Increasing vaccination of healthcare workers: a rapid review of intervention effectiveness, and factors influencing uptake during seasonal and pandemic influenza

Susan Baxter[1*], Duncan Chambers[1], Lindsay Blank[1], Anna Cantrell[1], Elizabeth Goyder[1]

[1]School of Health and Related Research (ScHARR), University of Sheffield, Sheffield, UK

*Corresponding author: s.k.baxter@sheffield.ac.uk

Conflict of interest: The authors have no conflicts of interest to declare.

Interim report: January 2021

Total word count: 16,334

Keywords: Systematic reviews; influenza vaccination; pandemic; healthcare workers

Important

This web report has been created once the normal NIHR Journals Library peer and editorial review processes are complete. The report has undergone full peer and editorial review as documented at NIHR Journals Library website and may undergo rewrite during the publication process. The order of authors was correct at editorial sign-off stage.

Any queries about this web report should be addressed to the NIHR Journals Library Editorial Office journals.library@nihr.ac.uk.

The research reported in this web report was commissioned and funded by the HS&DR programme as part of a series of evidence syntheses under project number 16/47/17. For more information visit
https://www.journalslibrary.nihr.ac.uk/programmes/hsdr/164717/#/

The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The HS&DR editors have tried to ensure the accuracy of the authors' work and would like to thank the reviewers for their constructive comments however; they do not accept liability for damages or losses arising from material published in this web report.

This web report presents independent research funded by the National Institute for Health Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health and Social Care. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health and Social Care.

List of abbreviations

B & A	Before and after study design
BMC	Biomedical Central
BMJ	British Medical Journal
CINAHL	Cumulative Index to Nursing and Allied Health Literature
COVID	Coronavirus
EMBASE	Excerpta Medica database
HMIC	Health Management Information Consortium
HSE	Health Service Executive
MEDLINE	Medical Literature Analysis and Retrieval System Online
MERS	Middle Eastern Respiratory Syndrome
NETSCC	NIHR, Evaluation, Trials and Studies Coordinating Centre
NHS	National Health Service
NIHR	National Institute for Health Research
PLOS	Public Library of Science
PROSPERO	International database of prospectively registered systematic reviews
RCT	Randomised controlled tr
SARS	Severe acute respiratory syndrome
UK	United Kingdom
USA	United States of America

Abstract

Background:

The UK National Health Service has the largest workforce in Europe, and the fifth largest in the world, with an estimated 1.3 million employees. Attention to staff health and well-being is a critical aspect of effective care delivery, and is of even more importance for maintaining services during periods of high demand. In most countries guidance for healthcare workers recommends annual influenza vaccination to prevent ill health during times of seasonal and pandemic influenza. However, research has frequently highlighted that uptake of influenza vaccination amongst healthcare workers is low.

Objectives:

This rapid review forms part of a wider review of organisational-level interventions to enhance the health and wellbeing of healthcare workers during times of increased demand for services. This synthesis focuses on the literature relating to the vaccination of staff during times of seasonal and pandemic influenza.

Methods:

We searched Medline, EMBASE, the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, CINAHL, HMIC (Health Management Information Consortium) and Web of Science in October and November 2020. The search was supplemented by reference list checking of included reviews, and using the “similar to” function within online journal repositories.

Brief inclusion and exclusion criteria were as follows:

- Population: Staff employed in healthcare organisations.

- Intervention/comparison: Studies evaluating interventions with the aim of increasing the uptake of influenza vaccination during periods of seasonal or pandemic influenza. Also, studies which reported factors influencing the outcomes of interventions.

- Outcomes: Effectiveness in terms of uptake, vaccination rates, health and wellbeing of staff, or data regarding views and perceptions.

- Setting: Healthcare services in any high or middle income country, including both hospital-based and community-based services.

- Study design: Any study published since 2010 reporting empirical data. We prioritised examination of other reviews, and supplemented this with scrutiny of abstracts of primary studies, in particular studies published more recently than the review sources.

The search results were screened against the inclusion criteria by two reviewers independently. As this was a rapid review, quality (risk of bias) assessment was not undertaken but any weaknesses of the literature as a whole were reported. We performed a narrative and framework synthesis of the included studies.

Results:

From a database of 1065 studies we included 13 reviews and 85 primary studies. The reviews synthesised between three and 37 primary studies, with the majority having few primary studies in common. The primary studies reported results from countries around the world with differing healthcare systems. Cross-sectional and survey designs dominated the literature.

Evidence from the studies indicates that interventions to increase the uptake of influenza vaccination amongst healthcare staff results in small to moderate increases in uptake for non-mandatory actions. Interventions which include mandatory requirements (such as completing formal opt-out declarations or compulsory vaccination) are more effective, but have issues of acceptability in many countries.

Interventions which include multiple elements are more effective than single actions. These elements should include evidence-based information regarding level of personal risk, methods of virus transmission, and efficacy and safety of the vaccine. Information should be specific to healthcare workers (rather than aimed at the general population), and address the individual barriers reported. Vaccinations should be freely available to staff via on-site or mobile clinics, with peer-to-peer vaccination having potential. Managerial support and the involvement of staff in planning programmes may be helpful, in particular those groups who are known to have low uptake (females and nursing staff).

The review indicates that interventions during times of pandemic require the same elements as those at other times, although additional attention to communications regarding vaccine safety and personal risk may be beneficial, as well as extra measures to extend convenient access to vaccination.

Limitations:

We carried out a rapid review to distil key messages for stakeholders, and therefore our searching methods were limited, and some relevant literature may not have been identified and included. As typical for rapid reviews we did not carry out critical appraisal of individual studies, but commented on the quality of the literature overall.

Conclusions:

Non-mandatory interventions to increase uptake of influenza vaccination amongst healthcare staff have small to moderate effectiveness, with rates often remaining low. Mandatory measures are more effective, but require ethical debate. Interventions with multiple strands have greater effectiveness than single components, with ease of access and evidence-based information particularly important during pandemics. Exploration of barriers amongst those least likely to be vaccinated (females, nursing staff) may be beneficial.

Funding and registration: NIHR Health Services & Delivery Research Programme (project number NIHR 130588). PROSPERO registration number CRD42020217851.

Plain English summary

The National Health Service (NHS) in the United Kingdom has an estimated 1.3 million workers. It is important to look after the health of these workers for their own wellbeing, and to make sure there are enough staff to deliver effective services. This is particularly important when services are stretched and staff are under pressure, such as during high winter demand or pandemics.

Guidance for healthcare workers recommends that they have the annual flu jab. However, research shows that only around 30% of staff are vaccinated. Those who are not vaccinated may get ill and be unable to work, or could pass infections on to their colleagues or patients. This rapid review looked for research published since 2010 on the flu vaccination of healthcare staff in developed countries. We wanted to know what might help more staff get vaccinated against seasonal and pandemic flu.

We looked at 13 other reviews in detail, and also closely examined recently published studies to check we weren't missing anything. The results suggest that actions taken by healthcare organisations which are not compulsory (such as providing information, having publicity campaigns, or establishing on-site or mobile clinics) can lead to small or moderate increases in the number of vaccinated workers. The number vaccinated however, often stays low (around 50 to 60%). Compulsory requirements (such as completing opt-out forms or mandatory vaccination) can lead to up to 97% of workers being vaccinated, but may not be acceptable to staff.

Programmes which use several different strategies are most effective. Staff need tailored, evidence-based information about levels of personal risk, methods of virus transmission, and efficacy and safety of the vaccine. Easy access to vaccination is crucial, especially during pandemics. Nurses and females may be less likely to get vaccinated, so exploration of their particular barriers is needed.

Scientific summary

Background

Guidance for healthcare workers in most countries recommends annual influenza vaccination to prevent ill health during times of seasonal and pandemic influenza. However, research has frequently highlighted that uptake of influenza vaccination amongst healthcare workers is low. Attention to staff health and well-being is important at all times, but especially during periods of high demand on services, such as winter pressures or times of pandemic.

Aims and objectives

The review aimed to answer the following research questions:

What is the evidence of effectiveness of system-level interventions to support influenza vaccination of healthcare staff?

What factors may enable or act as barriers to the uptake of influenza vaccination and implementation of these interventions?

What is the evidence regarding effectiveness for different sub-groups of staff such as professionals versus lower paid staff, different professions, or those working in different services?

Are there particular features of effective interventions during pandemic versus seasonal influenza?

Methods

We searched Medline, EMBASE, the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, CINAHL, HMIC (Health Management Information Consortium) and Web of Science in October and November 2020. Brief inclusion criteria are as follows:

Population: All staff employed within services providing healthcare in high and middle income countries.

Intervention: Activities to increase vaccination of healthcare staff against influenza. The intervention could take place in hospital and/or primary care settings.

Context: Extended periods of higher than usual demand for healthcare services including during pandemics or periods of high seasonal demand.

Outcomes: Any measure of effectiveness including number of staff vaccinated or intention to be vaccinated, outcomes for staff health and wellbeing, and also views and perceptions of healthcare staff.

Study design: Studies providing quantitative or qualitative data

Other criteria: Studies published since 2010.

Retrieved citations were downloaded to a reference management database (EndNote version 9). All citations were screened at title and abstract level by two members of the review team against the inclusion criteria, with any queries resolved by consensus during regular team meetings. In order to rapidly produce findings of relevance to stakeholder, we prioritised extraction of data from other existing reviews of relevance, and supplemented this with carrying out a brief extraction from the abstracts of primary studies. We drew on methods of framework synthesis to extract and tabulate key data from the included review papers, and then examine abstracts from the included primary studies.

Results

From a database of 1065 studies we included 13 reviews and 85 primary studies. The reviews included between three and 37 primary studies, and most had few primary studies in common. The primary studies reported results from many countries around the world, with cross-sectional and survey designs dominating. Evidence from the included studies indicated that interventions to increase the uptake of influenza vaccination amongst healthcare staff resulted in small to moderate increases in uptake for non-mandatory actions. Interventions which include mandatory requirements such as completing formal opt-out declarations are more effective, but tend to have challenges of acceptability in many countries.

Interventions which include multiple elements are more effective than single actions. Interventions should include evidence-based information regarding level of personal risk, methods of virus transmission, and efficacy and safety of the vaccine. Information should be specific to healthcare workers (rather than aimed at the general population), and address specific individual barriers reported. Vaccinations should be freely available to staff via on-site or mobile clinics, with peer-to-peer vaccination having potential. Managerial support and communication of messages is important, with the involvement of staff in planning programmes helpful, possibly in particular those groups who are known to have low uptake (female staff and nursing staff).

The review indicates that interventions during times of pandemic require the same elements as those at other times, although additional attention to clear communications regarding

vaccine safety and personal risk may be beneficial, as well as additional measures to extend convenient access to vaccination and effective project management.

Conclusions

Non-mandatory interventions to increase uptake of influenza vaccination amongst healthcare staff have small to moderate effectiveness, with rates often remaining low. Mandatory measures are more effective but require ethical debate. Interventions with multiple strands have greater effectiveness. Key elements are: measures to increase convenience of vaccination; and the inclusion of evidence-based messages tailored to healthcare workers regarding safety, efficacy, and personal risk. The elements are required both during periods of seasonal influenza and times of pandemic. Exploring barriers amongst groups least likely to be vaccinated (nurses, females) may be beneficial.

Implications for healthcare

1. Multiple components should be included within interventions aiming to increase the uptake of vaccinations amongst healthcare staff.

2. Ease of access to vaccination via the provision of walk-in, on-site or mobile clinics is associated with increased uptake of vaccinations.

3. Messaging aimed at healthcare workers should address knowledge and understandings of vaccination safety and efficacy, levels of personal risk, and the risk to others.

4. Information campaigns should be tailored specifically for healthcare worker audiences rather than duplicating messages intended for the general population. There should be a focus on providing the evidence underpinning information, including staff as sources of transmission.

5. There is a need to consider the clarity of vaccination policies within organisations, and the involvement of staff in developing policies is of potential value. Managerial support and leadership is important, together with a focus of on staff wellbeing rather than economic and service delivery rationales.

6. While mandatory policies increase vaccination, there are acceptability and ethical consideration which require further discussion and debate within healthcare and wider society. Some mandatory actions (such as formal opt out) may be more acceptable than others such as compulsory vaccination.

7. The literature indicates that particular groups are less likely to take up vaccination (females, nursing profession), so barriers for these groups needs to be specifically explored if uptake rates are to be improved.

8. Review of the evidence suggests that there is little difference between actions aiming to improve the uptake of vaccination during times of pandemic versus seasonal vaccination. Although attention to ensuring easy access, and evidence-based messaging may be of increased importance.

Recommendations for research

1. Further research is needed regarding the key components of multi-element interventions.

2. Further high quality evidence is needed which uses study designs other than cross-sectional and surveys to evaluate interventions.

3. Further evidence is needed regarding the association between the vaccination status of staff, and risk to patients and fellow staff. This is important to inform evidence-based messages for staff, and debates regarding mandatory measures. Examination of data on transmission of other types of infection in hospital environments may provide transferable learning.

4. There was a suggestion that intervention effectiveness may vary by healthcare setting, with hospital-based programmes offering less effectiveness. Greater evaluation of these differences and exploration of contextual factors would be beneficial.

