ORIGINAL ARTICLE

Effect of Chronic Illnesses on Length of Stay and Mortality of Community Acquired Pneumonia in a Community Hospital

Saurabh Dwivedi[1], Rajni Madaan[1], Saurav Pokharel[2], Bikash Bhattarai[3], Abhishek Sinha Ray[4], Meenakshi Ghosh[4]

[1]Internal Medicine, Latrobe Hospital, Excela Health, Latrobe, Pennsylvania
[2]Pulmonary Disease, Frye Regional Medical Center, Hickory, North Carolina
[3]Pulmonary Disease, Amita Health, Elk Grove Village, Illinois
[4]Nephrology, Good Samaritan Hospital, Kearney, Nebraska

Corresponding author: Saurabh Dwivedi, MD, MPH. 635 Jason Ct, Mount Pleasant, PA 15666 (drsaurabhdwivedi@gmail.com)

Abstract: The aim of this study was to determine the effect of demographics, substance abuse, and chronic illnesses on length of hospitalization and mortality of pneumonia. 866 patients admitted to a community hospital with diagnosis of community-acquired pneumonia were studied. Linear and logistic regression analyses were performed for the effect of chronic illnesses on length of stay and mortality. Age (p=0.064), coronary artery disease (p=0.017), congestive heart failure (p=0.011), history of neoplasm (p=0.079) and chronic kidney disease (p<0.001) were associated with increased length of stay. Age (p<0.001), history of stroke (p=0.013), history of neoplasm (p=0.028), and chronic kidney disease (p=0.005) were associated with higher mortality from community-acquired pneumonia. Asthma was associated with decreased length of stay (p=0.006) but no difference in mortality. Respiratory failure and congestive heart failure exacerbation were associated with longer length of stay (p<0.001) but no difference in mortality. ICU admission was associated with longer hospital stay and higher mortality (p<0.001). Septic shock secondary to pneumonia was associated with longer length of stay and higher mortality (p<0.0001). Age (p=0.04), alcohol abuse (p=0.03), coronary artery disease (p=0.05), congestive heart failure (p=0.009) and chronic kidney disease (p=0.011) were predictors of higher level of care needed during hospital stay for community acquired pneumonia.

Keywords: pneumonia, community acquired pneumonia, chronic illnesses, length of stay, mortality.

INTRODUCTION

Community acquired pneumonia (CAP) continues to be a significant cause of morbidity and mortality despite advances in medical sciences [1-3]. Influenza and pneumonia are the eighth leading cause of death in the United States causing 55,672 deaths annually [4-6]. During a two year prospective study of North America, overall

admissions of pneumonia were about 270 per 100,000 adults per year; this number is expected to grow as population ages [7]. 10 to 20% of patients hospitalized for pneumonia are estimated to require intensive care [8]. The economic burden of community-acquired pneumonia is estimated around $17 billion annually in United States[9].

Symptomatology, severity, presentation, and prognosis of pneumonia vary by presence of co-morbid illnesses [10], [11]. Age of the patient at the time of presentation is a significant predictor of mortality for hospitalized patients [7]. Male sex, hypertension, diabetes mellitus and history of neoplasm are all independently associated with increased mortality from pneumonia [12, 13]. Initial presentation in CAP can predict patient outcomes [14]. Higher severity of presentation from pneumonia with shock or renal failure predicts higher risk of death from it [9].

Worsening of co-morbid illnesses secondary to pneumonia also plays an important role in prognosis. Concurrent congestive heart failure decompensation due to pneumonia increases in-hospital mortality due to pneumonia [15]. Patient with chronic obstructive pulmonary disease (COPD) had worse prognosis and higher odds of mortality while asthma patients had better prognosis and lower mortality [16]. Pneumonia does increase hospital admissions for asthma exacerbations especially during flu season[17] but worsening of asthma is associated with better prognosis of pneumonia[18]. Presence of liver disease is highly predictive of bacteremia and worse prognosis in pneumonia[19]. Tobacco smoking is associated with increased odds of hospital admission with pneumonia[20]. Not only is alcohol intake a significant risk factor for development of CAP, it is also associated with higher intensity of care and longer hospital stay[21, 22]. Effect of other

substance abuse on prognosis of CAP has not been widely studied. Effect of clinical markers, severity of pneumonia and clinical presentation on need for hospitalization and mortality have been previously studied [23, 24] but there is paucity of data for effect of chronic illnesses on length of stay from a hospitalist's point of view.

