



SusQI project report: The upper “hand” of sustainability: Reducing the carbon footprint in hand surgery

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Abstract

Aims: To reduce the carbon footprint of carpal tunnel surgery by;

1. adapting a “lean and green theatre set up” by reducing the number of single use instruments, trays and drapes used per procedure; and
2. transforming to a “Green CTR patient pathway” by utilizing a minor procedure room (instead of theatre) and therefore bypassing the pre-theatre ward admission process.

Methods: A multidisciplinary team identified ‘hotspots’ leading to identified aims. A green patient pathway was proposed for elective day case hand surgery under local anaesthetic in minor procedure room”. Streamlined ‘minor hand procedure’ sets were agreed on and large generic limb drapes were replaced with two small 90cm square drapes. Use of a minor procedures room instead of a theatre was approved. 4 pilot *Lean and Green Hand Surgery* lists involving 17 patients utilising interventions above took place June - July 2021.

Measurement: A detailed itinerary of consumables used in theatre was obtained from procurement. We calculated the carbon footprint of patients’ journey through the hospital from admission onto a ward, transfer to the theatre suite and finally return to the ward prior to being discharged home. We calculated the cost savings and efficiency of this model per each CTR.

Results: Positive outcomes for both patients and staff were found; including reduced length of stay, reduced theatre list and surgical wait times, and reduced the number of staff required per procedure. Changing to a “Lean and Green” set up demonstrated a 31kg CO₂ and £33.71 reduction per case. This is an 80% reduction of the carbon footprint and 65% of the total cost.

Conclusions: This project demonstrated that a lean theatre set up and green patient pathway can deliver a safe, efficient, cost-effective and sustainable hand surgery service within an orthopaedic department. The preliminary results from our green pathway will hopefully soon be seen as the “Standard of Practice” in the two hospitals involved in this project. By upscaling to the whole of the UK, in which 53,000 CTRs are undertaken each year, we estimate the carbon footprint could be reduced by 1,643,000 Kg of CO₂e.



Background:

Operating theatres contribute up to 70% of hospital waste (2.8 billion pounds). Surgeons therefore witness vast amounts of plastic waste, much of which is deposited in our oceans as ‘plastic soup’ or in landfills as microplastics, both of which don’t biodegrade¹. Recent reports suggest microplastics are entering the human body through our water, food, and air, and microplastic was found in stool samples of participants from eight countries in Research from the Medical University of Vienna². It is within our role as medical professionals to reduce our waste, and by extension support healthier environments and communities.

Carpal tunnel release (CTR) is the most performed hand operation, with 53000 completed in the UK each year. It is a minor operation usually done under local anaesthesia. Our current pathway requires patients be admitted prior to their procedure. As hand and orthopaedic surgeons, we felt our team was well placed to target this patient pathway and procedure to implement sustainable changes. The project was undertaken at two district general hospitals in North Wales (Wrexham Maelor and Ysbyty Gwynedd) working under Betsi Cadwaladr University Health Board (BCUHB).

Specific Aims:

Our aim was to reduce the carbon footprint of carpal tunnel surgery by;

1. adapting a “lean and green theatre set up” by reducing the number of single use instruments, trays and drapes used per procedure.
2. transforming to a “Green CTR patient pathway” by
 - a) utilizing a minor procedure room (instead of theatre) and therefore bypassing the pre-theatre ward admission process

Methods:

We involved a multidisciplinary team (MDT) to support in identifying themes for high value improvement, and to collect data. This MDT included patients, junior doctors, hand therapists, theatre staff, higher management team (HMT), central sterile services unit (CSSU), procurement, infection control, and administrative staff (from booking and secretarial departments).

As a team we identified several hotspots and high levels of clinical waste for each CTR procedure (Appendix 1).

- Unnecessary/unused equipment and drapes in surgical kits
- Use of theatre when a suite would be sufficient
- Ward admissions, which are carbon intensive, could be avoided pre-surgery if operation took place in a suite. Ward admissions are unnecessarily lengthening patients time in hospital and exposing them to a wider number of staff and other patients. Admissions require additional staff, large amounts of paperwork and use additional resources (e.g., fully staffed ward, heating, catering, etc.).





- Patient travel for post-surgical follow-up

Aim 1:

Streamlined 'minor hand procedure' sets were agreed on by the surgeons, theatre practitioner and sterilisation services manager. Single use plastic pots and bowls were replaced with reusable plastic



receivers (see left images) and large generic limb drapes were replaced with two small 90cm square drapes adequate to provide a sterile surgical field (see right images).

