Infection Prevention & Control (IPC) Research during the Pandemic: An Opportunity for Saving Lives and Avoiding Costs

Dr John Conly on behalf of the WHO COVID-19 IPC R&D Expert Group

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World Health Organization

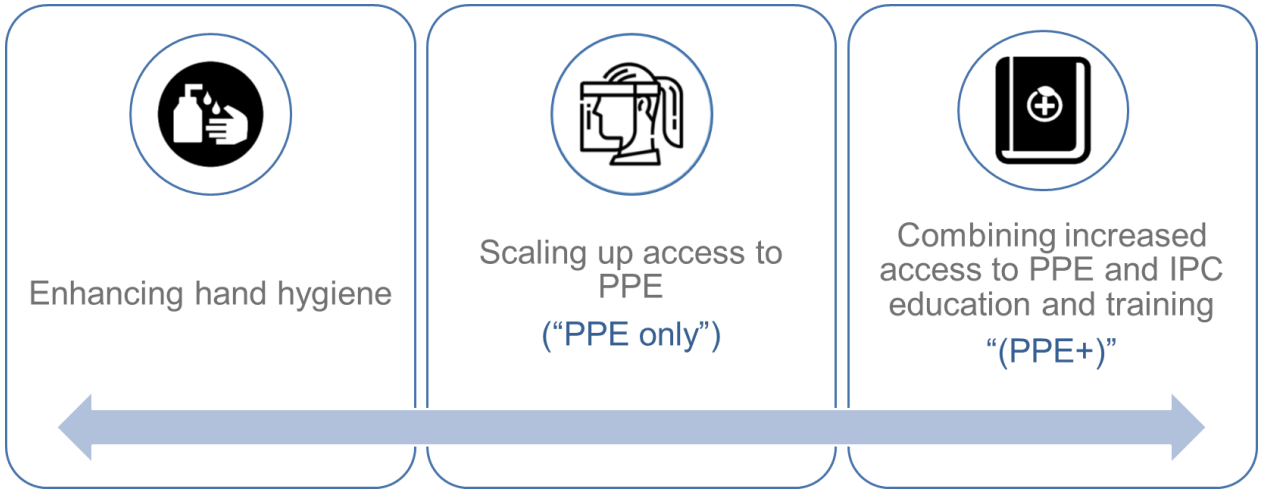
R&DBlueprint
Powering research to prevent epidemics

Introduction: R&D Objectives for IPC

1. understand the **effectiveness of public health and social measures** and **IPC strategies** to prevent SARS-CoV-2 transmission in health care and community settings
2. optimize the **effectiveness of personal protective equipment (PPE)** in reducing the risk of transmission in health care and community settings
3. identify the **role of the environment in transmission of SARS-CoV-2**

45 IPC research projects coordinated, funded, or led by WHO, in collaboration with the **COVID-19 IPC R&D Expert Group.** Results provided **innovative solutions** and helped to **inform WHO IPC guidelines for COVID-19**