The aim of this study was to examine the effects of sex, age, BMI, substance use (including tobacco, alcohol, cocaine, and cannabis) and co-morbid illness (including asthma, chronic obstructive pulmonary disease, diabetes mellitus, liver disease, coronary artery disease, congestive heart failure, history of stroke, history of neoplasm and kidney disease) on length of stay in the hospital (LOS), presentation of pneumonia, intensity of care needed, and mortality in patients admitted with community acquired pneumonia.

METHODS

Study Sample
All patients admitted to Interfaith Medical Center with a diagnosis of CAP over 3 years were screened. ICD-9 codes for pneumonia (486) and bacterial pneumonia (482.9) were used to screen initial list of about 2000 patients admitted. Out of these patients, 866 were included in the study and others were excluded based on reasons mentioned below.

Our goal was to restrict pathology to community-acquired pneumonia. We excluded patients with possible healthcare-associated pneumonia as well as aspiration pneumonia. The diagnosis of HCAP was based on documentation by physician besides using readmission within 90 days as exclusion criteria. The study was restricted to patients aged 18 and older. Immunocompromised patients including HIV/AIDS or currently receiving chemotherapy were excluded. Immunosuppressed patients can present with

very wide variety of etiology for pneumonia and we tried to restrict pneumonia pathology to community-acquired infections. Other admissions for primarily cardiac conditions like arrhythmias and myocardial infarction were excluded. Among CKD patients, patient with end stage renal disease and patients on dialysis were also excluded.

Data was retrospectively collected on demographic factors including age, race, sex, and body mass index, medical co-morbidities and substance abuse (tobacco, alcohol, cocaine, cannabis). Asthma, chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM), liver disease (alcoholic or non-alcoholic liver disease or chronic viral hepatitis), coronary artery disease (CAD), congestive heart failure (CHF), history of stroke, history of neoplasm and chronic kidney disease (CKD), as documented in the medical record, were chosen as predictors among co-morbid illness. Study sample could not be stratified based on race as majority of our patients were African America (86%). Information on substance abuse was derived from positive urine toxicology during hospital stay or from documentation as self-reported by patients. Differentiating patients based on opioid abuse and those on long-term dependence therapy could be perplexing, so we did not study opioid abuse in this sample.

Definition of Study Outcomes
Longer length of inpatient stay is an indicator of higher severity of infection and is in turn associated with poor outcomes, increased hospital costs, and increased mortality [25, 26]. Sicker patients require higher intensity of care during hospital stay, and intensity of care required during hospital stay in turn correlates to worse outcomes and higher mortality [25, 26]. We considered three study outcomes: length of hospital stay (days), level of care needed during hospitalization (ICU, higher level); and discharge disposition (discharged or expired). Patients

were also divided based on presence of respiratory failure, decompensation of CHF, and septic shock and their effect on length of stay and mortality was evaluated.

Baseline characteristics, pneumonia severity, presence of co-morbidities and mortality were examined after stratifying by gender. We compared all study variables by gender using t-tests for continuous variables (age, BMI, LOS) and chi-square tests for categorical variables (presence of co-morbid illness, substance abuse, intensity of care and mortality) (Table 1). Regression analyses were performed to study effect of co-morbidities and substance abuse on pneumonia severity and patient outcomes. Linear regression was performed for continuous outcome of length of stay (in days) and logistic regression was performed for dichotomous outcome of mortality.

In model 1, effect of age, sex, BMI, substance abuse and co-morbid illnesses on length of stay and mortality was studied (Table 2). Separate age-adjusted models were completed for each variable. In model 2, effect of presence of respiratory failure, CHF exacerbation and septic shock on length of stay and mortality was studied. Both the regressions were simultaneously adjusted for baseline characteristics, substance abuse and co-morbid illness (Table 3).

In model 3, we studied effect of higher level care needed (ICU or Telemetry) on length of stay and mortality. Both the regressions were simultaneously adjusted for baseline characteristics, substance abuse and co-morbid illness (Table 4). In model 4, effect of age, sex, BMI, substance abuse and presence of co-morbid illness on level of care needed during hospitalization was studied. Interfaith Medical Center is structured into three levels of care: ICU, telemetry, and a medical-surgical unit. ICU admissions were compared against floor admissions. We combined ICU and telemetry admissions into higher level of care and compared them to

floor admissions. Both the regressions were simultaneously adjusted for baseline characteristics, substance abuse and co-morbid illness.

RESULTS

Out of total 866 patients, 48.4% were men and 51.6% were women. Women were older at presentation than men (p=0.012) and had higher average BMI (p=0.009). Substance abuse including tobacco, alcohol, cocaine and cannabis were more prevalent among men (Table 1). Men had higher prevalence of COPD and liver disease, while women had a higher prevalence of bronchial asthma, DM, CAD, CHF and history of stroke. There were no significant differences for presence of history of neoplasm and CKD by sex (Table 1). There were no significant differences for presentation or severity of illness by gender. There was no significant difference for LOS by gender but mortality was higher among women as compared to men (p=0.007) (Table 1).

Table 1. Baseline characteristics of patients included in the study. Groups were compared for differences using t-test or chi-square testing.

	Total	Men	Women	p-value
Patients	866	419 (48.4%)	447 (51.6%)	<0.001
Age	60.19 ± 17.42	59.23 ± 16.55	61.09 ± 18.17	0.012
BMI	28.33 ± 8.77	26.04 ± 6.71	30.49 ± 9.88	0.009
Substance abuse				
Tobacco	450 (53.4%)	257 (63.3%)	193 (44.2%)	<0.001
Alcohol	272 (32.4%)	174 (43.1%)	98 (22.5%)	<0.001
Cocaine	96 (11.5%)	56 (13.4%)	40 (9.2%)	<0.001
Cannabis	88 (10.5%)	60 (14.9%)	28 (6.5%)	<0.001
Comorbidities				
COPD	216 (25%)	112 (26.8%)	104 (23.3%)	0.017
Asthma	200 (23.1%)	62 (14.8%)	138 (30.9%)	<0.001
Diabetes Mellitus	296 (34.2%)	130 (31.1%)	166 (37.1%)	<0.001
Chronic Liver disease	93 (10.8%)	59 (14.1%)	34 (7.6%)	<0.001
Coronary Artery disease	182 (21.1%)	73 (17.5%)	108 (24.4%)	<0.001
Congestive Heart Failure	202 (23.2%)	81 (9.4%)	121 (27.1%)	<0.001
Chronic Kidney Disease	223 (25.8%)	107 (25.8%)	116 (26.0%)	0.813
History of Stroke	100 (11.6%)	42 (10.0%)	58 (13.0%)	<0.001

History of Neoplasm	86 (9.9%)	45 (10.8%)	41 (9.2%)	0.118
Admitted to Unit				
Floor	446 (51.6%)	208 (49.8%)	238 (53.2%)	0.192
Telemetry	275 (31.8%)	137 (32.8%)	138 (30.9%)	0.251
ICU	144 (16.6%)	73 (17.5%)	71 (15.9%)	0.225
Disposition				
Discharged	775 (89.5%)	381 (90.9%)	394 (88.1%)	0.007
Expired	91 (10.5%)	38 (9.1%)	53 (11.9%)	0.007

Factors Associated with Length of Stay

In model 1, age-adjusted linear regression was performed for length of stay using baseline characteristics, substance abuse and co-morbid illness as predictors. Higher length of stay was observed for patients with increase in age (p=0.064). Patients with CAD (p=0.017), CHF (p=0.011), history of neoplasm (p=0.079) or CKD (p<0.001) as co-morbidities had longer length of stay. Presence of asthma (p=0.006) was associated with shorter LOS. There was no significant effect of sex, BMI, substance abuse, DM, chronic liver disease and history of stroke on LOS after multivariable adjustment (Table 2).

