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CHANGING HORIZONS IN ADULT IMMUNIZATION

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ABSTRACT

Childhood immunization is recommended and publicised globally. Whereas adult population, which comprises of more than 60% of total population, still suffers from vaccine preventable diseases due to factors ranging from personal neglect to immunosenescence. This burden is vastly seen in developing nations like India where adults constitute a large chunk of economic productivity. This article highlights the current scenario and recommendations for adult immunization globally taking in to account special conditions such as immunization in the geriatric population, pregnant women, and in travellers.

KEYWORDS: Adult immunization, Neglect, Current scenario.

1. INTRODUCTION

Immunization is a process by which immune system is made to generate a response against pathogens by inoculating certain agents.[1] The process of inoculation is called vaccination. Immunization programs are associated with goal of controlling/ eliminating/eradicating a disease. Vaccination is one of the most cost-effective strategies available in public health today. In addition to protecting the vaccinated individuals from developing a potentially serious complications, vaccines help protect the community by reducing the spread of infectious diseases through herd immunity.[2]

Although immunization has become a centrepiece of routine paediatric medical visits, it has not been as well integrated into routine health care visits for adults. Adolescents are often thought as healthy group but nevertheless they die due to illnesses that are preventable and treatable.

Due to the lack of centralised record-keeping, or cultural apathy towards transfer of medical knowledge, many adults are not sure of their immunization status and many are not vaccinated during childhood making them susceptible to certain diseases. Immunity conferred by childhood vaccines wanes off with age i.e. immunosenescence[3], justified by the fact that hematopoetic stem cells show a decline in function with ageing, which is also associated with increased production of pro-inflammatory cytokines and neutrophilic dysfunction.[4]

It has been found that associated comorbidities increase frequency of hospital admissions/ mortality due to vaccine preventable diseases among adult populations. Also, with growing age, adults become more susceptible to serious complications caused by common infections.

1.1 Current scenario

Many childhood vaccine preventable diseases are found in adults. In the late 20th century, massive diphtheria outbreak occurred in Russia spanning more than 157000 cases, and 5000 deaths which occurred mostly in adults more than 45 years age group.[5] This may be attributed to the fact that immunity against pertussis following primary booster wanes after ten years[6]Major spike of measles, mumps and rubella cases among adults in college campus and institutions, in both developed and developing countries is being noted. There is also an increase in number of community acquired pneumonia cases requiring hospitalization (S. Pneumoniae being the leading cause).

1.2 Burden of vaccine preventable diseases.

Over 2 lakh babies are born with birth defects because of Rubella infection during pregnancy in the Indian sub-continent.[7] Around 1,32,000 women in India each year are detected with cervical cancer and 74,000 of them die of its complications.[8] Each year, 300,000 new hepatitis cases occur in India with Hepatitis B surface antigen carriers estimated to be over 40 million. Increased incidence of symptomatic Hepatitis A among adults (3.4% to 12.3%) is being reported amongst the patients with acute viral hepatitis.[9]

Annually around 205,286 deaths related to chronic hepatitis occur.[10] Influenza has a global annual attack rate of 5%–10% in adults and 20%–30% in children. Three to five million cases of severe illness and about 250,000 to 500,000 deaths are reported globally during seasonal influenza epidemics.[11] In India, around 40,000 deaths occur due to Influenza annually.[8]

Numerous meningococcal outbreaks have been reported in temperate northern regions of India especially in and around Delhi, Meghalaya & Tripura.[12,13] In India, although, more than 30% of adolescent and adult population above 15 years of age are susceptible to Varicella, Varicella Zoster vaccine is still not a part of the Universal Immunization Program.[14]

Herpes was previously considered as a disease primarily occurring in elderly of age group more than 60 years. But nowadays, due to increasing incidence of HIV and other immunocompromised states such as diabetes, it is being evidently seen in younger adult population too. Globally, the incidence ranges from 1.2 to 1.4 cases/1000 healthy persons per year over the age 65 years.[15]

Invasive pneumococcal disease contributes to morbidity and mortality among adult population especially elderly older than 65 year. Consecutive WHO reports and numerous studies have revealed that Community Acquired Pneumonia (CAP) is the second-most common reason of death from infectious diseases in the Indian subcontinent.[16]

Despite the recommendations, immunity to tetanus and diphtheria wane among adults. Only 47% of adults over the age of 20 were found to have protective antibodies to both diseases.[17] The incidence of tetanus has dropped dramatically yet between 2001-2016, **Centres for Disease Control and Prevention – *US Department of Health and Human Services (CDC)*** reported 1261 cases including 16 neonatal cases in India. Thirteen cases of respiratory diphtheria were reported to the CDC from 1996-2016.[18] There is no data on incidence of pertussis in adults in Indian subcontinent.