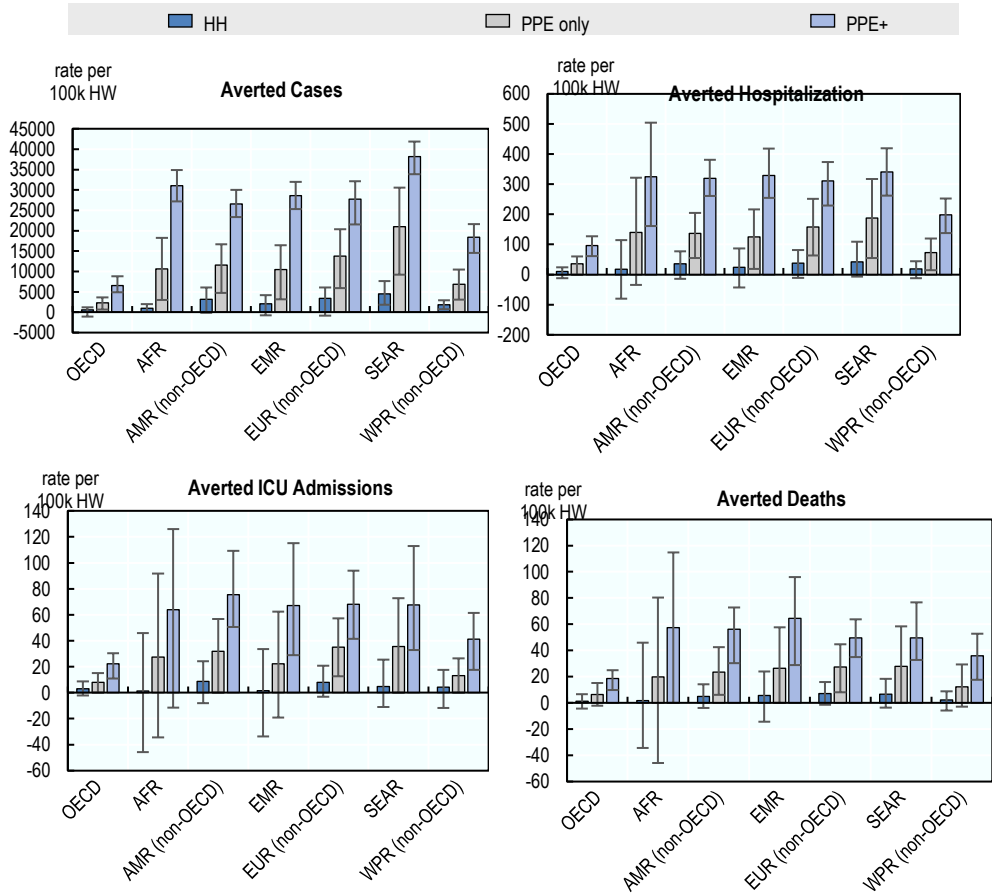
OECD/WHO Joint Project Cost-effectiveness of IPC Interventions to Reduce Transmission of SARS-CoV-2 Among HCWs