5. Further research on the implementation, acceptability and efficacy of vaccination status monitoring systems would be beneficial, together with further exploration of societal and worker views regarding mandatory components.

6. Existing research provides a clear consensus regarding the factors which influence vaccination uptake, and further primary studies on this topic are unlikely to add to the evidence base.

Funding and registration: NIHR Health Services & Delivery Research Programme (project number NIHR 130588). PROSPERO registration number CRD42020217851.

Word count: 1223

Background

The UK National Health Service (NHS) has the largest workforce in Europe, and the fifth largest in the world, with an estimated 1.3 million employees.[1] The delivery of safe, high-quality care requires staff to be in post, and be physically and mentally well, yet there are high levels of sickness absence and presenteeism amongst NHS staff.[2] Times of crisis and high demand for healthcare services, such as the COVID-19 pandemic and winter increases in accident and emergency attendance, tax the financial resources available and structural capabilities of healthcare services to provide adequate care.[3] Attention to staff health and well-being is therefore a critical aspect of crisis management in order that services can be maintained during periods of high demand.[3]

Sickness absence during periods of seasonal influenza are known to lead to substantial economic cost from lost working days, and absences also place pressure on colleagues and the healthcare system at a time of high patient demand. One study of a large hospital in Italy reported that over 11,100 working days had been lost during an influenza period in a single year. The authors estimated that the costs associated were approximately 1.7 million euros, and the average work loss was valued at 327 euros per person.[4] Economic modelling has indicated that influenza immunisation programmes for healthcare workers in hospitals are cost effective, with benefits outweighing the investment.[5]

In most countries guidance for healthcare workers recommends annual influenza vaccination, and in some countries it is even a mandatory condition for employment, although this is uncommon.[6] However, research has frequently highlighted that uptake of influenza vaccination amongst healthcare workers is typically low, with reports of typically only around 30% to 37% of staff being vaccinated.[7, 8] One review of uptake in European countries reported rates as low as 13%.[9] Some studies have suggested that while rates may slightly increase during pandemic influenza, there is no sustained effect on the uptake of influenza vaccination in subsequent years.[10] Other authors have concluded that there is no increase in rates even during influenza pandemic.[11]

This rapid review forms part of a wider systematic review, which is examining evidence on organisational interventions to support staff physical and mental wellbeing during times of particular pressure or crisis in health services. Our searches of the literature indicated that there was a substantial body of evidence relating to the specific area of influenza vaccination of healthcare staff. In the context of the current Covid-19 pandemic and initiation of a vaccination programme, together with the winter flu season, this report aims to provide a rapid synthesis of this sub-set of literature in advance of completion of the wider review.

Methods

The review comprises a rapid review of other systematic reviews (commonly termed a review of reviews or an umbrella review), supplemented by a mixed methods synthesis of key findings reported within the abstracts of primary studies.

Review questions

What is the evidence of effectiveness of system-level interventions to support influenza vaccination of healthcare staff?

What factors may enable or act as barriers to the uptake of influenza vaccination and implementation of these interventions?

What is the evidence regarding effectiveness for different sub-groups of staff eg professionals versus lower paid staff, different professions, and staff working in different services?

Are there particular features of effective interventions during pandemics versus seasonal influenza?

Identification of evidence

The information specialist on the team designed a search strategy, including search terms and electronic databases to be searched. The searches in electronic databases were run in October and November 2020. In addition to database searching we screened the included reviews for other review-level sources and primary studies, and used the “similar” function on online journals to identify other relevant sources.

Data sources

We searched Medline, EMBASE, the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, CINAHL, HMIC (Health Management Information Consortium) and Web of Science in October and November 2020. We also identified relevant UK websites and searched these for reports of relevance.

Inclusion criteria

Population: All staff employed within services providing healthcare in high and middle income countries.

Intervention: Activities to increase vaccination of healthcare staff against influenza. The intervention could take place in hospital and/or primary care settings.
Context: Extended periods of higher than usual demand for healthcare services including during epidemics and periods of high seasonal demand.
Outcomes: Any measure of effectiveness including number of staff vaccinated or intention to be vaccinated, health and wellbeing outcomes for staff, and also views and perceptions of healthcare staff.
Study design: Studies providing quantitative or qualitative data
Other criteria: Studies published since 2010.

Exclusion criteria:

- Studies that describe initiatives without providing any quantitative or qualitative data
- Conceptual papers and projections of possible future developments
- Studies conducted in low income country health systems
- Theses, conference abstracts, articles in professional magazines, books and book chapters.

Selection of studies

Retrieved citations were downloaded to a reference management database (EndNote version 7). All citations were screened at title and abstract level by two members of the review team against the inclusion criteria, with any queries resolved by consensus during regular team meetings. Potentially relevant citations were tagged and re-screened by the lead reviewer, with those appearing to be of review design identified for full paper review. Following examination of these studies of review design, the remaining potentially relevant citations were re-screened for inclusion in the synthesis of abstracts of primary studies.

Method of extraction and synthesis

In order to rapidly produce findings of relevance to stakeholder, we prioritised extraction of data from other existing reviews of relevance, and supplemented this with carrying out a brief extraction from the abstracts of primary studies. We drew on methods of framework synthesis, [12] to firstly extract and tabulate key data from the included review papers. This framework was then used to examine abstracts from the included primary studies and explore where these provided additional information.

Data extraction was performed by one reviewer, with discussion at regular team meetings of emerging framework items.

Quality appraisal

As typical for rapid reviews quality appraisal of individual studies was not carried out.[13] However, the design of individual studies was identified during the study reporting as a proxy for hierarchy of quality.

Patient and public involvement

We drew on the expertise of a public advisory group for the Centre producing this review. The group comprised seven individuals, with representation from people aged in their 20s to in their sixties, from people living in geographical locations around the country with different experiences of health and social care, and with different ethnicity and backgrounds. At the outset of the review at an initial meeting, we sought input regarding the role of public advisors, for a research study in which the implications of the work are for healthcare workers rather than directly for patients. Input from the group emphasised how aware users of healthcare are, of demands on staff and staff wellbeing, with some having personal experience of family or friends who work in healthcare services. They recommended that public advisors should have a role in the study, in particular regarding interpretation of the findings and assisting in presenting the results in a form which members of the public would find relevant and accessible.

Towards the end of the study a second meeting was convened, to discuss the emerging findings and aspects that were of interest to the public. Key messages for the public were identified as: the role of clear and accurate communication within organisations; the importance of ensuring access to and ease of vaccination; and the large differential between mandatory and voluntary actions. The group suggested edits to the plain English summary and discussed the development of an evidence briefing for a public audience.

Review findings

From a database of 1065 studies we included 13 reviews and 85 primary studies. See Figure 1 for a diagram illustrating the process of study selection and inclusion.

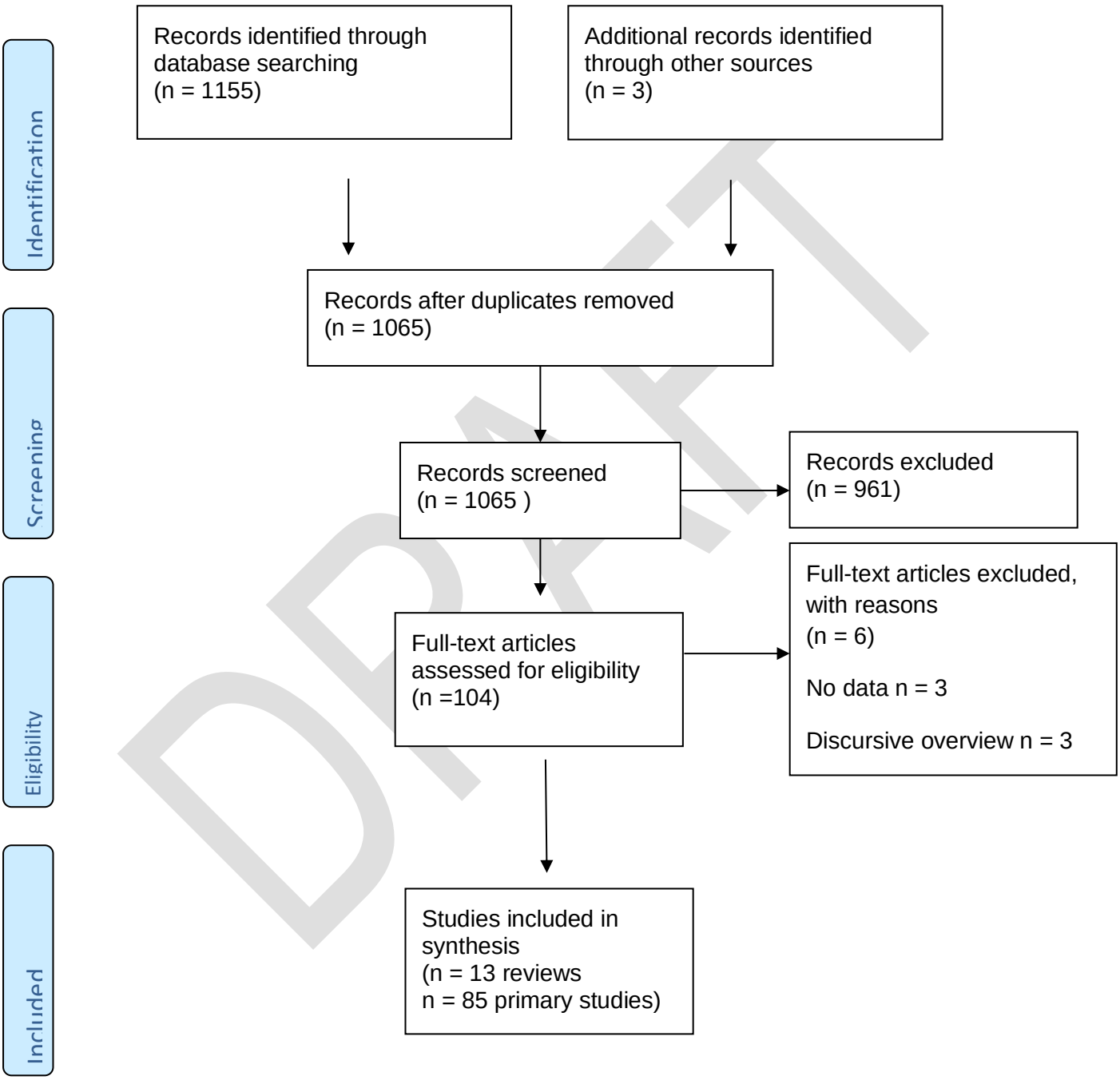

Figure 1. The process of study selection

Characteristics of the included studies

We identified 13 review-level sources which provided evidence regarding healthcare worker uptake of influenza vaccination. See Table 1 for a summary of the characteristics of each included review. Two of these reviews specifically considered pandemic influenza vaccination, [11, 14] while the rest synthesised evidence on seasonal influenza vaccination. The oldest review was published in 2010,[15] and the two most recent reviews were published in 2018.[7, 16]

The reviews included between three[17] and 37[18] primary studies. While there was some overlap in the sources included, for most there was only small duplication with other reviews. The studies differed in the date or study design inclusion criteria, or in regard to the research question being investigated. The Bellia et al. review[11] contained six studies in common with other reviews, Lorenc et al.[19] and also Prematunge et al.[14] each had four overlapping studies. Rashid et al. included three primary studies which were also included other reviews.[20] The Corace et al.[21] and Lam et al. review[15] contained two overlapping studies each. The Hollmeyer et al.[22]. and Vasilevska et al. reviews [18] contained one overlapping study each. Ng et al.[17] and Imai et al.[16] had no studies which were included in other reviews. The reviews which had the greatest similarity were Seale et al. and Stuart et al. which both focused on work carried out in Australia,[23, 24] and included seven of 15 and seven of 11 studies respectively in common. There was one other review[7] which was described as a "comprehensive review of the literature" and contained both "selected" reviews and primary studies, including six of the reviews which are also synthesised in our current review.

Table 1. Summary of the included reviews

First author, date	Focus of review	Included study designs	Date inclusion	Number of included studies
Bellia, 2013	Healthcare worker seasonal and pandemic influenza vaccine uptake	Unclear/any	To 2011	Unclear - 64 referenced
Corace, 2016	Behavioural models and theories relating to influenza vaccination in healthcare workers	Any	To 2014	10
Dini, 2018	Influenza vaccination efficacy, determinants of	Reviews and meta-analyses	Unclear	28

	uptake for healthcare workers			
Hollmeyer, 2013	Interventions to increase uptake of influenza vaccine amongst healthcare workers	Longitudinal and comparator studies	1990-2011	25
Imai, 2018	Effects of influenza on healthcare workers	Trials	1980-2018	13
Lam, 2010	Effectiveness of influenza vaccination campaigns for healthcare workers	Controlled studies, interrupted time series	To 2008	12
Lorenc, 2017	Review of qualitative evidence on influenza vaccination for healthcare workers	Qualitative studies	To 2016	25
Ng, 2011	Effectiveness of influenza vaccination in healthcare workers	RCTs	To 2011	3
Prematunge, 2012	Factors influencing pandemic vaccination of healthcare workers	Observational, non-interventional survey, interviews	2005-2011	20
Rashid, 2016	Interventions to increase uptake of influenza vaccination amongst healthcare workers	RCTs	To 2015	12
Seale, 2011	Uptake in Australian healthcare workers influenza vaccination	Any study design	To 2010	10
Stuart, 2012	Uptake in Australian healthcare	Studies containing data	2000-2011	11

	workers influenza vaccination			
Vasilevska, 2014	Factors associated with acceptance of vaccination (influenza, pertussis, smallpox, anthrax, and hepatitis B)	Studies providing odds ratios or where odds ratios could be calculated	To 2012	37

Effectiveness of influenza vaccination of healthcare staff

Included review studies outlined evidence relating to effectiveness of vaccination in terms of reduction of infection, illness, absence and economic impact; as well as the effectiveness of interventions to increase vaccination uptake. While our review was primarily focused on the latter question of staff uptake, we will firstly present data within included studies relating to overall vaccination efficacy in order to contextualise the subsequent findings.

