

**Guidebook on Adult Immunization  
in Occupational Health Settings**  
**Healthy Worker: Key to  
Productivity and Sustainability**







Guidebook on Adult  
Immunization in  
Occupational Health  
Settings

# Message From President

The Indian Association of Occupational Health (IAOH) is committed to improving the health and well-being of India's working population. Towards this goal, the IAOH—through its branches and close to 3000 members—propagates the culture of health promotion and health protection at the workplace.

The IAOH epitomizes the adage 'prevention is better than cure.'

One of the keys to preventing illnesses is adequate immunization of the workforce against various illnesses that can be prevented. Globally, vaccine-preventable diseases (VPDs) are targeted very effectively at the workplace through a consensus approach on vaccination at the workplace.

The IAOH, through some of its senior members, has been working with a team of experts in the space of VPDs to develop a document entitled 'Guidelines on Adult Vaccination in Occupational Health Settings,' which could be used to guide the adoption of vaccination in India's workplaces.

I am delighted to announce that this has now been completed and that the guidance document is being released at OCCUCON 2020 (the 70th National Conference of the Indian Association of Occupational Health), in Mumbai in January 2020.

I take this opportunity to congratulate the team of senior members of the IAOH, who along with external technical experts, have formulated the IAOH document entitled 'Guidelines on Adult Vaccination in Occupational Health Settings.'

I also compliment the team for its untiring efforts in ensuring that we have a clearly defined approach to the prevention of VPDs at the workplace.

I recommend that this document be read by members of IAOH and other professional bodies; it can serve as a guideline for the vaccination of India's vast working class.

I believe that this document will enable all stakeholders, including employees, to achieve optimum health and well-being in the workplace.

**Dr. SK Raut**

President, IAOH, India

January 2020, Mumbai



# Editorial

**Dr. T Rajgopal**

**Guidebook on Adult Immunization in Occupational Health Settings**  
**Healthy Worker: Key to Productivity and Sustainability**

The Indian Association of Occupational Health (IAOH), the largest not-for-profit professional voluntary organization in India, aims to provide scientific knowledge and guidance to industry on problems of occupational health and hygiene. The Indian Association of Occupational Health is affiliated to the International Commission on Occupational Health (ICOH), which is an international professional organization dedicated to scientific research. The IAOH has consultative status with the World Health Organization (WHO).

The IAOH believes that purposeful and involved occupational health services at the workplace, as envisaged by the International Labor Organization (ILO), are the best channel through which modern medicine can help industry achieve positive health and productivity.

Of the 1.30 billion population in India, over 63% belong to the productive age group, with a total workforce of around 458 million workers.

In as much as work can affect health, ill-health too can affect work. World over, it has been shown that health protection and health promotion at the workplace strengthen health, reduce absenteeism and presenteeism, as well as enhancing productivity. Global data show that for every single dollar invested in employee health and well-being, the returns can be as high as \$4. Health, engagement, and productivity are closely linked. An internal study by Unilever over a six-year period showed an overall return on investment of 2.33.<sup>1</sup>

Vaccination for the working population plays a significant role in reducing both absenteeism and presenteeism in the workplace. International organizations such as the Centers for Disease Control and Prevention have come out with specific schedules for adult immunization.<sup>2</sup> However, there is no such document available for adult immunization in India.

To address this important issue and in line with the IAOH's mission to help keep India's workplaces healthy, the IAOH held a consultative meeting with experts in the field of immunization to prepare guidelines for adult immunization in occupational health settings in India. The consultative meeting reviewed the role of vaccination in the context of India's vast working population and its potential impact on health, productivity, and sustainability—the theme of the OCCUCON 2020 (which incorporates the 70th National Conference of the Indian Association of Occupational Health).

The committee discussed the prevalence of vaccine-preventable illnesses in the working population, did a comprehensive literature survey in this field, and reviewed vaccine schedules for healthcare workers, pregnant employees, as also vaccines in the context of mass gatherings. The document entitled 'Guidebook on Adult Immunization in Occupational Health Settings' by the IAOH has been developed in conjunction with leading experts in this field in India. Adult vaccination is an important component of workplace occupational health services.<sup>3</sup>

The document reviews how human capital can be impacted by ill-health, the burden of vaccine-preventable diseases at the workplace, the challenges of adult immunization in India, and the positive outcomes of adult vaccination at the workplace. Vaccination can result in cost savings, reduced absenteeism and comorbidities, as well as having a positive impact on health insurance. The document takes stock of diverse recommendations and synthesizes them into evidence-based recommendations for adult immunization at the workplace.

This guidance document is expected to benefit thousands of employees across both the formal and informal sectors in India and is a significant step toward improving the health and well-being of workers in India.

**Dr. T Rajgopal**

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## Healthy Worker: Key to Productivity and Sustainability

In the modern world, workplace culture is quite dynamic as well as highly demanding, impacting health and wellness. In recent times, organizations in India have been focusing on incorporating wellness programs at work for better functioning, with the three major productivity gains being reduced healthcare costs, reduction in absenteeism, and increased employee engagement.<sup>1</sup> Of note, adult vaccination plays a significant role in ensuring the well-being of employees, as well as in keeping an organization profitable. Considering the necessity for increased awareness regarding the often-underestimated concept of adult vaccination in India, an expert meeting was held on 1<sup>st</sup> December 2019 under the aegis of the Indian Association of Occupational Health (IAOH) with the purpose of drawing attention to these issues and working toward developing guidelines on adult vaccination in an occupational health setting. The scientific deliberations led to the formulation of consensus recommendations on adult vaccination in the context of occupational health settings in India.

Meeting Name:

**Guidelines on Adult Vaccination in Occupational Health Setting.**

Theme of Meeting:

**Healthy Worker and Productivity.**

**The following experts participated in the deliberations:**

Sl. No.	Name	Designation
1	Dr. T Rajgopal	Past President, IAOH & Moderator for the session
2	Dr. SM Shanbhag	Past President, IAOH
3	Dr. Ashish Mishra	Organizing Secretary, OCCUCON 2020
4	Dr. SK Raut	President, IAOH
5	Dr. Bobby Joseph	Editor, <i>Indian Journal of Occupational and Environmental Medicine</i>
6	Dr. Parvaiz A Koul	Professor and Head, Internal and Pulmonary Medicine, Sher-i-Kashmir Institute of Medical Sciences, Srinagar
7	Dr. Subramanian Swaminathan	Senior Consultant, Infectious Disease, Gleneagles Global Health City, Chennai

### Objectives

- To understand the burden of vaccine-preventable diseases (VPDs) in the working population in India
- To identify the need for developing guidelines on adult vaccination in occupational settings
- To develop a ready reckoner for organizations on immunization at the workplace

Moreover, the theme of the forthcoming conference of the IAOH, i.e. OCCUCON 2020, is 'Healthy Worker: Key to Productivity and Sustainability.' Hence, the IAOH aims to invest in preventive health measures, particularly vaccination, to improve workplace productivity. This guideline document will emphasize the burden of important VPDs in India and also highlight key recommendations from experts.

## Human Capital: A Determinant of Economic Growth and Challenges in Workplace Wellness

Human capital, a crucial determinant of economic growth, is recognized as the level of education and health in a population. The term 'expected human capital' signifies the number of years an individual remains at their peak productivity at the workplace between the ages of 20 and 64. A recent survey ranked India 158 among 195 countries in terms of expected human capital, and unfortunately, the average Indian's peak productive period lasts only seven years, which is less than half that of a Chinese worker (peak productive period=20 years). Besides, India ranks below all other countries in the South Asian region in terms of functional health.<sup>2</sup>

People Matter-Sanofi Pasteur, a study conducted in 221 corporate institutions in India, focusing on 'The Contemporary Trends and Challenges of Workplace Wellness Programs in India 2019,' sought to evaluate industry trends and challenges that human resources (HR) professionals and business leaders encounter when it came to driving employee-wellness programs. The key findings of the survey are as follows:

- Most organizations (67%) offer health-risk-assessment programs, and 49% of the organizations surveyed are trying to focus on stress management.
- About 62% of the surveyed organizations have not taken any measures to tackle/control an outbreak of infectious diseases.<sup>1</sup>

Lack of employee awareness often hampers the efforts of companies toward organizing wellness programs. In fact, a recent survey conducted in major corporate organizations in metro cities showed a lack of understanding of influenza vaccines.<sup>3</sup> Another survey revealed that only 45% of employees were aware of the flu shots offered at the workplace, in contrast to 77% among employers who had implemented such programs.<sup>4</sup>

Work performance challenges related to modifiable health behaviors (e.g. inadequate/lack of physical activity, smoking, obesity, etc.) are highly prevalent, ultimately leading to loss of productivity and, thereby, affecting the economic/financial status of the organization. All these modifiable health factors not only contribute to increased levels of sickness absence but also give rise to phenomena called 'absenteeism and presenteeism.' Absenteeism refers to the count of days absent from work, whereas presenteeism refers to reduced productivity while at work.<sup>5</sup>