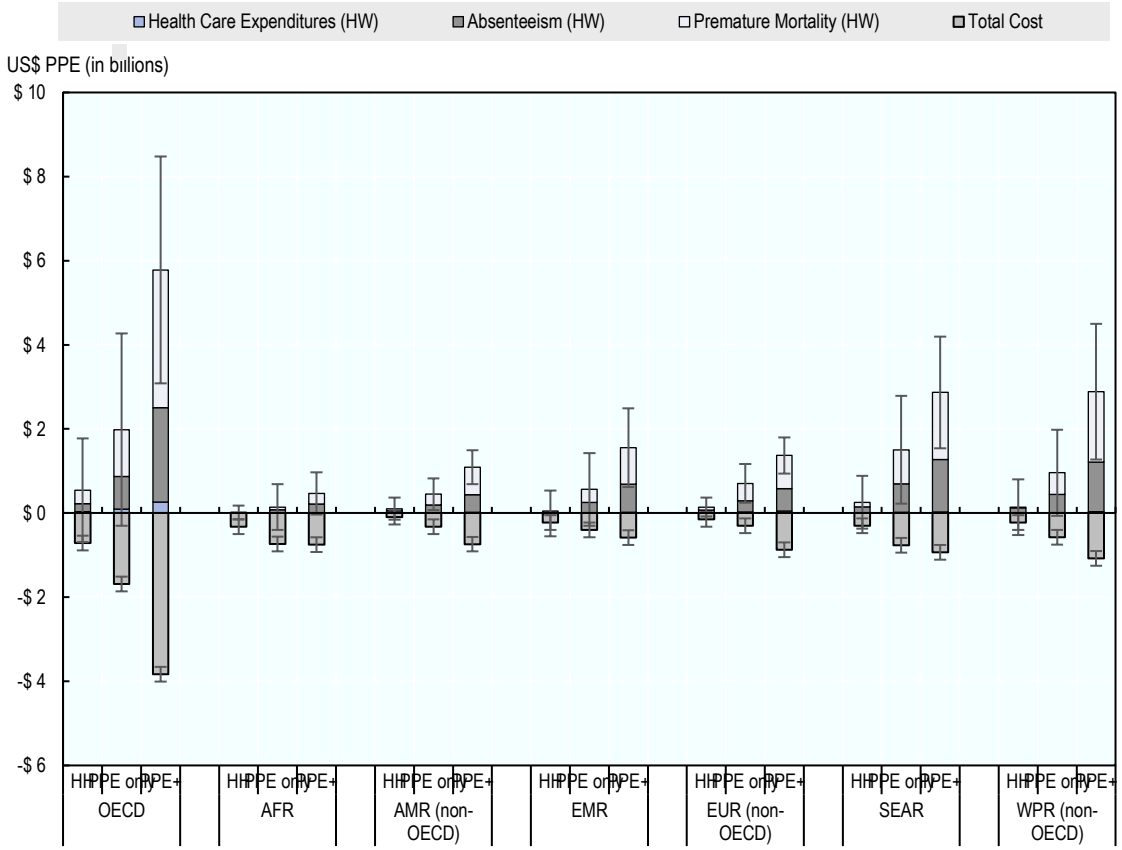


- Analysis with **global coverage, during the first 180 days of the pandemic**
- Using the **OECD Strategic Public Health Planning COVID-19 model**, that predicts disease outcomes by inputting **health impacts -** attributable morbidity and mortality, and **economic impacts -** medical costs of treatment, productivity loss due to absence from work and premature mortality and **effectiveness of IPC interventions** based on meta-analyses of scientific evidence

Cost-Effectiveness OECD/WHO Joint Project - Results

Combining **increased access to PPE with IPC training** yields the **greatest global health and economic gains**





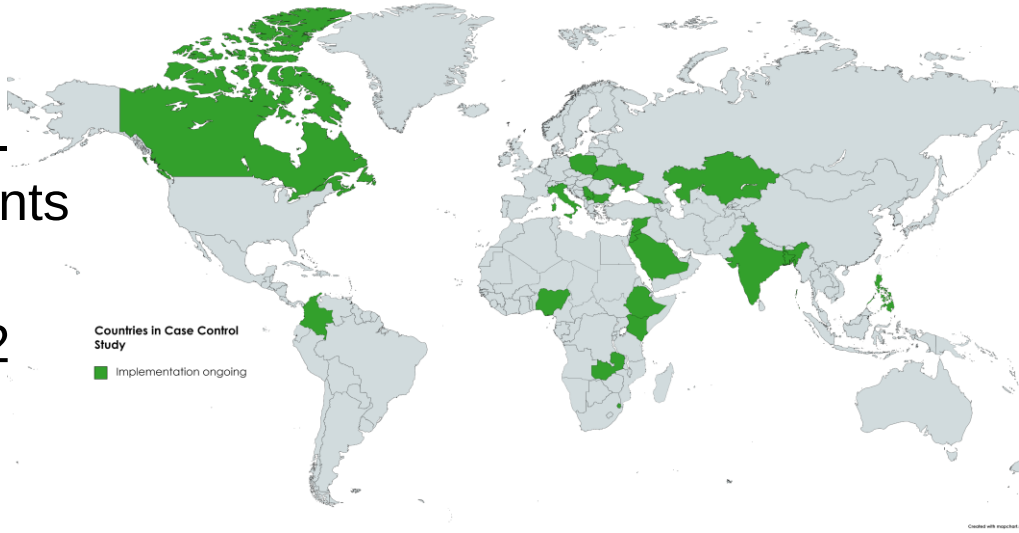
> 50% of new infections among HCWs in South-East Asia, Europe and the Americas, and approximately **one third of new infections** in other regions, could have been averted

- **$7.2 billion USD** net savings globally
- **Hand hygiene also cost-effective** in most regions

WHO Multicenter Case Control Study to Assess Risk Factors for COVID-19 in Healthcare Workers (HCWs)

Objectives

1. To characterize and assess the **IPC risk factors** for SARS-CoV-2 infection in HCWs with exposure to COVID-19 patients
2. To describe **clinical presentation, including serologic responses,** duration and disease severity for SARS-CoV-2 infection in HCWs



Interim findings

- **2285 HCWs** from **97 health facilities** in **19 countries** participated (~80% low-middle income)
- **Risk factors** for COVID-19 in HCWs identified so far
  - Prolonged **close contact** (>15min within 1 meter) [**OR 1.4**, 95%CI 1.0-1.8, P=0.05]
  - **Inconsistently wearing a respirator or a surgical mask or both compared to consistently wearing a respirator during AGPs** [**OR 4.8**, 95%CI 2.3-9.7, p<0.01]
  - **Not always appropriately performing hand hygiene** during prolonged patient contact [**OR 2.7,** 95%CI 1.7-4.2, P<0.01]

Understanding the Burden of Hospital-onset COVID-19 Infection (HOCI) and Developing Implementable Surveillance Systems

- **Living rapid review** on existing HOCI systems initially published in the Journal of Hospital Infection; **9 sets of definitions** and surveillance systems identified. Proportion of **HOCI cases varied from 0% to 15.2%**. A new definition was developed.
- **Network analysis of COVID-19 transmission** in health care settings using **patient movement data** and a risk **prediction algorithm** based on patient and specialty characteristics, and **development of a real-time and automated HOCI surveillance** and individual risk prediction system (not yet published).