Is vaccination effective and cost effective in reducing influenza and staff absence?

Evidence from two review-level sources[16, 17] supports influenza vaccination of healthcare workers as being an effective intervention for reducing infection, illness and absence from work. In the first of these reviews (a systematic review and meta-analysis which included 13 studies) it was found that influenza vaccination had a significant effect on the number of cases of laboratory confirmed influenza, and the number of days of absence due to influenza-like illness was significantly reduced.[16] While laboratory-confirmed influenza was significantly reduced, the pooled effect was not significant for influenza-like illness (pooled relative risk = 1.07, 95%CI; 0.95–1.20). The authors concluded that flu vaccination was a cost-effective intervention in terms of avoidance of absenteeism.

A review and meta-analysis of three randomised controlled trials (which was also included in the Dini et al. review) concluded that there is limited evidence that influenza vaccinations significantly reduce the incidence of influenza, the number of illness-like episodes, days with symptoms, or the amount of sick leave taken among vaccinated healthcare workers. However, there was a positive effect in terms of the number of laboratory confirmed cases, which reduced by 88%.[17] The authors pointed to the challenges in synthesising effects due to differing comparisons in the primary studies.

In addition to reporting this review study, the Dini et al. review identified three further reviews and one primary study (a randomised controlled trial) which provided evidence of effectiveness. These studies reported vaccine effectiveness of 88% to 90% amongst healthcare workers, with reductions in infections, days of illness, and absence from work.[7]

Does vaccination of healthcare workers protect patients?

Evidence regarding potential outcomes for patients as a result of healthcare worker vaccination was limited and conflicting. The authors of one review[17] called for patient safety to be emphasised as a rationale for healthcare workers to be vaccinated, but another review highlighted the poor quality of existing primary studies, with the authors concluding that evidence regarding the effect on patients was scarce.[7]

Effectiveness of interventions to increase uptake of influenza vaccination

Evidence from six review-level sources indicates that interventions have a small to moderate effect on uptake of seasonal influenza vaccination amongst healthcare workers.[7, 15, 20, 22-24] There were no data relating to effectiveness in the two included reviews which specifically examined pandemic influenza.

A review (of 12 studies) reported that eight of nine interventions in community settings led to small but improved rates of uptake for the intervention group compared to controls (relative risks of vaccination 1.04 to 8.05). Interventions in hospital settings achieved minimal to small improvements (relative risks of 0.86 to 1.78 and one study 2.74).[15] Another review, also of 12 studies found evidence of statistically significant positive effects of interventions in half of the studies included. The effects were generally modest however, with the largest vaccine uptake for any of the interventions being 57%, and differences between control and intervention groups in the range of 5.7–26.3% increase in uptake.[20] A review of 25 studies from eight countries reported similar increases in uptake of between 2.5% to 49% following one season of intervention. Only one included study did not find a positive effect.[22] A review which reports evidence from 28 other studies (including other reviews and primary studies) concluded that interventions lead to positive “moderate” effects, with one included review finding vaccination rates of more than 95% following a compulsory vaccination intervention.[7] As outlined above, authors of one review drew a distinction between the effectiveness of interventions in hospital

versus community settings (community greater efficacy) suggesting that context may be influential in effectiveness.[15]

A review specifically of interventions in Australian hospitals, concluded that interventions produce small effects on existing low uptake rates.[23] Three of the ten included interventions led to rates above 50%, with the highest being 58.7%. Another review from Australia carried out a year later identified three relevant intervention studies (one of which was included in the earlier review), with the two unique studies achieving coverage of up to 76% and 81%.[24]

Effectiveness by type of intervention

The review-level sources outlined a diverse range of influenza vaccination interventions and components of interventions including use of mandatory requirements, educational and promotional activities, enhancing availability and access, and managerial-level actions (see Table 2). Several reviews drew a distinction between what were termed "softer" interventions, such as promotional campaigns and education, and "harder" interventions which required staff to complete opt out forms, attend in-person meetings with managers, or mandatory vaccination.

Table 2. Review-level evidence summarising elements of interventions

Element of intervention	First author and date
Free vaccine	Hollmeyer 2013 Seale 2012 Stuart 2012
Easy access	Lam 2010 Rashid 2016 Hollmeyer 2013 Stuart 2012 Vasilevska 2014
Messages based on facts and address specific concerns	Lorenc 2018
Modified to different staff groups	Lorenc 2018
Modified according to individual barriers	Hollmeyer 2013
Mandatory vaccination	Hollmeyer 2013 Lorenc 2018 Lam 2010
Personal interview	Lam 2010
Active opt out/formal declination forms	Hollmeyer 2013 Lam 2010 Lorenc 2018
Non-punitive	Bellia 2013

Commitment and support from managers	Hollmeyer Lorenc 2018 Prematunge 2012
Leadership	Lorenc 2018
Perceived as being for staff wellbeing not as increasing productivity or patient safety	Lorenc 2018
Clarity of policies	Bellia 2013
Access to clinical and non-clinical staff	Stuart 2012
Educational activities/materials	Hollmeyer 2013 Lam 2010 Rashid 2016 Stuart 2012
Promotion of vaccination/increase awareness	Lam 2010 Rashid 2016 Seale 2012
Reminders	Hollmeyer 2013 Rashid 2016
Incentives/reward	Hollmeyer 2013 Rashid 2016 Stuart 2012
Variety of different elements in programme	Dini 2018 Hollmeyer 2013 Lam 2010 Rashid 2016

The interventions which were typically termed “harder” by study authors (including mandatory vaccination and other obligatory actions) were reported to have the greatest effectiveness, although many authors discussed the varying views and dilemmas regarding these actions. In one review, mandatory vaccination as a condition of employment (alongside other interventions) in the USA was reported to have resulted in uptake rates of up to 99%, with the authors reporting that few staff requested exemptions on health or religious grounds and a very small percentage of staff resigned or had their employment terminated (0.03%-0.15%).[22] In this review, the introduction of signed refusal forms alongside other existing interventions was reported to have increased uptake by 55%-71%. Another review concluded that campaigns involving legislative or regulatory components (such as mandatory declination form, or mandatory masks for unvaccinated personnel) achieved higher rates of uptake than all other interventions.[15]

One review of qualitative literature highlighted that health care professional beliefs around professional autonomy and the right to decide, created opposition to enforced vaccination.[19] The authors discussed the potential conflict between professional requirements to protect patients by being vaccinated, and individual civil liberty. This review also reported doubts from

staff as to whether organisations would have the logistical abilities to enforce mandatory vaccination, and highlighted the potential for mandatory interventions to erode the relationship between an organisation and its staff.[19] A further review also emphasised the value of ensuring that interventions were non-punitive.[11]

Several authors highlighted the difficulties that healthcare workers may face getting access to vaccination due to shift working and/or long hours, and the requirement to provide no-cost vaccination to encourage uptake. Interventions to optimise ease and convenience for healthcare workers were therefore a common elements of initiatives.

Three reviews reported that initiatives such as on-site or mobile clinics resulted in increased uptake of vaccination.[20, 22, 24] An average increase in vaccination uptake of 20% was suggested by enhancing ease of access, with programmes not including this element achieving improvements more typically around 9%.[22] One of the reviews noted that it was important to ensure that easy access initiatives were open to both clinical and non-clinical staff.[24] However, in contrast to these positive reports, another review concluded that this intervention had only minimal impact as a single element.[15] Authors of a review and meta-analysis[18] also found that interventions to increase convenience were not associated with increased uptake, but they noted the heterogeneity in reported effects. Ensuring that the vaccination was offered free to recipients was important in increasing uptake.[22-24]

Many of the interventions evaluated were designed to increase health care workers' awareness and/or knowledge about influenza vaccination. The evidence in regard to provision of educational materials or sessions was mixed, with two reviews reporting positive effects,[22, 24] but another finding minimal effectiveness,[15] and a fourth emphasising that it was not effective as a stand-alone initiative, but if combined with promotion and awareness raising might result in increased vaccination uptake.[20] Similarly, the evidence relating to promotion of influenza vaccine as a single intervention within an organisation was mixed, with two reviews finding it could be effective,[20, 23] and one indicating minimal effectiveness.[15]

Studies considered how the type and format of messages within organisations around influenza vaccination might influence levels of uptake. One review highlighted that messages should take account of individual barriers.[22] Another review suggested that communications should be based on facts, and address specific staff concerns.[19] There was also the recommendation in this review that information should be tailored to staff rather than patients.[19] The authors emphasised that messaging around influenza vaccination should ensure that it is

perceived as being for staff wellbeing, and not as increasing productivity or for patient safety.[19]

Two reviews indicated that reminders to staff could be helpful.[20, 22] Evidence on offering incentives to staff to take up vaccination was mixed, with two studies suggesting it could have benefits,[22, 24] but one review reporting that it was not effective either as a single intervention or when it was combined with educational initiatives.[20]

Three reviews evaluated the effectiveness of having an identified lead for vaccination within an organisation. One review suggested that this might be effective, [24] but two others found evidence of value only when combined with other elements (with education in one review; and combined with giving feedback on rates of uptake in the other).[20, 22] The value of having commitment and support from managers was highlighted in three reviews,[14, 19, 22] and the importance of leadership on the issue of vaccination (including all senior staff being vaccinated) was reported.[19] Other recommendations for management-level actions were that there should be clarity of policies on vaccination,[11] long term implementation of policies and interventions, [22] and that there should be personnel dedicated to the intervention programme who promote and organise vaccination for staff.[22]

A recurring finding amongst reviews was the "value-added" nature of combining several interventions, rather than initiatives comprising a single element alone. The Dini et al review, [7] which also included the Rashid et al. study [20] described combined approaches as being more effective. In the Rashid et al. source the authors concluded that a combination of three or five strategies was most effective.[20] Hollmeyer et al. argued that the number of components appeared to be proportional to the increase in uptake.[22] The Lam et al. review highlighted the need for more studies to determine which components should be combined to achieve optimal effectiveness.[15]

While the evidence indicated the effectiveness of multiple strands to interventions there was a lack of clarity in regard to which components "make the difference". In one review for example, the authors reported that the requirement to complete an opt out (declination) form resulted in between 55% to 71% uptake of vaccination, although this intervention was provided as one element within a suite of interventions, so the role of each element could not be determined[22] A review of initiatives involving legislative or regulatory components indicated that when these were one element of combined interventions that higher rates of uptake were achieved than single interventions alone.[15]

Evidence from primary studies

We supplemented the review-level evidence with data from the abstracts of 85 primary studies, to ensure that research which was published after the most recent reviews (2018) was included, and to evaluate whether there were any interventions or any influencing factors in this literature which had not been identified by the review sources (see Table 3, Table 4, Table 6 and Table 6).[8, 25-108]

Much of this literature was of cross sectional or survey design. Ten studies had more than one time point (before and after or cohort studies) and five of these supplementary studies were of randomised design. Nearly half of the primary studies were from North America. Six studies were published in 2019 [66, 72, 75, 79, 81, 101] and five in 2020.[28, 35, 63, 92, 104]

Table 3. Elements of effective interventions from primary studies

First author, date, country, study design	Elements of interventions																										
	Leadership/managerial commitment & support	Involvement of staff	Clear policies/regulations	Part of quality improvement strategy/culture	Data tracking	Reminders	Factual messages	Promotion/awareness raising	Perception – for staff wellbeing to staff	Educational activities/materials	Ethical focus on fairness/ethics	Modified to individuals/staff groups	Health checks/individual interview	Active opt out/declination form	Incentives/reward/non-punitive	Free vaccine	Easy access	Dedicated personnel	Mandatory vaccination	Multiple elements to programme	Clinical and non-clinical staff	Consequences for those not vaccinated	Peer vaccination	Identification of staff via database	Appointment scheduled/mass clinic	Social media	Flu champion
Totals	6 N	1	2	3	2	2	N	16 N	7 N	17 N	1	3	2	3 N ?	4 N	6	12	4	8 N N	7	1	4	2	1	N N	N	1
Abramson 2010 USA RCT								x		x																	
Ajenjo 2010 USA Retrospective cohort	x			x						x				x					x	x							
Akan 2016 Turkey Survey																x	x										
Antommaria 2013 USA XS											x																
Apisarnthanarak 2010 Thailand Non-RCT								x		x																	