In model 2, linear regression for LOS was conducted for only surviving cases. Patients with respiratory failure secondary to pneumonia had 10.6 more days (p<0.001) and patients with CHF decompensation 8.3 more days (p<0.001) of hospital stay as compared to patients with uncomplicated pneumonia. Septic shock secondary to pneumonia resulted in 10.3 more days (p<0.001) of hospital stay (Table 3).

In model 3, admission to telemetry was associated with about 3 more days of hospital stay, and admission to ICU was associated with about 11 more days of hospital stay regardless of admitting diagnosis (p < 0.001) after adjusting for age, sex, BMI, substance abuse and co-morbid illnesses (Table 4).

Table 2. Model 1 – Age-Adjusted Linear Regression for outcomes of length of stay (in days) and logistic regression for outcome of mortality using baseline characteristics, substance abuse and comorbidities as predictors.

	Length of Stay Coefficient ± SE (p value)	Mortality Odds ratio (95% CI, p value)
Sex	0.564 ± 0.744	1.140 (0.71 – 1.82)
Age	**0.066 ± 0.036 (p=0.064)**	**1.068 (1.05-1.08, p<0.001)**
BMI	0.026 ± 0.061	1.009 (0.97-1.05)

Tobacco	0.448 ± 0.770	0.932 (0.56-1.56)
Alcohol	0.585 ± 0.831	1.189 (0.63-2.23)
Cocaine	0.182 ± 1.207	1.064 (0.36-3.17)
Cannabis	- 0.680 ± 1.274	0.597 (0.14-2.59)
COPD	0.188 ± 0.862	0.702 (0.39-1.24)
Asthma	**-2.503 ± 0.907 (p=0.006)**	0.528 (0.24-1.15)
Diabetes Mellitus	0.733 ± 0.799	1.068 (0.67-1.71)
Chronic Liver disease	0.760 ± 1.201	1.958 (0.95-4.03)
Coronary Artery Disease	**2.295 ± 0.964 (p=0.017)**	1.206 (0.73-2.01)
Congestive Heart Failure	**2.367 ± 0.924 (p=0.011)**	1.356 (0.83-2.22)
Chronic Kidney Disease	**4.395 ± 0.870 (p<0.001)**	**1.965 (1.22-3.16, p=0.005)**
History of Stroke	1.923 ± 1.195	**2.022 (1.16-3.53, p=0.013)**
History of Neoplasm	**2.157 ± 1.267 (p=0.079)**	**1.943 (1.08-3.51, p=0.028)**

Age adjusted model was used independently for each variable. Linear regression was performed for length of stay in days and logistic regression was performed for mortality.

Table 3. Model 2 – Linear regression for outcome of length of stay and logistic regression for outcome of mortality using admitting diagnoses as predictor.

	Length of Stay Coefficient ± SE (p value)	Mortality Odds ratio (95% CI, p value)
Pneumonia with respiratory failure	10.646 ± 1.500 (p<0.001)	1.251 (0.53-2.96)
Pneumonia with CHF decompensation	8.302 ± 0.972 (p<0.001)	1.663 (0.93-2.98, p=0.088)
Pneumonia with Septic Shock	10.295 ± 2.357 (p<0.001)	20.479 (6.41-65.46, p<0.001)

Adjusted for sex, age, body mass index, substance abuse (tobacco, alcohol, cocaine and cannabis) and comorbid illness (Asthma, COPD, CAD, CHF, DM, Liver disease, Stroke, Neoplasm and Kidney disease). Patients admitted with pneumonia without complications were used as reference group.

