

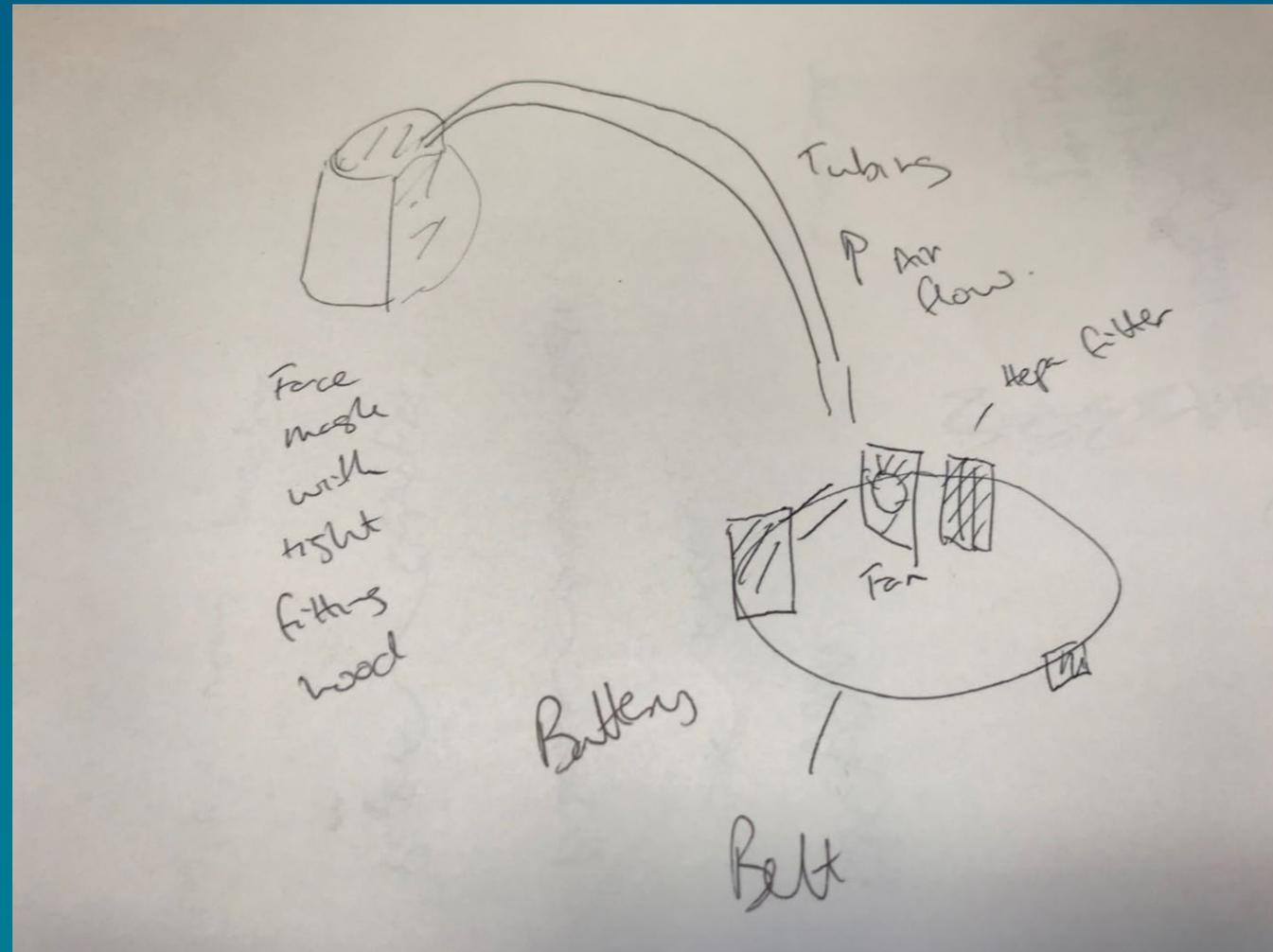
Implementation and evaluation of widespread powered air purifying respirator use as an alternative PPE strategy during COVID-19

