

## Should acellular pertussis vaccine be recommended to healthcare professionals?

A vacina pertússis acelular deve ser recomendada a profissionais de saúde?

¿La vacuna contra la tos ferina acelular se debe recomendar a los profesionales de la salud?

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### Abstract

*The aim of this study was to describe recent changes in the epidemiology of pertussis and existing policies regarding recommended and mandatory occupational vaccinations for healthcare professionals (HCPs). The authors carried out an extensive review of references on the PubMed and SciELO databases and the official sites of the World Health Organization, Pan American Health Organization, Centers for Disease Control and Prevention, and Brazilian Ministry of Health, using the keywords pertussis, vaccines and healthcare professionals. Vaccination against pertussis is recommended for HCPs in the United States, Canada, nine European countries, Australia, Hong Kong, Singapore, Costa Rica, Argentina and Uruguay, and in some countries it is compulsory. In Brazil, only one publication discussing the risk of pertussis among HCPs was found. Considering the reemergence of pertussis and the great number of associated hospitalizations and deaths registered in 2011, it is necessary to review public policies regarding HCP pertussis vaccination, particularly among workers in frequent contact with young babies.*

*Pertussis Vaccine; Health Personnel; Occupational Risks*

### Resumo

*O objetivo deste artigo é descrever as recentes mudanças na epidemiologia da pertússis e as políticas de vacinação voltadas à prevenção da coqueluche para profissionais de saúde. Os autores fizeram um levantamento dos artigos publicados no PubMed, SciELO e páginas da Internet da Organização Mundial da Saúde, Organização Pan-Americana da Saúde, Centers for Disease Control and Prevention (Estados Unidos) e do Ministério da Saúde usando as palavras-chave: pertussis, vacinas e profissionais de saúde. A vacinação de profissionais de saúde contra coqueluche é recomendada pela OMS, OPAS, CDC, e autoridades de saúde de nove países europeus, da Austrália, Hong Kong, Cingapura, Costa Rica, Argentina e Uruguai, e em alguns países é compulsória. No Brasil, identificamos apenas um artigo abordando a vacinação de profissionais de saúde contra coqueluche, mas considerando a reemergência da doença com grande número de hospitalizações e mortes em 2011, consideramos necessário rediscutir as políticas públicas envolvendo a vacinação dos profissionais de saúde, particularmente daqueles que têm contato frequente com lactentes jovens.*

*Vacina Contra Coqueluche; Pessoal de Saúde; Riscos Ocupacionais*

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## Introduction

The terms health care professionals (HCPs) and health care workers (HCWs) are applied to a range of professional categories that includes physicians, nurses, assistants, physiotherapists, dentists, radiologists and technicians and other professional caregivers. Vaccination of these professionals is important to protect their health and reduce the risk of disease transmission to patients. In addition, vaccination reduces the economic impact of diseases associated with morbidity, work absences and loss of productivity due to presenteeism<sup>1</sup>.

In Brazil, a specific law (NR32) recommends that HCPs receive vaccines against diphtheria, tetanus, measles, mumps, rubella, hepatitis B and influenza and states: “available efficient vaccines against other biological agents to which workers are, or may become, exposed must be provided free of charge by the employer”<sup>2</sup>. However, HCP vaccination policies vary considerably between different countries<sup>3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19</sup> and have changed over the two last decades due to new information on the epidemiological profile of pertussis and licensing of new safe and effective vaccines for use in adolescents and adults, such as the triple acellular (Tdap) vaccine that, besides protecting against diphtheria and tetanus, also protects against pertussis, and the quadruple vaccine against diphtheria, tetanus and pertussis combined with the inactivated polio vaccine (Tdap-IPV), already licensed in a number of countries<sup>7,8,9,10,11,12,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57</sup>.