A major outbreak of measles was noted in Kerala with large number of students in age group 13-19 being involved. The cause of the outbreak although uncertain, but can be attributed to waning immunity.[19]

ACIP (Advisory Committee on Immune Practices) guidelines from CDC which annually reviews the recommended adult immunization schedule to ensure it reflects the current recommendations. WHO Guidelines and API expert panel guidelines (2008)[20] are the major guidelines for adult immunization.

These guidelines jointly recommend vaccines for DPT – Tdap, MMR, Influenza (more than 50 years age group), Pneumococcal (more than 65 years age group), HPV (9-26 years age group) and Zoster (more than 60 years age group) among all healty adults.

However, vaccines for Hepatitis B, Hepatitis A, Meningococcal infection, Varicella, Hemophilus influenza infection, Typhoid, Rabies are recommended for high risk groups.[21] Details of high risk groups is delineated in sections pertaining to individual vaccines.

Cholera & Japanese B encephalitis are routinely not indicated due to lack of evidence.

2. Vaccine preventable diseases

2.1 Influenza vaccine

The burden of influenza associated respiratory illnesses is rising among the elderly, especially the geriatric age group..

In tropics and subtropics like India, complexities of influenza such as multiple peaks and year round activity are noted.[22] However, constant mutation with change in strain type due to antigenic drift is also noted.

Vaccine type: The vaccine composition is based on the most recent constant mutation and changed in epidemiological and antigenic analysis of the current circulating strain.

There is a separate vaccine for either hemisphere but depending upon current circulating strain, vaccine is given. The available vaccines in India are Trivalent inactivated or killed influenza vaccine and live attenuated vaccine Trivalent vaccine, recommended in Northern hemisphere, contains two influenza A strains and one influenza B strain while quadrivalent influenza vaccine, recommended in Southern hemisphere contains two influenza A strains and two influenza B strains.

Dose: Single dose of 0.5 ml intramuscular injection to deltoid containing 45 mcg of haemagglutinin influenza antigen inoculation or Live Attenuated Influenza Vaccine (LAIV) as 0.5 ml intranasal spray (0.25 ml per nostril) is currently recommended. The vaccine is only effective two weeks after administration.

Optimal schedule: Since the peak influenza season begins in October and lasts till May. September is considered to be optimal time to receive the vaccine.[23] It may be given with other vaccines as a separate injection. It has been noted that annual dose of vaccine reduced the mortality by 41% while complications and the length of hospital stay has been reduced by 75% in those vaccinated previously.[11]

Indication: Vaccine is indicated in all adults aged more than 50 years of age; persons having COPD, Cardiovascular disease, renal, hepatic, hematological and metabolic disorders; health care personnel and pregnancy.

Contraindication: all persons who have allergy to egg protein, in immunocompromised patients like HIV,

Pregnant women and individuals who have taken influenza antiviral medication in previous 48 hours.

2.2 Pneumococcal vaccine

Pneumococcal infection caused by Streptococcus pneumoniae is the leading bacterial cause of pneumonia worldwide and causes substantial morbidity and mortality. It is also the most important cause of otitis media, sinusitis, bronchitis & leads to Invasive Pneumococcal Disease.[24]

Out of the total ninety serotypes, eleven are responsible for seventy five percent of invasive infections in children and ten commonest forms constitute sixty two percent of all infections in world. In adults, serotypes 1, 3, 6, 7, 9, 14, 19 and 23 are most prevalent. Most common serotype-1, accounts for one-fourth of invasive infections in Indian population while in Indian population, serotype-6 accounts for 11.5% of invasive infections.[25]