A survey has shown that acute diseases, such as influenza, diarrhea, malaria, and dengue, followed by lifestyle diseases such as stroke, cardiovascular diseases, diabetes, and mental disorders, are primary contributors to workplace absenteeism.<sup>6</sup> Considering the increased burden of noncommunicable diseases (NCDs) and communicable diseases (CDs), insurance data for three financial years were studied; they showed that influenza and pneumonia had the highest average claim paid amount for the financial years 2014–2017.<sup>7</sup>

*Lancet 2018*

**India ranks 158 among 195 in terms of expected human capital.<sup>2</sup>**

**Higher improvements in expected human capital appear to be directly associated with faster economic growth.<sup>2</sup> India lags severely in this aspect.**

**Modifiable health factors affect workplace productivity and cause an increased rate of absenteeism as well as presenteeism.<sup>5</sup> Both absenteeism and presenteeism negatively affect the core profitability of any organization.<sup>6</sup> Presenteeism is defined as reduced productivity while at work.<sup>5</sup>**

# Burden and Impact of Vaccine-Preventable Diseases in Working Population and Role of Adult Immunization/Vaccination

## Epidemiological Burden

In India, it is challenging to estimate the actual burden of various diseases due to scarcity of systematic epidemiological data. Of note, the most common pneumococcal diseases, i.e. meningitis and pneumonia, are associated with high morbidity and mortality rates.<sup>8</sup>

Table 1 shows the prevalence/incidence of VPDs in India.

**Table 1:** Prevalence/Incidence of VPDs in India<sup>9–13</sup>

Disease	Incidence/Prevalence
Influenza	Between 2015 and 2019, 126,906 H1N1 cases and 7865 deaths were reported <sup>9</sup>
Pneumococcal disease <ul style="list-style-type: none"> <li>• Pneumonia</li> <li>• Meningitis</li> <li>• Septicemia</li> </ul>	As per a recent study, out of 374 adult invasive pneumococcal disease (IPD) cases: <sup>8</sup> <ul style="list-style-type: none"> <li>• 146 patients suffered from pneumonia (39%).</li> <li>• 91 patients had meningitis (24.3%).</li> <li>• 69 patients suffered from pneumococcal septicemia (18.4%).</li> </ul>
Hepatitis	<ul style="list-style-type: none"> <li>• In a study, among 599,605 cases tested for hepatitis A, 44,663 cases were found to be positive.<sup>10</sup></li> <li>• India has &gt;37 million HBV carriers.<sup>11</sup></li> </ul>
Measles and rubella	55,399 cases of measles and 1066 cases of rubella (all age groups). <sup>12</sup>
Typhoid	120/100,000 population-years in adults older than 15 years. <sup>13</sup>

VPDs: Vaccine-preventable diseases.

## Economic Burden

A study conducted in the USA showed that influenza, pneumococcal diseases, varicella, and herpes zoster infections cause a substantial economic burden. The researchers concluded that the economic burden of adult VPDs can only be reduced by broadening adult immunization efforts beyond influenza.<sup>14</sup>

Influenza negatively influences economic conditions through medical costs and lost productivity. Influenza is responsible for one-tenth of all sickness absences from work, which is roughly equivalent to the number of absences attributed to musculoskeletal disorders and twice the number attributed to psychiatric disorders. A typical case of influenza confines the patient to bed for three to four days and limits activity for several more days.<sup>15</sup>

A retrospective cohort study was conducted to evaluate the economic impact of community-acquired pneumonia (CAP) in US working-age adults. Among active employees and their adult dependents, the mean annual healthcare costs were found to be more than five times higher in patients with CAP as compared to individuals without CAP (\$20,961 vs. \$3783, respectively). A high proportion of CAP patients (19.5%) had to be hospitalized.<sup>16</sup>

**Preventive measures, such as influenza and pneumococcal vaccination targeting working-age adults with underlying medical conditions, may be the most crucial step in reducing the costs associated with CAP.<sup>16</sup>**

## Burden of VPDs at Workplace and Its Impact

The burden of influenza at the workplace is reflected in terms of work absenteeism, reduced work effectiveness, and increased physician office visits and hospitalization. Influenza-like infections were found to have significant mean annual attack rates of 5.3% in vaccinated and 26.2% in nonvaccinated working employees respectively.<sup>17</sup> Influenza causes almost a 50% mean reduction in the activity level/effectiveness at work.<sup>18</sup>

Tsai Y *et al.* reported that the mean work-loss hours per influenza-like illnesses is 23.6 hours, and the work-loss hours are even higher in cases of influenza-like illness episodes associated with hospitalization (47 hours).<sup>19</sup>

Another study showed that workplace inhalational hazards exposure substantially contributes to the development of multiple chronic respiratory diseases, including pneumonitis, causing an occupational burden of 19%.<sup>20</sup> Welders and those exposed to metal fumes are known to be at an increased risk for pneumococcal pneumonia and IPD. In 2015, an outbreak of serious pneumococcal disease was reported among a multinational workforce exposed to metal fumes while working on the refurbishment of an oil rig in a Belfast shipyard. Despite ensuring environmental control measures and using respiratory protective equipment, four confirmed and five probable cases were detected.<sup>21</sup>

### Burden of Comorbidities with Increasing Age and Their Impact

The proportion of the elderly population is rapidly increasing, and aging is frequently accompanied by different comorbidities and chronic diseases.<sup>22</sup> Aging is associated with complex changes in the immune system that make the elderly more susceptible to different infectious diseases.<sup>23</sup> For example, influenza in diabetes patients increases the risk of hospitalization and intensive care unit (ICU) admission by 3–6-fold and 4-fold, respectively.<sup>24,25</sup> The risk of myocardial infarction is reported to be six times higher within the first week of laboratory-confirmed influenza diagnosis.<sup>26</sup> At the population level, influenza circulation is associated with cardiovascular disease hospitalization and death, even after controlling for temporal and environmental factors.<sup>27–29</sup> A survey indicated that the overall incidence rate per 100,000 population of adult pneumococcal disease is 8.8 in healthy adults, 51.4 in adults with diabetes, 62.9 in adults with chronic lung disease, and 93.7 in adults with chronic heart disease. The incidence rates increased with advancing age in adults with comorbidities such as chronic lung disease, diabetes, etc.<sup>30</sup> A study conducted among 173 immunocompetent elderly individuals with CAP revealed that cardiopulmonary comorbidity accounts for 42% of pneumonia cases in this study population.<sup>31</sup> A population-based study showed that patients with asthma had a 3-fold increased risk of developing IPD vs. patients without asthma.<sup>32</sup> In another retrospective, longitudinal American study, diabetic patients were found to be at a higher risk of conditions such as fibrosis, pneumonia, and chronic obstructive pulmonary disease compared to healthy individuals. Increasing hemoglobin A<sub>1c</sub> (HbA<sub>1c</sub>) values were found to be significantly associated with the risk of developing pneumonia.<sup>33</sup> Research suggests that the incidence of pneumonia is increased 3- to 4-fold in chronic kidney disease patients and 10-fold in dialysis patients.<sup>34,35</sup>

**All the above studies manifest the earnest need for adult vaccination to not only stimulate the efficacy of childhood vaccines but also to prevent various comorbidities.<sup>36</sup>**

### Challenges of Adult Immunization in India

Immunization is considered one of the most advantageous and cost-effective disease-prevention strategies. Unlike childhood immunization programs, in India, adult immunization is a highly neglected and underpublicized issue. The Centers for Disease Control and Prevention (CDC) has prepared and circulated recommendations for adult vaccines.<sup>36</sup>

Several ambiguities and controversies exist in relation to adult immunization, especially in developing countries such as India. Even among published guidelines from international organizations such as the WHO, there is a dearth of a consensus regarding the optimal strategy for adult immunization, and most importantly, the issue of adult immunization in developing countries remains unaddressed.<sup>37</sup>

The challenges to adult immunization in India could be viewed from three aspects:

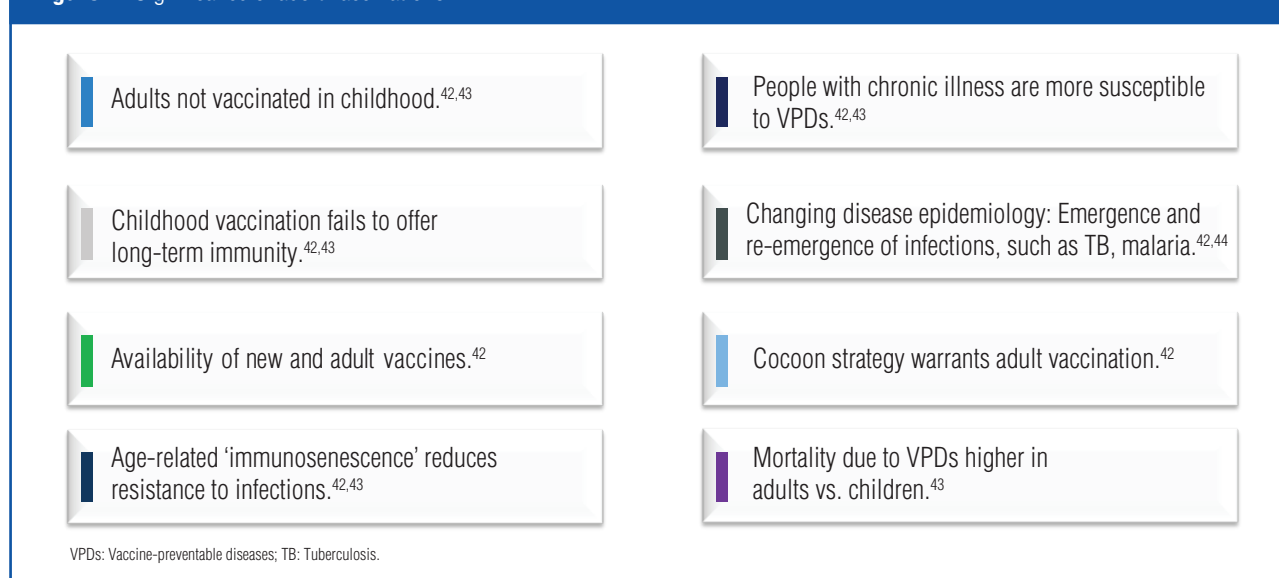
- **Individuals:** There is a dearth of knowledge among the general population in terms of CDs and the role of vaccination in preventing different infections.<sup>38</sup>
- **Healthcare providers:** Challenges to adult immunization include:
  - ◆ Failure of the provider to monitor patients' vaccination status.
  - ◆ Lack of authorization for medical technicians and nurses to vaccinate patients.
  - ◆ Lack of specialized vaccination centers.<sup>39</sup>

- **Government and regulatory policies:** The efficacy, safety, and cost of introducing vaccines for adults at the national level have not been addressed. In India, there is a dearth of proper epidemiological data focusing on the burden of CDs; this consequently does not drive policymakers to promote adult vaccination. The Ministry of Health and Family Welfare, Government of India, has issued guidelines on vaccination to strengthen Universal Immunisation Programme. However, the focus is predominantly on children, not adults.<sup>40</sup>
- Adult immunization is selective and not universal, and hence, it is challenging to reach through the public health system, causing difficulties in vaccinating the adult population.<sup>41</sup>

## Significance of Adult Vaccination and Its Benefits to an Organization

Adults require vaccination for numerous reasons, as shown in Figure 1.<sup>42–44</sup>

**Figure 1:** Significance of adult vaccinations.<sup>2,42–44</sup>



Interestingly, the proportion of adults who die of VPDs each year is 350-fold higher than that of children.<sup>43</sup>

A positive correlation exists between preventive healthcare and overall organizational benefits. This indicates a possible positive impact of preventive healthcare on the Indian industries. A healthy workforce ensures higher productivity, in turn, conferring greater profits and savings on medical expenditure.<sup>6</sup> Case studies have shown that vaccination programs, especially flu vaccine programs, yield a rich return on investment (ROI).<sup>45</sup>

Preventive healthcare can ensure better overall health. In this context, the WHO considers vaccination to be one of the most cost-effective (and often cost-saving) primary preventive measures to promote public health.<sup>46</sup>

## Outcomes of Adult Vaccinations to Organizations

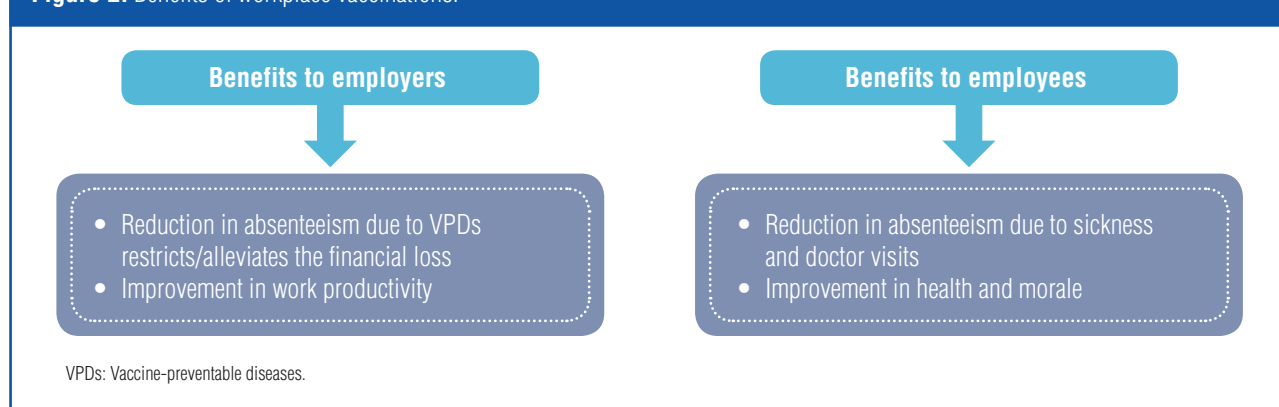
### Cost Savings

Workplace vaccination has several benefits for employers as well as employees (Figure 2).<sup>47</sup> For instance, workplace influenza vaccination campaigns are known to offer several health benefits and reduce financial losses.<sup>48</sup> The cost–benefit ratio for the influenza vaccination program is 4.2, i.e. return of €4 at the cost of €1 due to curtailed absenteeism. Influenza vaccination has broader merits: even nonvaccinated people stand to benefit, as the transmission of infection is restricted.<sup>49</sup>

The economic benefits of polysaccharide 23-valent (PPSV23) and/or conjugate pneumococcal vaccine 13-valent (PCV13) in adults, the elderly, and at-risk groups have been evaluated in many studies.<sup>50–56</sup>

**Workplace vaccination enables the translation of health benefits to financial benefits for the employer, with cost savings significantly outweighing the cost of the vaccination program.<sup>48</sup>**

**Figure 2:** Benefits of workplace vaccinations.<sup>47</sup>



A study conducted among elderly people (>60 years old) and at-risk adults (18–59 years old) in Turkey found an association between pneumococcal vaccination and positive ROI: Mean incremental savings of 45.4 million Yeni Türk liras (YTL) and 21.8 million YTL were accrued in elderly and at-risk adults, respectively.<sup>50</sup> A German study showed that implementation of sequential immunization with PCV13 first, followed by unconjugated capsular polysaccharide antigens (PPSV23), may lead to potential savings of €115–€187 million, for medical and nonmedical costs due to substantial reduction in total IPD cases, as well as hospitalized all-cause nonbacteremic pneumonia (NBP) and outpatient NBP cases.<sup>51</sup> In a retrospective study of a large cohort of 47,365 subjects aged ≥65 years, evidence suggests a vaccine effectiveness of 44% against pneumococcal bacteremia and, hence, its cost effectiveness for this indication.<sup>52</sup> A Spanish dynamic transmission model reported that the use of PCV13 for five years in a cohort of patients aged 65 to 69 years would avoid 10,360 cases of pneumococcal disease and 699 deaths, leading to an increase of 14,736 life-years. This may result in a corresponding cumulative saving of €3.8 million at a fixed price (€4.9 million at current prices) and would be an efficient intervention for the Spanish National Health System.<sup>53</sup>

**Pneumococcal vaccination is economically advantageous,<sup>53–56</sup> and it should be strongly recommended for adults and the elderly.**

## Reduction in Absenteeism

During the peak season, flu causes high rates of absenteeism and low productivity among affected individuals. A study that evaluated the costs and benefits of influenza vaccination showed that vaccination is associated with not only a 23% reduction in the absence rate but also a 30% improvement in lost working days and related expenses.<sup>49</sup> A study conducted among 1022 employees in a Malaysian petrochemical company revealed that the total number of days of sick leave (i.e. absenteeism) was 72 in vaccinated vs. 473 in nonvaccinated employees, whereas the total number of days of reduced productivity was 148 in vaccinated vs. 432 in nonvaccinated employees.<sup>48</sup>

## Role of Vaccination in Reducing Comorbidities

Vaccination plays an important role in reducing comorbidities in adults. Influenza and pneumococcal vaccines have beneficial effects beyond the direct advantages of vaccines. A retrospective observational study, conducted among the workforce of an Argentinean chemical company, reported the effectiveness rate of vaccination at 75.9±9.08% in decreasing the ILI occurrence and 81.36±6.69% in decreasing absenteeism due to ILI.<sup>58</sup> Influenza vaccines have been reported to reduce the risk of heart attack by 19%–45%, which is equipotent or better than preventive treatments such as cholesterol-lowering drugs (reduce risk 25%–30%) and lifestyle changes such as quitting smoking (reduces risk by 32%–43%).<sup>59</sup> The risk of all-cause mortality is 31% lower in influenza-vaccinated individuals with heart failure as compared with nonvaccinated patients.<sup>60</sup> A meta-analysis has shown that influenza vaccines have a protective effect against major adverse cardiovascular disease events.<sup>61</sup> Influenza vaccination also helps in reducing hospitalization by 54% in patients with diabetes.<sup>62</sup>

