Supplemental table S1 Risk of community-acquired pneumonia or pneumococcal disease in patients with chronic respiratory diseases (CRD)

Reference (country)	Methodology (N)	Disease definition	Underlying definition	No. of exposed cases with CRD	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Community-acquired pneumonia (all cause)						
Almirall 2008 [16] (Spain)	Population-based, case-control study, Nov 1999–Nov 2000 (1,336 cases)	Antibiotics, clinical and X-ray	Chronic bronchitis	216	>14	Multivariate: 1.81 (1.19–2.75)
			Asthma	375	>14	Multivariate: 1.67 (1.28–2.19)
Garcia-Vidal 2009 [17] (Spain)	Prospective, observational study, Jan 1995–Dec 2005 (146 cases, 224 episodes) Recurrent community-acquired pneumonia: new episode of community-acquired pneumonia requiring hospitalization <1 month or >3 years after first episode	Clinical, X-ray, blood culture, urinary tests	COPD	56	Adults	Multivariate: 1.53 (1.02–2.30)
Gau 2010 [18] (USA)	Retrospective case-control study, 2004–2006 (194 cases)	X-ray	COPD	91	≥65	Adjusted: 1.82 (1.17–2.82)
Jackson 2009 [19] (USA)	Population-based, nested case-control study, influenza seasons and pre-influenza periods of 2000/01 and 2002/03 (1,173 cases)	Clinical and X-ray				Multivariate:
			Lung disease, no medication or oxygen	6	≥65 65–74 75–84 85	2.0 (1.5–2.7) 3.1 (1.7–5.7) 2.3 (1.5–3.5) 1.1 (0.5–2.3)
			Lung disease with medication but not oxygen	36	≥65 65–74 75–84 85	2.5 (2.2–3.0) 2.9 (2.3–3.7) 2.8 (2.2–3.6) 1.9 (1.3–2.8)
			Lung disease, using oxygen	9	≥65 65–74 75–84 85	8.3 (5.5–12.7) 8.3 (4.4–15.7) 5.2 (2.7–9.9) 16.1 (3.7–69.9)
Juthani-Mehta 2013 [15] (USA)	Case-control study using a subset of a prospective cohort, 1997–2008 (193 cases)	Hospitalized pneumonia: ICD-9 criteria, clinical and chest X-ray	Chronic lung disease	49	70–79	Bivariate HR: 1.20 (0.87–1.66)

Reference (country)	Methodology (N)	Disease definition	Underlying definition	No. of exposed cases with CRD	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Loeb 2009 [20] (Canada)	Population-based, case-control study with collection of personal interview data, Sep 2002–Apr 2005 (717 cases)	Clinical and X-ray				Adjusted:
			COPD	343	≥65	13.53 (7.80–23.48)
			Asthma	168	≥65	3.04 (2.28–4.05)
Mullerova 2012 [21] (UK)	Nested case-control population-based on retrospective COPD cohort, 1996–2005 (1,469 cases)	Diagnosis code				Multivariate:
			COPD hospitalization (severe exacerbation)		≥45 (COPD)	2.73 (2.32-3.20)
			Moderate COPD exacerbation		≥45 (COPD)	1.28 (1.13-1.46)
Obiora 2013 [22] (UK)	Nested case-control study using primary care patient database, 2001–2002 (4,964 cases)	Medical records	Lung disease	1,201	Adults	2.74 (2.54–2.96)
Rodriguez 2009 [23] (Sweden)	Nested case-control study using the Health Improvement Network database, 2000–2005 (7,297 cases)	Pneumonia diagnosis code, validated by manual review of medical records	COPD	1,144	20–79	RR: 2.82 (2.45–3.24)
			Asthma	1,807	20–79	RR: 1.58 (1.44–1.74)
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Chronic lung disease		18–49 50–64 ≥65	Rate ratio: 8.6 (8.4–8.7) Rate ratio: 8.6 (8.5–8.7) Rate ratio: 6.6 (6.6–6.7)
			Asthma		18–49 50–64 ≥65	Rate ratio: 3.8 (3.8–3.9) Rate ratio: 4.7 (4.6–4.7) Rate ratio: 4.6 (4.5–4.6)
Vila-Corcoles 2009 [24] (Spain)	Population-based cohort study in community-dwelling individuals, 2002–2005 (473 cases)	Clinical, X-ray, microbiological and diagnosis code in hospital discharge database	Chronic lung disease	171	≥65	Multivariate HR: 2.91 (2.35–3.61)
Vinogradova 2009 [8] (UK)	Nested case-control study in 443 general practices in the UK 1996–2005 (17,172 cases)	Incident diagnosis code	Chronic respiratory disease	4,468 1,493	All ages 5–64	Adjusted: 2.42 (2.31–2.53) Adjusted: 2.31 (2.15–2.48)

