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Vaccination policies for healthcare personnel: Current challenges and future perspectives

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ABSTRACT

Healthcare personnel (HCP) are at occupational risk for acquisition of several vaccine-preventable diseases and transmission to patients. Vaccinations of HCP are justified to confer them immunity but also to protect susceptible patients and healthcare services from outbreaks, HCP absenteeism and presenteeism. Mandatory vaccination policies for HCP are increasingly adopted and achieve high and sustainable vaccination rates in short term. In this article we review the scientific evidence for HCP vaccination. We also address issues pertaining to vaccination policies for HCP and present the challenges of implementation of mandatory versus voluntary vaccination policies. Finally, we discuss the issue of mandatory vaccination of HCP against COVID-19.

Introduction

Vaccinations had a tremendous impact on human morbidity and mortality the past decades saving two to three million lives every year [1]. Yet, even countries with long-lasting vaccination programs continue to experience serious epidemics of vaccine-preventable diseases (VPDs) [2–4]. Healthcare personnel (HCP) constitute an occupational group disproportionately affected by several VPDs [5]. Moreover, HCP have been often traced as sources of transmission of VPDs to susceptible patients and onset of outbreaks [5–8]. Vaccinations of HCP are justified to confer them immunity against specific VPDs. Equally important is to indirectly protect vulnerable patients, especially those who cannot get vaccinated because of host factors (e.g. young infants, pregnant women) or those who do not elicit satisfactory immune responses after vaccination (e.g. elderly, immunocompromised patients). An additional benefit of HCP vaccinations is the protection of healthcare facilities from outbreaks and HCP absenteeism and presenteeism [5].

Seasonal influenza and hepatitis B vaccines are the prototype occupational vaccines for HCP for more than three decades. Since then, vaccination programs for HCP expanded in many countries and currently are integral component of infection control in healthcare facilities but also of preparedness and response plans for public health threats of global importance [9–12]. However, significant differences are noted between countries regarding indications and implementation frame (mandatory or voluntary vaccinations) [9,10,12]. Milestones in the configuration of modern vaccination policies for HCP include the 2009 A/H1N1 influenza pandemic and the recent measles epidemics in Europe. It is highly likely that the coronavirus disease 2019 (COVID-19) pandemic will also affect vaccination policies for HCP. This article presents the scientific rationale for vaccinating HCP and address issues pertaining to vaccination policies, under the prism of the ongoing COVID-19 pandemic.

Abbreviations: HCP, healthcare personnel; VPD, vaccine-preventable disease; COVID-19, coronavirus disease 2019; US, United States; WHO, World Health Organization; ILI, influenza-like illness; PCR, polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; VE, vaccine effectiveness; CI, confidence interval; RR, relative risk; ICU, intensive care unit; NICU, neonatal intensive care unit; MMR, measles-mumps-rubella.

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Scientific background for HCP vaccination: What is the evidence?

