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I, Jacob Rounds, hereby submit this original work as part of the requirements for the degree of Master of Science in Health Education (Public & Community Health).

It is entitled:

Cardiometabolic Risk Factors and MyChart Enrollment Among Adult Patients

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Cardiometabolic Risk Factors and MyChart Enrollment Among Adult Patients

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by

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Abstract

The purpose of this study was to assess the relationship between MyChart activation status and cardiometabolic risk factors (i.e., body mass index [BMI], blood pressure [BP], and smoking status) among adult patients seen at UC Health ambulatory outpatient facilities. The subsequent research questions were examined: 1) What percent of participants reported having an activated account status? 2) Does activated account status differ based on sex, age, BMI, diastolic BP, and smoking status? 3) Does activated account status differ based on BMI, diastolic BP, and tobacco smoking above and beyond demographic covariates? 4) Does the number of logins differ based on BMI, diastolic BP, and tobacco smoking above and beyond demographic covariates? The study consisted of adult patients ($n = 200,722$) who had an office appointment at one of UC Health's ambulatory locations between June 1, 2014 to June 1, 2015. Multivariable regression analyses indicated that overweight patients were significantly more likely to have an active MyChart account compared to normal weight counterparts, but patients with prehypertensive BP were significantly less likely to have an active account compared to those with normal BP. Former smokers were significantly less likely to have an activate account compared to patients who never smoked. Further, obese patients had a greater likelihood of logging into their MyChart account compared to normal BMI patients ($\beta = 2.65$), but individuals with a prehypertensive BP were significantly less likely to log into their MyChart account compared to normal range BP counterparts ($\beta = -1.20$). The study also found that active smokers were five times likelier to log into their MyChart account than never smokers ($\beta = 5.10$). Health care organizations and employees should consider these findings when developing strategies for MyChart enrollment and utilization.

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Introduction

Non-profit organizations predominantly set out to make choices that have valuable effects on their stakeholders. In addition to this, community benefit organizations must receive a profit in order to generate sustainability. Non-profit health care organizations, such as UC Health located in Cincinnati, Ohio, must obtain high levels of market share by providing services to a plethora of patients. Medical organizations across the globe are relying further on electronic medical record (EMR) systems to retain the large amounts of data collected ranging from financial to clinical information. UC Health is one organization that utilizes an EMR system known as Epic to assist with recording, tracking, and reporting this data. EMRs have become very efficient at data recording that the Centers for Medicare and Medicaid Services ([CMS], 2010), the government agency in charge of federal health care insurance, has created an incentive program for organizations that install an EMR program by a certain time frame. The incentive rule was put in place in 2009 by the American Recovery and Reinvestment Act (ARRA) that provided financial awards for health care organizations that transition to an EMR by a certain period. The program is broken out into a Medicare and Medicaid separate incentive. Physicians who document on a qualified EMR would receive a maximum benefit of \$44,000 for five years from the Medicare benefit, and a maximum of \$63,750 for six years from the Medicaid benefit (CMS, 2014)

The aspect of possessing an EMR is not sufficient enough to fulfill all established government regulations. Quality measures are set by EMRs so that end users may reach meaningful use goals. These measures allow for organizations to make sure that physicians and other clinical staff are conducting a thorough examination of their patients. Systems are able to

track accordingly which staff members are meeting, exceeding, and failing to meet these meaningful use measures and how the results of multiple sections differentiate.

One meaningful use quality measurement is the MyChart patient enrollment percentage per service professional. MyChart is an example of an electronic patient portal system which can be personally accessed through secure Web-based servers that provide patients with real-time access to their personal health record (Gerber, Laccetti, et al., 2014). The system provides patients with a variety of functions integrated with their medical chart including viewing test results, making medical appointments, and sending messages to clinicians and medical support staff. This allows patients to remain in the know with changes to their medical record, and allows staff to stay in constant communication with patients and caregivers with matters pertaining to medication changes and office visits.

MyChart enrollment provides patients with greater tools to improve relationships with their physicians while increasing knowledge about their own health. In the emphasis of health care relationships, patients require that their health care provider treats them with cordial respect and dignity. If this can be accomplished, then the company's market share could increase based on the positive results. Also, with an integrated system, such as MyChart, a person's health record is accessible through multiple facilities on numerous devices without geographical hindrances.

There is a high level of importance on examining MyChart with known health risk factors in adults. To highlight such need, research has shown that an increased body mass index (BMI) is associated with a greater risk of cancer (Arnold, et al., 2012; Bhaskaran, et al., 2014) and that uncontrolled blood pressure (BP) can lead to a higher chance of cardiovascular disease including

stroke and heart attack (James, et al., 2014). The three main factors attributing to cardiovascular disease include smoking, BP, and fasting glucose metrics (Mozaffarian, et al. 2016).