**An employee vaccination program is safe and effective with an effectiveness rate of 68%. Implementing an influenza vaccination program would reduce the burden of influenza-like illness (ILI) and can ensure better monetary prospects for the company.<sup>57</sup>**

In diabetes patients, influenza vaccination has been found to be associated with a significantly reduced rate of hospital admission, i.e. 30%, 22%, and 15% reduced rate of hospital admission due to stroke, heart failure, and pneumonia, respectively. Moreover, vaccinated individuals showed a 24% lower rate of all-cause mortality vs. nonvaccinated people.<sup>63</sup>

On the other hand, pneumococcal vaccines are known to reduce the risk of comorbidities. In a meta-analysis of eight observational studies, pneumococcal vaccination was associated with a significant reduction in the risk of acute coronary syndrome in the older population ( $\geq 65$  years old).<sup>64</sup> Pneumococcal vaccination is associated with a lower mortality rate in patients with chronic kidney disease (CKD) undergoing dialysis.<sup>65</sup> Vaccination with PCV13 induces antibody responses to vaccine serotypes in patients ( $\geq 50$  years old) with end-stage renal disease and on dialysis at two months post-vaccination.<sup>66</sup> In diabetes patients, pneumococcal vaccination confers a significant reduction in morbidity and mortality related to pneumococcal disease.<sup>67</sup> The Research Society for the Study of Diabetes in India (RSSDI) 2018 recommends patient education on pneumococcal and influenza vaccine to all adult diabetes patients. The recommendation is to use PCV13 for adults  $\geq 50$  years followed by a dose of PPSV23 at least one year later (and at least five years after their previous PPSV23 dose) depending on the clinical judgment of the physician.<sup>68</sup> A study evaluating the efficacy of PCV13 for healthcare workers found pneumococcal vaccination to be associated with a reduction of the rate of all pneumococcal infections, asymptomatic carriage of *Streptococcus pneumoniae*, and respiratory pneumococcal infections by 2.1, 2.2, and 2.1 times, respectively. A decrease in work absenteeism owing to respiratory infections was also observed.<sup>69</sup> Pneumococcal vaccination is associated with a decreased risk of cardiovascular events and mortality. Pneumococcal vaccination also decreases the risk of myocardial infarction and cerebrovascular events in the elderly.<sup>70</sup> The conjugated pneumococcal vaccine has shown promising effects in terms of reducing the rate of antibiotic resistance by slowing the spread of resistant pneumococcal serotypes (19A) and also by averting the disease occurrence. Therefore, the use of antibiotics can be obliterated.<sup>71</sup>

Dual vaccination with pneumococcal and influenza is effective in protecting elderly people with chronic illness from developing complications associated with respiratory, cardiovascular, and cerebrovascular diseases, thereby reducing hospitalization, coronary or intensive care admissions, and death.<sup>72</sup> In elderly patients (mean age: 84.6 years), a combination of influenza and pneumococcal vaccination was found to reduce the mortality rate by 38% vs. nonvaccinated individuals ( $p < 0.001$ ).<sup>73</sup>

## Benefits Health Insurance

In line with cost savings and reducing comorbidities, vaccination may help in reducing health insurance claims by preventing hospitalization and physician visits. In the USA, the CDC states that all Health Insurance Marketplace External plans and most other private insurance plans must cover the following list of vaccines without charging a copayment or coinsurance when provided by an in-network provider. This is true even for patients who have not met a yearly deductible. Doses, recommended ages, and recommended populations for these vaccines vary.<sup>74</sup>

- Hepatitis A
- Hepatitis B
- Herpes zoster
- Human papillomavirus
- Influenza
- Measles, mumps, rubella
- Meningococcal
- Pneumococcal
- Tetanus, diphtheria, pertussis
- Varicella

In India, as per the Insurance Regulatory and Development Authority (IRDAI) 2016–17 report, the highest numbers of claims are for the infectious disease category. Moreover, the working-age group (26–55 years) accounts for 42% of the total claims. The IRDAI encourages insurers to introduce wellness and preventive features as part of a health insurance policy. The IRDAI expects that such wellness and preventive features would help in not only reducing the incidence of lifestyle-related diseases but also in keeping claim costs in control, which may, in turn, make health insurance more affordable.<sup>75</sup>

A highly important aspect of workplace adult vaccination is to extend the benefits/provision of adult vaccination to the family members of employees. Considering the highly contagious nature of the VPDs such as influenza,<sup>76</sup> varicella,<sup>77</sup> and pneumococcal infections (caused by *Streptococcus pneumoniae*), extending vaccination benefits to family members may reduce the rate of absenteeism among employees,<sup>78</sup> owing to self-infection or family obligation.

## Adult Vaccination: Current Guidelines in India and Different Recommendations

Unlike the Pediatrics Immunization Guidelines, several divergences exist from region to region for adult vaccination in India. The most popular guidelines in India for adult vaccination are the WHO guidelines, guidelines of the Geriatric Society of India, the Advisory Committee on Immunization Practices (ACIP) guidelines from CDC, Association of Physicians of India—Expert panel guidelines, Research Society for Study of Diabetes in India guidelines, Indian Society of Nephrology guidelines, and Indian Medical Association guidelines.<sup>40,79,80</sup>

The recommended vaccines for all healthy adults in India are as follows:

- Influenza (>19 years onwards)<sup>81</sup>
- Pneumococcal (>50 years)<sup>80</sup>
  - ◆ Pneumococcal conjugate vaccine 13-valent
  - ◆ Pneumococcal polysaccharide vaccine 23-valent
- Human papillomavirus (15–45 years)<sup>80</sup>
- Herpes zoster (>60 years)<sup>81</sup>
- DPT (diphtheria, pertussis, and tetanus) (19 years onwards)<sup>80</sup>
- MMR (measles, mumps, and rubella) (19–60 years old)<sup>81</sup>

### Pneumococcal Disease: Burden, Serogroups, and Available Vaccines

Asia is highly burdened with pneumonia patients, with India being the highest contributor with 43 million cases.<sup>82</sup> In India, pneumonia and meningitis are the most common invasive pneumococcal diseases.<sup>83</sup> Pneumonia accounts for 39% of the total invasive pneumococcal disease cases.<sup>8</sup> Pneumococcal infection is associated with an increased risk of hospitalization due to heart diseases, as well as high in-hospital mortality.<sup>84</sup> In India, invasive pneumococcal disease is associated with the highest case-fatality rate (28%) among adults aged >50 years.<sup>39</sup> According to 2017 Global Burden of Disease, the reported incidence and mortality was increased by 26% and 33% among 50–69 years and ≥70 years age group, respectively.<sup>85</sup>

A trial conducted among more than 84,000 adults (aged ≥65 years) showed an efficacy of 46% (95% confidence interval [CI] 21.8%–62.5%) and 75% (95% CI 41.4%–90.8%) for pneumococcal vaccine in association with the prevention of vaccine-type pneumonia and invasive pneumococcal disease, respectively.<sup>86</sup> In a two-year prospective cohort study of adults, the pneumococcal vaccine was associated with a vaccine efficacy of 88.1% against pneumococcal CAP.<sup>87</sup>

The most common serotypes found in India are 1, 3, 5, 19F, 8, 14, 23F, 4, 19A, and 6B. These serotypes account for 54.9% of invasive pneumococcal disease cases. High nonsusceptibility to co-trimoxazole and the slow emergence of resistance to penicillin, tetracycline, and erythromycin have been reported. Vaccines are advocated by various Indian healthcare bodies/groups for older and younger adults with certain medical conditions.<sup>83</sup>

There are two types of pneumococcal vaccine: unconjugated capsular polysaccharide antigens (PPSV 23) and capsular polysaccharides conjugated with a protein carrier (PCV13). Table 2 highlights the detailed characteristics of both vaccines.<sup>71,88–90</sup>

**Table 2:** Characteristics for pneumococcal vaccines<sup>71,88–90</sup>

Characteristics	PPSV23	PCV13
Type of vaccine	Unconjugated capsular polysaccharide antigens	Capsular polysaccharides conjugated with a protein carrier
	Contains antigens from 23 common serotypes (1, 2, 3, 4, 5, 6B, 7F, 8, 9N, 9V, 10A, 11A, 12F, 14, 15B, 17F, 18C, 19A, 19F, 20, 22F, 23F, and 33F)	Contains antigens from 13 common serotypes (serotypes 1, 3, 4, 5, 6A, 6B, 7F, 9V, 14, 18C, 19A, 19F, and 23F)
Immune response	T-cell-independent immune response (IgM antibody produced, response declines in 3–5 years, and no anamnestic response at revaccination)	T-cell-dependent immune response (larger duration and boosting effect at revaccination)
Efficacy	Considerable efficacy proven against IPD (50%–70%) in immunocompetent elderly individuals	High efficacy (80%–90%) against vaccine-type IPD proven in children
	Unclear (null to small) efficacy against nonbacteremic pneumococcal pneumonia	At present, relatively small serotype coverage for IPD in the elderly (30%–40%)
	No efficacy demonstrated in reducing nasopharyngeal carriage	Potential efficacy in reducing nasopharyngeal carriage
	No impact proved in reducing the overall pneumococcal disease burden	Future reduction of vaccination impact in adults/elderly (because of indirect effects from the pediatric use of PCV13)

IPD: Invasive pneumococcal disease; IgM: Immunoglobulin M; PPSV23: 23-valent pneumococcal polysaccharide vaccine; PCV13: 13-valent pneumococcal conjugate vaccine.