HCP are frequently exposed to VPDs

It has been long recognized that HCP are a high risk occupational group for acquisition of VPDs [5]. Every year three million HCP are exposed to bloodborne pathogens through a percutaneous route, of which two million are exposed to hepatitis B. However, 40–75% of these injuries are underreported [13]. A *meta*-analysis of 58,245 laboratory-confirmed influenza cases showed that approximately 19% of unvaccinated HCP are infected with influenza virus every year compared with 5.4% of unvaccinated adults employed in non-healthcare settings [14]. Surveillance data also showed that HCP accounted for up to 7% of notified cases of measles in Europe the past years while several fatalities occurred among them [7,15,16]. Many VPDs that are considered as childhood diseases are associated with a serious course in adults. A modeling study using data from the United States (US) explored how modern routine vaccination programs have altered the risks of some VPDs [17]. The authors estimated that negative outcomes are 4.5 times increased for measles, 2.2 times increased for chickenpox, and 5.8 times increased for rubella in predominantly vaccine-protected communities compared to the pre-vaccine era, because of the significantly lower age at natural infection before the introduction of vaccinations [17]. The risk of measles in adulthood was fully realized during the 2017–2018 measles epidemic in Greece, when HCP had a 5.5-fold incidence rate of measles and concomitantly a 2-fold rate of measles-associated complications compared with the general population [15]. HCP are also a high-risk group for COVID-19. According to the World Health Organization (WHO), at least 115,000 HCP have died globally to COVID-19 as of May 2021 [18]. Overall, HCP are at occupational risk for COVID-19, influenza, measles, mumps, rubella, varicella, pertussis, hepatitis A, hepatitis B, tuberculosis, and meningococcal disease [14,19–30]. Finally, influenza and other VPDs have a significant negative impact on individuals with comorbidities. Although the number of HCP with comorbidities remains largely unknown, it is crucial to consider this high-risk occupational subgroup, given that some vaccines are contraindicated in specific underlying conditions while other vaccines that are not routinely administered to HCP may be indicated [31].

HCP often continue to work despite being ill

Presenteeism, defined as working while being ill [32], is common among HCP, even among those who work in high-risk settings, placing their patients and colleagues at risk. In an influenza outbreak that occurred in an oncology unit, two out of three infected HCP continued to work despite being symptomatic [33]. The main reasons for working while being ill were "sense of duty as an HCP" (56%) and "viewing their illness as too minor to pose risk to others" (44%) [33]. Similarly, a US survey found that 183 of 414 (41.4%) HCP with influenza-like illness (ILI) continued to work for a median of three days, mainly because of "still being able to perform job duties" and "not feeling bad enough to miss work" [34]. Furthermore, in a survey conducted in a US academic medical center in 2016 during the peak of influenza activity, 92% of HCP with ILI worked while ill, including those caring for transplant recipients [35]. These findings indicate gaps in HCP's knowledge about healthcare-associated influenza but also gaps in surveillance of employees' health and infection control procedures. Vanhems et al. quantified the risk of hospital-acquired ILI in 21,519 hospitalized patients in a French hospital during three influenza seasons [36]. Compared to patients with no exposure, those who have been exposed to at least one contagious HCP with ILI had a 5.48-fold increased risk to develop ILI, while those exposed to at least one contagious patient and one contagious HCP were 34.75-times more likely to develop ILI [36].

HCP are frequently traced as sources of transmission of VPDs

The rationale for vaccinating HCP also relies on the fact that HCP often are sources of transmission of VPDs in healthcare-associated outbreaks [8]. A misdiagnosed physician with measles was traced as the source of a nosocomial outbreak of 35 cases that occurred in an Italian hospital few years ago [7]. Combining high-resolution data from 18,765 contacts with polymerase chain reaction (PCR) testing over 12 days, doctors and nurses were traced as sources of influenza for hospitalized patients in a geriatric unit of a French tertiary-care hospital [37]. Jinadatha et al. analyzed through whole genome sequencing 14 COVID-19 clusters that occurred during a nine-month period in a US Veterans Affairs healthcare system, and found evidence of transmission between HCP on many occasions while in two clusters patients' infections were traced to HCP [38]. Overall, clusters predominantly involved HCP (99% of symptomatic cases and 89% of asymptomatic SARS-CoV-2 infected cases occurred in HCP). Of note, there was no documented transmission from patients to HCP [38]. In addition, in a skilled nursing facility with 90.4% (75/83) of residents and 52.6% (61/116) HCP fully vaccinated, a COVID-19 outbreak occurred after virus introduction from an unvaccinated symptomatic employee [39]. In particular, unvaccinated residents and HCP had three to four times higher attack rates of SARS-CoV-2 infection, onset of symptoms or hospitalization compared to vaccinated persons, which demonstrates a strong protective effect of vaccination [39]. Overall, there is evidence of transmission from HCP to patients of COVID-19, influenza, measles, mumps, rubella, varicella, pertussis, hepatitis A, and hepatitis B [6–8,22,37–42].

