

Infection control

Evidence summary

This document summarises the evidence presented in:

Development of decision support documents to assist decision making during a pandemic influenza response: evidence for personal protective equipment and antiviral measures, Dr Kathryn Glass, Stephanie Davis, Laura Martich, Prof Geoffrey N Mercer, National Centre for Epidemiology and Public Health, College of Medicine, Biology and Environment, Australian National University

and

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The full literature review, modelling study and other supporting documents are available on the Australian Government Department of Health and Ageing website at www.health.gov.au

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1 Introduction

The main aim of wearing personal protective equipment (PPE) during a pandemic is to reduce influenza transmission by providing a physical barrier between the wearer and the infectious agent. The effectiveness of PPE in mitigating an influenza pandemic is determined by the degree of transmissibility and severity of influenza. PPE that is suitable for influenza includes aprons, gowns, gloves and masks.¹ While evidence supports the use of PPE, in general, to prevent infection by viruses such as influenza, few studies have been done to quantify the effectiveness of its use in a pandemic. Similarly, the costs of implementing effective PPE use during a pandemic in the healthcare profession, the general population, or both, are not known.

To explore estimates of national usage and stockpiling requirements for various types of PPE, in the context of pandemic impact scenarios of varying severity, and alternative models of health care delivery in pandemic response, a research project based on mathematical modelling has been undertaken. Its key findings are included in this summary. This modelling also incorporates exploration of economic costs and likely usage by border protection agencies.

2 Personal protective equipment for pandemic influenza

2.1 Healthcare settings

High-quality evidence to support the use of PPE in healthcare settings is scarce. Although some studies indicate a benefit of surgical masks and respirators in preventing influenza infection, many studies show no significant benefit from their use. Healthcare workers show varying levels of compliance with the use of surgical masks and respirators. As the effectiveness of masks and respirators is particularly dependent on compliance and correct usage, low compliance has been cited by one systematic review as the likely cause of the low effectiveness of masks and respirators demonstrated by some studies.²

2.1.1 Effectiveness of personal protective equipment

Randomised controlled trials

Three trials were identified that explored the effectiveness of PPE in protecting healthcare workers against influenza in hospital settings. All trials only reported on the use of masks (respirators or surgical masks) and did not report on other forms of PPE. No trial provided a clear evaluation of the benefits of respirators or surgical masks in comparison with no masks.

Two trials compared the use of masks versus respirators. The first trial examined two groups of nurses working with patients with febrile respiratory illness. It found no significant difference in protection against influenza (confirmed by PCR or seroconversion) between the two groups. High compliance was confirmed by a limited audit of participants. Unfortunately, this trial lacked a no-mask control arm and thus did not generate data on whether masks were more effective than no masks. The second trial assigned healthcare workers to either a surgical mask group, a fit-tested respirator group or a non-fit-tested respirator group, with masks/respirators to be worn on while on shift. For all outcomes, respirators (fit-tested and non-fit-tested compared as one group) had rates of infection that were not significantly lower compared with surgical masks, but the trial lacked the power to detect differences between the three arms. It also did not examine masks in comparison with no protection.

Another trial considered mask use by healthcare workers, comparing self-reported acute respiratory illness of those randomised to wear surgical masks at all times while on duty versus those who only wore masks when required to by their job or task.³ No significant difference was found for rates of acute respiratory illness between the two groups. Limitations of this study are that there was no laboratory confirmation of influenza, and it is possible that the case definition used for acute respiratory illness (which was not specified) would capture a wide variety of viruses that cause upper respiratory tract infection.

