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Original Article

Attitudes of influenza-vaccinated health care workers toward masks to prevent nosocomial transmission of influenza

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Background Influenza viruses are highly contagious. Health care workers (HCWs) are at risk of occupational exposure to influenza and may transmit the infection to their patients and coworkers.

Objectives The aim of the study was to characterize the attitudes of HCWs regarding the use of surgical masks to prevent nosocomial influenza transmission. Furthermore, we assessed the informational needs of HCWs with regard to infection control measures.

Methods A survey was conducted among HCWs, using an anonymous questionnaire, at a German University Hospital during an influenza vaccination campaign.

Results Overall, 40·5% of the HCWs were vaccinated against seasonal influenza, and 35·2% were vaccinated against Influenza A/H1N1 (''swine flu''). In total, 1445 vaccinees completed the anonymous questionnaire. Of all respondents, 70·5% stated that the infection control recommendation ''wearing a surgical'' mask was appropriate to avoid influenza transmission. The percentage of HCWs who would like to have had more information about the infection control measures was 67·5%.

Conclusions Appropriate interventions ought to be taken to reduce the risk of exposure to influenza viruses among HCWs. Adherence to recommendations for the use of masks among HCWs needs to be evaluated. Further work is required to highlight the informational needs of HCWs to gain an appreciation of infection control measures.

Keywords Health care workers, infection control, influenza, masks, novel influenza A/H1N1, swine flu.

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Introduction

Health care workers (HCWs) are at risk of occupational exposure to influenza.[1,2] The emergence of the new Influenza A virus H1N1/2009 highlighted the importance of identifying infection control measures to mitigate influenza virus transmission. Appropriate protective measures ought to be implemented to reduce the risk for transmission in health care settings.

The most important prevention strategy is the immunization of HCWs.[3] However, the influenza vaccination rates of HCWs are often insufficient, and in case of the H1N1/2009 pandemic, the vaccine was available relatively late.

Data is scarce on the acceptance of simple personal protective measures among HCWs. There are only a few studies that compare surgical masks with FFP2 masks (equivalent to a N95 respirator). The efficacy of these different mask types is being controversially discussed.[4–11] Surgical masks are designed to trap respiratory secretions expelled by the wearer. Surgical masks are not designed to prevent the inhalation of airborne particles (including viruses and bacteria), and their ability to protect HCWs varies widely. In contrast, FFP2 (N95) masks are designed to reduce individual's exposure to airborne contaminants, including viruses and bacteria.[8] Beyond the optimal protection of HCWs against respiratory infections, the fivefold to tenfold cost difference between these two mask types needs to be addressed.[12]

Little data is available concerning the effectiveness of non-pharmaceutical intervention for the prevention of influenza transmission in households.[12,13] Hand hygiene with or without the use of masks seemed to reduce influenza transmission in households in Hong Kong.[13] A recent prospective clinical trial of face mask usage in Australia

reported that community use of face masks is unlikely to be an effective control policy for seasonal respiratory diseases owing to low rates of adherence with wearing masks. However, in this study, there was no difference reported, in terms of adherence, between FFP2 masks and surgical masks. This is an important finding, as there is a common belief among HCWs that FFP2 masks are less comfortable compared with surgical masks.[12]

At the University Hospital Frankfurt/Main in Germany, the infection control policy for influenza is droplet and contact isolation. HCWs were instructed to wear a FFP2 mask during direct contact with an influenza-infected patient when they are not vaccinated against the relevant virus (i.e. non-compliance to seasonal vaccine recommendation or before the H1N1/2009 vaccine became available). Vaccinated HCWs ought to wear a surgical mask when caring for known patients with influenza. HCWs should not work with patients when they show symptoms of an infectious disease themselves. However, in an epidemic situation, there is a high risk that HCWs transmit the virus to patients, as infected individuals begin secreting the virus via throat and nose 24 hours before the first clinical symptoms appear; furthermore, infected HCWs may continue working, despite being ill.[3]

In 2009, there were two events at the University Hospital Frankfurt in which an interdisciplinary team (occupational health, infection control, virology and infectious diseases) enacted a recommendation that influenza-unvaccinated HCWs with direct patient contact had to wear a surgical mask during their work in hospital (i.e. during all contacts with all patients):

First, to control a seasonal influenza outbreak among immunocompromised patients, unvaccinated HCWs had to wear masks from 9 January 2009 to 27 February 2009.[14]

Secondly, HCWs had to wear masks from 29 July 2009 to 10 August 2009, after a nurse of the emergency room – who had several occupational H1N1/2009 contacts – was deemed to have an occupational-acquired H1N1 infection.[15] At this time, the vaccine against H1N1/2009 was not yet available in Germany, and the strategy was to contain the spread of the virus.