Bert 2020 Italy XS								x		x							x			x							
Chambers 2015 Canada RCT										x																	
Conte 2016 Italy B&A								x																			
Cozza 2015 Italy Survey												x															
Crupi 2010 USA XS										x							x					x					
Edelstein 2014 UK Survey										x		x								x			x	x	N	N	x
Feemster 2011 USA Survey																			x								
Fricke 2013 USA Survey								x						x		x	x					x					
Gilardi 2018 Italy B&A								x									x										
Heinrich-Morrison 2015 Australia Survey								x												x	x						
Hill 2015 USA Qualitative	x	x												x													
Hirsch 2011 USA Survey	x													N													
Honda 2013 Japan B&A	x							x					x	x		x											
Lee 2013 USA XS					x	x				x																	
Lehman 2016 USA RCT																									N		
Lin 2012 USA Survey								x		x						x	x										
Lindley 2014 USA Qualitative			x																			x					
Lindley 2019 USA XS																			x								
Little 2015 UK Survey																			x								
Llupia 2010 Spain B&A								x							x		x										
Llupia 2013 Spain B&A								x		N																	
Looijmans-van den Akke 2011 Netherlands XS								x		x								x									
Maltezou 2019 Greece Cohort	x			x													x										

Maurer 2012 USA Survey																			x								
*McLlwain 2010 UK Survey	x							x																			
Mustafa 2017 Qatar B&A					x			x		x						x	x	x		x							
Nace 2012 USA XS										x																	
Podczervinski 2015 USA B&A										x				x	N												
Quach 2013 USA XS								x		x									x								
Quan 2012 Country unknown Survey														x			x		x				x	x			
Rakita 2010 USA Cohort																			x								
Rodriguez-Fernandez 2016 Spain B&A										x																	
Rothan-Tondeur 2011 France RCT							N					x															
Sawyer 2012 USA B&A	N							N						N		x			N								
Stead 2019 UK Survey														?					N								
Thompson 2013 USA XS												x															
Tognetto 2020 Italy XS										x							x			x							
Yassi 2010 Canada Qualitative			x	x					x						x												
Yue 2017 USA Survey						x										x	x			x							
Zielonka 2016 Poland XS								x								x											

X = reports effectiveness N = reports not effective Studies in bold = randomised controlled trials (RCT)

XS = cross-sectional design B&A = before and after design USA = United States of America UK = United Kingdom

The additional intervention components outlined in the primary sources were: the involvement of staff; embedding vaccination within quality improvement and/or organisational culture; peer vaccination; making appointments for staff, use of social media, and having a flu champion.

The involvement of staff was recommended in one study which used local teams and consensus to identify strategies to implement an opt-out process. The resulting declination form was described as being well accepted and easy to use, and achieved moderate-to-high levels (48% to 100%) of usage.[55] The adoption of vaccination as part of a quality improvement strategy or organisational culture was recommended by three studies.[26, 72, 106] The first of these (a qualitative study carried out in Canada)[106] recommended creating a healthy workplace culture in order to promote vaccine uptake. A US study described how adding vaccination rates to quality scores increased uptake.[26]

Two studies included evaluation of a peer vaccination programme. In the first of these,[47] a survey was carried out to explore which interventions were used in acute hospitals in England. The authors identified 25 different strategies, with peer vaccination achieving the greatest increase (8.5%) followed by educational DVDs, and then use of a flu champion. A cohort study from the US[87] evaluated interventions which had a mandatory component. The authors found that institution of mobile vaccination, mandatory declination, and peer-to-peer vaccination efforts increased uptake from 44.0% to 62.9% of healthcare professionals. It was noted that in order to achieve greater uptake a mandatory vaccination campaign was initiated which required unvaccinated professionals to wear masks during the influenza season, and this increased rates of compliance to over 90%.

A randomised controlled trial found that there was no significant effect on uptake of sending an e-mail to healthcare workers with a pre-scheduled appointment for influenza vaccination (which could be changed or cancelled), compared to sending a request to schedule an appointment.[61] A survey of UK hospitals [47] found that offer of a drop-in appointment in the organisation's occupational health department was associated with a significant decrease in vaccine uptake (−18%).

In addition to scrutinising these studies for additional intervention components, we drew on them to provide an indication of the frequency of report of different types of interventions in the literature, and highlighted where there was report of effectiveness versus no significant effect (Table 3). As can be seen the most commonly reported interventions involved firstly educational materials or activities, and secondly promotion or awareness-raising of vaccination amongst staff. The third most reported intervention was efforts to increase

convenience and access to vaccination, typically by having on-site or mobile clinics, which in much of the literature from North America was termed “mobile carts”. As with the review-level sources there was evidence of almost all these interventions resulting in some positive effect (apart from offering appointments), but rates reported often remained low, except for those actions with mandatory components.

We outline below the evidence regarding effectiveness from the primary studies which were published since the year of the most recent included reviews (2018), and highlight where the findings add to or are at variance from the review-level sources.

Two recent studies investigated mandatory actions, one in the USA and one in the UK.[66, 101] A qualitative study of views of staff in the UK found that there was little support for mandatory vaccination, and that if declination forms are adopted, there should be care to avoid stigmatising staff.[101] The study from the US considered the effect of legal requirement at a state level, in addition to requirements for vaccination or compulsory mask wearing at an institutional level, and found that additional state-level requirement for vaccination or mask wearing if unvaccinated increased influenza vaccination uptake.[66] Both these studies echo the reviews in finding mandatory action to be an effective intervention, but that outside North America it is less acceptable to healthcare workers.

The most recent literature echoes the value of combined approaches to increasing uptake. A study from Italy for example used education, awareness, and improved access, and reported an increase of 46% over the previous year.[35] Another study from Italy identified easy access as having a key role in a campaign which included education, personal email invitation and on-site vaccination. As indicated in the reviews which found only low to moderate effectiveness, vaccination rates in the four included hospitals though remained between 4% and 12%.[104]

A study which used discrete choice methods to evaluate healthcare professional preferences to intervention components, echoes the review-level sources in finding that walk-in and mobile vaccination stations were preferable to having a designated staff clinic and specific appointments.[63] Another study confirmed review results in recommending vaccination on-site, vaccination of the heads of the departments, and promotion of a culture of safety and ethical duty in the workplace.[72]

Effectiveness amongst different groups of staff

Four reviews concluded that staff from the medical profession were more likely to be vaccinated than other staff groups, both prior to any intervention and subsequent to intervention. Take up from those in the nursing profession was typically described as poor.[7, 11, 22, 23] One review and meta-analysis however, found that data regarding nursing versus medical professional uptake was heterogeneous, and the authors noted possible publication bias.[18] One review noted that there was a wide range of uptake amongst ancillary and support staff.[96] A primary study found no difference in uptake between clinical and non-clinical staff.[48]

One review concluded that female staff were less likely to be vaccinated than males.[11] This was confirmed by three included primary studies.[32, 36, 62] Five primary studies reported that older age tended to be associated with higher uptake.[62, 79, 80, 84, 88] One primary study found in contrast that staff of younger age were more likely to be vaccinated.[81]

Table 4. Evidence relating to sub-group differences in uptake

Doctors more likely than nurses	Bellia 2013 Dini 2018 Hollmeyer 2013 Seale 2011 Vasilevska 2014
Wide range amongst ancillary and support staff	Seale 2011 Feemster 2011
Age	Quintyne 2018 Petek 2018 Nowalk 2010 Napolitano 2019 Lewthwaite 2014 Oguz 2019
Female less likely to be vaccinated	Arda 2011 Bellia 2013 Bonnacorsi 2013 Lewthwaite 2014

Factors influencing the uptake of influenza vaccination amongst healthcare workers

Eight of the 13 included reviews reported factors which influence the uptake of vaccination by healthcare workers.[7, 11, 14, 18, 19, 21, 24, 109] There was a high level of consensus amongst the reviews in regard to these factors. Table 5 summarises the reviews which reported each influencing factor.

Table 5. Influencing factors identified from review-level sources

Influencing factor	Studies reporting this factor
Perceived individual risk and severity of illness (vulnerability)	Bellia 2013 Corace 2016 Dini 2018 Fitzsimmons 2014 Lorenc 2018 Prematunge 2012 Stuart 2012 Vasilevska 2014
Desire for self-protection	Dini 2018 Lorenc 2018 Prematunge 2012 Stuart 2012 Vasilevska 2014
Desire to protect family	Bellia 2013 Dini 2018 Prematunge 2012 Stuart 2012 Vasilevska 2014
Desire to protect patients	Corace 2016 Lorenc 2018 Prematunge 2012 Stuart 2012 Vasilevska 2014
Perceptions of efficacy of vaccine	Bellia 2013 Corace 2016 Lorenc 2018 Prematunge 2012 Stuart 2012 Vasilevska 2014
Perceptions of safety of vaccine	Bellia 2013 Corace 2016 Dini 2018 Lorenc 2018 Prematunge 2012 Stuart 2012 Vasilevska 2014
Incomplete knowledge	Bellia 2013 Lorenc 2018 Dini 2018

	Fitzsimmons 2014 Stuart 2012
Past vaccination history	Bellia 2013 Corace 2016 Dini 2018 Prematunge 2012
Self-efficacy	Corace 2016
Cues to action/anticipated regret	Corace 2016 Prematunge 2012
Peer pressure	Bella 2013 Fitzsimmons 2014 Lorenc 2018 Prematunge 2012
Experience of the illness	Bellia 2013 Dini 2018
Inconvenience/insufficient free time	Bellia 2013 Stuart 2012
Attention in media	Bellia 2013 Prematunge 2012
Trust in health department	Prematunge 2012

The factor most commonly described as influential was the individual worker's perception of their own level of risk. All reviews highlighted this as a key obstacle to increasing uptake. In one,[11] the authors described how perceived lack of severity of the disease, belief in their own health and strength, and lack of identification of themselves as being in an at risk group, led to a view of themselves as having limited susceptibility. A review which used the psychological theories of behaviour change[21] also indicated that risk perception attitude was a factor in vaccination decision-making. A review of qualitative literature[19] highlighted a perception that influenza illness predominantly affects older and less healthy individuals, and should be easily manageable by healthy adults.

Five review-level sources described self-protection as a key motivator for vaccination. A review and meta-analysis[18] indicated that the desire to protect oneself and/or family or friends was the factor most associated with the intention to be vaccinated (pooled odds ratio 3.42 [95% CI, 2.42–4.82]. The review by Bellia et al. also concluded that a worker's desire for self-protection (in some studies alongside protection of their families) was the strongest factor behind their intentions regarding vaccination.[11]

Four of the reviews reported that the desire to protect patients influenced the decision to be vaccinated,[14, 18, 21, 24] The meta-analysis by Vasilevska et al.[18] reported a pooled odds ratio of 4.11 [95% CI, 3.12–5.41] association between a desire to protect patients against seasonal influenza (not pandemic) and vaccination uptake (after a single outlier study was removed

from the calculation which was suggesting greater heterogeneity). Another review reported that perceptions regarding patient safety could distinguish workers who were vaccinated versus those who were not, as healthcare staff who based their decision solely on individual risk were less likely to take up vaccination.[14] One review in contrast concluded that avoidance of illness in patients was a lesser influence than self-protection. A belief amongst some workers that patients are more likely to be infected by other patients than by healthcare workers was described.[19]

Perceptions regarding the safety and efficacy of the vaccine were reported in all the reviews to be key influencing factors. Authors described concerns that vaccination caused influenza, there were fears of side effects, and also other more general concerns about vaccination safety.[7, 11, 19] One review described "woeful ignorance, nonchalance, and disregard" regarding the value of vaccination amongst healthcare workers.[109] Another study outlined beliefs that vaccination was not effective, and reports that there was insufficient scientific evidence to justify vaccination programmes.[19] A meta-analysis concluded that while there was evidence that beliefs regarding vaccine safety and potential to cause disease were associated with a desire to be vaccinated, there was some evidence of heterogeneity and publication bias (P = 0.021).[18]

Linked to perceptions of safety and efficacy were reports of healthcare workers having incomplete knowledge about influenza and influenza vaccination.[7, 11, 19, 24, 109] Two reviews highlighted in particular limited knowledge regarding the potential of themselves to be transmitters of influenza.[11, 19] The latter review described some healthcare staff perceiving that it was unlikely that they would transmit infection. Stuart et al. reported healthcare workers being unaware of guidelines recommending influenza vaccination.[24]

Four reviews highlighted the role of history of vaccination in uptake. Previous receipt of the seasonal influenza vaccine was positively associated with intentions and future intentions and receipt of vaccination in subsequent seasons in four reviews.[7, 11, 14, 21] Two of these reviews used behaviour change frameworks to examine the literature, and drew attention to concepts of self-efficacy and habit in predicting those who are vaccinated.[14 , 21] Two reviews described how past experience of an illness increased intentions to be subsequently vaccinated.[7, 11]

Four reviews reported the role of peer pressure in vaccination decision-making, with colleagues influencing decision-making either for or against vaccination.[11, 14, 19, 109] Two reviews described staff referring to inconvenience and having insufficient free time to attend for vaccination as key obstacle.[11, 24]

Two reviews reported how attention in the media was influential on individual worker decision-making. Both these reviews related specifically to pandemic influenza.[11, 14] This latter review also described how the level of trust that staff members had in their organisation's health department was important.