What is mostly important however is the fact that hospitalized patients are a pool of patients at increased risk for complications because of host factors, such as age and comorbidities. In a pertussis outbreak in a Neonatal Unit, an employee was coughing for at least one month before the diagnosis was suspected [41]. Contact tracing revealed 113 exposed infants, including 11 (9.7%) who developed pertussis [41]. A review of pertussis outbreaks in Neonatal Units found that unvaccinated HCP constituted sources of infection in one half of pertussis outbreaks published over a 12-year period [6]. Neonates in Neonatal Units are a high-risk group of patients due to their underlying conditions, including prematurity [6]. In this age-group, pertussis may result in severe complications such as pneumonia, apnea, seizures, and encephalopathy [6]. The major impact of host determinants was also shown in a prospective surveillance-based study conducted in a Canadian network of 54 acute-care hospitals from 2006 through 2012 [43]. The authors studied 3299 adults with laboratory-confirmed influenza, including 570 (17.3%) with healthcare-associated influenza and found that the latter were significantly older (median age: 81 versus 59 years; p-value < 0.001) and had a worse 30-day outcome in terms of discharge (59% versus 87.9%; p-value < 0.001) and case-fatality rate (11.6% versus 5.9%; p-value < 0.001) [43]. Moreover, persons with comorbidities or extreme age (young infants, elderly) may elicit insufficient immune responses after vaccination [44]. A study conducted in a French hospital over five influenza seasons (2004–2009) found an overall adjusted influenza vaccine effectiveness (VE) of 89% [95% confidence interval (CI): 39% to 98%] among HCP compared to 42% (95% CI: −39% to 76%) among hospitalized patients [45]. Vulnerable patients often rely on herd immunity for their protection, and vaccination declination by HCP may explicitly pose an avoidable risk to them.

High rates of absenteeism are recorded among non-vaccinated HCP

Influenza is a major driver of absenteeism in healthcare workforce during winter, when demand for healthcare services peaks. A study in an Italian hospital with 5,544 HCP and an overall influenza vaccine uptake rate of < 3% over three influenza seasons, recorded a total of 11,000 days of absence per year which concerned all HCP categories [46]. A *meta*-analysis of pooled results from a total of 13 studies showed a significant impact of influenza vaccination of HCP on laboratory-confirmed influenza [pooled relative risk (RR): 0.40; 95% CI: 0.23–0.69], ILI-associated absenteeism (pooled RR: 0.62, 95%; CI: 0.45–0.85), and duration of absenteeism (pooled shorter sick leave: −0.46; 95% CI: −0.71 - −0.21) [47]. In addition, influenza vaccination of HCP was cost-saving based on avoided absenteeism in all published economic evaluations and overweighed the costs of program implementation [47]. High absenteeism rates were also found in an observational, prospective cohort study conducted in 2020–2021 during the COVID-19 pandemic in five tertiary-care hospitals in Greece [48]. In this study the authors compared 4,823 HCP vaccinated with the Pfizer-BioNTech mRNA COVID-19 vaccine to 2,622 HCP who declined vaccination and found that COVID-19 vaccination not only significantly reduced HCP morbidity associated with COVID-19, ILI, and acute respiratory infection, but also significantly reduced the number of episodes and duration of absenteeism [48]. The VE among fully vaccinated HCP was 94.16% against COVID-19 and 66.42% against absenteeism [48]. However, COVID-19 among HCP is not only associated with increased morbidity and absenteeism rates, but also with excess healthcare costs. We estimated that absenteeism accounted for 80% of all expenditures to manage HCP either exposed to or infected with SARS-CoV-2 during the first COVID-19 pandemic wave in Greece [49].