Acellular pertussis vaccines especially formulated for adolescents may contribute to a substantial reduction in the incidence of the disease<sup>7,57,58,59,60,61,62</sup>. The *Bordetella pertussis* and diphtheria toxoid antigen content of these vaccines is lower than whole cell vaccines and the acellular vaccines recommended for children and they are as safe as the double-adult vaccine (dT)<sup>7,9,23,24,29,38,57,58,59,60,61,62</sup>. It is currently recommended in several countries that adolescents and adults receive at least one booster of the dT vaccine in combination with the acellular pertussis (Tdap) vaccine<sup>1,7,57,58,59,60,61,62</sup>. Increasing numbers of developed nations prefer IPV, and Tdap-IPV or Tdap + IPV vaccines are specially indicated to people who are in contact with immunocompromised people or children immunized with the oral polio vaccine (OPV)<sup>1,14</sup>.

In this paper we review the current HCP vaccination recommendations, focusing on the pertussis acellular vaccines, through a data search of the PubMed (January/2000 to March/2012),

World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), Pan American Health Organization (PAHO) and the Brazilian Ministry of Health websites based on the following key words: vaccine, pertussis, *Bordetella pertussis*, health professionals, and vaccination coverage.

## Pertussis clinical manifestations and diagnosis

Pertussis, also known as “whooping cough”, is an infectious disease with a high transmission rate (90%) caused by the bacterium *B. pertussis*. Humans are the sole hosts of *B. pertussis*, and transmission occurs through contact with respiratory droplets from an infected individual. The incubation period of pertussis ranges from seven to 10 days, and the signs and symptoms of the disease vary according to age, vaccination condition, and time lapse since the last dose of the vaccine.

Pertussis typically occurs in the following three phases:

- 1) Catarrhal (one to two weeks): characterized by a runny nose, intermittent cough and low-grade fever. Symptoms can be not distinguished from other respiratory infections and the infected person is most contagious in this phase;
- 2) The paroxysmal phase (four to six weeks): characterized by paroxysms of intense coughing often followed by vomiting and a loud “whoop”. These symptoms are more frequently seen in infants, the most vulnerable group with the highest rates of complications, such as pneumonia, weight loss, seizures, encephalopathy and eventually death;
- 3) Convalescence (two to six weeks): the most common symptom is a chronic cough.

Pertussis diagnosis is hindered due to the fact that signs and symptoms can not be differentiated from other respiratory diseases. Culture is considered the gold standard for pertussis diagnosis. However, its sensitivity is low, and many countries included PCR and serology to improve pertussis surveillance. Even in regions where these lab tests were introduced the true burden of pertussis is still underestimated<sup>3,4,6,7,19,22,29</sup>.

## Pertussis vaccines

Pertussis vaccines have been in use since the 1940s, but are not recommended after seven years of age due to their reactogenicity. It is estimated that protection after natural infection and/or pertussis vaccination lasts between 5 and 10 years. In locations with low vaccination coverage,

circulation of *B. pertussis* in the community accounts for natural “boost”. However, vaccination leads to a reduction in bacterial circulation and a subsequent loss of protection after natural infection, resulting in an increase in the incidence of the disease among teenagers and young adults, who become a significant source of infection of children<sup>29,30,31,32,33,34,35,36,37,38,39,40</sup>.

Protection against the most serious forms of the disease offered by whole cell vaccines and acellular vaccines is greater in the early years after vaccination. Although the risk of hospitalization and death due to pertussis is lower in adults, the disease causes substantial morbidity in these groups and is one of the most common causes of continuous cough<sup>22,24, 29,32,33,38,42</sup>. Separate vaccination of adolescents and adults became possible after the development and approval of specific vaccines for each group. The pertussis vaccines for adults licensed for use in Brazil are listed in Table 1. Only acellular vaccines with reduced quantity of diphtheria toxoid can be administered to adults, and they can be produced individually or in combination with IPV<sup>7,8,9,10,11,12,13,14,29</sup>.

During the last decade, the use of these vaccines for adolescents and adults, particularly those in contact with young babies, has been introduced in several countries<sup>3,6,7,18,19,25,26,27,29,30, 31,32,38,43,46,49,52,57</sup>.