Evidence from primary studies

Examination of the primary studies did not add any additional influencing factors to those reported in the review-level sources. One study found that religion was not a key element for the majority of employees.[29] The majority of these studies were of cross-sectional or survey design. The literature was not dominated by any particular countries, with studies from many different European countries, the Middle East, USA, Canada, Australia, and China. The most commonly described factor influencing decision-making was healthcare worker perceptions of vaccine efficacy and/or side effects (see Table 6). While 34 studies reported this as a key element, two studies found that this was not a main factor. The second most commonly reported factor was individual perceptions regarding their level of risk. The studies published since the date of the most recent reviews (2018) confirmed the review-level evidence rather than reporting any novel findings.

Table 6. Influencing factors reported in the primary studies

First author and date	Influencing factor							
	Protect patients/ethical obligation/professional need	Perceived risk	Personal protection/family	Perceptions of efficacy, side effects	Time/convenience	Media reports	Colleagues/social influence	Religion
Totals	8 N	17	6	34	5	3	3	1
Akan 2010 Turkey Survey	x	x		x	x			
Alhalaseh 2020 Jordan Survey		x		x				
Antommaria 2018 USA XS								Few employees
*Arda 2011 Survey				x		x		
Asma 2016 Turkey Survey		x		x			x	
Banach 2013 Turkey Survey								
*Bonaccorsi 2013 Italy Survey	N	x	x					
Bonaccorsi 2015 Italy Survey			x	x				
*Brandt 2011 Germany Survey				x				
Conte 2016 Italy B&A		x		x				
Cozza 2015 Italy Survey	x	x		x				
Daugherty 2011 USA Survey				x of policy				
Dedoukou 2010 Greece XS		x	x	x				
Dubnov 2010 Israel Survey				x				
Eaton 2017 USA Survey				x of policy	x			
Edelstein 2014 UK Survey								
Feemster 2011 USA Survey								
*Ferguson 2010 Australia Survey				x				
Fricke 2013 USA Survey								
Gilardi 2018 Italy B&A								
Heinrich-Morrison 2015 Australia B&A		x		x				

*Henriksen 2011 USA Survey	x							
Hidiroglu 2010 Turkey Qualitative		x		x transmission to patients		x	x	
Hopman 2011 Netherlands XS	x	x		x	x		x	
Hussain 2018 Canada Cohort								
*Lewthwaite 2014 UK Survey		x		x	x			
Liao 2020 Hong Kong Modelling				x safety more than efficacy	x			
Little 2015 UK Survey	x			x				
Mo 2019 Hong Kong Survey		x		x benefits				
Mytton 2013 UK Survey	x	x		x				
Napolitano 2019 Italy Survey				x				
Nowalk 2010 USA Survey								
Oguz 2019 Turkey Survey								
*Parlakay 2012 Turkey Survey				x				
*Parry 2011 UK Survey				x				
Petek 2018 Slovenia Survey		x	x	x				
Quintyne 2018 Ireland Survey				x				
Rabensteiner 2018 Italy Survey				x				
Rong 2020 China Survey		x		x				
Schult 2012 USA Survey		x		x				
*Seale 2011 China Survey				x				
Seale 2010 Australia Survey	x most		x	x				
Seale 2010 China Survey				x				
Shrikrishna 2015 UK Survey				x				
Socan 2013 Slovenia Survey		x		x				
Stead 2019 UK Survey + qualitative				x				
Tagajdid 2011 Morocco Survey						x		
*Virseda 2010 Spain Survey	x		x	x				

Uptake of vaccination during seasonal influenza versus pandemics

We scrutinised the literature for any evidence regarding differential effects of interventions during times of seasonal influenza versus times of influenza pandemic. Two of the review-level sources,[11, 14] and two of the identified primary studies specifically considered vaccination during influenza pandemics. [71, 74]

A review of both seasonal and pandemic influenza vaccination presents mixed evidence regarding the impact of pandemic on rates of influenza vaccine uptake amongst healthcare workers. The review cites studies which found increases, rates changing little during a pandemic from other times, and also lower rates during a pandemic.[11] The authors conjectured that rates may be lower during a pandemic as there may be concerns regarding accelerated authorisation procedures, and there may be emotional tolerance of the pandemic and perceptions of its' controllability over time. This review echoes the wider literature in recommending a multi-faceted approach to interventions.

A review of pandemic influenza vaccination in 2012[14] concluded that there was overall similarity between this literature and studies on seasonal influenza vaccination. The authors highlighted the need though for interventions during pandemics to address limited time and access of healthcare workers to vaccination, provide education and information to counteract the strong role of mass media, and specifically address adverse perceptions regarding the safety of rapidly developed vaccines. This review also found that a past history of seasonal influenza vaccination was the strongest predictor of being vaccinated during a pandemic. A second review supported the finding regarding the influential role of the media on individual worker decision-making during times of pandemic.[11]

Prematunge et al.[14] concluded that the factors which influence decision-making during pandemics (most notably perception of risk to self and family, views regarding severity of the illness, and perceptions regarding the safety of the vaccine) were similar to those underpinning uptake for seasonal flu vaccination. Although perceptions regarding safety were more heavily influenced by the mass media and views relating to the speed of vaccine development. Another review noted that the desire to protect patients was reported less than self-protection, as the motivation to be vaccinated during pandemics.[18]

A study which explored the knowledge and attitudes of healthcare workers in Chinese intensive care units during the 2009 influenza pandemic highlighted poor knowledge of influenza amongst workers, even though most had completed a training programme.[71] A UK

report published in 2010 indicates the role of managerial factors in organisational actions, highlighting that flexible and accessible delivery approaches, visible leadership, an effective communication strategy, a robust plan with clear governance arrangements and sound project management are essential to pandemic vaccination programmes.[74] The need for trust between workers and the organisation's health department was also reported.[14]

Quality of the literature

As this review was a rapid synthesis of literature to distil key messages, we did not carry out a critical appraisal of included studies. However, we provide an overview commentary regarding the quality of the literature.

Authors of many of the included reviews drew attention to the need for more, and higher quality studies on influenza vaccination amongst healthcare staff.[7, 15, 16] There are a small number of randomised controlled trials and reviews and meta-analysis of these, but the literature is dominated by cross-sectional and survey studies. Authors of one review and meta-analysis [15] criticised the available primary studies for failure to report the number of health care personnel exposed to the campaign, and for the number of health care personnel for whom there was no follow-up. They acknowledged that cross-sectional and before-after studies were more feasible to carry out, but highlighted the need for having comparable control groups.

All but one of the included reviews were carried out to a reasonable standard, with detailed reporting of sources searched, study identification processes and rigorous analysis. One review was unclear in regard to its selection criteria, describing the synthesis of a "sub-set" of documents retrieved for a wider study on influenza.[11] While the selection criteria were unclear, the sources and search strategy were described, and we made the decision to include this source as it was one of only two reviews which specifically considered pandemic influenza.

Discussion and conclusions

Rapid review of the literature indicates that interventions to increase influenza vaccination amongst healthcare staff can be effective in achieving increased uptake. Improvement for most (non-compulsory) actions are small to moderate however, with typical vaccination rates post-intervention of around 50% to 60%. While this is an improvement on the baseline rates commonly cited of around 30%, this may be insufficient to achieve meaningful reduction in staff laboratory-confirmed influenza rates, staff ill health, or shortage of staff due to sickness absence. There was consensus in the literature that multiple intervention elements are

required if the uptake of influenza vaccination amongst healthcare staff is to be increased. Figure 2 provides a summary of the elements which influence uptake, and the four suggested points of intervention which need to be combined within a multi-element programme.

The review highlights that gaps in knowledge and understanding exist amongst some staff, in particular in regard to vaccine safety, potential side effects, and efficacy. However, a key factor which influences decision-making is a perception of limited personal risk, and of the effects of influenza illness as being of limited severity. Interventions which are intended to address these factors are needed, but informational messages should be clearly based on available evidence and aimed specifically at healthcare workers, rather than the general population. Perceptions regarding limited personal risk of illness are important not just for uptake of vaccines, but potentially for other health and safety decision-making. Authors of one review[17] highlighted the need to more clearly link healthcare worker vaccination to patient safety rather than personal risk, which would require further clarity in research findings to support evidence-based messaging.

This review indicates that while there is clear evidence that interventions can increase the uptake of influenza vaccination; that the effects tend to be modest for actions which do not involve mandatory components. While vaccination is a compulsory requirement of employment in healthcare organisations in some countries, there are considerable ethical debates on this controversial policy. The involvement of staff is essential in the development of local guidance, with a requirement for leadership and managerial support for successful implementation of any interventions. Some studies reported uncertainty amongst staff regarding standards and guidelines, so there appears to be a gap in regard to clarity of organisational policies which needs attention. Some types of mandatory requirement (for example formal refusal forms) may be more acceptable than others, and there is a need to explore this further with staff. Any intervention requires systems to enable monitoring of staff vaccination status, and while the literature discussed the ethics of enforcing vaccination, there was little discussion regarding staff disclosure, or monitoring procedures and systems.

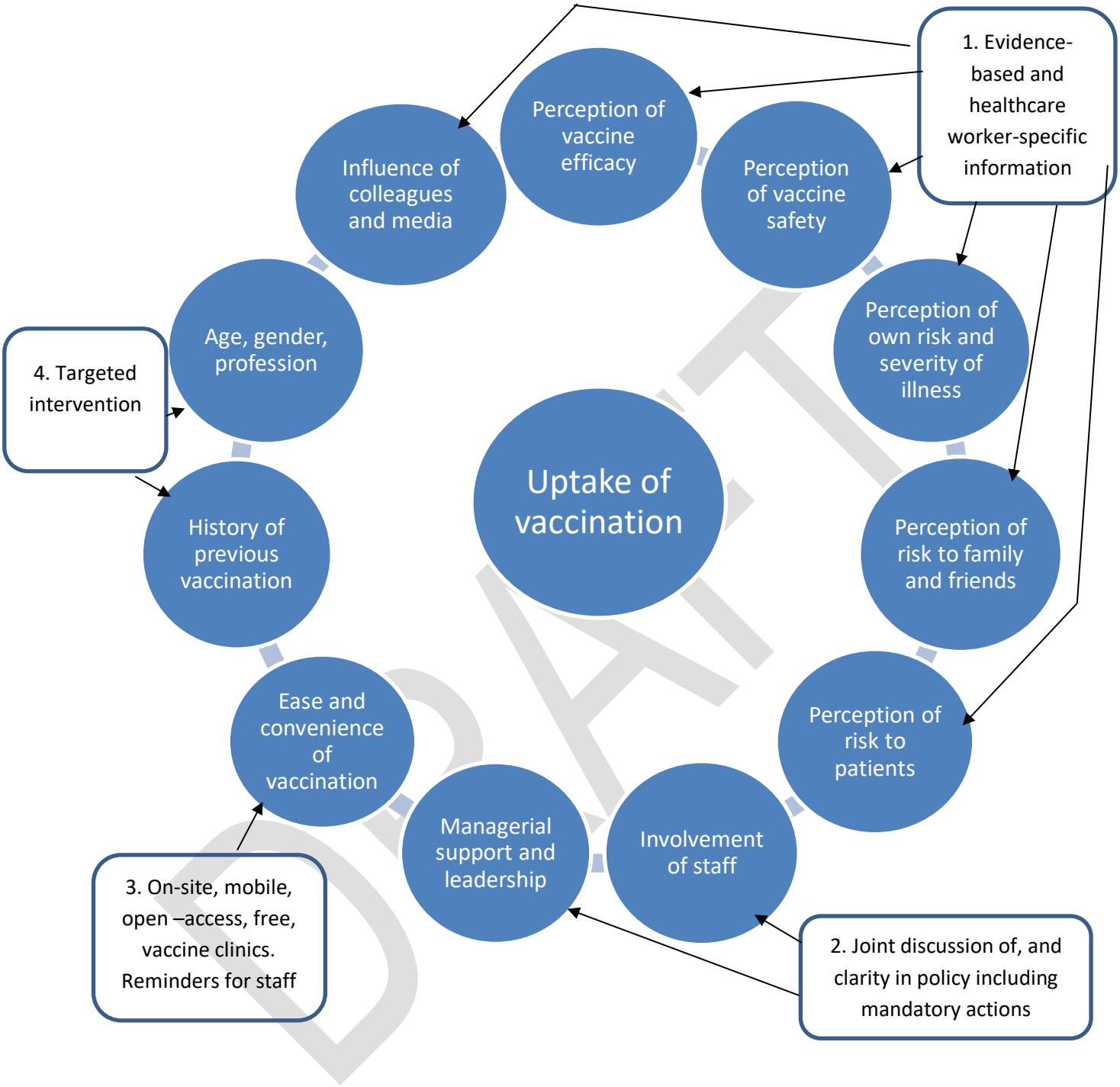

Figure 2. Summary of influencing factors and multiple elements of interventions

Lack of convenience or access to vaccination was a commonly reported obstacle by healthcare workers, so any intervention should ensure that this factor is addressed as a primary element. Having mobile or on-site clinics was a key element of effective interventions. Studies on pandemic influenza stressed that convenience of vaccination should be given even

more consideration during times of high demand. The requirement for vaccination to be free for staff was emphasised, and provision of reminders was reported to be of value.

