8 Rizan C, Bhutta MF. Environmental impact and life cycle financial cost of hybrid (reusable/single-use) instruments versus single-use equivalents in laparoscopic cholecystectomy. *Surg Endosc* 2022;36:-78. doi: 10.1007/s00464-021-08728-z pmid: 34559257

9 Labib PL, Ford B, Winfield M, Douie WJ, Kanwar A, Sanders G. Revising a laparoscopic appendicectomy set to reduce reliance on disposable surgical instruments: supporting the transition to sustainable surgical practice. *Ann R Coll Surg Engl* 2023. doi: 10.1308/rcsann.2023.0015 pmid: 37051744

10 Marsden O, Clery P, D'Arch Smith S, Leedham-Green K. Sustainability in Quality Improvement (SusQI): challenges and strategies for translating undergraduate learning into clinical practice. *BMC Med Educ* 2021;21:. doi: 10.1186/s12909-021-02963-7 pmid: 34717607

11 van Straten B, Dankelman J, van der Eijk A, Horeman T. A circular healthcare economy; a feasibility study to reduce surgical stainless steel waste. *Sustain Prod Consum* 2021;27:-75doi: 10.1016/j.spc.2020.10.030

12 Kwakye G, Brat GA, Makary MA. Green surgical practices for health care. *Arch Surg* 2011;146:-6. doi: 10.1001/archsurg.2010.343 pmid: 21339421