Observational studies

Two cohort studies were identified that assessed the effectiveness of PPE during the 2009 (H1N1) influenza pandemic,^{4,5} as well as three cross-sectional studies that investigated PPE alone or as one of several interventions to prevent influenza transmission.^{6,7,8}

Of the five studies, only one conclusively observed a significant protective effect from the use of PPE: Marshall et al⁵ found that gloves had a significant protective effect against H1N1 influenza (as confirmed by PCR or seroconversion). One study identified that suboptimal adherence to face shield use during high-risk procedures was significantly associated with a higher risk of infection.⁶ However, the intrinsic bias in cross-sectional studies and the limited information on potential sources of participant infection outside the hospital setting prevent firm conclusions being drawn from these studies.

2.1.2 Acceptability and compliance

Several studies have assessed the use of surgical masks and respirators by healthcare workers and report varying levels of compliance. While randomised trials have generally found high levels of compliance with both surgical masks and respirators, reports from cross-sectional studies and other sources are generally lower.^{3, 9, 10} A 2007 Australian study in which emergency department staff agreed to wear respirators when caring for patients with respiratory illness found that, by the end of a 4-week period, only 16.7% of participants were still wearing a respirator.¹¹ A United States survey of intensive care workers found that 68% reported 'high' adherence to recommended PPE for prevention of influenza.¹²

Low compliance may be due to harms associated with PPE use. Multiple studies report that healthcare workers find wearing PPE uncomfortable or that PPE interferes with daily tasks. A Singaporean cross-sectional study of healthcare workers in the aftermath of SARS found that acne, itch and rash were the most common harms reported after wearing a respirator, and that dry skin, itch and rash were reported by glove users.¹³ A German study that surveyed healthcare workers during the 2009 pandemic found that 69.1% of healthcare workers felt bothered by having to wear a mask at work.¹⁴ In a 2007 Australian study, participants found respirators 'hot' and 'hard to breathe through', and reported that that they had difficulties 'communicating with patients'.¹¹ These concerns, as well as headaches, dehydration and skin peeling off nostrils, have been reported by other Australian studies using quantitative and qualitative methods to survey intensive care units and emergency department staff.^{15, 16} A trial comparing respirators and surgical masks reported significantly higher levels of discomfort and other adverse effects (such as headaches) associated with respirator use.

Another reported reason for lack of compliance among healthcare workers was that the use of PPE creates time constraints for already busy staff.^{6, 15} A simulation exercise in the United Kingdom found that increased time required for proper use of PPE compromised normal ward functioning.¹⁷ Lack of knowledge of recommended PPE protocols may also contribute to low compliance.¹²

2.2 Community settings

High-quality evidence to support the use of PPE in community settings is scarce. Although some studies support the benefit of surgical masks and respirators in preventing influenza infection, many studies show no significant benefit from their use. Some studies examined compliance in overseas settings, where wearing masks is more culturally accepted in day-to-day life. Although Australian studies have shown that many citizens and healthcare workers are willing to wear masks or respirators in the event of a pandemic, this may not be reflected in actual compliance. There are many barriers to compliance, particularly for respirator use; some of these are actual or perceived harms to the user.

2.2.1 Effectiveness of personal protective equipment

Randomised controlled trials

Eight randomised controlled studies on the effectiveness of face masks were conducted in community settings;^{18, 19, 20, 21, 22, 23, 24, 25} however, these included flaws in study design or execution such as poor adherence to mask wearing, contamination of study groups, lack of statistical power or early study termination. Five studies examined face mask use in conjunction with hand washing and noted significant reductions of secondary attack ratios or influenza-like illness incidence.^{19, 21, 22, 23, 24} However, due to the nature of the study design, it was not possible to distinguish whether this effect was due to the mask use, hand washing or a combination of both. One study demonstrated significantly lower incidence of influenza-like illness in household contacts with mask or respirator use, but the study design did not allow evaluation of which method was more effective.²⁰

Observational studies

Two studies were identified that examined the use of PPE in conjunction with other measures to prevent respiratory infection in non-healthcare settings.^{26, 27} Both found a significant reduction in the incidence of influenza-like illness, but the contribution of the PPE to this outcome could not be quantified.