Different studies reveal that the initial PCV13 dose has the potential to enhance responses to a subsequent PPSV23 dose, compared with PCV13 alone.<sup>91–93</sup> PCV13 displays a more robust or greater immune response compared to PPSV23 in the majority of shared pneumococcal serotypes.<sup>83</sup>

Based on the serotype covered by the conjugated form, i.e. PCV13, and considering the seroprevalence in India, it is crucial to add PCV13 to ensure coverage for all prevalent serotypes in the country.<sup>83</sup> Different professional societies in India such as the Geriatric Society,<sup>94</sup> Indian Society of Nephrology,<sup>79</sup> API,<sup>36</sup> RSSDI,<sup>68</sup> IMA,<sup>80</sup> and Mass Gathering Advisory Board Consensus Recommendation 2016,<sup>88</sup> have recommended the implementation of pneumococcal vaccination in adults.

Various guidelines have advocated the use of pneumococcal vaccines sequentially for preventing disease occurrence among older adults. The chronological evolution of pneumococcal vaccine recommendations from global advocacy groups is detailed in Table 3.<sup>95,96</sup>

**Table 3:** Chronological evolution of pneumococcal vaccine recommendations<sup>95,96</sup>

Advocacy group/body	Recommendation/s
Global Initiative for Chronic Obstructive Lung Disease (GOLD, 2019) <sup>95</sup>	<ul style="list-style-type: none"> <li>PCV13 and PPSV23 recommended for all patients ≥65 years of age.</li> <li>PPSV23 also recommended for younger COPD patients with significant comorbid conditions, including chronic heart or lung disease.</li> </ul>
Advisory Committee on Immunization Practices (ACIP, 2019) <sup>96</sup>	<ul style="list-style-type: none"> <li>ACIP recommends administration of PCV13 based on shared clinical decision-making for adults aged ≥65 years (who do not have an immunocompromising condition (e.g. CSF leak, or cochlear implant) and who have not previously received PCV13. <ul style="list-style-type: none"> <li>If the decision is made to administer PCV13, it should be given at least 1 year before PPSV23. PCV13 and PPSV23 should not be co-administered.</li> </ul> </li> <li>ACIP continues to recommend PCV13 in series with PPSV23 for adults aged ≥19 years with an immunocompromising condition, CSF leak, or cochlear implant.</li> </ul>

COPD: Chronic obstructive lung disease; PPSV23: 23-valent pneumococcal polysaccharide vaccine; PCV13: 13-valent pneumococcal conjugate vaccine; CSF: Cerebrospinal fluid.

## Influenza: Burden and Available Vaccines

Influenza viruses are highly unstable in nature and cause pandemics. Figure 3 highlights the year-wise prevalence of influenza and mortality due to influenza. In 2017, the virus was unusually widespread in various parts of the country and caused three times higher mortality than that in the pandemic year, i.e. 2009.<sup>9</sup>

**Figure 3:** Number of reported cases and deaths due to influenza.<sup>9</sup>

	2009	2010	2015	2016	2017
Cases	27,236	20,604	42,592	1786	38,811
Mortality	981	1763	2990	265	2266

The following prefilled syringes of influenza vaccines are available in India:

- Trivalent inactivated vaccine
- Quadrivalent inactivated
- Live, attenuated nasal spray (lyophilized)<sup>80</sup>

### Vaccines for Influenza in Adults: Recommendations

- One dose every year is recommended.
- For inactivated vaccines, 0.5 mL is administered intramuscularly in the deltoid.
- Live, attenuated vaccine is sprayed into each nostril.<sup>80</sup>
- The trivalent vaccine provides protection against two strains of influenza A virus and one strain of influenza B strain, whereas quadrivalent vaccine provides protection against one additional Influenza B strain.<sup>97</sup>
- Quadrivalent vaccine is recommended for yearly administration.<sup>98</sup>

A number of studies have shown beneficial effects and safety of concomitant use of pneumococcal and influenza vaccines (Table 4).

**Table 4:** Concomitant use of pneumococcal and influenza vaccines<sup>99,100</sup>

Study author	Patients	Outcome of coadministration of pneumococcal and influenza vaccines
Sumitani M, <i>et al.</i> <sup>99</sup>	A total of 98 adults with chronic respiratory disease underwent the additive inoculation of influenza vaccine (I-V) and 23-valent pneumococcal vaccine (P-V) to prevent lower respiratory tract infections.	<ul style="list-style-type: none"> <li>• Significant reduction in: <ul style="list-style-type: none"> <li>◆ Number of respiratory infections (3.16 vs. 1.95 infections; p=0.0004)</li> <li>◆ Number of hospitalizations (0.79 vs. 0.43 hospitalizations; p=0.001).</li> </ul> </li> </ul>
Christenson B, <i>et al.</i> <sup>100</sup>	100,242 participants aged ≥65 years; 76% of the participants received both vaccines.	<ul style="list-style-type: none"> <li>• The incidence of hospital treatment was lower in vaccinated group vs. non-vaccinated group.</li> <li>• In vaccinated group, the incidence of hospital treatment was: <ul style="list-style-type: none"> <li>◆ 46% lower for influenza</li> <li>◆ 29% lower for pneumonia</li> <li>◆ 36% lower for pneumococcal pneumonia</li> <li>◆ 52% for IPD</li> </ul> </li> <li>• 57% lower mortality was observed in the vaccinated cohort (15.1 vs. 34.7 deaths per 1000 inhabitants).</li> </ul>

Contd. on next page

**Table 4:** Concomitant use of pneumococcal and influenza vaccines<sup>101–103</sup> (*Contd. from previous page*)

Study author	Patients	Outcome of coadministration of pneumococcal and influenza vaccines
Grilli G, <i>et al.</i> <sup>101</sup>	A total of 124 elderly individuals were vaccinated with either influenza split vaccine or pneumococcal 23-valent, or with both vaccines at the same time in different sites	<ul style="list-style-type: none"> <li>Concomitant use of both vaccines: <ul style="list-style-type: none"> <li>Was not associated with statistically significant reduction in both mean antibody concentrations</li> <li>Was safe, effective, and economically advantageous</li> </ul> </li> </ul>
Freneck R, <i>et al.</i> <sup>102</sup>	A total of 1116 participants (age 50–59 years old) were randomized to receive inactivated influenza vaccine (TIV) with PCV13 (group 1) or placebo (group 2).	<ul style="list-style-type: none"> <li>The concomitant administration was demonstrated to be immunogenic and well tolerated.</li> </ul>
Schwarz T, <i>et al.</i> <sup>103</sup>	<p>A total of 1160 adults aged ≥65 years. Participants were randomized into 2 groups:</p> <ul style="list-style-type: none"> <li>Participants received either PCV13, administered concomitantly with TIV (PCV13+TIV) followed 1 month (day 29–43) later by placebo (PCV13+TIV/placebo) or</li> <li>Participants received placebo, administered concomitantly with TIV (placebo+TIV) followed 1-month (day 29–43) later by PCV13 (placebo+TIV/PCV13).</li> </ul>	<ul style="list-style-type: none"> <li>Concomitant PCV13+TIV demonstrates acceptable immunogenicity and safety compared with either agent given alone.</li> </ul>

IPD: Invasive pneumococcal disease; TIV: Inactivated influenza vaccine; PCV13: 13-valent pneumococcal conjugate vaccine.

**The most noteworthy fact is that PCV13 and influenza vaccine (trivalent/quadrivalent) can be recommended concomitantly.**

## Hepatitis A and B: Burden and Available Vaccines

Viral hepatitis is a major healthcare problem in India. The health threat posed by hepatitis is comparable to three dreadful CDs—HIV/AIDS, malaria, and tuberculosis.