Paul Elkington

University of Southampton and University Hospitals Southampton

p.elkington@soton.ac.uk

The origins: perceived urgent need March 2021



In house design and production of respirators

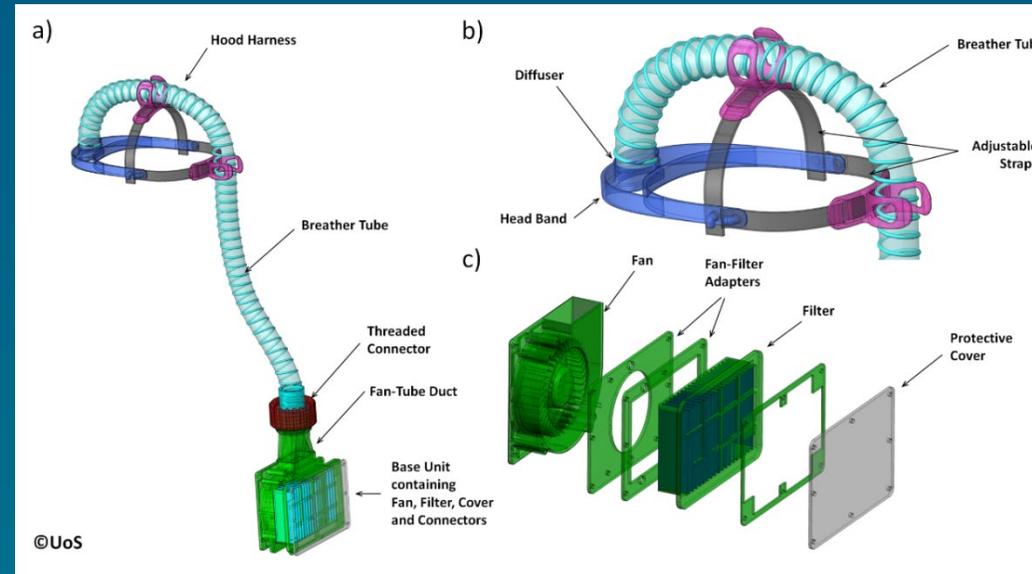
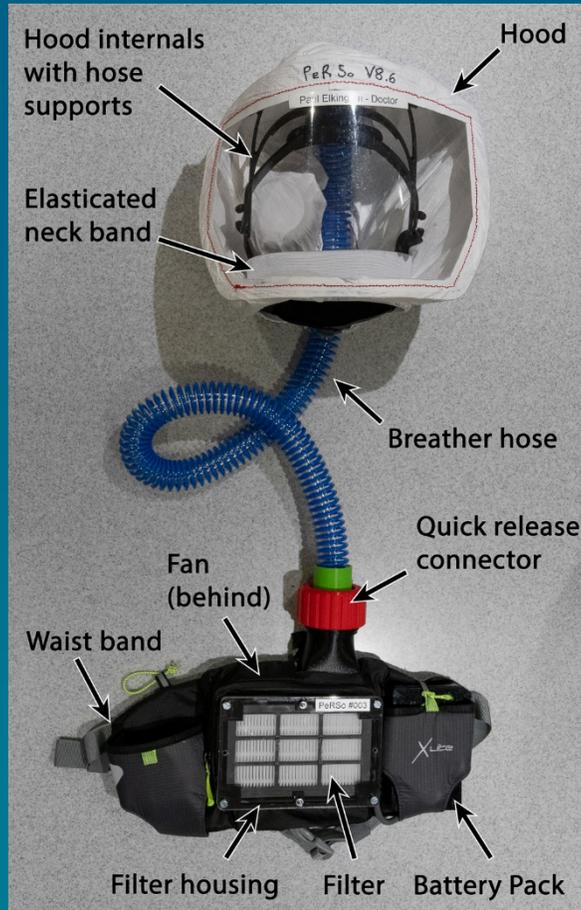


Initial evaluation



3D printed connectors

Early PeRSo prototype and open access design



Downloaded almost 2,500 times

<https://www.frontiersin.org/articles/10.3389/fmedt.2021.664259/full>

Production version: INDO Lighting and wave 1 implementation



Lecture theatre 2

Deployed on COVID positive wards in place of surgical face mask

“I have felt sick with fear every day coming to work, now I feel safe”

