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Comorbidity Analysis on ICU Big Data

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Abstract

Comorbidity is the simultaneous presence of two chronic diseases or conditions in a patient. As part of a larger research study, the aims of this study were to explore comorbid conditions in intensive care unit (ICU) patients and to compare the comorbidity across different demographic groups, and to determine what comorbid health problems coexisted in the patients with hospital-acquired pressure injury (HAPI). The average number of comorbid conditions was 6.4 with range from 0-20 in the ICU patients. African American patients had significantly more comorbid health problems than other race/ethnicity groups. Asian and Hispanic female patients showed higher comorbidity than male patients across age. The patients with HAPIs had significantly more comorbid health problems than the patients without HAPIs -- the average numbers were almost two-fold. We found comorbid health problems that existed with HAPI in ICU patients. 'Other diseases of lung' and 'Disorders of fluid, electrolyte, and acid-base balance' were most frequently coexisting health problems in the ICU patients with HAPI. Exploratory plots are helpful to discover patterns or hypotheses relevant to clinical management in critical care. Inclusion of patients' comorbid health problems to ICU HAPI risk assessment may be helpful. Identification of patients at a high risk for the development of HAPI and the early preventative interventions can help reduce length of stay as well as costly complications.

Keywords: comorbidity, hospital-acquired pressure injury, intensive care units,

1. Introduction

Hospital-acquired pressure injury (HAPI) defined as a localized skin injury or underlying tissue damage during an inpatient hospital stay [1]. HAPI rates have been decreased through quality assessment and preventive efforts of healthcare institutions [2, 3]; however, HAPIs are still not acceptable due to negative patient outcomes and additional health care costs. Existing research studies report demographic, intrinsic, and extrinsic risk factors for HAPI development [4].

Several research studies reported that acute illness and chronic conditions are associated with HAPI, such as diabetes, septic shock, hypotension, cardiovascular diseases, infectious diseases, infectious and neoplastic diseases [4-8]. It is desirable to examine whether these findings are consistent through many research studies. Comorbidity is the concurrent existence of two chronic conditions in a patient. Severe comorbidities need to be considered in the outcome evaluation of ICU patients with HAPI.

As part of a larger research study, the aims of this study were to explore comorbid conditions in intensive care unit (ICU) patients and to compare the comorbidity across different demographic groups, and to determine what comorbid health problems coexisted in the patients with HAPIs.

2. Methods

We retrieved 4 years of de-identified ICU patient data from an academic institution in central Ohio, the United State. The data collection was previously approved by the institutional review board. We described the detailed description about data extraction and preparation in another journal article [9]. The data contained demographic and clinical information from 12652 patient encounters. For the purpose of this study, we used patients' demographic data (age, gender, and race/ethnicity) and comorbidity data. The patient had an admission diagnosis and discharge diagnoses formally presented by using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. The admission diagnosis was an overall reason for his/her admission while discharge diagnoses indicated the patient's clinical problems during the ICU stay. We used discharge diagnoses data to operationally define comorbid conditions. We conducted an exploratory study. We summarized the comorbid conditions of the ICU patients by using descriptive statistics. We compared the comorbid conditions between different demographic groups by using chi-square test and ANOVA. Next, we filtered the patients with HAPIs and explored the comorbid conditions in the specific group of patients. Comorbidity association was examined by using univariate analyses.

3. Results

The data elements used in the analysis were age, gender, race/ethnicity, and discharge diagnoses data. The number of cases was 12652. The average age was 57.5 years old with standard deviation of 15.5 and 7178 (56.7%) were male patients. In terms of race/ethnicity, 10225 (80.8%) were White, 1929 (15.2%) were African American, 94 (0.8%) were Hispanic, 77 (0.6%) were Asian/Native Hawaiian, and others were 327 (2.6%). There were unique 832 comorbid conditions in the ICU patients. Among them, 61 were significantly associated with HAPIs. The comorbid conditions ranges from 0-20 in the ICU patients. The average number of comorbid conditions per patient was 6.4 with the standard deviation of 4.5 (Figure 1).
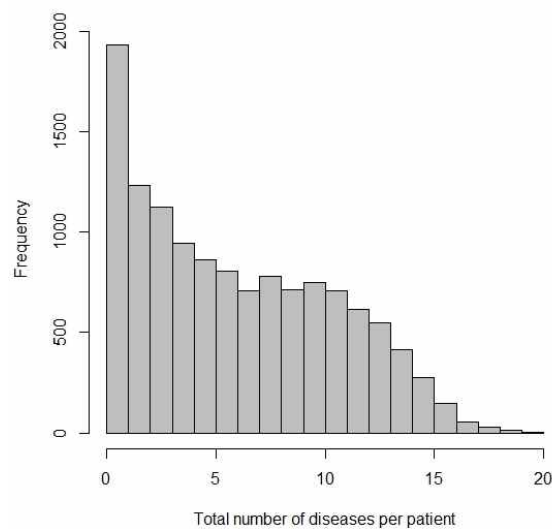

