The impact of Gender, Medical History and Vital Status on Emergency Visits and Hospital Admissions: A Remote Patient Monitoring Case Study

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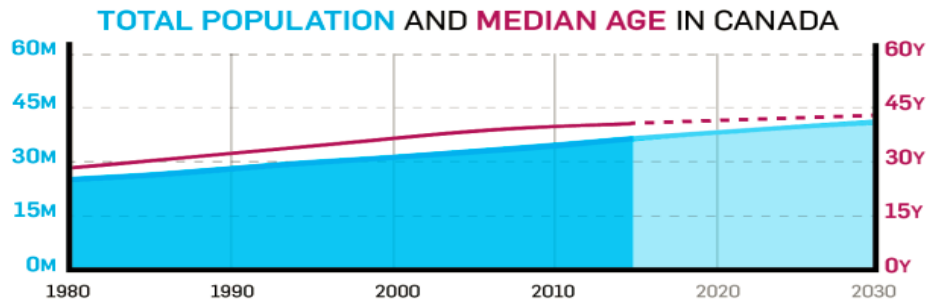
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Agenda

- Research Problem

- Research Objective

- Overview of RPM Program

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- Results

- Key Findings

- Conclusion

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Research Problem

➤ Aging Population & Associated HealthCare Costs

TOTAL POPULATION AND **MEDIAN AGE** IN CANADA

(graph: 1980–2030, population 0M–60M, median age 0Y–60Y)

CANADIANS AGED 65 AND OLDER:

2005: **1 IN 8**   2030: **1 IN 4**

Source:http://www.ctvnews.ca/health

COPD Costs

$49.0 BILLION

$32.1 BILLION

Costs attributable to having COPD were $32.1 billion in 2010 with a projected increase to $49.0 billion by 2020.

2010   2020

Source:https://www.cdc.gov

❖ **In 2012/13, Canadians over 65 accounted for 78%** of the **most expensive type of hospital stays**: COPD, pneumonia and HF (CIHI).

❖ **Patients with COPD**: **Highest rates** of **Hospital Readmissions**, return within 7 days to **ER Visit.**
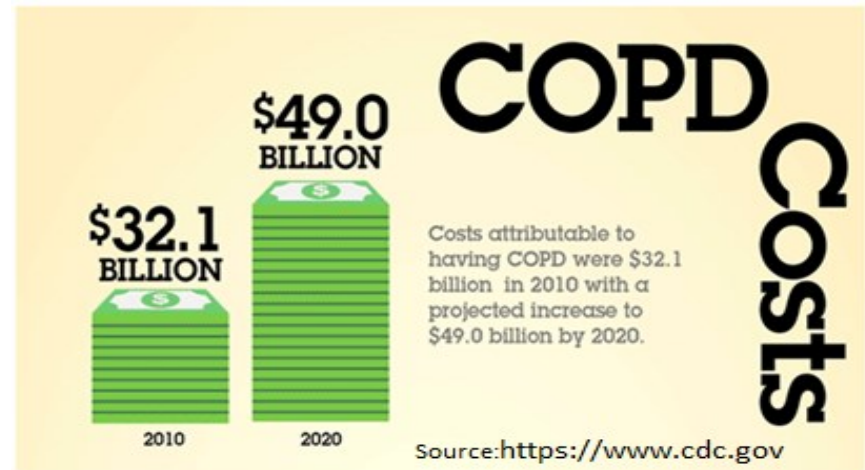
Key Questions?

❖ What are the **contributing factors** to **lengthy hospitalizations and multiple Emergency Visits** on patients with COPD and HF?

❖ **Can identification** of such facts lead to **reduction** on **healthcare costs** as well as **improved outcomes** for the **patients.**

