Assessment of naturally ventilated hospital bays using CO_2 monitoring as a proxy to prioritise resources for engineering interventions.

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Question: Are our wards well ventilated and how can we tell?

BACKGROUND

The World Health Organisation (WHO) have produced a roadmap[1] to help assess and improve indoor ventilation in the context of COVID-19. However, assessing the effectiveness of naturally ventilated areas can be difficult, especially when hospital buildings predate publications of technical standards. The UK Scientific Advisory group for Emergencies (SAGE) suggest monitoring CO_2 levels can be used as a proxy for good ventilation in multi-occupancy areas[2].

Most multi-occupied bays at the 900 bedded Arrowe Park Hospital site are naturally ventilated. The ventilation specifications in these bays was not attainable. In order to assess if they were adequately ventilated, the hospital's Infection Prevention and Control (IPC) Team undertook a trust wide CO_2 monitoring survey.
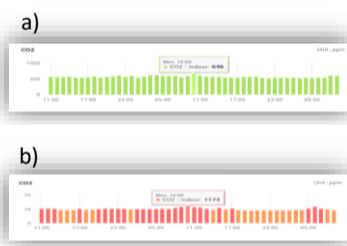

Figure 2: LIVE reading in the form of colour coded graphs available on the IQ Air website.

a) Low CO_2 levels

b) high CO_2 levels

Results

- **A low reading of <800 ppm** was recorded in 93 of 135 (69%) areas
- **A medium reading of 800-1499 ppm** was recorded in 30 of 135 (22%) of areas
- **A high reading of >1500 ppm** was recorded in 12 of 135 (9%) of areas. intervention.

Examples of raw data extracted from devices is shown in Figures 4 & 5.

The results suggest that ventilation of the wards is compromised during high activity periods & when doors or windows are closed

Figures 6 a/b: Although only CO_2 levels were monitored in this study, additional parameters include particle counts, temperature & humidity. Data is available LIVE on the IQ Air website (a) or via a phone app (b).

6 a) Data available on website

6 b) Data available on phone App.

Acknowledgement: To the Wirral University Hospital Infection Control Nurses, who managed the placement of devices across the hospital.

Method

Six commercially available, portable Non-Dispersive Infra-Red (NIDR) ® AirVisual Pro (IQAIR) CO_2 monitors (Figure 1) were deployed to135 occupied areas across the trust, from the period of July-Dec 2021. Each device was left in area for a minimum of 48 hours. The devices continuously measured CO2 in ppm. Raw data was analysed to look for peak CO_2 levels attained.

Most areas monitored were naturally ventilated ward bays – see figure 3 for average ward. A small number of mechanically ventilated area were also monitored. e.g. patient waiting areas.

Although raw data extracted directly from the devices was used for analysis, LIVE data was available via the AIRVISUAL website and app. (Figures 2, 6).

Figure 1: ® AirVisual Pro (IQAIR)

Reference ranges used according to published guidelines for multi-occupancy areas. [2,3]

- CO2 <800ppm are acceptable & indicate good ventilation
- Co2 >1,500ppm indicates poor ventilation and requires intervention
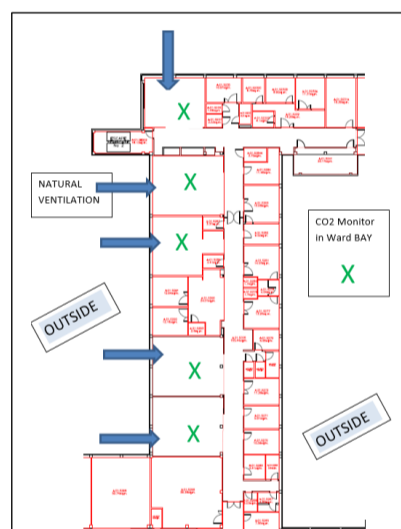- *Co2 levels from 800-1499ppm were to be investigated further in this audit*

Figure 3: Average ward layout
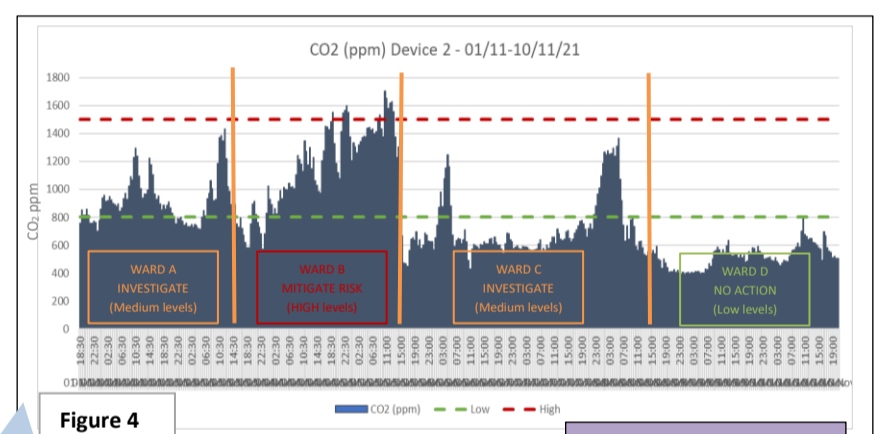
Figure 4 & 5 show examples of raw data collected.

Figure 4 highlights assessment of risk on the readings observed.

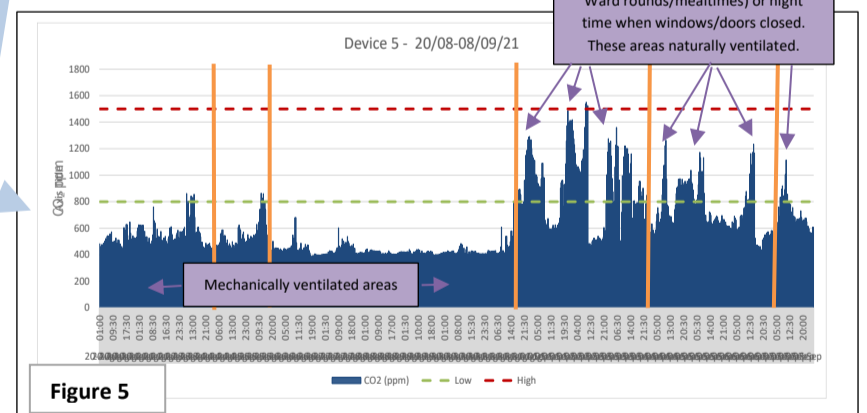Figure 5 highlights more detailed investigation of levels observed.

Figure 4

Figure 5

Discussion/Conclusion:

- During the COVID-19 pandemic, there was a need for assessment of ventilation status across the hospital.
- Use of the CO2 monitors helped provide a snapshot proxy assessment of naturally ventilated areas.
- Engineering solution and limited resources could then be prioritised to areas which were poorly ventilated.
- This includes the use of air purifiers in worse affected areas to reduce the risk of nosocomial spread.
- Fluctuations observed during the day can also guide schedules for opening windows balanced with thermal comfort.
- Co2 monitoring is a low-cost method. It can be performed as a scheduled, rolling programme to cover large areas or ad hoc to assess individual areas of concern.

References:
1. World Health Organization. (2021). Roadmap to improve and ensure good indoor ventilation in the context of COVID-19. World Health Organization.
2. EMG-SPI-B: Application of CO2 monitoring as an approach to managing ventilation to mitigate SARS-CoV-2 transmission. Published 11th June 2021
3. CIBSE COVID-19 VENTILATION GUIDANCE V4 23rd October