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Factors Influencing the Mortality Rate of Patients Admitted with Chronic Disease in Urban Hospitals in DC Metropolitan Area: EHR Big Data Analysis

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Abstract

Chronic disease is the leading cause of deaths worldwide. Lifestyle choices, such physical inactivity, poor nutrition, inadequate stress management, alcohol abuse, and tobacco smoking, are the major contributors for chronic disease development. Approximately 75% of Americans aged 65 or older suffer from more than one chronic disease, with the most prevalent combination being hypertension (HTN) with type 2 diabetes mellitus (T2DM), or Cardiovascular disease (CVD). However, the inability to effectively use electronic health records (EHR) to garner large clinical data on the prevalence and the factor that affects chronic diseases and their associated outcomes have been reported. The difficulties in accessing hospital datasets for extraction continue to be challenging. We collaborated with a research institution located in the Washington DC metropolitan area to gain access to urban hospitals' datasets to extract unidentified information with diabetes, myocardial infarction and the associated independent variables (age, gender, race, and the lab results) with an outcome variable (mortality rate).

Methods: Secondary data from inpatients with diabetes and myocardial infarction were selected from 2014-2015 urban hospitals data warehouse. For diabetes, we used the ICD-9 codes 25000 (ICD-9: 25000) and myocardial infarction (MI) was 41000 (ICD-9: 41000) and the data extraction design was purposely selected accordingly. We also accessed factors that critically affected the outcome of the inpatients.

Results: For the 2014 data, females and African Americans were admitted more than their male counterpart across the DM and MI only categories. For the 2015 data, females and African Americans were also admitted more than their male counterparts for DM and MI only. However, it important to note that more males with DM±MI were admitted than in 2015 while more females were admitted for females in the same category. There was no statistically significant among African Americans across the disease categories in both years. A reduction in mortality rate (4%) was also noted from 2014 to 2015. BMI, DBP, PP, glucose and AIC levels were all statistically significant across the disease categories ($p < 0.001$) with HDL significant ($p < 0.05$) for only 2014 but $p > 0.253$) for SBP in 2015.

Conclusion: Access to enhance the use of readily available EHR data in future clinical research is new and involving. It has been confirmed that similar studies could be encouraged as such studies would lead into using the EHR data in determining the relationships between the prevalent of chronic diseases such as obesity, heart diseases and diabetes and the factors that impact the outcomes of patients admitted with such diseases. This innovative research method would enable future biomedical investigators to have access to available data rather than years of waiting for bed side data collection for pilot or population research.

Keywords: Chronic disease; Mortality rates; Diabetes; Myocardial infarction; Electronic health records

Abbreviations: BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; PP: Pulse Pressure; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein; AIC: Glucosylated hemoglobin; SCRP: Sensitive C-Reactive Protein

Background

Chronic diseases are the leading cause of high mortality rate worldwide [1]. Lifestyle choices, such as consumption of energy-dense and nutrient-poor diets, physical inactivity, inadequate stress management, alcohol abuse, and tobacco smoking, are the major contributors for their development. Chronic diseases are defined as conditions that "*last one year or more and require ongoing medical attention or limit activities of daily living or both*", poor nutrition and sedentary lifestyles normally result in obesity, diabetes, increased blood pressure, elevated glucose and lipid blood levels [2]. These lifestyle alterations constitute the main metabolic risk factors involved in the development of cardiovascular diseases (CVD) which is the leading cause of death exacerbated by chronic diseases in the world [1].

In the United States, six in ten people suffer from at least one chronic disease, also the leading causes of death and disabilities in the country and the main contributors of the nation's US$3.5 trillion annual healthcare costs [2]. Chronic disease accounted for close to 60% of all deaths in 2019 [3]. Obesity is a significant contributing factor in the development of diabetes and it affects about one in five children and one in three adults in the country [2]. The cost of obesity to the health care system is estimated at US$147 billion per year [2]. Hispanics (47.0%) and non-Hispanic blacks (46.8%) have the highest prevalence of obesity, followed by non-Hispanic whites (37.9%) and non-Hispanic Asians (12.7%) [4]. There are also significant differences in obesity prevalence depending on income and educational level, and these associations also differ by sex and race/ethnicity. As the U.S. population ages, the concern for the social and economic impact of multiple chronic conditions grows [5]. Approximately 75% of Americans aged 65 or older suffer from more than one chronic disease [6]. Documentation on the racial/ethnic differences in the prevalence of single and multiple chronic conditions among 56,280 Americans aged 60 to 79 years who responded to the National Health Interview Survey (NHIS) from 2006 through 2014 has been reported [6]. The analyzed age group has the highest prevalence of many major chronic diseases. Racial/ethnic differences were greatest for T2DM, with 30% of non-Hispanic blacks and 29% of Hispanics having diabetes compared to 17% of non-Hispanic whites [6]. The combination of T2DM and cancer was similar among racial/ethnic groups at age 60, but "more than twice as high" among non-Hispanic blacks by age 79. Co-occurrence of T2DM, CVD, and cancer increased with age in all three racial/ethnic groups [6].