Purpose of the Study

While the efficiency and cost benefits associated with MyChart and other patient portal systems has been researched to a degree (Bredfeldt, 2012), the research regarding the association between MyChart activation and the change in specific health aspects is limited. The present study assessed the relationship between MyChart activation status and cardiometabolic risk factors (i.e., BP, BMI, and smoking status) among adult patients seen at all UC Health ambulatory outpatient facilities over a one-year period. Specifically, the following research questions were examined:

- 1) What percent of participants reported having an activated account status?
- 2) Does activated account status differ based on sex, age, BMI, diastolic BP, and tobacco smoking?
- 3) Does activated account status differ based on BMI, diastolic BP, and tobacco smoking above and beyond demographic covariates (i.e., sex, age)?
- 4) Does the number of logins differ based on BMI, diastolic BP, and tobacco smoking above and beyond demographic covariates (i.e., sex, age)?

Methods

Participants

This study was a secondary data analysis of 137,837 adult patients who were seen at all UC Health ambulatory outpatient facilities from June 2014-June 2015.

Measures

The variables extracted from Epic included patient's age, sex, BP, BMI, and smoking status. For the purpose of this study, age was categorized as: 18 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, 70 to 79, and 80 and older. This dissection made age groups easier to compare while supplying each levels with a sufficient volume of patients. BMI was categorized based on parameters set by the Center for Disease Control and Prevention (CDC) (About Adult BMI, 2015): underweight (≥ 18.4 kg/m²), normal weight (18.5 kg/m² – 24.9 kg/m²), overweight (25 kg/m² – 29.9 kg/m²), and obese (≤ 30 kg/m²). For the purpose of this study, we defined <25 kg/m² as normal. Diastolic BP was also defined based on the CDC's parameters (High Blood Pressure, 2015): normal (≥ 79 mmHg), pre-hypertension (80 – 89 mmHg), and hypertension (≤ 90 mmHg).

The outcome variables, MyChart enrollment status (i.e., non-activated, activated) and number of MyChart account logins during that period were also extracted. Activated is defined as the participant was given a MyChart code at the time of a visit to a UC Health medical facility, accessed the MyChart website that is housed on UC Health's intranet, and entered in their code to activate their account. Non-activated included other MyChart account statuses: activation code generated first time but not used, activation code generated but disabled, inactivated, and patient declined. A patient may have accrued logins but have a deactivated account if they tried unsuccessfully to log in leading to an account lockdown. When an account is first activated a login tally is also accrued.

Procedures

This study is a secondary analysis of data from UC Health's reporting system in Epic known as Clarity, which stores large amounts of historical data. The information used in this

study was gathered by contacting UC Health. The organization consists of over 750 physicians in a multitude of specialties including colon and rectal surgery, gynecology, and maternal fetal medicine spanning throughout the Greater Cincinnati area (University of Cincinnati Physicians, 2015). All adult patients who were seen at an ambulatory site within the UC Health organization's network from June 1, 2014 through June 1, 2015 were included in the present study. UC outpatient ambulatory sites range from inner-city to urban and rural office settings. This dispersed geographical mapping allows for services to be provided to a diverse patient base that accounts for many different demographic subsections within Ohio, Indiana, and Kentucky. Outpatient accounts were chosen to be researched over emergency or inpatient primarily due to their scattered physical locations. Additionally, the latter patient contexts can include a large portion of individuals in poor health at the time of their visit. Further, only the most recent visit for each individual was recorded to ensure that a small grouping of patients with multiple visits would not skew the data. Affiliate offices were not included in this reporting due to the inefficiencies that sometimes accompany data from external employees and offices. To ensure the highest possible standard of data collection, we chose to only use data from internal offices specifically employed with UC Health.

Data Analysis

All data were entered and analyzed using IBM SPSS (version 23.0). We performed descriptive statistics, chi-square analyses, logistic regression and linear regression analyses. Our primary outcomes were activated account status and number of logins. Frequency distributions for BMI, diastolic BP, smoking status, and demographic characteristics (i.e., age and sex) were performed. A series of univariate logistic regression analyses were performed to examine predictors of MyChart account status. A total of 137,837 cases were included in the logistic

regression models since we delimited these analyses to only include completed cases. All statistically significant predictors were retained and included in the multivariable regression model. Specifically, we performed a multivariable regression analysis to examine whether activated account status differed based on BMI, diastolic BP, smoking status, and demographic covariates (i.e., age and sex). In a follow-up analysis, a multiple linear regression model was performed to determine whether number of MyChart account logins differed based on BMI, diastolic BP, smoking status, and demographic covariates (i.e., sex and age).