Prospective feedback via online survey

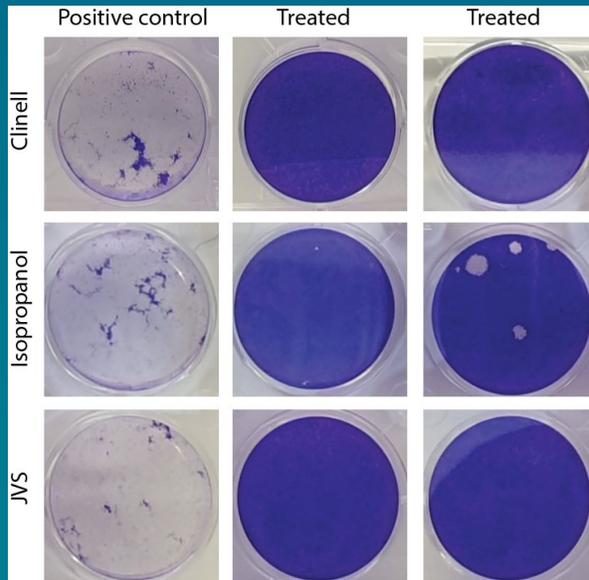
- Significant findings vs droplet protection
 - more comfortable (p 0.011)
 - harder to doff (p < 0.001)
 - patients respond better (p 0.044)
 - wearer feels safer (p < 0.0001)
 - overall experience is better (p 0.006)

- 1,396 staff requested reissue for wave 2



Regulatory hurdles for use in place of FFP3 masks

- PeRSo 3.0 approved 22nd September 2020
 - Previously certified PAPR with medical grade filter inserted
- PeRSo 1.0 approved 6th April 2021
 - Simple mass produced version made in UK



- Validation of efficacy of killing SARS-CoV-2
- Previously approved PAPRs did not have to go through same validations

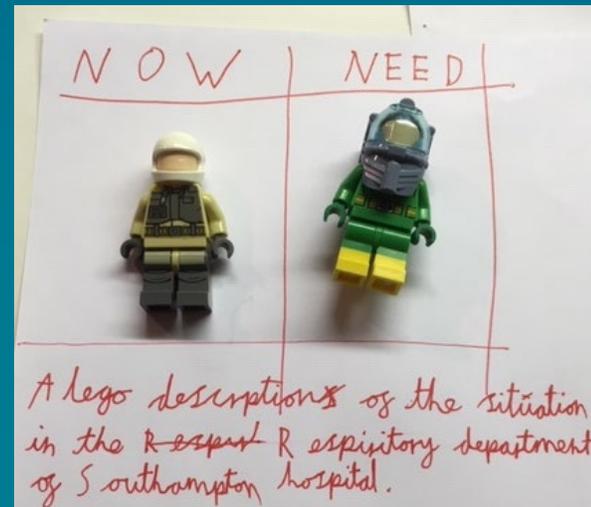
Additional benefits of wide PeRSo use

- During second wave, 3,629 deployed across trust
- 5% of staff who fail fit testing could return to work
- Much more robust FFP3 supply as daily use minimised
- No failure during use, compared to 18% mask failure during CPR