Voluntary vaccination policies for HCP have largely failed

Despite long-term recommendations for influenza vaccination of HCP, uptake rates remain largely suboptimal in most countries. A survey on seasonal influenza vaccination programs across the WHO European Region in 2014–2015, reported a median of 29.5% influenza vaccination rates among HCP in 26 countries, with few of them reporting rates > 75% [50]. Overall, most countries reported coverage rates < 40%, including some countries where there was an indication of decline [50]. Yet, there are few isolated cases of large healthcare facilities that succeeded to raise influenza vaccine coverage rates > 90% over one to seven influenza seasons through multimodal vaccination campaigns without vaccine mandates [51–53]. These campaigns included wide communication during the vaccination period; free and easy access to influenza vaccination; interviews, declination forms and mask-wearing for non-compliant HCP; weekly vaccination reports to managers and target vaccination rates among others [51–53]. Common denominator of these successful campaigns was the fact that when they implementetd the mutlimodal vaccination campaigns the influenza vaccination rates were non-negligible, ranging from 56% to 72%; this means that at least half of employees had already a positive attitude toward influenza vaccination [51–53]. Beyond the question about the sustainability of high vaccination rates without vaccine mandates, the issue of utilization of human resources and efforts, including costs, should also be addressed. Human resources and efforts are even more significant nowadays, in the context of the on-going COVID-19 pandemic.

In a similar line, although voluntary vaccination programs against measles for HCP exist in many European countries, there are significant immunity gaps among them [12]. Published data indicate that only 9% to 63% of HCP in European hospitals had received two shots of measles vaccine, and considering their history of natural infection, it was estimated that 13% to 36% of them are susceptible to measles [54]. These findings explain the large number of HCP affected during the devastating measles epidemics in Europe the past years [15,55,56]. Overall, European countries as well as many countries globally rely mostly on recommendations to immunize HCP or may not have vaccination policies specifically for HCP at all [12]. Although data about vaccination rates among HCP are largely fragmentary or unknown in many countries, several studies indicate significant immunity gaps against other VPDs as well [57]. Susceptibility rates range from 15.7% to 25% for mumps, 4.5% to 18.6% for rubella, 4.1% to 16.7% for varicella, 48.3% to 68.8% for pertussis, 22.6% to 35% for hepatitis B, and 21.2% to 64.3% for tetanus and diphtheria [5]. Suboptimal vaccination rates among HCP are also reported in many studies globally, ranging from 18.8% to 70.5% against measles and mumps, 22.2% to 70.5% against rubella, 1.9% to 70.4% against varicella, 0% to 49% against pertussis, 3.6% to 5.8% against hepatitis A, 40% to 95% against hepatitis B, and 35.7% to 47.3% against tetanus-diphtheria [5,57].

Table 1 summarizes the advantages and challenges of voluntary vaccination policies for HCP, focusing on influenza vaccination. Main advantages include high acceptability rates by HCP and prioritization of the principle of HCP's autonomy over the principle of patients' safety. Challenges include efforts to raise and sustain influenza vaccination rates every year. This has to do with the innate limitations of influenza vaccines, namely the suboptimal effectiveness which varies by age, host factors, and season, and the need for a shot every year. On the other hand, almost all other vaccines require two or three doses in a time frame of few months and confer excellent long-term protection. In practice, considerable efforts are needed every year to approach, educate, and convince every employee to get influenza vaccination, and to implement continuous education and communication strategies. Even with a combination of strategies, influenza vaccination rates rarely exceed 60% [5]. This translates to high costs but also increased use of available human resources. Finally, Carter and Yentis explored the experiences of seven HCP groups over a one-year period employed in a United Kingdom hospital with voluntary vaccination programs [58]. Beyond gaps in the availability and quality of information about vaccination, all HCP groups experienced external pressure to get vaccinated, mostly from their hospital Trust, managers, and colleagues [58]. The authors argue that "a mandatory vaccination program would be better than a voluntary vaccination program with wide-spread coercion" [58].