Zhu & Abbas, et al. J Hosp Infect. 2021, https://pubmed.ncbi.nlm.nih.gov/34098049/

Price et al. Clin Infect Dis 2020, https://pubmed.ncbi.nlm.nih.gov/32634822/

Myall, et al. 2021, https://www.medrxiv.org/content/10.1101/2021.09.28.21264240v1

Price et al. (2020). Clinical Infectious Diseases. https://pubmed.ncbi.nlm.nih.gov/32634822/

Understanding the Impact of the Pandemic on Healthcare-associated Infection (HAIs) and Antimicrobial Resistance (AMR)

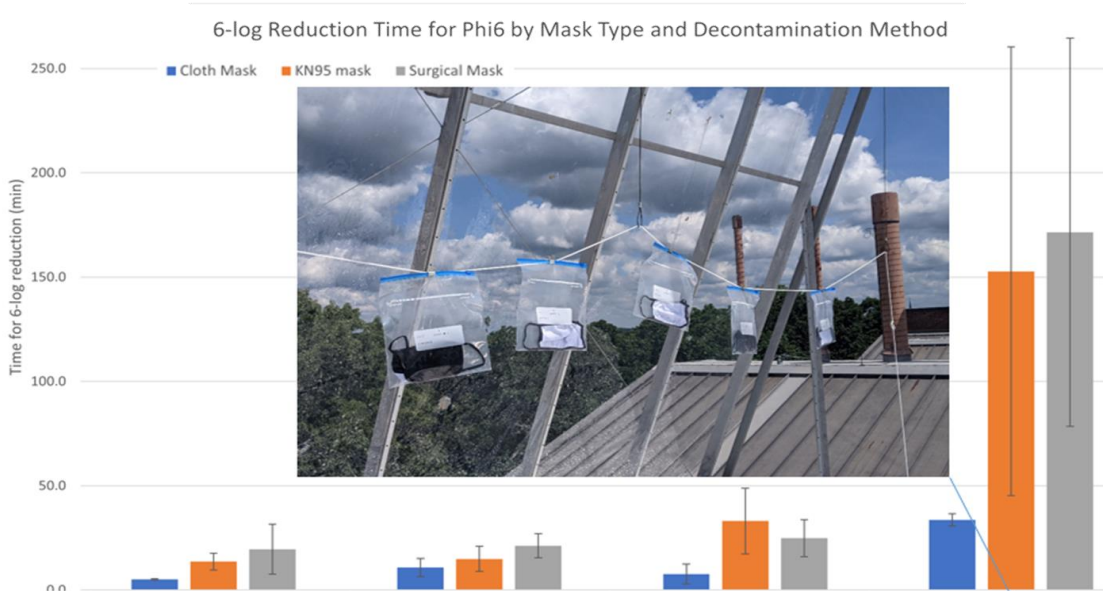
- **Study 1 (London):** of 1,047 bloodstream infections (BSI), **38% were HAIs**, with **bloodstream HAI rate increased to 132.3** during the Wave 1 and to **190.9 per 100,000 patient-days** during Wave 2, compared to 100.4 across the pandemic (with significant increases in elective inpatients). P**atients with HAI had longer hospital stays (≈20 days) and 26.7% higher mortality rates.**
- **Study 2 (Singapore): decreasing trends** of incidence **of HAIs in intensive care units** and **of carbapenem-resistant organisms** in 2020 compared to previous years.