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Research Objective

- ❖ Utilize Remote Patient Monitoring (RPM) Program
- ❖ Demonstrate that Predictive analytics applied on patient data captured remotely can help identify risk factors to lengthy hospitalization and multiple ER Visits.
- ❖ Key Metrics Evaluated: Impact of gender and medical history on ER visits and hospital admissions
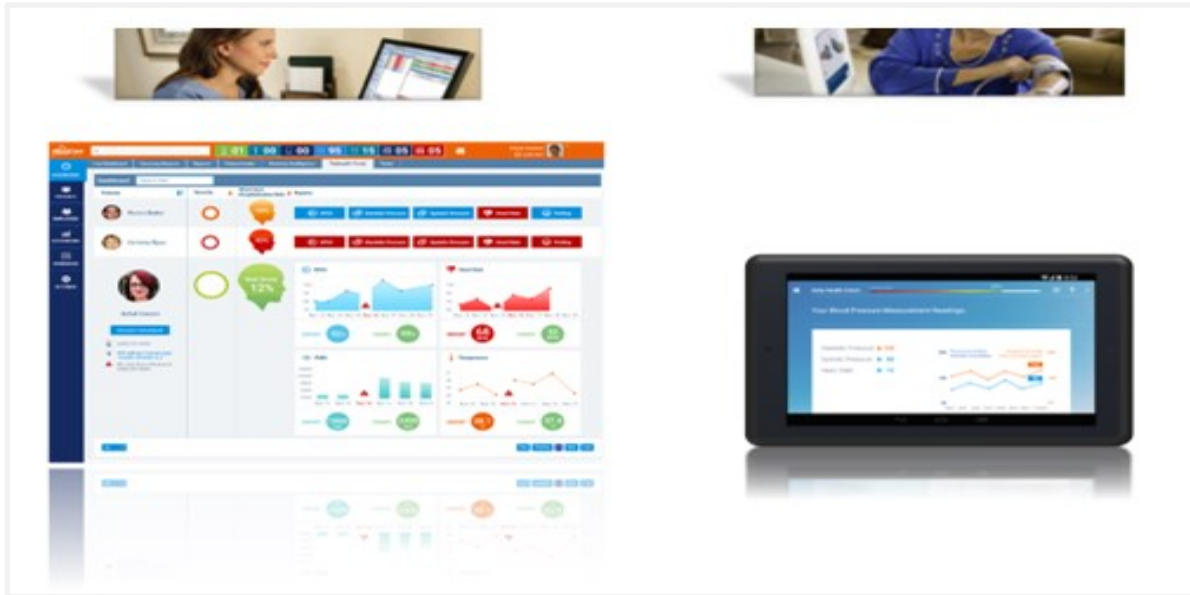
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Overview of RPM Program

Program Goal:

❖ Reducing Hospital Admissions and Emergency Department Visits for Chronically ill patients using Remote Patient Monitoring and Telehealth Tools

Facilitated by:
❖ Patient Monitoring
❖ Data Collection
❖ Analysis
❖ Action

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Methods

Data Details

- A subset of de-identified dataset collected from patients participating in the RPM programs in 2016-17.

- Data elements included chronic disease, age, sex, hospitalization details, emergency room visit details and clients vital status.

- Data Preparation: To facilitate the analysis: Cleaning, Linking and Standardization

Summary Statistics

- 69, STD: 17.6, Min 20, Max 97, (N=84)
- 14% more Female Clients than Males

Distribution of Cohort

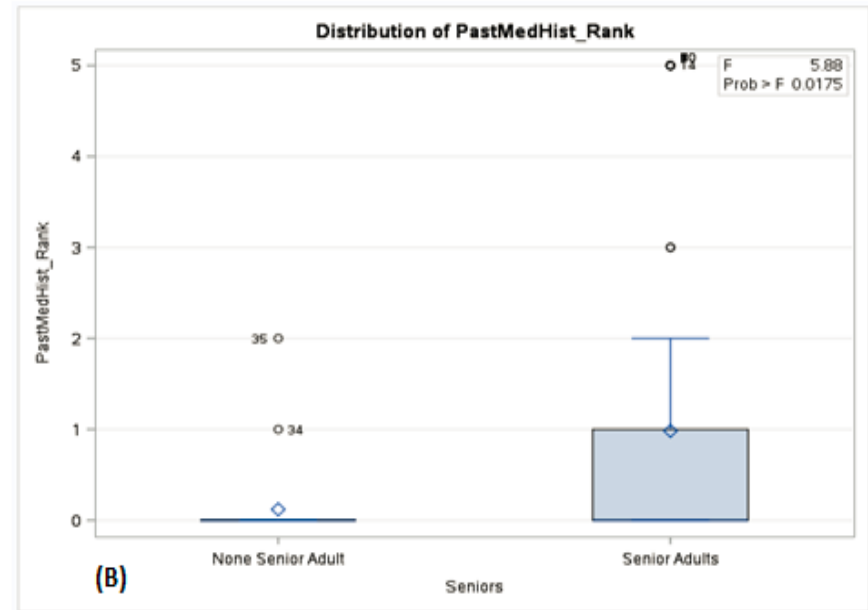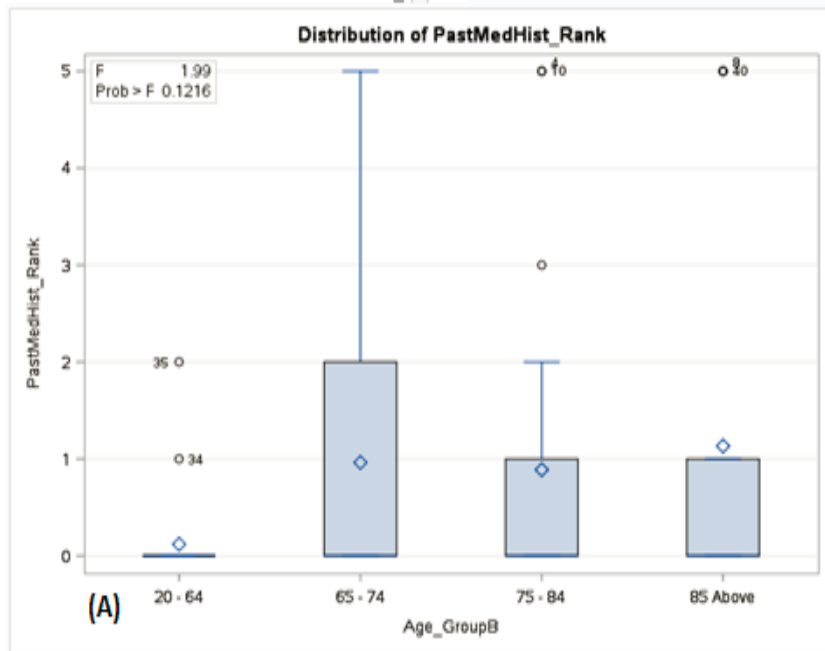- 70% Seniors Age 65+
- 30% Adults Age <65
- 57% Female
- 43% Male
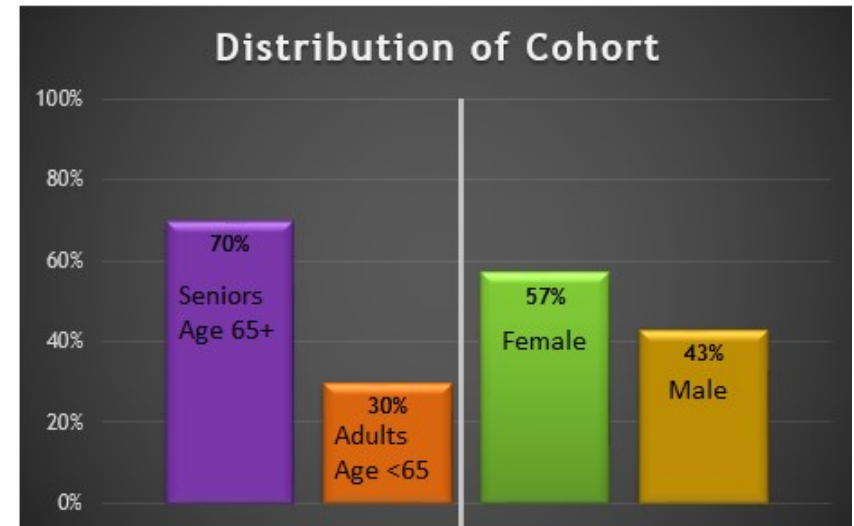
Predictive Analytics

- Probabilistic Analysis
- Correlation Analysis on patient attributes to hospital admissions

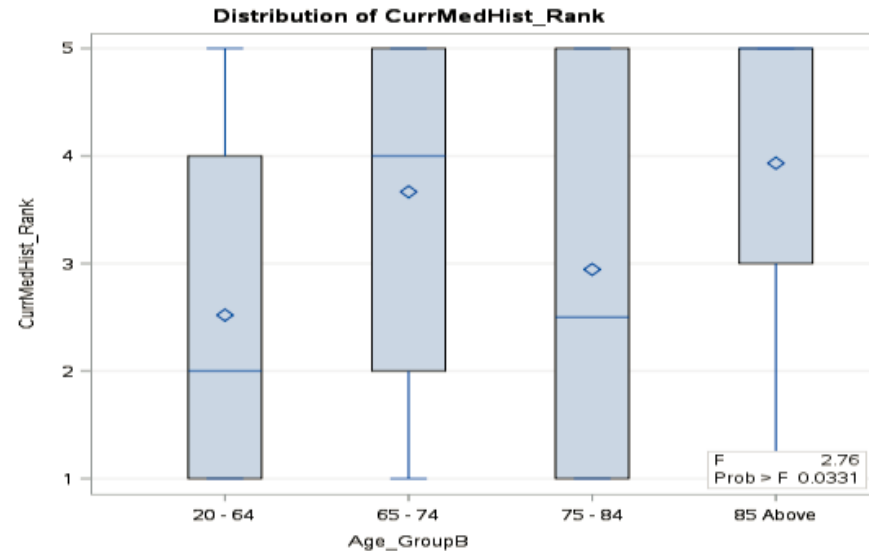**UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY**