2.2.2 Acceptability and compliance

An Australian study from 2007 found that 58% of respondents in the community would be very or extremely willing to wear a face mask if requested to do so by the government, and less than 8% would not be at all willing to do so.²⁸ A high level of compliance was associated with a higher level of concern for self and family. Various demographic factors have also been shown to influence compliance with PPE, including older age, being female and having a higher level of education.^{28, 29}

An Australian study on mask use in the community that used non-fit-tested respirators found that only 21% of adult contacts reported wearing face masks ‘most or all’ of the time.²⁰ Cited reasons for not wearing face masks include discomfort (see Section 3.4.3), incorrectly fitted masks, social acceptability of mask wearing, forgetting to wear it, or (in the case of a study that only considered children as index cases) the child disliking the adult wearing a mask.^{20, 30} A study conducted in Hong Kong found higher compliance: 49% of cases and 26% of contacts reported wearing face masks ‘often’ or ‘always’ within their households.¹⁹

Given that compliance was low in trials where participants received individual instructions, compliance outside of research settings is considered to be even less likely. Even when PPE is used in the community, it may not be used effectively due to incorrect technique. This is demonstrated by a study on respirator use by residents in post-hurricane New Orleans, which found that only 24% of participants demonstrated proper donning technique in using the respirator.³¹

Studies in community settings also report discomfort and difficulty carrying out day-to-day tasks with both surgical masks and respirators.^{20, 30} Interestingly, an Australian intervention trial comparing surgical masks and respirators did not report significantly higher levels of discomfort with respirator use.²⁰ There have been suggestions that face mask use may actually lead to increased influenza transmission through disregard of self-isolation measures in symptomatic individuals, or repeated touching or adjusting of wet masks.³² Although the literature review did not identify any studies relating to this issue,

it should be taken into consideration, and reinforces the importance of education and communication to the public as part of any recommendations regarding the use of PPE.

2.3 Modelling studies - effectiveness

Few modelling studies have investigated the effects of PPE on an influenza pandemic. Most of these studies focused on the use of masks or respirators by the general public, and indicated benefits such as reductions in reproduction number, infectivity and susceptibility, as well as the ability to delay a pandemic and reduce its size.^{33, 34, 35, 36, 37} One study noted the size of the reduction depended heavily on when masks were implemented, with a difference of 7% in the eventual number of cases if masks were implemented at the time when 100 individuals were infected compared with when 1000 individuals were infected (of a hypothetical population of one million).³³

All modelling studies of effectiveness considered differing levels of adherence to face mask use; however, none were able to take into account some of the more complex issues that would occur during a pandemic, such as the logistical issues of delivering masks to large numbers of the population, or different attack rates within different population subgroups.³⁸ Modelling suggests that mask and respirator use will be effective in slowing and reducing the effect of an influenza pandemic.

2.4 Modelling studies – usage

Mathematical modelling undertaken by McVernon et al estimated, from available data, the likely PPE usage in a pandemic event for a range of clinical settings (general practice (GP) surgery, dedicated GP practice, emergency department (ED), hospital, intensive care unit (ICU)) and categorised requirements according to the following indications for use:

- *Overhead (per setting per day)* covers the use of masks by receptionists in GP surgeries, the use of PPE by cleaners in hospital wards, and also the use of PPE by non-influenza-like illness (ILI) patients potentially exposed to infection in health care settings;
- *Per ILI (per prevalent influenza case)* tracks the amount of PPE required each day by patients and their treating health care workers during the course of the epidemic.

Based on these specified patterns of use, and assuming no limits on PPE availability, usage requirements were tracked in several pandemic scenarios, using different practice models, including non-cohorted, partial and fully cohorted models.

In a mixed model of care in which ILI patients were managed alongside others, the modelling showed that the majority of masks were used in the hospital setting in all scenarios examined, and predominantly as ‘overhead’, reflecting the large number of staff associated with an individual influenza case over a 24 hour period. Given the fact that overhead usage of PPE accrued at a daily rate, the length of the underlying epidemic was a key driver of PPE stockpile consumption, making less transmissible epidemics a greater drain on stockpiles. Severity became a strong determinant of use only for the most extreme assumptions (in the order of one in ten cases requiring hospitalization).

Given the predominant requirements of mask use for overhead, practice delivery models that group likely infectious patients together were associated with marked reductions in consumption. These benefits were observed in the hospital sector, but were most pronounced in GP clinics where ILI patients were directed to dedicated services, due to reduced overhead requirements.

An approximate estimate of the likely relative use of other forms of PPE in relation to the mask consumption reported in the figures above has been derived from historical national and jurisdictional datasets on stockpile deployment during the 2009 influenza H1N1 pandemic, allowing ready calculation of requirements and likely costs.

Goggles	Gowns	Respirators	Gloves	Masks
1	2-3	3-5	10-20	25-50

PPE for border workers

PPE requirements for border workers will vary depending on the number of arrivals in such an event, and the proportion of passengers presenting with influenza-like illness. Assuming the number of arrivals does not change substantially in a pandemic event, estimated mask requirements for border control purposes ranged from approximately 350-1200 items per day.

2.5 Costs and cost-effectiveness

The major direct costs associated with PPE are the costs associated with purchase price, storage, stockpiling and distribution. Depending on the scope of measure used, and the severity and transmissibility of the pandemic, these costs range from minor to massive (see Tables 1 and 2).

Though a lack of primary data and studies examining costs in this area make it difficult to accurately estimate detailed costings for PPE, it is likely that costs will be high. An Australian simulation exercise of caring for a patient with suspected avian influenza found that, during the first 6 hours alone, healthcare workers would require around 19 respirators, 22 gowns and 25 sets of gloves if infection control policies were followed appropriately.³⁹ If respirators are recommended for all patient encounters, rather than only for aerosol-generating procedures, this would increase costs dramatically because respirators are considerably more expensive than surgical masks.¹⁷

Indirect costs are particularly relevant in healthcare settings, and include time taken by staff to don and remove PPE, potentially increased time for routine clinical tasks and increased costs associated with disposal of large amounts of clinical waste.

In two studies identified that assessed the cost-effectiveness of PPE, the first³⁷ modelled the use of face masks using the disease parameters of pandemic H1N1 in the United States, and was the only modelling study identified that considered the effectiveness of masks by different age groups. This study found that significant net savings could be achieved through the use of masks by 25% of the population, with the majority of savings achieved when mask wearing is highest in the adult group. However, while this report described cost inputs of influenza well, it did not provide adequate detail on the costs associated with mask use, and it is unclear whether costs of supply, disposal and instructions on how to use the masks were included.

The second study investigated actual direct costs and cost-effectiveness of different levels of response measures in hospitals in Singapore.⁴⁰ PPE was one of several strategies used at different response levels, including use of antivirals for postexposure prophylaxis and restricted patient movement. This study found that protective measures targeted only at

infectious patients yielded the lowest cost per death averted (due to hospital-based outbreak), while full protection throughout the hospital (including full PPE for all healthcare workers) prevented many deaths but was extremely expensive. Cost-effectiveness was influenced by high case fatality rates, virulence and a high proportion of atypical cases, with stringent measures proving more cost-effective for more severe viruses.

Recent modelling estimates of national usage and stockpiling requirements of PPE by McVernon et al showed that in a cohorting practice delivery model there were marked differences in consumption. These differences would translate into substantial economic cost savings. These savings relate not only to the raw costs of masks and other items of PPE, but also the costs of maintenance and storage of the stockpile.

With regard to costs associated with ensuring availability of PPE, the purchase of options to buy PPE in a pandemic event, where available, may offer cost savings over stockpiling. However this option is associated with residual risk to government arising from uncertainties in production capacity and transport logistics during a global public health emergency.

2.6 Use of personal protective equipment in different pandemic stages

2.6.1 General considerations

The primary aim of PPE is to reduce transmission, and it can be used in all pandemic stages. PPE has several advantages over other pandemic mitigation strategies such as vaccines and antivirals because it is relatively inexpensive, can be started immediately to prevent transmission and does not require specific knowledge of the virus. The adverse effects associated with PPE use at the individual level are relatively minor, although these may influence compliance. In general, compliance with PPE is unlikely to be high, although it may increase with disease severity.

Healthcare settings

In healthcare settings, PPE should be considered the ‘last line of defence’ in a hierarchy of infection control measures that prevent nosocomial transmission, including systems for early identification of cases, environmental and engineering controls (e.g. adequate ventilation) and other infection control measures such as hand hygiene.⁴¹

During the Initial Action stage, it would be important to err on the side of caution and recommend the use of full PPE (possibly including use of respirators) for those caring for symptomatic patients. As more information on the virus becomes available during the Targeted Action stage, it is possible that this would be able to be scaled back to a more sustainable and evidence-based level. Another permutation would be for continuous use of PPE by all front-line healthcare workers (e.g. emergency department staff). This would have greatest benefits in preventing transmission if initiated during the Initial Action stage; however, the discomfort and increased difficulty in performing routine clinical tasks make this likely to be of low acceptability to healthcare workers if the perceived risk is low.

Community settings

The likelihood of PPE reducing transmission in the community will be higher if it is adopted early and alongside other pandemic mitigation measures. Clinical and modelling

studies suggest that earlier initiation of PPE improves its effectiveness in community settings.

If PPE is to be considered for the whole of the community in an effort to delay or reduce the size of the pandemic, this is most effective if initiated when there are few cases (during the Initial Action stage). However, the huge resources required for this measure, as well as the likelihood of low compliance make its feasibility low.

If PPE is to be used for symptomatic individuals or their household contacts, early application seems to offer the greatest benefit. This requires people to recognise the early signs and symptoms of influenza and either already possess, or have prompt access to, masks. While it is feasible that, in the early stages of the pandemic (Initial Action stage), public health authorities may be able to coordinate mask distribution to cases and contacts, these systems are very likely to be overwhelmed during the Targeted Action stage.

Border settings

General PPE issues with compliance are also likely to extend to border staff and incoming passengers. PPE is most effective when used in combination with other measures such as hand washing.² Surgical masks, when compared to the N95 respirators, have similar effectiveness in reducing risk of transmission, are more easily accessible, do not require fitting and are more comfortable to use.⁴² Use of surgical masks instead of N95 respirators would allow greater distribution of masks to border staff.

PPE could also be considered for provision to airline passengers for use during the flight and upon arrival. However, the problems with compliance and incorrect use would be compounded in this group, and there may be problems with adequate supply, or diverting equipment away from healthcare workers, who are at higher risk.

2.6.2 Stage-specific considerations

Initial Action stage —healthcare settings

During the Initial Action stage, PPE will be of most benefit in healthcare settings where potential cases are assessed. In this stage, transmissibility and severity of the virus will be relatively unknown, and so a precautionary approach should be taken in guidelines for the use of PPE. Use of gloves, gowns, masks and eye protection by people who are caring for patients with suspected or confirmed pandemic influenza will provide maximal protection for healthcare workers. It may also be prudent for suspected and confirmed cases in healthcare settings to use face masks. The successful implementation of PPE use in the Initial Action stage will require clear case definitions for suspected cases; and guidance on what PPE should be used, and how and when to don, remove and dispose of PPE. The practical aspects of developing and communicating these guidelines may be considerable, particularly if the global pandemic situation is changing rapidly.

The benefits of using PPE in healthcare settings during the Initial Action stage are considerable if transmission to healthcare workers can be avoided, particularly if the disease is of high severity. The disadvantages include the discomfort and minor irritations associated with PPE, as well as depletion of stockpiled equipment, which may be in limited supply during the Targeted Action stage if the virus has high transmissibility.

It will be important to promptly assess international reports of virus severity and transmissibility, and incorporate these into local guidelines.

Initial Action stage —community settings

PPE may be of use to prevent transmission in household settings where cases are being cared for. This could involve cases or contacts wearing masks and adopting other infection control measures such as hand hygiene, adequate distancing (e.g. sleeping in separate rooms) and ventilation, where possible.

Initial Action stage

Recommending the use of masks at a population level would require massive resources to supply and distribute masks, and would most likely exhaust government and private stocks very quickly (as occurred in Mexico at the start of the 2009 (H1N1) pandemic).⁴³ A more targeted approach may be feasible. Household contacts of cases may benefit from mask wearing, particularly if this is initiated soon after the index case becomes symptomatic. Use of PPE in the Targeted Action stage is summarised in Tables 1 and 2.

Table 1 Use of face masks and respirators in Initial Action stage

Scope	Purpose	Pros and cons	Resource implication	Notes
Whole population	Reduces transmission in public places, workplaces and schools	<p>Pros: May reduce community transmission. If high adherence, may delay epidemic peak or decrease epidemic size. May empower population (ability to take personal protective action).</p> <p>Cons: Requires enormous stockpile. Major logistical difficulties of distribution. Large resources required for risk communication on how to use masks appropriately. Huge amounts of waste created. May lead to disregard of other protective actions (e.g. hand hygiene or social distancing) through feeling of being protected</p>	Massive	<ul style="list-style-type: none"> • Limited evidence to support this measure. • Compliance unlikely to be high unless severity is high. • No culture of mask wearing in Australia. • Type of mask (respirator or surgical mask) needs to be defined. • If inadequate stocks, homemade masks could be used; large effort required to communicate how to make and use homemade masks.
Symptomatic people in healthcare settings	Reduces nosocomial transmission from people known or presumed to be infected	<p>Pros: Decreases number of healthcare workers requiring antiviral postexposure prophylaxis. Decreases probability of nosocomial outbreaks.</p> <p>Cons: Very unlikely to decrease community transmission</p>	Minor to moderate, depending on transmissibility	<ul style="list-style-type: none"> • Limited evidence to support this measure but plausible based on knowledge of influenza. • Symptomatic individuals should be identified and supplied with masks. • Type of mask (respirator or surgical mask) will need to be defined.
Symptomatic people in the community	Reduces community transmission from people known or presumed to be infected	<p>Pros: May decrease attack rate in household contacts and community contacts.</p> <p>Cons: Requires resources to stock and supply masks in a timely fashion, and for risk communication on how to use masks appropriately. Large amount of waste generated. May lead to disregard of other protective actions (e.g. self-isolation) by symptomatic cases.</p>	Minor to high, depending on transmissibility	<ul style="list-style-type: none"> • Limited evidence to support this measure but plausible based on knowledge of influenza. • Possible stigmatisation of people wearing masks. Benefits likely to be greatest if started as early. • Type of mask (respirator or surgical mask) will need to be defined.
Individuals working in key roles with face-to-face contact with the public	Reduction of transmission to key workers at higher risk	<p>Pros: Allows key workers to continue to work while giving them some protection, and services can continue to function. Decrease absenteeism of those in key roles. Reduction in morbidity and mortality if severe cases are prevented.</p> <p>Cons: Unlikely to reduce community transmission. Masks may impede ability to do job. Resources required for supply and distribution of masks, and training in their use. Difficulty defining 'key workers'. Preferential supply of masks to some groups may be seen as inequitable</p>	Moderate to very high, depending on transmissibility and severity	<ul style="list-style-type: none"> • Limited evidence to support this measure but plausible based on knowledge of influenza. • Unlikely to have high level of compliance unless severity is high. • Type of mask (respirator or surgical mask) will need to be defined

