SusQI Project Report
Improving Ventilation & Laminar Flow Efficiency In Theatres

TEAM MEMBERS:

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Background:

The NHS is aiming to be the world's first 'net zero' national health service.[1] Energy use makes up 10% of the NHS carbon emissions footprint,[2] and data suggests that operating theatres are one of the most energy intensive areas of hospitals, using three to six times more energy than clinical wards.[3] The majority (90-99%) of operating theatre energy consumption relates to theatre maintenance (heating, ventilation and air conditioning)[3] with these items often left on when the theatre is not in use. Leaving ventilation systems on when not required can lead to significant cost and environmental implications.

Planned elective surgery takes place during daytime hours, Monday-Friday only, with emergency and trauma theatres working potentially around the clock. The aim for this project is for both laminar and conventional theatre ventilation to be automatically switched off completely (0% energy usage) between the hours of 7pm -7am in our elective theatres and 8pm – 7am in the emergency and trauma theatres with the use of the override button (which turns ventilation back on for a preset period of 2 hours) if any surgery is performed overnight.

Specific Aims:

To implement an automatic ventilation system switch off, at designated times, to improve efficiency and reduce cost and environmental implications.

Methods:

The first part of the project involved information gathering. We involved the theatre staff to determine how the ventilation system was currently utilised and the best times for full switch off as well as their perceptions of the potential change. A QR code and link to a staff survey around the understanding of the use of laminar flow within theatres was created with findings in our results section.

The current practice was believed to be all 6 theatres were programmed to go into setback mode at midnight -7 am. After the engineer visited it was noticed that despite the programming this was not physically happening meaning the ventilation was on 100% of the time. This meant the baseline we were working from was worse than expected.

IPC (Infection Prevention and Control) and the Ventilation Safety Group were contacted to gain permission for the proposed change to fully switch off.

The Trust's Sustainability Manager, Estates department and the ventilation company (Clean air solutions) helped to investigate the possibility of switching off both the laminar flow and conventional ventilation. Unfortunately, early in the project several barriers were identified;

- It was realised that we do not have the ability to turn off the laminar flow either manually or automatically, there is only a setback button, therefore we would not even be able to implement a manual switch off by the staff even with education and changes of procedures without changes to the system being required, which has financial implications.
- The override button in theatre 2 was found to be broken.
- Theatres 3 and 5 override buttons could not be checked as were not accessible during testing due to emergency and trauma patients being operated on.
- Conventional ventilation and the laminar flow are not being linked meaning programming a full switch off for the ventilation would not enable an automatic full switch off laminar flow again this requires changes to the system with financial implications

At the time of writing only 3 out of 6 theatres (1, 4 and 6) could go ahead with any changes, and the only changes that could be made without any financial implications were to increase the hours the theatre went into setback mode and not full switch off. Therefore, as from the 27th December 2024 Theatres 1, 4 and 6 physically go into setback mode at 7pm – 7am.

Whilst this was extremely disappointing from the point of view of this project this did lead to highlighting issues with the system and funding has now been found via Grants for the work to take place. There are two elements to the funding the new BMS controllers and sensors are being funded through the NHS Energy Efficiency Fund and the new inverters are being funded through government Salix grant funding. The aim is to complete the work required by the end of March 2025 therefore both the data for what we have achieved now and what we should achieve in the future will be provided.

Measurement:

Patient outcomes:
There are no expected direct patient benefits. IPC and the ventilation safety group were consulted to ensure patient safety would be maintained. The risk of the ventilation system not being switched on would be low, once the theatre staff enter the theatre to set up for the procedure the absence of the usual background noise made by the system would be difficult to go unnoticed. The use of the override button ensures patient safety will be maintained. An increase in infection rates would

become apparent via the usual auditing and Inphase incident reporting processes and thoroughly investigated.

Population outcomes:
No directly measurable population outcomes although reduction in energy and expenditure may potentially benefit the wider population

Environmental sustainability:
Energy usage was modelled using data provided by the Estates department which showed Energy consumption specifically for ventilation as 342,988.80 (kWh) per year. The carbon footprint was estimated using the emission factor of 0.27522 KgCO2e/kWh from the UK Government. It takes into account the greenhouse gas emissions associated with electricity generation, transmission and distribution and well-to-tank emissions for electricity generation and transmission and distribution. Calculation: (energy consumption) 342,988.80 (kWh pa) X 0.27522 kgCO2e/kWh (carbon emissions factor).
The current carbon footprint of the ventilation system within the main theatres per year is 94,397.38 kgCO2e.

Economic sustainability:
The cost of energy to the Trust (17p per kWh) was provided by the estates department. Our current spending on the ventilation system is £58,308.09 per year.

Social sustainability:
We explored staff perceptions of the project and how this may impact on staff via a survey.