## Vaccine recommendations for HCPs

HCP vaccination recommendations vary according to country, vaccine availability, and to the risk estimates of the different preventable diseases immunization, the latter of which depends on epidemiological information<sup>1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16,17,18,19</sup>. Most countries recommend the use of the influenza and hepatitis B vaccines; however, after the licensing of acellular vaccines for adolescents and adults, many countries have introduced these vaccines for HCPs. In the United States<sup>1,7,8,9,10,11,12</sup>, Canada<sup>13</sup>, various European countries<sup>14,15</sup>, Australia<sup>16,17</sup> and some Latin America countries<sup>18,19</sup>, acellular pertussis vaccines combined with the tetanus and diphtheria toxoids (Tdap) and IPV standalone or with Tdap (Tdap-IPV) are already recommended for all or some HCPs<sup>1,14</sup> (Tables 2 and 3).

The inclusion of the acellular pertussis vaccine is due to an increase in the incidence of pertussis in certain European countries<sup>28,29,30,31,32,33, 34,35,36,37,38,39,40</sup>, the USA<sup>1,7,8,9,10,11,12,21,24,25,26,27</sup>, Canada<sup>13,22,23</sup> and Australia<sup>16,17,41,42,43</sup>. In these regions pertussis currently affects all age groups, and incidence rates are particularly high in adolescents and young adults<sup>36,38,43</sup>.

The reemergence of pertussis can be associated with a number of factors, including: incomplete protection provided by vaccines; waning of immunity after 5 to 20 years; introduction of new diagnostic tests, such as PCR and serologic tests; high perception of the disease during outbreaks and high notification rates of suspicious cases; circulation of new strains not covered by

Table 1

Combined pertussis vaccines for adults.

Presentation	Sanofi Pasteur		GSK	
	Tdap-IPV	Tdap	Tdap	Tdap-IPV
Indicated age	> 3 years and adults	> 4 years and adults	> 4 years and adults	> 4 years and adults
Pertussis toxoid (µg)	2.5	2.5	8.0	8.0
PHA (µg)	5.0	5.0	8.0	8.0
PRN (µg)	3.0	3.0	2.5	2.5
FIM 2 + 3 (µg)	3.0	5.0	-	-
Diphtheria toxoid	≥ 2 IU (2 Lf)	2 Lf	≥ 2 IU (2.5 Lf)	≥ 2 IU (2.5 Lf)
Tetanus toxoid	≥ 20 IU (5 Lf)	5 Lf	≥ 20 IU (5 Lf)	≥ 20 IU (5 Lf)
Polio (D-Ag-U)				
1	40	-	-	40
2	8	-	-	8
3	32	-	-	32

FIM: fimbria; PRN: pertactina; PHA: phytohaemagglutinin.

Table 2

Acellular pertussis vaccines recommended for health care professionals (HCPs) by country and year.

Country/Region	Reference	Year	Recommendation
United States	7	2005	Adults aged between 19 and 64 years and those with contact with babies < 12 months (parents, grandparents aged < 65 years and HCPs), HCPs working in hospitals or ambulatory care settings and have direct patient contact
Canada	13	2006	All HCPs in contact with infants ≤ 18 months
World (World Health Organization)	6	2011	HCPs working with infants or immunocompromised people, especially in maternity and pediatric units
Germany	14	2011	All HCPs
Austria	14	2011	Pediatricians and HCPs working in neonatal centers
Belgium	14	2011	All HCPs
France	14	2011	HCPs in direct patient contact
Finland	14	2011	Pediatricians and HCPs in neonatal centers
Netherlands	14	2011	All HCPs
Luxembourg	14	2011	All HCPs
Norway	14	2011	Pediatricians and HCPs in neonatal centers
United Kingdom	14	2011	All HCPs
Uruguay	18	2012	HCPs, especially those in direct contact with infants < 6 months
Americas (Pan American Health Organization)	19	2012	Recommended for HCPs to prevent transmission to infants < 6 months and immunocompromised people

Table 3

Countries with recommendations for inactivated polio vaccine (IPV) use among health care professionals (HCPs) <sup>14</sup>.

