Adult Immunization in Occupational Settings: A Consensus of Indian Experts

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Abstract

There is an increasing focus on instituting wellness programs at the workplace among organizations in India. Such programs are aimed at improving employee health, which in turn, helps in reducing absenteeism, as well as in increasing work productivity and improving employee engagement. Of note, adult vaccination plays a significant role in ensuring the well-being of employees, as well as in keeping an organization profitable. The burden of vaccine-preventable diseases (VPDs) in adults is increasing in India, causing significant morbidity and disability. Moreover, adult immunization is an underpublicized concept in India. There is an urgent need to create awareness about adult immunization in India, particularly in occupational health settings—both at the employee and employer levels. In view of this, an expert meeting was held under the aegis of the Indian Association of Occupational Health (IAOH) to discuss key issues pertaining to the burden of VPDs in the working population in India and to formulate guidelines on adult vaccination in occupational health settings. This consensus guideline document may act as a guide for organizations across India to create awareness about adult vaccination and also to design workplace vaccination programs to promote better health among employees.

Keywords: Adult vaccination, occupational health, recommendations, vaccine-preventable disease, wellness programs

INTRODUCTION

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 7 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.[1]

People Matters-Sanofi Pasteur conducted a study in 221 corporate institutions in India in 2019 to assess the challenges of workplace-wellness programs. The survey showed that the majority (62%) of organizations did not take any measures to tackle an outbreak of infectious diseases at the workplace.[2] Furthermore, lack of employee awareness is one of the crucial factors that affect the success of a wellness program. A recent survey conducted in major corporate organizations in metro cities showed a lack of understanding of influenza vaccines among employees.

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employees.[3] Another survey revealed that only 45% of employees were aware of flu shots offered at the workplace, in contrast to 77% among employers (who had implemented such programs).[4]

Work performance challenges related to modifiable health behaviors (e.g. inadequate/lack of physical activity, smoking, obesity, etc.) are highly prevalent, ultimately leading to a 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 the phenomena called “absenteeism and presenteeism.” Absenteeism refers to the count of days absent from work, whereas presenteeism refers to reduced productivity while at work.[5] 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.[6] Furthermore, insurance data for the financial years 2014–2017 for India showed that influenza and pneumonia had the highest average claim amount paid for these financial years.[7] This draws our attention toward the increasing burden of vaccine-preventable diseases (VPDs) in adults in India. Moreover, VPDs have been found to be associated with significant morbidity and disability in India.[8]

### Burden and Impact of VPDs in Working Population and Role of Adult Immunization

In India, it is challenging to estimate the actual burden of various diseases due to the scarcity of systematic epidemiological data. Of note, the most common pneumococcal diseases, that is, meningitis and pneumonia, are associated with high morbidity and mortality rates.[9]

Table 1 shows the prevalence/incidence of VPDs in India.[9-14]

#### Table 1: Prevalence/incidence of vaccine-preventable diseases (VPDs) in India[9-14]

| Disease | Incidence/Prevalence |
|---------|----------------------|
| Influenza | Between 2015 and 2019, 126,906 H1N1 cases and 7865 deaths were reported.[10] |
| Pneumococcal disease | As per a recent study, out of 374 adult invasive pneumococcal disease (IPD) cases: |
| Pneumonia | 146 patients suffered from pneumonia (39%). |
| Meningitis | 91 patients had meningitis (24.3%). |
| Septicemia | 69 patients suffered from pneumococcal septicemia (18.4%).[9] |
| Hepatitis | In a study, among 599,605 cases tested for hepatitis A, 44,663 cases were found to be positive.[11] |
| India has >37 million HBV carriers.[12] |
| Measles and rubella | 55,399 cases of measles and 1066 cases of rubella (all age groups).[13] |
| Typhoid | 120/100,000 population-years in adults older than 15 years.[14] |

**VPDs: Vaccine-preventable diseases**

#### Burden of VPDs in workplace

The burden of influenza in the workplace is reflected in terms of work absenteeism, reduced work effectiveness, and increased physician office visits and hospitalization. Research suggests that influenza-like infections are associated with significant mean annual attack rates of 5.3% in vaccinated and 26.2% in nonvaccinated working employees.[15] Influenza causes almost a 50% mean reduction in the activity level/effectiveness at work.[16] A study by Tsai et al. reported that the mean work-loss hours per influenza-like illnesses is 23.6 h, and the work-loss hours are even higher in cases of influenza-like illness episodes associated with hospitalization (47 h).[17] Furthermore, exposure to workplace inhalational hazards substantially contributes to the development of multiple chronic respiratory diseases, including pneumonitis, causing an occupational burden of 19%.[18] Welders and those exposed to metal fumes are known to be at an increased risk for pneumococcal pneumonia and invasive pneumococcal disease (IPD).[19]