Are mandatory vaccination policies the solution?

Mandatory vaccination policies are not a new concept. The exceptional impact of pediatric vaccinations on humanity the past century was largely accomplished with mandatory policies. Available evidence indicates that no single intervention other than mandatory vaccination policies can achieve high (>90%) and sustainable influenza vaccination rates among HCP [10]. That said, although mandatory influenza vaccinations for HCP were used for the first time in mid-2000's, it was the 2009 influenza H1N1 pandemic that triggered their implementation in many healthcare facilities across the US with excellent results. For example, during the 2017–2018 influenza season, influenza vaccine uptake was 94.8% among HCP working in healthcare facilities with mandatory vaccination policies compared to 47.6% where vaccination was not required, promoted or offered on-site [59]. Concomitantly, influenza vaccination rates were considered as an index of highest standards of safety in healthcare facilities. However, mandatory influenza vaccinations of HCP were not an isolated policy but rather a holistic approach addressing both administrative and atti-

Table 1
Influenza vaccination policies for HCP: advantages, disadvantages and challenges.

Vaccination policy	Advantages	Disadvantages – Challenges
Voluntary	• more acceptable by HCP • no issues of autonomy of HCP	• significant efforts to raise vaccine uptake rates • continued education and communication strategies are required • significant cost in terms of human resources • even with combination of strategies and actions, rarely > 60% coverage
Mandatory	• easier implementation, less cost • prioritize the principal of patient safety • promote safety culture • achievement of high and sustainable vaccine uptake rates within a few influenza seasons	• appropriate regulatory frame required • political commitment required • commitment at the level of healthcare facility manager • support by scientific societies required • lower acceptance rates by HCP
Mixed policy*	• easier implementation (specific settings) • (probably) more acceptable by HCP • prioritizes patient safety and professional ethics in high-risk departments • high coverage (97%) in departments providing healthcare services to high-risk patients	• appropriate regulatory frame required • political commitment required • commitment at the level of healthcare facility manager • support by specific scientific societies required • acceptance rates by HCP working in specific settings • risk assessment needed (vaccinate all HCP entering an ICU?) • disadvantages of voluntary policies still apply for the remaining HCP • possibly vaccine uptake will become more weak in other departments

HCP: healthcare personnel; ICU: intensive care unit; NICU: neonatal intensive care unit.
* Mandatory vaccination of HCP caring for high-risk patients (e.g. HCP in ICUs, NICUs, hematology-oncology departments), voluntary vaccination for the remaining HCP.

tudinal barriers, by providing easy access to vaccination, free-of-charge vaccination, education to address concerns and mistrust of employees about vaccines and vaccinations, and leadership support [60]. From 2018 Australia and England implement mandatory influenza vaccination policies as a condition to working for HCP in high-risk departments [e.g. intensive care units (ICUs), neonatal ICUs, transplant and oncology units] [61,62], while the following vaccinations are strongly recommended for all non-immune HCP: hepatitis B, influenza, measles-mumps-rubella (MMR), varicella, pertussis (specifically for staff working with children), poliomyelitis, and tetanus/diphtheria.

Although evidence comes mainly from influenza vaccinations, recently Talbot et al published the experience of Vanderbilt University Medical Center, which expanded its vaccination program over three influenza seasons, and beyond influenza, mandatory vaccinations included MMR, varicella, and hepatitis B vaccines [63]. The authors showed significant increase of HCP vaccination rates for all three vaccines reaching 99% vaccination rates [63]. Successful state-wide implementation of mandatory vaccinations for HCP against MMR, varicella, pertussis, hepatitis B, diphtheria, tetanus, but no influenza, was also shown in New South Wales, Australia in 2007 through the Health Policy Directive and was associated with effective communication, vaccination free-of-charge, access to occupational health services, and appropriate data collection and reporting systems [64].