The literature indicates that influenza vaccination uptake is particularly poor amongst some staff groups including females, younger staff, and the nursing profession. If rates are to be increased beyond moderate levels it seems important to examine what factors underpin decision-making against vaccination for these individuals. There also seems a particular need for the involvement of these groups in intervention development, in order to address obstacles that are experienced by these staff.

Strengths and limitations

This rapid review was undertaken by an experienced team, including methodological experts. We followed a protocol developed in collaboration with the NIHR HS&DR programme team as the review was designed to provide timely information to stakeholders, and to help clarify research priorities. The protocol was registered prospectively with the PROSPERO database of systematic review protocols.

We performed a search for published literature dating back to 2010 (a span of 10 years) in a range of databases, which was supplemented by searching for similar papers to key studies and reference list checking of reviews. This was clearly worthwhile as three included reviews were identified via these means.

The requirement to produce the review rapidly, and the volume of relevant literature identified meant that we abbreviated the review process by prioritising detailed scrutiny of review-level sources, and supplemented this with only screening and collecting data from the abstracts of other primary studies. We also used study design as a proxy for quality, and did not carry out quality appraisal of included sources. This may be considered a limitation when measured against the gold standard of full systematic review methods, but enabled us to provide key messages for stakeholders in a timely fashion.

A strength of the review is that we considered both quantitative and qualitative data, with the evidence regarding views and perceptions of staff providing key insights into barriers to intervention efficacy. In the narrative synthesis, we drew on both these sources of evidence to provide a detailed examination of how and where intervention elements may be beneficial.

We have summarised the evidence from the studies using a framework that we hope will be helpful for decision-makers needing a summary overview.

Implications for healthcare

1. Multiple components should be included within interventions aiming to increase the uptake of vaccinations amongst healthcare staff.

2. Ease of access to vaccination via the provision of walk-in, on-site or mobile clinics is associated with increased uptake of vaccinations.

3. Messaging aimed at healthcare workers should address knowledge and understandings of vaccination safety and efficacy, levels of personal risk, and the risk to others.

4. Information campaigns should be tailored specifically for healthcare worker audiences rather than duplicating messages intended for the general population. There should be a focus on providing the evidence underpinning information, including staff as sources of transmission.

5. Review of the literature highlights that there is a need to consider the clarity of vaccination policies within organisations, with the involvement of staff in developing policies of potential value. Managerial support and leadership is important, together with a focus of on staff wellbeing rather than economic and service delivery rationales.

6. While mandatory policies increase vaccination, there are acceptability and ethical consideration which require further discussion and debate within healthcare and wider society. Some mandatory actions (such as formal opt out) may be more acceptable than others such as compulsory vaccination.

7. The literature indicates that particular groups are less likely to take up vaccination (younger staff, females, nursing profession), so may need to be specifically targeted if uptake rates are to be improved.

8. Review of the evidence suggests that there is little difference between actions aiming to improve the uptake of vaccination during times of pandemic versus seasonal vaccination. Although attention to ensuring easy access, and evidence-based messaging may be of increased importance.

Recommendations for research

1. Further research is needed regarding the key components of multi-element interventions.

2. Further high quality evidence is needed which uses study designs other than cross-sectional and surveys to evaluate interventions.

3. Further evidence is needed regarding the association between the vaccination status of staff, and risk to patients and fellow staff. This is important to inform evidence-based messages for staff, and debates regarding mandatory measures. Examination of data on transmission of other types of infection in hospital environments may provide transferable learning.

4. There was a suggestion that intervention effectiveness may vary by healthcare setting, with hospital-based programmes offering less effectiveness. Greater evaluation of these differences and exploration of contextual factors would be beneficial.

5. Further research on the implementation, acceptability and efficacy of vaccination status monitoring systems would be beneficial, together with further exploration of societal and worker views regarding mandatory components.

6. Existing research provides a clear consensus regarding the factors which influence vaccination uptake, and further primary studies on this topic are unlikely to add to the evidence base.

Conclusions

There is evidence that interventions can increase the uptake of influenza vaccination, but the effects tend to be modest for actions which do not involve mandatory components. Interventions with multiple elements lead to greater effectiveness than single actions. Components should include easy access to vaccination, and evidence-based and healthcare staff tailored messaging about safety and efficacy, personal risk, and risk to others. Leadership, managerial support, and staff involvement in programmes are important to consider. Wider debate regarding organisational policies and mandatory actions is required if uptake is to reach high levels amongst healthcare workers.

Disclaimer

This report presents independent research funded by the National Institute for Health Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health and Social Care. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health and Social Care.

Acknowledgements

We thank the members of the Sheffield Evidence Synthesis Centre Public Advisory Group for their contributions.

Contribution of authors

Susan K Baxter (Senior Research Fellow in Public Health): Protocol development; study selection; report writing
Anna Cantrell (Research Associate in Health Economics and Decision Science): Information retrieval
Duncan Chambers (Research Fellow in Public Health): Study selection; data extraction
Lindsay Blank (Research Fellow in Public Health): Study selection; data extraction
Elizabeth Goyder (Professor in Public Health) Protocol development
All authors commented on drafts of the protocol and report

Data sharing

Any additional data not included in this report and its appendices are available on request. All queries should be submitted to the corresponding author.

References

1. Rolewicz L, Palmer B. *The NHS workforce in numbers.* London: Nuffield Trust; 2019.
2. West M. *The NHS crisis of caring for staff: what do we need to do?* London: Kings Fund; 2019.
3. Adibe B, Perticone, K., Hebert, C. *Creating Wellness in a Pandemic: A Practical Framework for Health Systems Responding to Covid-19*. London: Nejm Catalyst Innovations in Care Delivery; 2020.
4. Gianino MM, Politano G, Scarmozzino A, Stillo M, Amprino V, Di Carlo S*, et al.* Cost of Sickness Absenteeism during Seasonal Influenza Outbreaks of Medium Intensity among Health Care Workers. *International Journal of Environmental Research and Public Health* 2019;**16**
5. Meijboom MJ, Riphagen-Dalhuisen J, Hak E. The potential economic value of influenza vaccination for healthcare workers in The Netherlands. *Influenza and other Respiratory Viruses* 2018;**12**:457-64.
6. Talbot TR. Revised SHEA position paper: Influenza vaccination of healthcare personnel. *Infection Control and Hospital Epidemiology* 2010;**31:** 987-995.
7. Dini G, Toletone A, Sticchi L, Orsi A, Bragazzi NL, Durando P. Influenza vaccination in healthcare workers: A comprehensive critical appraisal of the literature. *Human Vaccines & Immunotherapeutics* 2018;**14**:772-89.
8. Giannattasio A, Mariano M, Romano R, Chiatto F, Liguoro I, Borgia G*, et al.* Sustained low influenza vaccination in health care workers after H1N1 pandemic: a cross sectional study in an Italian health care setting for at-risk patients. *BMC Infectious Diseases* 2015;**15**:329.
9. Music T. Protecting patients, protecting healthcare workers: a review of the role of influenza vaccination. *International Nursing Review* 2012;**59**:161-7.
10. Honda H, Padival S, Shimamura Y, Babcock HM. Changes in influenza vaccination rates among healthcare workers following a pandemic influenza year at a Japanese tertiary care centre. *The Journal of Hospital Infection* 2012;**80**:316-20.
11. Bellia C, Setbon M, Zylberman P, Flahault A. Healthcare worker compliance with seasonal and pandemic influenza vaccination. *Influenza and Other Respiratory Viruses* 2013;**7 Suppl 2**:97-104.
12. Brunton G, Oliver S, Thomas J. Innovations in framework synthesis as a systematic review method. *Research Synthesis Methods* 2020;**11**:316-30.
13. Moher D, Stewart L, Shekelle P. All in the Family: systematic reviews, rapid reviews, scoping reviews, realist reviews, and more. *Systematic Reviews* 2015;**4**:183.

14. Prematunge C, Corace K, McCarthy A, Nair RC, Pugsley R, Garber G. Factors influencing pandemic influenza vaccination of healthcare workers--a systematic review. *Vaccine* 2012;**30**:4733-43.

15. Lam P-P, Chambers LW, MacDougall DMP, McCarthy AE. Seasonal influenza vaccination campaigns for health care personnel: systematic review. *Canadian Medical Association Journal* 2010;**182**:E542-8.

16. Imai C, Toizumi M, Hall L, Lambert S, Halton K, Merollini K. A systematic review and meta-analysis of the direct epidemiological and economic effects of seasonal influenza vaccination on healthcare workers. *PLOS ONE* 2018;**13**:e0198685.

17. Ng ANM, Lai CKY. Effectiveness of seasonal influenza vaccination in healthcare workers: a systematic review. *Journal of Hospital Infection* 2011;**79**:279-286.

18. Vasilevska M, Ku J, Fisman DN. Factors associated with healthcare worker acceptance of vaccination: a systematic review and meta-analysis. *Infection Control and Hospital Epidemiology* 2014;**35**:699-708.

19. Lorenc T, Marshall D, Wright K, Sutcliffe K, Sowden A. Seasonal influenza vaccination of healthcare workers: systematic review of qualitative evidence. *BMC Health Services Research* 2017;**17**:732.

20. Rashid H, Yin JK, Ward K, King C, Seale H, Booy R. Assessing Interventions To Improve Influenza Vaccine Uptake Among Health Care Workers. *Health Affairs* 2016;**35**:284-92.

21. Corace KM, Srigley JA, Hargadon DP, Yu D, MacDonald TK, Fabrigar LR*, et al.* Using behavior change frameworks to improve healthcare worker influenza vaccination rates: A systematic review. *Vaccine* 2016;**34**:3235-42.

22. Hollmeyer H, Hayden F, Mounts A, Buchholz U. Review: interventions to increase influenza vaccination among healthcare workers in hospitals. *Influenza and Other Respiratory Viruses* 2013;**7**:604-21.

23. Seale H, Macintyre CR. Seasonal influenza vaccination in Australian hospital health care workers: a review. *The Medical Journal of Australia* 2011;**195**:336-8.

24. Stuart MJ. Review of strategies to enhance the uptake of seasonal influenza vaccination by Australian healthcare workers. *Communicable diseases Intelligence Quarterly Report* 2012;**36**:E268-76.

25. Abramson ZH, Avni O, Levi O, Miskin IN. Randomized trial of a program to increase staff influenza vaccination in primary care clinics. *Annals of Family Medicine* 2010;**8**:293-8.

26. Ajenjo MC, Woeltje KF, Babcock HM, Gemeinhart N, Jones M, Fraser VJ. Influenza vaccination among healthcare workers: ten-year experience of a large healthcare organization. *Infection Control and Hospital Epidemiology* 2010;**31**:233-40.

27. Akan H, Yavuz E, Yayla ME, Kulbay H, Kaspar EC, Zahmacioglu O*, et al.* Factors affecting uptake of influenza vaccination among family physicians. *Vaccine* 2016;**34**:1712-8.
28. Alhalaseh L, Yasein N. Influenza vaccine: Immunization rates, knowledgand attitudes of healthcare workers in Jordan. *Kuwait Medical Journal* 2020;**52**:156-63.
29. Antommaria AH, Prows CA. Content analysis of requests for religious exemptions from a mandatory influenza vaccination program for healthcare personnel. *Journal of Medical Ethics* 2018;**44**:389-91.
30. Antommaria AHM. An Ethical Analysis of Mandatory Influenza Vaccination of Health Care Personnel: Implementing Fairly and Balancing Benefits and Burdens. *American Journal of Bioethics* 2013;**13**:30-7.
31. Apisarnthanarak A. Reduction of seasonal influenza transmission among healthcare workers in an intensive care unit: A 4-year intervention study in Thailand. *Infection Control and Hospital Epidemiology* 2010;**31**:996-1003.
32. Arda B. Did the pandemic have an impact on influenza vaccination attitude? a survey among health care workers. *BMC Infectious Diseases* 2011;**11**.
33. Asma S, Akan H, Uysal Y, Pocan AG, Sucakli MH, Yengil E*, et al.* Factors effecting influenza vaccination uptake among health care workers: a multi-center cross-sectional study. *BMC Infectious Diseases* 2016;**16**:192.
34. Banach DB, Zhang C, Factor SH, Calfee DP. Support for mandatory health care worker influenza vaccination among allied health professionals, technical staff, and medical students. *American Journal of infection control* 2013;**41**:354-6.
35. Bert F, Thomas R, Lo Moro G, Scarmozzino A, Silvestre C, Zotti CM*, et al.* A new strategy to promote flu vaccination among health care workers: Molinette Hospital's experience. *Journal of Evaluation in Clinical Practice* 2020;**26**:1205-11.
36. Bonaccorsi G, Lorini C, Santomauro F, Guarducci S, Pellegrino E, Puggelli F*, et al.* Predictive factors associated with the acceptance of pandemic and seasonal influenza vaccination in health care workers and students in Tuscany, Central Italy. *Human Vaccines & Immunotherapeutics* 2013;**9**:2603-12.
37. Bonaccorsi G, Santomauro F, Porchia BR, Niccolai G, Pellegrino E, Bonanni P*, et al.* Beliefs and opinions of health care workers and students regarding influenza and influenza vaccination in Tuscany, Central Italy. *Vaccines* 2015;**3**:137-47.
38. Brandt C, Rabenau HF, Bornmann S, Gottschalk R, Wicker S. The impact of the 2009 influenza A(H1N1) pandemic on attitudes of healthcare workers toward seasonal influenza vaccination 2010/11. *European Communicable Disease Bulletin* 2011;**16**.
39. Chambers LW, Crowe L, Lam P-P, MacDougall D, McNeil S, Roth V*, et al.* A new approach to improving healthcare personnel influenza immunization programs: a randomized controlled trial. *PloS one* 2015;**10**:e0118368.