#### 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, chronic diseases, and increased susceptibility to infectious diseases.[20,21] Influenza increases the risk of hospitalization and intensive care unit (ICU) admission by 3–6-fold and 4-fold, respectively, in diabetes patients.[22,23] Also, the risk of myocardial infarction is nearly six times higher within the 1st week of laboratory-confirmed influenza diagnosis.[24] 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 are increased with advancing age in adults with comorbidities such as chronic lung disease, diabetes, etc.[25] A study conducted among 173 immunocompetent elderly individuals with community-acquired pneumonia revealed that cardiopulmonary comorbidities account for 42% of pneumonia cases in this study population.[26]

#### Challenges of adult immunization in India

Adult immunization is a highly neglected and underpublicized issue. Even among published guidelines from international organizations such as the World Health Organization (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.[27] Lack of awareness among the general population, failure of health care providers (HCPs) to monitor patients’ vaccination status, lack of specialized vaccination centers for adults, and lack of drive among policymakers to promote adult vaccination are key challenges to adult immunization in India.[28-30]

#### Significance of adult vaccination and its benefits to an organization

Adults require vaccination for numerous reasons. One of the primary reasons is age-related immunosenescence, which reduces an individual’s resistance to infections.[31,32] Moreover, adults are frequently associated with chronic illnesses that increase susceptibility to infections.[31,32] Interestingly, the
Influenza vaccination also helps in reducing protective effect against major adverse cardiovascular disease with heart failure as compared with nonvaccinated patients. Smoking (reduces risk by 32–43%) and lifestyle changes such as quitting treatments such as cholesterol-lowering drugs (reduce 19%–45%, which is equipotent or better than preventive 25–30%) and nonbacteremic pneumonia (NBP) and outpatient NBP cases. A Spanish dynamic transmission model reported that the use of PCV13 for 5 years in a cohort of patients aged 65–69 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.

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, varicella, and pneumococcal infections (caused by Streptococcus pneumoniae), extending vaccination benefits to family members may reduce the rate of absenteeism among employees, owing to self-infection or family obligation.

Role of vaccination in reducing comorbidities
Influenza and pneumococcal vaccines have beneficial effects beyond the direct advantages of vaccines. 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%). The risk of all-cause mortality is 31% lower in influenza-vaccinated individuals with heart failure as compared with nonvaccinated patients. A meta-analysis has shown that influenza vaccines have a protective effect against major adverse cardiovascular disease events. Influenza vaccination also helps in reducing hospitalization by 54% in elderly patients with diabetes.

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 the acute coronary syndrome in the older population (≥65 years old). Vaccination with PCV13 induces antibody responses to vaccine serotypes in patients (≥50 years old) with end-stage renal disease and on dialysis at 2 months postvaccination. In diabetes patients, pneumococcal vaccination confers a significant reduction in morbidity and mortality related to pneumococcal disease. 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 ≥50 years followed by a dose of PPSV23 at least 1 year later (and at least 5 years after their previous PPSV23 dose), depending on the clinical judgment of the physician. Pneumococcal vaccination also decreases the risk of myocardial infarction and cerebrovascular events in the elderly. 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 disease occurrence. Therefore, the use of antibiotics can be avoided. Dual vaccination with the pneumococcal and influenza vaccines 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.

Adult vaccination plays an important role in reducing the burden of VPDs, as well as in reducing workplace absenteeism, thus, improving productivity. Ultimately, it contributes to greater profits for the organization. Considering the necessity for increased awareness regarding the often-underestimated concept of adult vaccination in India, an expert meeting was held on 1 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 occupational health settings. The scientific deliberations led to the formulation of consensus recommendations on adult vaccination in the context of occupational health settings in India.

**ADULT VACCINATION: CURRENT GUIDELINES IN INDIA AND DIFFERENT RECOMMENDATIONS**

Unlike the Pediatrics Immunization Guidelines, several divergences exist from region to region regarding 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 the Centers...
for Disease Control and Prevention (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 (IMA) guidelines.\[30,52,53\]

The recommended vaccines for all healthy adults in India are as follows:\[53,54\]

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

### Pneumococcal disease: Burden, serogroups, and available vaccines

Asia is highly burdened with pneumonia patients, with India being the highest contributor with 43 million cases.\[53\] In India, pneumonia and meningitis are the most common IPDs.\[56\] Pneumonia accounts for 39% of the total IPD cases.\[9\] Pneumococcal infection is associated with an increased risk of hospitalization due to heart diseases, as well as high in-hospital mortality.\[157\] In India, IPD is associated with the highest case-fatality rate (28%) among adults aged >50 years.\[29\] According to the 2017 Global Burden of Disease study, the reported incidence and mortality of pneumococcal infection increased by 26% and 33% among the 50–69 years and >70 years age groups, respectively.\[58\] The most common serotypes isolated in India are 1, 3, 5, 19F, 8, 14, 23F, 4, 19A, and 6B. These serotypes account for 54.9% of IPD cases. A high nonsusceptibility to co-trimoxazole and the slow emergence of resistance to penicillin, tetracycline, and erythromycin has been reported. Vaccines are advocated by various Indian health care bodies/groups for older and younger adults with certain medical conditions.\[166\]