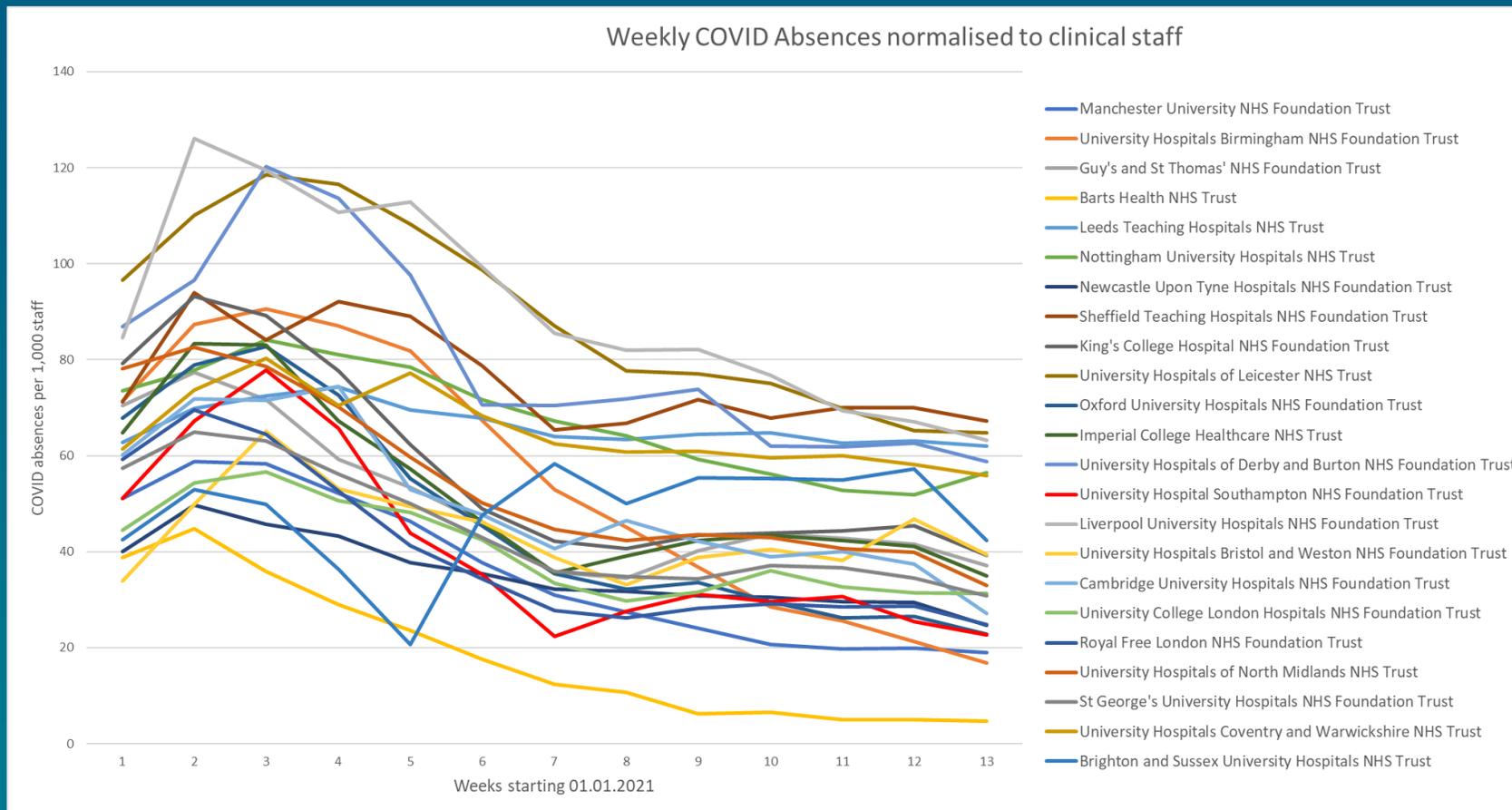
 The American Journal of Emergency Medicine
Volume 38, Issue 1, January 2020, Pages 12-17

N95 filtering facepiece respirators do not reliably afford respiratory protection during chest compression: A simulation study

Sung Yeon Hwang MD ^a, Hee Yoon MD ^a , Aerin Yoon RN ^b, Taerim Kim MD ^a, Guntak Lee MD ^a, Kwang Yul Jung MD ^a, Joo Hyun Park MD ^a, Tae Gun Shin MD ^a, Won Chul Cha MD ^a, Min Seob Sim MD ^a, Seonwoo Kim PhD ^c



COVID absences Jan – Mar 2021



2.5-fold lower staff absence at UHS during pandemic versus at worst performing Trust

Advantages of inexhaustible high efficacy PPE



BBC: August 2020

Aerosol emission from the respiratory tract: an analysis of relative risks from oxygen delivery systems

F Hamilton, F Gregson, D Arnold, S Sheikh, K Ward, J Brown, E Moran, C White, A Morley, AERATOR group, B Bzdek, J Reid, N Maskell, JW Dodd

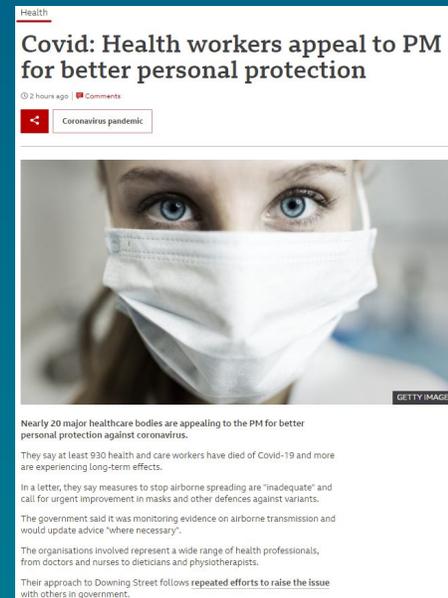
doi: <https://doi.org/10.1101/2021.01.29.21250552>

As a consequence, the risk of SARS-CoV-2 aerosolisation is likely to be high in all areas where patients with Covid-19 are coughing. Guidance on personal protective equipment policy should reflect these updated risks.

