Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Opinion to address the personal protective equipment shortage in the global community during the COVID-19 outbreak

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ABSTRACT

The current COVID-19 pandemic is stretching both the global supply for face masks and personal protective equipment (PPE). Production capacity is severely limited in many countries. This is a call for the R&D community, particularly to those in the polymer degradation and stability field. We have not only an opportunity but an obligation to engage and collaborate with virology and bio-medical experts. We require comparative R&D for extended, reuse and recyclability options. There is urgent need for large scale institutional approaches and methods that can be quickly applied locally by non-experts with limited resources.

Opinion

The COVID-19 outbreak is putting additional strain on hospital resources in many countries. Current predictions on the numbers of patients needing hospitalisation and intensive care support is quickly becoming reality. One resource that has attracted global attention is personal protective equipment (PPE), in particular, filtering facepiece respirators (the widely used face masks), which are suitable for filtrating of airborne pathogens and used by millions of healthcare professionals and public responders.

Given the current trends witnessed elsewhere, Australia and the United States, as a well as many other countries, will suffer escalating numbers of COVID-19 infections requiring hospitalisation in the near future. The result will put tremendous pressure on healthcare personnel and their services. The existing limited global supply and competition for face masks is leading to severe shortages. Now is the time to prepare for a worst-case scenario in which the demand for face masks cannot be sustained. Such a situation, which the global community has never had to experience before, will require novel and alternative actions requiring close coordination between our medical and materials engineering, as well as our manufacturing experts and industry. Urgent temporary solutions must be found for refreshing face masks for reuse and extended wear. We need to consider additional risk management solutions to best deal with likely scenarios that we hope to avoid. This is a call for action from the global engineering and research communities to explore the underlying materials science of face masks. Experts in polymer degradation and stability can collaborate with medical/health, virology and bio-medical experts in the search for urgent temporary solutions.

Preliminary work as pointers for what can be accomplished exists and a global response has already been triggered. References on disinfection of face masks containing a polymer-fibre filter suggest that under suitable conditions a filtration efficiency of >94.74 [1] can be achieved after thermal disinfection treatment without sustaining damage to the filter unit [2]. Disinfection and extended use, though, is not without risk and there are suggestions that some parts of a mask may suffer physical damage during repeated disinfection cycles [2]. By careful monitoring of the material properties before and after disinfection we believe this risk can be managed and viable options for reuse exist. Recycling and disinfection methods may include simple thermal treatments, exposure to hydrogen peroxide vapours, UV or gamma-irradiation sterilisation, ethylene oxide gas, detergent-based cleaning methods or the application of spray-on disinfectants. Existing methods or alternatives currently under consideration will need to be assessed for their own specific merits, with sterilization

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efficiency, filtration function and overall performance (mechanical properties and fitting) to be evaluated. Indeed, recent news stories have shown some hospitals already using hydrogen peroxide [3] or UV-irradiation [4] on used filtering facepiece respirator type face masks demonstrating ingenuity out of necessity. It also highlights a need for materials scientists to support these activities as well as develop improved disinfection methods that are robust and amenable to a number of different settings where resources may be highly varied. We need a focus on large scale recyclability approaches, as well as simple and easy to conduct methods within the context of 'anything is better than nothing' that could work on the local level and also be carried out by the public who are NOT experts and may only have limited resources, for example, in countries with less well established healthcare services.

Based on current data, approaches and likely technical feasibility, we present the following recommendations in preparation for an ongoing global pandemic. The overarching goal is clear, namely what can the materials experts offer to enhance the availability of additional PPE and face masks?

The materials R&D community should immediately focus on:

1. Comprehensive evaluation of the many options for PPE and face mask recycling that partially already exist.
2. Strategies for large scale recycling and extended use of PPE and face masks and its impact on material properties and functionality. What could be most easily scaled-up?
3. In parallel explore simple measures that could aid individual users where personal ownership of items is easily maintained. Tracking of individual use and history may also be feasible in hospital settings, thereby enabling perhaps easier acceptance of recycled or re-conditioned items.
4. Best methods for recycling and re-sterilisation based on comparative testing. What are the pro and cons of particular approaches? Such questions from the end user and medical community will evolve and must be dealt with.
5. Some of these areas will require close coordination between materials, medical/health, virology and bio-medical experts to achieve ongoing protection and anti-viral properties for reconditioned or recycled equipment.

In parallel, the medical and waste management experts in the health services may wish to consider:

6. Implementation of short-term alternative waste management strategies at hospitals with waste teams exploring how to separately collect visually reusable face masks and similar PPE as a potential asset to keep for the near future.
7. The impact of different recycling and disinfection methods on the functionality and protective nature of unused masks in comparison with previously used items.

Disclaimer

These are subjective and personal opinions of researchers in the polymer materials reliability field in the context of the current global COVID-19 pandemic only. There is no intent to challenge existing guidelines for PPE/mask use policies or give any preference to PPE/mask manufacturers and any specific technologies that may already exist or are under development.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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