NON-INTERVENTIONAL (NI) STUDY PROTOCOL

Study information

Title	Assessment of 13-valent pneumococcal conjugate vaccine effectiveness among people with HIV in the United States
Protocol number	B1851217
Protocol version identifier	3.0
Date	06 December 2023
Active substance	
Medicinal product	Prevnar 13
Research question and objectives	The primary objectives include: 1. Estimate vaccine effectiveness (VE) of PCV13 for invasive pneumococcal disease (IPD) among people living with HIV (PLWH) ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up 2. Estimate VE of PCV13 for pneumococcal pneumonia among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up 3. Estimate VE of PCV13 for all-cause pneumonia among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up The secondary objectives of this study are to estimate: 1. Estimate VE of PCV13 for pneumococcal pneumonia or pneumonia with unspecified causes among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up 2. Estimate VE of PCV13 for pneumonia with unspecified causes among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up

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2. LIST OF ABBREVIATIONS

Abbreviation	Definition
AE	Adverse event
ART	Antiretroviral therapy
CAP	Community-acquired pneumonia
CAPiTA	The Community-Acquired Pneumonia Immunization Trial in Adults
CI	Confidence interval
CIOMS	Council for International Organizations of Medical Sciences
CPT	Current procedural terminology®
CSF	Cerebrospinal fluid
EC	Ethics Committee
EMA	European Medicines Agency
ENCePP	European Network of Centres for Pharmacoepidemiology and Pharmacovigilance
FDA	Food and Drug Administration
GEP	Good Epidemiological Practice
GPP	Good Pharmacoepidemiology Practices
HCPCS	Healthcare Common Procedure Coding System
HIPAA	Health Insurance Portability and Accountability Act
HIV	Human immunodeficiency virus
HR	Hazard ratio
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification

Abbreviation	Definition
ICD-10-CM	International Classification of Diseases, Tenth Revision, Clinical Modification
ICD-9-PCS	International Classification of Diseases, Ninth Revision, Procedure Coding System
ICD-10-PCS	International Classification of Diseases, Tenth Revision, Procedure Coding System
IEA	International Epidemiological Association
IPD	Invasive pneumococcal disease
IRB	Institutional review board
ISPOR	International Society for Pharmacoeconomics and Outcomes Research
NDC	National Drug Code
PCV	Pneumococcal conjugate vaccine
PCV13	13-valent pneumococcal conjugate vaccine
PCV15	15-valent pneumococcal conjugate vaccine
PCV20	20-valent pneumococcal conjugate vaccine
PPSV23	23-valent pneumococcal polysaccharide vaccine
PLWH	People living with HIV
RZV	Recombinant zoster vaccine
SVI	Social Vulnerability Index
VE	Vaccine effectiveness
VT	Vaccine-type

3. RESPONSIBLE PARTIES

Principal Investigator(s) of the Protocol

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4. ABSTRACT

Title	Assessment of PCV13 vaccine effectiveness among people with HIV
Rationale and background	People living with HIV (PLWH) are at increased risk of pneumococcal infections. A recent meta-analysis shows that in the era of advanced antiretroviral therapy, the incidence of invasive pneumococcal disease (IPD) in PLWH is approximately 30 times higher when compared with the general population [1]. Even with timely and effective treatment, the case fatality rate of IPD is at least 8% in PLWH [2] and up to 25% of PLWH experience recurrent episodes of IPD in the subsequent 12 months [3]. International guidelines recommend pneumococcal vaccination for immunocompromised individuals [4] and previous research has shown that the pneumococcal conjugate vaccine (PCV) is safe and immunogenic in PLWH [5-8]. Studies have assessed the clinical efficacy/effectiveness of PCV in adults, but patients with immunocompromising conditions or treatments were either excluded from the studies, or vaccine effectiveness (VE) estimates were calculated overall and not specifically among PLWH or among people with other immunocompromising conditions [9, 10]. Given the lack of PCV13 VE data in immunocompromised adults, this study was designed to estimate PCV13 VE against pneumococcal disease in PLWH aged ≥18 years, overall and, if feasible, at 3, 5, and 7 years after vaccination.
Research objectives	The primary objectives include: 1. Estimate vaccine effectiveness (VE) of PCV13 for invasive pneumococcal disease (IPD) among people living with HIV (PLWH) ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up 2. Estimate VE of PCV13 for pneumococcal pneumonia among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up 3. Estimate VE of PCV13 for all-cause pneumonia among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up The secondary objectives of this study are to: 1. Estimate VE of PCV13 for pneumococcal pneumonia or pneumonia with unspecified causes among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up

	2. Estimate VE of PCV13 for pneumonia with unspecified causes among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up
Design	The VE study will be a retrospective cohort study using health care administrative claims and laboratory data.
Population	PLWH will be identified using administrative claims and include individuals with at least one inpatient International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) or International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) code related to HIV or at least 2 outpatient ICD-9-CM or ICD-10-CM codes related to HIV at least 30 days, but no more than 730 days apart, during January 1, 2014 and December 31, 2021. PLWH are required to have at least six months of continuous enrollment in one or more health plans and pharmacy benefits after their first HIV-related ICD-9-CM or ICD-10-CM. These six months of continuous enrollment will be considered the baseline period, during which baseline covariates including demographics, comorbidities, and preventative care will be measured. The end of the study will occur on the last date that administrative claims data will be available, September 30, 2022.
Data source	Health care administrative claims and laboratory data will be provided by Komodo Health. Komodo Health uses artificial intelligence and data analytics to combine and link patient-level information from more than 150 payers in the United States, including Medicare, Medicaid, and Commercial plans. Currently, Komodo Health has patient-level data on approximately 325 million individuals and these data include inpatient and outpatient claims, pharmacy dispensing claims, provider specialty claims, and mortality information.
Data analyses	Cox proportional hazards models will be used to estimate the hazard ratio (HR) for each outcome comparing vaccinated PLWH with unvaccinated (no PCV13) PLWH. To explore potential changes in VE over time, HRs will also be generated during specific time periods (0-3, 3-5, 5-7 years) using piecewise Cox regression models, if there is adequate sample size. All models will be adjusted for time-fixed and time-varying covariates of interest using inverse probability of treatment weighting. VE will be calculated as 1 minus the estimated HR for each outcome.

5. AMENDMENTS AND UPDATES

Version Identifier	Date	Amendment Type (substantial or administrative)	Protocol Section(s) Changed	Summary of Amendment(s)	Reason
2.0	02 August 2023	Substantial	9.1 Study Design	1. Individuals must now have at least one inpatient or at least two outpatient HIV-related ICD-9-CM and ICD-10-CM codes occurring at least 30 days but no more than 730 days apart 2. Study follow-up will now begin 90 days after index date	1. Limiting the time between outpatient HIV diagnosis codes decreases misclassification of HIV infection in administrative claims data 2. Starting follow-up 90 days after index decreases the likelihood that outcome events occurred before and/or triggered an HIV diagnosis
			9.3 Variables	1. Added time-varying covariate for annual HIV viral load testing 2. Added time-varying covariate for annual CD4 cell count testing 3. Added time-varying covariate for respiratory virus season 4. Added an alternate definition for outpatient candidiasis infection (ICD-9-CM or ICD-10-CM code and antifungal treatment within 7 days 5. Changed payor categories	1. Minimize confounding due to different HIV care seeking patterns among PCV13 vaccinated and unvaccinated individuals 2. Minimize confounding due to different HIV care seeking patterns among PCV13 vaccinated and unvaccinated individuals 3. Minimize confounding due to increased risk for respiratory virus infections during fall and winter months 4. Increase specificity of candidiasis infections within administrative claims 5. Revised payor categories match actual payor categories in data provided by Komodo
			9.5 Study size	Added 'Total number of events' columns to Tables 2 and 3	Demonstrates that the study has sufficient statistical power for IPD and all-cause pneumonia outcomes
			9.7 Data analysis	Restricted stratified analysis by index year to first 3 years of follow-up	Due to possible waning of the VE and different lengths of follow-up by index year, VE stratification by year of HIV diagnosis will be restricted to the first 3 years of follow-up.
			Appendix	1. Added Appendix Table 9 for CD4 cell count laboratory CPT codes	Added Appendix Table 9, 10, and 13 as new variables are now included

				2. Added Appendix Table 10 for HIV viral load laboratory CPT codes 3. Added Appendix Table 13 for candidiasis antifungal NDCs	
3.0	21 November 2023	Substantial	9.1 Study Design	1. Removed requirement for six months of continuous enrollment before members' first HIV-related ICD-9-CM or ICD-10-CM code 2. Study follow-up begins six months after the first HIV-related ICD-9-CM or ICD-10-CM code	Analysis will include incident and prevalent HIV cases during 2014 - 2021, rather than only including incident cases during 2015-2021
			9.2.1 Inclusion criteria	1. Removed criterion for six months of continuous enrollment before first HIV-related ICD-9-CM or ICD-10-CM code 2. Require at least six months of continuous enrollment after the first HIV-related ICD-9-CM or ICD-10-CM code instead of 90 days.	Analysis will include incident and prevalent HIV cases during 2014 - 2021, rather than only including incident cases during 2015-2021
			9.2.2 Exclusion criteria	Removed exclusion for individuals with evidence of ART therapy during baseline period	Analysis will include incident and prevalent HIV cases during 2014 - 2021, rather than only including incident cases during 2015-2021
			9.3 Variables	1. Added additional opportunistic infections to covariates measured during baseline and follow-up 2. Removed specific negative control exposure and negative control outcomes from table	1. Control for potential confounding due to any opportunistic infection 2. Study team would like to explore additional negative control exposures and outcomes in analyses beyond Shingrix and candidiasis
			Appendix	Added additional ICD-9-CM and ICD-10-CM codes for opportunistic infections	Provided diagnosis codes to identify additional opportunistic infections

6. MILESTONES

Milestone	Planned date
Start of data collection	06 March 2023
End of data collection	30 October 2024
Final study report	30 October 2024

7. RATIONALE AND BACKGROUND

Human immunodeficiency virus (HIV) infection leads to extensive defects in the immune system,including the progressive depletion and dysfunction of $CD4^+$ T cells, perturbation of the B cell compartment with reduced resting memory B cells, and suboptimal humoral immune responses [11-14]. People living with HIV (PLWH) are at increased risk of pneumococcal infections. While antiretroviral therapy (ART) can restore the immune system and consequently lower the risk of pneumococcal infections [2, 15], the burden of pneumococcal infections persists in PLWH [16, 17]. A recent meta-analysis shows that in the era of advanced ART, the incidence rate of invasive pneumococcal disease (IPD) in PLWH is approximately 30 times higher when compared with the general population [1]. Even with timely and effective treatment, the case fatality rate of IPD is at least 8% in PLWH [2]. Up to 25% of PLWH experience recurrent episodes of IPD in the subsequent 12 months [3].