MedRxiv: 1st February 2021

Healthcare workers 7 times as likely to have severe COVID-19 as other workers

BMJ: 8th December 2020



BBC: 19th January 2021

Covid: Science advisers call for better PPE for healthcare workers

By David Shulman
Science editor
5 days ago

Coronavirus pandemic



Healthcare workers have welcomed a change in scientific advice on how to protect them from coronavirus.

A document by the government's scientific advisory group (Sage) says higher grade masks may be needed when caring for Covid patients.

BBC: 24th April 2021 SAGE advice

Covid-19: Health staff in plea for better protection

David Shulman
Science editor
3 June | Comments

Coronavirus pandemic



BBC: 3rd June 2021

Guidance for CDC and HSE support powered respirator use

My hospital uses powered air-purifying respirators (PAPRs). Will they protect me from SARS?

Yes. PAPRs use HEPA filters (high-efficiency particulate air filters), which are as efficient as P-100 filters and will protect against SARS. PAPRs provide a higher level of protection than disposable respirators.



<https://www.cdc.gov/niosh/npptl/topics/respirators/factsheets/respsars.html>



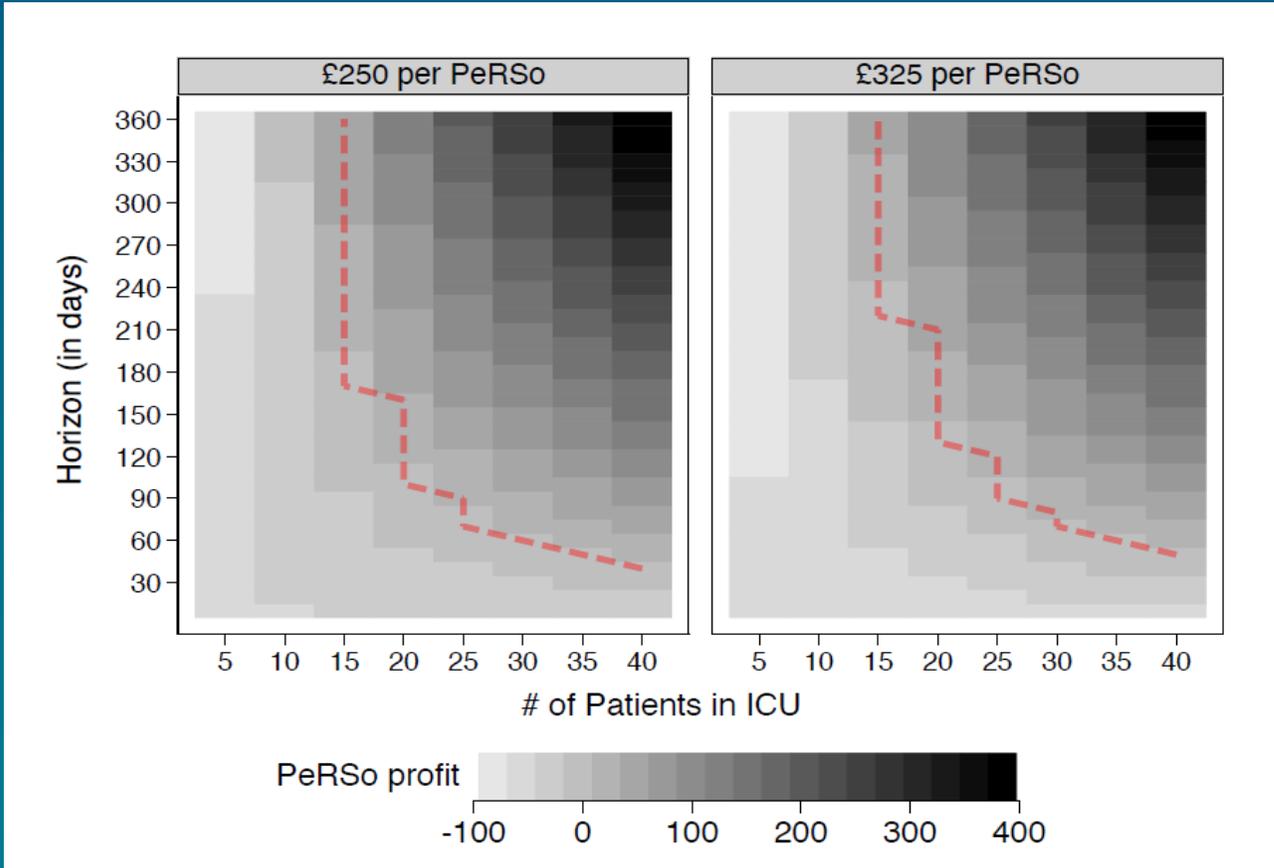
Respiratory protective equipment at work

65 For example, it is recommended that continuous wear time for tight-fitting (unpowered) RPE is less than an hour, after which the wearer should take a break. Otherwise, the RPE can become uncomfortable to wear, leading to loosening or removal of the mask in the work area. In these situations, where RPE is required to be worn continuously for long periods, powered respirators or airline BA, for example a loose-fitting facepiece such as a hood or helmet, are better options.