Country	Recommendation
Austria	Recommended for specific HCP groups or health care settings
Cyprus	All HCPs
Finland	All HCPs
France	Mandatory for all HCPs
Germany	Recommended for specific HCP groups or health care settings
Ireland	Recommended for specific HCP groups or health care settings
Lithuania	All HCPs
Luxembourg	All HCPs
Malta	All HCPs
Switzerland	All HCPs
United Kingdom	All HCPs

vaccines; and other unidentified factors. In developed countries, acellular pertussis vaccines were introduced after 1999, and nowadays the majority of pertussis cases are diagnosed in adolescents and adults that received acellular vaccines. There is no doubt that the duration of protection after acellular vaccines is limited. Furthermore, the low duration of protection after whole cell vaccines and natural infection was observed when

vaccination was limited to these vaccines in the USA, Canada and Europe. The comparison of current trends between countries is limited because different countries use different vaccines, employ different vaccination schedules, have variable coverage rates and use different pertussis case research and reporting methods.

The recent reemergence of pertussis in Latin American countries that still use whole cell vac-

cines has led to a great number of deaths. However, this reemergence cannot be explained by the introduction of acellular vaccines or new diagnostic tests, because access to these tests is not universal. Rather, it is probable that Latin American countries are experiencing a similar trend to that registered in developed countries over the last decade, where an age shift of pertussis was observed towards adolescents and adults due to high vaccination coverage rates among children. The availability of new diagnostic resources for pertussis, such as PCR and serology, has helped to identify pertussis as one of the main causes of prolonged cough illness in adults<sup>22</sup> and has shown that the disease may exist in mild or asymptomatic forms<sup>33,51</sup>. The large majority of pertussis cases are reported in young babies, but the disease may affect people of any age group, including the elderly<sup>28,39,34,35,37,41,45,47,50,51,56</sup>.

Seroepidemiologic investigations of the disease conducted in different countries show that the annual incidence of pertussis in adolescents and young adults varies between 1 and 6%<sup>34,35,37,40,44</sup> and that infection rates are greater among HCPs than in other professionals<sup>24</sup>.

### Pertussis in HCPs: risks to patients and health workers

HCPs may contract pertussis and transmit the disease to their patients and hospital colleagues, thus causing disease outbreaks<sup>1,8,10,11,15,16,45,48,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105</sup>. Residents and those working in emergency rooms are at risk of acquiring pertussis<sup>24</sup>; however, other HCPs, such as nurses, physiotherapists and people who are in direct contact with patients are at greater risk of becoming infected<sup>63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105</sup>. Adults generally develop a milder form of the disease than children, however morbidity and the chances of complications are high<sup>1,7,21,22,23,24,29,30</sup>. In adults the disease generally lasts for four weeks, with 25% of patients developing complications<sup>24</sup>. It should be noted that even asymptomatic or mild cases may transmit *B. pertussis* to others, including family members<sup>51,66,69,72,73,83,96</sup>.

The majority of pertussis outbreaks associated with HCPs have been reported in pediatric hospitals<sup>8,63,68,69,87,83,96</sup>, particularly in neonatal care units and intensive care services<sup>65,66,67,69,72,88,94,98,103</sup> with hospitalized infants in units that treat immunocompromised or institutionalized patients<sup>64,95,104</sup>. Recently, a pertussis outbreak was also detected among HCPs who

worked in a laboratory specialized in pertussis diagnosis<sup>96</sup>.

Although pertussis hospital outbreaks involve only a small number of individuals, they may be very costly due to the recommended investigation and control measures that involve the temporary removal of the professionals from the working environment, the use of prophylactic antibiotics and laboratory tests of infected cases<sup>65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105</sup>, as well as problems associated with noncompliance with recommended prophylaxis<sup>76,92,93,94,95,97,98,99</sup>.

Most of the information on pertussis in HCPs comes from the United States, Canada, Europe and Australia, where laboratory resources for the confirmation of cases in adults, such as PCR and specific serology, are more easily available<sup>16,17,57,58,59,60,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,97,98,99,100,101,102,103,104</sup>.

In the United States, pertussis outbreaks in HCPs were reported more than three decades ago<sup>105</sup> and reports of pertussis outbreaks involving HCPs have become increasingly common since the 1990s, especially during pertussis epidemics which occur every three to four years even in vaccinated populations<sup>10,11,66,67,67,68,69,70,71,72,73,74,75,76,77,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,97,98,99,100,101,102,103,104,74,75,76,77,78,79,80,81</sup>.