International guidelines recommend pneumococcal vaccination for immunocompromised individuals [4]. In the United States, one dose of 13-valent pneumococcal conjugate vaccine (PCV13) has been recommended to PLWH since 2012 [18]. Currently, the CDC recommends 20-valent pneumococcal conjugate vaccine (PCV20) alone or 15-valent pneumococcal conjugate vaccine (PCV15) followed by pneumococcal polysaccharide vaccine (PPSV23) for adults aged 19-64 years with certain underlying medical conditions, including HIV infection, and for all adults aged ≥65 years [19].

Previous research has shown that PCV13 is safe and immunogenic in adults, including PLWH [5-8]. A few studies also assessed the clinical efficacy/effectiveness of a PCV in adults. In a large, randomized, placebo-controlled clinical trial (CAPiTA) of over 84,000 Dutch adults aged ≥65 years, PCV13 showed efficacy against both vaccine-type (VT) IPD (VE 75%; 95% confidence interval [CI]: 41% to 91%) and VT non-bacteremic pneumococcal community-acquired pneumonia (CAP) (VE 45%; 95 % CI: 14%-65%) [9]. PCV13 efficacy persisted throughout the clinical trial (mean follow-up: 4 years) [9]. A population-based, test negative design, surveillance study reported a PCV13 VE of 73% (95% CI: 13%-92%) against VT CAP in hospitalized adults aged ≥65 years [10]. In a clinical trial conducted in HIV-infected adults in Malawi recently hospitalized with pneumonia, two doses of PCV7 demonstrated substantial protection against recurrent pneumococcal infection caused by vaccine serotypes or serotype 6A (VE 74%; 95% CI: 30%-90%) [3], although there was no protection against mortality.

Although the CAPiTA study provides important information on PCV13 VE in adults, patients with any immunocompromising condition or treatment were excluded from the study. In contrast to CAPiTA, the study by McLaughlin et al. included immunocompromised adults; however, PCV13 VE was reported for the entire study population [10]. Thus, there is a lack of data on PCV13 VE specific to immunocompromised adults. In the absence of such data, in a CDC cost-effectiveness

model, it was assumed that PCV13 VE in immunocompromised adults was 25% (95% CI: 14%-30%) against VT IPD and 15% (95% CI: 5%-22%) against VT pneumonia, both of which are approximately one third of the VE measured in healthy adults/adults with chronic medical conditions [20, 21].

There has been a longstanding recommendation for pneumococcal vaccination for PLWH in the United States. PCV13 was recommended for PLWH in 2012 and the uptake in PLWH is higher compared with individuals with other risk conditions [22, 23]; this allows us to examine PCV13 VE in the PLWH population over time. Given the lack of PCV13 VE data in immunocompromised adults, this study was designed to estimate PCV13 VE against pneumococcal disease in PLWH aged ≥18 years, overall and, if feasible, at 3, 5, and 7 years after vaccination. In addition to IPD and pneumococcal pneumonia, we will include all-cause pneumonia as a disease endpoint in the analysis, because *S. pneumoniae* is the most common bacterial cause of all-cause pneumonia [24].

8. RESEARCH QUESTION AND OBJECTIVES

The primary objectives of this study are:

1. Estimate VE of PCV13 for IPD among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up
2. Estimate VE of PCV13 for pneumococcal pneumonia among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up
3. Estimate VE of PCV13 for all-cause pneumonia among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up

The secondary objectives of this study are:

1. Estimate VE of PCV13 for pneumococcal pneumonia or pneumonia with unspecified causes among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up
2. Estimate VE of PCV13 for pneumonia with unspecified causes among PLWH ≥18 years of age, overall and, if feasible, at 3, 5, and 7 years of follow-up

9. RESEARCH METHODS

9.1. Study Design

The VE study will be a retrospective cohort study using health care administrative claims and laboratory data (Figure 1).

PLWH will be identified using administrative claims and include individuals with at least one inpatient International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) or International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) code related to HIV (Appendix Table 1) or at least 2 outpatient ICD-9-CM or ICD-10-CM codes related to HIV at least 30 days, but no more than 730 days apart, during January 1, 2014 and

December 31, 2021. PLWH are required to have at least six months of continuous enrollment in one or more health plans and pharmacy benefits after their first HIV-related ICD-9-CM or ICD-10-CM code. These six months of continuous enrollment will be considered the baseline period, during which baseline covariates including demographics, comorbidities, and preventative care will be measured. The baseline period was also selected to minimize the number of outcome events that existing prior to or triggered an HIV diagnosis.

The date following the last date of the baseline period will be defined as the index date. The end of the study will occur on the last date that administrative claims data will be available, September 30, 2022.

For PLWH who receive PCV13 after their index date, we will include the time between their index date and the 13 days after their PCV13 vaccination date as unvaccinated follow-up time. Any outcomes occurring during this time will be counted as events in the unvaccinated cohort. Follow-up that occurs 14 days or more after PCV13 vaccination will be defined as vaccinated follow-up time.

Unvaccinated (no PCV13) PLWH will be followed from index date until the earliest occurrence of the following: 13 days after PCV13 vaccination, death, end of health plan enrollment, or end of study period. Vaccinated PLWH will be followed from 14 days after their PCV13 vaccination, or index date if they were vaccinated during the baseline period, until the earliest occurrence of the following: death, end of health plan enrollment, or end of study period.

9.2. Setting

Health care administrative claims and laboratory data will be provided by Komodo Health. Komodo Health uses artificial intelligence and data analytics to combine and link patient-level information from more than 150 payers in the United States, including Medicare, Medicaid, and Commercial plans.

Komodo Health will provide administrative claims data and HIV-related laboratory data available during January 1, 2014 through September 30, 2022 for individuals who have at least one ICD-9-CM or ICD-10-CM code related to HIV (Appendix Table 1) or at least one ART medication dispensed (Appendix Table 2).

9.2.1. Inclusion Criteria

To be eligible for the vaccine effectiveness study, individuals must meet the following criteria:

1. HIV infection defined as at least one inpatient International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) or International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) code related to HIV (Appendix Table 1) or ≥2 outpatient ICD-9-CM or ICD-10-CM codes related to HIV at least 30 days, but no more than 730 days apart, during January 1, 2014 and December 31, 2021

   AND

2. At least 18 years of age at the time of the first recording of HIV-related ICD-9-CM or ICD-10-CM code

AND

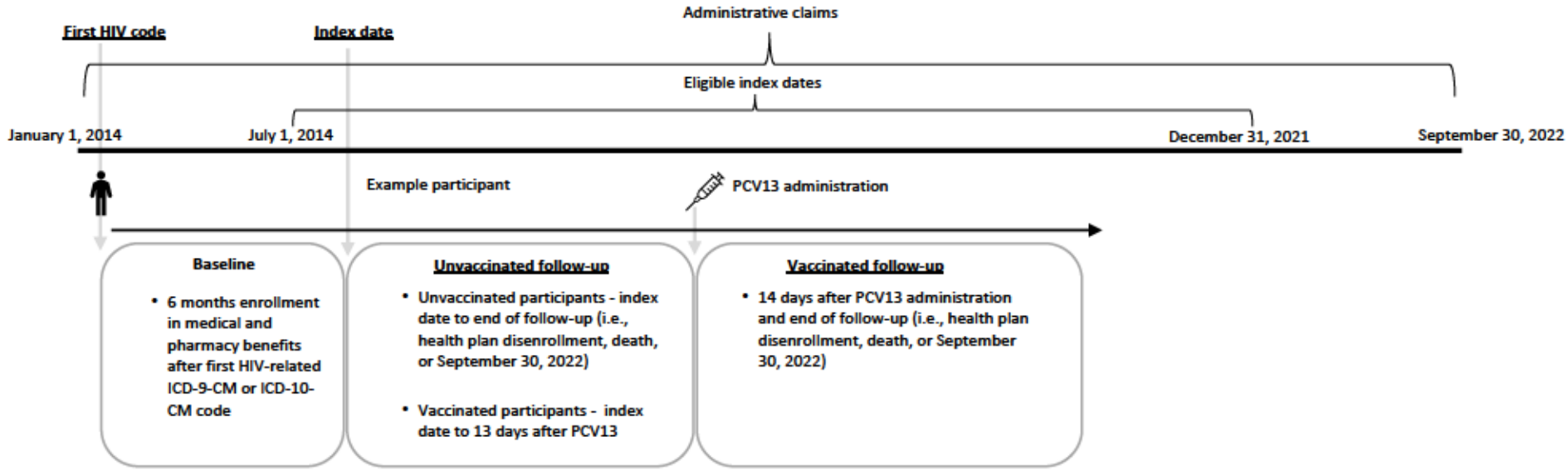
3. At least six months of continuous enrollment in medical and pharmacy plans after the first HIV-related ICD-9-CM or ICD-10-CM code between January 1, 2014 and December 31, 2021. A gap of 30 days or less in enrollment will be allowed during this six month period.