Results:

Patient outcomes:
As expected, no direct patient benefits and no adverse effects to patients observed.

Environmental and economic sustainability:
Table 1: Summary of CO2e and cost reductions based on changes implemented and planned.

	Usage per year (kWh)	**Greenhouse gas emissions (kgCO2e)**	**Cost (£)**
Before project	342,988.80	94,397.38 kgCO2e	£58,308.09
Projected Energy Consumption After project change 1 (Theatres 1, 4 & 6 in setback mode):	292,030.46	80,372.62 kgCO2e	£49,645.18
If Theatre 3 & 5 override buttons work - project change 2 (meaning 1, 3, 4, 5 & 6 all in setback mode):	269,736.19	74,236.79 kgCO2e	£45,855.15
When work is completed – project change 3 (all 6 theatres fully switched off):	177,619.20	48,884.36 kgCO2e	£30,195.26

Following the first changes a saving of £8,663 and 14,025 kgCO2e has been achieved from placing Theatres 1, 4 and 6 in setback mode. On completion of the second and third changes with the funded work, estimated to be complete by April 2025, a reduction of £28,113 and 45,513 KgCO2e could be reached. This is the equivalent electricity consumption of 16.8 average households for a year (Ofgem) and equivalent CO2e to driving 134,102 miles in an average car.

Social sustainability:
60% of the staff who completed the staff survey believed turning off the ventilation when not needed was the right thing to do. More education with staff around patient safety and how long it takes to make theatre 'patient ready' when emergency patients come in should increase this number and increase staff satisfaction.

Once work is complete a further survey regarding the staff's thoughts on the complete shut-off will be gathered.

Discussion:

Shutting down equipment at the end of the working day seems like a natural thing to do, but many areas within a hospital are 24/7. Elective theatres at Warwick Hospital usually end their day at 6pm, however the Emergency and Trauma theatres plan to operate until 8pm and remain open overnight for further unplanned, emergency requirements.

Staff had concerns about patient safety if a patient is booked in for surgery during the night after the ventilation system is shut down. IPC and the ventilation safety group were consulted and the ventilation company made assurances that if ventilation was in complete shut down mode it would only take 15 minutes for the system to make the theatre environment ready.

Ensuring staff are educated to turn the ventilation system on at the time of patient booking, this allows time for the patient to arrive in the department and be anaesthetised before surgery commences.

The risk of the ventilation system not being switched on would be low, once the theatre staff enter the theatre to set up for the procedure the absence of the usual background noise made by the system would be difficult to go unnoticed.

The timescale of this project has meant the full benefits are not yet realised but by completing this project and encountering the challenges of faulty override buttons and automatic system limitations led to the acquisition of Grant money enabling this work to take place.

Conclusions:

Despite this project only making a small change to the utilisation of the ventilation system due to the challenges and barriers, some benefits were still realised and any reduction in the energy used will contribute to the target delivery of a net zero NHS. Had this project not been undertaken it is unlikely the issues with the ventilation system would have been identified, the biggest success of

this project was being granted the funding to carry out the essential works needed to allow for an automatic 100% shutdown.

Having both the conventional ventilation and the laminar flow linked together in this way will ensure optimum efficiency of the shutdown without relying on the staff to remember to switch it off at the end of the day.

The more energy we save the better our carbon footprint and the by product, cost improvements are equally welcomed in a time where energy prices continue to soar. Releasing these vital funds will hopefully benefit patient care in other areas.

Hopefully this project will prompt other departments to look at any devices left on when not in use relevant to their areas and encourage them to look at ways to improve their efficiency.

References

1. www.england .nhs.uk/greenernhs/wp-content/uploads/sites/51/2022/07/B1728-delivering-a-net-zero-nhs-july-2022.pdf
2. Tennison I, Roschnik S, Ashby B, Boyd R, Honilton I, Oreszczyn T, et al. Health care's response to climate change: a carbon footprint assessment of the NHS in England. Lancet Planet Health, 2012; 5(2): e84-e92
3. MacNeil A, Lillywhite R, Brown C. The impact of surgery on global climate: a carbon footprinting study of operating theatres I three health systems. Lancet Planet Health, 2017; 1(9): e381-e8

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 X Staff engagement X MDT / Cross-department communication ☐ Skills and capability of staff X 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	☐ clear guidance / evidence / policy to support the intervention. ☐ Incentivisation of the strategy – e.g., QOF in general practice ☐ systematic and coordinated approach X clear, measurable targets ☐ long-term strategy for sustaining and embedding change developed in planning phase X integrating the intervention into the natural workflow, team functions, technology systems, and incentive structures of the team/service/organisation	X Dedicated time X 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 X Financial investment	X aims aligned with wider service, organisational or system goals. ☐ Links to patient benefits / clinical outcomes ☐ Links to staff benefits X 'Permission' given through the organisational context, capacity and positive change culture.