Reference (country)	Methodology (N)	Disease definition	Underlying definition	No. of exposed cases with CRD	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Pneumococcal pneumonia						
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Chronic lung disease		18–49 50–64 ≥65	Rate ratio: 8.9 (8.1–9.7) Rate ratio: 9.8 (9.3–10.3) Rate ratio: 7.7 (7.3–8.0)
			Asthma		18–49 50–64 ≥65	Rate ratio: 3.7 (3.4–4.0) Rate ratio: 4.9 (4.6–5.2) Rate ratio: 5.9 (5.6–6.3)
Invasive pneumococcal disease						
Flory 2009 [25] (USA)	Population-based surveillance study, 2002–2004 (609 cases)	Bacteremia pneumococcal pneumonia: microbiological	Asthma	71	≥18	Adjusted: 2.1 (1.5–2.9)
Inghammar 2013 [13] (Sweden)	Nested case-control study, 1987–2008 (4,084 cases)	Positive culture from a normally sterile fluid	COPD	248 25 147 76	≥18 18–59 60–79 ≥80	Adjusted: 4.7 (4.0–5.6) 10.3 (5.8–18.0) 6.3 (5.1–7.8) 4.0 (3.0–4.8)
			Asthma	71 26 31 14	≥18 18–59 60–79 ≥80	Adjusted: 2.0 (1.5–2.6) 4.9 (3.0–7.8) 1.9 (1.3–2.9) 1.5 (0.9–2.7)
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Chronic lung disease		18–49 50–64 ≥65	Rate ratio: 6.3 (4.7–8.5) Rate ratio: 7.7 (6.8–8.8) Rate ratio: 6.2 (5.4–7.0)
			Asthma		18–49 50–64 ≥65	Rate ratio: 2.5 (1.9–3.2) Rate ratio: 3.8 (3.2–4.5) Rate ratio: 4.1 (3.4–5.0)
van Hoek 2012 [12] (UK)	Comparison of prevalence of clinical risk factors in the general population with that in hospitalized patients with invasive pneumococcal disease, 2002–2009 (22,298 cases)	ICD diagnosis code; microbiological	Chronic respiratory disease	938 2,364	16–64 ≥65	16.8 (15.7–18.0) 5.1 (4.8–5.4)
Watt 2007 [26] (USA)	Case-control prospective study, population-based active laboratory surveillance, 1999–2002 (118 cases)	Positive culture from a normally sterile fluid	COPD Asthma	7 8	≥18 ≥18	Univariate: 4.6 (1.3–15.9) Univariate: 1.3 (0.6–2.9)

Grey rows represent cohort studies; white rows represent case-control studies. *Unless otherwise specified.

CI, confidence interval; CRD, chronic respiratory disease; COPD, chronic obstructive pulmonary disease; HR, hazard ratio; ICD, International Classification of Diseases; OR, odds ratio, RR: relative risk.

Supplemental table S2 Risk of community-acquired pneumonia or pneumococcal disease in individuals who smoke

Reference (country)	Methodology (N)	Disease definition	Underlying definition	Number of smokers	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Community-acquired pneumonia						
Almirall 2014 [29] (Spain)	Population-based case-control study (471 cases)	Clinical, X-ray, antibiotics	Passive smoker		>14 <65 ≥65	Adjusted: 1.18 (0.90–1.57) 0.98 (0.68–1.41) 1.56 (1.00–2.45)
Almirall 2008 [16] (Spain)	Population-based, case-control study, Nov 1999–Nov 2000 (1,336 cases)	Antibiotics, clinical and X-ray	Ex-smoker Current smoker Passive smoker	423 365 143	>14 >14 >14	Univariate: 1.37 (1.14–1.64) 1.34 (1.11–1.62) 1.22 (0.93–1.61)
			Pack-yrs: ≤150 Pack-yrs: >150	354 362	>14 >14	Multivariate: 1.01 (0.81–1.26) 1.46 (1.14–1.86)
Gau 2010 [18] (USA)	Retrospective case-control study, 2004–2006 (194 cases)	X-ray	Ex-smoker Current smoker	60 28	≥65 ≥65	Adjusted: 1.88 (1.15–3.06) 2.34 (1.22–4.50)
Jackson 2009 [19] (USA)	Population-based, nested case-control study, influenza seasons and pre-influenza periods of 2000/01 and 2002/03 (1,173 cases)	Clinical and X-ray	Former smoker	57	≥65 65–74 75–84 85	Multivariate: 1.3 (1.1–1.5) 1.3 (1.0–1.6) 1.4 (1.1–1.7) 1.6 (1.1–2.3)
			Current smoker	9	≥65 65–74 75–84 85	Multivariate: 1.8 (1.4–2.3) 1.6 (1.1–2.5) 2.3 (1.5–3.7) 2.4 (1.1–5.1)

Reference (country)	Methodology (N)	Disease definition	Underlying definition	Number of smokers	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Juthani-Mehta 2013 [15] (USA)	Case-control study using a subset of a prospective cohort, 1997-2008 (193 cases)	Hospitalized pneumonia: ICD-9 criteria, clinical and chest X-ray	Current smoker	18	70–79	Bivariate HR: 1.95 (1.16–3.26)
			Former smoker	103	70–79	Bivariate HR: 1.68 (1.24–2.27)
			Pack-yrs smoking		70–79	Multivariate HR: 1.01 (1.00–1.01)
Mullerova 2012 [21] (UK)	Nested case-control population-based on retrospective COPD cohort, 1996–2005 (1,469 cases)	Diagnosis code				Multivariate: 1.04 (0.90–1.2)
			Former smoker		≥45 (COPD)	
			Current smoker		≥45 (COPD)	0.99 (0.86–1.14)
Obiora 2013 [22] (UK)	Nested case-control study using primary care patient database, 2001–2002 (4964 cases)	Medical records	Current smoker	1,219	Adults	1.69 (1.57–1.83)
Rodriguez 2009 [23] (Sweden)	Nested case-control study using the Health Improvement Network database, 2000–2005 (7,297 cases)	Pneumonia diagnosis code, validated by manual review of medical records	Smoker	3,161	20–79	RR: 1.52 (1.40–1.65)
			Ex-smoker	1,839	20–79	RR: 1.14 (1.04–1.25)
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Smoker		18–49	Rate ratio: 3.3 (3.2–3.3)
					50–64	Rate ratio: 4.0 (3.9–4.0)
					≥65	Rate ratio: 3.6 (3.5–3.6)
Vila-Corcoles 2009 [24] (Spain)	Population-based cohort study in community-dwelling individuals, 2002–2005 (473 cases)	Clinical, X-ray, microbiological and diagnosis code in hospital discharge database	Smoking	58	≥65	Multivariate HR: 1.12 (0.83–1.49)

Pneumococcal pneumonia

Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Smoker		18–49	Rate ratio: 3.0 (2.7–3.3)
					50–64	Rate ratio: 4.4 (4.1–4.6)
					≥65	Rate ratio: 3.9 (3.6–4.3)

Reference (country)	Methodology (N)	Disease definition	Underlying definition	Number of smokers	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Invasive pneumococcal disease						
Flory 2009 [25] (USA)	Population-based surveillance study, 2002–2004 (609 cases)	Bacteremia pneumococcal pneumonia: microbiological	Current smoker	207	≥18	Adjusted: 2.2 (1.7–3.0)
Jacups 2011 [30] (Australia)	Prospective surveillance cohort study, 1987–1998 (cohort 1); retrospective chart review cohort study, 1999–2008 (cohort 2) (205 cases for cohorts 1+2)	Bacteremic pneumococcal pneumonia: X-ray, microbiological	Smoker	146	≥14	Multivariate adjusted RR: 2.7 (1.9–3.7)
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Smoker		18–49	Rate ratio: 3.6 (2.8–4.5)
					50–64	Rate ratio: 4.3 (3.7–5.0)
					≥65	Rate ratio: 4.2 (3.2–5.5)
Watt 2007 [26] (USA)	Case-control prospective study, population-based active laboratory surveillance, 1999–2002 (118 cases)	Positive culture from a normally sterile fluid	Self-reported: Former smoker	21	≥18	Univariate: 1.5 (0.8–2.8)
			Current smoker	11	≥18	Univariate: 1.1 (0.5–2.3)
			Passive smoker	29	≥18	Univariate: 0.7 (0.4–1.1)

Grey rows represent cohort studies; white rows represent case-control studies. *Unless otherwise specified.
CI, confidence interval; HR, hazard ratio; ICD, International Classification of Diseases; OR, odds ratio, RR: relative risk.