9.2.2. Exclusion Criteria

Patients meeting the following criterion will not be included in the study:

1. Evidence of PCV13 vaccination before the first HIV-related ICD-9-CM or ICD-10-CM code

Figure 1. Illustrative timeline for study participants



9.3. Variables

Table 1. Variables, definitions, and measurement periods

Variable type	Variable	Definition	Measurement period
Exposure	PCV13 vaccination	Current procedural terminology® (CPT) codes and National Drug Codes (NDC) listed in Appendix Table 3	Follow-up
Primary outcomes	IPD	ICD-9-CM or ICD-10-CM codes listed in Appendix Table 4	Follow-up
	Pneumococcal pneumonia	ICD-9-CM or ICD-10-CM codes listed in Appendix Table 4	Follow-up
	All-cause pneumonia	ICD-9-CM or ICD-10-CM codes listed in Appendix Table 4	Follow-up
	Pneumococcal pneumonia or pneumonia with unspecified causes	ICD-9-CM or ICD-10-CM codes listed in Appendix Table 5	Follow-up
	Pneumonia with unspecified causes	ICD-9-CM or ICD-10-CM codes listed in Appendix Table 5	Follow-up
Covariates	Age	Calculated as [year individual meets HIV criteria] – [birth year] Categorized as 18-49, 50-64, 65-74, and ≥75 years	Baseline
	Sex	Male, Female, Other, Unknown	Baseline
	Social Vulnerability Index (SVI)	SVI characterizes resiliency of a community when faced by external pressures and stresses [25, 26]. SVI ranges from 0 to 100, where a value of 100 indicates the most vulnerable population. SVI will be estimated using zip code and will be categorized as low (lowest quartile), average (middle two quartiles) and high (highest quartile).	Baseline
	Payor	Medicaid/CHIP, Medicare, Commercial, Dually eligible, Other, Unknown	Baseline
	US region	Northeast, North Central, South, West, Unknown	Baseline

Variable type	Variable	Definition	Measurement period
	Index year	Calendar year of first HIV diagnosis code	Baseline
	Alcoholism	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.1	Baseline and follow-up
	Asplenia	CPT/Healthcare Common Procedure Coding System (HCPCS), ICD-10-Procedure Coding System (ICD-10-PCS), ICD-9-Procedure Coding System (ICD-9-PCS), ICD-9-CM, or ICD-10-CM codes listed in Annex Table 1.2	Baseline and follow-up
	Asthma	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.3	Baseline and follow-up
	Chronic heart disease	CPT/HCPCS, ICD-10-PCS, ICD-9-PCS, ICD-9-CM, or ICD-10-CM codes listed in Annex Table 1.4	Baseline and follow-up
	Chronic kidney disease and renal failure	CPT/HCPCS, ICD-10-PCS, ICD-9-PCS, ICD-9-CM, or ICD-10-CM codes listed in Annex Table 1.5	Baseline and follow-up
	Chronic liver disease	CPT/HCPCS, ICD-10-PCS, ICD-9-PCS, ICD-9-CM, or ICD-10-CM codes listed in Annex Table 1.6	Baseline and follow-up
	Chronic lung disease	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.7	Baseline and follow-up
	Cigarette smoking	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.8	Baseline and follow-up
	Diabetes mellitus	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.9	Baseline and follow-up
	Generalized malignancy	CPT/HCPCS, ICD-10-PCS, ICD-9-PCS, ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.10	Baseline and follow-up
	Hodgkin's lymphoma	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.11	Baseline and follow-up
	Immunosuppressive medications	PLWH will considered on immunosuppressive medications if:	Baseline and follow-up

Variable type	Variable	Definition	Measurement period
		1) ≥1 NDC, HCPCS, or ICD-10-PCS code in Appendix Table 6 2) ≥ 1 NDC (using orals only) in Appendix Table 6 where the daily dose is ≥ 20mg or prednisone or prednisone equivalent for a duration of ≥14 consecutive days	
	Leukemia	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.12	Baseline and follow-up
	Multiple myeloma	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.13	Baseline and follow-up
	Nephrotic syndrome	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.14	Baseline and follow-up
	Non-Hodgkin's lymphoma	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.15	Baseline and follow-up
	Organ transplant	CPT/HCPCS, ICD-10-PCS, ICD-9-PCS, ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.16	Baseline and follow-up
	Sickle cell disease or other hemoglobinopathies	ICD-9-CM or ICD-10-CM codes listed in Annex Table 1.17	Baseline and follow-up
	Hepatitis B	ICD-9-CM or ICD-10-CM codes listed in Annex Table 2.1	Baseline and follow-up
	Hepatitis C	ICD-9-CM or ICD-10-CM codes listed in Annex Table 2.2	Baseline and follow-up
	Annual physical exam	CPT/HCPCS codes listed in Annex Table 3.1	Baseline and follow-up
	Annual influenza vaccine	CPT/HCPCS, ICD-10-PCS, ICD-9-PCS, or NDC codes listed in Appendix Table 7	Baseline and follow-up
	Any pneumonia infection	ICD-9-CM or ICD-10-CM codes listed in Appendix Table 4	Baseline
	Any hospitalization	Evidence of inpatient claims	Baseline and follow-up
	Opportunistic infections	ICD-9-CM or ICD-10-CM codes listed in Appendix Table 14	Baseline and follow-up
	ART adherence	ART use will be identified by NDC codes listed in Appendix Table 2	Baseline and follow-up

Variable type	Variable	Definition	Measurement period
		Adherence will be measured as 'Proportion of days covered = (Number of days covered by any ART, excluding ritonavir and cobicistat) ÷ (total days)*100'[27] every six months Individuals with >80% of days covered will be classified as 'adherent' and individuals with ≤80% of days covered will be classified as 'non-adherent'[27]	
	CD4 cell count	Categorized as <200, 200-499, ≥500 cells/mm^3	Baseline and follow-up
	PPSV23 vaccination	NDC and CPT codes listed in Appendix Table 8	Baseline and follow-up
	Annual CD4 laboratory test	CD4 laboratory tests will be identified by CPT codes listed in Appendix Table 9 Individuals who have at least one CD4 laboratory test performed during each year of follow-up	Baseline and follow-up
	Annual viral load laboratory test	Viral load laboratory tests will be identified by CPT codes listed in Appendix Table 10 Individuals who have at least one viral load laboratory test performed during each year of follow-up	Baseline and follow-up
	Respiratory virus season	Respiratory virus season occurs between October 1 and April 30	Follow-up
Sensitivity analysis outcome	All-cause pneumonia not associated with HIV	ICD-9-CM or ICD-10-CM codes listed in Appendix Table 11	Follow-up

9.4. Data Sources

The source of data for the VE study will be health care administrative claims and HIV-laboratory data provided by Komodo Health. Komodo Health uses artificial intelligence and

data analytics to combine and link patient-level information from more than 150 payers in the United States, including Medicare, Medicaid, and Commercial plans. Currently, Komodo Health has patient-level data on approximately 325 million individuals and these data include inpatient and outpatient claims, pharmacy dispensing claims, provider specialty claims, and mortality information.

Komodo Health will provide administrative claims available between January 1, 2014 through September 30, 2022 for individuals who have at least one ICD-9-CM or ICD-10-CM code related to HIV (Appendix Table 1) or at least one ART medication dispensed (Appendix Table 2).

9.5. Study Size

The planned analyses do not involve hypothesis testing and sample size calculations are not applicable. However, we examined the precision of PCV13 vaccine effectiveness for IPD and all-cause pneumonia among people living with HIV at 36 months and 97 months (which was the maximum follow-up time available from feasibility assessments) after index (Table 2 and Table 3). Komodo Health provided the following information for the precision estimates:

- 175,000 individuals had ≥1 inpatient or ≥ 2 outpatient HIV ICD-9-CM or ICD-10-CM code diagnosis codes between January 1, 2014 and December 31, 2021
- 56,000 (32%) of these individuals received PCV13 after their first HIV diagnosis code

The following assumptions regarding incidence and PCV13 VE for IPD and all-cause pneumonia were used:

- IPD incidence among PLWH is 183 cases per 100,000 population [28]
- All-cause pneumonia incidence among PLWH is 5,487 cases per 100,000 population
- VE for IPD due to any serotype ranges from 7.5% to 22.5%
    - Published VE estimates for vaccine type IPD range from 25% to 75% [20]. Because one-third of the adult IPD burden is considered PCV13 type [29], we multiplied this range by 30% to arrive at 7.5% to 22.5%
- VE for all-cause pneumonia ranges from 5% to 15% [30]
- Annual censoring of individuals due to loss to follow-up or death may range between 4% or 10%

Survival and censoring times were simulated assuming exponential distributions. Vaccination status was modelled as a time-varying covariate [31]. Hazard ratios were assumed as 1 - (VE/100). Simulations were run 100 to 200 times per scenario. Cox regression models were run on each simulated dataset to estimate the 95% confidence

intervals (CI) for the log HRs. Means were generated and exponentiated to obtain the 95% CIs for the VEs using (1 - HR) x 100 and used to describe VE precision.

Table 2. Precision of PCV13 vaccine effectiveness estimates for invasive pneumococcal disease

Hypothesized Vaccine Effectiveness (%)	36 months of follow-up			97 months of follow-up		
	Lower 95% confidence interval estimate	Upper 95% confidence interval estimate	Total number of events	Lower 95% confidence interval estimate	Upper 95% confidence interval estimate	Total number of events
Scenario #1 – 4% annual censoring						
7.5	-12	25	837	-5	19	1492
22.5	3	37	817	11	33	1452
Scenario #2 – 10% annual censoring						
7.5	-15	25	766	-6	21	1272
22.5	2	38	752	9	33	1224

Table 3. Precision of PCV13 vaccine effectiveness estimates for all-cause pneumonia

Hypothesized Vaccine Effectiveness (%)	36 months of follow-up			97 months of follow-up		
	Lower 95% confidence interval estimate	Upper 95% confidence interval estimate	Total number of events	Lower 95% confidence interval estimate	Upper 95% confidence interval estimate	Total number of events
Scenario #1 – 4% annual censoring						
5	1	9	23,370	2	7	38,848
15	11	19	23,119	13	17	38,176
Scenario #2 – 10% annual censoring						
5	1	9	21,558	2	8	33,257
15	11	19	21,327	12	18	32,750

Given the precision estimates in Tables 1 and 2, the planned study should have adequate precision to address the primary objectives.

9.6. Data Management

Komodo will create analytic files comprising people who have at least one HIV related ICD-9-CM or ICD-10-CM code or claim for an ART medication to treat HIV. The analytic files will include person-level data, including information on baseline demographic and clinical characteristics, study outcomes, and health plan enrollment dates. Variables will be created based on information from healthcare claims and enrollment information, which will be

linked at the person level using a unique ID, which is deidentified. Data for this study will be processed and managed by Pfizer, Inc., and all analyses—as described in the final version of the Study Protocol—will be directed by study investigators.