Vaccine type: Pneumococcal polysaccharide vaccine (PPSV) and Pneumococcal conjugate vaccine (PCV) are the two kinds of pneumococcal vaccine is available for clinical use. The current PPSV23 formulation contains the following capsular serotypes: 1, 2, 3, 4, 5, 6B, 7F, 8, 9N, 9V, 10A, 11A, 12F, 14, 15B, 17F, 18C, 19F, 19A, 20, 22F, 23F, and 33F. It provides protection against 80% to 90% of the pneumococcal capsular serotypes causing disease. Whereas, PCV13 contains the following capsular serotypes: 1, 3, 4, 5, 6A, 6B, 7F, 9V, 14, 18C, 19A, 19F, and 23F.[26]

Dose & optimal schedule: In Adults more than 65 years of age, a single dose 0.5 ml intra muscular to deltoid of PCV13 followed by PPSV 23 after one year is recommended. Whereas in immunocompromised individuals, PCV13 followed by PPSV23 after eight weeks with PPSV 23 booster after five years is advised. The two vaccines must not be co-administered & minimum acceptable interval between the two is 8 weeks.

Indication: Pneumococcal vaccine is indicated among all individuals who are 65 years and older, persons having comorbidities like Diabetes mellitus, chronic renal failure, COPD, Bronchial asthma, cirrhosis, asplenia & splenectomy. Due to increased vulnerability of pilgrims, it is also recommended for use in mass gatherings.[27]

Adverse effects: The adverse reactions to pneumococcal vaccine are not severe and are self limited. Injection site reactions are the most common adverse effects. Systemic symptoms such as fever, chills, fatigue, headache, myalgia and arthralgia occurs in less than five percent individuals receiving the vaccine.

2.3 HPV

HPV is a sexually transmitted pathogen. Papillomavirus infection is known to be a precursor to cervical cancer. Persistent infection with high-risk genotypes such as 16 & 18 causes seventy percent of all cancers of cervix.[28] Over fifty percent of all females of reproductive age group are infected during their lifetime. Vaccines are equally efficacious against carcinoma cervix & precancerous lesions. HPV strains 6 and 11 are known to cause genital warts hence the quadrivalent vaccine is preferred in males.

Vaccine types: A quadrivalent HPV4 vaccine containing L1 protein like particles of HPV 6, 11, 16 and 18 marketted as Gardasil and a bivalent HPV2 vaccine containing L1 protein like particles of HPV 16 and 18 branded as Cervarix are the two varieties of HPV vaccines which are commercially available.

Dose: Three doses of 0.5 ml intramuscular in deltoid at 0, 2 and 6 months are administered.

Optimal schedule: According to API and Federation of Obstetrics & Gynecological Society of India, age group 11 to 26 years in females and 13 to 21 years in males and may be offered for females upto 45 years.[29] However, the vaccination is considered less beneficial if an individual is already sexually active.

If an individual has completed valid vaccination series with any HPV vaccine no additional doses are needed in future.

Considerations & Contraindications: While no intervention is needed if vaccinated while pregnant and pregnancy testing is not needed before vaccination, HPV vaccine is not recommended in pregnancy as there is a need of further research in this context.[30] It is contraindicated in individuals with history of hypersensitivity to vaccine components such as yeast.

However, HPV vaccine is not contraindicated during lactation and can be safely administered to immune suppressed individuals since it is not a live vaccine.

2.3 Zoster vaccination

Herpes Zoster/Shingles is a neurocutaneous disease occurs due to reactivation of Varicella Zoster virus.

Vaccine types & schedule: Recombinant glycoprotein vaccine and Live attenuated vaccine are the two types of Zoster vaccine available globally. Live attenuated vaccine, branded as Zostavax, is a lyophilized preparation of oka strain of live attenuated Varicella Zoster Virus. However, two doses of Recombinant glycoprotein vaccine, separated by two to six months, is preferred over live zoster due to better immunogenicity.[31]

Indications & Contraindications: All adults more than 60 years are advised to take zoster vaccination. Only contraindication is for the women of childbearing age

group, pregnancy, immunocompromised state, as it is a live vaccine.