Supplemental table S3 Risk of community-acquired pneumonia or pneumococcal disease in patients with diabetes mellitus

Reference (country)	Methodology (N)	Disease definition	Underlying definition	Number of cases with comorbidity	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Community-acquired pneumonia						
Almirall 2008 [16] (Spain)	Population-based, case-control study, Nov 1999–Nov 2000 (1,336 cases)	Antibiotics, clinical and X-ray	Treated diabetes mellitus	135	>14	Univariate: 1.43 (1.11–1.92)
Ehrlich 2010 [31] (USA)	Retrospective, longitudinal cohort study using Kaiser Permanente Medical Care Program database, including subcohort of survey responders (70,645 patients with diabetes)	ICD-9 diagnosis code	Diabetes		≥18	Multivariate HR: 1.92 (1.84–1.99)
Jackson 2009 [19] (USA)	Population-based, nested case-control study, influenza seasons and pre-influenza periods of 2000/01 and 2002/03 (1,173 cases)	Clinical and X-ray				Univariate, adjusted:
			Diabetes without insulin	6	≥65	1.0 (0.8–1.3)
			Diabetes with insulin	11	≥65	1.3 (1.0–1.5)
Juthani-Mehta 2013 [15] (USA)	Case-control study using a subset of a prospective cohort, 1997–2008 (193 cases)	Hospitalized pneumonia: ICD-9 criteria, clinical and chest X-ray	Diabetes mellitus	56	70–79	Bivariate HR: 1.05 (0.77–1.43)
Kornum 2008 [32] (Denmark)	Population-based, case-control study, 1997–2005 (34,239 cases)	Hospitalized pneumonia: ICD discharge codes	Diabetes (overall)	4,489	≥15 15–39 40–64 65–79 ≥80	Adjusted: RR: 1.26 (1.21–1.31) RR: 3.21 (2.51–4.12) RR: 1.65 (1.51–1.81) RR: 1.22 (1.15–1.29) RR: 1.11 (1.05–1.18)
			Type 1 diabetes	101	≥15 15–39 40–64	RR: 4.43 (3.40–5.77) RR: 5.15 (3.61–7.36) RR: 3.43 (2.14–5.50)

Reference (country)	Methodology (N)	Disease definition	Underlying definition	Number of cases with comorbidity	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Kornum 2008 (cont'd)			Type 2 diabetes	4,388	≥15 15–39 40–64 65–79 ≥80	RR: 1.23 (1.19–1.28) RR: 2.15 (1.51–3.06) RR: 1.62 (1.47–1.77) RR: 1.22 (1.15–1.29) RR: 1.11 (1.05–1.18)
			Diabetes (types 1 & 2) A1C level <7%	1,149	≥15	RR: 1.22 (1.14–1.30)
			A1C level ≥9%	568	≥15	RR: 1.60 (1.44–1.76)
			Duration ≥10 years	1,224	≥15	RR: 1.37 (1.28–1.47)
Mullerova 2012 [21] (UK)	Nested case-control population-based on retrospective COPD cohort, 1996–2005 (1,469 cases)	Diagnosis code	Diabetes		≥45 (COPD)	Multivariate: 1.07 (0.89–1.28)
Rodriguez 2009 [23] (Sweden)	Nested case-control study using the Health Improvement Network database, 2000–2005 (7,297 cases)	Pneumonia diagnosis code, validated by manual review of medical records	Diabetes	792	20–79	RR: 1.28 (1.13–1.44)
Seminog 2013 [14] (UK)	Retrospective cohort study of individuals hospitalized with diabetes mellitus, using two data sets of linked hospital admission and death records (Oxford Record Linkage Study [1963–1998] and all-England linked hospital episode statistics [1999–2011])	Lobar pneumonia: ICD diagnosis codes	Diabetes mellitus	2007–2011 (England): 2,287	<60	Rate ratio: 2.34 (2.23–2.47)
				15,648	≥60	Rate ratio: 1.61 (1.58–1.65)
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Diabetes		18–49	Rate ratio: 3.1 (3.1–3.2)
					50–64	Rate ratio: 3.0 (3.0–3.0)
					≥65	Rate ratio: 2.8 (2.8–2.8)
Skull 2009 [33] (Australia)	Case-cohort study (1,952 cases)	Hospitalized community-acquired pneumonia: diagnosis code, X-ray	Diabetes		≥65	Multivariate: RR: 1.22 (1.05–1.42)

