Improving Usability, Safety and Patient Outcomes with Health Information Technology
F. Lau et al. (Eds.)

doi:10.3233/978-1-61499-951-5-36

Adoption Strategies for Electronic Patient Portals: Employing Advanced Data Mining and Analytics

Jagpaul BOLA*[a], Rebecca CHAROW*[a], Jennifer HOPE[a], Vasiliki BAKAS[b], Lembi BISHOP[a], Selina BRUDNICKI[a], Laura WILLIAMS[b], and David WILJER[1,a,c,d]
[a] *UHN Digital, University Health Network, Toronto, ON, Canada*
[b] *Patient Experience, University Health Network, Toronto, ON, Canada*
[c] *Department of Psychiatry, University of Toronto, Toronto, ON, Canada*
[d] *Institute of Health Policy, Management, and Evaluation, University of Toronto, Toronto, ON, Canada*

Abstract. Patient portals are becoming increasingly available at medical institutions, worldwide. Reporting of patient portal adoption strategies is scarce. A multi-institutional health network in Toronto, Canada is seeing great success with its portal adoption by patients, with an annual adoption rate of almost 65%. In the literature, annually adoption rates in Canada range between 5% and 10%. This significant difference and high adoption is attributed to a multifactorial approach that includes a dedicated operations team to engage with patients and staff, a co-design approach for portal development and more recently, new data-driven strategies to affirm and recommend promotion approaches. Advanced data mining and analytics are promising tools to help improve the adoption rate. This paper will describe five analytics tools used to describe and potentially improve patient portal adoption rates.

Keywords. Patient portal, personal health records, adoption, big data, data mining, data analytics, consumer informatics

1. Introduction

Globally, online patient portals are increasingly becoming commonplace at medical institutions [1]. Patient portals enable its users to access their personal health records (PHRs) that are tethered to institutional electronic health records (EHRs) in addition to a variety of other activities, such as receiving appointment notifications, communicating with health care providers, and sharing PHRs with family or other providers [2-3]. As medical institutions actively move towards patient-centric approaches, patient portals have become popularized to promote patient engagement and subsequent self-care, enhance patient-provider relationships, and improve health care quality (convenience, satisfaction, patient safety and clinical efficiency) [4]. Although growing, evidence regarding patient portals is immature, particularly as it pertains to adoption [1].

Currently, patient portal adoption across single and multi-institutional health systems in Canada range between 5%-10% annually [2]. Seminal patient portals, such as

* Contributed equally.
[1] Corresponding Author. E-mail: David.Wiljer@uhn.ca

the Kaiser Permanente and Veterans Health Administration portals in the United States, have achieved higher rates, particularly after the deployment of additional portal features [2]. For instance, registrations on Kaiser Permanente's portal drastically increased from 9% to 27% after integrating PHR functionality in 2006 [5]. The most recent reported adoption rate by Kaiser Permanente is now 70% [6]. We are currently operating under the generally accepted adoption definition of at least one login or activated account [1]; although recognizing its limitations, we are working on refining this definition. At the University Health Network (UHN) in Toronto, Canada, the annual adoption rate is 64.8 %, with 43,000 'myUHN' patient portal registrations during the first 14 months.

UHN is a multi-institutional health system, consisting of 4 patient sites (Toronto General Hospital, Toronto Western Hospital, Princess Margaret Cancer Centre, Toronto Rehab Institute). During this period, all sites cumulatively reported 1,129,346 clinic and day/night care visits and 122,578 emergency visits [7]. We sought to employ advanced data mining and analytics strategies from other industries (i.e. retail and finance), starting in May 2018, to better understand myUHN users and patient flow and to ultimately increase our adoption rate. This paper will describe five analytics tools used to describe and improve adoption rates.

2. Advanced Data Mining and Analytics Tools and Techniques

myUHN was developed and its promotion implemented into hospital workflows with a user-centered design approach [8]. myUHN features are: real-time access to PHRs and laboratory testing results, appointment notifications, wayfinding for clinic information and patient education, and creating proxy accounts[2]. To gain access to myUHN, patients are offered a registration code at almost all client-facing areas, including clinics, imaging, phlebotomy, and information desks. myUHN is a fairly new service and staff education is ongoing. In order to ensure our patients needs are met, patients can also obtain codes over the phone by contacting the myUHN Support Operations line. This makes our adoption rate the proportion of codes registered over the codes offered. This code offering structure was selected based on a key needs assessment finding: patients preferred to receive registration codes at any site as opposed to a single, centralized area along with having the option to call in if a code was not offered in person. To determine the patterning of our code offers and registrations, we use:

- Dashboards
- Moving Averages
- