Declarations
OUTLINE

• Introduction

• SAHCS Guideline

• Vaccines with strong local evidence for use

• Vaccines that are recommended but local data lacking

• Vaccines- no recommendation

• Conclusion
The world before vaccines

Examples of major disease outbreaks

**Flu pandemic**
- **1918-1920**
- > 50-100 million deaths worldwide

**Polio**
- **NEW YORK**
- **1916**
- 6,000 deaths

**Yellow fever**
- **PHILADELPHIA**
- **1793**
- >5,000 deaths

**Cholera pandemic**
- **EUROPE**
- **1829-1851**
- >200,000 deaths

**Smallpox epidemic**
- **INDIA**
- **1974**
- 15,000 deaths

**Flu pandemic**
- **1918-1920**
- > 50-100 million deaths worldwide
Vaccination essential element for promoting

• Health equity

• Economic equity (reducing medical & non-medical costs)

• Social equity – access to the health care system

• Vertical equity intervention- vaccines for diseases of poverty
Vaccinate to Prevent Disability

Catastrophic disability

- Defined as a loss of independence in ≥ 3 ADL
- 72% who experience catastrophic disability have been hospitalized
- Leading causes of catastrophic disability
  1. Strokes
  2. CHF
  3. Pneumonia and influenza
  4. Ischemic heart disease
  5. Cancer
  6. Hip fracture

Ferrucci et al. JAMA 277:728, 1997

1= Very fit
2= Well
3= Well, with treated chronic disease
4= Apparently vulnerable
5= Mildly frail
6= Moderately frail
7= Severely frail
8= Very severely frail
9= Terminally ill
Low Vaccine Coverage in HIV

• Coverage rates among HIV patients reportedly low
  • In US influenza vaccination coverage 25-43%
  • In France influenza coverage is 30.9%

• Multifactorial
  • Lack of knowledge of current vaccine recommendations
  • Lack of infrastructure in clinics to provide vaccines
  • Concerns about vaccine safety
  • Insurers not willing to pay for vaccines
36.9 million living with HIV
Remarkable individual and population health benefits

Source: UNAIDS/WHO estimates
Top 10 global causes of deaths, 2016

- Ischaemic heart disease
- Stroke
- Chronic obstructive pulmonary disease
- Lower respiratory infections
- Alzheimer disease and other dementias
- Trachea, bronchus, lung cancers
- Diabetes mellitus
- Road injury
- Diarrhoeal diseases
- Tuberculosis

Top 10 causes of deaths in low-income countries in 2016

<table>
<thead>
<tr>
<th>Cause Group</th>
<th>Crude death rate (per 100 000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicable, maternal, neonatal and nutritional conditions</td>
<td></td>
</tr>
<tr>
<td>Lower respiratory infections</td>
<td>80</td>
</tr>
<tr>
<td>Diarrhoeal diseases</td>
<td>70</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>60</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>50</td>
</tr>
<tr>
<td>Stroke</td>
<td>45</td>
</tr>
<tr>
<td>Malaria</td>
<td>40</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>35</td>
</tr>
<tr>
<td>Preterm birth complications</td>
<td>30</td>
</tr>
<tr>
<td>Birth asphyxia and birth trauma</td>
<td>25</td>
</tr>
<tr>
<td>Road injury</td>
<td>20</td>
</tr>
<tr>
<td>Noncommunicable diseases</td>
<td></td>
</tr>
<tr>
<td>Injuries</td>
<td></td>
</tr>
</tbody>
</table>

South Africa

- 7.9 million South African are HIV-infected
- ~4.4 million on ART
- Estimated ART coverage 62%
- Estimated viral suppression rate 87.3%
Trends in prevalence of selected opportunistic infections associated with HIV/AIDS in Uganda
Guideline Development

• Experts in the field of vaccination
  • Vaccines for Africa Initiative (VACFA)
• National Institute for Communicable Diseases (NICD)
• Academics
• Private Sector
• Rural health
• Pediatricians & Physicians
• South African Cochrane Centre
• Full day workshop
• Presentation of local data
• Discussion
• Recommendation
  • Consensus if no local data
• Draft of guidelines
  • Evidence based
  • Based on best international practice
  • Circulated and comments received