The purpose of this study was to ascertain the attitudes of HCWs after these two events regarding the use of masks to prevent nosocomial influenza transmission. Furthermore, we assessed the informational needs of HCWs with regard to infection control measures.

Methods

Study population and questionnaire

The Frankfurt University Hospital is a 1169-bed hospital with 3900 employees (e.g. 726 physicians, 1300 nurses and 850 medical technicians) in 24 medical disciplines and research departments. It has approximately 42 000 inpatient admissions and about 200 000 outpatients, annually.

Each year, from October to February, the University Hospital offers (and advises on) influenza vaccination to HCWs. Immunizations against seasonal influenza started from 8 October 2009, and immunizations against ''swine flu'' started from 26 October 2009. Until the end of December 2009, the vaccinated HCWs were asked to complete an anonymous questionnaire.

The questionnaire comprised seven questions divided into three areas of inquiry:

1. Demographic data: age, sex, profession group.
2. Attitude toward surgical masks for the prevention of nosocomial influenza transmission, respirator tolerance in HCWs.
3. Informational needs with regard to influenza infection control measures.

Ethical considerations

Participants were informed that all the information gathered would be anonymous and kept confidential. Participation was voluntary, completion of the questionnaire implied consent for study participation. Participants cannot be identified from the material presented, and the study has caused no plausible harm to the participating individuals.

Statistical analysis

Statistical analysis of the data and calculation of P values were calculated with chi-square test two-tailed, using the BiAS program for Windows 9.04 (Epsilon Verlag, Hochheim Darmstadt 2007). P values $<0{\cdot}05$ were defined as statistically significant.

Results

From October 2009 to the end of December 2009, overall, 40·5% (n = 1579/3900) of the HCWs of the University Hospital Frankfurt were vaccinated against seasonal influenza and 35·2% (n = 1372/3900) were vaccinated against Influenza A/H1N1 (''swine flu''). In total, 1445 vaccinees completed the anonymous questionnaire. Approximately 63% (n = 911/1445) of the participants were women and 37% (n = 534) were men, in accordance with the age and gender distribution of the employees. Demographic characteristics of the study population are shown in Table 1.

Of all respondents, 70·5% (n = 1019/1445) stated that the infection control recommendation ''wearing a surgical mask'' was appropriate. Nurses and medical technicians showed a significantly higher agreement (P = 0·03) than physicians (see Table 2).

Overall, 65·7% (n = 949/1445) of the participants were affected by the recommendation ''wearing a mask'', which means that they had direct patient contact and were not

Table 1. Demographic characteristics of the study population (n = 1445)

Age	%	*n*
up to 20	1·6	23
21–30	25·1	363
31–40	31·3	453
41–50	24·9	360
51–60	14·4	208
over 60	2·6	38
Gender		
Male	37·0	534
Female	63·0	911
Job description		
Physicians	27·2	393
Medical students	3·0	44
Nurses	29·7	429
Medical technicians	10·6	153
Scientists	8·9	129
Administrative personnel	10·1	146
Maintenance, catering, workshop, transport	6·7	97
Others	3·7	54
		1445

vaccinated against seasonal influenza in January 2009 or otherwise that they could not have been vaccinated against ''swine flu'' during the July 2009 recommendation because at this time point no H1N1/2009 vaccine was available.

Notably, employees who were not affected by the infection control recommendation stated more often (71·6% – n = 355/496) that they believed the recommendation to be adequate, whereas HCWs with a risk of becoming infected themselves or transmitting influenza to their patients were less likely (69·9% – n = 664/949) to believe that the recommendation was appropriate; however, the results were not significant (P = 0·57).