40. Conte A, Quattrin R, Filiputti E, Cocconi R, Arnoldo L, Tricarico P*, et al.* Promotion of flu vaccination among healthcare workers in an Italian academic hospital: An experience with tailored web tools. *Human Vaccines and Immunotherapeutics* 2016;**12**:2628-33.

41. Cozza V, Alfonsi V, Rota MC, Paolini V, Ciofi degli Atti ML. Promotion of influenza vaccination among health care workers: findings from a tertiary care children's hospital in Italy. *BMC Public Health* 2015;**15**:697.

42. Crupi RS, Di John D, Mangubat PM, Asnis D, Devera J, Maguire P*, et al.* Linking emergency preparedness and health care worker vaccination against influenza: a novel approach. *Joint Commission Journal on Quality and Patient Safety* 2010;**36**:499-503.

43. Daugherty EL. Perceptions and influence of a hospital influenza vaccination policy. *Infection Control and Hospital Epidemiology* 2011;**32**.

44. Dedoukou X, Nikolopoulos G, Maragos A, Giannoulidou S, Maltezou HC. Attitudes towards vaccination against seasonal influenza of health-care workers in primary health-care settings in Greece. *Vaccine* 2010;**28**:5931-3.

45. Dubnov J, Kassabri W, Bisharat B, Rishpon S. Influenza vaccination coverage determinants among employees of the Nazareth Hospital in Israel. *The Israel Medical Association Journal* 2010;**12**:338-41.

46. Eaton JL, Mohr DC, McPhaul KM, Kaslow RA, Martinello RA. Access, Education and Policy Awareness: Predictors of Influenza Vaccine Acceptance Among VHA Healthcare Workers. *Infection Control and Hospital Epidemiology* 2017;**38**:970-5.

47. Edelstein M, Pebody R. Can we achieve high uptakes of influenza vaccination of healthcare workers in hospitals? A cross-sectional survey of acute NHS trusts in England. *Epidemiology and infection* 2014;**142**:438-47.

48. Feemster KA, Prasad P, Smith MJ, Feudtner C, Caplan A, Offit P*, et al.* Employee designation and health care worker support of an influenza vaccine mandate at a large pediatric tertiary care hospital. *Vaccine* 2011;**29**:1762-9.

49. Ferguson CD. Pandemic influenza vaccination: Will the health care system take its own medicine? *Australian Journal of Rural Health* 2010;**18**.

50. Fricke KL. Correlates of improved influenza vaccination of healthcare personnel : A survey of hospitals in Louisiana. *Infection Control and Hospital Epidemiology* 2013; 10.1086/670992.

51. Gilardi F, Castelli Gattinara G, Vinci MR, Ciofi Degli Atti M, Santilli V, Brugaletta R*, et al.* Seasonal Influenza Vaccination in Health Care Workers. A Pre-Post Intervention Study in an Italian Paediatric Hospital. *International Journal of Environmental Research and Public Health* 2018;**15**.

52. Heinrich-Morrison K, McLellan S, McGinnes U, Carroll B, Watson K, Bass P*, et al.* An effective strategy for influenza vaccination of healthcare workers in Australia: experience at a large health service without a mandatory policy. *BMC Infectious Diseases* 2015;**15**:42.

53. Henriksen Hellyer JM, DeVries AS, Jenkins SM, Lackore KA, James KM, Ziegenfuss JY*, et al.* Attitudes toward and uptake of H1N1 vaccine among health care workers during the 2009 H1N1 pandemic. *PloS One* 2011;**6**:e29478.

54. Hidiroglu S, Ay P, Topuzoglu A, Kalafat C, Karavus M. Resistance to vaccination: the attitudes and practices of primary healthcare workers confronting the H1N1 pandemic. *Vaccine* 2010;**28**:8120-4.

55. Hill JN, Smith BM, Evans CT, Anaya H, Goldstein B, LaVela SL. Implementing a declination form programme to improve influenza vaccine uptake by staff in Department of Veterans Affairs spinal cord injury centres: A pilot study. *Journal of Hospital Infection* 2015;**91**:158-65.

56. Hirsch P, Hodgson M, Davey V. Seasonal influenza vaccination of healthcare employees: results of a 4-year campaign. *Infection Control and Hospital Epidemiology* 2011;**32**:444-8.

57. Honda H, Sato Y, Yamazaki A, Padival S, Kumagai A, Babcock H. A successful strategy for increasing the influenza vaccination rate of healthcare workers without a mandatory policy outside of the United States: a multifaceted intervention in a Japanese tertiary care center. *Infection Control and Hospital Epidemiology* 2013;**34**:1194-200.

58. Hopman CE. Determination of factors required to increase uptake of influenza vaccination among hospital-based healthcare workers. *Journal of Hospital Infection* 2011;**77**.

59. Hussain H, McGeer A, McNeil S, Katz K, Loeb M, Simor A*, et al.* Factors associated with influenza vaccination among healthcare workers in acute care hospitals in Canada. *Influenza and other Respiratory Viruses* 2018;**12**:319-25.

60. Lee SJ, Harrison R, Rosenberg J, McLendon P, Boston E, Lindley MC. Influenza vaccination among health care personnel in California: 2010-2011 influenza season. *American Journal of Infection Control* 2013;**41**:e65-e71.

61. Lehmann BA, Chapman GB, Franssen FME, Kok G, Ruiter RAC. Changing the default to promote influenza vaccination among health care workers. *Vaccine* 2016;**34**:1389-92.

62. Lewthwaite P, Campion K, Blackburn B, Kemp E, Major D, Sarangi K. Healthcare workers' attitude towards influenza vaccination after the 2009 pandemic. *Occupational Medicine* 2014;**64**:348-51.

63. Liao QY, Ng TWY, Cowling BJ. What influenza vaccination programmes are preferred by healthcare personnel? A discrete choice experiment. *Vaccine* 2020;**38**:4557-63.

64. Lin CJ, Nowalk MP, Zimmerman RK. Estimated costs associated with improving influenza vaccination for health care personnel in a multihospital health system. *Joint Commission Journal on Quality and Patient Safety* 2012;**38**:67-72.

65. Lindley MC, Dube D, Kalayil EJ, Kim H, Paiva K, Raymond P. Qualitative evaluation of Rhode Island's healthcare worker influenza vaccination regulations. *Vaccine* 2014;**32**:5962-6.

66. Lindley MC, Mu Y, Hoss A, Pepin D, Kalayil EJ, van Santen KL*, et al.* Association of State Laws With Influenza Vaccination of Hospital Personnel. *American Journal of Preventive Medicine* 2019;**56**:e177-e83.

67. Little KE, Goodridge S, Lewis H, Lingard SW, Din S, Tidley M*, et al.* Occupational vaccination of health care workers: uptake, attitudes and potential solutions. *Public Health* 2015;**129**:755-62.

68. Llupia A. New interventions to increase influenza vaccination rates in health care workers. *American Journal of Infection Control* 2010;**38**.

69. Llupia A, Mena G, Olive V, Quesada S, Aldea M, Sequera VG*, et al.* Evaluating influenza vaccination campaigns beyond coverage: a before-after study among health care workers. *American Journal of infection Control* 2013;**41**:674-8.

70. Looijmans-van den Akker I, Hulscher ME, Verheij TJ, Riphagen-Dalhuisen J, van Delden JJ, Hak E. How to develop a program to increase influenza vaccine uptake among workers in health care settings? *Implementation Science* 2011;**6**:47.

71. Ma X. Knowledge and attitudes of healthcare workers in Chinese intensive care units regarding 2009 H1N1 influenza pandemic. *BMC Infectious Diseases* 2011;**11**:24.

72. Maltezou HC, Katerelos P, Protopappa K, Dounias G. Seasonal influenza vaccination in healthcare personnel in Greece: 3-year report. *Future Microbiology* 2019;**14**:55-8.

73. Maurer J, Harris KM, Black CL, Euler GL. Support for seasonal influenza vaccination requirements among US healthcare personnel. *Infection Control and Hospital Epidemiology* 2012;**33**:213-21.

74. McLlwain C. Learning the lessons from the H1N1 vaccination campaign for health care workers. London: Department of Health, 2010.

75. Mo PKH, Wong CHW, Lam EHK. Can the Health Belief Model and moral responsibility explain influenza vaccination uptake among nurses? *Journal of Advanced Nursing* 2019;**75**:1188-206.

76. Mustafa M, Al-Khal A, Al Maslamani M, Al Soub H. Improving influenza vaccination rates of healthcare workers: a multipronged approach in Qatar. *Eastern Mediterranean Health Journal* 2017;**23**:303-10.

77. Mytton OT, O'Moore EM, Sparkes T, Baxi R, Abid M. Knowledge, attitudes and beliefs of health care workers towards influenza vaccination. *Occupational Medicine* 2013; 10: 189-195.

78. Nace DA, Handler SM, Hoffman EL, Perera S. Impact of the raising immunizations safely and effectively (RISE) program on healthcare worker influenza immunization rates in long term care settings. *Journal of the American Medical Directors Association* 2012;**13**:806-10.

79. Napolitano F, Bianco A, D'Alessandro A, Papadopoli R, Angelillo IF. Healthcare workers' knowledge, beliefs, and coverage regarding vaccinations in critical care units in Italy. *Vaccine* 2019;**37**:6900-6.

80. Nowalk MP. Establish the habit : Influenza vaccination for health care personnel. *Journal for Healthcare Quality* 2010;**32**.

81. Oguz MM. Improving influenza vaccination uptake among healthcare workers by on-site influenza vaccination campaign in a tertiary children hospital. *Human vaccines & immunotherapeutics* 2019;**15**:1060-5.

82. Parlakay AO, Abdulmumin AH, Kara A, Cengiz AB, Ince E, Ciftci E*, et al.* Prior to influenza pandemics 2009 evaluation of views of health care staff. *Cocuk Enfeksiyon Dergisi* 2012;**6**:37-9.

83. Parry HM, Damery S, Fergusson A, Draper H, Bion J, Low AE. Pandemic influenza A (H1N1) 2009 in a critical care and theatre setting: Beliefs and attitudes towards staff vaccination. *Journal of Hospital Infection* 2011;**78**:302-7.

84. Petek D, Kamnik-Jug K. Motivators and barriers to vaccination of health professionals against seasonal influenza in primary healthcare. *BMC Health Services Research* 2018;**18**:853.

85. Podczervinski S, Stednick Z, Helbert L, Davies J, Jagels B, Gooley T*, et al.* Employee influenza vaccination in a large cancer center with high baseline compliance rates: comparison of carrot versus stick approaches. *American Journal of Infection Control* 2015;**43**:228-33.

86. Quach S. Immunizing health care workers against influenza : A glimpse into the challenges with voluntary programs and considerations for mandatory policies. *American Journal of Infection Control* 2013.

87. Quan K. Voluntary to mandatory : evolution of strategies and attitudes toward influenza vaccination of healthcare personnel. *Infection Control and Hospital Epidemiology* 2012;**33**.

88. Quintyne KI, Daly E, Brabazon E, Finnegan P, Kavanagh P. Attitudes and uptake of seasonal Influenza Vaccination for Health Service Executive (HSE) Staff. *Irish Medical Journal* 2018;**111**:749.

89. Rabensteiner A, Buja A, Regele D, Fischer M, Baldo V. Healthcare worker's attitude to seasonal influenza vaccination in the South Tyrolean province of Italy: barriers and facilitators. *Vaccine* 2018;**36**:535-44.

90. Rakita RM. Mandatory influenza vaccination of healthcare workers: a 5-year study. *Infection Control and Hospital Epidemiology* 2010;**31**.

91. Rodriguez-Fernandez R, Martinez-Lopez AB, Perez-Moreno J, Gonzalez-Sanchez MI, Gonzalez-Martinez F, Hernandez-Sampelayo T*, et al.* Impact of an influenza vaccine educational programme on healthcare personnel. *Epidemiology and Infection* 2016;**144**:2290-4.

92. Rong H, Lai X, Ma X, Hou Z, Li S, Jing R*, et al.* Seasonal influenza vaccination and recommendation: The difference between general practitioners and public health workers in China. *Vaccines* 2020;**8**.

93. Rothan-Tondeur M, Filali-Zegzouti Y, Golmard JL, De Wazieres B, Piette F, Carrat F*, et al.* Randomised active programs on healthcare workers' flu vaccination in geriatric health care settings in France: the VESTA study. *The Journal of Nutrition, Health & Aging* 2011;**15**:126-32.