Figure 1. Comorbid conditions

In terms of race/ethnicity, African American patients had 8 comorbid conditions on average, which was significantly more than White (6, $p<.001$), Hispanic (6, $p<.001$), and Asian (7, $p=.041$) patients. Asian and Hispanic female patients had more comorbid conditions than male patients across age (regression lines with 95% CI) (Figure 2).
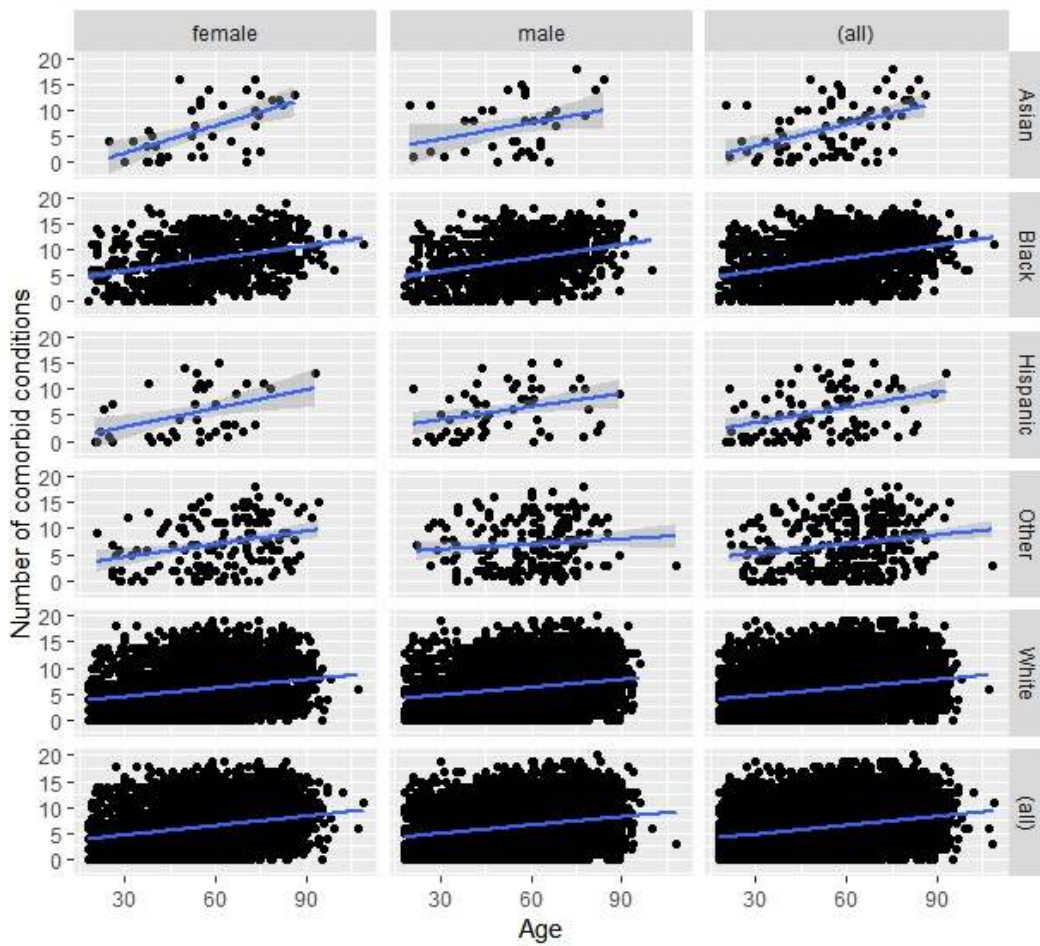
Figure 2. Number of comorbid conditions by age and race/ethnicity