Adverse Effects Injection site reactions like Pain at injection site (eight in ten),.redness, swelling at injection site (one in four), itching at injection site (one in thirty) are comonly seen. Fever (Mild -one in ten & moderate - one in sixty-five) is also often reported. Acute retinal necrosis is seen in 12% and occurs usually within six days to two months. Vaccination associated zoster can occur in immunocompromised individuals.[32]

2.4 Tdap

DTap vaccine is routinely recommended in children, with a single booster dose at 11-12 years followed by TD at ten year intervals throughout life.[18] However due to immunosenescence, there is rise in incidence of Diphtheria and tetanus among the adults.

Acellular pertussis vaccine (DTaP) should be used for older children instead of whole cell vaccine (DTwP) because it is associated with less neurological complications. The vaccination schedule varies with status of primary immunization.

Dose: The dose is 0.5ml given intramuscularly preferably in deltoid. DTaP or DTwP vaccine should be used for first booster at 18 months while Tdap (low dose diphtheria and acellular pertussis) may be used for the second booster at five years and 10-15 years.

Optimal Schedule: For adults between 18 and 64 years who have completed their primary vaccination schedule, a booster dose of Td vaccine is indicated every ten years till the age of 65[21]. One dose Tdap vaccine may be administered in place of Td vaccine. For adults more than 18 years who have not received prior vaccination against diphtheria, pertussis and tetanus, three doses of Td vaccine are indicated; two doses are administered at least four weeks apart, and the third dose is given 6-12 months after the second dose.[33]

Pregnant women should receive one dose of Tdap during each pregnancy, around 27-36 weeks of gestation regardless of prior history of receiving Tdap.[34]

Anaphylaxis after a previous dose is an absolute contraindication. However, encephalopathy not attributable to another identifiable cause within seven days of previous dose is a contraindication for Tdap only.

Human tetanus immune globulin (TIG: 3000-5000 IU IM) is indicated in those who have sustained a severe wound which is contaminated. It is also recommended for HIV patients and immunocompromised patients with concerning wounds, regardless of their tetanus immunization.[35]

Strict clinical caution is advised if GBS is noted within six weeks after a previous dose or Arthus-type hypersensitivity is reported after a previous dose. Progressive or new onset neurological disorder, uncontrolled seizures, encephalopathy are to be cautioned until a treatment regimen has been established and the condition has stabilized.

2.5 Mmr

Measles is a major killer of children , mainly in developing countries, accounting for 875,000 deaths each year around the world.[36] Complications from measles affect every organ and adults are likely to suffer encephalitis, hepatitis, hypocalcaemia, pancreatitis.[37] Mumps although the disease is mild, ten percent individuals develop complications.

Dose & Schedule: According to recommendations, all adults born in 1957 or later with out acceptable level of immunity to MMR and non pregnant women of child bearing age without evidence of rubella immunity with focus on reducing congenital rubella syndrome should be given one dose of MMR vaccine, 0.5ml, subcutaneous in outer aspects of triceps.[38]

Two dose MMR vaccine is recommended in Health care workers, Students planning to travel and Adults with HIV with CD4 more than 200 cells for atleast 6-12 months.[39]

In outbreak scenario, two doses separated by 28 days are to be administered with first dose 72 hours after the initial exposure.

Contraindications: It is absolutely contra-indicated in patients with allergy to neomycin, pregnancy and immunodeficiency. (CD count less than 200)

Adverse Effects: Fever is reported to develop in 5-15% within 6-12 days of immunization, Rash is seen in 5%, lymphadenopathy is seen 5% in children & 20% in adults, joint pain is seen in 25% (occurs within 7-21 days) and thrombocytopenia is seen in one in 25000-40000 vaccine doses. Febrile seizures are also rarely reported as one in 3000 MMR doses. Hypersensitivity reactions are also sometimes seen.[40]

2.6 Hepatitis A

Hepatitis A, spread by close contact with affected individuals mainly via feco-oral route is highly endemic in Indian sub-continent.