• Review of guideline recommendation
  • Every 3-5 years
  • Identify gaps in local data –help inform future guidelines
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Indication</th>
<th>Safety CD4 count</th>
<th>Doses for unvaccinated adults</th>
<th>Booster</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMR vaccine</td>
<td>Measles, mumps, rubella, measles</td>
<td>&gt; 200 cells/mL</td>
<td>3 doses (28 days apart)</td>
<td>Protection likely lifelong</td>
<td>Mainly indicated in measles seronegative HIV-infected women of childbearing age. Pregnancy should be awaited for 6 months after vaccination.</td>
</tr>
<tr>
<td>Influenza A</td>
<td>R</td>
<td>Any</td>
<td>1 dose</td>
<td>Yearly</td>
<td>-</td>
</tr>
<tr>
<td>Pneumococcal</td>
<td>R</td>
<td>Any</td>
<td>1 dose</td>
<td></td>
<td>Given with IPV13 but given 8 weeks after IPV13.</td>
</tr>
<tr>
<td>Polysaccharides (IPV13)</td>
<td>RS</td>
<td>&gt; 200 cells/mL</td>
<td>1 dose</td>
<td>1-10 years</td>
<td>Given in pregnancy combined with tetanus-diphtheria (DTPa/Td).</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>R</td>
<td>Any</td>
<td>4 doses: (40µg of 3 doses (20µg)</td>
<td>Not clear-cut evidence</td>
<td>-</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>RS - travel, MSM, liver disease</td>
<td>&gt; 200 cells/mL</td>
<td>2 doses</td>
<td>10 years</td>
<td>-</td>
</tr>
<tr>
<td>Meningococcal</td>
<td>RS</td>
<td>Any</td>
<td>2 doses</td>
<td>3 years</td>
<td>-</td>
</tr>
<tr>
<td>Peptiscus-ovoiduria</td>
<td>R</td>
<td>Any</td>
<td>1 dose</td>
<td>10 years</td>
<td>-</td>
</tr>
<tr>
<td>Polomyelocinated</td>
<td>RS</td>
<td>&gt; 200 cells/mL</td>
<td>3 doses</td>
<td>None</td>
<td>-</td>
</tr>
<tr>
<td>Human papilloma virus (HPV)</td>
<td>RS - female, MSM</td>
<td>&gt; 200 cells/mL</td>
<td>3 doses</td>
<td>None</td>
<td>-</td>
</tr>
<tr>
<td>Varicella</td>
<td>NR</td>
<td></td>
<td></td>
<td></td>
<td>May be considered if CD4 count &gt; 400 cells/mL.</td>
</tr>
<tr>
<td>Zoster</td>
<td>RS</td>
<td>&gt; 200 cells/mL</td>
<td>1 dose</td>
<td>None</td>
<td>Only if CD4 count &gt; 200 cells/mL.</td>
</tr>
</tbody>
</table>

MMR, measles, mumps, and rubella; R, recommended; RS, recommended in selected individuals; NR, not recommended; VL, viral load; HBAb, hepatitis B surface antibody; MSM, men who have sex with men.
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

• Recommendations made on the basis:
  • Vaccines with strong local evidence for use
    • Influenza
    • Pneumococcal vaccination
    • Hepatitis B, Tetanus-diphtheria
  • Vaccines recommended but either local data lacking or warranted in selected cases
    • Pertussis
    • Meningococcal, hepatitis A
  • Vaccines with no recommendation (NR) OR recommended in selected individuals (RS)
    • Varicella
    • Herpes Zoster
    • Measles, mumps & rubella
Vaccines with strong local evidence for Use
ACUTE LOWER RESPIRATORY INFECTIONS

- 2nd common cause of illness
- 3rd common cause of death
- Most common agent: virus
  - mainly RSV and influenza in children and elderly
Influenza in South Africa

- Responsible for a 10-fold increased mortality rate
- In SA influenza kills between 6,000-11,000 people every year
  - Half of these deaths are in the elderly
  - About 30% in HIV-infected individuals
- Highest rates of hospitalization
  - The elderly (65 years and older)
  - **HIV-infected people**
  - Pregnant women
  - Children less than five years
Impact of Human Immunodeficiency Virus on the Burden and Severity of Influenza Illness in Malawian Adults: A Prospective Cohort and Parallel Case-Control Study

Antonia Ho,1,2 Stephen J. Aston,1,2 Hannah Jany,3,2 Tamara Mitchell,2 Maaike Ablaerts,2 Mavis Mwenye,2 Jane Mallowa,4,5 Mulinda Nyirenda,4,5 Dean Everett,1,2 Robert S. Heyderman,2,3,8 and Neil French1,2

Conclusions. HIV is an important risk factor for influenza-associated ILI and severe presentation in this high–HIV prevalence African setting. Targeted influenza vaccination of HIV-infected African adults should be reevaluated, and the optimal mechanism for vaccine introduction in overstretched health systems needs to be determined.

