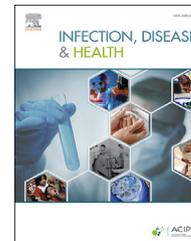




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Discussion paper

Clinician perceptions of respiratory infection risk; a rationale for research into mask use in routine practice

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Abstract Outbreaks of emerging and re-emerging infectious diseases are global threats to society. Planning for, and responses to, such events must include healthcare and other measures based on current evidence. An important area of infection prevention and control (IPC) is the optimal use of personal protective equipment (PPE) by healthcare workers (HCWs), including masks for protection against respiratory pathogens. Appropriate mask use during routine care is a forerunner to best practice in the event of an outbreak. However, little is known about the influences on decisions and behaviours of HCWs with respect to protective mask use when providing routine care. In this paper we argue that there is a need for more research to provide a better understanding of the decision-making and risk-taking behaviours of HCWs in respect of their use of masks for infectious disease prevention. Our argument is based on the ongoing threat of emerging infectious diseases; a need to strengthen workforce capability, capacity and education; the financial costs of healthcare and outbreaks; and the importance of social responsibility and supportive legislation in planning for global security. Future research should examine HCWs' practices and constructs of risk to provide new information to inform policy and pandemic planning.

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Highlights

- Emerging and reemerging infectious diseases continue to pose a threat to human health and global security.
- Outbreaks of respiratory infection result in human and economic costs including staff illness and wider societal disruption.
- Clinicians' use of personal protective equipment is critical to reducing the risk of transmission of infectious disease.
- Training in the use of PPE should take account of clinicians' and patients' perceptions of risk.
- Individual and societal responsibility towards infection prevention may influence clinicians' use of protective masks.

Introduction

Preventing the transmission of infectious diseases in healthcare settings, and in society more broadly, is a core goal of contemporary public health and infection prevention and control (IPC). In recent years outbreaks of emerging infectious diseases caused by respiratory viruses have drawn considerable global attention, in particular severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS) and pandemic influenza A, H1N1₂₀₀₉ (Table 1). Consequently, global and national planning for pandemic diseases is grounded in the expectation that a novel respiratory infection is most likely to be responsible for the next pandemic or infectious disease emergency [1].

Respiratory infectious diseases are transmitted via contact, droplet and/or airborne modes, necessitating healthcare worker (HCW) use of surgical masks or respirators and other personal protective equipment (PPE) together with appropriate hand hygiene. Hospital-based transmission of respiratory infectious diseases of high consequence, such as influenza, can be minimised by limiting the part HCWs play as vectors or victims of disease. HCWs may continue to work with mild respiratory illness (presenteeism), which can be serious or life-threatening if transmitted to vulnerable patients, but they also may suffer serious effects from occupationally-acquired respiratory infections, leading to increased staff absenteeism, which will compromise patient care during epidemics. While policies and protocols for optimal use of PPE and other transmission-based precautions exist in the majority

of healthcare facilities, HCW compliance with them is typically limited, particularly in non-outbreak situations or in the early stages before an outbreak is recognised [2,3]. In particular, HCWs' use of protective masks when caring for patients with respiratory infections is an important and well-documented IPC measure [4]. Yet HCW use of protective masks, and PPE in general, during routine care is often suboptimal and can result in healthcare-associated acquisition of infection [5] (Table 2).

While HCW compliance with the use of protective masks during infectious disease outbreaks has been well reported [6], there has been limited examination of HCW behaviours with respect to protective mask use during routine clinical care [3]. Consistent routine use of protective masks, based on relevant clinical indications, is important in preventing or delaying transmission from an unrecognised initial/index case [7]. The appropriate use of PPE, including respiratory protection, and hand hygiene in routine care is critical to minimising pathogen transmission to staff and other patients; sub-optimal use exposes both HCWs and patients to infection. Compliance of HCWs with wearing a protective mask may be related to their perception of risk and their risk-taking behaviours. The existing IPC literature primarily focuses on this topic in the context of SARS or other pandemic respiratory diseases, with few papers investigating risk constructs for healthcare workers in routine care.

The first and classic response to suboptimal behaviour is educative, with the provision of in-service and other training. We argue that the factors that lead to suboptimal use go far beyond knowledge and education, as well

Table 1 Vignette 1.

In 2015, a patient who had travelled in the Middle East attended an emergency department in Seoul and was diagnosed as the first case of MERS-coronavirus (CoV) infection in South Korea. Local transmission led to a further 28 cases, including six HCWs. A subsequent national outbreak resulted in 186 healthcare associated cases within the first month with over one fifth of these cases being HCWs. One reason for so many HAIs has been attributed to sub-optimal use of routine protective equipment by HCWs and the potential for infected HCWs to act as vectors of infection [13].

Table 2 Vignette 2.

In September 2018 a UK healthcare worker contracted monkeypox after caring for a patient with the disease prior to diagnosis. In a Eurosurveillance report (add in ref) about the case, public health officials said that some HCWs had been exposed as they were not wearing optimal personal protective equipment.

documented in other behaviours such as hand hygiene [8]. Interventions, and the research efforts used to generate evidence to support them, must take account of individuals' constructs and perceptions of risk and risk-taking behaviour. These perceptions are necessarily heterogeneous and vary between individuals and clinical settings. Therefore, an understanding of the perceptions and behaviours regarding PPE use in different contexts is needed to inform successful behaviour change interventions [9]. The importance and urgency of addressing suboptimal mask use by HCWs is, in our view, based on a range of interconnected reasons all of which are critical to global health and security. These are as follows:

The continuing burden of emerging infectious diseases

For many centuries, since the age of the plague and smallpox epidemics to the 20th century outbreak of HIV/AIDS, human infectious diseases of high consequence have presented a significant global public health challenge. These pandemics have resulted in deaths and disability of millions of people across the world, as well as causing social and economic disruption. Despite improvements in communicable disease prevention and control, including effective sanitation, vector control, vaccines, and the International Health Regulations developed by the World Health Organization (WHO) [10], the new, emerging infectious diseases continue to threaten the well-being and economic stability of society and impose a significant burden on healthcare. Although some infectious diseases, such as plague or smallpox, no longer present an active global pandemic threat, this century has seen both new and re-emerging infectious diseases give rise to widespread outbreaks. Of particular current concern is re-assortment of RNA in viruses such as influenza A which contributes to emerging pandemic influenza strains [11]. Furthermore, several zoonotic viral diseases that have infected humans through animal-to-human contact have also demonstrated human-to-human transmission, such as Nipah virus [12].

Antecedents for the increasing burden of infectious diseases include a global population boom, changes in the use of land and environment, loss of wild life habitat, increased contact between wild and domestic animals and humans, the expansion in travel, an ageing population and developments in medical interventions. The latter two have led to an increase in the number of immune-compromised people who are susceptible to significant disease from emerging infections. Many of these people attend, or are frequent inpatients of, healthcare facilities

and therefore are at risk of healthcare-associated infections (HAIs).

Cheaper, easier and faster modes of travel, particularly by air, have enabled emerging infectious diseases to disperse more widely in short periods of time, than ever before. A clear example of this was SARS, which spread from one "super-spreader" in a hotel in Hong Kong to numerous other countries via international guests who were infected, by contact, while staying in the same hotel [13]. Similarly a large outbreak of MERS involving 186 cases resulted from a single traveller returning to South Korea from the Middle East and attending several hospital emergency departments after he became unwell [14].

The number of active outbreaks that are present around the world will vary on any given day; however at time of writing there were traveller alert notices for at least twelve different infectious diseases in more than 50 countries [15] and, on average, 90 global infectious diseases emergencies are notified via the WHO each day [16].

Workforce capability and capacity

The use of protective respiratory masks has a human resource impact in healthcare organisations. Clinicians are at a higher risk of acquiring influenza and other respiratory diseases than adults working in non-healthcare settings [17]. Sub-optimal protective mask use can increase this risk, which is exacerbated during high-risk periods such as the winter respiratory virus season. Staff illness from respiratory infections has a direct impact on the workforce resulting in loss of productivity and associated economic burden within the healthcare setting, particularly with influenza [18].

Other respiratory viral diseases, such as the common cold, also contribute to a reduced work output [19–21]. Productivity is affected if workers take leave to care for family members who are ill or children, because schools have been closed. Although annual influenza vaccination is widely promoted as a means to reduce staff illness, average uptake by HCWs is poor, unless is it mandatory. Seasonal vaccine efficacy varies from year to year because of variable matching between vaccine and circulating strains, but is generally less than 50–60% [22]. Even when HCW flu vaccine uptake is high the risk remains, because of vaccine mismatch with circulating strain, limited vaccine efficacy and/or mild or subclinical (but transmissible) infection in vaccinated subjects [23]. Consequently, HCWs should still use respiratory protection when caring for patients with respiratory symptoms and/or patients at high risk of infection during outbreaks or high levels of respiratory infections in the community.

Not wearing a protective mask increases the risk of occupationally-acquired respiratory disease. HCW absenteeism due to influenza increases on average by two days per HCW, both during pandemic and a seasonal virus outbreaks [24]. Ip et al. [25] examined overall sickness absences including sick leave due to acute respiratory infection (ARI) for four distinct influenza periods between 2004 and including the 2009 influenza A(H1N1)pdm09 pandemic in Hong Kong. Results showed that the daily HCW absenteeism rate for ARI increased from the pre-pandemic

baseline by 26.5% and 90.9% during the epidemic and pandemic periods respectively [24]. Similarly in Canada, researchers demonstrated a significant increase in the rate of sick hours between the pre-influenza and 2012/2013 influenza period with only 14% of staff having zero sick hours Productivity Losses Related to the Common Cold [26]. A study examining the effect of influenza vaccination on emergency department workers' absentee rates reported that 30% of vaccinated and 55% of non-vaccinated workers required sick leave for influenza-like illness [27], although significant absenteeism during the H1N1 influenza pandemic was not noted in the Australian emergency workforce [28]. Staff illness compromises the quality and safety of patient care by loss of continuity of care through the requirement to employ agency staff in place of regular staff, who may be unfamiliar with the specialism of the clinical setting [28]. Staff absenteeism during outbreaks of emerging or high consequence infectious diseases, may also be due to HCWs fear of acquiring the infection [29].

Similarly, presenteeism, or coming to work when ill, also results in a loss of productivity due to staff not working at full capacity [30]. The health and safety of other staff are put at risk by HCWs who continue to work while ill, while patient safety may be compromised through impaired clinical judgement. In a study undertaken in a children's hospital in Philadelphia, 299 (55%) of medical staff who were surveyed, reported that they would work with significant respiratory symptoms, despite acknowledging the infection risk to their co-workers and patients [31]. In another study over 40% of US HCWs who were surveyed worked with symptoms of influenza-like illness [32]. Whilst it is important to avoid presenteeism, it may be occasionally unavoidable e.g. because of significant or specialised staff shortages. If so, the risk may be mitigated by appropriate mask use. The HCWs work capability may also be impaired by any physical and psychological consequences of wearing a mask, such as claustrophobia, respiratory distress, discomfort and skin irritation.

Financial costs and consequences

The financial costs to society for respiratory infectious diseases can be significant. A US study estimated the annual economic burden of influenza, in 2003, to be around US\$90 billion [31], while lost productivity due to influenza in France and Germany was estimated at US\$10–15 billion per year [33].

Sub-optimal mask use is likely to be associated with an increase in financial costs for individuals, the healthcare system and subsequently the wider society. Although existing research has not examined the direct costs of not wearing a protective mask, Van Buynder et al. (2015) estimated the financial cost of HCWs absenteeism due to influenza-like-illness to be greater than CAN\$1 million during the 2012/2013 winter season in a health district in British Columbia [26]. In addition, there are sick leave payments for staff and the costs incurred to replace them with casual staff. Workers Compensation fees may be driven up by HCWs who take risks by not wearing masks.

Furthermore, there are significant monetary costs associated with patients acquiring a healthcare associated

respiratory infection. The probability of a patient acquiring an influenza-like-illness increases when exposed to an infectious HCW, with one study reporting a relative risk of 5.48 when compared to no documented exposure [34].

Expenses for a HAI include the overall cost of care for any additional inpatient bed days as a result of the infection, antiviral medication, other supportive therapy, radiology, laboratory and direct costs associated with the use of isolation and PPE measures. A Korean study reported an average medical cost for a patient hospitalised with influenza in 2013/2014 was US\$ 3104.3 ± 4638.1 [35]. When a higher level of IPC measures is required e.g. MERS or other emerging infectious disease, these costs can be excessive. Veater et al. (2017) calculated an additional cost of 119 pounds sterling per person per day, mainly due to staff time and PPE costs [36].

Third, sub-optimal mask use is associated with reductions in cost effectiveness of training methods in the use of PPE. Effective training in PPE use is resource intensive and thus expensive to execute, whether delivered as demonstration learning by experts or technology-based education. Inadequate training in PPE protocols is cited as one of the causes for poor compliance with PPE [37]. These findings question the cost-effectiveness of current training methods. There is also a financial cost attached to the incorrect choice or unnecessary use of a mask, particularly in the case of the more expensive particulate respirator mask, or during a global outbreak event where stocks may be limited.

Knowledge, education & skill factors

The knowledge and skills of HCWs are factors that affect protective mask use, therefore investigating how knowledge and cognition impacts on the HCW decision-making for mask use can inform the delivery of education and how policies are implemented. Some of the aspects of knowledge related to mask use that may influence HCW behaviour include the source of knowledge, the indications for mask use, which type of mask to choose, how the mask functions to provide protection and how to put on and remove the mask safely. In the context of an emerging infection and limited available information, personal experience can influence HCWs' perceptions of risk and behaviours related to protective mask use [38,39]. In contrast, a study undertaken in an outpatient paediatric setting, demonstrated that the use of PPE was not influenced by infectious risk perception [40].

Prior education and training will provide some of the essential information and skills required for optimal mask use but, in practice, routine training in the use of PPE is often cursory or non-existent. In a survey of healthcare workers in the US, 43% of doctors reported having received PPE training only as students (including clinical rotations) or not at all (c.f. 8% of nurses) [41]. Despite prior education, HCWs may not apply their knowledge to the workplace [42]. The method of training is therefore an important consideration for effective retention of knowledge and skills over time. Several studies argue for improving the evaluation and training of HCWs using PPE for infectious diseases and examining the effectiveness of various teaching approaches

[43,44]. The recent Ebola virus disease (EVD) outbreak instigated intensive PPE training around the world, with a focus on donning and doffing protocols to maximise HCW safety. Unsafe use of PPE has been blamed for some HCWs becoming infected with EVD or SARS; subsequently several research studies have reviewed the effectiveness of different training techniques for the safe donning and doffing of PPE [45]. These have included interactive online courses, and classroom teaching that incorporates fluorescent dye or harmless bacteriophages as surrogate markers of contamination [46]. Video-reflexive ethnography (VRE) has been used as an interventional methodology to improve IPC practices [47]. This method allows the HCW to view video footage of themselves making decisions around and subsequently using protective masks in every-day complex work. The clinicians can then reflect on their behaviour and suggest ways in which their own and colleagues' mask use can be optimised.

Although the techniques taught for donning and doffing protective masks as part of routine PPE are generally heterogeneous around the world, there are variations in mask design which may affect skills. There is also a lack of standardisation between and within institutions as to which clinical indications warrant a N95 or surgical mask.

Social behaviour and responsibility

Within society in general, individuals are not only motivated to protect themselves from infectious disease but often demonstrate a moral responsibility to protect others if they themselves are infectious [48]. During periods of high-risk for respiratory infectious disease, such as the annual influenza season or a novel influenza pandemic, health departments have, and may, encourage or mandate the use of a protective respiratory mask by the general public to minimise the transmission from symptomatic people to others [49]. In healthcare facility waiting rooms it is recommended that symptomatic patients be given a respiratory mask to wear to protect others as part of respiratory hygiene [49]. This social behaviour may alter the perception of risk for staff towards mask use in two ways, particularly in the emergency department. Firstly, HCWs may take a view that it is the patient's, not their own, responsibility to abide by these infection prevention measures and purposefully choose not to wear a mask on the basis of responsibility. Secondly, they may not perceive a risk of becoming infected if a patient is wearing a mask and so will not use one. There are several risks for HCWs adopting this behaviour. The patient may not wear the mask correctly or remove it at any time, especially if they are kept waiting for long periods, thus exposing other patients and HCWs. Additionally, the patient may not be able to tolerate a mask for long if unwell and will then remove it. Clinical examination may put the HCW at higher risk of exposure, even if the patient is wearing the mask correctly when they enter the room or cubicle and certain procedures, such as taking a swab for influenza testing, collection of an induced sputum specimen or intubation, require removal of the patient's mask.

If an HCW fails to adequately explain why they are wearing a mask it can erect a social barrier between the

HCW and patient. Patients may feel stigmatised if staff wear a mask to care for them [50] while staff may feel that wearing a mask in the ED can inhibit empathy and rapport with a sick patient [51]. HCWs working in paediatric units have expressed concern that PPE may frighten their patients [52].

Social interactions within the workplace can influence the health-related behaviour of workers. The safety climate and group norms at hospital unit level have been shown to influence the risk-taking behaviour associated with facial protective equipment [53].

Regulatory frameworks

The use of protective masks in the healthcare setting is governed locally by policies in health and safety and IPC. As indicated earlier, adherence to such policies and guidelines is often poor. Similar to other types of PPE and IPC measures, there is no strong culture of enforcement of policy relating to protective masks in the healthcare setting. This raises questions about the efficacy of mask policies, their awareness by HCWs and how they are judged by clinical staff.

In some countries, state-wide legislation mandates the use of a protective mask for various categories of clinical staff during the annual influenza season, if they have not received the influenza vaccination [49]. This enforced measure has been resisted by some clinical staff because of its impact on personal choice [54] and by others as illogical when considering the risk from all respiratory pathogens [55].

Although many countries provide national occupational safety and health policy direction, few enforce protective mask use in healthcare settings. Nevertheless, sub-optimal mask use reinforces poor behaviour in the workplace and contravenes Workforce Health and Safety responsibilities of employees [56].

Disruptive global societal consequences

The behaviours of HCWs towards protective mask use can affect the progression of a respiratory infectious disease outbreak and, if inappropriate, facilitate a pandemic. The consequences of a pandemic on a global scale are significant, with substantial negative societal effects. Ease of access to international travel has been a significant factor in the worldwide spread of recent pandemics such as pandemic influenza A H1N1₂₀₀₉, SARS and MERS, therefore international travel and trade are often restricted [57]. Personal freedom of movement is also affected by public health quarantine measures and the prohibition of public gatherings. Education is disrupted through school closures which results in parents taking time off work as a consequence.

In addition to the consequences described above, the provision of healthcare to the general population can be disrupted. In 2009, the influenza A H1N1₂₀₀₉ pandemic impacted severely on the normal functioning of emergency departments in Australia [58]. More than three times the number of patients were seen, most with non-serious influenza symptoms. Staff reported that heavy workloads,

lack of infection control facilities and distraction from their core business compromised the care of non-flu patients. Large numbers of patients requiring care will lead to bed shortages and hospital admission gridlock, probable loss of critical care beds which are blocked with long stay respiratory patients and the cancellation of routine surgical lists [59]. Furthermore, there will be fewer HCWs available to provide the care due to their own illness or having to look after family members.

In this paper we detail why we need to know more about HCWs' decision-making and risk-taking behaviour in relation to the use of masks for protection against infectious respiratory diseases. We argue that the value of such research would be its potential impact on the ongoing threat of emerging infectious diseases, workforce capability, capacity and educational needs, the financial costs of healthcare and outbreaks and the importance of social responsibility and appropriate legislation in planning for global security. Specifically, research is required to determine whether HCWs' perception of risk as it relates to the protection of themselves and others against transmission of infection influences their behaviour towards the use of a protective mask. There is also a need to determine the personal, professional and contextual factors that impact on HCWs' perceptions of risk and their use of protective masks for infectious diseases. An exploration of the practices and constructs of risk by HCWs will therefore provide valuable information to inform policy and pandemic planning.

Summary

The sub-optimal use by HCWs of protective masks for respiratory diseases has a significant impact at individual, organisational, societal and global levels. Furthermore, the consequences of poor mask use will be exacerbated during a widespread outbreak or pandemic of a novel infectious respiratory disease, when pharmacological agents or vaccination are unavailable. Minimising the transmission of respiratory disease through protective mask use leads to better outcomes for healthcare, workforce capability and economic stability. This paper has presented the background and justification for research into the attitudes and behaviour of HCWs towards protective mask use for respiratory infectious diseases during non-outbreak situations so as to optimise the use of masks when indicated in every day practice. The research can provide insight into perceptions of risk and risk-taking behaviour in respect of mask use for respiratory infectious diseases and help to bridge the gap between theory and practice (see Table 3).

Table 3 Tribute to the mask.

There was a sick traveller in bed Who had an airborne infection to spread The staff did their tasks, but didn't wear masks, and now many people are dead!

Authorship statement

RB and RS originated the concept for the paper and RB drafted the manuscript. GLG and RS had critical review and input into the preparation of the manuscript. All authors approved the final version of the manuscript.

Declarations of conflicts of interest

RZS is a Senior Editor and GLG a Section Editor of Infection, Disease and Health but neither had a role in peer review or editorial decision-making of the manuscript. The authors declare no other conflict of interest.

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Ethical Considerations

Ethics approval is not required as this is a discussion paper.

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