The risk of contracting pertussis through contact with patients has been very well documented<sup>15,16,17,21,31,61,62,65,66,67,68,69,70,71,72,74,104,105</sup>. In 2003, in the United States, a single baby with pertussis transmitted the disease to 17 HCPs that in turn transmitted it to 307 people<sup>66</sup>.

During an outbreak in Cincinnati, 2% of the employees (87 out of 3,764) of a pediatric hospital developed pertussis, leading to the following morbidities: 97% (84/87) of the infected employees had a cough for over two weeks; 74% (64/87) had a paroxysmal cough; and 31% (27/87) suffered from post-cough vomits<sup>80</sup>.

Ten patients and five employees of a hospital in Atlanta developed pertussis during a period of only two months. A total of 630 of the 1,330 HCPs were treated with erythromycin prophylaxis and a half dose of the child acellular vaccine (DTaP) in an attempt to control the epidemic, since the specific adult formulation had still not been licensed at the time<sup>21</sup>.

In 2003, the investigation of a case of pertussis in a premature newborn hospitalized in an intensive care unit revealed that the index case was a 36 year-old nurse who had worked with a paroxysmal cough for three weeks, and was only removed from work after developing pneumothorax. During the investigation, it was discovered that four out of a total of 72 exposed health professionals also developed the disease<sup>65</sup>.

In 2004, an investigation of a pertussis outbreak that affected six children born between 4 and 16 of June in Texas, identified 29 children under four months of age who met the clinical criteria for pertussis, of which 11 had had contact with a nurse who was later confirmed as having pertussis. This professional worked with cough and dyspnea symptoms while in contact with 113 babies, of which 11 (9.7%) developed the disease<sup>72</sup>.

Since the symptoms of pertussis in adolescents and adults generally consists of an extensive cough without fever, it is not always easy to recognize the disease, and the majority of the HCPs maintain their usual activities during the maximum transmissibility phase, thus exposing patients and fellow workers to pertussis<sup>16,17,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,93,94,95,96,97,98,99,100,101,102,103,104,105</sup>. The growth culture is considered the gold standard for pertussis diagnosis; however, test sensitivity is poor since *B. pertussis* exhibits a slow growth. In locations where the PCR test is not available, the disease is seldom recognized in adults and, therefore, outbreak control measures are seldom taken<sup>68</sup>. In addition, recommended hospital outbreak control measures are not always effectively implemented<sup>65,69,72,73,74,75,76,81</sup>.

In a study of a case involving four health professionals diagnosed with pertussis conducted in Atlanta, the average cough duration before the index case was identified varied between 11 and 25 days<sup>65</sup>.

Another study concluded that precaution measures (isolation and chemoprophylaxis) were inadequate in 17 out of 28 confirmed pertussis cases, resulting in the exposure of 355 HCPs, each of which exposed an average of nine other HCPs to the disease (variation 1 to 86). Adequate precautionary measures were adopted in a little more than one third of cases (11 out of a total of 28 cases) during another outbreak. A total of 355 HCPs were exposed to 17 patients with pertussis without any protection, and it was considered that exposure to pertussis would be "probably inevitable" in more than 80% of the contacts<sup>69</sup>.

In France, pertussis is not a disease that requires compulsory notification and approximately half of the notified pertussis cases are from hospitals where an HCP is affected<sup>86</sup>. Several pertussis intra-hospital transmission cases have also been reported in the last decade. In 1997, a 55 year-old nurse worked for five weeks with a cough until she was eventually diagnosed with pertussis. The investigation showed that nine out of 61 health professionals (15%) who had been in contact with the index case had serological indications of recent pertussis infection<sup>82</sup>.

The investigation of a pertussis outbreak between November 2000 and March 2011 after confirmation of three cases among hospital health professionals revealed that 91 people were exposed to infected patients, including 77 HCPs, 12 patients and two patients' relatives, generating four additional pertussis cases<sup>83</sup>.