Zhu, et al. Clin Infect Dis 2021, https://pubmed.ncbi.nlm.nih.gov/34596212/

Kariyawasam R et al. *ARIC.* AMR in COVID-19 Patients: A Systematic Review and Meta-Analysis (November 2019 - June 2021) Accepted Feb 2022

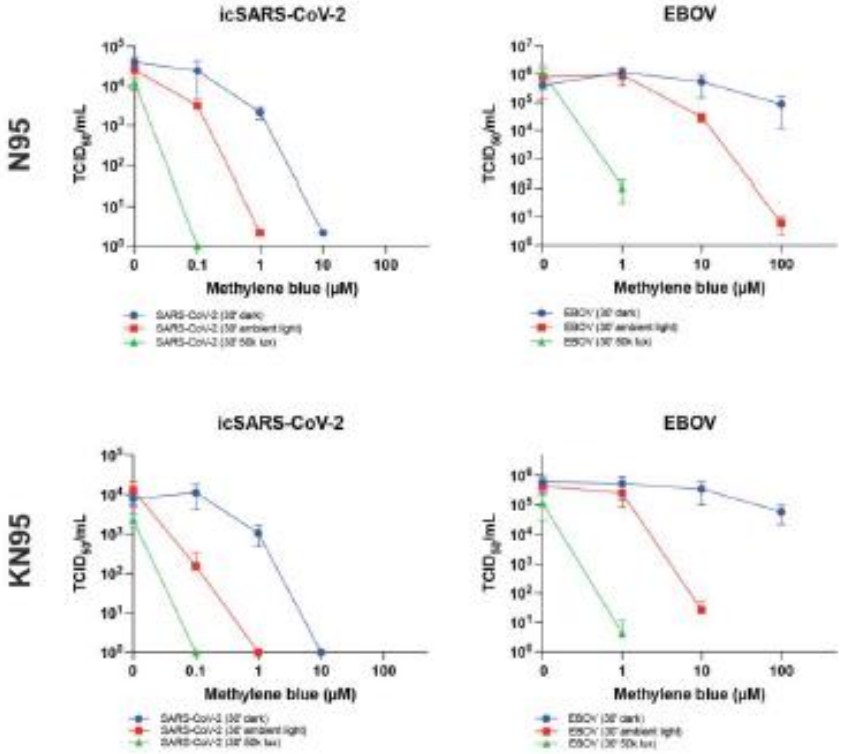
Optimize PPE Effectiveness: Addressing PPE Shortages Through Innovative Decontamination Processes

Rapid, On-Site Decontamination of Facemasks in Low-Resource Settings (M. Fisher, M. Sobsey et al.)



Time (min) for 6log reduction	Wet Heat		Dry Heat		Rice Cooker		Sunlight	
	T-6log	StDev	T-6log	StDev	T-6log	StDev	T-6log	StDev
Cloth Mask	5.1	0.3	10.8	4.4	7.7	4.8	33.6	2.9
KN95 mask	13.6	4	15	6	33.1	15.8	152.8	107.6
Surgical Mask	19.6	12	21.3	5.8	24.9	8.9	171.5	93.1

Exploring inactivation of SARS-CoV-2, MERS-CoV, Ebola, Lassa with methylene blue



Florine Scholte et al., Exploring inactivation of SARS-CoV-2, MERS-CoV, Ebola, Lassa, and Nipah viruses on N95 and KN95 respirator material using photoactivated methylene blue to enable reuse, American Journal of Infection Control (Under revision)

Optimize PPE Effectiveness - Addressing PPE Shortages: Pre-treatment, Antimicrobial Treatment, Delivery

DeMaND-2 Project: Pretreatment with Methylene Blue:

Respirators' pretreatment + ambient light

- remained effective for up to 3 weeks against SARS-CoV-2 Delta and MERS on N95s and KN95s

Surgical masks pretreatment + ambient light

- effective at fully inactivating (>99.9%) SARS-CoV-2 Beta variant within 5 minutes at concentrations of 5µM or higher.

Community masks pretreatment + ambient light

- inactivated >99.9% of SARS-CoV-2 Beta variant within 30 minutes for concentrations of 2.6 µM or higher
- Full inactivation to limit of detection occurred for concentrations of 50 µM (Mask 5) or higher.

https://doi.org/10.1017/ice.2021.230

The Use of Drones for the Delivery to Remote First Nations Communities During Covid-19 (J Conly, W Hawkins, et al.)

