

# Community Acquired Pneumonia (CAP) Requiring Hospitalization in HIV Infected (HIV+) and Un-infected (HIV-) Patients: Evaluation of Patients Identified by ICD-9 Codes

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## Background:

Community acquired pneumonia (CAP) remains one of the most frequent complications in HIV+ patients as well as in the aging general population. Cohort studies rely on ICD-9 codes for identification of this and other events of interest; hence, it is important to validate and/or enhance their performance. The reliability of ICD-9 codes for hospital admissions for CAP in HIV infected (HIV+) patients compared to non-infected group (HIV-) has not been recently assessed. VACS-8 is a cohort of HIV+ and HIV- individuals, prospectively enrolled from 8 sites, and site-matched by age, gender, and race; it provides a setting in which this question can be investigated.

## Objectives:

- 1) To assess the reliability of ICD-9 codes for CAP compared to the gold standard of chart review in HIV+ and HIV- subjects enrolled in VACS-8.
- 2) To determine the frequency of risk factors for health-care associated pneumonia (HCAP) among subjects admitted with CAP.
- 3) To determine the frequency of microbiologically confirmed diagnosis of bacterial CAP.
- 4) To evaluate the positive predictive value of ICD-9 codes when combined with other parameters that can be easily retrieved from electronic data.

## Methods:

- The administrative records of 6,523 subjects enrolled in VACS (3,257 HIV+, 3,266 HIV-) between 2005-2008 were searched for inpatient ICD-9 codes consistent with possible bacterial or viral pneumonia. A wide range of codes possibly consistent with CAP were used to capture the most number of events. Only patient's first event was included.
- Charts of patients identified as admission for first CAP event (N=549) were reviewed using standardized forms.
- Patients were categorized as having CAP present on admission when the following criteria were met: a) clinical (symptoms, signs, laboratory), b) radiologic, and c) receipt of antibacterial drugs directed against CAP (Table 1). Patients who developed criteria consistent with pneumonia >48 hours after admission were categorized as hospital-acquired pneumonia (HAP).
- Characteristics of patients with confirmed CAP present on admission are shown in Table 2.
- Patients transferred from other health care facility were included in the analysis if their initial presentation at the VA was for pneumonia. Patients admitted from the community with risk factors for HCAP are presented in Table 3.
- Positive predictive value (PPV) was calculated as the number of chart review confirmed pneumonia events divided by the number identified by specific ICD-9 codes or code groupings; and for code groupings in combination with data on antimicrobial use within 72 hours of admission (Table 4).
- Microbiologic diagnosis of confirmed CAP on admission was categorized as definitive, presumed, or suspected by data abstracted by chart review (Table 5).
- Characteristics between the groups were compared using chi-square or Student's T-test.

## Results:

**Table 1. Subjects admitted with pneumonia identified by ICD-9 codes. CAP ICD-9 codes are those consistent with bacterial or viral pneumonia. CAP confirmed as present on admission by chart review.**

	Total	HIV+	HIV-	P
	6,523	3,257	3,266	
	N (%)	N (%)	N (%)	
<b>Subjects with any inpatient CAP ICD-9 code</b>	549 (8)	433 (13)	116 (4)	<0.01
<b>Confirmed CAP at admission</b>	396 (72)	320 (74)	76 (66)	0.2
A. Symptoms/signs c/w CAP	508 (93)	401 (93)	107 (92)	0.7
B. Radiograph c/w CAP	407 (74)	329 (76)	78 (67)	0.1
C. Antibacterials for CAP within 48 hours of admission	489 (89)	387 (89)	102 (87)	0.6
<b>No CAP on admission</b>	108 (20)	78 (18)	30 (26)	0.4
A. Symptoms c/w CAP	79 (73)	56 (72)	23 (77)	0.6
B. Radiograph c/w CAP	8 (7)	6 (8)	2 (7)	0.9
C. Antibacterials for CAP within 48 hours of admission	67 (62)	48 (62)	19 (63)	0.9
<b>Hospital-acquired Pneumonia (HAP)</b>	14 (3)	9 (2)	5 (4)	0.8
<b>Unable to adjudicate</b>	31 (6)	26 (6)	5 (4)	0.2

**Table 2. Characteristics of patients with confirmed CAP present on admission. Laboratory data at time of event**

	Total	HIV+	HIV-	P
	N=396	N=320	N=76	
Age (years)	53.2	52.1	57.8	<0.01
Male Gender	97%	98%	95%	0.1
Non-white race	86%	89%	72%	<0.01
Diabetes mellitus	25%	24%	30%	0.2
EGFR <60 cc/min	9%	27%	28%	0.9
COPD	10%	9%	14%	0.2
Tobacco use ever	87%	86%	88%	0.3
Hazardous alcohol use	29%	29%	28%	0.8
CD4 <200 cells/μL	--	39%	--	--
VL <400 RNA copies/mL	--	44%	--	--
On antiretroviral treatment	--	68%	--	--