Vaccine Type: Live attenuated hepatitis A vaccine branded as Bio Vac-A is available in India which is well-tolerated and is highly immunogenic. A combination inactivated vaccine, TWINRIX, is also licensed in India which contains Hepatitis A (HAVRIX) and Hepatitis B (ENGERIX-B). The seroconversion rate, defined as an antibody concentration of more than 20 MU/mL

following primary vaccination series, approximates 100% in healthy adults and children.[41]

Dose: Two-dose series Hep A [Havrix 6-12 months apart or Vaqta 6-18 months apart (minimum interval: 6 months)] whereas Three-dose series Hep A - Hep B [Twinrix at 0,1,6 months (minimum interval: four weeks between doses 1 and 2, 5 months between doses 2 and 3)].

Indications: The hepatitis A vaccine is recommended to those individuals who are at risk for hepatitis A virus infection like patients of chronic liver disease, HIV infection, bisexuals, homosexuals, Injection or non-injection drug use, travel in countries with high or intermediate endemic hepatitis A and pregnancy.[42]

However, universal immunization is not recommended yet. HAV vaccine is contraindicated if patient has hstory of anaphylaxis or in case of Pregnancy.

16 % individuals receiving HAV vaccine develop fever, injection-site reaction, rash. Although not frequently reported, serious events can include Gullian Barre syndrome, transaminitis or Immune thrombocytopenia; but their relationship to vaccination is uncertain.[43] Safety of hepatitis A vaccination during pregnancy is also limited and hence warranted only for those at specific risk for example those undergoing International travel.

2.7 Hepatitis b vaccine

Hepatitis B is a major public health problem in India especially among health care workers and other high risk groups with high incidence of chronicity leading to significant morbidity and mortality.

Vaccine Types: Hepatitis B vaccine is available both as a yeast, mammalian or plasma cell derived single antigen vaccine and recombinant vaccine. Plasma-derived vaccine is not used nowadays due to risk of transmission of infections.[44]

HEPLISAV-B, Engerix-B and Recombivax HB are the three recombinant vaccines available. HEPLISAV-B combines hepatitis B surface antigen with Dynavax's proprietary Toll-like Receptor (TLR)[10] agonist to enhance the immune response while Engerix-B does not contain any adjuvant.[45]

Dose & schedule: Two doses of HEPLISAV-B at least four weeks apart or three dose series of Engerix-B or Recombivax HB at 0, 1, 6 months is advised. A minimum interval of four weeks between first two doses, interval of eight weeks between second and third doses and an interval of sixteen weeks between doses first and third dose is recommended.[46]

In adults, the dose is 20 mcg and those on hemodialysis, the dose is 40 mcg. Booster is not needed in immunocompetent adults. However, may be administered when anti-HBs levels decline to less than10mIU/ml and more than 65 years.[47]

Protection after vaccination is noted at 20-30% after first dose, 75-80% after second dose and 90-95% after third dose. If vaccination is interrupted after the first dose, the second dose should be administered as soon as possible. For three-dose series, the second and third doses should be separated by at least two months. If only third dose is delayed, it should be administered when convenient.[48]

Indications: Hepatitis B vaccine is recommended for all individuals at risk for hepatitis B virus infection like those with chronic liver disease/chronic kidney disease, HIV infection, sexual exposure risk/current or recent injection drug use, percutaneous or mucosal risk for exposure to blood products, health care workers, travel in countries with high or intermediate endemic hepatitis B and pregnancy.

Adverse Effects: Pain over injection site is most common adverse effect noted (25%); fever, headache, joint pain and myalgia can also be seen in few individuals following the vaccination. A series of reports showed association between hepatitis B vaccination and multiple sclerosis in 1998 but at least six subsequent studies failed to show a significant association.[49]

2.8 Varicella

Varicella is a self limited infection but can cause significant complications such as soft tissue infection, pneumonia, hepatitis, and encephalitis. Patients at risk of complications include adults, pregnant women and immunocompromised hosts. It is a live attenuated vaccine.

Vaccine Type: Single antigen varicella vaccine (1350(PFU) of Oka strain) for healthy individuals of 12 months of age and older and a combination of measles, mumps, rubella, varicella vaccine (MMRV) (with 9772 PFU) for 12 months to 12 years of age[50] are the two live attenuate vaccines currenntly available in India.