Results

Participant Characteristics

The study's population of activated MyChart accounts consists of 35.5% males ($n = 18,384$) and 64.5% of females ($n = 33,337$) (Table 1). The age makeup of activated accounts was 14.1% 18-29 year olds, 16.1% 30-39 year olds, 18.3% 40-49 year olds, 23.0% 50-59 year olds, 18.5% 60-69 year olds, 7.7% 70-79 year olds, and 2.3% at 80 years and above. In the BMI category underweight/normal patients accounted for 30.0% of the population, overweight patients accounted for 30.4% of the population, and obese patients accounted for 39.5% of the population. In the diastolic BP category 59.2% of patients in the population rated as normal, 31.4% rated as pre-hypertensive, and 9.4% rated as hypertensive. The smoking status category was comprised of 65.1% never smokers, 23.8% former smokers, and 10.4% active smokers.

Cardiometabolic Risk Factors and MyChart Account Status

Univariate regression analyses revealed that sex, age, BMI, diastolic BP, and smoking status significantly predicted MyChart Account Status (Table 2). Therefore, all variables were retained and included in the final multivariable logistic regression model. In addition, a multiple

linear regression analysis was conducted to determine if these variables were predictors of the number of account logins.

The multivariable logistic regression model significantly predicted activated account status (omnibus chi-square = 4,970.03, $df = 13$, $p < .001$) and accounted for 5.0% (Nagelkerke R-squared=0.050) of the variance in activated account status. Statistically significant predictors for activated account status were BMI, BP, smoking status, age, and sex (see Table 2). Specifically, adult patients who were overweight were significantly more likely to have an activated MyChart account status (OR=1.05, CI=[1.01, 1.08], $p = .002$) than patients who had a normal weight status. Patients who had diastolic BP levels indicative of hypertension were significantly less likely to have an activated MyChart account status (OR=0.82, CI=[0.79, 0.85], $p = 0.001$) than their counterparts who had normal diastolic BP levels. For smoking status, former smokers were significantly less likely to have an activated MyChart account status (OR = 0.46, CI = [0.44, 0.48], $p < .001$) than adult patients who never used tobacco. For demographic covariates, adult patients were more likely to have an Activated MyChart account status if they were female (OR =1.37, CI = [1.34, 1.41], 30-39 years of age (OR =1.93, CI = [1.85, 2.02], $p < .001$), 40-49 years of age (OR = 2.03, CI = [1.95, 2.12], $p < .001$), 50-59 years of age (OR =2.03, CI = [1.96, 2.12], $p < .001$), 60-69 years of age (OR =1.92, CI = [1.84, 2.00], $p < .001$), and 70-79 years of age (OR =1.34 CI = [1.27, 1.41], $p < .001$) compared to males and the 18-29 year old age group. Patients who were 80 years of age and above were significantly less likely to have an activated MyChart account status (OR =0.78 CI = [0.72, 0.85], $p < .001$) than the 18-29 year old age group.

Cardiometabolic Risk Factors and Number of MyChart Account Logins

A follow-up multiple linear regression analysis was conducted to determine if these variables were predictors of the number of MyChart account logins. The multiple linear regression analysis significantly predicted the number of account logins ($R=0.094$, $R^2=.009$, ANOVA: $F_{(13,51,707)}=35.33$, $p < .001$) (Table 3). Adult patients who were obese were more likely to have MyChart account logins ($\beta = 2.65$) than their normal weight counterparts. Patients with pre-hypertension diastolic BP levels were less likely to have MyChart account logins ($\beta = -1.20$) compared to patients with normal BP levels. Active smokers were more likely to have MyChart account logins ($\beta = 5.10$) than adult patients who never used tobacco. Females and all age groups were also statistically significant in this model.

Discussion

Results of this study showed that 25.8% of the total adult population is enrolled in MyChart. Researchers found that overweight patients were significantly more likely to have an activated MyChart account status than patients who had a normal weight status. Additionally, patients who were recorded as having hypertensive BP levels were significantly less likely to have an activated MyChart account status than those who had normal diastolic BP levels. However, the findings for smoking exhibited that former smokers were significantly less likely to have an activated MyChart account status than adult patients who never used tobacco. No previous studies could be found to support or contradict these findings.