The Use of Drones for The Delivery of Diagnostic Test Kits and Medical Supplies to Remote First Nations Communities During Covid-19, American Journal of Infection Control (Under revision)

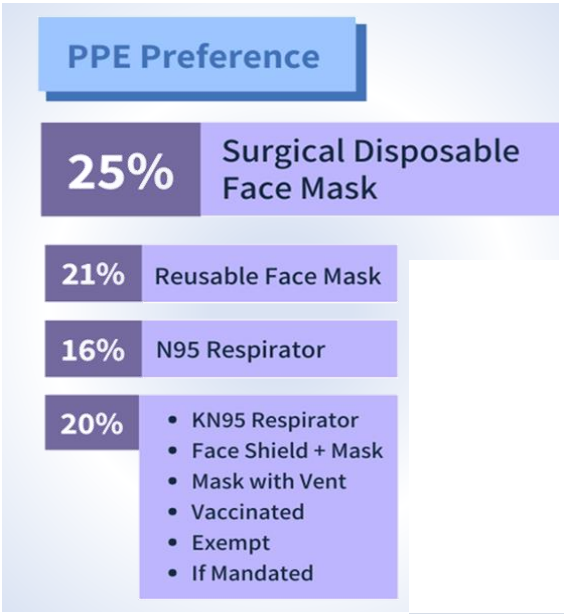
Enhanced Medical and Community Face Masks with Antimicrobial Properties: A Systematic Review

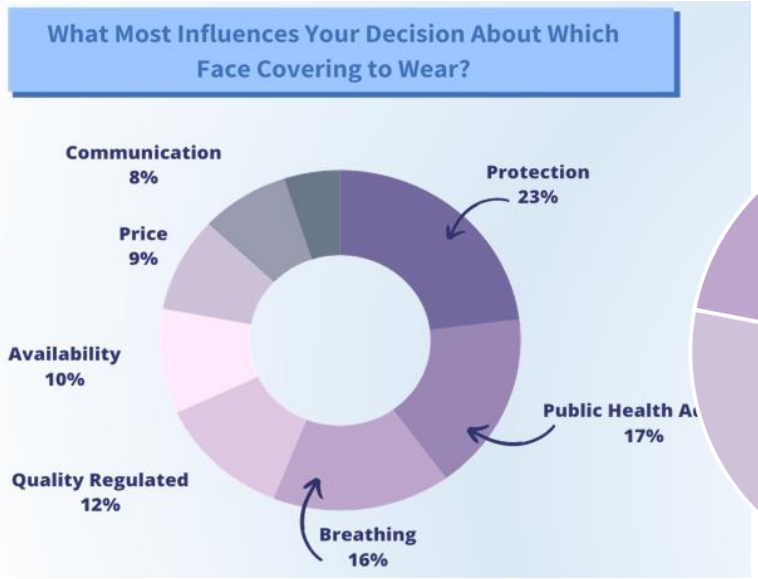
" […] antimicrobial treatment is a promising route to extending the life and improving the safety of face masks. In order to reach significant achievements, shared and precise methodology and reporting is needed" https://doi.org/10.3390/jcm10184066

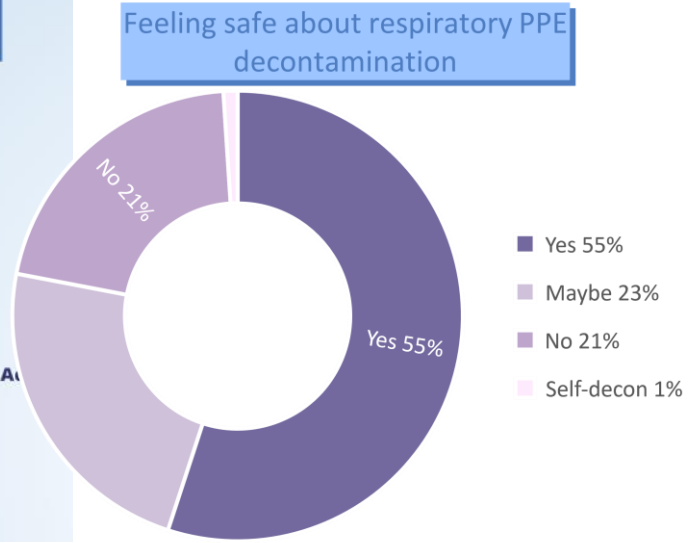
Optimize PPE Effectiveness: Improving Design and Human-Experience