In DC Metropolitan area, one in every ten non-Hispanic white residents is obese, while more than one in every three non-Hispanic blacks is obese in D.C [7]. Combining overweight and obesity rates, 53.9% of the Districts' adults are overweight or obese, with 45 to 64-year-olds holding the highest rate of obesity at 29.6% with CVD and stroke being the first and third leading causes of death in D.C., respectively [8-10]. Nationwide, CVD is also the leading cause of death [3]. High blood pressure, which is a major risk factor for myocardial infarction, affects 26.4% of the DC area residents, but its prevalence among non-Hispanic blacks is 40.8% [11]. Residents earning less than US$24,999 per year [8]. In wards seven and eight, more than 90% of residents are non-Hispanic blacks [12]. Among those 25 years and older, 85% do not have a bachelor's degree or higher, featuring the lowest educational attainment level among all wards in the District. Wards seven and eight also concentrate the residents with the lowest mean household income- $56,633 and $50,467, respectively [8].

However, the inability to effectively use Electronic Health Records (EHR) to garner large clinical data to research on the prevalence and the factor that affects chronic diseases and their associated outcomes has been difficulties to access hospital datasets and extraction [13,14]. EHR would enable access to readily available biomedical lab results such as AIC, HDL, LDL, SBP, DBP, CRP as these biomedical results are directly linked to chronic disease development. Hence, access to EHR would enable researcher easy access to biomedical data for clinical research that may provide answers to chronic disease prevention and eventual eradication. To bridge this gab, we collaborated with a research institution located in the DC metropolitan area to enable access to urban hospitals which gave access to extraction of unidentified data of patients with diabetes and myocardial infarction and the associated independent variables (age, gender, race, comorbidities, lab results) and outcome variables. Overall, there are limited studies on the factors affecting the prevalence of chronic diseases in inpatients with diabetes and myocardial infarction using EHR due to lack of interoperability of available datasets or because almost all data are sparse and not standardized. Globally, the trend of chronic diseases hospitalizations will continue to escalate if innovative preventive measures are not put in place. Current pattern of the longitudinal association between risk factors among type 2 diabetes and myocardial infarction hospitalized patients with their health outcomes is lacking. Therefore, this research is focusing on population-based retrospective longitudinal study of 1,500 inpatients hospitalized in urban hospitals Washington DC metropolitan area.

Method

The study population was identified from large healthcare datasets of more than 163,000 inpatient admissions and more than 2 million outpatient visits each year which serve more than a half-million patients each year. Operating in urban and non-urban locations, MedStar Health serves a diverse patient population and offers a wide variety of healthcare services. Explorys Technology Platform and Data Security Data were collected using the Explore application in the Explorys technology platform (Explorys, Inc.). Data used in Explore is de-identified according to HIPAA and HITECH standards and mapped into UMLS ontologies to facilitate data collection and querying. Patients are assigned unique identifier

codes, which allow longitudinal documentation of clinical care across all participating institutions. This methodology has been independently validated and reviewed by the RAND Corporation and found to be an accurate methodology for improving algorithm accuracy rates for patient matching [15]. SNOMED-CT hierarchy is used to map diagnoses, findings and procedures. SNOMED and RxNorm are used to map prescribed medication to pharmacological class and drug identities respectively. Logical Observation Identifiers Names and Codes (LOINC) hierarchy is used to map laboratory test observations. This data is automatically updated every 24 hours. Validation of Explorys data prior to using the Explorys platform in this study, internal data validation was completed by comparing data output from Explorys with patient records in the various MedStar EHR systems. This validation was completed by the Quality Assurance Division of the MedStar Health Information Technology Department. Cohort discovery Cases of inpatients diabetic myocardial were identified from the MedStar Health System cohort between January 2014 to December 2015.

Data Extraction and Measures

Using ICD 9 codes for diabetes (25000) and myocardial infarction (41000), data were extracted from urban hospitals. We purposefully sampled from the 2014 and 2015 datasets, 1000 inpatients diagnosed with both diabetes and myocardial infarction, 500 diagnosed with only diabetes (DM) and 500 with only myocardial infarction.

Clinical and demographic measures obtained were: Age, Gender, Race, Other measures included Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Pulse Pressure,(PP), Low Density Lipoprotein (LDL), High Density Lipoprotein (HDL), Glucose (Blood glucose obtained through finger stick), AIC (Average levels of blood glucose), CRP C-Reactive Protein(CRP) and Mortality, characterized as dying as an inpatient.

Statistical Analysis

The data were cleaned, merged using common fields, and analyzed. Descriptive statistics were used to summarize the clinical and demographic characteristics of the patients. ANOVA was used to compare differences in means of specific clinical outcomes across the three disease categories (DM, MI, DM±MI) and separately for 2014 and 2015. All the analyses were conducted using IBM SPSS software (version 25.0, IBM SPSS). All tests were two-tailed at the 5% (α=0.05) level of significance.