This study discovered that obese patients were more likely to have MyChart account logins than their normal weight counterparts, and patients with pre-hypertension diastolic BP levels were less likely to have account logins compared to patients with normal BP levels. Active smokers were more likely to have MyChart account logins than adult patients who never used

tobacco. A possible explanation for the conflicting results of smoking status could be the quality of patient health. Sicker patients may need to access their MyChart account more often than their healthy counterparts, and much research has pointed to a correlation between smoking and poor health (Mozaffarian, et al., 2016)

Pertaining to demographics, the greatest number of activated MyChart accounts was seen in patients from the age of 30 to 79 years old; patients age 18 to 29 and above 79 years old were significantly less likely to have an activated account. Females were significantly more likely to have an activated MyChart account compared to males. These findings are similar to a previous study which observed that older females were more likely to have a greater number of patient portal accounts than other sociodemographic groups (Mikles & Mielenz, 2014).

Study Limitations

While this study has noted strengths, the limitations should be noted. Foremost, researchers could not verify that the data was collected with the standard practices of UC Health in a standard medical office examination room with calibrated instruments. Generalizability of study findings may be limited since this study was conducted in UC Health ambulatory outpatient facilities. Patient self-reported variables rely on honesty and memory recall of the answers that were recorded. Due to the software limitations of separating and grading both systolic and diastolic BP values, researchers could only include diastolic BP in the final results. Finally, this retrospective review is cross-sectional in nature and causal relationships or MyChart utilization changes overtime cannot be determined.

Conclusions and Future Recommendations

This novel study provided valuable findings that add to the current literature by enhancing the understanding of what types of patients utilize the functionality of MyChart in

addition to exploring utilization based on health indicators. The results of this study can help professionals in the health and informatics field determine the relationship, if any, between health variables, habits, and electronic health records and portals. Stage 3, the highest level of meaningful use, focuses on improving the quality and efficiency of health care for populationbased health. This includes analyzing health attributes of patients including low-density lipoprotein (LDL) levels, blood pressure, and hemoglobin A1C levels (Vila & Pfeiffer, 2014). Financial incentives by CMS will be tied to meeting or not meeting these levels, and organizations will be rated based on how well their physicians do. Additionally, this study has shown that UC health has shown tremendous growth in MyChart enrollment since implementing the program in 2012.

This study further highlights the demographics of those who utilize MyChart compared to those who use it sparingly. This may be important to health organizations that plan on addressing their patient portal marketing measures. Furthermore, communicating with patients on an interpersonal level should be a top priority for health care providers and organizations to encourage increasing the utility of MyChart to improve patient health and patient-physician relationships. Additional research is needed to further explore what aspects of MyChart patients are utilizing when logging into the system (e.g., checking lab results, sending messages to physician, etc.). Future studies should examine the relationships between geographical location, ethnicity and race with MyChart utilization to determine if a person's socio geographic plays a role. From the role of organizations currently using Epic, future research should focus on MyChart enrollment ratios of individual physicians and office locations. This will assist with finding root causes of high and low enrollment numbers based on office policies and provider behaviors. Finally, further research should compare system implementation, patient care quality,

and financial efficiency of MyChart between health care organizations of similar structural makeup and geographic locations.

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Tables

Table 1

Demographic Characteristics

Characteristic	<i>n</i> (%)
Sex	
Male	33,337 (64.5%)
Female	18,384 (35.5%)
Age	
18-29	7,241 (14.1%)
30-39	8,261 (16.1%)
40-49	9,406 (18.3%)
50-59	11,798 (23.0%)
60-69	9,486 (18.5%)
70-79	3,957 (7.7%)
80 and above	1,167 (2.3%)
BMI Category	
Underweight/Normal weight	13,085 (30.0%)
Overweight	13,226 (30.4%)
Obese	17,235 (39.5%)
Blood Pressure	
Normal	25,530 (59.2%)
Pre-Hypertension	13,558 (31.4%)
Hypertension	4,067 (9.4%)
Smoking Status	
Never	33,655 (65.1%)
Former Smoker	12,294 (23.8%)
Active Smoker	5,362 (10.4%)
MyChart Account Activation Status	
Non-Activated	149,001 (74.2%)
Activated	51,721 (25.8%)

Note. Percents refer to valid percents. Missing values excluded

Table 2

Univariate Logistic Regression Models and Final Multivariable Logistic Regression Model with odds ratios and confidence intervals for activated account status