Retention of study-related data, documents, and other materials will be governed by Pfizer Policy on Records and Information Management, and per this policy, will remain effective for a period of 5 years from the date of project initiation. Amendments must be made only with the prior approval of Pfizer. Agreement from all study collaborators must be obtained for all amendments.

9.7. Data Analysis

Cox proportional hazards models will be used to estimate the hazard ratio (HR) for each outcome comparing vaccinated PLWH with unvaccinated (no PCV13) PLWH. To explore potential changes in VE over time, HRs will also be generated during specific time periods (0-3, 3-5, 5-7 years of follow-up) using piecewise Cox regression models, if there is adequate sample size. All models will be adjusted for time-fixed and time-varying covariates of interest using inverse probability of treatment weighting. The time-fixed covariates of interest include sex, age, payor, SVI, previous pneumonia infection, and hospitalization and will be measured during the baseline period. The time-varying covariates include risk factors for pneumonia (alcoholism, asplenia, asthma, chronic heart disease, kidney, liver, and lung diseases, cigarette smoking, diabetes, immunosuppressive conditions and medications, and sickle cell disease), annual physical exams, annual influenza vaccine, hospitalization, opportunistic infections, ART adherence, annual CD4 and viral load laboratory tests, and an indicator for respiratory virus season.

VE will be calculated as 1 minus the estimated HR for each outcome.

We will conduct two sets of analyses for each outcome. In the first set, we will examine the first event for each outcome and in the second set, all recurrent outcome events during follow-up will be included. In the first set of analyses, unvaccinated (no PCV13) PLWH will be followed from index date until the earliest occurrence of the following: outcome, PCV13 vaccination, death, end of health plan enrollment, or end of study period, and vaccinated PLWH will be followed from 14 days after vaccination date, or index date if vaccinated during the baseline period, until the earliest occurrence of outcome, death, end of health plan enrollment, or end of study period. In the second set of analyses unvaccinated (no PCV13) PLWH will be followed from index date until the earliest occurrence of PCV13 vaccination, death, end of health plan enrollment or end of study period and vaccinated PLWH will be followed from 14 days after vaccination date, or index date if vaccinated during the baseline period, until earliest occurrence of death, end of health plan enrollment, or end of study period.

Several stratified analyses will be conducted. PPSV23 is recommended for PLWH and feasibility data provided by Komodo suggest that one in four PWLH who received PCV13 during 2014-2015 also received PPSV23 within two years. Rather than censor or exclude

individuals who receive PPSV23, we will calculate PCV13 VE among PWLH who have/have not received PPSV23 before and during the study period.

Feasibility assessments from Komodo indicate that approximately 25% of PWLH have at least one CD4 cell count or percentage laboratory result available. Therefore, we will calculate PCV13 VE among the subset of PWLH who have a CD4 cell count during the baseline period or follow-up, and potentially stratify by CD4 category using each patient's lowest value during the study.

Additional VE stratifications by ART adherence during follow-up, year of HIV diagnosis, and age will be assessed for feasibility as well, as these affect patients' immune status and immune reconstitution. Due to possible waning of the VE and different lengths of follow-up by index year, VE stratification by year of HIV diagnosis will be restricted to the first 3 years of follow-up.

A sensitivity analysis will also be conducted. In this analysis, causes of pneumonia that are characteristic of HIV, for example pneumonia due to cytomegalovirus, mycobacteria, and fungi, will be excluded from our definition of all-cause pneumonia.

Residual confounding of our VE estimates due to inadequate control for health care seeking behavior and immune status in our analyses will be explored. To do so, we will employ a negative control exposure and a negative control outcome. Potential negative control exposures include vaccinations that are recommended for PLWH but would not be expected to have any protective effect against the pneumonia outcomes of interest. If residual confounding does not exist, the negative control vaccine would not have an effect on the pneumonia outcomes. However, if the analysis demonstrates that the negative control vaccine protects against these outcomes, this suggests the presence of residual confounding.

Similarly, potential negative control outcomes are outcomes that share the same sources of biases as the primary outcomes in our study population but are not causally-related to PCV13 vaccination. For example, immune status is an important predictor of pneumonia outcomes among PLWH, but we will be missing CD4 laboratory values for most of our study population. In order to detect potential residual confounding by lack of control for immune status, a potential negative control outcome could include a more common AIDS defining illness such as candidiasis. Again, if no residual confounding exists, PCV13 vaccination would have no effect on the occurrence of the negative control outcomes. However, if the results suggest that PCV13 vaccination prevents the negative control outcomes, residual confounding may exist.

Detailed methodology for summary and statistical analyses of data collected in this study will be documented in a statistical analysis plan (SAP), which will be dated, filed and maintained by the sponsor. The SAP may modify the plans outlined in the protocol; any major modifications of primary endpoint definitions or their analyses would be reflected in a protocol amendment.

9.8. Quality Control

Upon initiation of analyses, edit, range, and logic checks will be performed on each data field by the project programmer to ensure the quality and completeness of the study database and all of the variables therein. Only observed data will be used in measuring study variables. It is anticipated that demographic information will be available for nearly all individuals in the study population. All other variables will be defined based on the presence of specific data (e.g., diagnosis, procedure, and drug codes) in the analytic file; the absence of such data will be assumed to indicate the absence of the characteristic/event captured by the variable.

9.9. Limitations of the Research Methods

There are several limitations in this study. Given that this is an observational study using health care administrative claims data, residual confounding due to missing or unmeasured information is possible. To examine this, we will assess the effect of PCV13 on a negative control outcome and the effect of a negative control exposure on our outcomes of interest. If the HRs in any of these models are less than 1.0, it would indicate that residual confounding exists and may result in adjustment of our VE estimates.

Second, health care administrative claims data will be available from January 1, 2014 through September 30, 2022. The recommendation to vaccinate all PLWH was published in June 2012, and some PLWH may have received PCV13 prior to January 1, 2014 and be misclassified as unvaccinated. In addition, PLWH eligible for the study may have received PCV13 vaccination during a time period in which we do not have their claims data. Misclassification of PCV13 vaccine status may lead to lower estimates of vaccine effectiveness than in truth, because our unvaccinated cohort will incorrectly include vaccinated PLWH.

In addition, we are using ICD-9-CM and ICD-10-CM codes to define HIV infection. Our definition of HIV infection requires at least one HIV-related diagnosis code in the inpatient setting or at least two HIV-related diagnosis codes in the outpatient setting. While this definition of HIV has been used in previous administrative claims database studies, it is possible that these codes may be used by health care providers to order laboratory tests to rule out HIV infection and thus, some individuals without HIV will be included in our study population.

9.10. Other Aspects

Not applicable

10. PROTECTION OF HUMAN PARTICIPANTS

10.1. Patient Information

This study involves data that exist in deidentified/anonymized structured format and contain no patient personal information.

10.2. Patient Consent

As this study involves deidentified/anonymized structured data, which according to applicable legal requirements do not contain data subject to privacy laws, obtaining informed consent from patients by Pfizer is not required.

10.3. Institutional Review Board (IRB)/Ethics Committee (EC)

The study databases will be de-identified prior to their release to study investigators, as set forth in the corresponding Data Use Agreement. The study databases have been evaluated and certified by an independent third party to be compliant with the Health Insurance Portability and Accountability Act (HIPAA) of 1996 statistical de-identification standards and to satisfy the conditions set forth in Sections 164.514 (a)-(b)1ii of the HIPAA Privacy Rule regarding the determination and documentation of statistically de-identified data. Use of the study databases for health services research is therefore fully compliant with the HIPAA Privacy Rule and federal guidance on Public Welfare and the Protection of Human Subjects (45 Code of Federal Regulations [CFR] 46 §46.101) and IRB approval is not required.

10.4. Ethical Conduct of the Study

The study will be conducted in accordance with legal and regulatory requirements, as well as with scientific purpose, value and rigor and follow generally accepted research practices described in *Good Pharmacoepidemiology Practices* (GPP) issued by the International Society for Pharmacoepidemiology (ISPE), Good Epidemiological Practice (GEP) guidelines issued by the International Epidemiological Association (IEA), Good Outcomes Research Practices issued by the International Society for Pharmacoeconomics and Outcomes Research (ISPOR), International Ethical Guidelines for Epidemiological Research issued by the Council for International Organizations of Medical Sciences (CIOMS), European Medicines Agency (EMA) European Network of Centres for Pharmacoepidemiology and Pharmacovigilance (ENCePP) Guide on Methodological Standards in Pharmacoepidemiology, and Food and Drug Administration (FDA) Guidance for Industry: Good Pharmacovigilance and Pharmacoepidemiologic Assessment, and FDA Draft Guidance for Industry and FDA Staff: Best Practices for Conducting and Reporting of Pharmacoepidemiologic Safety Studies Using Electronic Healthcare Data Sets and/or equivalent.

11. MANAGEMENT AND REPORTING OF ADVERSE EVENTS/ADVERSE REACTIONS

This study involves data that exist as structured data by the time of study start. In these data sources, individual patient data are not retrieved or validated, and it is not possible to link (i.e., identify a potential association between) a particular product and medical event for any individual. Thus, the minimum criteria for reporting an adverse event (AE) (i.e., identifiable patient, identifiable reporter, a suspect product, and event) cannot be met.

12. PLANS FOR DISSEMINATING AND COMMUNICATING STUDY RESULTS

Formal communication of the results of this research will be done by study investigators through peer-reviewed publications. For all publications relating to the Study, Pfizer will comply with recognized ethical standards concerning publications and authorship, including

Section II - "Ethical Considerations in the Conduct and Reporting of Research" of the Uniform Requirements for Manuscripts Submitted to Biomedical Journals, http://www.icmje.org/index.html#authorship, established by the International Committee of Medical Journal Editors.

In the event of any prohibition or restriction imposed (e.g., clinical hold) by an applicable competent authority in any area of the world, or if the investigator is aware of any new information which might influence the evaluation of the benefits and risks of a Pfizer product, Pfizer should be informed immediately.