Results

❖ Variation on Client Medical History

(A) Distribution of PastMedHist_Rank — F 1.99, Prob > F 0.1216; by Age_GroupB (20 - 64, 65 - 74, 75 - 84, 85 Above)

(B) Distribution of PastMedHist_Rank — F 5.88, Prob > F 0.0175; by Seniors (None Senior Adult, Senior Adults)

❖ **The probability of having past medical records based on age is statistically significant**
❖ **The older the patient the higher the presence of more than one comorbidities (p=0.0175)**

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Distribution of Current Medical by Age

Distribution of CurrMedHist_Rank

Distribution of CurrMedHist_Rank
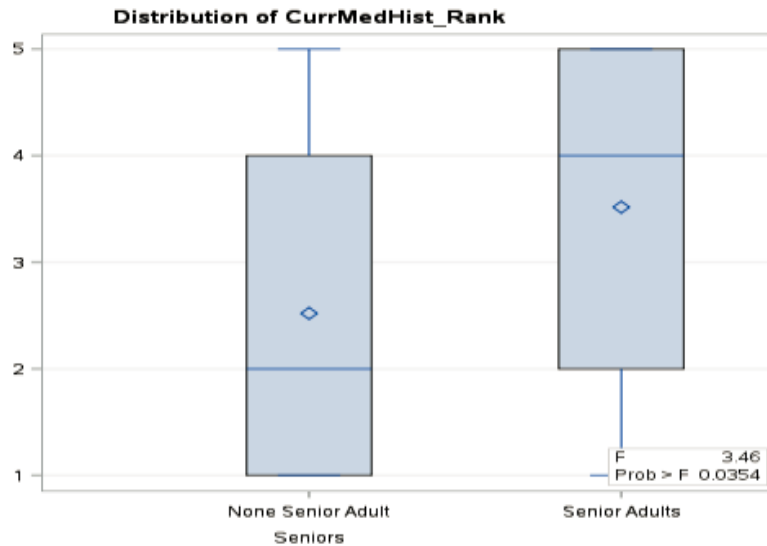
- ❖ Statistically significant number of seniors adults with current medical history (p=0.0354).
- ❖ A drill down on senior adults indicates a statistically significant number on clients aged 85 and over, (p=0.00331).
- ❖ No indication that past and current medical history varies by gender

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Hospital Admissions

- ❖ 20 hospital admissions, length of stay 2 to 11 days.
- ❖ 10 unique patients, 60%, 2 or more hospital admissions
- ❖ Exasperation of COPD was the most common reason for of the hospitalization (64%).

Correlation of Hospital Admissions by Gender

Gender = Male

Pearson Correlation Coefficients, N = 45 Prob > |r| under H0: Rho=0				
	PastMedHist_Rank	CurrMedHist_Rank	Allergy_Rank	hadmitflagA
PastMedHist_Rank	1.00000	0.28391 0.0588	-0.18180 0.2320	0.54218 0.0001
CurrMedHist_Rank	0.28391 0.0588	1.00000	0.27665 0.0658	0.25335 0.0931
Allergy_Rank	-0.18180 0.2320	0.27665 0.0658	1.00000	0.40786 0.0054
hadmitflagA	0.54218 0.0001	0.25335 0.0931	0.40786 0.0054	1.00000

Gender = Female

Pearson Correlation Coefficients, N = 53 Prob > |r| under H0: Rho=0				
	PastMedHist_Rank	CurrMedHist_Rank	Allergy_Rank	hadmitflagA
PastMedHist_Rank	1.00000	0.42006 0.0017	0.59503 <.0001	0.01317 0.9254
CurrMedHist_Rank	0.42006 0.0017	1.00000	0.46671 0.0004	-0.20971 0.1318
Allergy_Rank	0.59503 <.0001	0.46671 0.0004	1.00000	-0.12991 0.3539
hadmitflagA	0.01317 0.9254	-0.20971 0.1318	-0.12991 0.3539	1.00000

- ❖ Statistical significant correlation for male clients on hospital admissions and past medical history ($p=0.0001$), allergies ($p=0.0054$).