Variable	Non-Activated Account	Activated Account	Univariate Regression				Multivariable Regression			
	<i>n</i> (%)	<i>n</i> (%)	<i>B</i> (SE)	OR	95% CI	<i>P</i> Value	<i>B</i> (SE)	OR	95% CI	<i>P</i> Value
Sex										
Male	64,406 (77.8)	18,384 (22.2)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
Female	84,595 (71.7)	33,337 (28.3)	0.32 (0.01)	1.38	(1.35, 1.41)	<.001	0.32 (0.01)	1.37	(1.34, 1.41)	<.001
Age										
18-29	37,327 (83.3)	7,509 (16.7)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
30-39	20,132 (70.9)	8,261 (29.1)	0.71 (0.02)	2.04	(1.97, 2.11)	<.001	0.66 (0.02)	1.93	(1.85, 2.02)	<.001
40-49	21,717 (69.8)	9,406 (30.2)	0.77 (0.02)	2.15	(2.08, 2.22)	<.001	0.71 (0.02)	2.03	(1.95, 2.12)	<.001
50-59	27,110 (69.7)	11,798 (30.3)	0.77 (0.02)	2.16	(2.09, 2.24)	<.001	0.71 (0.02)	2.03	(1.96, 2.12)	<.001
60-69	22,103 (70.0)	9,486 (30.0)	0.76 (0.02)	2.13	(2.06, 2.21)	<.001	0.65 (0.02)	1.92	(1.84, 2.00)	<.001
70-79	13,030 (76.7)	3,957 (23.3)	0.41 (0.02)	1.51	(1.45, 1.58)	<.001	0.29 (0.03)	1.34	(1.27, 1.41)	<.001
80 and above	6,440 (84.7)	1,167 (15.3)	-0.10 (0.03)	0.90	(0.84, 0.96)	.002	-0.25 (0.04)	0.78	(0.72, 0.85)	<.001
BMI Category										
Underweight/Normal weight	37,707 (74.2)	13,084 (25.8)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
Overweight	32,150 (70.8)	13,266 (29.2)	0.17 (0.01)	1.19	(1.16, 1.22)	<.001	0.05 (0.02)	1.05	(1.01, 1.08)	.002
Obese	40,644 (70.2)	17,235 (29.8)	0.20 (0.01)	1.22	(1.19, 1.25)	<.001	-0.02 (0.02)	0.98	(0.95, 1.01)	.25
Blood Pressure										
Normal	63,146 (71.2)	25,530 (28.8)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
Pre-Hypertension	31,744 (70.1)	13,558 (29.9)	0.05 (0.01)	1.06	(1.03, 1.08)	<.001	-0.02 (0.01)	0.98	(0.96, 1.01)	.18
Hypertension	11,438 (73.8)	4,067 (26.2)	-0.13 (0.02)	0.88	(0.85, 0.91)	<.001	-0.20 (0.02)	0.82	(0.79, 0.85)	<.001
Smoking status										
Never	87,185 (72.1)	33,655 (27.9)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
Former Smoker	25,355 (82.5)	5,362 (17.5)	-0.60 (0.02)	0.55	(0.53, 0.57)	<.001	-0.78 (0.02)	0.46	(0.44, 0.48)	<.001
Active Smoker	27,659 (69.2)	12,294 (30.8)	0.14 (0.01)	1.15	(1.12, 1.18)	<.001	0.01 (0.01)	1.01	(0.98, 1.04)	.65

Note. Ref=referent. A total of 137,837 cases were included in the analysis.

Table 3

Multiple Linear Regression Analysis Predicting BMI, Blood Pressure, and Smoking status

Variable	B	SE B	B	t	P value
Sex					
Male	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
Female	-1.55	0.34	-0.02	-4.58	< .001
Age					
18-29	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
30-39	4.11	0.58	0.04	7.12	< .001
40-49	2.96	0.57	0.03	5.24	< .001
50-59	3.75	0.54	0.04	6.94	< .001
60-69	5.27	0.57	0.06	9.30	< .001
70-79	6.23	0.72	0.05	8.63	.001
80 and above	3.96	1.14	0.02	3.47	.002
BMI Category					
Underweight/Normal weight	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
Overweight	-0.42	0.41	-0.01	-1.01	.31
Obese	2.65	0.39	0.03	6.79	< .001
Blood Pressure					
Normal	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
Pre-Hypertension	-1.20	0.38	-0.01	-3.15	.002
Hypertension	-0.66	0.62	-0.01	-1.08	.28
Smoking status					
Never	(Ref)	(Ref)	(Ref)	(Ref)	(Ref)
Former Smoker	0.62	0.53	0.01	1.16	0.25
Active Smoker	5.10	0.39	0.06	13.03	< .001
Constant	17.07	0.61	-	27.95	<.001

Note. Ref=referent. A total of 137,837 cases were included in the analysis.