

Retrofitting UK hospitals to reduce overheating risk

Academic case study of Addenbrooke Hospital, Cambridge



Addenbrooke Hospital, Cambridge. Credit for image: [D. Dinneen](#)

1. SUMMARY

To support policymakers and practitioners to understand the role of building design in mitigating overheating risk and improving energy efficiency, researchers from the University of Cambridge (UK) and University of Loughborough (UK) analysed building adaptations, to mitigate overheating risk, for NHS hospitals built in the 1960s. The aim of the analysis was to find out which, if any, of five building adaptations would be successful in maintaining the indoor temperature of Addenbrooke Hospital, Cambridge, at a thermally comfortable level – below 28°C for 95% of occupied hours (CIBSE, 2006). The analysis also considered the implications of each proposed adaptation for energy consumption and carbon emissions. Each of the five building adaptations were tested against expected future temperature increases up to the year 2080.

2. CONTEXT

Climate change poses a range of challenges to all organisations. They need to be resilient to extreme weather events, such as heatwaves, and should also seek to reduce their carbon footprint to support carbon reduction targets. The NHS as a major employer and service provider, faces particular challenges. It provides services to 1 million patients and visitors every 36 hours and it is responsible for 30% of public sector (3% of all UK) carbon emissions.

The NHS estate faces physical exposure to overheating, while also providing services to socially vulnerable people, including children, older people and people in ill health. There is a sizable base of evidence that people over the age of 65 and children are particularly vulnerable to periods of excess heat, mainly due to their biophysical characteristics and limited adaptive capacities (Lindley et al, 2015), while. This is a challenge for the NHS, as people over the age of 65 make up 41% of hospital admission rates and the mean length of stay is five days; and 1.5 million under 5s were admitted between 2014-2015.

3. ACTIVITIES

The aim of the five proposed building adaptations is to mitigate overheating risk using a responsible amount of energy. Although the adaptations were modelled in one hospital environment – a south-east facing, seven-bed ward in Cambridge, UK – the authors suggest the findings are relevant to other similar built environments. Addenbrooke Hospital is similar in design to 50 other (15%) of NHS hospitals.

The original authors proposed alternative heating and ventilation strategies and assessed their effectiveness in mitigating overheating risk. Section 3 of this case study presents the results of the assessment, arrived at by modelling each of the five building adaptations against expected temperature increases up to the year 2080. Brief descriptions of the alternative adaptation strategies are as follows:

1. Sealed building. Mechanical ventilation with heating and cooling
2. Sealed Mechanically ventilated environment, radiant ceilings active in winter (heating) and summer (cold water from cooling); heat recovery
3. A hybrid option, with natural ventilation and concurrent mechanical ventilation supply, heat recovery, opening windows and Perimeter Heating
4. Natural cross ventilation, perimeter heating
5. Natural stack ventilation with perimeter heating

Extended descriptions of each of the adaptation strategies are presented in the original academic paper (Short et al, 2011).

4. OUTCOMES

To test the effectiveness of the five proposed adaptation strategies, weather models were created (Lomas and Giridharan, 2012) and reviewed (Jones et al, 2009) to assess each adaptation's performance in typical and extreme future weather scenarios in the 2000's, 2030, 2050 and 2080. Conclusions were drawn from the extent to which each building adaptation provided for an internal environment below 28°C for 95% of expected human-occupied hours, the CIBSE (2006) benchmark of 'thermal comfort'. Other benchmarks of thermal comfort were referred to in the original analysis, which should be consulted for a thorough description of the approach taken to reach the following conclusions. This benchmark is referred to in this case study as it is frequently used in studies on overheating in buildings in the UK.

- The existing building will be too hot by the 2030's particularly in extreme weather years when temperatures exceed expected averages. Moreover, the current building is more energy intensive (100GJ/100m³) and has a greater carbon footprint (179kgCO₂/m²) than the benchmark levels for UK hospitals (55-65GJ/100m³ and 142kgCO₂/m², respectively). These are baseline measurements.
- Building adaptations 1 and 2 would be expected to provide a thermally comfortable internal environment in typical and extreme years up until 2080. Both strategies are more energy intensive than options 3, 4 and 5, with option 2 only slightly below the UK hospital benchmark levels of energy consumption (approx. 60GJ/100m³) and carbon emissions (137kgCO₂/m²).

- Building adaptations 3, 4 and 5 would be expected to provide a thermally comfortable internal environment in typical, but not extreme years up until 2080. All three adaptations are below energy consumption and carbon emissions benchmarks.

All five adaptations provide for a thermally comfortable internal environment until 2030. After 2030, however, building adaptations including mechanical ventilation are needed to maintain internal thermal comfort. To minimise energy demand, the analysis recommends installing building adaptations that can be modified to provide additional cooling in future years when so needed.

5. CONCLUSION

The conclusion of the analysis was that “a degree of mechanical intervention will be required in extreme years [of heat] and provision should be made for its eventual installation [however] wholesale air conditioning is not necessary now, nor in the immediate future” (Short et al, 2012). This case study is a brief overview of an academic paper and credit is due to its authors (ibid) for the insights provided here.

6. CHALLENGES

The work showed that there is a trade-off between minimising overheating risk and energy efficiency in the long run, as building adaptations that are most effective for addressing overheating (adaptations 1 and 2 in this case study) are energy intensive. To overcome this challenge, the original authors recommend installing building adaptations that can be upgraded to provide greater cooling in future years, when less energy intensive technologies become insufficient.

There is also something of a trade-off between patient safety and some natural ventilation techniques, due to risks associated with fully opening windows to let cool air in on hospital wards – concerns relate to infections and patients falling out, for example. In terms of the challenges of the study itself, there is of course a degree of uncertainty involved in modelling air temperatures 60 years into the future, compounded by the uncertainty of future carbon emission scenarios.

7. PARTNERS

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8. CONTACT

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