Another outbreak in a maternity center involving five HCPs led to 10 probable cases among a group of 101 HCPs who were exposed to the disease out of a total of 201 professionals that worked in the center and agreed to participate in the investigation. Only 60% of participants took the prescribed antibiotic, 85% of the suspects used masks, and only 46% used the mask correctly<sup>85</sup>. One of the reasons for noncompliance with prophylactic measures is the high rate of side effects associated with the use of macrolides (33%)<sup>84</sup>. However, the main reason for noncompliance is a lack of awareness among HCPs of the risks the disease poses<sup>71,81</sup>.

### Cost implications of Pertussis outbreaks in hospitals

Although pertussis outbreaks that occurred in hospital settings affected relatively few patients (between two and 17) and HCPs (between five and 13), the cost implications were substantial due to the need to investigate the presence of the disease in a large number of people, absenteeism and measures against pertussis<sup>66,68,69,70,80,92</sup>.

During an outbreak in Cincinnati, 79 employees had to stay off work for at least five days and 622 people took antibiotics for 14 days<sup>80</sup>.

It is estimated that each pertussis case costs between US\$164 and US\$357, while the cost of controlling hospital outbreaks varies between US\$19,500 and US\$195,000, depending on the number of professionals exposed to the disease<sup>66,68,69,70,92</sup>.

The estimated cost of managing the exposure of 355 HCPs in a tertiary care center for children in Cincinnati during a period of 20 months was US\$69,770, while vaccination of the professionals involved cost approximately US\$60,000<sup>69</sup>.

The cost of a pertussis outbreak involving HCPs in France was €46,661, of which 42% was due to loss of productivity<sup>83</sup>.

An estimate based on the direct and indirect costs (temporary work absence) associated with outbreak control suggested that HCP vaccination could decrease costs by 238% and reduce the chances of infection by 46%<sup>66</sup>.

### Vaccine acceptance and the difficulties in implementing other prophylactic measures to prevent the spread of pertussis

Despite recommendations, many HCPs do not get vaccinated<sup>77,87,88,89,90,91,92,93</sup> because they wrongly believe that infection or vaccination during childhood provides permanent protection<sup>87,88,89,90,91,92,93</sup>. Studies also show that the following main factors are associated with low vaccine coverage in HCPs: low perception of risk; lack of specific knowledge of vaccines; unawareness of vaccination recommendations and legislation and lack of orientation by the health authorities (Table 4). Lack of access to vaccines in the workplace due to cost factors also hinder compliance with vaccination recommendations. This is the case not only with new vaccines, such as Tdap and Tdap-IPV, but also for those vaccines traditionally recommended for HCPs<sup>8,16,17,88,89</sup>.

Low coverage and incomplete vaccination regimens put the exposed individual at risk and generate expenses for employees and for the employers in the form of laboratory tests, treatment and/or immunoprophylaxis. Despite this, prophylactic measures to avoid infections are not always adopted in a timely manner<sup>63,64,65,66,67,68,69,70,71,72,73,74,75,76</sup>.

Lack of knowledge of the recommendation regarding the use of chemoprophylaxis after exposure to pertussis is a relevant issue even in countries where vaccines for HCPs are recommended<sup>17,76,80,81,82,92</sup>.

An investigation into the knowledge and attitudes with regard to pertussis vaccination performed in the USA with 63 HCPs showed that only 19% were aware that pertussis is a mandatory notifiable disease and half (52%) were aware of pertussis vaccination recommendations for HCPs in force in the USA since 2006. Almost half (48%) were not aware of the need to prescribe prophylactic antibiotics for people exposed to

pertussis, and only 22% knew that the patients' close contacts should also be tested<sup>75</sup>.

In a study conducted in France, physicians were more aware of occupational vaccinations than other HCPs and pediatricians were the best informed regarding the need to protect against flu and pertussis<sup>87</sup>. In Germany<sup>91</sup> and Australia<sup>97</sup> misconceptions about pertussis were more prevalent among nursing health professionals. It should be pointed out that these professionals have greater direct contact with high risk children, and have been more frequently identified as primary cases in pertussis outbreaks reported in neonatal units<sup>65,66,67,68,69,72,94,98</sup>.