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16. APPENDIX

Table 1. Diagnosis Codes for Identifying HIV infection

Code	Type	Description
042	ICD-9-CM	HIV-1 infection
V08	ICD-9-CM	Asymptomatic HIV disease
B20	ICD-10-CM	HIV-1 infection
Z21	ICD-10-CM	Asymptomatic HIV disease

Table 2. National Drug Codes for Identifying HIV Antiretrovirals (see excel)

Table 3. National Drug Codes and CPT® Codes for Identifying PCV13 Vaccination

Code	Type	Description
50090194409	NDC	13-valent pneumococcal conjugate vaccine
54569661300	NDC	13-valent pneumococcal conjugate vaccine

50090194400	NDC	13-valent pneumococcal conjugate vaccine
00005197105	NDC	13-valent pneumococcal conjugate vaccine
00005197104	NDC	13-valent pneumococcal conjugate vaccine
00005197102	NDC	13-valent pneumococcal conjugate vaccine
00005197101	NDC	13-valent pneumococcal conjugate vaccine
90670	CPT	13-valent pneumococcal conjugate vaccine

Table 5. Diagnosis Codes for Identifying Pneumococcal Pneumonia and Pneumonia with Unspecified Causes

Condition	ICD-9-CM		ICD-10-CM	
	Codes	Description	Codes	Description
Pneumococcal pneumonia	481	Pneumococcal pneumonia	J13	Pneumonia due to Streptococcus pneumoniae
	482.9 + 041.2	Bacterial pneumonia, unspecified + pneumococcus	J15.9 + B95.3	Unspecified bacterial pneumonia + Streptococcus pneumoniae
	485 + 041.2	Bronchopneumonia, organism unspecified + pneumococcus	J18.0 + B95.3	Bronchopneumonia, unspecified organism + Streptococcus pneumoniae
	486 + 041.2	Pneumonia, organism unspecified + pneumococcus	J18.8 + B95.3 J18.9 + B95.3	Other pneumonia, unspecified organism + Streptococcus pneumoniae Pneumonia, unspecified organism + Streptococcus pneumoniae
	510.x + 041.2	Empyema + pneumococcus		
	510 + 041.2	Empyema with fistula + pneumococcus	J86.0 + B95.3	Pyothorax with fistula + Streptococcus pneumoniae
	510.9 + 041.2	Empyema without mention of fistula + pneumococcus	J86.9 + B95.3	Pyothorax without fistula + Streptococcus pneumoniae
Pneumonia with unspecified causes	480-486 487.0	Viral, bacterial, unspecified pneumonia		
	480.9	Viral pneumonia, unspecified	J12.9	Viral pneumonia, unspecified
	482.9	Bacterial pneumonia, unspecified	J15.9	Unspecified bacterial pneumonia
	485	Bronchopneumonia, organism unspecified	J18.0	Bronchopneumonia, unspecified organism
	486	Pneumonia, organism unspecified	J18.8 J18.9	Other pneumonia, unspecified organism Pneumonia, unspecified organism

Table 4. Diagnosis Codes for Identifying Invasive Pneumococcal Disease, All-Cause Pneumonia, and Pneumococcal Pneumonia

Condition	ICD-9-CM		ICD-10-CM	
	Codes	Description	Codes	Description
IPD				
Bacteremia	790.7 + 041.2 771.83 + 041.2	Bacteremia + pneumococcus	R78.81 + B95.3	Bacteremia + Streptococcus pneumoniae as the cause of diseases classified elsewhere (Streptococcus pneumoniae)
	038.2	Pneumococcal septicemia	A40.3	Sepsis due to Streptococcus pneumoniae
	038.9 + 041.2	Unspecified septicemia + pneumococcus	A41.9 + B95.3	Sepsis, unspecified organism + Streptococcus pneumoniae
Meningitis	320.1	Pneumococcal meningitis	G00.1	Pneumococcal meningitis
	320.9 + 041.2	Meningitis due to unspecified bacterium + pneumococcus	G00.9 + B95.3 G04.2 + B95.3	Bacterial meningitis, unspecified + Streptococcus pneumoniae Bacterial meningoencephalitis and meningomyelitis, not elsewhere classified + Streptococcus pneumoniae
	322.9 + 041.2	Meningitis, unspecified + pneumococcus	G03.9 + B95.3	Meningitis, unspecified + Streptococcus pneumoniae
Other	421.x + 041.2	Endocarditis + pneumococcus		
	421 + 041.2	Acute and subacute bacterial endocarditis + pneumococcus	I33.0 + B95.3	Acute and subacute infective endocarditis + Streptococcus pneumoniae
	421.1 + 041.2	Acute and subacute infective endocarditis in diseases classified elsewhere + pneumococcus	I39 + B95.3	Endocarditis and heart valve disorders in diseases classified elsewhere + Streptococcus pneumoniae
	421.9 + 041.2	Acute endocarditis, unspecified + pneumococcus	I33.9 + B95.3	Acute and subacute endocarditis, unspecified + Streptococcus pneumoniae
	711.0 + 041.2	Septic arthritis + pneumococcus	M00.00 + B95.3 M00.20 + B95.3 M00.80 + B95.3 M00.9 + B95.3 M00.10 + B95.3	Staphylococcal arthritis, unspecified joint + Streptococcus pneumoniae Other streptococcal arthritis, unspecified joint + Streptococcus pneumoniae Arthritis due to other bacteria, unspecified joint + Streptococcus pneumoniae Pyogenic arthritis, unspecified + Streptococcus pneumoniae Pneumococcal arthritis, unspecified joint + Streptococcus pneumoniae

	711.01 + 041.2	Pyogenic arthritis, shoulder region + pneumococcus	M00.011 + B95.3	Staphylococcal arthritis, right shoulder + Streptococcus pneumoniae
			M00.012 + B95.3	Staphylococcal arthritis, left shoulder + Streptococcus pneumoniae
			M00.019 + B95.3	Staphylococcal arthritis, unspecified shoulder + Streptococcus pneumoniae
			M00.211 + B95.3	Other streptococcal arthritis, right shoulder + Streptococcus pneumoniae
			M00.212 + B95.3	Other streptococcal arthritis, left shoulder + Streptococcus pneumoniae
			M00.219 + B95.3	Other streptococcal arthritis, unspecified shoulder + Streptococcus pneumoniae
			M00.811 + B95.3	Arthritis due to other bacteria, right shoulder + Streptococcus pneumoniae
			M00.812 + B95.3	Arthritis due to other bacteria, left shoulder + Streptococcus pneumoniae
			M00.819 + B95.3	Arthritis due to other bacteria, unspecified shoulder + Streptococcus pneumoniae
			M00.119 + B95.3	Pneumococcal arthritis, unspecified shoulder + Streptococcus pneumoniae
			M00.111 + B95.3	Pneumococcal arthritis, right shoulder + Streptococcus pneumoniae
			M00.112 + B95.3	Pneumococcal arthritis, left shoulder + Streptococcus pneumoniae
	711.02 + 041.2	Pyogenic arthritis, upper arm + pneumococcus	M00.021 + B95.3	Staphylococcal arthritis, right elbow + Streptococcus pneumoniae
			M00.022 + B95.3	Staphylococcal arthritis, left elbow + Streptococcus pneumoniae
			M00.029 + B95.3	Staphylococcal arthritis, unspecified elbow + Streptococcus pneumoniae
			M00.221 + B95.3	Other streptococcal arthritis, right elbow + Streptococcus pneumoniae
			M00.222 + B95.3	Other streptococcal arthritis, left elbow + Streptococcus pneumoniae
			M00.229 + B95.3	Other streptococcal arthritis, unspecified elbow + Streptococcus pneumoniae
			M00.821 + B95.3	Arthritis due to other bacteria, right elbow + Streptococcus pneumoniae
			M00.822 + B95.3	Arthritis due to other bacteria, left elbow + Streptococcus pneumoniae
			M00.829 + B95.3	Arthritis due to other bacteria, unspecified elbow + Streptococcus pneumoniae
			M00.129 + B95.3	Pneumococcal arthritis, unspecified elbow + Streptococcus pneumoniae
			M00.121 + B95.3	Pneumococcal arthritis, right elbow + Streptococcus pneumoniae
			M00.122 + B95.3	Pneumococcal arthritis, left elbow + Streptococcus pneumoniae
	711.03 + 041.2	Pyogenic arthritis, forearm + pneumococcus	M00.031 + B95.3	Staphylococcal arthritis, right wrist + Streptococcus pneumoniae
			M00.032 + B95.3	Staphylococcal arthritis, left wrist + Streptococcus pneumoniae
			M00.039 + B95.3	Staphylococcal arthritis, unspecified wrist + Streptococcus pneumoniae
			M00.231 + B95.3	Other streptococcal arthritis, right wrist + Streptococcus pneumoniae
			M00.232 + B95.3	Other streptococcal arthritis, left wrist + Streptococcus pneumoniae
			M00.239 + B95.3	Other streptococcal arthritis, unspecified wrist + Streptococcus pneumoniae
			M00.831 + B95.3	Arthritis due to other bacteria, right wrist + Streptococcus pneumoniae
			M00.832 + B95.3	Arthritis due to other bacteria, left wrist + Streptococcus pneumoniae
			M00.839 + B95.3	Arthritis due to other bacteria, unspecified wrist + Streptococcus pneumoniae
			M00.139 + B95.3	Pneumococcal arthritis, unspecified wrist + Streptococcus pneumoniae
			M00.131 + B95.3	Pneumococcal arthritis, right wrist + Streptococcus pneumoniae
			M00.132 + B95.3	Pneumococcal arthritis, left wrist + Streptococcus pneumoniae
	711.04 + 041.2	Pyogenic arthritis, hand + pneumococcus	M00.041 + B95.3	Staphylococcal arthritis, right hand + Streptococcus pneumoniae
			M00.042 + B95.3	Staphylococcal arthritis, left hand + Streptococcus pneumoniae
			M00.049 + B95.3	Staphylococcal arthritis, unspecified hand + Streptococcus pneumoniae
			M00.241 + B95.3	Other streptococcal arthritis, right hand + Streptococcus pneumoniae
			M00.242 + B95.3	Other streptococcal arthritis, left hand + Streptococcus pneumoniae
			M00.249 + B95.3	Other streptococcal arthritis, unspecified hand + Streptococcus pneumoniae
			M00.841 + B95.3	Arthritis due to other bacteria, right hand + Streptococcus pneumoniae