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.\[50,59-61\]

Studies reveal that the initial PCV13 dose has the potential to enhance responses to a subsequent PPSV23 dose, compared with PCV13 alone.\[62\] Pneumococcal conjugate vaccine 13 displays a more robust or greater immune response compared to PPSV23 in the majority of shared pneumococcal serotypes.\[56\]

Based on the serotype covered by the conjugated form, that is, PCV13, and considering the seroprevalence in India, it is crucial to add PCV13 to ensure coverage for all prevalent serotypes in the country.\[56\] Different professional societies in India, such as the Geriatric Society, the Indian Society of Nephrology, the Association of Physicians of India, the RSSDI, IMA, and Mass Gathering Advisory Board Consensus Recommendation 2016, have recommended the implementation of pneumococcal vaccination in adults.\[48,52,53,59,63,64\]

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 \[65,66\]

### Influenza: Burden and available vaccines

Influenza viruses are highly unstable in nature and cause pandemics. Figure 1 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 in the pandemic year, that is, 2009.\[10\]

The following prefilled syringes of influenza vaccines are available in India:\[53\]

- Trivalent inactivated vaccine
- Quadrivalent inactivated
- Live, attenuated nasal spray (lyophilized)

### Vaccines for influenza in adults: Recommendations

A number of studies have shown the beneficial effects and safety of concomitant use of pneumococcal and influenza vaccines [Table 4].\[66,70\] Therefore, 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.\[71\] The prevalence of hepatitis B is estimated to be 2–7% based on the presence of surface antigen.\[72,73\] India has around 50 million hepatitis B virus (HBV) carriers.\[73\] Chronic HBV infections are responsible for 40–50% of hepatocellular carcinoma and 20–30% of cases of cirrhosis.\[72\]

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.\[53\]
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. 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. Hepatitis A immunization is recommended for the following groups of adults:

- 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

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 the MMR vaccine is 0.5 mL by the subcutaneous route in the upper arm.

The available vaccines in India are listed below:

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

Diphtheria, pertussis, and tetanus (DPT): Burden and available vaccines

Globally, the rising incidence of diphtheria in adults is a point of concern, with around 600,000 cases reported annually. Data on the incidence of adult pertussis in India is 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 outbreaks.

IPD: invasive pneumococcal disease; IgM: immunoglobulin M; PPSV23: 23-valent pneumococcal polysaccharide vaccine; PCV13: 13-valent pneumococcal conjugate vaccine
**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.

Recently, an outbreak of 110 cases of varicella was reported at a large private university in Chennai.

**Vaccines for varicella in adults: Recommendations**

Varicella vaccine is available as a live, attenuated vaccine.

A two-dose series at 4-8-week intervals if previously did not receive the 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 the first dose.

The 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.

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| Advocacy group/body | Recommendation/s |
|---------------------|------------------|
| Global Initiative for Chronic Obstructive Lung Disease (GOLD, 2019) | PCV13 and PPSV23 recommended for all patients ≥65 years of age. PPShV23 also recommended for younger COPD patients with significant comorbid conditions, including chronic heart or lung disease. |
| Advisory Committee on Immunization Practices (ACIP, 2019) | 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). 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. ACIP continues to recommend PCV13 in series with PPSV23 for adults aged ≥19 years with an immunocompromising condition, CSF leak, or cochlear implant. |

**Typhoid: Burden and available vaccines**

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

The typhoid vaccines available in India are listed below:

- Vi-capsular polysaccharide vaccine
- Vi-polsaccharide 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 the case of the unconjugated vaccine, a booster is recommended once every 3 years.

Typhoid vaccination should compulsorily be given to food-handlers.

**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. A study reported the annual incidence of human rabies in India as 20,565 with the majority of patients being adult males.