Reference (country)	Methodology (N)	Disease definition	Underlying definition	Number of cases with comorbidity	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Vila-Corcoles 2009 [24] (Spain)	Population-based cohort study in community-dwelling individuals, 2002–2005 (473 cases)	Clinical, X-ray, microbiological and diagnosis code in hospital discharge database	Diabetes mellitus	120	≥65	Multivariate HR: 1.04 (0.85–1.29)
Vinogradova 2009 [8] (UK)	Nested case-control study in 443 general practices in the UK 1996–2005 (17,172 cases)	Incident diagnosis code	Diabetes	1,344 264	All ages 5–64	Adjusted: 1.36 (1.27–1.47) Adjusted: 1.74 (1.49–2.02)

Pneumococcal pneumonia

Reference (country)	Methodology (N)	Disease definition	Underlying definition	Number of cases with comorbidity	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Jacups 2011 [30] (Australia)	Prospective surveillance cohort study, 1987–1998 (cohort 1); retrospective chart review cohort study, 1999–2008 (cohort 2) (205 cases for cohorts 1+2)	Bacteremic pneumococcal pneumonia: X-ray, microbiological	Diabetes	44	≥14	Multivariate, adjusted: RR: 2.3 (1.6–3.3)
Seminog 2013 [14] (UK)	Retrospective cohort study of individuals hospitalized with diabetes mellitus, using two data sets of linked hospital admission and death records (Oxford Record Linkage Study [1963–2011] and all-England linked hospital episode statistics [1999–2011])	ICD diagnosis codes	Diabetes mellitus	2007–2011 (England): 82 327	 < 60 ≥60	 Rate ratio: 2.03 (1.55–2.65) Rate ratio: 1.54 (1.32–1.79)
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Diabetes		18–49 50–64 ≥65	Rate ratio: 3.1 (2.9–3.3) Rate ratio: 3.0 (2.8–3.1) Rate ratio: 2.8 (2.7–2.9)

Invasive pneumococcal disease

Reference (country)	Methodology (N)	Disease definition	Underlying definition	Number of cases with comorbidity	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Flory 2009 [25] (USA)	Population-based surveillance study, 2002–2004 (609 cases)	Bacteremia pneumococcal pneumonia: microbiological	Diabetes mellitus	65	≥18	Adjusted: 1.4 (1.0–2.0)

Reference (country)	Methodology (N)	Disease definition	Underlying definition	Number of cases with comorbidity	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Inghammar 2013 [13] (Sweden)	Nested case-control study, 1987–2008 (4084 cases)	Positive culture from a normally sterile fluid	Diabetes mellitus	298	≥18	Multivariate: 1.7 (1.5–1.9)
Seminog 2013 [14] (UK)	Retrospective cohort study of individuals hospitalized with diabetes mellitus, using two data sets of linked hospital admission and death records (Oxford Record Linkage Study [1963–1998] and all-England linked hospital episode statistics [1999–2011])	Pneumococcal septicemia and meningitis: ICD diagnosis codes	Diabetes mellitus	2007–2011 (England): 33 / 93	<60 / ≥60	Rate ratio: 2.06 (1.33–3.14) / Rate ratio: 1.50 (1.12–2.01)
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Diabetes		18–49 / 50–64 / ≥65	Rate ratio: 3.0 (2.4–3.7) / Rate ratio: 2.6 (2.3–2.9) / Rate ratio: 2.5 (2.2–2.9)
van Hoek 2012 [12] (UK)	Comparison of prevalence of clinical risk factors in the general population with that in hospitalized patients with invasive pneumococcal disease, 2002–2009 (22,298 cases)	ICD diagnosis code; microbiological	Diabetes	703 / 1,495	16–64 / ≥65	4.6 (4.2–5.0) / 2.3 (2.2–2.5)
Watt 2007 (USA) [26]	Case-control prospective study, population-based active laboratory surveillance, 1999–2002 (118 cases)	Positive culture from a normally sterile fluid	Diabetes mellitus	37	≥18 / ≥18 / ≥18 (chronic renal failure)	Univariate: 1.7 (1.0–2.9) / Multivariate: 1.5 (0.8–2.6) / Multivariate: 5.8 (2.3–14.8)
Wotton 2012 [34] (UK)	Retrospective cohort study of individuals hospitalized with immune-mediated diseases, using two data sets of linked hospital admission and death records (Oxford Record Linkage Study [ORLS1: 1963–1998; ORLS2: 1999–2008] and all-England linked hospital episode statistics [1999–2008])	ICD diagnostic codes	Diabetes mellitus (since <30 years of age)		All ages (ORLS2) / All ages (England)	Rate ratio: 3.30 (2.07–5.07) / Rate ratio: 3.90 (3.55–4.28)

Grey rows represent cohort studies; white rows represent case-control studies. *Unless otherwise specified.

A1C, glycated hemoglobin; CI, confidence interval; ChI, Charlson index; HR, hazard ratio; ICD, International Classification of Diseases; OR, odds ratio, RR: relative risk.

Supplemental table S4 Risk of community-acquired pneumonia or pneumococcal disease in patients with chronic heart disease

Reference (country)	Methodology	Disease definition	Underlying definition	Number of exposed cases	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Community-acquired pneumonia						
Almirall 2008 [16] (Spain)	Population-based, case-control study, Nov 1999–Nov 2000 (1,336 cases)	Antibiotics, clinical and X-ray	CHF	114	>14	Univariate: 1.81 (1.33–2.49)
			Heart valve disease	59	>14	Univariate: 1.70 (1.11–2.61)
			Coronary artery disease	80	>14	Univariate: 1.05 (0.76–1.45)
Gau 2010 [18] (USA)	Retrospective case-control study, 2004–2006 (194 cases)	X-ray	CHF	63	≥65	Adjusted: 1.60 (1.04–2.46)
			Coronary artery disease	77	≥65	Adjusted: 1.40 (0.94–2.08)
Jackson 2009 [19] (USA)	Population-based, nested case-control study, influenza seasons and pre-influenza periods of 2000/01 and 2002/03 (1,173 cases)	Clinical and X-ray				Multivariate:
			Non-CHF heart disease	32	≥65 65–74 75–84 85	1.2 (1.1–1.4) 1.2 (1.0–1.6) 1.1 (0.9–1.4) 1.5 (1.0–2.3)
			Mild CHF	10	≥65 65–74 75–84 85	1.9 (1.5–2.5) 2.3 (1.4–4.0) 3.2 (2.2–4.8) 1.1 (0.6–1.8)
			Severe CHF	8	≥65 65–74 75–84 85	3.3 (2.3–4.7) 2.8 (1.5–5.4) 3.5 (2.1–5.8) 2.7 (1.1–6.6)
Juthani-Mehta 2013 [15] (USA)	Case-control study using a subset of a prospective cohort, 1997–2008 (193 cases)	Hospitalized pneumonia: ICD-9 criteria, clinical and chest X-ray	Coronary heart disease	70	70–79	Bivariate HR: 1.25 (0.93–1.68)