			M00.842 + B95.3	Arthritis due to other bacteria, left hand + Streptococcus pneumoniae
			M00.849 + B95.3	Arthritis due to other bacteria, unspecified hand + Streptococcus pneumoniae
			M00.149 + B95.3	Pneumococcal arthritis, unspecified hand + Streptococcus pneumoniae
			M00.141 + B95.3	Pneumococcal arthritis, right hand + Streptococcus pneumoniae
			M00.142 + B95.3	Pneumococcal arthritis, left hand + Streptococcus pneumoniae
	711.05 + 041.2	Pyogenic arthritis, pelvic region and thigh + pneumococcus	M00.051 + B95.3	Staphylococcal arthritis, right hip + Streptococcus pneumoniae
			M00.052 + B95.3	Staphylococcal arthritis, left hip + Streptococcus pneumoniae
			M00.059 + B95.3	Staphylococcal arthritis, unspecified hip + Streptococcus pneumoniae
			M00.251 + B95.3	Other streptococcal arthritis, right hip + Streptococcus pneumoniae
			M00.252 + B95.3	Other streptococcal arthritis, left hip + Streptococcus pneumoniae
			M00.259 + B95.3	Other streptococcal arthritis, unspecified hip + Streptococcus pneumoniae
			M00.851 + B95.3	Arthritis due to other bacteria, right hip + Streptococcus pneumoniae
			M00.852 + B95.3	Arthritis due to other bacteria, left hip + Streptococcus pneumoniae
			M00.859 + B95.3	Arthritis due to other bacteria, unspecified hip + Streptococcus pneumoniae
			M00.159 + B95.3	Pneumococcal arthritis, unspecified hip + Streptococcus pneumoniae
			M00.151 + B95.3	Pneumococcal arthritis, right hip + Streptococcus pneumoniae
			M00.152 + B95.3	Pneumococcal arthritis, left hip + Streptococcus pneumoniae
	711.06 + 041.2	Pyogenic arthritis, lower leg + pneumococcus	M00.061 + B95.3	Staphylococcal arthritis, right knee + Streptococcus pneumoniae
			M00.062 + B95.3	Staphylococcal arthritis, left knee + Streptococcus pneumoniae
			M00.069 + B95.3	Staphylococcal arthritis, unspecified knee + Streptococcus pneumoniae
			M00.261 + B95.3	Other streptococcal arthritis, right knee + Streptococcus pneumoniae
			M00.262 + B95.3	Other streptococcal arthritis, left knee + Streptococcus pneumoniae
			M00.269 + B95.3	Other streptococcal arthritis, unspecified knee + Streptococcus pneumoniae
			M00.861 + B95.3	Arthritis due to other bacteria, right knee + Streptococcus pneumoniae
			M00.862 + B95.3	Arthritis due to other bacteria, left knee + Streptococcus pneumoniae
			M00.869 + B95.3	Arthritis due to other bacteria, unspecified knee + Streptococcus pneumoniae
			M00.169 + B95.3	Pneumococcal arthritis, unspecified knee + Streptococcus pneumoniae
			M00.161 + B95.3	Pneumococcal arthritis, right knee + Streptococcus pneumoniae
			M00.162 + B95.3	Pneumococcal arthritis, left knee + Streptococcus pneumoniae
	711.07 + 041.2	Pyogenic arthritis, ankle and foot + pneumococcus	M00.071 + B95.3	Staphylococcal arthritis, right ankle and foot + Streptococcus pneumoniae
			M00.072 + B95.3	Staphylococcal arthritis, left ankle and foot + Streptococcus pneumoniae
			M00.079 + B95.3	Staphylococcal arthritis, unspecified ankle and foot + Streptococcus pneumoniae
			M00.271 + B95.3	Other streptococcal arthritis, right ankle and foot + Streptococcus pneumoniae
			M00.272 + B95.3	Other streptococcal arthritis, left ankle and foot + Streptococcus pneumoniae
			M00.279 + B95.3	Other streptococcal arthritis, unspecified ankle and foot + Streptococcus pneumoniae
			M00.871 + B95.3	Arthritis due to other bacteria, right ankle and foot + Streptococcus pneumoniae
			M00.872 + B95.3	Arthritis due to other bacteria, left ankle and foot + Streptococcus pneumoniae
			M00.879 + B95.3	Arthritis due to other bacteria, unspecified ankle and foot + Streptococcus pneumoniae
			M00.179 + B95.3	Pneumococcal arthritis, unspecified ankle and foot + Streptococcus pneumoniae
			M00.171 + B95.3	
			M00.172 + B95.3	

				Pneumococcal arthritis, right ankle and foot + Streptococcus pneumoniae Pneumococcal arthritis, left ankle and foot + Streptococcus pneumoniae
	711.08 + 041.2	Pyogenic arthritis, other specified sites + pneumococcus	M00.08 + B95.3 M00.28 + B95.3 M00.88 + B95.3 M00.9+ B95.3 M00.18 + B95.3	.Staphylococcal arthritis, vertebrae + Streptococcus pneumoniae Other streptococcal arthritis, vertebrae + Streptococcus pneumoniae Arthritis due to other bacteria, vertebrae + Streptococcus pneumoniae Pyogenic arthritis, unspecified + Streptococcus pneumoniae Pneumococcal arthritis, vertebrae + Streptococcus pneumoniae
	711.09 + 041.2	Pyogenic arthritis, multiple sites + pneumococcus	M00.09 + B95.3 M00.29 + B95.3 M00.89 + B95.3 M00.19 + B95.3	Staphylococcal polyarthritis + Streptococcus pneumoniae Other streptococcal polyarthritis + Streptococcus pneumoniae Polyarthritis due to other bacteria + Streptococcus pneumoniae Pneumococcal polyarthritis + Streptococcus pneumoniae
	730.0x + 041.2 730.2x + 041.2	Osteomyelitis + pneumococcus		
	730.00 + 041.2	Acute osteomyelitis, site unspecified + pneumococcus	M86.00 + B95.3 M86.10 + B95.3 M86.20 + B95.3	Acute hematogenous osteomyelitis, unspecified site + Streptococcus pneumoniae Other acute osteomyelitis, unspecified site + Streptococcus pneumoniae Subacute osteomyelitis, unspecified site + Streptococcus pneumoniae
	730.01 + 041.2	Acute osteomyelitis, shoulder region + pneumococcus	M86.011 + B95.3 M86.012 + B95.3 M86.019 + B95.3 M86.111 + B95.3 M86.112 + B95.3 M86.119 + B95.3 M86.211 + B95.3 M86.212 + B95.3 M86.219 + B95.3	Acute hematogenous osteomyelitis, right shoulder + Streptococcus pneumoniae Acute hematogenous osteomyelitis, left shoulder + Streptococcus pneumoniae Acute hematogenous osteomyelitis, unspecified shoulder + Streptococcus pneumoniae Other acute osteomyelitis, right shoulder + Streptococcus pneumoniae Other acute osteomyelitis, left shoulder + Streptococcus pneumoniae Other acute osteomyelitis, unspecified shoulder + Streptococcus pneumoniae Subacute osteomyelitis, right shoulder + Streptococcus pneumoniae Subacute osteomyelitis, left shoulder + Streptococcus pneumoniae Subacute osteomyelitis, unspecified shoulder + Streptococcus pneumoniae
	730.02 + 041.2	Acute osteomyelitis, upper arm + pneumococcus	M86.021 + B95.3 M86.022 + B95.3 M86.029 + B95.3 M86.121 + B95.3	Acute hematogenous osteomyelitis, right humerus + Streptococcus pneumoniae Acute hematogenous osteomyelitis, left humerus + Streptococcus pneumoniae Acute hematogenous osteomyelitis, unspecified humerus + Streptococcus pneumoniae

			M86.122 + B95.3 M86.129 + B95.3 M86.221 + B95.3 M86.222 + B95.3 M86.229 + B95.3	Other acute osteomyelitis, right humerus + Streptococcus pneumoniae Other acute osteomyelitis, left humerus + Streptococcus pneumoniae Other acute osteomyelitis, unspecified humerus + Streptococcus pneumoniae Subacute osteomyelitis, right humerus + Streptococcus pneumoniae Subacute osteomyelitis, left humerus + Streptococcus pneumoniae Subacute osteomyelitis, unspecified humerus + Streptococcus pneumoniae
	730.03 + 041.2	Acute osteomyelitis, forearm	M86.031 + B95.3 M86.032 + B95.3 M86.039 + B95.3 M86.131 + B95.3 M86.132 + B95.3 M86.139 + B95.3 M86.231 + B95.3 M86.232 + B95.3 M86.239 + B95.3	Acute hematogenous osteomyelitis, right radius and ulna + Streptococcus pneumoniae Acute hematogenous osteomyelitis, left radius and ulna + Streptococcus pneumoniae Acute hematogenous osteomyelitis, unspecified radius and ulna + Streptococcus pneumoniae Other acute osteomyelitis, right radius and ulna + Streptococcus pneumoniae Other acute osteomyelitis, left radius and ulna + Streptococcus pneumoniae Other acute osteomyelitis, unspecified radius and ulna + Streptococcus pneumoniae Subacute osteomyelitis, right radius and ulna + Streptococcus pneumoniae Subacute osteomyelitis, left radius and ulna + Streptococcus pneumoniae Subacute osteomyelitis, unspecified radius and ulna + Streptococcus pneumoniae
	730.04 + 041.2	Acute osteomyelitis, hand + pneumococcus	M86.041 + B95.3 M86.042 + B95.3 M86.049 + B95.3 M86.141 + B95.3 M86.142 + B95.3 M86.149 + B95.3 M86.241 + B95.3 M86.242 + B95.3 M86.249 + B95.3	Acute hematogenous osteomyelitis, right hand + Streptococcus pneumoniae Acute hematogenous osteomyelitis, left hand + Streptococcus pneumoniae Acute hematogenous osteomyelitis, unspecified hand + Streptococcus pneumoniae Other acute osteomyelitis, right hand + Streptococcus pneumoniae Other acute osteomyelitis, left hand + Streptococcus pneumoniae Other acute osteomyelitis, unspecified hand + Streptococcus pneumoniae Subacute osteomyelitis, right hand + Streptococcus pneumoniae Subacute osteomyelitis, left hand + Streptococcus pneumoniae Subacute osteomyelitis, unspecified hand + Streptococcus pneumoniae
	730.05 + 041.2	Acute osteomyelitis, pelvic region and thigh + pneumococcus	M86.051 + B95.3 M86.052 + B95.3 M86.059 + B95.3 M86.151 + B95.3 M86.152 + B95.3 M86.159 + B95.3 M86.251 + B95.3 M86.252 + B95.3 M86.259 + B95.3	Acute hematogenous osteomyelitis, right femur + Streptococcus pneumonia Acute hematogenous osteomyelitis, left femur + Streptococcus pneumonia Acute hematogenous osteomyelitis, unspecified femur + Streptococcus pneumonia Other acute osteomyelitis, right femur + Streptococcus pneumonia Other acute osteomyelitis, left femur + Streptococcus pneumonia Other acute osteomyelitis, unspecified femur + Streptococcus pneumonia Subacute osteomyelitis, right femur + Streptococcus pneumoniae Subacute osteomyelitis, left femur + Streptococcus pneumoniae Subacute osteomyelitis, unspecified femur + Streptococcus pneumoniae
	730.06 + 041.2	Acute osteomyelitis, lower leg + pneumococcus	M86.061 + B95.3 M86.062 + B95.3 M86.069 + B95.3 M86.161 + B95.3	Acute hematogenous osteomyelitis, right tibia and fibula + Streptococcus pneumoniae Acute hematogenous osteomyelitis, left tibia and fibula + Streptococcus pneumoniae Acute hematogenous osteomyelitis, unspecified tibia and fibula + Streptococcus pneumoniae