Factors Associated with Mortality
Multivariable-adjusted logistic regression was performed for outcome of mortality simultaneously using baseline characteristics, substance abuse and co-morbid illness as predictors. Mortality significantly increased with age. Mortality increased by 6.8% per year increase in age (Odds ratio 1.068, p<0.001) (Table 2). Age adjusted regression models for sex, BMI and substance abuse did not show any significant relationship. After adjusting for age, sex, BMI and substance abuse in logistic regression, mortality outcome from co-morbid illness showed increased mortality with history of stroke (p=0.013), neoplasm (p=0.028) and CKD (p=0.005). In model 2, logistic regression of mortality showed about 20 times higher odds of mortality in patients admitted with septic shock secondary to pneumonia as compared to patients admitted with uncomplicated pneumonia (p<0.001) after adjusting for age, sex, BMI, substance abuse and presence of co-morbid illnesses. Presence of respiratory failure or CHF

decompensation did not differ statistically from uncomplicated pneumonia in terms of mortality (Table 4). In model 3, ICU admission was associated with higher odds of mortality (p < 0.001) as compared to floor admissions after adjusting for age, sex, BMI, substance abuse and presence of co-morbid illnesses. The telemetry admissions were not significantly different from floor admission in terms of mortality (Table 4).

Factors Associated with Level of Care
In model 4, logistic regression analysis was performed to predict level of care required (ICU or higher level) based on age, sex, BMI, substance abuse and preexisting co-morbid illness. Higher age (p=0.046) and patients with CKD (p=0.011) were more likely to require ICU care during hospital stay. Patients with higher age (p=0.041), alcohol abuse (p=0.029), CAD (p=0.048) and CHF (p=0.004) were more likely to require overall higher level of care during hospital stay.

Table 4. Model 3 – Linear regression for outcomes of length of stay (in days) and logistic regression for outcome of mortality using intensity of inpatient care as predictor.

	Length of Stay Coefficient ± SE (p value)	Mortality Odds ratio (95% CI, p value)
Telemetry	3.82 ± 0.47 (p<0.001)	1.074 (0.32-3.59, p=0.91)
ICU	11.05 ± 1.28 (p<0.001)	69.53 (26.92-203.8, p<0.001)

Adjusted for sex, age, body mass index, substance abuse (tobacco, alcohol, cocaine and cannabis) and comorbid illness (asthma, COPD, CAD, CHF, DM, liver disease, stroke, neoplasm and kidney disease). Admissions to floor were used as reference group. Telemetry admissions and ICU admissions were compared to floor admissions for length of stay and mortality.

DISCUSSION

Higher mortality was observed for women in unadjusted samples but results were not significant after multivariate adjustment. This could possibly be explained by higher prevalence of DM, CAD and CHF among women in our sample. In previous studies

lower mortality has been observed in females [27, 28]. Patients with prior history of cerebrovascular event with or without existing deficit had significantly higher mortality but no significant difference in LOS or level of care needed. Patients with CKD and history of neoplasm had significantly higher length of stay and

mortality. CKD was also predictive of critical care needed during hospital admission for community acquired pneumonia. These findings are similar to previous studies of prognosis of pneumonia [9, 12, 13].

Patients with asthma who presented with pneumonia had significantly shorter LOS but no differences in mortality. This is contrary to expectation of higher mortality and morbidity from coexisting asthma. A possible explanation could be higher incidence of atypical pneumonia in asthma patients which has lower morbidity and mortality as compared to other bacterial etiologies [18]. Presence of liver disease did not affect LOS, mortality or level of care on our sample [27, 28]. While patients with significant lung damage from smoking could have been accounted for under COPD, there was no effect of tobacco smoking on length of stay or mortality. Tobacco smoking has been shown to increase odds of hospital admission and mortality from pneumonia [29].

Length of stay and mortality were significantly higher for patients admitted to the ICU independent of diagnoses and in those with diagnosis of septic shock, which is an expected finding [9]. Length of stay was higher for patients admitted with respiratory failure or decompensation of CHF secondary to pneumonia but there was no difference in mortality. Higher in-hospital mortality has been previously observed in pneumonia patients with worsening CHF [15]. Our exclusion of patients admitted with primarily cardiac diagnoses could account for this difference of observation. Heart diseases independent of pneumonia continue to be the leading cause of mortality and morbidity in United States [5].