69 Other head-worn PPE can potentially interfere with RPE, preventing one or more of the components from working correctly (eg eye protection, ear protection and safety helmets – see Figure 6). Where possible, choose equipment where the different forms of protection required are combined (often referred to as integrated or combined PPE), eg eye, face, head and respiratory protection provided by a powered helmet respirator.

<https://www.hse.gov.uk/pubns/priced/hsg53.pdf>

Economic modelling: cost saving after 8 – 12 weeks vs FFP3



UHS ITU during second wave

Red line = time to cost saving, based on an ITU with 180 staff, comparing disposable PPE with PerSo use and all ongoing costs

Summary

- Widespread respirator deployment has been successful in a large NHS trust
 - Preferred by staff
 - Preferred by patients
 - Cost-saving after approximately 2 months
 - Environmentally sustainable
 - Communication is much better: we all lip read partially
 - Associate with low staff absence and low mortality
- We propose that personal respirators should become part of PPE strategy for the chronic phase of the pandemic

Acknowledgements and conflicts of interest

- COI: Impact case study and potential research revenue share from INDO



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Service evaluation: Saul Faust, Ally Munro

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Indo Lighting: Tom Baynham, Laurence Baynham, Simon Martin

Many others: Sophie Fletcher, Anastasios Lekkas, Wessex AHSN, McLaren Racing, Kemp Sails

University Hospital Southampton Outcomes

Together we have made a difference

What is becoming apparent is just what this collective effort has meant for us all. UHS is in top the 10% of trusts across the UK for low death rates in Covid-19 positive patients and nosocomial (hospital acquired) infection. A great achievement and testament to how you have worked individually and as teams over this period in order to protect the safety of each other and our patients. That of course does not diminish the difficulty of what we've all faced.



Challenges to mass implementation

Stakeholder	Role and responsibilities
Director and nursing leads for infection prevention and control	Protocols for use, donning and doffing, assessment of usage areas
Medical and nursing director	Prioritising staff for roll-out; ensuring compliance with regulatory guidance
Communications	Updating all staff on deployment and prioritisation strategy of new PPE; news release to inform public
Logistics and estates	Deployment centres, storage areas, charging stations 7 day distribution needed in December / January
Education team	Training staff in use, cleaning, storage, return at end of contract
Procurement and Purchasing	Confirming contract and delivery schedule, liaising with design team for technical aspects of manufacture, replacement hoods, spare batteries, on site storage arrangements
Local industry	Production of units, shipping in parts, regulatory approvals
University	Initial concept and prototype evaluation; prospective analysis of deployment
End users: Doctors, nurses, healthcare assistants, research teams, phlebotomists, cleaning staff, porters	Compliance with training, storage, ongoing use, return when leaving post

Wave 1 data further support widespread deployment

ARTICLES | VOLUME 5, ISSUE 9, E475-E483, SEPTEMBER 01, 2020

Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study

Long H Nguyen, MD * • David A Drew, PhD * • Mark S Graham, PhD * • Amit D Joshi, PhD • Chuan-Guo Guo, MS • Wenjie Ma, ScD • et al. [Show all authors](#) • [Show footnotes](#)

Lancet Public Health 31st July 2020

At least a 3-fold increased risk of positive COVID-19 test

SARS-CoV-2 seroprevalence and asymptomatic viral carriage in healthcare workers: a cross-sectional study 

Thorax 11th Sept 2020

Seroprevalence was greatest among those working in housekeeping (34.5%), acute medicine (33.3%) and general internal medicine (30.3%), with lower rates observed in participants working in intensive care (14.8%).

A prospective study of 3, 6, 9 and 12 month respiratory outcomes following COVID-19 related hospitalisation

Lancet Respiratory Medicine 2021 *In press*

At 12 months after discharge, radiologic changes persisted in 24% of patients.