The HAPI group had significantly more comorbid conditions than non-HAPI group. The average number of comorbid conditions was 10.9 in the HAPI group whereas 6.1 in non-HAPI group and the difference was significant (t=-38.584, df = 1201, p < 2.2e-16) (Figure 3).
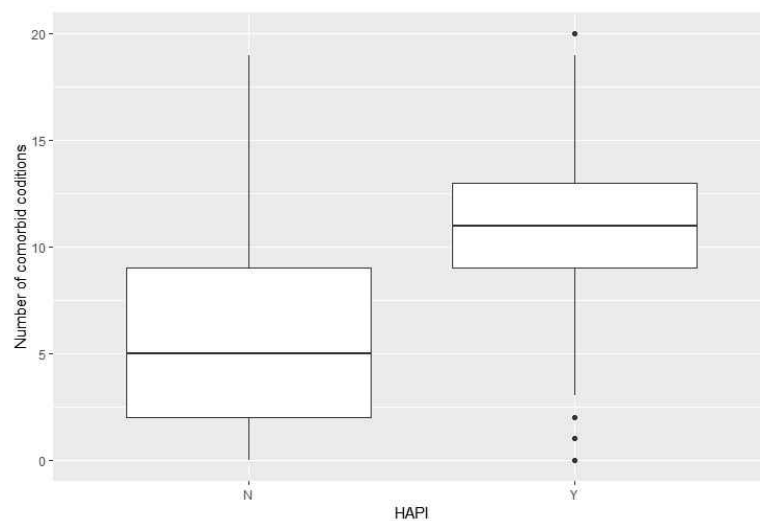

Figure 3. Comparison between HAPI (n=965) and non-HAPI (n=11687)

The top 20 most frequent comorbid conditions in the patients with HAPIs were summarized in Table 1. *Other diseases of lung; Disorders of fluid, electrolyte*, *and acid-base balance*; and *Other anaphylactic shock, not elsewhere classified* were most frequent.

Table 1. Top 20 most frequent comorbid conditions in the ICU patients with HAPI

Disease	Freq	%
Other diseases of lung	765	79
Disorders of fluid, electrolyte, and acid-base balance	684	71
Other anaphylactic shock, not elsewhere classified	555	58
Incision, excision, and occlusion of vessels	541	56
Other and unspecified anemias	509	53
Acute kidney failure	491	51
Symptoms involving cardiovascular system	459	48
Cardiac dysrhythmias	426	44
Diabetes mellitus	398	41
Heart failure	344	36
Chronic kidney disease (CKD)	336	35
Other disorders of urethra and urinary tract	308	32
Other bacterial pneumonia	288	30
Other and unspecified protein-calorie malnutrition	283	29
Hypertensive chronic disease	279	29
Essential hypertension	275	28
Operations on bone marrow and spleen	229	24
Complications peculiar to certain specified procedures	214	22
Candidiasis	192	20
Purpura and other hemorrhagic conditions	188	19

Figure 4 shows a plot of the comorbid conditions in patients with HAPIs. Gradation indicates co-occurrence frequencies. *Other diseases of lung* (represented as 'X518' in Figure 4) and *Disorders of fluid, electrolyte, and acid-base balance* (X276) showed the most frequent comorbid conditions (577 times). The following conditions co-occurring were *Other anaphylactic shock, not elsewhere classified* (X995) and *Incision, excision, and occlusion of vessels* (X38) (528 times); *Other anaphylactic shock, not elsewhere classified* (X995) and *Other diseases of lung* (X518) (476 times); *Other diseases of lung* (X518) and *Incision, excision, and occlusion of vessels* (X38) (467 times); and *Other anaphylactic shock, not elsewhere classified* (X995)and *Disorders of fluid, electrolyte, and acid-base balance* (X276) (453 times).