Hepatitis A virus (HAV) is accountable for 10%–30% of acute hepatitis and 5%–15% of acute liver failure cases.<sup>104</sup> The prevalence of hepatitis B is estimated to be 2%–7%, based on the presence of surface antigen.<sup>105,106</sup> India has around 50 million hepatitis B virus (HBV) carriers.<sup>106</sup> Chronic HBV infections are responsible for 40%–50% of hepatocellular carcinoma and 20%–30% cases of cirrhosis.<sup>105</sup>

Vaccines available for immunization against HAV include inactivated vaccines such as single-antigen (HAV antigen) vaccines or combination vaccines containing both HAV and HBV antigens. For hepatitis B, recombinant DNA, inactivated subunit vaccine is available.<sup>80</sup>

### Vaccines for Hepatitis A and B in Adults: Recommendations

- Single-antigen vaccine formulations should be administered in a two-dose schedule at 0 and 6–12 months.<sup>80</sup>
- If the combined hepatitis A and hepatitis B vaccine is used, administer three doses at 0, 1, and 6 months; alternatively, a four-dose schedule, administered on days 0, 7, and 21 to 30 followed by a booster dose at month 12 may be used.<sup>107</sup>

- Hepatitis A immunization is recommended for the following groups of adults:<sup>36</sup>
  - ◆ People with chronic liver disease
  - ◆ Men who have sex with men
  - ◆ People who use illegal drugs
  - ◆ People infected with other hepatitis viruses
  - ◆ People who receive clotting factor concentrates
  - ◆ People who have received or are awaiting a liver transplant
  - ◆ Food-handlers
- Live hepatitis B vaccine is administered subcutaneously at a dose of 0.5 mL.
- For hepatitis B, recombinant DNA or plasma-derived, inactivated subunit vaccine is available.
- For adult hepatitis B vaccination, a three-dose series is recommended to those people not previously vaccinated.
- The second dose should be administered one month after the first dose; the third dose should be administered at least six months after the first dose.
- The recommended dose at >18 years of age is 1 mL (20 µg) given intramuscularly.<sup>80</sup>

### Measles, Mumps, Rubella (MMR): Burden and Available Vaccines

According to the WHO global report, there were 55,399 cases of measles and 1066 cases of rubella in India in 2018.<sup>12</sup> Mumps outbreaks occur more in densely populated places such as hostels, colleges, schools, military barracks, and poor socioeconomic settings. In a sailor training center in India, a total of 58 cases of mumps were reported in three months.<sup>108</sup> A recent study conducted by health science students at Manipal University, India found the prevalence of serological susceptibility to rubella to be 16.6%.<sup>109</sup>

The available vaccines in India are listed below:<sup>80</sup>

- Measles only (M).
- Combination of:
  - ◆ Measles and rubella (MR).
  - ◆ Measles, mumps, and rubella (MMR).
  - ◆ Measles, mumps, rubella, and varicella (MMRV).

#### Vaccines for MMR in Adults: Recommendations

- For MMR, live, attenuated vaccine is available.
- All adults should receive two doses of MMR vaccine at 4–8-week intervals. If previously immunized, only one dose is required.
- The dosage for MMR vaccine is 0.5 mL by the subcutaneous route in the upper arm.<sup>80</sup>

### Diphtheria, Pertussis, and Tetanus (DPT): Burden and Available Vaccines

Globally, the rising cases of diphtheria in adults is a point of concern, with around 600,000 cases reported annually.<sup>110</sup> Data on the incidence of adult pertussis in India are scarce, but the incidence of adult pertussis is assumed to be high in states where childhood immunization coverage is adequate because the reduced natural circulation of pertussis leads to infrequent adolescent boosting.<sup>111</sup> Tetanus poses a public health problem in several parts of the world, especially in tropical developing countries. In 2008, tetanus caused more than 61,000 deaths worldwide.<sup>110</sup>

The available DPT vaccines in India are listed below:<sup>80</sup>

- DTwP: Diphtheria, tetanus, and whole-cell pertussis vaccine, commonly known as triple antigen.
- DTaP: Diphtheria, tetanus, and acellular pertussis vaccine.
- Tdap: Diphtheria, tetanus, and acellular pertussis vaccine (reduced antigen content).
- DT: Diphtheria and tetanus vaccine.
- Td: Diphtheria (reduced dose) and tetanus vaccine.

#### Vaccines for DPT in Adults: Recommendations

- The two types of DPT vaccine are whole-cell pertussis vaccine and acellular pertussis vaccine.<sup>80</sup>
- People who previously did not receive Tdap at or after age 11 years, should receive one dose of Tdap, then Td booster every 10 years.<sup>81</sup>
- Adults who have completed their primary vaccination during childhood should receive a Td vaccine every 10 years.<sup>80,81</sup>
- The recommended dose is 0.5 mL administered intramuscularly at the anterolateral thigh or deltoid muscle.<sup>80</sup>

DPT: Diphtheria, pertussis and tetanus toxoids; Tdap: Tetanus, diphtheria, and pertussis; Td: Tetanus and diphtheria.

### Varicella (Chickenpox): Burden and Available Vaccines

In India, >30% of individuals aged 15 years or above are susceptible to varicella-zoster virus (VZV) infection, and the seroprevalence of VZV increases with age. In older individuals, varicella is more severe and prolonged, with mortality rates being 15–25 times higher than in children.<sup>112</sup> Recently, an outbreak of 110 cases of varicella was reported at a large private university in Chennai.<sup>113</sup>

#### Vaccines for Varicella in Adults: Recommendations

- Varicella vaccine is available as a live, attenuated vaccine.<sup>80</sup>
- A two-dose series at 4–8-week intervals if previously did not receive varicella-containing vaccine (varicella or MMRV [measles, mumps-rubella-varicella vaccine] for children).
- If previously received one dose of varicella-containing vaccine: One dose at least 4 weeks after first dose.<sup>81</sup>
- Minimum interval between the first and the second doses should be 4 weeks, and 0.5 mL should be administered subcutaneously in the anterolateral thigh or upper arm.<sup>80</sup>

### Typhoid: Burden and Available Vaccines

In India, the incidence of typhoid is 120/100,000 population-years in adults older than 15 years.<sup>13</sup> Increasing antibiotic resistance and widespread multidrug-resistant strains make the treatment of typhoid difficult and challenging.<sup>114</sup>

The typhoid vaccines available in India are listed below:

- Vi-capsular polysaccharide vaccine.
- Vi-polysaccharide conjugate vaccine conjugated with tetanus toxoid (TCV).

#### Vaccines for Typhoid in Adults: Recommendations

- The Vi vaccine is given as a single intramuscular dose of 0.5 mL.
- In case of unconjugated vaccine, a booster is recommended once every 3 years.<sup>80</sup>
- Typhoid vaccination should compulsorily be given to food-handlers.<sup>115</sup>

#### Rabies: Burden and Available Vaccines

Rabies is almost always fatal but preventable. One-third of global human deaths due to rabies in all age groups occur in India.<sup>116</sup> A study reported the annual incidence of human rabies in India as 20,565, with the majority of patients being adult males.<sup>117</sup>

In India, the following rabies vaccines are available:

- Human diploid cell vaccine (HDCV).
- Purified chick embryo cell vaccine (PCEC).
- Purified duck embryo vaccine (PDEV).
- Purified Vero-cell rabies vaccine (PVRV).

#### Vaccines for Rabies in Adults: Recommendations

- Rabies vaccine is available as concentrated, purified cell culture, and as embryonated egg-based vaccine.
- Pre-exposure prophylaxis is particularly important for animal-handlers, veterinarians, and others employed in the care of animals (farmworkers, zookeepers). The regimen is one dose of 0.1 mL vaccine given intradermally on days 0, 7, and 21 or 28.
- The schedule for post-exposure prophylaxis is four doses at 0, 3, 7, and 14/28 days. For pre-exposure prophylaxis, three doses at 0, 7, and 28 days are recommended.
- The usual dose is 1 mL given intramuscularly in anterolateral thigh or deltoid for human diploid cell vaccine, purified chick embryo cell vaccine, and purified duck embryo vaccine. It should never be given in the gluteal region. Purified Vero-cell vaccine should be given at 0.5 mL intramuscularly.<sup>80</sup>

#### Human Papillomavirus (HPV): Burden and Available Vaccines

More than 80% of sexually active women acquire genital human papillomavirus (HPV) by 50 years of age. About 6.6% of women are estimated to harbor cervical HPV infection. HPV serotypes 16 and 18 are responsible for nearly 76.7% of cervical cancer cases in India.<sup>118</sup>

Two HPV vaccines (bivalent and quadrivalent vaccines) are commercially available. Bivalent vaccine (HPV2) protects against HPV types 16 and 18, whereas the quadrivalent one (HPV4) protects against four types of HPV (6,11,16, and 18).<sup>80</sup>

#### Vaccines for HPV in Adults: Recommendations

- Vaccine for HPV is available as recombinant protein capsid liquid vaccine.
- A three-dose schedule (at 0, 1–2 months, and 6 months) is recommended for individuals 15 to 45 years.
- Quadrivalent vaccine is administered at 0, 2, and 6 months, and bivalent vaccine is administered at 0, 1, and 6 months. A usual dose of 0.5 mL is administered intramuscularly in the deltoid muscle of the upper arm.<sup>80</sup>