More than 40 studies done showed that a single dose of varicella vaccine had an approximate effectiveness of 80% in preventing varicella disease, 95-98% in preventing moderate (50-500 lesions) or severe disease (more than 500 lesions).[51]

Dose & recommendations: All adults who have never had chicken pox are recommended to receive two doses 0.5ml in deltoid area subcutaneously.[17] Health care personnel with no evidence of immunity to varicella and individuals with HIV infection with CD4 count more than 200cells/microL with no evidence of immunity are also recommended to get varicella vaccine.

Contraindications: However, immunocompromised conditions like HIV when CD4 less than 200cells/microL are absolute contraindications for Varicella vaccine.

Adverse Effects: Injection site reaction are seen in 30% individuals receiving the vaccine, initial localized rash (2-5 lesions at the injection site) progressing to a generalized rash is seen within one month, febrile seizures can be seen in 15% and disseminated vaccine virus or meningitis is seen in 1.9% individuals. Vaccine associated zoster has also been reported to occur rarely within 3 months of vaccination.[52]

2.9 Typhoid vaccine

Enteric fever caused by salmonella typhi is transmitted by faeco-oral route and is a systemic illness characterized by fever, abdominal pain, vomiting, loose stools etc.

Vaccine Types: In endemic areas 4 types of vaccine are available for clinical use. Vi conjugate vaccines are preferred because of longer lasting immunogenicity and safety in infants and young children up to 15 years old.[53] Vi-TT typhoid conjugate vaccine is a 4th generation vaccine that provides long term immunity. It consists of Vi polysaccharide antigen of salmonella enterica serovar typhi linked to tetanus toxoid carrier protein, which is administered as a single IM dose.[54]

Doses & Schedules: PEDATYPH is a Vi-TT conjugate typhoid vaccine available in INDIA. Vi polysaccharide vaccine consists of Vi polysaccharide antigen, administered as a single 0.5ml IM dose. If continued protection is needed, revaccination is recommended every two to three years.[55]

Ty21a vaccine is a oral live attenuated vaccine, available as capsules/sachets, administered in three to four doses on alternate days. It is indicated only after the age of six. If continuation protection needed, revaccination every three to five years is recommended. This vaccine is contraindicated in immunodeficiency states, acute febrile illness and acute gastrointestinal illness.[54]

Typhoid vaccine is recommended in travellers to endemic areas, Close contacts with typhoid and also lab workers working with S typhi.

2.10 Haemophillus influenzae vaccine

Haemophilus influenza is the most common cause of bacterial meningitis and other invasive diseases like epiglottitis, pneumonia, septic arthritis, bacteremia. The widespread use of vaccine has now led to a dramatic decline in the incidence of invasive Hib disease in children.

However, active immunization is still the most important strategy for the prevention of Hemophilus influenzae type b (Hib) infection. In an Randomised Control Trial, it was noted that Hib conjugate vaccines prevented more than 95% of invasive Hib disease.[56]

Dose: This vaccine is administered as a single 0.5ml dose of Hemophilus influenzae b (HiB) conjugate vaccine intramuscularly.

In special conditions like anatomical or functional asplenia (including sickle cell disease) one dose is recommended if previously did not receive Hib. In case of elective splenectomy, one dose is indicated preferably at least 14 days before splenectomy.[57] In hematopoietic stem cell transplant (HSCT) a three dose series is recommended four weeks apart starting from 6-12 months after successful transplant, regardless of Hib vaccination history.[58]

2.11 Meningococcal vaccine

Meningococcal meningitis, caused by Neisseria meningitides is one of the most devastating infections and tends to strike young individuals which can progress over hours to death.

It is an inactivated vaccine and is available in two formulations, first being **quadrivalent meningococcal vaccine**, which contains 50 mcg of each of the capsular polysaccharide antigens from serogroups A, C, Y and W135 conjugated to diphtheria toxoid.[59] Another is, **monovalent meningococcal vaccine**, which is not available in India. The vaccine used in outbreak, is serogroup vaccine and high risk individuals include travelers to regions in which meningococcal disease is hyper endemic or epidemic, military recruits, and microbiologists exposed to Neisseria meningitides.

2.12Rabies vaccine

Rabies is a fatal neurological disease and is increasing due to increasing trends of domestication of dogs and increased interaction between wild animals and humans. Currently no treatment is available for this dreaded disease and vaccination based prophylaxis is the mainstay.