In a study that involved almost 2,000 HCPs in Sweden in 2007<sup>71</sup>, only 13% of interviewees planned to take the acellular pertussis vaccine. The main factor associated with vaccine refusal was the belief that vaccination against pertussis during childhood provides permanent protection.

The difficulties involved in achieving compliance with pertussis vaccination of HCPs in some countries have led to discussions regarding compulsory vaccination<sup>10,11,16,17</sup>. In Germany, 68.4% of 1,215 HCPs supported mandatory vaccination for HCPs, however, acceptations of mandatory vaccination was lower among nurses, the group with lower immunization coverage rates<sup>91</sup>.

Even in some regions in Australia, where the pertussis vaccination is compulsory for health professionals, more than one third of professionals believed that they remained protected after vaccination during childhood<sup>97</sup>.

### Pertussis in Brazil

In Brazil, acellular pertussis vaccines for adolescents and adults (Tdap and Tdap-IPV) are only available in private clinics and, although recommended by the Brazilian Society of Immunization and by Medical Associations, they have not yet been included in the NR32 for HCPs<sup>2,3,4,5</sup>.

Table 4

Factors associated with acceptance and refusal of acellular pertussis vaccines by health care professionals (HCPs)<sup>17,75,81,87,88,89,90,91</sup>.

Acceptance	Refusal
1. Received a recommendation to take vaccination from a physician	1. Lack of a personal recommendation for vaccination
2. Awareness of CDC recommendation for pertussis vaccination for HCPs	2. Misconception that vaccine received previously protects for life
3. Encouraged to take vaccination by coworker	3. Low perception of the personal risks of contracting pertussis
4. Belief that HCPs may spread pertussis to patient and family	

CDC: Centers for Disease Control and Prevention.

Pertussis incidence rates in Brazil are very low compared with many countries and most cases are reported in infants under six months of age<sup>3,4,54,55,56</sup>. Pertussis diagnosis is generally carried out using clinical criteria and with or without the culture method<sup>3,4,54,55,56</sup>. Although culture is considered the gold standard for pertussis diagnosis, it rarely gives positive results when the classic criterion for pertussis (a cough lasting for more than two weeks) is adopted. Pertussis is seldom suspected in adults and it is generally not possible to confirm diagnosis through growth culture<sup>54,55,56</sup>. Lack of data does not mean that the disease does not occur, and recent studies in Latin American countries<sup>45,46,47,48,49,50,51,52,53,54,55,56</sup>, including Brazil<sup>45,56</sup>, have shown that young adults (19 to 39 years of age) are a source of infection to children<sup>56</sup>. With regard to transmission among HCPs, only one publication concerning a teaching hospital in the State of São Paulo was found<sup>106</sup>. The number of pertussis cases and associated deaths has risen in Brazil. In 2011, there were 2,257 cases and 55 deaths<sup>3</sup>. In the State of São Paulo, 913 cases and 23 deaths were recorded, corresponding to about 40% of pertussis cases and deaths registered in Brazil<sup>4</sup>. It is important to emphasize that RT-PCR pertussis diagnosis has only been introduced in the State of São Paulo<sup>3,4</sup>.

### The main issues associated with the Tdap and Tdap-IPV vaccines

The Tdap and Tdap-IPV vaccines recommended for HCPs are safe and their reactogenicity profile is similar to that of the dT and dT-IPV vaccines<sup>7,8,9,16,29,100,101,102,103,104,107,108,109,110,111,112,113,114,115,116,117,118,119,120</sup>. Fewer local reactions were reported among Tdap or Tdap-IPV recipients compared with those who received Tdap or Tdap-IPV. The majority of adverse events were local reactions, similar to those observed in children who received four doses of DTaP<sup>7,62,107,108,109,113</sup>.

There is little information on the efficacy of Tdap and Tdap-IPV vaccines for HCPs. However, immune response is excellent and, based on efficacy data in adolescents and adults, it is estimated that vaccine effectiveness is almost 80%<sup>7,23</sup>. Seroconversion occurs after only one week in more than 40% of individuals and high seroconversion rates (> 90%) against diphtheria, tetanus, pertussis and poliovirus have been reported after two to four weeks<sup>107,108</sup>.