## Vaccination Schedule for Healthcare Workers: Recommendations

Ensuring health and safety in the work environment is of paramount importance. The adoption of safe working practices together with immunization will significantly improve the protection of the individual worker against specific VPDs.<sup>80</sup> The Advisory Committee on Immunization Practices (ACIP) strongly recommends that all healthcare workers should be vaccinated against (or have documented immunity to) hepatitis B, influenza, measles, mumps, rubella, and varicella (Table 5).<sup>119</sup>

<b>Table 5: Vaccination schedule for healthcare workers<sup>80,119</sup></b>		
<b>Vaccine</b>	<b>Dose/s</b>	<b>Schedule</b>
Hepatitis B	3	0–1–6 months
Hepatitis A	2/1	0–6 months or single dose (live vaccine)
Tdap	1	1 dose every 10 years
Varicella (Chickenpox)	2*	2 doses at 4–8 weeks interval
Polio (IPV)	1 or 2	If previously unimmunized 2 doses (0, 4–8 weeks)
Influenza	1	1 dose every year
Pneumococcal		
• PCV13	1	• >50 years 1 single dose
• PPSV23	2	• 2 doses 5 years apart in high risk patients
Typhoid	1	Single dose. If unconjugated vaccine, give 3 yearly
MMR	2	2 doses at 4–8 weeks interval
Meningococcal (ACWY)	1	1 dose is enough; repeat dose after 3–5 years if still at risk
Rabies	3	Pre-exposure prophylaxis 0, 7, and 28 days (especially veterinarians)

IPV: Inactivated polio vaccine, Tdap: Tetanus diphtheria (acellular) pertussis; MMR: Measles, mumps, and rubella. \*Single dose for live vaccine.

## Vaccination Schedule During Pregnancy: Recommendations

Table 6 provides recommendation of various vaccines during preconception and pregnancy.

Table 6: Vaccination schedule during preconception and pregnancy <sup>80</sup>			
Vaccine	Dose/s	Schedule	Remarks
Preconception			
Hepatitis B	3	0–1–6 month	Avoid conception for at least 4 weeks after MMR or varicella vaccine
Varicella (Chickenpox)	2	2 doses at 4–8 weeks	
MMR	2	2 doses at 4–8 weeks	
HPV	3	0–1 month (HPV2) or 2–6 months (HPV4)	
Influenza	1	1 dose every year	
During pregnancy			
TT/Td	2	1 dose early in pregnancy and 2nd dose 4 weeks after 1st dose	
Tdap	1	3rd trimester	
Influenza	1	1 at any stage of gestation	
During lactation			
All vaccines except typhoid and yellow fever can be given as catch-up immunization.			
TT: Tetanus Toxoid; Td: Tetanus and adult diphtheria; HPV: Human papillomavirus; MMR: Measles, mumps, and rubella.			

TT: Tetanus Toxoid; Td: Tetanus and adult diphtheria; HPV: Human papillomavirus; MMR: Measles, mumps, and rubella.

## Vaccination for Travel and Mass Gatherings: Recommendations

Several factors, such as place of travel, staying conditions, and activities at the place of visit, are to be considered while choosing immunization for travelers. Hajj is one of the largest annual mass gatherings in the world.<sup>88</sup> Meningococcal vaccine is compulsory for Hajj pilgrims.<sup>89</sup> A high prevalence of respiratory tract infections (RTIs), including pneumonia, is evident in Hajj pilgrims.<sup>88</sup> With Hajj pilgrims being highly susceptible to RTIs due to factors such as age, previous illnesses, intense crowding, and air pollution, the Preventive Vaccination for Pneumococcal Disease in Mass Gatherings (PREVENT) expert in Saudi Arabia advise the administration of pneumococcal vaccine.<sup>120</sup> Tables 7 and 8 present vaccination recommendations given for Hajj pilgrims and Kumbh Mela attendees.

**Table 7:** Vaccine recommendations for Hajj pilgrims<sup>89,120</sup>

Vaccine recommendations	Comments
Meningococcal	Mandatory
Influenza	Recommended
Polio (IPV)	<15 years, endemic countries
Yellow fever	Endemic countries
Pneumococcal	<ul style="list-style-type: none"> <li>PCV13: 4 weeks before traveling for Hajj</li> <li>PPSV23: Post-return from Hajj (depends upon risk status)</li> </ul>
Hepatitis A	Recommended
Hepatitis B	Recommended

IPV: Inactivated polio vaccine; PCV 13: Pneumococcal conjugate vaccine 13; PPSV23: 23-valent pneumococcal polysaccharide vaccine.

**Table 8:** Vaccine recommendations for Kumbh Mela attendees<sup>89</sup>

Vaccine recommendations	Comments
Typhoid	Strong recommendation
Hepatitis A	Strong recommendation
Hepatitis B	For prolonged stay
Japanese encephalitis	If stay is over 1 month
Influenza	Strong recommendation
Yellow fever	Travelers coming from endemic countries
Diphtheria, pertussis, tetanus	Should be up to date
Measles, mumps, rubella	Should be up to date
Rabies	Pre-exposure prophylaxis
Polio (IPV)	1 booster (IPV)
Cholera	Oral vaccine advised

IPV: Inactivated polio vaccine.

## Vaccination Program at Workplace

In India, there are no guidelines or practices for vaccination in the workplace. A vaccination program at the workplace must ideally involve managers and supervisors. For vaccination program at workplace, few following points are to be considered:<sup>47</sup>

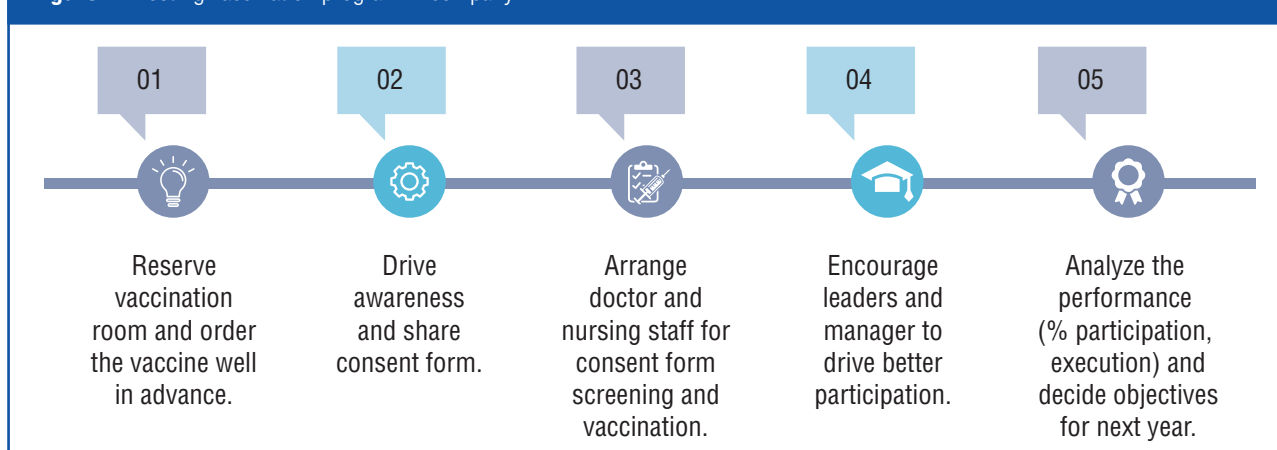
- It is very important to have clear objectives for the vaccination program.
- Subsequently, an execution team needs to be formed. The leadership team must be involved.
- A strong communication plan needs to be developed, focusing on how vaccination, as a wellness program, benefits employees.
- To create awareness about vaccination at the workplace, an organization must design employee-centric ways of communication, such as:
  - ◆ Displaying posters in break rooms, cafeterias, and other high-visibility areas with the date and time details of the program
  - ◆ Circulation of different article communications (e.g. emailers, intranet, newsletters, etc.)
- Business leaders may take initiatives in communicating the importance of vaccines to employees to encourage mass participation.
- Social media may be engaged in creating awareness.
- A comfortable and convenient location and time for vaccination may ensure better participation.

**A vaccination program at the workplace must ideally involve managers and supervisors. The leadership team must be involved. A comfortable and convenient location and time for vaccination may ensure better participation.<sup>47</sup>**

### Hosting a Vaccination Program in Company

Hosting a vaccination program within company premises is a great way to demonstrate a company's commitment to providing accessible health and wellness benefits. Extending vaccination to employees' families can be a significant step to ensure better participation (Figure 4).<sup>47</sup>

**Figure 4:** Hosting vaccination program in company.<sup>47</sup>



## Conclusion and Future Directives

- Vaccine-preventable diseases cause a substantial healthcare burden in India and should be effectively controlled with vaccination, especially in the workplace.
- Apart from the direct benefits of vaccination such as productivity and reduction in absenteeism, it is important to highlight the spin-off benefits of vaccination in terms of reduction in cardiovascular comorbidities and hospitalization.
- Adult vaccination potentially enhances company/business profits.
- Awareness must be created about vaccination, and vaccine recommendations must be circulated among all working professionals in any industry.
- Extending the benefits of adult vaccination to the family members of employees is pertinent for ensuring wider protection; thus, the risk of contagion can be further reduced.
- This will keep the family safe and healthy and will reduce the rate of absenteeism.

### Vaccination recommended by IAOH for working adults.

Vaccine	19–21 years	22–26 years	27–49 years	50–64 years	≥65 years
Influenza vaccine (Quadrivalent)	1 dose annually				
Pneumococcal conjugate (PCV13)	Special situation*			1 dose*	
Pneumococcal polysaccharide (PPSV23)				1 dose	
Tetanus, diphtheria, pertussis (Tdap or Td)	1 dose Tdap, then Td booster every 10 years				
Measles, mumps, rubella (MMR)	2 doses (4–8 weeks interval) 1 dose (if previously immunized)				
Varicella	2 doses (4–8 weeks interval) <sup>o</sup> 1 dose (if previously received) <sup>o</sup>				
Zoster live					1 dose
Human papillomavirus (HPV)	3 doses schedule (0, 1–2 months, 6 months) <sup>∞</sup>				
Hepatitis A (Hep A)	2 doses (Single antigen vaccine; 0 and 6–12 months) or 3 doses (Combined Hep A and Hep B; 0, 1, and 6 months) <sup>@</sup>				
Hepatitis B (Hep B)	3 doses (0, 1, 6 months) <sup>!</sup>				
Meningococcal A, C, W, Y	1 or 2 doses depending on indication, then booster every 5 years if risk remains				
<i>Haemophilus influenzae</i> type b (Hib)	1 or 3 doses depending on indication				
Special vaccine recommendation					
Rabies <sup>§</sup>	<ul style="list-style-type: none"><li>• Total 3–4 doses</li><li>• Pre-exposure: 4 doses (0, 7, 21, 28 days)</li><li>• Post-exposure: 4 doses (0, 3, 7, 14/28 days)</li></ul>				
Typhoid	<ul style="list-style-type: none"><li>• Compulsory for food-handlers</li></ul>				
Vaccine recommendation for healthcare workers					
Recommended vaccines	<ul style="list-style-type: none"><li>• Hepatitis A and B,</li><li>• Tdap</li><li>• Varicella (Chickenpox)</li><li>• Polio (IPV)</li><li>• Influenza</li></ul>			<ul style="list-style-type: none"><li>• Pneumococcal</li><li>• Typhoid</li><li>• MMR</li><li>• Meningococcal (ACWY)</li><li>• Rabies</li></ul>	

## Vaccination recommended by IAOH for working adults.

Vaccine	19–21 years	22–26 years	27–49 years	50–64 years	≥65 years
Vaccination during preconception and pregnancy					
Preconception	<ul style="list-style-type: none"><li>• Hepatitis B</li><li>• Varicella (Chickenpox)</li><li>• MMR</li><li>• HPV</li><li>• Influenza</li></ul>				
During pregnancy	<ul style="list-style-type: none"><li>• TT/Td</li><li>• Tdap</li><li>• Influenza^</li></ul>				
Lactation	<ul style="list-style-type: none"><li>• All vaccines except typhoid and yellow fever can be given as catch-up immunization</li></ul>				
Vaccine recommended for mass gathering					
Kumbh Mela attendees	<ul style="list-style-type: none"><li>• Typhoid—Strong recommendation</li><li>• Influenza—Strong recommendation</li><li>• Hepatitis A—Strong recommendation</li><li>• Hepatitis B—For prolonged stay</li><li>• Japanese encephalitis—If stay is over 1 month</li><li>• Yellow fever—For endemic countries</li><li>• Rabies—Pre-exposure</li><li>• Polio—1 booster</li><li>• Cholera oral vaccine advised</li></ul>				
Hajj pilgrims	<ul style="list-style-type: none"><li>• Meningococcal (mandatory)—Mandatory</li><li>• Influenza—Recommended</li><li>• Polio (IPV)—&lt;15 years, endemic countries</li><li>• Yellow fever—Endemic countries</li><li>• Pneumococcal<ul style="list-style-type: none"><li>◆ PCV13: 4 weeks before traveling for Hajj</li><li>◆ PPSV23: Post-return from Hajj (depends upon risk status)</li></ul></li><li>• Hepatitis A and B—Recommended</li></ul>				

■ Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection

■ No recommendation

■ Recommended vaccination for adults with an additional risk factor

\*PCV13 is recommended in series with PPSV23 for adults aged ≥19 years with an immunocompromising condition, CSF leak, or cochlear implant. For PPSV23 dosing instruction, please refer to the respective guideline for special situations.

\*Administer 1 dose PCV13 followed by 1 dose PPSV23 at least 1 year after PCV13. PCV13 is recommended based on shared clinical decision making for adults who do not have an immunocompromising condition, cerebrospinal fluid (CSF) leak, or cochlear implant, and who have not previously received PCV13. Immunocompromising conditions include chronic renal failure, nephrotic syndrome, immunodeficiency, iatrogenic immunosuppression, generalized malignancy, human immunodeficiency virus, Hodgkin disease, leukemia, lymphoma, multiple myeloma, solid organ transplants, congenital or acquired asplenia, sickle cell disease, or other hemoglobinopathies.

\*Pre-exposure prophylaxis as well as post-exposure vaccine is recommended for risk groups such as medical and paramedical personnel treating rabies patients, veterinarians, laboratory personnel working with rabies virus; others, such as zookeepers, dog catchers, forest staff, postmen, policemen, courier boys, etc.

\*Not at risk but want protection from hepatitis A: Single-antigen vaccine formulations: Administer in a 2-dose schedule at 0 and 6–12 months. Combined hepatitis A and hepatitis B vaccine: Administer 3 doses at 0, 1, and 6 months.

\*Not at risk but want protection from hepatitis B: 3 doses. The second dose should be administered one month after the first dose; the third dose should be administered at least 6 months after the first dose.

\*At any stage of pregnancy. Note: No QIV in India has labeled indication for pregnancy

\*Strong recommendation.

\*2-dose series VAR 4–8 weeks apart if previously did not receive varicella-containing vaccine (VAR or MMRV [measles mumps–rubella–varicella vaccine] for children); if previously received 1 dose varicella-containing vaccine: 1 dose VAR at least 4 weeks after first dose.

\*A three-dose schedule (at 0, 1–2 months, and 6 months) is recommended for individuals above 15 to 45 years.

■ Meningococcal ACWY special situations:

- Anatomical or functional asplenia (including sickle cell disease), HIV infection, persistent complement component deficiency, eculizumab use: 2-dose series MenACWY (Menactra, Menveo) at least 8 weeks apart and revaccinate every 5 years if risk remains.
- Travel in countries with hyperendemic or epidemic meningococcal disease, microbiologists routinely exposed to *Neisseria meningitidis*: 1 dose MenACWY and revaccinate every 5 years if risk remains.
- First-year college students who live in residential housing (if not previously vaccinated at age 16 years or older) and military recruits: 1 dose MenACWY.

■ Hepatitis A special situations:

At risk for hepatitis A virus infection (2-dose series Hep A or 3-dose series Hep A-Hep B; as mentioned above.)

- Chronic liver disease
- Clotting factor disorders
- Men who have sex with men
- Injection or non-injection drug use
- Homelessness
- Work with hepatitis A virus in research laboratory or nonhuman primates with hepatitis A virus infection
- Travel in countries with high or intermediate endemic hepatitis A
- Close personal contact with international adoptee

■ Hepatitis B special situations:

At risk for hepatitis B virus infection (3 dose series; as mentioned above)

- Hepatitis C virus infection
- Chronic liver disease
- Sexual exposure risk
- HIV infection
- Current or recent injection drug use
- Percutaneous or mucosal risk for exposure to blood
- Incarcerated persons
- Travel in countries with high or intermediate endemic hepatitis B

■ *Haemophilus influenzae* type b vaccination special situations:

- Anatomical or functional asplenia (including sickle cell disease): 1 dose Hib if previously did not receive Hib; if elective splenectomy, 1 dose Hib, preferably at least 14 days before splenectomy
- Hematopoietic stem cell transplant (HSCT): 3-dose series Hib 4 weeks apart starting 6–12 months after successful transplant, regardless of Hib vaccination history

IPV: Inactivated polio vaccine, Tdap: Tetanus diphtheria (acellular) pertussis; TT: Tetanus Toxoid; Td: Tetanus and adult diphtheria; HPV: Human papillomavirus; MMR: Measles, mumps, and rubella.

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