The sheep brain-derived nerve tissue semple vaccine is no longer used. Tissue culture vaccines (TCV) such as human diploid cell vaccine, purified chicken embryo cell vaccine (PCECV), and newer and less expensive Vero cell-purified rabies vaccines are now being propagated for clinical use . TCV are used for pre and post-exposure prophylaxis as they are easy to administer, highly immunogenic, and have a good margin of safety.[60]

Schedule Pre-exposure Prophylaxis: For high-risk groups like veterinarians, lab personnel, medical and paramedical, dog catchers, forest staff etc. Three doses at days 0, 7, and 28 days as a Pre-exposure prophylaxis is recommended.

The HDCV and PCEV(1ML) or purified Vero cell rabies vaccine (0.5ml) are administered by intramuscular route

in the deltoid region or the anterolateral thigh. Booster dose should is recommended when the titre falls below 0.5 IU/ml.

Schedule Post-exposure Prophylaxis: A person who is exposed and never been vaccinated against rabies should get five doses of rabies vaccine at 0, 3, 7, 14 and 28 days respectively as a Post-exposure prophylaxis. They also should get human rabies immune globulin (20 IU/kg body weight; up to a maximum of 1500 IU) at the same time as first dose. Whereas, a person who has been previously vaccinated should get two doses – first on day 0 and another on third day.

3 Immunization in elderly

With ever increasing population of elderly people aged more than 60 years in India and the advancing age leading to poor immunity, the burden of vaccine preventable diseases is also increasing day by day thereby contributing to significant morbidity and mortality. Table -1 mentions the vaccines currently recommended worldwide in this age group.

VACCINE	RECOMMENDATIONS
Influenza inactivated (IIV) or Influenza recombinant (RIV)	1 dose annually
Tetanus, diphtheria, pertussis (Tdap or Td)	1 dose Tdap, then Td or Tdap booster every 10 years
Zoster recombinant (RZV) *(preferred)* OR Zoster live (ZVL)	2 doses
Pneumococcal polysaccharide (PPSV23)	1 dose

Table 1 – Immunization recommendations in elderly.[61]

Vaccines like Varicella - 2 doses, Pneumococcal conjugate(PCV13) - 1 dose, Hepatitis A - 2 or 3 doses depending on vaccine, Hepatitis B - 2 or 3 doses depending on vaccine, Meningococcal A, C, W, Y - 1 or 2 doses depending on indication, Meningococcal B - 2 or 3 doses depending on vaccine and indication and Haemophilus influenzae type b - 1 or 3 doses depending on indication are recommended vaccination for elderly with an additional risk factor or another indication.

Vaccines like Measles, mumps, rubella (MMR), Influenza live, attenuated(LAIV) and Human papillomavirus (HPV) are not recommended for the elder age group.

4 Immunization in hiv

HIV infection, an immunocompromised state, is a risk factor for morbidity and mortality caused by a number of infections that can be prevented by immunization. Vaccines tend to be less immunogenic and antibody responses are shorter-lived in the setting of HIV-infection but adequate responses can be achieved when given early.

Inactivated vaccines are generally safe and acceptable. Certain live vaccines have sufficient safety data and are recommended in those who have CD4 counts more than 200 cells/microL. Live vaccines are contraindicated in those with low CD4 thresholds because of the absence of safety data and the concern of vaccine-associated infection.

INACTIVATED VACCINES	VACCINES FOR WHICH HIV IS AN INDICATION	GIVEN ONLY IN SPECIAL CONDITION
• Influenza vaccine	• Pneumococcal vaccine	• HAV vaccine
• Td or Tdap	• Meningococcal vaccine	• Hemophilus influenzae b vaccine
• HPV Vaccination		• MMR vaccine cell count>200
		• Varicella vaccine (CD4 cell count >200 to 350 cells/microL)
		• Zoster vaccination(>50 years)

Table 2 – Immunization recommendations in HIV.[62]

5 Immunization in pregnancy

Maternal immunization protects both the mother and fetus and provide passive protection against vaccine-preventable infections. Trans-placental passage of antibodies depends on maternal concentration, antibody type (IgG are only transported) and gestational age. Maternal IgG levels reach peak about 4weeks after immunization and hence ideal time is in the early third trimester to achieve maximum maternal antibody levels and antibody transfer before delivery. Use of vaccines is strongly discouraged during pregnancy unless the pregnant women is at substantial risk of exposure.

