



Vaccination of health care workers against pertussis: Meeting the need for safety within hospitals



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ABSTRACT

Pertussis outbreaks in hospitals are reason for substantial concern as they do cause significant morbidity amongst patients and physical and emotional stress and absence from work amongst affected staff. Further, there is a substantial financial burden for the concerned institution. For these reasons, health care institutions should implement prophylactic measures, i.e. pertussis immunisation for their staff. Diphtheria–tetanus–acellular pertussis component combination vaccines with reduced antigen content (“Tdap”) have a proven acceptable tolerability with reactogenicity and safety profiles not substantially different from Td vaccines without the pertussis component. Further, excellent immunogenicity after a single dose with an estimated duration of protection for 10 years has been shown in adults.

In high risk situations, e.g. in pregnant health care workers and those in contact with infants <6 months of age, antibiotic prophylaxis should also be recommended to previously immunised, pertussis exposed health care workers. Local programmes based on education, conviction and common sense should be implemented for health care workers rather than mandatory pertussis immunisation. In addition, health care workers need to be informed and regularly reminded about the impact of exposure to pertussis.

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1. Introduction

Pertussis is a frequent disease and it is caused primarily by *Bordetella pertussis* infection; pertussis affects humans at any age [1–3]. Due to variability in clinical presentation, heterogenous diagnostic approaches and different surveillance systems the true incidence of pertussis is poorly defined. Prospective clinical studies suggest that it is probably in the range of 400–1000 cases per 100,000 population per year [4,5]. Depending on national recommendations, infants should receive 2 (“2 + 1” schedule) or 3 (“3 + 1” schedule) doses of pertussis containing combination vaccines and coverage with these is high in most countries. However, vaccine induced immunity wanes within few years after the 3rd (“2 + 1” schedule) or 4th dose (“3 + 1” schedule) in the 2nd year of life and again after the 5th dose (frequently recommended before school entry) [6,7]. The recently observed epidemiological shift towards an increase of pertussis disease in school-age children, adolescents and adults [8] is in accordance with waning immunity and has been counteracted with the introduction of further booster doses in several countries [2,3]. As many studies have shown, pertussis may occur

in hospitals and other health care settings sporadically but may also be the cause of outbreaks of variable magnitude [9–13]. These outbreaks are reason for substantial concern as they do cause significant morbidity amongst patients, physical and emotional stress and absence from work amongst affected staff, and financial burden for the concerned institution [14,15]. For these reasons, health care institutions are well advised to implement prophylactic measures, i.e. pertussis immunisation for their staff, to ensure safety of patients and personnel [16,17]. The purpose of this manuscript is to reflect the role of health care workers in the occurrence of pertussis in their professional environments and to discuss preventive measures.

2. Methods

A PubMed search in order to identify reports about pertussis outbreaks in hospitals was performed comprising the years 1980 until May 2013, limited to publications in English and German language. The following keywords were used: “pertussis” OR “*Bordetella pertussis*” AND “outbreak”. The search was filtered for Title/Abstract and revealed 229 references. These were screened for relevance regarding the topic of this review and those found most useful for the purpose of this brief review are listed in the references. Further, relevant information regarding pertussis immunisation in health care workers was retrieved from the

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author's literature collection and specific Internet websites (Centers for Disease Control and Prevention, USA; Robert Koch-Institute, Germany; Health Protection Agency, United Kingdom, and others).

3. Results

3.1. The role of health care workers in the transmission of *B. pertussis*

It has long been known that health care workers can acquire *B. pertussis* infections within or outside of their professional environment and transmit it to their private or professional contacts, i.e. household members and colleagues or patients, respectively. Apparently, the risk appears to be highest for transmission from patients to health care workers in the paediatric setting [18], especially when pertussis or any other transmissible disease is not considered in the patient and no isolation precautions are made. Vice versa, transmission of *B. pertussis* from health care workers to patients is equally if not more troublesome, especially if neonates, young infants, or other high risk patients are involved [9,11,12,19].

3.2. Impact of pertussis in hospitals

Each single case of pertussis acquired in a health care setting, whether it affects a patient (nosocomial infection) or a health care worker, causes suffering and carries the risk of rapid local spread [9–13]. Not surprising, pertussis outbreaks in health care settings are resource intensive and frequently disruptive as affected health care workers have to be excluded from work for at least 5 days and infection control staff will be occupied [13–15]. Further, costly diagnostic testing and prophylactic antibiotics will be required [13,15].

With this background, preventive active pertussis immunisation for all health care workers not only appears logical from a medical and ethical (reducing the risk for nosocomial infections!) point of view but also beneficial from an economic perspective with a benefit-cost ratio of approximately 2.4 in one study [15]. It should be noted, however, that calculations of benefit-cost ratios will vary between different institutions as benefits in terms of prevention of pertussis are largely driven by the base-case incidence of pertussis in HCW whereas the costs of the vaccine are relatively similar in most countries.