			M86.162 + B95.3 M86.169 + B95.3 M86.261 + B95.3 M86.262 + B95.3 M86.269 + B95.3	Other acute osteomyelitis, right tibia and fibula + Streptococcus pneumoniae Other acute osteomyelitis, left tibia and fibula + Streptococcus pneumoniae Other acute osteomyelitis, unspecified tibia and fibula + Streptococcus pneumoniae Subacute osteomyelitis, right tibia and fibula + Streptococcus pneumoniae Subacute osteomyelitis, left tibia and fibula + Streptococcus pneumoniae Subacute osteomyelitis, unspecified tibia and fibula + Streptococcus pneumoniae
	730.07 + 041.2	Acute osteomyelitis, ankle and foot + pneumococcus	M86.071 + B95.3 M86.072 + B95.3 M86.079 + B95.3 M86.171 + B95.3 M86.172 + B95.3 M86.179 + B95.3 M86.271 + B95.3 M86.272 + B95.3 M86.279 + B95.3	Acute hematogenous osteomyelitis, right ankle and foot + Streptococcus pneumoniae Acute hematogenous osteomyelitis, left ankle and foot + Streptococcus pneumoniae Acute hematogenous osteomyelitis, unspecified ankle and foot + Streptococcus pneumoniae Other acute osteomyelitis, right ankle and foot + Streptococcus pneumoniae Other acute osteomyelitis, left ankle and foot + Streptococcus pneumoniae Other acute osteomyelitis, unspecified ankle and foot + Streptococcus pneumoniae Subacute osteomyelitis, right ankle and foot + Streptococcus pneumoniae Subacute osteomyelitis, left ankle and foot + Streptococcus pneumoniae Subacute osteomyelitis, unspecified ankle and foot + Streptococcus pneumoniae
	730.08 + 041.2	Acute osteomyelitis, other specified sites + pneumococcus	M86.08 + B95.3 M86.18 + B95.3 M86.28 + B95.3	Acute hematogenous osteomyelitis, other sites + Streptococcus pneumoniae Other acute osteomyelitis, other site + Streptococcus pneumoniae Subacute osteomyelitis, other site + Streptococcus pneumoniae
	730.09 + 041.2	Acute osteomyelitis, multiple sites + pneumococcus	M86.09 + B95.3 M86.19 + B95.3 M86.29 + B95.3	Acute hematogenous osteomyelitis, multiple sites + Streptococcus pneumoniae Other acute osteomyelitis, multiple sites + Streptococcus pneumoniae Subacute osteomyelitis, multiple sites + Streptococcus pneumoniae
	730.2 + 041.2 730.21 + 041.2 730.22 + 041.2 730.23 + 041.2 730.24 + 041.2 730.25 + 041.2 730.26 + 041.2 730.27 + 041.2 730.29 + 041.2	Unspecified osteomyelitis, site unspecified + pneumococcus Unspecified osteomyelitis, shoulder region + pneumococcus Unspecified osteomyelitis, upper arm + pneumococcus Unspecified osteomyelitis, forearm + pneumococcus Unspecified osteomyelitis, hand + pneumococcus Unspecified osteomyelitis, pelvic region and thigh + pneumococcus Unspecified osteomyelitis, lower leg + pneumococcus Unspecified osteomyelitis, ankle and foot + pneumococcus Unspecified osteomyelitis, multiple sites + pneumococcus	M86.9 + B95.3	Osteomyelitis, unspecified + Streptococcus pneumoniae

	730.28 + 041.2	Unspecified osteomyelitis, other specified sites + pneumococcus	M46.20 + B95.3 M46.21 + B95.3 M46.22 + B95.3 M46.23 + B95.3 M46.24 + B95.3 M46.25 + B95.3 M46.26 + B95.3 M46.27 + B95.3 M46.28 + B95.3	Osteomyelitis of vertebra, site unspecified + Streptococcus pneumoniae Osteomyelitis of vertebra, occipito-atlanto-axial region + Streptococcus pneumoniae Osteomyelitis of vertebra, cervical region + Streptococcus pneumoniae Osteomyelitis of vertebra, cervicothoracic region + Streptococcus pneumoniae Osteomyelitis of vertebra, thoracic region + Streptococcus pneumoniae Osteomyelitis of vertebra, thoracolumbar region + Streptococcus pneumoniae Osteomyelitis of vertebra, lumbar region + Streptococcus pneumoniae Osteomyelitis of vertebra, lumbosacral region + Streptococcus pneumoniae Osteomyelitis of vertebra, sacral and sacrococcygeal region + Streptococcus pneumoniae
Pneumonia				
All-Cause	480-486 487.0	Viral, bacterial, unspecified pneumonia		
	480	Pneumonia due to adenovirus	J12.0	Adenoviral pneumonia
	480.1	Pneumonia due to respiratory syncytial virus	J12.1	Respiratory syncytial virus pneumonia
	480.2	Pneumonia due to parainfluenza virus	J12.2	Parainfluenza virus pneumonia
	480.3	Pneumonia due to SARS-associated coronavirus	J12.81 J12.82	Pneumonia due to SARS-associated coronavirus Pneumonia due to coronavirus disease 2019
	480.8	Pneumonia due to other virus not elsewhere classified	J12.3 J12.89	Human metapneumovirus pneumonia Other viral pneumonia
	480.9	Viral pneumonia, unspecified	J12.9	Viral pneumonia, unspecified
	481	Pneumococcal pneumonia [Streptococcus pneumoniae pneumonia]	J18.1 J13	Lobar pneumonia, unspecified organism Pneumonia due to Streptococcus pneumoniae
	482	Pneumonia due to Klebsiella pneumoniae	J15.0	Pneumonia due to Klebsiella pneumoniae
	482.1	Pneumonia due to Pseudomonas	J15.1	Pneumonia due to Pseudomonas
	482.2	Pneumonia due to Hemophilus influenzae [H. influenzae]	J14	Pneumonia due to Hemophilus influenzae
	482.3	Pneumonia due to Streptococcus, unspecified	J15.4	Pneumonia due to other streptococci
	482.31	Pneumonia due to Streptococcus, group A	J15.4	Pneumonia due to other streptococci
	482.32	Pneumonia due to Streptococcus, group B	J15.3	Pneumonia due to streptococcus, group B
	482.39	Pneumonia due to other Streptococcus	J15.4	Pneumonia due to other streptococci

	482.4	Pneumonia due to Staphylococcus, unspecified	J15.20	Pneumonia due to staphylococcus, unspecified
	482.41	Methicillin susceptible pneumonia due to Staphylococcus aureus	J15.211	Pneumonia due to Methicillin susceptible Staphylococcus aureus
	482.42	Methicillin resistant pneumonia due to Staphylococcus aureus	J15.212	Pneumonia due to Methicillin resistant Staphylococcus aureus
	482.49	Other Staphylococcus pneumonia	J15.29	Pneumonia due to other staphylococcus
	482.81	Pneumonia due to anaerobes	J15.8	Pneumonia due to other specified bacteria
	482.82	Pneumonia due to escherichia coli [E. coli]	J15.5	Pneumonia due to Escherichia coli
	482.83	Pneumonia due to other gram-negative bacteria	J15.6	Pneumonia due to other aerobic Gram-negative bacteria
	482.84	Pneumonia due to Legionnaires' disease	A48.1	Legionnaires' disease
	482.89	Pneumonia due to other specified bacteria	J15.8	Pneumonia due to other specified bacteria
	482.9	Bacterial pneumonia, unspecified	J15.9	Unspecified bacterial pneumonia
	483	Pneumonia due to mycoplasma pneumoniae	J15.7	Pneumonia due to Mycoplasma pneumoniae
	483.1	Pneumonia due to chlamydia	J16.0	Chlamydial pneumonia
	483.8	Pneumonia due to other specified organism	J16.8	Pneumonia due to other specified infectious organisms
	484.1	Pneumonia in cytomegalic inclusion disease	B25.0	Cytomegaloviral pneumonitis
	484.3	Pneumonia in whooping cough	A37.91 A37.01 A37.11 A37.81	Whooping cough, unspecified species with pneumonia Whooping cough due to Bordetella pertussis with pneumonia Whooping cough due to Bordetella parapertussis with pneumonia Whooping cough due to other Bordetella species with pneumonia
	484.5	Pneumonia in anthrax	A22.1	Pulmonary anthrax
	484.6	Pneumonia in aspergillosis	B44.0	Invasive pulmonary aspergillosis
	484.7	Pneumonia in other systemic mycoses	J17	Pneumonia in diseases classified elsewhere
	484.8	Pneumonia in other infectious diseases classified elsewhere	J17 B77.81	Pneumonia in diseases classified elsewhere Ascariasis pneumonia
	485	Bronchopneumonia, organism unspecified	J18.0	Bronchopneumonia, unspecified organism