Risk Factors for Influenza-Associated Severe Acute Respiratory Illness Hospitalization in South Africa, 2012–2015

Stefano Tempia,1,2 Sibongile Walaza,3,4 Jocelyn Moyes,5,4 Adam L. Cohen,1,5 Claire von Mollendorf,3,4 Florette K. Treurnicht,2 Marietjie Venter,6,7 Marthi Pretorius,3,8 Orienka Hellforssee,9 Senzo Mtshali,3 Mpho Seleka,3 Akhona Tshangela,1 Athewon Nguvaneza,2 Johanna M. McAnerny,2 Nicole Wolter,1 Anne von Gottberg,1,9 Halima Dawood,10,11 Ebrahim Variava,12,13,14 Shabir A. Madhi,3,15,16 and Cheryl Cohen1
Influenza Vaccination of Pregnant Women and Protection of Their Infants

Shabir A. Madhi, M.D., Ph.D., Clare L. Cutland, M.D., Locadiah Kuwanda, M.Sc., Adriana Weinberg, M.D., Andrea Hugo, M.D., Stephanie Jones, M.D.,
Peter V. Adrian, Ph.D., Nadia van Niekerk, B.Tech., Florette Treurnicht, Ph.D.,
Justin R. Ortiz, M.D., Mariëtjie Venter, Ph.D., Avy Violari, M.D.,
Kathleen M. Neuzil, M.D., Eric A.F. Simões, M.D., Keith P. Klugman, M.D., Ph.D.,
and Marta C. Nunes, Ph.D., for the Maternal Flu Trial (Matflu) Team*


Influenza vaccination in HIV-infected individuals: Systematic review and assessment of quality of evidence related to vaccine efficacy, effectiveness and safety

Cornelius Remschmidt*, Ole Wichmann, Thomas Harder

Conclusion: This systematic review indicates that TIV is effective in preventing influenza infection in HIV-infected adults but not in young children. For both age-groups, only limited evidence exists for other outcomes, indicating a need for further studies.

Vaccine 2014; 32:5585-5592
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

- **Influenza**
  - 1 dose yearly
  - Irrespective of CD4+ cell count, HIV viral load or pregnancy status
Pneumococcal Infection

- HIV-infected individuals have a **35 to 60 fold increase risk** of invasive IPD
  - **Higher rates of bacteremia**
  - Often at risk of **recurrent** pneumococcal infections
  - Associated with a **2-fold higher mortality rate**
  - Risk elevated despite the use of ART
- Some good reasons why vaccination important in this population
- Vaccines available
  - Polysaccharide vaccine (PPV23)
  - Conjugate vaccine (PCV13)
Antiretroviral Therapy as Prevention of ... Pneumococcal Infections?
Incidence and Risk Factors for Invasive Pneumococcal Disease in HIV-Infected and Non-HIV-Infected Individuals Before and After the Introduction of Combination Antiretroviral Therapy: Persistent High Risk Among HIV-Infected Injecting Drug Users

• 18% of adults were diagnosed with HIV & IPD simultaneously (within 1 month)
• 68% diagnosed with IPD more than 1 month after HIV diagnosis
• Incidence rates were lower for HIV-positive on ART compared with untreated
  • HIV-infected with CD4+ of 500 cells/mL³ significantly lower
  • 71 per 100 000 versus 269 per 100 000 (all HIV-positive adults)
  • This is still 7 times higher than general population (11 per 100 000 population)
Persisting high prevalence of pneumococcal carriage among HIV-infected adults receiving antiretroviral therapy in Malawi: a cohort study

Ellen Heinsbroek\textsuperscript{a}, Terence Tafatatha\textsuperscript{b}, Amos Phiri\textsuperscript{b}, Bagrey Ngwira\textsuperscript{b,c}, Amelia C. Crampin\textsuperscript{b,d}, Jonathan M. Read\textsuperscript{e} and Neil French\textsuperscript{a}

Control of pneumococcal disease in African HIV remains a priority

AIDS 2015; 29:1837-1844
Persistent High Burden of Invasive Pneumococcal Disease in South African HIV-Infected Adults in the Era of an Antiretroviral Treatment Program