The performance of mandatory vaccination policies for HCP has been evaluated in several studies. In a study conducted at M.D. Anderson Cancer Center, Houston, the authors showed that the increase of influenza vaccination rate among HCP from 56% to 94% over an eight-year period, and especially in HCP working in high-risk areas, was associated with a significant reduction of the proportion of nosocomial influenza infections in immunocompromised cancer patients [65]. Beyond the expected reduction of avoidable VPD-associated morbidity and fatalities among HCP and vulnerable patients, mandatory vaccinations will save healthcare costs. Frederick et al showed that the implementation of mandatory influenza vaccination policies in outpatient settings during three influenza seasons had a considerable impact on HCP symptomatic absenteeism during the peak influenza season [66]. In particular, mandatory influenza vaccination policies reduced by approximately one third the rate of absenteeism among 2,304 HCP working in three healthcare facilities where vaccine mandates were in place compared with 1,759 HCP working in four healthcare facilities where influenza vaccination was not required [66]. They also found that HCP symptomatic absenteeism diminishes as influenza vaccine uptake rates increase [66]. Similarly, a Canadian retrospective study of a cohort of 10,079 full-time HCP of whom 77% were vaccinated, showed that unvaccinated HCP had twice the increase of all-cause illness absenteeism in winter compared with vaccinated staff [67].

The past years, some European countries have adopted mandatory vaccination policies against specific VPDs for HCP as a measure to increase vaccination rates and this is regulated either at the national level or at the level of healthcare facilities [12]. Mandatory vaccination policies in Europe concern mainly vaccinations against hepatitis B, MMR, tetanus, diphtheria, poliomyelitis, and pertussis [12]. In practice there are differences between countries in terms of level of enforcement of mandatory vaccinations, and in particular in terms of penalties and exemptions. By definition, mandatory vaccination policies require some kind of penalty for declining vaccination [68]. In Europe, refusal of mandatory vaccinations by HCP is usually associated with move to a position with no direct patient contact or to a position caring for less vulnerable patients; termination of employment or payment of a fine may also apply to non-compliant HCP [12].

In summary, influenza vaccine mandates for HCP are subject to the following advantages: easier and less costly implementation than voluntary programs; achievement of high and sustainable vaccination rates within few years; and promotion of a culture of safety over HCP's autonomy (Table 1). Challenges include the need for an appropriate regulatory frame, political commitment, and support from scientific societies. Acceptance of vaccine mandates is also an issue, and varies significantly by HCP profession and vaccine [69].

Finally, mixed vaccination policies refer to mandatory vaccinations implemented for specific HCP groups or high-risk departments to ensure that highly vulnerable patients are protected, while voluntary vaccinations are in place for the remaining HCP

(Table 1). Although a mixed vaccination policy ensures that highly vulnerable patients are protected, the possibility that vaccine uptake rates will become weaker in other departments should be considered.

Vaccination of HCP against COVID-19 as a case study

As of February 9, 2022, almost 400 million confirmed cases of COVID-19, including more than 5,75 million deaths, were reported from the WHO [29]. The COVID-19 pandemic is an exceptional physical and mental challenge for HCP worldwide [70,71]. HCP work at the frontline and provide healthcare to COVID-19 patients and are therefore at higher risk of occupational exposure to the virus than the general population [72–76]. Infected HCP may transmit the infection to susceptible patients, colleagues, and relatives [77,78]. Indeed, high incidence of infection, transmission to patients, and absenteeism have been recorded among HCP during the COVID-19 pandemic [18,38,39,79]. The perceived increased risk of exposure to SARS-CoV-2 and transmission of infection to others, the extended working hours and supposed stigma from relatives can be revealed with several psychological manifestations comprising poor sleep quality, stress, post-traumatic stress symptoms, anxiety, and depression [80–82]. The availability of safe and effective COVID-19 vaccines is expected to change the landscape within healthcare facilities. Beyond the physical protection of HCP, vaccination should be regarded as a necessary tool for the overall safety of HCP, patients, and healthcare services.