3.3. Pertussis vaccination in health care workers

No monovalent pertussis vaccines are currently available. However, two diphtheria–tetanus–acellular pertussis component combination vaccines with reduced antigen content (“Tdap”) compared to conventional high antigen content vaccines (“DTaP”) for infants and young children are available in most countries for use from 4 years of age onwards without an upper age limit (at least in Europe). These vaccines have proven to be of acceptable tolerability and their safety profiles are not substantially different from tetanus–diphtheria toxoid (“Td”) vaccines without the pertussis component and excellent immunogenicity [20–22]. Detailed characteristics of these vaccines have been published elsewhere [23,24]. The monovalent pertussis component of one of these two vaccines has been tested in the only pertussis vaccine efficacy trial in adults to date and was shown to be 92% efficacious [5]. However, as with many other vaccines, efficacy under real life conditions apparently is significantly lower than in efficacy trials and of limited duration [25]. In Australian high school students, pertussis vaccine efficacy was assessed after mass immunisation and found to be 78.0% (95% CI: 60.7–87.6%) for all reported pertussis cases ($n = 167$) and 85.4% (95% CI: 83.0–87.5%) for laboratory-confirmed cases [26]. Similarly, as assessed during a pertussis outbreak amongst US students, receipt of an adolescent Tdap booster dose had an effectiveness of

65.6% (95% CI: –35.8% to 91.3%) against confirmed and probable cases and 70.6% (95% CI: –110.3% to 95.9%) against laboratory confirmed cases [27]. Not unexpectedly, attack rates were highest in higher grade students (6–12) in whom the last vaccine dose (if given at all) was longer ago compared to lower grade students (1–5).

In accordance with respective national recommendations, not only health care workers themselves should be encouraged to be immunized against pertussis but they should also ensure their private close contacts (especially household members) receive pertussis immunisations in a complete and timely fashion. This will provide indirect protection in addition to direct protection (= own immunisations) and thereby has the potential to reduce the likelihood of acquisition of *B. pertussis* and spread within the hospital.

3.4. Procedures in health care workers after exposure to pertussis in hospitals

Before the availability of pertussis component vaccines for adults, antibiotic prophylaxis was the only effective option for health care workers when exposed to pertussis in their private or professional environments. Exposure may be defined as close contact with someone with pertussis (index case) between onset of symptoms (catarrhal stage of pertussis) and the first 21 days of disease (considered the period of contagiousness) or until 5 days of effective antibiotic treatment in the index case [28], whatever comes first.

No vaccine is 100% efficacious and in the case of pertussis the most optimistic estimate is 92% [5]. Therefore, the question whether Tdap immunised health care workers should still receive additional antibiotic post-exposure prophylaxis is a valid one and controversial at the same time. There is only one published study which attempted to answer the question. In this study from the USA, 86 Tdap immunised health care workers were exposed to pertussis during a 30 month observation period and they were randomized to either receive antibiotic post-exposure prophylaxis with daily symptom monitoring for 21 days or symptom monitoring alone [29]. *B. pertussis* infection (!) occurred in 1 (2.4%) of 42 health care workers with antibiotics compared to 6 (13.6%) of 44 health care workers without antibiotic prophylaxis. Five infections were based on serological criteria only whereas 2 were diagnosed by a positive PCR. However, none of the 7 supposedly infected health care workers developed cough and the authors themselves raise doubts about the validity of their findings as asymptomatic infections do not have the same implications as pertussis disease would have.

Therefore, data regarding the optimal procedures in exposed and previously vaccinated health care workers are still inconclusive and recommendations in different countries vary. Swiss recommendations restrict antibiotic prophylaxis to exposed health care workers considered to be “susceptible” [30]. Susceptibility here is defined as the lack of microbiological proven *B. pertussis* infection and no pertussis vaccination in the previous 10 years. The obvious advantage of such a liberal recommendation is the incentive for immunised HCW to avoid a course of antibiotics and other restrictions that may go along with exposure in unimmunised individuals (e.g., exclusion from work) and this advantage may influence the willingness of health care workers to get immunised against pertussis before concrete exposure. It must be emphasized, however, that such a strategy must be accompanied by explicit education of these “non-susceptible”, exposed individuals to immediately report any onset of respiratory symptoms suggestive of pertussis (rhinitis and/or cough) during the potential incubation period which is up to 21 days after the last contact with the contagious index case. Onset of symptoms will prompt diagnostic tests (preferentially PCR for *B. pertussis* from a nasopharyngeal specimen), antibiotic treatment (e.g., azithromycin 1 × 500 mg on day 1, 250 mg once daily on days

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