The following were the limitations of our study. Firstly, the sample was limited to patients admitted to a community hospital in Brooklyn. Interfaith Medical Center is primarily non-profit and located in a less privileged area of Brooklyn and caters to surrounding neighborhoods. This sample is very different from the national population and thus our findings may not be generalizable. We had multiple exclusion criteria and these results only apply to patients admitted with CAP. Third, we did not include microbiologic data in the study and tried to classify pneumonia based on presentation. This could be a major limitation to our study. Fourth, we did not classify pneumonia on the basis of etiology, which might obscure some key findings. The higher association of atypical pneumonia with asthma is possibly the reason for lower morbidity and mortality in asthmatics admitted with pneumonia, rather than effect of actual asthma. Another potential problem is higher rate of homelessness in the patients served by the hospital, which delays safe discharge planning. Fifth, we did not have sufficient information and could not quantify relationship based on amount or frequency of substance abuse. Despite these weaknesses, the study does have strengths. We evaluated relationships of only CAP in terms of morbidity and mortality. Limiting the sample and etiology may have helped reduce dilution of relationships and helped reveal relationships. We included all previously studied co-morbid illnesses in addition to substance abuse for effect on morbidity and mortality of CAP. Effect of chronic illnesses on patient outcomes have been studied regardless of admitting diagnoses [30, 31]. We studied the effect of chronic illnesses specifically in the case of community acquired pneumonia. In today's era of hospital medicine, with increased focus on decreasing length of stay and prioritizing dispositions, it is necessary to further explore the factors which contribute to length of hospitalization and mortality.

In conclusion, in patients admitted with community acquired pneumonia, length

of hospital stay increased with age, coronary artery disease, congestive heart failure, history of neoplasm and chronic kidney disease. Morbidity from pneumonia increased with age, chronic kidney disease, history of stroke and history of neoplasm. Age, alcohol abuse, coronary artery disease, congestive heart failure and chronic kidney disease were predictors of higher level of care during hospital stay. Our findings emphasize the burden of chronic diseases on health care and contribution to poor outcomes in pneumonia.

Notes
Potential conflicts of interest: Authors declare no conflicts of interest.