94. Sawyer MH, Peddecord KM, Wang W, Deguire M, Miskewitch-Dzulynsky M, Vuong DD. A public health initiative to increase annual influenza immunization among hospital health care personnel: the San Diego Hospital Influenza Immunization Partnership. *American Journal of infection Control* 2012;**40**:595-600.

95. Schult TM, Awosika ER, Hodgson MJ, Hirsch PR, Nichol KL, Dyrenforth SR*, et al.* Innovative approaches for understanding seasonal influenza vaccine declination in healthcare personnel support development of new campaign strategies. *Infection Control and Hospital Epidemiology* 2012;**33**:924-31.

96. Seale H, Kaur R, Wang Q, Yang P, Zhang Y, Wang X*, et al.* Acceptance of a vaccine against pandemic influenza A (H1N1) virus amongst healthcare workers in Beijing, China. *Vaccine* 2011;**29**:1605-10.

97. Seale H, Leask J, MacIntyre CR. Attitudes amongst Australian hospital healthcare workers towards seasonal influenza and vaccination. *Influenza and Other Respiratory Viruses* 2010;**4**:41-6.

98. Seale H, Wang Q, Yang P, Dwyer DE, Wang X, Zhang Y*, et al.* Influenza vaccination amongst hospital health care workers in Beijing. *Occupational Medicine* 2010;**60**:335-9.

99. Shrikrishna D, Williams S, Restrick L, Hopkinson NS. Influenza vaccination for NHS staff: Attitudes and uptake. *BMJ Open Respiratory Research* 2015;**2**:1-4.

100. Socan M, Erculj V, Lajovic J. Knowledge and attitudes on pandemic and seasonal influenza vaccination among Slovenian physicians and dentists. *European Journal of Public Health* 2013;**23**:92-7.

101. Stead M, Critchlow N, Eadie D, Sullivan F, Gravenhorst K, Dobbie F. Mandatory policies for influenza vaccination: Views of managers and healthcare workers in England. *Vaccine* 2019;**37**:69-75.
102. Tagajdid MR, El Annaz H, Belefquih B, Doblali T, Casalegno JS, Mekki Y*, et al.* Factors influencing uptake of influenza vaccine amongst healthcare workers in a regional center after the A(H1N1) 2009 pandemic: lessons for improving vaccination rates. *The International Journal of Risk & Safety in Medicine* 2011;**23**:249-54.
103. Thompson MG, McIntyre AF, Naleway AL, Black C, Kennedy ED, Ball S*, et al.* Potential influence of seasonal influenza vaccination requirement versus traditional vaccine promotion strategies on unvaccinated healthcare personnel. *Vaccine* 2013;**31**:3915-21.
104. Tognetto A, Zorzoli E, Franco E, Gervasi G, Paglione L, Di Ninno F*, et al.* Seasonal influenza vaccination among health-care workers: the impact of different tailored programs in four University hospitals in Rome. *Human Vaccines & Immunotherapeutics* 2020;**16**:81-5.
105. Virseda S, Restrepo MA, Arranz E, Magan-Tapia P, Fernandez-Ruiz M, de la Camara AG*, et al.* Seasonal and Pandemic A (H1N1) 2009 influenza vaccination coverage and attitudes among health-care workers in a Spanish University Hospital. *Vaccine* 2010;**28**:4751-7.
106. Yassi A. Vaccination of health care workers for influenza: promote safety culture, not coercion. *Canadian Journal of Public Health* 2010;**101**.
107. Yue X, Black C, Ball S, Donahue S, De Perio MA, Laney AS*, et al.* Workplace interventions associated with influenza vaccination coverage among health care personnel in ambulatory care settings during the 2013-2014 and 2014-2015 influenza seasons. *American Journal of Infection Control* 2017;**45**:1243-8.
108. Zielonka TM, Szymanczak M, Jakubiak J, Nitsch-Osuch A, Zycinska K. Influenza vaccination coverage rate for medical staff: Influence of hospital-based vaccination campaign. *Advances in Experimental Medicine and Biology* 2016;**885**:31-8.
109. FitzSimons D, Hendrickx G, Lernout T, Badur S, Vorsters A, Van Damme P. Incentives and barriers regarding immunization against influenza and hepatitis of health care workers. *Vaccine* 2014;**32**:4849-54.

Appendix 1. Example search strategy

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to November 02, 2020>

Search Strategy:

---

1 Mental Health/ (39781)

2 Mental Disorders/ (163851)

3 (wellbeing or well being).ti,ab. (94086)

4 mental health.ti,ab. (147625)

5 Depression/ (121305)

6 depress$.ab,ti. (465824)

7 Anxiety/ (82632)

8 exp Anxiety Disorders/ (79934)

9 anxiet$.ab,ti. (196443)

10 Suicide/ (39609)

11 suicid$.ab,ti. (78763)

12 Health Status/ (82585)

13 "Quality of Life"/ (199092)

14 health$.ab,ti. (2797600)

15 exp Health/ (371000)

16 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (3724268)

17 health workforce/ or exp health personnel/ (531770)

18 "nhs staff".ab,ti. (564)

19 "nhs workforce".ab,ti. (113)

20 17 or 18 or 19 (532214)

21 16 and 20 (171389)

22 Pandemics/ (38109)

23 pandemic$.ab,ti. (53918)

24 exp coronavirus/ (40149)

25 exp Coronavirus Infections/ (43458)

26 ((corona* or corono*) adj1 (virus* or viral* or virinae*)).ti,ab,kw,kf. (2216)

27 (coronavirus* or coronovirus* or coronavirinae* or CoV or HCoV*).ti,ab,kw,kf. (50181)

28 ("2019-nCoV" or 2019nCoV or nCoV2019 or "nCoV-2019" or "COVID-19" or COVID19 or "CORVID-19" or CORVID19 or "WN-CoV" or WNCoV or "HCoV-19" or HCoV19 or "2019 novel*" or Ncov or "n-cov" or "SARS-CoV-2" or "SARSCoV-2" or "SARSCoV2" or "SARS-CoV2" or SARSCov19 or "SARS-Cov19" or "SARSCov-19" or "SARS-Cov-19" or Ncovor or Ncorona* or Ncorono* or NcovWuhan* or NcovHubei* or NcovChina* or NcovChinese* or SARS2 or "SARS-2" or SARScoronavirus2 or "SARS-coronavirus-2" or "SARScoronavirus 2" or "SARS coronavirus2" or SARScoronovirus2 or "SARS-coronovirus-2" or "SARScoronovirus 2" or "SARS coronovirus2").ti,ab,kw,kf. (66628)

29 (respiratory* adj2 (symptom* or disease* or illness* or condition*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw,kf. (541)

30 (("seafood market*" or "food market*" or pneumonia*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw,kf. (1663)

31 ((outbreak* or wildlife* or pandemic* or epidemic*) adj1 (Wuhan* or Hubei or China* or Chinese* or Huanan*)).ti,ab,kw,kf. (319)

32 Middle East Respiratory Syndrome Coronavirus/ (1380)

33 ("middle east respiratory syndrome*" or "middle eastern respiratory syndrome*" or MERSCoV or "MERS-CoV" or MERS).ti,ab,kw,kf. (5985)

34 ("severe acute respiratory syndrome*" or SARS).ti,ab,kw,kf. (33617)

35 ("SARS-CoV-1" or "SARSCoV-1" or "SARSCoV1" or "SARS-CoV1" or SARSCoV or SARS-CoV or SARS1 or "SARS-1" or SARScoronavirus1 or "SARS-coronavirus-1" or "SARScoronavirus 1" or

"SARS coronavirus1" or SARScoronovirus1 or "SARS-coronovirus-1" or "SARScoronovirus 1" or "SARS coronovirus1").ti,ab,kw,kf. (24105)

36 or/24-35 (97614)

37 Influenza A Virus, H1N1 Subtype/ (15515)

38 (h1n1 or "swine flu" or "swine adj3 influenza").ab,kf,kw,ti. (18219)

39 Influenza, Human/ (50003)

40 (flu$ or influenza$).ab,ti. (1681738)

41 or/22-40 (1788684)

42 21 and 41 (5616)

43 Health Promotion/ (74600)

44 ((organi?ation$ or workplace$ or workforce$ or staff$) adj3 (intervention$ or program$ or project$ or support$)).ab,ti. (28416)

45 ((promot$ or support$ or service$ or project$ or program$ or priorit$) adj3 (emotion$ or health$ or wellbeing or "well being" or wellness)).ab,ti. (303651)

46 or/43-45 (372834)

47 42 and 46 (809)

48 limit 47 to humans (791)

49 limit 48 to english language (753)

50 limit 49 to yr="2010 -Current" (551)

51 winter demand$.ab,ti. (3)

52 winter pressure$.ab,ti. (80)

53 winter surge$.ab,ti. (11)

54 Seasons/ (107578)

55 Cold Temperature/ (51667)

56 51 or 52 or 53 or 54 or 55 (157352)

57 16 and 20 and 46 and 56 (48)

58 limit 57 to humans (48)

59 limit 58 to english language (45)

60 limit 59 to yr="2010 -Current" (29)

61 60 not 50 (11)

Appendix 2. Studies excluded at full paper review

1. Al Knawy BA, Al-Kadri HMF, Elbarbary M, Arabi Y, Balkhy HH, Clark A. Perceptions of postoutbreak management by management and healthcare workers of a Middle East

respiratory syndrome outbreak in a tertiary care hospital: a qualitative study. BMJ open. 2019;9(5):e017476.

2. AlAteeq DA, Aljhani S, Althiyabi I, Majzoub S. Mental health among healthcare providers during coronavirus disease (COVID-19) outbreak in Saudi Arabia. Journal of Infection and Public Health. 2020;13(10):1432-7.

3. Alquezar-Arbe A, Pinera P, Jacob J, Martin A, Jimenez S, Llorens P, et al. Impact of the COVID-19 pandemic on hospital emergency departments: results of a survey of departments in 2020 - the Spanish ENCOVUR study. Emergencias. 2020;32(5):320-31.

4. Asmundson GJG, Taylor S. How health anxiety influences responses to viral outbreaks like COVID-19: What all decision-makers, health authorities, and health care professionals need to know. Journal of Anxiety Disorders. 2020;71 (no pagination).

5. Bielicki JA, Duval X, Gobat N, Goossens H, Koopmans M, Tacconelli E, et al. Monitoring approaches for health-care workers during the COVID-19 pandemic. The Lancet Infectious Diseases. 2020;20(10):e261-e7.

6. Calo F, Russo A, Camaioni C, De Pascalis S, Coppola N. Burden, risk assessment, surveillance and management of SARS-CoV-2 infection in health workers: a scoping review. Infectious Diseases of Poverty. 2020;9(1):139.

7. Capolongo S, Gola M, Brambilla A, Morganti A, Mosca EI, Barach P. COVID-19 and healthcare facilities: A decalogue of design strategies for resilient hospitals. Acta Biomedica. 2020;91(Supplement 9):50-60.

8. Carenzo L, Costantini E, Greco M, Barra FL, Rendiniello V, Mainetti M, et al. Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy. Anaesthesia. 2020;75(7):928-34.

9. Carlson AL, Budd AP, Perl TM. Control of influenza in healthcare settings: early lessons from the 2009 pandemic. Current opinion in infectious diseases. 2010;23(4):293-9.

10. Conversano C, Marchi L, Miniati M. Psychological distress among healthcare professionals involved in the COVID-19 emergency: Vulnerability and resilience factors. Clinical Neuropsychiatry. 2020;17(2):94-6.

11. Dunn M, Sheehan M, Hordern J, Turnham HL, Wilkinson D. 'Your country needs you': the ethics of allocating staff to high-risk clinical roles in the management of patients with COVID-19. Journal of medical ethics. 2020;46(7):436-40.

12. El-Hage W, Hingray C, Lemogne C, Yrondi A, Brunault P, Bienvenu T, et al. Health professionals facing the coronavirus disease 2019 (COVID-19) pandemic: What are the mental health risks? Encephale. 2020;46(3 Supplement):S73-S80.

13. FitzSimons D, Hendrickx G, Lernout T, Badur S, Vorsters A, Van Damme P. Incentives and barriers regarding immunization against influenza and hepatitis of health care workers. Vaccine. 2014;32(38):4849-54.

14. Maltezou HC, Tsakris A. Vaccination of health-care workers against influenza: our obligation to protect patients. Influenza and other respiratory viruses. 2011;5(6):382-8.

15. Music T. Protecting patients, protecting healthcare workers: a review of the role of influenza vaccination. International nursing review. 2012;59(2):161-7.

16. Soklaridis S, Lin E, Lalani Y, Rodak T, Sockalingam S. Mental health interventions and supports during COVID- 19 and other medical pandemics: A rapid systematic review of the evidence. General Hospital Psychiatry. 2020;66:133-46.

17. Stewart AM, Cox MA. State law and influenza vaccination of health care personnel. Vaccine. 2013;31(5):827-32.

18. Stuart RL, Gillespie EE, Kerr PG. A pilot study of an influenza vaccination or mask mandate in an Australian tertiary health service. The Medical journal of Australia. 2014;200(2):83-4.