4. Discussion

As part of a larger research study, we have performed an exploratory data analysis to determine comorbid health problems in ICU patients by using a 4 years of ICU patient data. The average number of comorbid conditions was 6.4 with range from 0-20 in the ICU patients. African American patients had significantly more comorbid health problems than other race/ethnicity groups. Asian and Hispanic female patients showed higher comorbidity than male patients across age. The patients with HAPIs had significantly more comorbid health problems than the patients without HAPIs -- the average numbers were almost two-fold. *Other diseases of lung; Disorders of fluid, electrolyte, and acid-base balance; Other anaphylactic shock, not elsewhere classified; Incision, excision, and occlusion of vessels; Other and unspecified anemias; Acute kidney failure* showed more than 50% of the ICU patients with HAPIs. Among them, *Other diseases of lung* (X518) and *Disorders of fluid, electrolyte, and acid-base balance* (X276) were most frequently coexisting health problems. Comorbidities need to be considered to manage patients' health problems and to come up with individualized interdisciplinary health care plans [10]. For example, head of bed positioning is carefully considered for the patients with HAPI and ventilator associated pneumonia as the prevention guidelines provides conflict recommendations [1, 11].
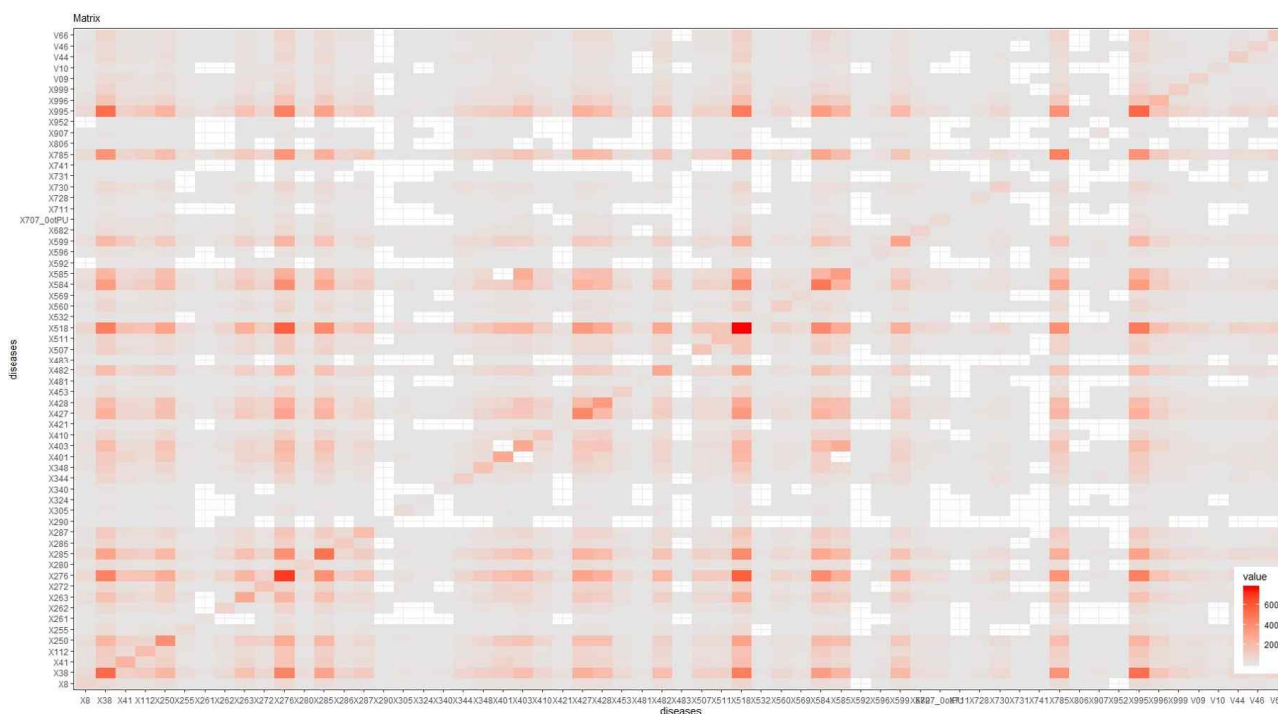
Figure 4. Comorbid conditions in patients with HAPI

Inclusion of patients' comorbid health problems to ICU HAPI risk assessment may be helpful. Our findings showed possible health problems that co-existed with ICU HAPI. Understanding relationships among comorbid conditions is important to improving clinical care [12, 13]. We found comorbid health problems that existed with HAPI in ICU patients.

The adoption of electronic health records enables us to collect and store cumulative excessive electronic data for big data analysis [14]. Clinical data are multi-dimensional and heterogeneous, which are challenging for clinical data scientists [15]. Exploratory plots are helpful to discover patterns or hypotheses relevant to clinical management in critical care. Identification of patients at a high risk for the development of HAPI and the early preventative interventions can help reduce length of stay as well as costly complications. The findings of this study have limited generalizability due to the data were from a single academic institution.

5. Acknowledgment

References

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