Tdap and Tdap-IPV vaccines were recommended only for adolescents and young adults (< 64 years of age) with an interval of at least two years after the use of dT<sup>7</sup>; however, there is cur-

rently no minimum interval between dT and Tdap or Tdap-IPV<sup>9,114,120</sup> and data confirms that Tdap can be used safely in the elderly, albeit with a reduction in antibody levels<sup>115,116</sup>.

The Advisory Committee on Immunization Practices (ACIP) recommends that adults aged ≥ 65 years (including HCPs) who have or who anticipate having close contact with an infant < 12 months of age and who have not previously received dTpa should receive a single dose of Tdap to protect against pertussis, regardless of the interval since the last tetanus or diphtheria-toxoid containing vaccine<sup>9</sup>. European studies of Tdap-IPV also showed that this vaccine can be safely used after dT<sup>107,108</sup>.

When necessary (e.g., travel or epidemics), Tdap or Tdap-IPV vaccines may be given to pregnant women, preferentially after the first trimester of pregnancy<sup>9,12,13,18,19,114</sup>.

It is estimated that protection lasts for 5 to 10 years<sup>110,111,112,113,117,118,119</sup>; however, until now, only a few countries recommend redosing of these vaccines<sup>31</sup>. Recent studies confirmed that a dTpa vaccine can be given 5 to 10 years after the previous dose in adults immunized with the same product<sup>117,118,119</sup>.

Several studies have provided evidence that Tdap and Tdap-IPV may be given simultaneously with other vaccines whether they contain a live agent or not (influenza, triple viral, hepatitis B and HPV)<sup>7,9,109,114</sup>.

### Conclusions

Pertussis has reemerged in a number of countries and is considered a risk to HCPs, their patients and family members.

HCPs play an important role in suspecting, reporting and treating pertussis. Pertussis outbreaks in health care facilities have been detected in different countries. Measures to investigate, treat and control pertussis clusters are not very effective and generate a huge waste of resources that could be much better employed in disease prevention.

HCP pertussis immunization benefits both the community and the individual, since it reduces the risk of contraction and transmission of the disease.

Little information on the risk and acceptance of pertussis vaccines by HCPs is available in Brazil, and it is crucial to disseminate information on the risks of this disease and the benefits of vaccination, and improve pertussis surveillance with introduction of new diagnostic tests (RT-PCR and serology).



Considering the close association between vaccine acceptance and recommendations that laypeople receive from HCPs, the latter should receive continuing education on this subject to enable them to provide information on the benefits offered by the vaccines as recommended by the Medical Associations.

Considering the difficulties in diagnosing the disease and delays in the implementation of measures to control the dissemination of *B. pertussis* in hospitals, this study recommends greater attention on the part of health authorities with regard to the control and management of pertussis.

## Resumen

*El propósito de este artículo es describir los recientes cambios en la epidemiología y políticas de vacunación para la prevención de la tos ferina en los profesionales de la salud. Los autores realizaron un estudio de los artículos publicados en PubMed, sitios como SciELO, de la OMS, OPS, CDC y Ministerio de Salud de Brasil con las siguientes palabras clave: vacunas contra la tos ferina y profesionales de la salud. La vacunación de los trabajadores de la salud contra la tos ferina es recomendada por la OMS, la OPS, CDC y por las autoridades sanitarias de 9 países europeos, de Australia, Hong Kong, Singapur, Costa Rica, Argentina y Uruguay, y en algunos países es obligatoria. En Brasil, se ha identificado un solo artículo sobre la vacunación de los trabajadores de la salud contra la tos ferina, sin embargo, frente al resurgimiento de la enfermedad con un gran número de hospitalizaciones y muertes en 2011, consideramos que es necesario revisar la política pública de vacunación de los profesionales de la salud, especialmente si tienen contacto con niños pequeños.*

*Vacuna contra las Tos Ferina; Personal de Salud; Riesgos Laborales*

## Contributors

J. C. Moraes and L. F. Bricks contributed to project design and the drafting and final approval of this article. T. Carvalhanas contributed to project design and the critical review and final approval of this article.

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## Conflicts of interests

L. F. Bricks works in Sanofi Pasteur, Brazil.

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