Scope	Purpose	Pros and cons	Resource implication	Notes
Individuals caring for sick people in their homes	Reduces transmission to carers	Pros: Reduction in household attack rate. Cons: Requires resources to stock and supply masks in a timely fashion, and for risk communication in how to use masks appropriately. High amount of waste generated.	Minor to moderate, depending on transmissibility	<ul style="list-style-type: none"> • Benefits likely to be greatest if started as early as possible. • Unlikely to have high level of compliance unless severity is high. • Type of mask (respirator or surgical mask) will need to be defined.
Healthcare workers caring for symptomatic patients	Reduces transmission to healthcare workers	Pros: Allows key workers to continue to work while giving them some protection. Decreases absenteeism of healthcare workers and allows healthcare systems to continue to function. Decreases amount of antivirals required for postexposure prophylaxis. Cons: Discomfort associated with use of PPE (particularly respirators). Requires resources to stock and supply masks. Guidelines and training required in how to use masks appropriately. Increased difficulty communicating with patients and increased amount of time for usual clinical tasks when healthcare system already under stress. Increased amount of clinical waste generated. May offer lower level of protection than continuous wear. Potential shortages of masks when transmissibility is high.	Minor to high, depending on transmissibility	<ul style="list-style-type: none"> • Already extensively practiced infection control measure so may be more acceptable. • Limited evidence to support this measure but plausible based on knowledge of influenza. • Requires systems to promptly identify symptomatic individuals. • Unlikely to have high level of compliance unless severity is high. • Type of mask (respirator or surgical mask) will need to be defined for different risk situations. • Needs to be considered 'last line of defence' in hierarchy of infection control measures
Front-line healthcare workers (continuous wear)	Reduces transmission to healthcare workers	Pros: Allows key workers to continue to work while giving them some protection. Decrease absenteeism of healthcare workers and allow healthcare systems to continue to function. May offer higher level of protection than intermittent wear. Decreases amount of antivirals required for postexposure prophylaxis. Cons: Higher level of discomfort associated with continuous use of PPE (particularly respirators). Requires resources to stock and supply masks. Guidelines and training required in how to use masks appropriately. Increased difficulty communicating with patients and increased amount of time for usual clinical tasks when healthcare system already under stress. Very large amounts of clinical waste generated.	Moderate to high	<ul style="list-style-type: none"> • As for healthcare workers caring for symptomatic patients, except does not require systems for identification of symptomatic individuals.

PPE = personal protective equipment

Table 2 Use of gloves, gowns and eye protection in Targeted Action stage

Scope	Purpose	Pros and cons	Resource implication	Notes
Healthcare workers caring for symptomatic patients	Reduces transmission to healthcare workers	<p>Pros: Allows key workers to continue to work while giving them some protection. Decreases absenteeism of healthcare workers and allows healthcare systems to continue to function.</p> <p>Cons: Guidelines and training required in how to appropriately use PPE. Increased amount of time for usual clinical tasks when healthcare system already under stress. Increased amount of clinical waste generated. May offer lower level of protection than continuous wear. Potential shortages of PPE if transmissibility is high.</p>	Minor to high, depending on transmissibility	<ul style="list-style-type: none"> • Adds to extensively practiced infection control measure so may be more acceptable. • Limited evidence to support this measure but plausible based on knowledge of influenza. • Symptomatic individuals must be identified promptly. • Compliance unlikely to be high unless severity is high. • PPE needs to be considered 'last line of defence' in hierarchy of infection control measures.
Front-line healthcare workers (continuous wear)	Reduces transmission to healthcare workers	<p>Pros: Allows key workers to continue to work while giving them some protection. Decreases absenteeism of healthcare workers and allows healthcare systems to continue to function.</p> <p>Cons: Discomfort caused by continuous wear. Guidelines and training required in how to appropriately use PPE. Increased amount of time for usual clinical tasks when healthcare system already under stress. Increased amount of clinical waste generated. May offer higher level of protection than intermittent wear. Potential shortages of PPE.</p>	Moderate to high	<ul style="list-style-type: none"> • As above except does not require systems for identification of symptomatic individuals.