Although HCP were immediately identified as a high priority group for COVID-19 vaccination, part of them are also hesitant to get vaccinated [83–88]. Overall, there was significant variability in acceptance rates and willingness of HCP to get the COVID-19 vaccine mainly due to concerns regarding its safety and efficacy [89]. Consequently, divergences in the choice of HCP to receive the vaccine influenced immunization rates. As of August 21, 2021, the median full vaccination rates among HCP in 17 European Union/European Economic Area countries was 79%, however with exceptional differences between countries (range: 23.3% to 100%) [3]. Similarly, 30% of HCP in US hospitals were still unvaccinated as of September 15, 2021 [90]. Though vaccination data is offered for the general public, public health officials may report COVID-19 vaccination rates among HCP in order to trace and guarantee proper safety in individuals at the front lines of the pandemic.

The issue of mandatory COVID-19 vaccination for HCP to mitigate the impacts of the COVID-19 pandemic on HCP and healthcare facilities emerged in public health discussions the past months. Currently, several countries are implementing or plan to implement *ad hoc* laws for mandatory COVID-19 vaccination or severe work restrictions for unvaccinated HCP, including Italy, France, Greece, Australia, and Canada [91–96]. National data from Italy indicate excellent results within less than three months after the implementation of mandatory vaccinations for HCP: 94.42% of a total of 1,958,461 HCP have been fully vaccinated while only 35,691 HCP (1.82% of the total) were still unvaccinated as of August 2021 [97]. On August, 23 2021, the U.S. Food and Drug Administration, approved the first mRNA COVID-19 vaccine for the prevention of COVID-19 in individuals 16 years of age and older [98]. Currently several COVID-19 vaccines have been approved globally. This will facilitate the possible inclusion of mandatory vaccination policies among HCP in the US and elsewhere. The beneficial impact of mandatory vaccination policies against COVID-19 for HCP will be revealed in real-life the coming months.

Yet, mandatory COVID-19 vaccination for HCP raises ethical issues [99–101]. Given that the benefits of vaccination in general concern both the vaccinated person (host immunity) and indirectly other persons, in our case vaccination ethics should be examined under the prisma of HCP, patients, and colleagues in healthcare facilities. Beneficence arguments include the fact that the intensification of COVID-19 vaccination will protect vaccinated HCP but also it is expected that it will indirectly protect susceptible patients, colleagues, and healthcare facilities [94,100], and is ethically imperative in the COVID-19 era [101].

Conclusions

HCP have long been recognized as an occupational group at risk for acquisition of VPDs and transmission to vulnerable patients. Although several countries have comprehensive vaccination programs for HCP, there are significant gaps in vaccination programs regarding the number of vaccines, indications, and implementation frame. Switch to a mandatory public health policy requires the fulfillment of the following four prerequisites: first, it should be a public health necessity; second, the policy has to be proven that it is effective; third, the policy should pose no risk for the person; and fourth, the policy should be the only solution. In our opinion, all abovementioned criteria are fulfilled for vaccination of HCP against several VPDs.

Voluntary vaccinations have largely failed to achieve and sustain high vaccination rates in HCP and in many cases HCP remain susceptible to several VPDs. Mandatory vaccination policies for HCP have been successfully implemented the past decade in the US and should be considered for VPDs that may cause significant morbidity and mortality among HCP and patients. We argue that the rights of patients for safe healthcare services should prevail over the rights of HCP to accept or decline vaccinations. Healthcare facilities have the moral duty to protect patients and employees, and ensure the implementation of the principle of "zero tolerance" against VPDs.

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CRediT authorship contribution statement

Helena C. Maltezou: Conceptualization, Writing – original draft. **George Dounias:** writing - review & editing. **Venerando Rapisarda:** Writing – review & editing. **Caterina Ledda:** Writing – original draft.

Declaration of Competing Interest

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

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