Perceived Workload using combination of PPE (e.g., respirators + visors) vs PAPR (Padoveze et al., unpublished)

Field testing procedure of N95 mask + face shield (left) vs Light PAPRs (right).
PAPRs **reduced perceived workload** (NASA Task Load Index) and **increased usability** (System Usability Scale score) & **communication** among HCWs







Human Factors Survey (A. Price, L. Chu et al. unpublished)

Lessons Learned: Research on IPC Interventions

- on the **cost-effectiveness of IPC interventions**
  - enhanced PPE use, IPC training and hand hygiene could have **prevented millions of infections among** HCWs and **billions of associated costs** on a global scale
  - **sustained IPC programmatic support** and **training** among all HCWs and **budgeted and operational plans for rapid PPE procurement scale-up** at the start of a pandemic must be prioritized to save lives and costs

- on **HCW infections,** research has yielded **identification of risk factors** for SARS-CoV-2 infection among HCWs, and **capability to assess high-risk breaches** in IPC practices

- patient **hospital-onset COVID-19 infection (HOCI)** posed significant harm to patients; **real-time surveillance and risk prediction systems must be in place and be maintained**, allowing early identification of HOCI and **informing local IPC practices** to prevent spread to patients and HCWs. The methods can be translated to monitoring transmission of **other pathogens**

Lessons Learned: PPE

- Severe PPE shortages at pandemic arrival demonstrated that pre-COVID models for **manufacturing, logistic and disposal of PPE was not sufficient, sustainable nor resilient** - there is a **need for decentralized/regional approaches** in context of a pandemic
- HCW and population **perceptions are critical to PPE uptake**, **adherence** and extended use
- Need for a paradigm shift regarding PPE of the future **in context of climate change – focusing on reusable/biodegradable PPE given waste generation** from PPE
- The increased attention on **PPE should not hinder the attention on other IPC measures**; the combined use of PPE with other measures is significantly more effective than PPE alone
- **Gaps exist among research outputs and the actionable outcomes** required for writing evidence-based cost-effective IPC global measures. Further collaboration is required
- **More well-designed, timely, robust studies** (e.g., multicentric RCT) are required to generate high-quality evidence **on PPE efficacy and safety**

Priorities to Expand Research Capabilities for Future Pandemic Preparedness Related to IPC Interventions

- **Understanding HCW infections: surveillance with standardized methods** for reliable estimation of **HCW cases and outcomes** and **identification of occupational vs community acquisition** and **exposure settings**; understanding the **role of working conditions** (e.g., overload, excess working hours, variations in post-infection return-to-work criteria; understanding the epidemiology of **reinfection**
- **Assessing HCW behaviour following vaccination:** impact of mandatory vaccination on **HCWs behaviours and outcomes**; impact of the COVID-19 vaccination on **PPE/IPC measures** (de-escalation).
- **Understanding HOCI among patients: effectiveness of** innovative **real-time surveillance and WGS to detect transmission in health care** and understand the dynamics; assessing the **impact of tailored IPC measures** implemented according to real-time HOCI surveillance data; **applicability** of these methods **to other pathogens**
- **Assessing the impact of the pandemic on AMR and HAI: in COVID-19 and other patients**; **assessing impact on antibiotic use and access**; understanding **emerging and re-emerging pathogens** associated with surges of COVID-19 cases

Priorities to Expand Research Capabilities for Future Pandemic Preparedness Related to PPE

- High-quality evidence on **medical masks vs respirators effectiveness** and **adverse events** in the **context of prolonged use**, **repeated use** and in **combination with other PPE**
- Effectiveness of **PPE decontamination methods** and **need for standardised protocols**
- **Human factors**: effective & safe PPE use; does PPE use **affect compliance** with IPC measures?
- **Non-medical masks**: adequate **standards** for manufacturing, mass-production, **optimal use**, performance assessment, decontamination and **communication strategies to public**
- **Improve PPE international standards**, design processes, taking into **consideration physical differences, as well as gender (e.g., female) and ethnicity**
- **Lifecycle of PPE and non-medical masks**: optimising logistics, management, surveillance, waste management, minimizing the environmental impact, need for innovative solutions
- **Exit strategy for PPE use** in the context of the pandemic scaling back

Thank you

WHO COVID-19 IPC R&D expert group

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