Vaccines routinely recommended in pregnancy are Influena inactivated vaccine, Tdap, Td, Hepatitis A and Hepatitis B. while those **contraindicated in pregnancy** are Human papilloma virus, Varicella, MMR vaccine, LAIV, Tuberculosis and Zoster.[63]

6 Immunization in lung diseases

Adults with COPD or asthma are highly susceptible to lung infections majorly due to impaired muco-ciliary clearance. Influenza vaccine, pneumococcal vaccine, Tdap vaccine and zoster vaccine are currently widely being recommended by CDC.[64]

7 Immunization in solid organ transplant

Recipients of solid-organ transplantation are at risk of severe infections due to their life-long immunosuppression. Therefore, several vaccines are recommended to prevent morbidity and mortality in such cases.

INACTIVATED VACCINES	
Seasonal influenza virus	Human papillomavirus
Hepatitis B,A virus	DTaP, Td
Pneumococcus (PCV13 and PPSV23)	Recombinant zoster vaccine (RZV)
Meningococcal vaccine	Haemophilus influenzae

Table 3 – Immunization recommendations in Solid Organ Transplant.[65]

8 Vaccines for travellers

According to WHO guidelines, routine vaccination for Diphtheria, tetanus, and pertussis; Hepatitis B, Haemophilus influenzae type b, Human papillomavirus, Influenza, Measles, mumps and rubella, Pneumococcal diseases, Poliomyelitis, Rotavirusa and Varicella is recommended for travellers[66]. However, vaccine for Tuberculosis i.e. BCG is no longer a routine in most industrialized countries.

Vaccines for Cholera, Hepatitis A, Japanese encephalitis, Meningococcal diseases, Rabies, Tick-borne encephalitis, Typhoid fever and Yellow fever are recommended for selective use by travellers Yellow fever vaccination is mandatory for travel to endemic countries as per International Health Regulations. Proof for vaccination to meningococcal disease, influenza and polio has been necessitated by Saudi Arabia for hajj or umrah pilgrims.

9 Vaccines in trial

Dengue - CYD-TDV (chimeric yellow dengue virus tetravalent dengue vaccine), Hepatitis C vaccine, Hepatitis E vaccine - Helicon (HEV 239 vaccine), Leprosy vaccine, Malarial vaccine (Presently in phase 2 clinical trials), CMV vaccine (Presently in phase 2 clinical trials) and Hook worm vaccine are the ones being in different phases of clinical trials and are expected to carve a niche of their own in the vaccination world soon in years to come.

10 Limitations of adult immunization

Healthy adults are harder to reach through public health system and hence vaccination of this age-group becomes difficult. It has been noted that adult immunization is currently confined to selective not universal, most probably due to the fact that different vaccines have different target groups.

Furthermore, there is a limited perception on part of the health care providers and beneficiaries that adult vaccine preventable diseases are significant health problems and there are doubts in the minds of some health care providers and public about the efficacy and safety of several of the vaccines used for adults.

Increased cost and low availability in developing nations like India also serves as a roadblock towards healthy ageing thereby delaying the conversion of a vaccine into vaccination.

11 Strategies for reaching out to adults

Majority of adults can be reached to increase the demand for adult vaccination by improving provider and public awareness and ensuring them that health care system has an adequate capacity and strategies to deliver vaccines to adults. There is also a necessity to ensure adequate financing mechanisms to support the expanded delivery of vaccines to adults and adequate support for research to develop and implement Universal Immunization Schedule meant solely for adults.

12 CONCLUSION

Vaccinations are recommended throughout life to prevent infectious diseases and their sequelae. Vaccines of adults is very important given that more than 25% of mortality are due to infectious diseases in our country.

Although many issues revolving around efficacy, safety, and cost of introducing vaccines for adults at the national level are yet to be resolved, there is an urgent need to sensitize the health planners as well as health care providers regarding this pertinent issue.

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