Aim 2:

Use of a minor procedures room instead of a theatre was approved by Infection control and Estates departments. This meant that patients did not require ward admission prior to their CTR procedure. Patients were instead admitted and discharged directly from the theatre suite, decreasing their contact with staff and other patients. This also reduced the number of staff, and staff time, allocated to each patient to undertake a safe, effective minor hand operating list.

Suitable sites for the change were identified between theatre staff and management teams. The Local Safety Standards for Invasive Procedures (LocSSIP) checklist was identified as being appropriate to assess and ensure changes were fully compliant with local policy and had patient safety at its heart.

We proposed a "Green patient pathway - for elective day case hand surgery under local anaesthetic in minor procedure room" (Appendix 2) and highlighted its benefits to senior hospital management team (HMT) and to previous patients. This new pathway would not only reduce the carbon footprint of the service, but also generate significant cost and efficiency savings. The pathway was positively received as valuable for patient, staff and environmental sustainability. We highlighted the potential cost savings for the Trust which made it attractive to the HMT.

We undertook 4 pilot *Lean and Green Hand Surgery* lists involving 17 patients utilising principles outlined above in June and July 2021 across the two hospitals. We actively obtained feedback from patients and staff during each list to ensure continuous improvement in delivery of care.

Measurements:

Aim 1:

- We collected a detailed itinerary of consumables used in theatre for pre and post changes
- Cost of consumables that could be removed or changed was obtained from the procurement team





- The ICE database³, SDU Carbon conversion factors⁴ and Small World Consulting were used to determine the carbon footprint for individual components of consumables.
- Volume of clinical waste generated for one CTR generated was measured using a handheld weighing machine. Waste stream emissions factors from Rizan (2021)⁵ were used.
- CSSU provided information on the process of sterilisation for the surgical instruments and trays.

Aim 2:

- We calculated the carbon footprint of patients' journey through the hospital from admission onto a ward, transfer to the theatre suite and finally return to the ward prior to being discharged home, using emissions factors from the SDU⁴.
- We calculated the cost savings and efficiency of this model per each CTR.

We actively sought patient and staff feedback via forms and a pathway folder for suggestions on improvement. There was a debriefing meeting at the end of each list to review the day's events and highlight what went well and what could be improved.

Results:

Clinical outcomes:

The consensus among staff was that streamlining the surgical equipment and pathway had no detrimental effect on the procedure, and that it improved staff productivity. There were no superficial or deep infections and other wound related issues reported in the 23 patients at six months post surgery.

Patient satisfaction was overwhelmingly positive. Some examples are "fantastic set up", "I was very happy to have this" and "Thank you to all the staff". There were no intra or postoperative complications during our trial phase.

Environmental sustainability:

Aim 1:

Smaller trays with fewer, re-sterilisable instruments demonstrated the largest impact with a reduction of 14.7kg CO₂e. This did not include further potential reductions identified by sterilisation services, who noted that the smaller tray usage meant more sets could be processed in each autoclave sterilisation cycle. Using smaller drapes reduced the emissions by 9.245Kg CO₂e.

The average amount of clinical waste reduced from 3.5kg to 1.23kg, represents a 65% reduction in clinical waste and emissions associated with their disposal (via incineration) (Appendix 3).

Aim 2:

Bypassing ward admission meant a further reduction in the carbon footprint by 6.31 Kg per patient. By utilizing a minor procedure room instead of a main theatre suite or ultra-clean air theatre, there were likely further indirect savings from reduced energy use and water use which was not possible to measure.



In total, we demonstrated a 31kg CO₂ reduction per case. This is an 80% reduction of the carbon footprint of this procedure.

Social sustainability:

Our new pathway led to a more streamlined and enjoyable patient and staff journey.

For patients, their overall length of time at hospital was reduced, as was their contact with other patients and staff. Our pathway reduced theatre lists, shortening wait times for patients, reduced the risk of same day cancellation, and reduced the number of staff required per procedure. This is extremely beneficial to patients, as timely surgical intervention is vital for optimal surgical results from CTR.

This is also especially relevant to staff, and the NHS, given issues caused by the Covid19 pandemic, which has considerably increased surgical waiting times across the UK. It is vital to create safe, resilient patient pathways to promote recovery of planned surgery from COVID 19.

Economic sustainability:

The average CTR list of consumables cost the tax-payer £51.27. Changing to a “Lean and Green” theatre set up had a potential saving of £33.71 for each CTR, a saving of 65% of the total cost.

Barriers encountered:

Covid19 impact:

Location: Three potential sites were identified for our changes however two had to be excluded as there was no clear segregation of patients as per their COVID screening. In Bangor this was not possible during the competition phase, and procedures continued in a main theatre. A suitable minor procedures room was identified however subsequently lost after pilot lists due to Endoscopy for urgent cancer screening related work. We are continuing CTR in theatres using a “lean and green theatre” set up and are in the process of developing a service where CTR will be performed in an outpatient setting.