Women stated more often (72·1% – n = 657/911) than men (67·8% – n = 362/534) that the infection control recommendation was appropriate, but likewise the difference was not statistically significant (P = 0·08).

Discomfort because of masks

Overall, 84·8% (n = 805/949) of the HCWs gave feed back whether the mask disturbed them. In total, 69·1% (n = 556/805) of the HCWs felt bothered by the mask. Nurses showed a significant higher degree of discomfort when compared to physicians (P = 0·03). In general, women felt significantly more disrupted by the masks than men (P < 0·01) (see Table 3).

Informational needs

The percentage of HCWs who would like to have had more information as to the infection control measures was 67·5%, with the highest rate (73·9%) among nurses (see Table 4). There was no significant difference when compared to physicians (P = 0·35) or between women and men (P = 0·79).

Most frequently (30·7%) the Occupational Health Service and the Infection Control Department were considered as the source of desired information. Second most (30·0%) desired information source was the Institute of Medical Virology and the Department of Infectious Diseases. In the third place (28·6%), the disciplinarians were mentioned as an information source.

Discussion

The outbreak of the Influenza A/H1N1 (''swine flu'') in April 2009 provided a major challenge to health services

Table 2. Agreement with infection control recommendation ''wearing a mask'' to prevent influenza transmission in the University Hospital (n = 1445). Question: *''Do you believe that the infection control recommendation 'wearing a surgical mask' was appropriate?''*

	Yes [%]	*P*-value	No [%]	*P*-value	Do not know [%]
Overall (n = 1445)	70·5% (n = 1019)		16·0% (n = 231)		13·5% (n = 195)
Affected by the recommendation (n = 949)	69·9% (n = 664)	0·57	19·3% (n = 183)	<0·05	10·7% (n = 102)
Not affected by the recommendation (n = 496)	71·6% (n = 355)		9·7% (n = 48)		18·8% (n = 93)
Physicians (n = 393)	66·4% (n = 261)	<0·05	24·7% (n = 97)	<0·05	8·9% (n = 35)
Nurses (n = 429)	73·2% (n = 314)		15·2% (n = 65)		11·7% (n = 50)
Medical technicians (n = 153)	76·5% (n = 117)		9·2% (n = 14)		14·4% (n = 22)
Scientists (n = 129)	70·5% (n = 91)		10·9% (n = 14)		18·6% (n = 24)
Administrative personnel (n = 146)	69·2% (n = 101)		10·3% (n = 15)		20·5% (n = 30)
Others (e.g. students and maintenance) (n = 195)	69·2% (n = 135)		13·3% (n = 26)		17·4% (n = 34)
Female (n = 911)	72·1% (n = 657)	0·08	13·7% (n = 125)	<0·05	14·2% (n = 129)
Male (n = 534)	67·8% (n = 362)		19·9% (n = 106)		12·4% (n = 66)

Table 3. Annoyance because of masks - in total, 949/1445 of the participants were affected by the recommendation ''wearing a mask''. Overall, 805/949 health care workers (HCWs) gave feed back if the mask disturbed them. Question: *''Did the mask interfere with your work or did the mask disturb you?''*

	Pretty much [%]	*P*-value	A bit [%]	No [%]	*P*-value	Do not know [%]
Overall (*n* = 805)	21·6% (*n* = 174)		47·5 (*n* = 382)	30·3 (*n* = 244)		0·6 (*n* = 5)
Physicians (*n* = 304)	16·4 (*n* = 50)	0·03	51·3 (*n* = 156)	31·6 (*n* = 96)	0·60	0·7 (*n* = 2)
Nurses (*n* = 314)	23·9 (*n* = 75)		46·5 (*n* = 146)	29·3 (*n* = 92)		0·3 (*n* = 1)
Medical technicians (*n* = 52)	21·2 (*n* = 11)		48·1 (*n* = 25)	28·8 (*n* = 15)		1·9 (*n* = 1)
Scientists (*n* = 13)	46·2 (*n* = 6)		7·7 (*n* = 1)	46·2 (*n* = 6)		0·0 (*n* = 0)
Administrative personnel (*n* = 27)	29·6 (*n* = 8)		48·1 (*n* = 13)	22·2 (*n* = 6)		0·0 (*n* = 0)
Others (e.g. students and maintenance) (*n* = 95)	25·3 (*n* = 24)		43·2 (*n* = 41)	30·5 (*n* = 29)		1·1 (*n* = 1)
Female (*n* = 485)	26·8 (*n* = 130)	<0·05*	45·6 (*n* = 221)	27·0 (*n* = 131)	<0·05	0·6 (*n* = 3)
Male (*n* = 320)	13·8 (*n* = 44)		50·3 (*n* = 161)	35·3 (*n* = 113)		0·6 (*n* = 2)

*$P < 0{\cdot}00002$.

Table 4. Informational needs of health care workers (HCWs) because of influenza infection control measures (*n* = 1445). Question: *''Would you like to have more information about the infection control recommendation?''*

	Yes [%]	No [%]	Do not know [%]
Overall (*n* = 1445)	67·5 (*n* = 976)	24·4 (*n* = 352)	8·1 (*n* = 117)
Physicians (*n* = 393)	71·0 (*n* = 279)	25·4 (*n* = 100)	3·6 (*n* = 14)
Nurses (*n* = 429)	73·9 (*n* = 317)	20·0 (*n* = 86)	6·1 (*n* = 26)
Medical technicians (*n* = 153)	65·4 (*n* = 100)	24·8 (*n* = 38)	9·8 (*n* = 15)
Scientists (*n* = 129)	58·9 (*n* = 76)	27·1 (*n* = 35)	14·0 (*n* = 18)
Administrative personnel (*n* = 146)	55·5 (*n* = 81)	28·8 (*n* = 42)	15·8 (*n* = 23)
Others (e.g. students and maintenance) (*n* = 195)	63·1 (*n* = 121)	26·2 (*n* = 51)	10·8 (*n* = 23)
Female (*n* = 911)	67·3 (*n* = 613)	23·9 (*n* = 218)	8·8 (*n* = 80)
Male (*n* = 534)	68·0 (*n* = 363)	25·1 (*n* = 134)	6·9 (*n* = 37)

around the world.[16] On account of this, the health care system needs to be aware of the safety of their HCWs because they are at significant risk of getting infected and also of transmitting the disease to patients.[15] Besides vaccination (as far as available), hand hygiene (disinfection and/or washing), masks, protective clothing, gloves and protective goggles were reported to be the most effective personal protective equipment against the influenza virus.[4,17,18] However, required protective measures should be evaluated with regard to practicability and effectiveness.

In a recently published essay, John M. Barry wrote: ''*The single most important weapon against the influenza pandemic will be a vaccine. The second most important will be communication*''.[19] There is obviously a need for greater information with respect to infection control measures. In our survey, more than two-thirds of respondents required more information on preventive measures (see Table 4). However, compliance with infection control regulations requires knowledge, and that depends on further vocational training and on comprehensive communication strategies as well as on truthfulness. Returning to John M. Barry: ''*The truth should not be managed, it should be told*''.[19] The continuous inclusion of the HCWs into infection control measures ought to be a matter of course and a basic necessity to ensure the functionality of the health care system. Otherwise, HCWs might not report to work during a severe pandemic because of personal fears of becoming ill. The partly emotional reactions of public because of the emergence of the novel Influenza virus H1N1/2009 clearly showed that there is a need for reliable and timely information.[20]

HCWs need to understand why infection control measures (e.g. immunizations and use of personal protective equipment) are important to them because non-compliance not only increases the individual risk of getting infected but also increases the risk for the whole health care community and, of course, for patients. Unfortunately, experi-

ence has shown that despite decades of effort to encourage HCWs to be immunized against seasonal influenza, vaccination levels remain insufficient and usually far below 50%.[3] Current data shows that vaccination rates among HCWs against swine flu are just as low; by the end of December 2009, an estimated 22% of US HCWs had received the swine flu vaccine.[21] On this account, physical interventions might play a crucial role in minimizing nosocomial transmission of influenza viruses. It is therefore necessary to understand the attitudes of HCWs toward masks and the workplace tolerability of respirators. Obviously, a single mask type does not fit everyone and is not suitable for every work situation.[22] A recently published US study demonstrated that a large percentage of HCWs were unwilling to wear N95 respirators for an entire 8-hour work shift because of facial heat and pressure as well as communication interference.[23] Beyond that, N95 masks might cause skin irritations such as rash and acne, further limiting the compliance of HCWs.[9] In our survey, over 70% of participants stated that the infection control recommendation ''wearing a surgical mask'' was appropriate. Only 16% of the replying HCWs believed the recommendation was inappropriate (see Table 2). However, 69·1% of the HCWs felt bothered by the mask (see Table 3).

Multiple studies have demonstrated that HCWs, in general, comply poorly with respiratory protection guidelines, especially when a N95 respirator is recommended.[24] However, a recently published randomized Canadian study demonstrated that the incidence of laboratory-confirmed influenza was similar in HCWs wearing a surgical mask compared with HCWs wearing a N95 mask.[5] At the University Hospital Frankfurt, the N95 mask (FFP2) is only used for personnel at highest risk of exposure (i.e. aerosol-generating procedures; laboratory-confirmed H1N1 infections). In routine health care settings, surgical masks are principally used. The compliance with wearing a mask at the University Hospital Frankfurt is generally good, and there has not been any documented nosocomial influenza transmission among HCWs after the two infection control recommendations in January and July 2009.

Conclusions

HCWs who provide direct care for patients with known or suspected influenza infection ought to observe contact and droplet precautions, including the use of masks, respirators, gowns, gloves and protective goggles.[25]

Adherence to recommendations for the use of masks needs to be evaluated and appropriate interventions ought to be taken to reduce the risk of exposure to influenza viruses among HCWs. Discomfort because of masks and behavioral risk factors should be taken into account. However, the use of personal protective equipment - such as mask and respirators - ought to be considered as the ''last line of defense'' in a hierarchy of infection control measures to avoid influenza transmission among HCWs. Top priority should be given to high influenza vaccination rates among HCWs, which has been shown to protect both HCWs and patients.[3,6] Nevertheless, physical interventions (e.g. personal hygiene, barriers and distancing) are effective against the spread of a broad range of respiratory viruses and ought not to be neglected particularly because a pandemic vaccine will be delayed for at least 3 months, by which time the pandemic would have already peaked in all likelihood.[9]

Limitations

To appreciate the results of our study, some potential limitations need to be addressed:

First, the results from a single academic institution may not be applicable to other institutions.

Second, given that we only questioned HCWs who received an influenza vaccination, it might be possible that HCWs who are not willing to get vaccinated against the influenza oppose infection control measures more frequently as HCWs who received their influenza vaccination.

Third, the ''social desirability bias'' (i.e. selecting a choice of answers considered as being the most ''socially favorable'') may lead to bias in our survey, which may in turn affect the reliability of some of the answers.

What this paper adds:

1. What is already known on this subject?
- Previous studies have shown that HCWs can serve as vectors for influenza transmission because they are at risk for both acquiring influenza from patients and transmitting it to patients.
- Physical interventions are effective in preventing the spread of respiratory viruses.

2. What this study adds?
- Only a few studies deal with the workplace tolerability of masks commonly worn by HCWs and the informational needs of HCWs.

3. Suggestions for further research
- The results of this study underscore the need for an ongoing focus on and evaluation of strategies to reduce the transmission of the influenza among HCWs.
- Further work is needed to highlight the important role of masks for preventing influenza among HCWs and to respect the informational needs of HCWs to establish an understanding for infection control measures.

Contribution

CB and SW drafted the manuscript.

SW and HFR conceived the study and the study design, performed the analysis and interpretation of the data.

All authors had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors read and approved the final manuscript.

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Conflict of interest

The views in this article are the personal views of the authors and do not necessarily represent the views of the professional organizations or institutions within which we are members.

CB has been a member of an advisory board on pediatric vaccines (not for influenza vaccines) for GlaxoSmithKline Germany.

The authors have no further relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript.

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