PPE = personal protective equipment

Standdown stage

During the Standdown stage, the primary benefit of PPE will be to continue to offer protection from ongoing cases to healthcare workers, and possibly household contacts of new cases. It is assumed that the transmissibility and severity of the virus will be better understood in this stage, making infection control guidelines (such as the type of PPE required for different types of patient care) more reflective of the actual risk of transmission. If an influenza vaccine has been deployed by the Standdown stage, this will also decrease reliance on PPE for protection.

It will be important to evaluate the usefulness of PPE through reviewing successes and failures in the community and healthcare settings. Retrospective studies (e.g. case-control and cohort studies) should be conducted to quantify the protective effect afforded by PPE in healthcare settings and, where relevant, in the community.

4 Hand washing

The research commissioned in these reports did not specifically address hand hygiene. Hand hygiene for healthcare workers is a standard component of normal practice and should comply with the National Health and Medical Research Council. Australian Guidelines for the Prevention and Control of Infection in Healthcare.

Information on hand hygiene in a healthcare setting is also available on the Hand Hygiene Australia website at <http://www.hha.org.au/home.aspx> and in the WHO *Guidelines on hand hygiene* at http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf.

6 Conclusions

Using PPE has several advantages over other pandemic mitigation strategies (such as vaccines and antivirals) as it is relatively cheap and can be started immediately. However, there is limited evidence to support public health recommendations for the use of PPE to prevent transmission of influenza in both healthcare and community settings. A particularly pressing requirement is establishing the effectiveness of respirators compared with surgical masks to prevent transmission of influenza, given the high cost of respirators and potential shortages that may occur during a pandemic.

Full compliance with PPE requires correct and consistent usage. This has been shown to be problematic in both household and healthcare settings. Demographic factors and perceived risk of disease have been shown to influence compliance, and further research is required to determine how to best improve use of PPE.

PPE is only one of several measures that can be used to mitigate an influenza pandemic. Its use should always be considered in the context of other non-pharmaceutical strategies such as social distancing, hand hygiene and respiratory etiquette as well as pharmaceutical mitigation strategies such as use of antivirals for prophylaxis.

Modelling of PPE usage has shown that cohorted models of care greatly reduce PPE usage requirements, largely through direction of ILI patients to a smaller number of dedicated treatment settings resulting in marked reductions in overhead. However, while designated flu clinics used the least PPE of the three practice models evaluated, they may not be feasible in some settings. In particular, it was noted that around 2.5% of GP practices are found in remote and very remote areas, with a further 27.5% in regional areas. These practices may not have sufficient patients or staff to warrant flu clinics, and cohorting within medium and large GP practices may provide a suitable alternative in such cases.

Comparison of estimated PPE requirements with the present national medical stockpile indicates that current holdings of surgical masks could be roughly of the order needed to accommodate need in a moderate-fast growing pandemic, given implementation of a full cohorting model of care, as described above.

Beyond these cases, the feasibility of maintaining a national PPE stockpile sufficient for all possible scenarios would require considerable investment under the 'best practice' assumptions of our model, which must be weighed up against likely benefits of other preventive interventions that may be stockpiled or deployed in a pandemic event such as antivirals and pre-pandemic vaccines.

The costs of stockpile maintenance and storage must be considered in addition to the purchase price of individual items, and will scale accordingly with stockpile size. These costs are reasonable given that it is highly unlikely that sufficient requirements to protect the population would be available on the market in a pandemic event. Where possible, the purchase of options as an alternative to stockpiling may result in cost-savings, but carries a residual risk due to uncertainties in production and transport logistics during a public health emergency.

References

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