Results

The demographic distribution showed that more females and African Americans were admitted than their counterparts across the DM and MI only categories in 2014 data. In addition, more females and African Americans were also admitted more than their male counterparts for DM and MI only in 2015. However, it important to note that more males with DM±MI were admitted than in 2015 while more females were admitted for females in the same category. There was no statistically significant among African Americans across the disease categories in both years. A reduction in mortality rate (4%) was also noted from 2014 to 2015 (Tables 1 and 2).

Patient & Hospital Measures	Diabetes Only	MI Only	DM ± MI
Gender			
Male	172 (34.4%)	201 (40.2%)	282 (56.4%)
Female	328 (65.6%)	299 (59.8%)	218 (43.6%)
Race			
African American	339 (67.8%)	276 (55.2%)	286 (57.2%)
Caucasians	143 (28.6%)	215 (43.0%)	203 (40.6%)
Other	12 (2.4%)	8 (1.6%)	10 (2.0%)
Mortality Rate			
Alive	400 (80%)	369 (73.8%)	356 (71.2%)
Diseased	100 (20%)	131 (26.2%)	144 (28.8%)

Table 1: Patient and hospital characteristics by disease category in 2014.

Patient & Hospital Measures	Diabetes Only	MI Only	DM ± MI
Gender			
Male	173 (34.6%)	226 (45.2%)	203 (40.7%)
Female	327 (65.4%)	274 (54.8%)	296 (59.3%)
Race			
African American	334 (66.8%)	290 (58.0%)	304 (60.9%)
Caucasians	152 (30.4%)	198 (39.6%)	184 (36.9%)
Other	9 (1.8%)	11 (2.2%)	11 (2.2%)
Mortality Rate			
Alive	397 (79.4%)	386 (77.2%)	375 (75.2%)
Diseased	103 (20.6%)	114 (22.8%)	124 (24.8%)

Table 2: Patient and hospital characteristics by disease category in 2015.

Furthermore, Tables 3 and 4 results revealed that age, BMI, DBP, PP, glucose and AIC levels were all statistically significant across the disease categories ($p<0.001$) with HDL significant ($p<0.05$) for only 2014 but $p>0.253$) for SBP in 2015.

Variables	DM	MI	DM±MI	P-value
Age (years)	61.58±15.07	69.62±13.32	68.07±11.97	0.000
BMI (kg/m²)	32.25±8.77	28.75±7.63	29.54±7.70	0.000
SBP (mmHg)	133.89±20.64	130.60±21.92	133.24±22.56	0.052
DBP (mmHg)	75.94±12.09	73.48±12.40	73.17±12.90	0.001
PP (mmHg)	57.94±17.13	57.12±18.56	60.07±18.91	0.039
LDL (mmol/L)	91.74±37.12	88.04±44.73	85.54±41.29	0.088
HDL mmol/L)	49.03±17.43	46.78±16.67	45.23±16.97	0.004
Glucose (mg/dl)	155.80±88.29	127.69±53.33	151.48±69.93	0.000
A1C (mmol/mol)	7.53±1.97	6.73±1.62	7.39±1.89	0.000
SCRP (mg/L)	24.22±48.50	27.46±41.28	37.10±62.24	0.082

Table 3: 2014 variables according to disease categories in mean±/SD.

Variables	DM	MI	DM±MI	P-value
Age	61.68±14.69	68.29±13.58	68.84±12.13	0.000
BMI	32.39±8.64	29.24±7.49	30.13±7.94	0.000
SBP	133.20±19.75	128.32±20.28	130.05±20.20	0.001
DBP	76.89±12.74	73.05±11.65	71.64±12.35	0.000
PP	56.29±17.13	55.30±17.47	58.43±17.42	0.019
LDL	87.92±38.24	83.96±39.32	82.09±38.92	0.085

HDL	49.05±18.27	47.54±17.12	47.14±17.50	0.253
GLUCOSE	156.98±89.78	129.74±64.88	153.82±81.16	0.000
A1C	7.64±2.13	6.71±1.74	7.29±1.99	0.000
SCRP	24.73±44.99	29.09±48.46	36.33±54.35	0.122

Table 4: 2015 variables according to disease categories in mean±SD.

Discussion and Conclusion

The result of this study confirmed that age, BMI, DBP, PP, glucose and AIC were factors that critically affected the outcome of inpatients with chronic diseases such as diabetes and myocardial infarction in the 2014 and 2015 admissions. Our findings identified 1,500 cases and highlighted greater association or trends with increased proportion of diabetic inpatients, therefore confirming the ability of the EHR as a tool for measuring population health outcomes. It is also important to note that when compared with the 2013 admissions, variables such as age, gender and race distribution were statistically significant only in the DM category when compared with DM + MI category [13]. For the clinical measures, SBP was only statistically significant in 2015 while LDL and SCRP were not statistically significant in both years. Hence, it has been confirmed that similar projects could be encouraged as such studies would lead into using the EHR data in determining the relationships between the prevalent of chronic diseases such as obesity, heart diseases and diabetes and the factors that impact the outcomes of patients admitted with such ailments. The result of this project would enable future biomedical investigators readily access to data rather than years of waiting for bed side data collection for pilot or population research.

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