EGFR, estimated glomerular filtration rate; COPD, chronic obstructive pulmonary disease. alcohol use based on AUDIT-C score. CD4, CD4 cell count; VL, viral load

**Table 3. Risk factors for health care associated pneumonia (HCAP) among patients with confirmed CAP present on admission**

	Total	HIV+	HIV-	P
	N= 396	N=320	N=76	
<b>Admitted from home without HCAP risk factors</b>	353 (89%)	291 (91%)	62 (82%)	0.04
<b>Admitted from home with HCAP risk factors</b>	11 (3%)	9 (3%)	2 (3%)	1.0
<b>Transferred from other acute care hospital</b>	13 (3%)	9 (3%)	4 (5%)	0.9
<b>Transferred from NH, skilled nursing or other non-acute health care facility*</b>	19 (5%)	11 (3%)	8 (11%)	0.5

Risk factors for HCAP include discharged from acute care hospital within 90 days and/or HD, IV antibiotics or chemotherapy, or wound care within 30 days. NH, nursing home

**Table 4. Positive predictive value (PPV) of ICD-9 codes for CAP and models based on modifying screening codes +/- antimicrobial use within 72 hours of admission (<72h) abstracted from pharmacy administrative data. PPV calculated as number of chart confirmed CAP/number identified by ICD-9 code**

ICD-9 code(s)	Description	All CAP PPV	HIV+ CAP PPV	HIV- CAP PPV	P
480, 487	Viral pneumonia N=5	60%	75%	0%	0.2
481	S. pneumoniae pneumonia N=29	83%	84%	67%	0.4
482-485	Bacterial pneumonia of other etiologies N=59	71%	71%	67%	0.8
486	Pneumonia organisms unspecified N=418	74%	75%	71%	0.5
391, 506, 507, 510, 513, 521	Miscellaneous lung infections (aspiration, abscess, empyema, other) N=39	46%	47%	44%	0.8
<b>ICD-9 code groups</b>					
1	All ICD-9 codes N=549 (396/320/76)*	72%	74%	66%	0.07
2	All ICD-9 codes + antimicrobials <72h N=508 (383/311/72)	75%	77%	69%	0.1
3	Reduced set of ICD-9 codes≠ N=512 (379/311/68)	74%	75%	69%	0.2
4	Reduced set of ICD-9 codes + antimicrobials <72h N=477 (367/303/64)	77%	78%	73%	0.3

\*In parenthesis N for confirmed CAP for respective groups (All/HIV+/HIV-) ≠Reduced set of ICD-9 codes: codes 480-487;

**Table 5. Microbiologic work-up and etiologic diagnosis of confirmed CAP**

	Total	HIV+	HIV-	P
	N=396	N=320	N=76	
<b>Work-up</b>				
Smear from respiratory sample obtained within 48 hours of admission	235 (59%)	204 (64%)	31 (41%)	<0.05
Respiratory and/or blood cultures obtained within 48 hours	359 (91%)	297 (93%)	62 (82%)	<0.01
<b>Diagnosis of bacterial CAP</b>				
Definitive	45 (11%)	41 (13%)	4 (5%)	
Presumed	33 (8%)	26 (8%)	7 (9%)	
Suspected	309 (78%)	245 (77%)	64 (84%)	0.2*

Definitive, likely pathogen isolated from sterile site or + antigen test; Presumed, identification of likely pathogen from sputum or other resp. sample; Suspected, all others. \*Definitive + presumed vs. suspected.

## Discussion and Conclusions:

- Within VACS-8, significantly more HIV+ subjects (13% HIV+ vs. 4% HIV-) had an ICD-9 code for CAP; on 74% and 66%, respectively, the diagnosis was confirmed by chart review (10% and 2.3%, respectively of the total sample).
- HIV+ patients were younger and more likely to be non-white, but did not differ significantly in other comorbidities.
- Majority of subjects were admitted from the community and had no risk factors for HCAP, HIV+ were less likely to have risk factors for HCAP (P<0.05).
- Overall PPV for ICD-9 codes for pneumonia was 72%, and was not significantly different between the two groups. PPV was modestly enhanced by either adding antimicrobial use at admission or using a reduced set of screening codes. Best PPV (77%) was obtained with the use of the reduced set of ICD-9 codes with addition of the administrative pharmacy data.
- Significantly more HIV+ subject had samples submitted for microbiologic evaluation. However, the overall diagnostic yield was low and not significantly different between the groups.
- It is important to understand the limitation of studies based on ICD-9 codes; our study suggest that within the VA system, results would not be significantly biased by HIV status.
- An algorithm including radiologic findings (which could be retrieved with natural language processing) could increase the PPV for CAP ICD-9 codes.
- Validated ICD-9 codes can be used in future work to map to ICD-10 codes.

## References:

Crothers K, Huang L, Goulet JL, Goetz MB, Brown ST, Rodriguez-Barradas MC, Oursler KK, Rimland D, Gibert CL, Butt AA, Justice AC. HIV infection and risk for incident pulmonary diseases in the combination antiretroviral therapy era. Am J Respir Crit Care Med. 2011;183(3):388-395.