Reference (country)	Methodology	Disease definition	Underlying definition	Number of exposed cases	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Mor 2013 [10] (Denmark)	Population-based case-control study using healthcare databases in northern Denmark, 1994–2008 (67,162 cases)	Hospitalized pneumonia (including hospital-acquired pneumonia): ICD diagnosis code	Overall CHF	12,339	≥15	Adjusted: 1.81 (1.76–1.86)
			Cardio-myopathy	371	≥15	2.05 (1.80–2.33)
			Heart valve disease	703	≥15	2.19 (2.00–2.40)
			Acute myocardial infarction	2,704	≥15	1.69 (1.59–1.80)
			Atrial fibrillation	5,713	≥15	1.72 (1.66–1.78)
			Others	2,848	≥15	1.99 (1.89–2.09)
Mullerova 2012 [21] (UK)	Nested case-control population-based on retrospective COPD cohort, 1996–2005 (1,469 cases)	Diagnosis code	Myocardial infarction		≥45 (COPD)	Multivariate: 1.0 (0.85–1.19)
			CHF		≥45 (COPD)	1.37 (1.20–1.57)
Nyboe 2014 [11] (Denmark)	Nationwide cohort study in adults with closed versus unclosed atrial septal defect using Danish National Patient Registry, 1997–2009 (240 cases)	Diagnosis code	Atrial septal defect: Closed	161	≥18	Adjusted HR: 2.8 (2.3–3.5)
			Unclosed	79	≥18	3.1 (2.4–4.0)
Obiora 2013 [22] (UK)	Nested case-control study using primary care patient database, 2001–2002 (4,964 cases)	Medical records	Myocardial infarction	630	Adults	1.36 (1.23–1.50)
Rodriguez 2009 [23] (Sweden)	Nested case-control study using the Health Improvement Network database, 2000–2005 (7,297 cases)	Pneumonia diagnosis code, validated by manual review of medical records	Ischemic heart disease	1,244	20–79	RR: 1.28 (1.16–1.42)
			Myocardial infarction	512	20–79	RR: 1.42 (1.22–1.65)
			CHF	533	20–79	RR: 2.63 (2.21–3.14)
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Chronic heart disease		18–49	Rate ratio: 4.9 (4.9–5.0)
					50–64	Rate ratio: 4.3 (4.2–4.3)
					≥65	Rate ratio: 3.8 (3.8–3.8)

Reference (country)	Methodology	Disease definition	Underlying definition	Number of exposed cases	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Vila-Corcoles 2009 [24] (Spain)	Population-based cohort study in community-dwelling individuals, 2002–2005 (473 cases)	Clinical, X-ray, microbiological and diagnosis code in hospital discharge database	Chronic heart disease	99	≥65	Multivariate HR: 1.46 (1.16–1.84)
Vinogradova 2009 [8] (UK)	Nested case-control study in 443 general practices in the UK 1996–2005 (17,172 cases)	Incident diagnostic code	Chronic heart disease	3,239 321	All ages 5–64	Adjusted: 1.63 (1.54–1.72) Adjusted: 2.05 (1.78–2.37)
Pneumococcal pneumonia						
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Chronic heart disease		18–49 50–64 ≥65	Rate ratio: 5.1 (4.6–5.5) Rate ratio: 4.2 (4.0–4.4) Rate ratio: 3.8 (3.6–3.9)
Invasive pneumococcal disease						
Inghammar 2013 [13] (Sweden)	Nested case-control study, 1987–2008 (4,084 cases)	Positive culture from a normally sterile fluid	CHF	333	≥18	Multivariate: 1.7 (1.4–1.9)
Shea 2014 [7] (USA)	Retrospective cohort study using three healthcare claims repositories, 2006–2010	Diagnosis/drug codes	Chronic heart disease		18–49 50–64 ≥65	Rate ratio: 3.9 (3.0–5.1) Rate ratio: 2.9 (2.6–3.3) Rate ratio: 3.2 (2.8–3.6)
van Hoek 2012 [12] (UK)	Comparison of prevalence of clinical risk factors in the general population with that in hospitalized patients with invasive pneumococcal disease, 2002–2009 (22,298 cases)	ICD diagnosis code; microbiological	Chronic heart disease	1,213 4,841	16–64 ≥65	6.9 (6.5–7.4) 3.0 (2.9–3.1)

Reference (country)	Methodology	Disease definition	Underlying definition	Number of exposed cases	Population age (years) (other predisposing condition)	Fold risk elevation OR (95% CI)*
Watt 2007 [26] (USA)	Case-control prospective study, population-based active laboratory surveillance, 1999–2002 (118 cases)	Positive culture from a normally sterile fluid	CHF	26	≥18	Univariate: 9.9 (4.3–23.0)
			History of myocardial infarction	7	≥18	Univariate: 2.6 (0.9–7.5)
			Coronary artery disease	15	≥18	Univariate: 2.9 (1.3–6.2)

Grey rows represent cohort studies; white rows represent case-control studies. *Unless otherwise specified.

CI, confidence interval; HR, hazard ratio; CHF, congestive heart failure; ICD, International Classification of Diseases; OR, odds ratio, RR: relative risk.