References
1. Mandell, L. and M. Niederman, *Antimicrobial treatment of community acquired pneumonia in adults: a conference report.* Canadian Journal of Infectious Diseases and Medical Microbiology, 1993. **4**(1): p. 25-28.
2. Marrie, T., et al., *Community-acquired pneumonia requiring hospitalization. Is it different in the elderly?* Journal of the American geriatrics society, 1985. **33**(10): p. 671-680.
3. Apisarnthanarak, A. and L.M. Mundy, *Etiology of community-acquired pneumonia.* Clinics in chest medicine, 2005. **26**(1): p. 47-55.
4. Heron, M., et al., *National vital statistics reports.* National Vital Statistics Reports, 2009. **57**(14).
5. Xu, J., et al., *National vital statistics reports.* National vital statistics reports, 2010. **58**(19).
6. Kenneth D. Kochanek, M.A., Sherry L. Murphy, B.S., Jiaquan Xu, M.D., and Elizabeth Arias, Ph.D., *Mortality in United States 2017.* CDC **68**(9): p. 77.
7. Marrie, T.J., H. Durant, and L. Yates, *Community-acquired pneumonia requiring hospitalization: 5-year prospective study.* Review of Infectious Diseases, 1989. **11**(4): p. 586-599.
8. Marrie, T.J. and J.Q. Huang, *Epidemiology of community-acquired pneumonia in Edmonton, Alberta: an emergency department-based study.* Canadian respiratory journal: journal of the Canadian Thoracic Society, 2005. **12**(3): p. 139-142.
9. Rello, J., et al., *Severe community-acquired pneumonia in the elderly: epidemiology and prognosis.* Clinical infectious diseases, 1996. **23**(4): p. 723-728.
10. Ruiz, M., et al., *Etiology of community-acquired pneumonia: impact of age, comorbidity, and severity.* American journal of respiratory and critical care medicine, 1999. **160**(2): p. 397-405.
11. Campbell, G., *Overview of community-acquired pneumonia. Prognosis and clinical features.* The Medical clinics of North America, 1994. **78**(5): p. 1035-1048.
12. Fine, M.J., et al., *Prognosis and outcomes of patients with community-acquired pneumonia: a meta-analysis.* Jama, 1996. **275**(2): p. 134-141.
13. Fine, M., et al., *Prognosis of patients hospitalized with community-acquired pneumonia.* The American journal of medicine, 1990. **88**(5N): p. 1N-8N.
14. Gilbert, K. and M.J. Fine. *Assessing prognosis and predicting patient outcomes in community-acquired pneumonia.* in *Seminars in respiratory infections.* 1994.
15. Musher, D.M., et al., *The association between pneumococcal pneumonia and acute cardiac events.* Clinical infectious diseases, 2007. **45**(2): p. 158-165.
16. Chen, Y., et al., *In a retrospective study of chronic obstructive pulmonary disease inpatients, respiratory comorbidities were significantly associated with prognosis.* Journal of clinical epidemiology, 2005. **58**(11): p. 1199-1205.
17. Ehrlich, R. and E. Weinberg, *Increase in hospital admissions for acute childhood asthma in Cape Town, 1978-1990.* South African Medical Journal, 1994. **84**(5): p. 263-266.
18. Daian, C.M., A.H. Wolff, and L. Bielory. *The role of atypical organisms in asthma.* in *Allergy and asthma proceedings.* 2000. OceanSide Publications.
19. Metersky, M.L., et al., *Predicting bacteremia in patients with community-acquired pneumonia.* American journal of respiratory and critical care medicine, 2004. **169**(3): p. 342-347.
20. Almirall, J., et al., *Risk factors for community-acquired pneumonia in adults: a population-based case–control study.*

European Respiratory Journal, 1999. **13**(2): p. 349-355.

21. Fernández-Solá, J., et al., *High alcohol intake as a risk and prognostic factor for community-acquired pneumonia.* Archives of Internal medicine, 1995. **155**(15): p. 1649-1654.

22. Saitz, R., W.A. Ghali, and M.A. Moskowitz, *The impact of alcohol-related diagnoses on pneumonia outcomes.* Archives of internal medicine, 1997. **157**(13): p. 1446-1452.

23. Garau, J., et al., *Factors impacting on length of stay and mortality of community-acquired pneumonia.* Clinical Microbiology and Infection, 2008. **14**(4): p. 322-329.

24. Menendez, R., et al., *Duration of length of stay in pneumonia: influence of clinical factors and hospital type.* European Respiratory Journal, 2003. **22**(4): p. 643-648.

25. Barie, P.S., L.J. Hydo, and E. Fischer, *Utility of illness severity scoring for prediction of prolonged surgical critical care.* Journal of Trauma-Injury, Infection, and Critical Care, 1996. **40**(4): p. 513-519.

26. Weintraub, W., et al., *Determinants of prolonged length of hospital stay after coronary bypass surgery.* Circulation, 1989. **80**(2): p. 276-284.

27. Arnold, F.W., et al., *Hospitalization for community-acquired pneumonia: the pneumonia severity index vs clinical judgment.* Chest, 2003. **124**(1): p. 121-124.

28. Flanders, W.D., et al., *Validation of the pneumonia severity index.* Journal of general internal medicine, 1999. **14**(6): p. 333-340.

29. Bello, S., et al., *Tobacco smoking increases the risk for death from pneumococcal pneumonia.* Chest, 2014. **146**(4): p. 1029-1037.

30. Librero, J., S. Peiró, and R. Ordiñana, *Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days.* Journal of clinical epidemiology, 1999. **52**(3): p. 171-179.

31. Rochon, P.A., et al., *Comorbid illness is associated with survival and length of hospital stay in patients with chronic disability: a prospective comparison of three comorbidity indices.* Medical care, 1996: p. 1093-1101.