Marta C. Nunes¹, Anne von Gottberg², Linda de Gouveia², Cheryl Cohen³, Locadiah Kuwanda¹, Alan S. Karstaedt⁴, Keith P. Klugman²,⁵, Shabir A. Madhi¹,²*

Conclusion: Despite a stable prevalence of HIV and the increased roll-out of HAART for treatment of AIDS patients in our setting, the burden of IPD has not decreased among HIV-infected adults. The study indicates a need for ongoing monitoring of disease and HAART program effectiveness to reduce opportunistic infections in African adults with HIV/AIDS, as well as the need to consider alternate strategies including pneumococcal conjugate vaccine immunization for the prevention of IPD in HIV-infected adults.
HIV and Influenza Virus Infections Are Associated With Increased Blood Pneumococcal Load: A Prospective, Hospital-Based Observational Study in South Africa, 2009–2011
Estimated incidence of invasive pneumococcal disease amongst HIV-infected and uninfected persons by age category, South Africa, 2017

GERMS-SA, unpublished data

Slide courtesy – Susan Meiring
EDITORIAL COMMENT

Pneumococcal vaccination of HIV-infected young adults is an important global priority

Francesca Chiodi
Protection of adults against pneumococcal disease- "Tale of Two Vaccines"

PCV13 effective against both bacteremic & non-bacteremic CAP

Overall evidence supports sequential use of PCV13 followed by PPV23

— should provide adults with long-term protection
Immune response to polysaccharide vaccine

[Diagram showing the immune response to polysaccharide vaccine.]

- Polysaccharide binds to the B cell via BCR (B cell receptor).
- Differentiation of B cells into plasma cells.
- Depletion of memory B-cell pool.
- No production of memory B cells.
- Antibody production by plasma cells.
- Production of IgG2 and IgM antibodies.

Immune response to conjugate vaccine
Immunogenicity: Opsonophagocytic Activity Following One and Two Doses of PCV13 and PPV23: Serotype 1

Paradiso PR. Clin Infect Dis 2012; 55: 259-64
This Study adds to evidence supporting current pneumococcal vaccination recommendations combining the conjugate and polysaccharide pneumococcal vaccines in the United States and Europe for HIV-infected individuals.
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

• **Pneumococcal**
  • All HIV-infected regardless of CD4+ with suppressed viral load
  • Prime-boost approach
  • PCV13 followed by PPV23 eight weeks later
  • PCV13 alone is sufficient
**Table 1** Summary of advisory group recommendations for inactivated vaccines with broad indications for HIV-infected adults

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Pneumococcal</td>
<td>Not recommended in resource-limited settings</td>
<td>Recommended for all patients. Use PCV-13 (one dose) regardless of HIV control. PPV recommended only for those with additional risk factors which include: - Age ≥65 years old - Younger adults with concurrent comorbidity (e.g., asplenia) based on national program recommendations</td>
<td>Recommended for all patients. Use PCV-13 (one dose) No repeat dosing advised</td>
<td>Recommended for all patients. Use PCV-13 and PPV-23 Previously unvaccinated: 1 dose of PCV-13 followed by 1 dose of PPV-23 at ≥2 months later Previously vaccinated with PPV-23; 1 dose of PCV-13 at ≥3 years followed 2 months later with 1 dose of PPV-23</td>
<td>Recommended for all patients. Use PCV-13 and PPV-23 Previously unvaccinated: 1 dose of PCV-13 followed by 1 dose of PPV-23 at ≥8 weeks later (preferably when CD4 count ≥200 cells/mm³). Repeat PPV-23 dose 5 years later Previously vaccinated with PPV-23, give PCV-13 at ≥1 year later followed by PPV-23 at 5 years later</td>
</tr>
</tbody>
</table>
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

• Hepatitis B
  • Prevalence in HIV-infected individuals ranges 0.4%- 23%
  • Administration of vaccine shown to be safe
  • Four-double-dose regimen
  • Best responses in those with undetectable VL & CD4+ >200 cells/μL
Diphtheria Outbreaks in South Africa

• 15 cases occurred in eThekwini, KZN province 2015
  - most cases occurred in people who were not vaccinated or partially vaccinated

• 2 confirmed cases 2016- KZN

• Diphtheria kills 1, infects 3 in Western Cape – August 2017
  - 4 lab-confirmed cases & 1 asymptomatic carrier

• 3 cases (aged 20,11 & 10 yrs), KZN province since March 2018
  - 2 of the cases have demised

• Catch-up campaign
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

• Tetanus-diphtheria (Td)
  • Vaccinated irrespective of CD4+ count
  • Booster vaccine every 10 years (until more data available)
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