	486	Pneumonia, organism unspecified	J18.8 J18.9	Other pneumonia, unspecified organism Pneumonia, unspecified organism
	487	Influenza with pneumonia	J10.00 J10.08 J11.00 J11.08 J12.9	Influenza due to other identified influenza virus with unspecified type of pneumonia Influenza due to other identified influenza virus with other specified pneumonia Influenza due to unidentified influenza virus with unspecified type of pneumonia Influenza due to unidentified influenza virus with specified pneumonia Viral pneumonia, unspecified
	510.x	Empyema		
	510	Empyema with fistula	J86.0	Pyothorax with fistula
	510.9	Empyema without mention of fistula	J86.9	Pyothorax without fistula
			J85.1	Abscess of lung with pneumonia
	136.3	Pneumocystosis	B59	Pneumocystosis
Pneumococcal	481	Pneumococcal pneumonia	J13	Pneumonia due to Streptococcus pneumoniae
	482.9 + 041.2	Bacterial pneumonia, unspecified + pneumococcus	J15.9 + B95.3	Unspecified bacterial pneumonia + Streptococcus pneumoniae
	485 + 041.2	Bronchopneumonia, organism unspecified + pneumococcus	J18.0 + B95.3	Bronchopneumonia, unspecified organism + Streptococcus pneumoniae
	486 + 041.2	Pneumonia, organism unspecified + pneumococcus	J18.8 + B95.3 J18.9 + B95.3	Other pneumonia, unspecified organism + Streptococcus pneumoniae Pneumonia, unspecified organism + Streptococcus pneumoniae
	510.x + 041.2	Empyema + pneumococcus		
	510 + 041.2	Empyema with fistula + pneumococcus	J86.0 + B95.3	Pyothorax with fistula + Streptococcus pneumoniae
	510.9 + 041.2	Empyema without mention of fistula + pneumococcus	J86.9 + B95.3	Pyothorax without fistula + Streptococcus pneumoniae

Table 6. National Drug Codes and Procedure Codes for Identifying Immunosuppressive Medications (see excel)

Table 7. National Drug Codes and Procedure Codes for Identifying Influenza Vaccinations (see excel)

Table 8. National Drug Codes and CPT® Codes for Identifying PPSV23 Vaccination

Code	Type	Description
90732	CPT	Pneumovax 23
00006473900	NDC	Pneumovax 23
00006473901	NDC	Pneumovax 23
00006473950	NDC	Pneumovax 23
00006474100	NDC	Pneumovax 23
00006483701	NDC	Pneumovax 23
00006483702	NDC	Pneumovax 23
00006483703	NDC	Pneumovax 23
00006489400	NDC	Pneumovax 23
00006489400	NDC	Pneumovax 23
00006494300	NDC	Pneumovax 23
00006494301	NDC	Pneumovax 23
00247040201	NDC	Pneumovax 23
50090145200	NDC	Pneumovax 23
50090145209	NDC	Pneumovax 23
54569141200	NDC	Pneumovax 23
54569653800	NDC	Pneumovax 23
54868333901	NDC	Pneumovax 23
54868333909	NDC	Pneumovax 23
54868432000	NDC	Pneumovax 23
54868432009	NDC	Pneumovax 23
55045354202	NDC	Pneumovax 23
00005230931	NDC	Pnu-Imune 23
00005230933	NDC	Pnu-Imune 23
54868070700	NDC	Pnu-Imune 23

Table 9. CPT® codes to identify CD4 laboratory tests

Code	Type	Description
86361	CPT	Absolute CD4 count
86360	CPT	Absolute CD4 and CD8 counts with ratio

Table 10. CPT® codes to identify viral load laboratory tests

Code	Type	Description
87534	CPT	Infectious agent detection by nucleic acid (DNA or RNA); HIV-1, direct probe technique
87535	CPT	Infectious agent detection by nucleic acid (DNA or RNA); HIV-1, amplified probe technique
87536	CPT	Infectious agent detection by nucleic acid (DNA or RNA); HIV-1, quantification

Table 11. Diagnosis Codes for Identifying All-Cause Pneumonia not due to HIV

Condition	ICD-9-CM		ICD-10-CM	
	Codes	Description	Codes	Description
All-Cause	480-486 487.0	Viral, bacterial, unspecified pneumonia		
	480	Pneumonia due to adenovirus	J12.0	Adenoviral pneumonia
	480.1	Pneumonia due to respiratory syncytial virus	J12.1	Respiratory syncytial virus pneumonia
	480.2	Pneumonia due to parainfluenza virus	J12.2	Parainfluenza virus pneumonia
	480.3	Pneumonia due to SARS-associated coronavirus	J12.81 J12.82	Pneumonia due to SARS-associated coronavirus Pneumonia due to coronavirus disease 2019
	480.8	Pneumonia due to other virus not elsewhere classified	J12.3 J12.89	Human metapneumovirus pneumonia Other viral pneumonia
	480.9	Viral pneumonia, unspecified	J12.9	Viral pneumonia, unspecified
	481	Pneumococcal pneumonia [Streptococcus pneumoniae pneumonia]	J18.1 J13	Lobar pneumonia, unspecified organism Pneumonia due to Streptococcus pneumoniae
	482	Pneumonia due to Klebsiella pneumoniae	J15.0	Pneumonia due to Klebsiella pneumoniae
	482.1	Pneumonia due to Pseudomonas	J15.1	Pneumonia due to Pseudomonas
	482.2	Pneumonia due to Hemophilus influenzae [H. influenzae]	J14	Pneumonia due to Hemophilus influenzae
	482.3	Pneumonia due to Streptococcus, unspecified	J15.4	Pneumonia due to other streptococci
	482.31	Pneumonia due to Streptococcus, group A	J15.4	Pneumonia due to other streptococci
	482.32	Pneumonia due to Streptococcus, group B	J15.3	Pneumonia due to streptococcus, group B
	482.39	Pneumonia due to other Streptococcus	J15.4	Pneumonia due to other streptococci
	482.4	Pneumonia due to Staphylococcus, unspecified	J15.20	Pneumonia due to staphylococcus, unspecified
	482.41	Methicillin susceptible pneumonia due to Staphylococcus aureus	J15.211	Pneumonia due to Methicillin susceptible Staphylococcus aureus

	482.42	Methicillin resistant pneumonia due to Staphylococcus aureus	J15.212	Pneumonia due to Methicillin resistant Staphylococcus aureus
	482.49	Other Staphylococcus pneumonia	J15.29	Pneumonia due to other staphylococcus
	482.81	Pneumonia due to anaerobes	J15.8	Pneumonia due to other specified bacteria
	482.82	Pneumonia due to escherichia coli [E. coli]	J15.5	Pneumonia due to Escherichia coli
	482.83	Pneumonia due to other gram-negative bacteria	J15.6	Pneumonia due to other aerobic Gram-negative bacteria
	482.84	Pneumonia due to Legionnaires' disease	A48.1	Legionnaires' disease
	482.89	Pneumonia due to other specified bacteria	J15.8	Pneumonia due to other specified bacteria
	482.9	Bacterial pneumonia, unspecified	J15.9	Unspecified bacterial pneumonia
	483.1	Pneumonia due to chlamydia	J16.0	Chlamydial pneumonia
	483.8	Pneumonia due to other specified organism	J16.8	Pneumonia due to other specified infectious organisms
	484.3	Pneumonia in whooping cough	A37.91 A37.01 A37.11 A37.81	Whooping cough, unspecified species with pneumonia Whooping cough due to Bordetella pertussis with pneumonia Whooping cough due to Bordetella parapertussis with pneumonia Whooping cough due to other Bordetella species with pneumonia
	484.5	Pneumonia in anthrax	A22.1	Pulmonary anthrax
			J17	Pneumonia in diseases classified elsewhere
	484.8	Pneumonia in other infectious diseases classified elsewhere	J17 B77.81	Pneumonia in diseases classified elsewhere Ascariasis pneumonia
	485	Bronchopneumonia, organism unspecified	J18.0	Bronchopneumonia, unspecified organism
	486	Pneumonia, organism unspecified	J18.8 J18.9	Other pneumonia, unspecified organism Pneumonia, unspecified organism
	487	Influenza with pneumonia	J10.00 J10.08 J11.00 J11.08 J12.9	Influenza due to other identified influenza virus with unspecified type of pneumonia Influenza due to other identified influenza virus with other specified pneumonia Influenza due to unidentified influenza virus with unspecified type of pneumonia Influenza due to unidentified influenza virus with specified pneumonia Viral pneumonia, unspecified

	510.x	Empyema		
	510	Empyema with fistula	J86.0	Pyothorax with fistula
	510.9	Empyema without mention of fistula	J86.9	Pyothorax without fistula
			J85.1	Abscess of lung with pneumonia

Table 12. National Drug Codes and CPT® Codes for Identifying Recombinant Zoster Vaccination

Code	Type	Description
58160082801	NDC	Shingrix
58160082803	NDC	Shingrix
50090514700	NDC	Shingrix
58160081912	NDC	Shingrix
58160082311	NDC	Shingrix
50090337200	NDC	Shingrix
90750	CPT	Zoster Vaccine Recombinant, Adjuvanted, Suspension for Intramuscular Injection

Table 13. National Drug Codes for Identifying Candidiasis Antifungals (see excel)

Table 14. Diagnosis Codes for Identifying Opportunistic Infections (see excel)

ANNEX 1. LIST OF STAND ALONE DOCUMENTS

If there is no document to be listed, delete the table and write "None".

Number	Document reference number	Date	Title
1	1	January 24, 2023	Annex Code Tables

ANNEX 2. ENCEPP CHECKLIST FOR STUDY PROTOCOLS

Not required

ANNEX 3. ADDITIONAL INFORMATION

Not applicable

Document Approval Record

Document Name:	B1851217 FINAL PROTOCOL V3.0_06Dec2023
Document Title:	Assessment of 13-valent pneumococcal conjugate vaccine effectiveness among people with HIV in the United States

Signed By:	Date(GMT)	Signing Capacity
PPD	11-Dec-2023 17:45:08	Business Line Approver
	11-Dec-2023 18:26:55	Author Approval