Staffing: Theatre staff levels were badly affected in the last 2 weeks of this project due to the third wave of COVID which led to some list cancellations.

Booking issues: Patients were required to self-isolate for 72 hours prior to surgery and have a negative Covid swab, cancellations resulted in wasted, unnecessary swabs and wasted patient journeys. Until national guidelines change to allow us to abandon pre-operative COVID swabs, this will continue to be an issue. We are anticipating new Welsh guidelines where routine pre-operative COVID screening will be suspended to be published in the near future.

District Nurse Referral: As patients were being discharged from the procedure room in Wrexham, we experienced some logistical challenges in completing admission and discharge paperwork. Further work is being done to streamline this pathway further to reduce excessive paperwork.



Conclusions:

This project demonstrated that a lean theatre set up and green patient pathway can deliver a safe, efficient, cost-effective and sustainable hand surgery service within an orthopaedic department. The changes made and lessons learned in developing this project can be readily implemented in almost any other surgical procedure, and in any service that relies heavily on patient follow up appointments such as diagnostic services. The preliminary results from our green pathway will hopefully soon be seen as the “Standard of Practice” in the two hospitals involved in this project.

The whole team passionately believes that our small project could have huge implications by upscaling to the whole of the UK, in which 53,000 CTRs are undertaken each year. We estimate the carbon footprint could be reduced by 1,643,000 Kg of CO₂e by simple changes such as smaller drapes, essential surgical instruments and performing CTR in a minor procedure room setting. These savings do not take into account indirect energy savings such as electricity, water, re-sterilisation and NHS supply chain by less reliance on procurement.

We are considering additional ways that we can target savings across the triple bottom line of environmental, social and financial sustainability. We focused on selective areas in the patient pathway such as bypassing ward admission. We have since modelled the pre and post operative pathway with inclusion of follow-up being moved to virtual appointments. This along with other changes identified, would decrease staff time by 50% across the pathway. We believe that a more sustainable surgical practice is very achievable, and if replicated in other operations the waste, carbon and financial savings are potentially enormous.



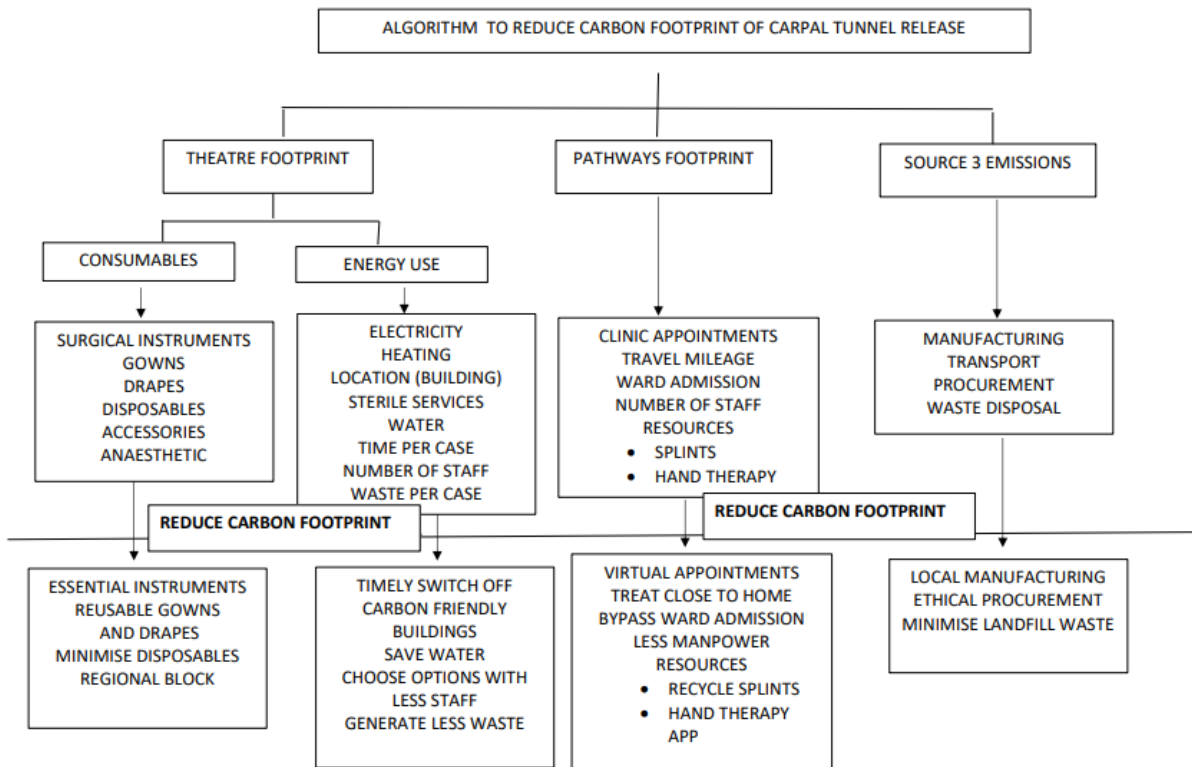
References:

1. Plastic breakdown and fragmentation - plastic soup foundation [available from: <https://www.plasticsoupfoundation.org/en/plastic-problem/plastic-environment/break-down/>].
2. Microplastics detected in humans for the first time 2018 [available from: <https://www.meduniwien.ac.at/web/en/about-us/news/detailsite/2018/news-october-2018/microplastics-detected-in-humans-for-the-first-time/>].
3. The Inventory of Carbon & Energy database. Available from: [Embodied Carbon Footprint Database - Circular Ecology](#)
4. *Care pathways guidance on appraising sustainability (Sustainable Development Unit, 2015)* Available from: <http://www.sduhealth.org.uk/areas-of-focus/carbon-hotspots/pharmaceuticals/cspm/sustainable-care-pathways-guidance.aspx>
5. Rizan C, Bhutta M, Reed M, Lillywhite R. The carbon footprint of waste streams in a UK hospital. *Journal of Cleaner Production* 286 (2021) 125446. <https://www.sciencedirect.com/science/article/abs/pii/S0959652620354925>



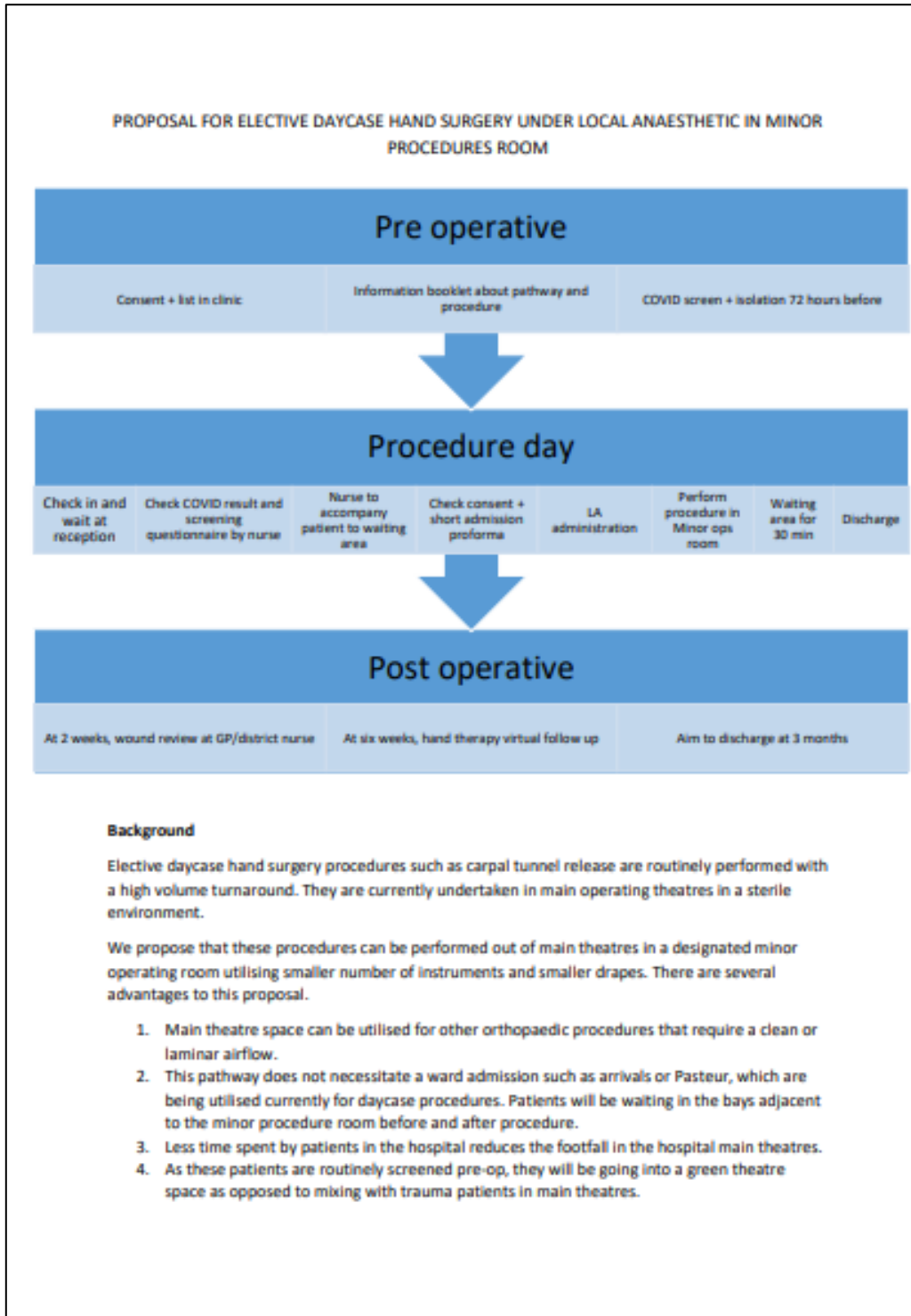


Appendix 1: Algorithm to identify waste and reduce carbon footprint of CTR





Appendix 2: Proposal for elective day case hand surgery under local anaesthetic in minor procedures room





5. This pathway offers significant cost savings^{3,4} to the Health board as there will be less instruments and theatre expendables used in minor procedure set up.
6. This resonates hugely with the sustainable care in the NHS by making a positive environmental impact through reduction of carbon footprint⁵ by cutting down on unnecessary procurement and waste generation.
7. This proposal is in line with the Trust's purpose of "delivering excellent care" and strategic goal of "improving safety and outcomes to match the NHS best."

Location

1. Endoscopy suite in modular theatres would be ideal as the adjacent bays are best suited for patients to wait before and after procedure. Currently, there is space and availability here on a Thursday PM and Friday. It is fitted with mechanical ventilation with air changes.
2. Minor procedure room in the old endoscopy suite would be well suited to perform these procedures. Patients would need to wait in the reception area of endoscopy before and after procedure. There is availability here on Friday PM. This has natural ventilation with an Air condition machine installed in the room.