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**

The rabies vaccine is available as a concentrated, purified cell culture, and as an 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 postexposure 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.
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.[85] 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).[53]

Vaccines for HPV in adults: Recommendations

Vaccine for HPV is available as a recombinant protein capsid liquid vaccine.
A three-dose schedule (at 0, 1-2 months, and 6 months) is recommended for individuals aged 15-45 years.
The quadrivalent vaccine is administered at 0, 2, and 6 months, and the 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.[53]

Vaccination schedule for health care 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.[53] The ACIP strongly recommends that all health care workers should be vaccinated against (or have documented immunity to) hepatitis B, influenza, MMR, and varicella [Table 5].[53,86]

Vaccination schedule during pregnancy: Recommendations

Table 6 provides recommendations for various vaccines during preconception and pregnancy.[83]

Vaccination for travel and mass gatherings: Recommendations

Several factors such as place of travel, staying conditions, and activities at the place of the visit are to be considered while choosing immunization for travelers. Hajj is one of the largest annual mass gatherings in the world.[59] Meningococcal vaccine is compulsory for Hajj pilgrims.[53] A high prevalence of respiratory tract infections (RTIs), including pneumonia, is evident in Hajj pilgrims.[59] 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) experts in Saudi Arabia advise the administration of the pneumococcal vaccine. Tables 7 present vaccination recommendations for Hajj pilgrims and Kumbh Mela attendees.[55,87]
Table 5: Vaccination schedule for healthcare workers[^53,86]

| Vaccine          | Dose/s | Schedule                  | Remarks                                                                 |
|------------------|--------|---------------------------|-------------------------------------------------------------------------|
| 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) |                      |

[^53,86]: IPV: inactivated polio vaccine, Tdap: tetanus diphtheria (acellular) pertussis; MMR: measles, mumps, and rubella. *Single dose for live vaccine

Table 6: Vaccination schedule during preconception and pregnancy[^53]

| 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 |                                                                     |

[^53]: All vaccines except typhoid and yellow fever can be given as catch-up immunization.

[^53]: TT: tetanus toxoid; Td: tetanus and adult diphtheria; HPV: human papillomavirus; MMR: measles, mumps, and rubella

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 a vaccination program at the workplace, the following points are to be considered:[^33]

- 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. e-mailers, 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.[^33]

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
Table 8: 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 |            |             |             |           |
| 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) |            |             |             |           |
| Zoster live                                | 1 dose (if previously received) |             |             |             |           |
| Human papillomavirus (HPV)                 | 3 doses schedule (0, 1-2 months, 6 months)* | |             |             |           |
| Hepatitis A (Hep A)                        | 2 doses (Single-antigen vaccine; 0 and 6-12 months) | |             |             |           |
| Hepatitis B (Hep B)                        | 3 doses (0, 1, 6 months) | |             |             |           |
| Meningococcal A, C, W, Y                   | 1 or 2 doses depending on indication, then booster every 5 years if risk remains | |             |             |           |
| Haemophilus influenza type b (Hib)         | 1 or 3 doses depending on indication | | | |           |

Special vaccine recommendation

Rabies* | Total 3-4 doses | Pre-exposure: 4 doses (0, 7, 21, 28 days) | Post-exposure: 4 doses (0, 3, 7, 14/28 days) |

Typhoid | Compulsory for food-handlers |

Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection. No recommendation 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. **2-dose series VAR 4–8 weeks apart if previously did not receive the 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. °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. °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.

Vaccine recommendation for healthcare workers

Recommended vaccines

- Hepatitis A and B
- Tdap
- Varicella (Chickenpox)
- Polio (IPV)
- Influenza
- Pneumococcal
- Typhoid
- MMR
- Meningooccal (ACWY)
- Rabies

Vaccination during preconception and pregnancy

Preconception

- Hepatitis B
- Varicella (Chickenpox)
- MMR
- HPV
- Influenza

During pregnancy

- TT/Td
- Tdap
- Influenza°

Contd...
Lactation

Vaccines recommended for mass gathering

Kumbh Mela attendees

- Typhoid—Strong recommendation
- Influenza—Strong recommendation
- Hepatitis A—Strong recommendation
- Hepatitis B—For prolonged stay
- Japanese encephalitis—If stay is over 1 month
- Yellow fever—For endemic countries
- Rabies—Pre-exposure
- Polio—1 booster
- Cholera oral vaccine advised

Hajj pilgrims

- Meningococcal (mandatory)—Mandatory
- Influenza—Recommended
- Polio (IPV)—<15 years, endemic countries
- Yellow fever—Endemic countries
- Pneumococcal
- PCV13: 4 weeks before traveling for Hajj
- PPSV23: Post-return from Hajj (depends upon risk status)
- Hepatitis A and B—Recommended

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

+ Strong recommendation. 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, Menvio) 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 HAV 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 HAV in research laboratory or nonhuman primates with HAV infection
- Travel in countries with high or intermediate endemic hepatitis A
- Close personal contact with international adoptee

Hepatitis B special situations:

- At risk for HBV 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
vaccination to employees’ families can be a significant step to ensure better participation [Figure 2].

Tables 8 provide a summary of recommendations by IAOH for working adults

**CONCLUSION AND FUTURE DIRECTIVES**

VPDs cause a substantial health care 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 reduce the rate of absenteeism.

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