- ❖ For female participants, no such correlation is found

- ❖ However, there was statistically significant correlation between allergies and past medical history at ($p<0.0001$) on females

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Correlation Analysis by Age, Gender

Age 75 to 84, no hospitalizations
- ❖ On males, strong correlation on past and current medical history that was statistically significant.
- ❖ On Females presence of allergies was associated with Past medical history

Age 85+ with Hospitalizations
- ❖ Strong correlation between past and current medical history on males, similar findings not found on females

Gender = Female
Age_GroupB=75 - 84

Pearson Correlation Coefficients, N = 10 Prob > |r| under H0: Rho=0			
	PastMedHist_Rank	CurrMedHist_Rank	Allergy_Rank
PastMedHist_Rank	1.00000	0.43072 0.2140	0.84095 0.0023
CurrMedHist_Rank	0.43072 0.2140	1.00000	0.58381 0.0764
Allergy_Rank	0.84095 0.0023	0.58381 0.0764	1.00000

Gender = Male
Age_GroupB=75 - 84

Pearson Correlation Coefficients, N = 5 Prob > |r| under H0: Rho=0			
	PastMedHist_Rank	CurrMedHist_Rank	Allergy_Rank
PastMedHist_Rank	1.00000	0.95258 0.0123	.
CurrMedHist_Rank	0.95258 0.0123	1.00000	.
Allergy_Rank	.	.	.

- ❖ **Strong indication of differing features by Age and Gender**
- ❖ **Need careful evaluation/factorization of variables used in predictive modelling**

Correlation on Client vital Status

- ❖ Statistical significant correlation between min, max blood pressure and weight (P<0.001).
- ❖ There is also significant correlation between SPo2 and pulse rate.

Pearson Correlation Coefficients Prob > |r| under H0: Rho=0 Number of Observations					
	ave_weight	ave_pulse	ave_spo2	ave_bpmin	ave_bpmax
ave_weight	1.00000 4171	-0.14714 <.0001 4109	-0.03855 0.0150 3984	0.06260 <.0001 3871	0.11982 <.0001 3873
ave_pulse	-0.14714 <.0001 4109	1.00000 4913	-0.14872 <.0001 4764	0.08549 <.0001 4601	-0.00891 0.5457 4603
ave_spo2	-0.03855 0.0150 3984	-0.14872 <.0001 4764	1.00000 4765	0.02042 0.1731 4454	-0.00970 0.5176 4456
ave_bpmin	0.06260 <.0001 3871	0.08549 <.0001 4601	0.02042 0.1731 4454	1.00000 4604	0.49093 <.0001 4598
ave_bpmax	0.11982 <.0001 3873	-0.00891 0.5457 4603	-0.00970 0.5176 4456	0.49093 <.0001 4598	1.00000 4606

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Next research questions:
- ❖ What does this correlation indicate on cohort of patients with/without hospitalizations?
- ❖ Is there any temporal relationships in vital status leading up to an adverse event?

Key Findings

Participation in RPM

❖ Larger volume of female clients who participated in the program at 57% compared to 43% male.

Variation on Commodities

❖ Analysis indicates variations by age and gender on the existence of multiple medical conditions.

Probability of Having Medical Conditions

❖ A statistically significant indication that Senior adults age 65+ have a past medication condition (p=0.0175).

❖ A statistically significant indication on presence on current medical conditions on seniors aged 85+ (p=0.0331).

Correlation Analysis

❖ On **female clients**, a strong correlation on presence of allergies, current and past medical history, however these factors were **not correlated** to **hospital admissions**.

❖ On **male clients**, past medical history (p=0.0001) and presence of allergies (p=0.0054) all **strongly correlation to hospitalization**.

❖ **Vital status, statistically significant correlation** on average: weight vs blood pressure, pulse vs weight, pulse and SPo2 (p<0.0001)

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Conclusion

❖ There is need to understand the cohort of patients participating in telehealth programs using Analytics

❖ Potential to drive the necessary care needed leading to improved patient experience, reduction of cost of care and better outcome.

❖ Analytics facilitated by statistical quantification of patient attributes thus provide evidence on variation across many data points collected on those patients.

This paper provides

❖ Several dimensions of analysis that shows variations among patients age and gender on; **presence of past and current medical history**, **hospitalization** and **distribution** on **clients vital status.**

❖ **In future works**, we will perform further analysis **to understand if hospitalization** can be **explained by the correlation seen in the client vital status prior to admission event** as opposed to analysis on the whole timeframe when clients participates in the study.

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