- Human papilloma virus
  - In SA HPV- preteen girls 9-13 yrs- regardless of HIV status
  - Recommended for all HIV-infected adult men (MSM) & women,
  - Can be given regardless of CD4+ count, ART use or viral load
Vaccines that are recommended but either local data lacking or warranted in select cases
Pertussis

The Pertussis Problem

Stanley A. Plotkin
Department of Pediatrics, University of Pennsylvania, Philadelphia

Pertussis is resurgent, and many cases are occurring in vaccinated children and adolescents. In countries using acellular vaccines, waning immunity is at least part of the problem. This article discusses possible improvements in those vaccines.

Clinical Infectious Diseases January 2014

Re-emergence of pertussis: what are the solutions?

Bordetella pertussis Infection in South African HIV-Infected and HIV-Uninfected Mother–Infant Dyads: A Longitudinal Cohort Study

Marta C. Nunes,1,2 Sarah Downs,1,2 Stephanie Jones,1,2 Nadia van Niekerk,1,2 Clare L. Cutland,1,2 and Shabir A. Madhi1,2,3

Conclusions. Bordetella pertussis identification was common among young infants with respiratory illness, most of whom were too young to be fully protected through direct vaccination. Vaccination of pregnant women might be a valuable strategy in a setting such as ours to prevent B. pertussis–associated illness in women and their young infants.

Review

Pertussis in Africa: Findings and recommendations of the Global Pertussis Initiative (GPI)

Rudzani Muloiwa a, Nicole Wolter b, Ezekiel Mupere c, Tina Tan d, A.J. Chitkara e, Kevin D. Forsyth f, Carl-Heinz Wirsing von König g, Gregory Hussey h,*

Vaccine 36 (2018) 2385–2393
## Risk of pertussis with HIV infection and exposure

### Table: Risk ratio (95% confidence interval)

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Risk ratio (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anukam (2004)</td>
<td>22.82 (6.93, 75.14)</td>
</tr>
<tr>
<td>Kayina (2015)</td>
<td>1.57 (0.64, 3.90)</td>
</tr>
<tr>
<td>Barger-Kamate (2016)</td>
<td>1.43 (0.44, 4.65)</td>
</tr>
<tr>
<td>Muloiwa (2016)</td>
<td>2.47 (1.26, 4.85)</td>
</tr>
<tr>
<td>Nunes (2016)</td>
<td>3.01 (1.15, 7.90)</td>
</tr>
<tr>
<td>Soofie (2016)</td>
<td>1.16 (0.54, 2.49)</td>
</tr>
<tr>
<td>du Plessis (2018)</td>
<td>1.28 (0.69, 2.38)</td>
</tr>
</tbody>
</table>

**Overall** (I-squared = 75.7%, p = 0.001)  
**Overall** (I-squared = 27.9%, p = 0.236)

### Diagram: Risk ratio – risk of pertussis increases with HIV exposure (blue) or infection (red)

**Slide courtesy of Dr Muloiwa**
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

• Pertussis
  – Emerging epidemiological data on burden of pertussis in HIV endemic countries
  – Only pregnant women regardless of CD4+ count or viral load
  – Recommend acellular vaccine
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

• Meningococcal
  • Should be considered
  • 2 dose schedule (12 weeks apart)
  • Booster every 5 years

• Hepatitis A
  • Recommended in high risk groups
    • MSM, IV drug users, travel, chronic liver disease
  • Ideally vaccinate those with CD4+ count >200
Vaccines- no recommendation is given
Varicella zoster virus-associated morbidity and mortality in Africa – a systematic review

Hannah Hussey1, Leila Abdullahi2, Jamie Collins3, Rudzani Muloiva4, Gregory Hussey2 and Benjamin Kagina5

Methods

- Developed search query
- Applied the search query in 9 databases: (PubMed, Web of Science, CENTRAL, Scopus, Africa-Wide, PDQ-Evidence, Wholis, Ebase and CINAHL)
- Screened studies for eligibility
- Data extraction and analysis
Mortality and HIV infection

**Mortality** - Two studies reported mortality:

- Poulsen et al. 2005 reported a fatality rate of 0.13% - varicella
- Siddiq et al. 2014 had a 30.8% mortality - CNS infection

9 studies had data on HIV

Rubaihayo - Incidence was 1340 cases per 100 000 population pre-ART
- 330 cases per 100 000 population after ART became available

