THE UK'S CLEAN AIR HOSPITAL FRAMEWORK: THE ROLE OF HOSPITALS AS ANCHOR INSTITUTIONS IN ACHIEVING IMPROVED AIR QUALITY WITHIN THE COMMUNITIES THAT THEY SERVE

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Healthcare services are significant contributors to both ambient air pollution and greenhouse gas emissions (NHS England 2023). Additionally, hospitals often bring together vulnerable patients in high-traffic environments, typically in urban areas with elevated background concentrations of ambient pollutants. Consequently, there is a pressing need for hospitals to reduce their emissions of airborne pollutants, ideally within the context of achieving net-zero emissions. This project aims to examine how the UK's Clean Air Hospital Framework (CAHF) can enhance air quality at two major hospitals in the UK: the Royal Victoria Infirmary (RVI) and Freeman Hospital in Newcastle. Both hospitals are implementing the CAHF as part of their efforts to meet their 2030 sustainability goals.

CAHF originated from a collaboration between the Great Ormond Street Hospital and the Global Action Plan, an environmental charity in the UK (Global Action Plan 2022). It is designed as a self-assessment tool with a structured pathway, guiding hospitals towards achieving cleaner air environments. The framework requires 221 compliance actions to be satisfied to achieve a 100% rating. These actions spread across 7 policy categories: Travel, Procurement, Design & Construction, Energy, Local Air Quality, Communication, and Outreach. The Framework assesses hospitals against these policy areas providing a comprehensive approach to improving air quality rather than a single policy action focus. Participating hospitals in this study aim to achieve 70%, Excellent Status, by the end of 2025.

The current research will assess the effectiveness of integrating CAHF into broader NHS and city initiatives for air quality improvement, and how this benefits public health. It will also explore the hospitals' role as anchor institutions in advancing air quality and health benefits in their communities.

The sequence of implementing the project is iterative with the review loop constantly active within every phase. A mixed methods approach to collection and analysis of data was adopted to allow for broader and more grounded study across the multidisciplinary policy focus areas within the CAHF (Almeida 2018).

An initial assessment using the CAHF scoring matrix resulted in a 38% score, categorized as "Getting There" within the framework. Procurement (13.9% of the maximum) and energy generation (16.4%) emerged as the areas with the least progress, primarily due to existing long-term contracts in these sectors. This highlights the critical role of contracting towards achieving CAHF target goals within the hospital. Table 1 presents the weighting of all CAHF policy areas, and the baseline status achieved at the Royal Victoria Infirmary and Freeman Hospital in Newcastle.

Table 1. CAHF Weighting and hospital baseline achievement percentage.

CAHF Focus areas	Category weighting	Baseline percentage
Travel	28%	11%
Procurement	14%	2%
Design and Construction	18%	9%
Energy generation	6%	1%
Local air quality	6%	5%
Communication & Training	18%	6%
Hospital Outreach & Leadership	10%	4%

Air quality data was collected through the installation of 8 indoor AQ monitors (4 per hospital), 2 automatic continuous ambient AQ monitors (1 per hospital), and 36 NO_2 diffusion tubes. The diffusion tube lab analysis aligns with Newcastle City's Quality Assurance (QA) and equivalence testing, allowing the adoption of the council's bias correction factor. Field QA measures included the use of blanks and co-location with the Urban Observatory's chemiluminescence-based NO2 monitoring unit. The air quality monitoring strategy provides high geospatial and temporal resolution of project AQ indicators allowing the evaluation over time of the effectiveness of CAHF actions.

Baseline NO_2, $PM_{2.5}$, and PM_{10} concentrations at the RVI were 18µg/m^3, 5.8µg/m^3, and 8.9µg/m^3, respectively, below UK annual averages (NO_2: 40µg/m^3, $PM_{2.5}$: 25µg/m^3, PM_{10}: 40µg/m^3) but exceeding WHO guidelines (NO_2: 10µg/m^3, $PM_{2.5}$: 5µg/m^3, PM_{10}: 15µg/m^3). Air quality data analysis indicated a strong influence of city background pollution levels on the RVI. Indoor particulates monitors revealed varying pollution levels between hospitals. Particulate matter ($PM_{2.5}$ and PM_{10}) concentrations exhibited a pronounced weekend peak, particularly during evening hours, associated with increased foot traffic. Further investigation is ongoing. While NO_2 levels across all diffusion tube monitoring locations complied with UK guidelines (40µg/m^3), they mostly exceeded WHO limits (10µg/m^3) at both hospitals. Addressing NO_2 hotspots is necessary, with potential solutions including a delivery transport hub and increased electric vehicle use in patient transport. Data from the RVI site for the 2023 calendar year is shown in Table 2.

Table 2. Air quality statistics for NO_2, PM_{10} and $PM_{2.5}$ at the RVI continuous monitoring site

Concentrations (µg m^{-3})	NO_2	$PM_{2.5}$	PM_{10}
Annual mean	16.6	6.4	10.0
24 hr maximum	39.8	39.5	46.5
24 hr 99th percentile	36.5	28.6	35.8
1 hr maximum	85.0	73.2	118
1hr 99th percentile	54.6	30.2	37.7

Measured NO_2 concentrations at both hospitals, determined using diffusion tubes, consistently fell below those predicted by the ADMS model and DEFRA background levels. A significant discrepancy of over 10µg/m^3 at Leases Park Community Centre suggests a potential mitigating effect of the surrounding dense woodland (Table 3). Source apportionment analysis revealed varying contributions from road traffic pollution at each monitoring site. The observed divergence between modelled and measured concentrations indicates the influence of localized factors not accounted for in the predictive model. However, Investigations to identify causal factors for the observed variations in measured and predicted concentrations are still on going.

Table 3. Measured and ADMS predicted concentrations of NO_2 (µg/m^3) at select diffusion tube locations across the RVI

Site location	ID	Meas.	ADMS
Multistorey Entrance	R-M-1	32.0	31.7
Hospital Supplies Centre	R-S-1	24.0	31.1
Great North Children	R-G-1	21.5	30.0
Car Park 1	R-C-1	21.9	30.4
New Victoria Wing Taxi Park	R-N-1	22.8	29.6
Emergency Triage Entrance	R-E-2	23.0	27.1
Leases Park Community Centre	R-L-2	13.1	25.6
Urban Observatory	R-U-1	31.0	31.5
New multistorey Entrance	R-M-3	31.9	27.1

It is hoped that this study will act as an exemplar for the CAHF approach and encourage other hospitals to engage in this process.

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