Other locations such as clinic room 1 in Rose Neath in Orthopaedic Outpatients have been suggested. There is general unwillingness on part of the upper limb surgeons to undertake procedures in this room due to the guidance issued by BOA (page 6)² which specifically states that such procedures be performed in a designated minor procedure room. There is a need for air changes in the room to perform minor procedures⁴.

Inclusion criteria

Patients listed and consented for elective hand surgery procedures under local anaesthetic

1. Carpal tunnel release
2. Trigger finger release
3. Selective fasciotomy / fasciectomy.

Exclusion criteria

Other more invasive procedures that involve metalwork and bony exposure. However, there is potential to do these cases in the modular theatres if we create patient pathways incorporating walking wounded such as hand and wrist trauma including flexor tendon repair, which will further reduce the burden on trauma in main operating theatres.

Staff

1. One nurse to help with tray turnaround in procedure room
2. One nurse/HCA for admission and discharge process.

Equipment

1. Theatre operating light.
2. Minor hand procedure tray (a set of six instruments).

Audit of outcomes

1. Prospective collection of infection rates.
2. Collection of PROMs through the National registry from British Society of Hand Surgery.

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REFERENCES

1. BOA, BSSH and Royal College of Surgeons guidance on carpal tunnel surgery [carpal tunnel syndrome treatment | Royal College of Surgeons - RCS | Search results page 1 | Evidence search | NICE](#)
2. [C19-Surg-001 - Elective pre-operative pathway V1.6 - 30.06.20.pdf \(wales.nhs.uk\)](#)
3. Leblanc MR, Lalonde DH, Thoma A, et al. Is main operating room sterility really necessary in carpal tunnel surgery? A multicenter prospective study of minor procedure room field sterility surgery. *Hand (N Y)*. 2011;6:60–63.
4. A detailed cost and efficiency analysis of performing carpal tunnel surgery in the main operating room versus the ambulatory setting in Canada. *Hand (N Y)*. 2007;2:173–178.
5. [Sustainable services | The King's Fund](#)
6. Humphreys H, Coia JE, Stacey A, Thomas M, Belli AM, Hoffman P, Jenks P, Mackintosh CA; Healthcare Infection Society. Guidelines on the facilities required for minor surgical procedures and minimal access interventions. *J Hosp Infect*. 2012 Feb;80(2):103-9. doi: 10.1016/j.jhin.2011.11.010. Epub 2011 Dec 20. PMID: 22192171.





Appendix 3: Waste reduction.

Cases 1-7 undertaken using old theatre setup, cases 8-24 using the lean green setup.