Compston – Healthy HIV neg seroprevalence 45%
- Symptomatic HIV pos seroprevalence 57%
  \[ OR=1.6 \ (95\% \ CI, \ 1.1-2.6) \]

Evidence of HIV impact on both seroprevalence & incidence
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

• Varicella
  • Limited data on vaccination in adolescents or adults
  • In Africa- lack of epidemiologic & socio-economic data
Herpes Zoster Vaccine

• HIV-infected persons at risk for VZV reactivation
  – Estimated incidence of 3.2 cases per 100 person-years

• Limited data on use of vaccine in HIV

• May be considered in HIV
  – History of varicella or zoster or
  – VZV positive without history of varicella vaccination
  – ≥60 years CD4 count ≥200 cells/mm³
• Benefits of zoster vaccine
  – Reduce incidence of shingles
  – Reduce severity of disease
  – Reduce occurrence of post-herpetic neuralgia

• Concerns that remain
  – Lack of data on ideal dosing schedule
  – Safety & efficacy
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

• Zoster
  – No data in Africa to support use of this vaccine
Guidelines for the vaccination of HIV-infected adolescents and adults in South Africa

- **Measles, mumps & rubella (MMR)**
  - Contra-indicated with CD4+ counts <200 cells.

- **Polio**
  - Exceedingly rare in SA
  - Live vaccine contra-indicated in HIV
  - Inactivated recommended for those infected with HIV
<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Indication</th>
<th>Safety CD4+ count</th>
<th>Doses for unvaccinated adults</th>
<th>Booster</th>
<th>Comments</th>
</tr>
</thead>
</table>
| MMR vaccine                   | Measles, mumps or rubella seronegative          | ≥ 200 cells/mL    | 2 doses (28 days apart)       | Protection likely lifelong | Mainly indicated in measles seronegative HIV-infected women of childbearing age  
|                               |                                                 |                   |                               |                          | Pregnancy should be avoided for 1 month after vaccination               |
| Influenza                     | R                                               | Any               | 1 dose                        | Yearly                    | -                                                                         |
| Pneumococcal Conjugated (PCV13) | R                                               | Any               | 1 dose                        |                          | Given with PPV23 but must be given first                                   |
| Pneumococcal                  | R                                               | ≥ 200 cells/mL    | 1 dose                        | 5–10 years                | Given with PCV13 but given 8 weeks after PCV13                            |
| Polysaccharide (PPV23)        |                                                 |                   |                               |                          | Can be given to patients with CD4 count < 200 cells/mL if on ART and VL suppressed  
|                               |                                                 |                   |                               |                          | Maximum 2 booster doses, 1 booster dose in patients < 65 years. Poor response if CD4+ cell count < 200 cells/mL and VL not suppressed |
| Hepatitis B                   | R                                               | Any               | 4 doses (40 μg) or 3 doses (20 μg) | Not clear awaiting evidence | -                                                                         |
| Hepatitis A                   | R – travel, MSM, liver disease                  | ≥ 200 cells/mL    | 2 doses                        | 10 years                  | -                                                                         |
| Meningococcal                 | R                                               | Any               | 2 doses                        | 5 years                   | -                                                                         |
| Tetanus-diphtheria (Td)       | R                                               | Any               | -                             | 10 years                  | -                                                                         |
| Pertussis-acellular           | R                                               | Any               | 1 dose                        | 10 years                  | Given in pregnancy combined with tetanus-diphtheria (DTPa/dTpa)            |
| Poliomyelitis-inactivated     | R                                               | ≥ 200 cells/mL    | 3 doses                        | none                      | -                                                                         |
| Human papilloma virus (HPV)   | R – females, MSM                                | Any               | 2 doses                        | none                      | May be considered if CD4+ count > 400 cells/mL                              |
| Varicella                     | NR                                              | -                 | -                             |                          | -                                                                         |
| Zoster                        | R                                               | ≥ 200 cells/mL    | 1 dose                        | none                      | Only use if CD4+ count ≥ 200 cells/μL                                     |

MMR, measles, mumps, and rubella; R, recommended; R5, recommended in selected individuals; NR, not recommended; VL, viral load; HBsAb, hepatitis B surface antibody; MSM, men who have sex with men.
Conclusion

• Are opportunities to expand immunization for HIV-infected Adolescents & Adults

• Vaccinate during stable disease

• Communicate with patients about the importance of vaccination and the availability of vaccines

• Vaccination is the most cost effective intervention of 21\textsuperscript{st} century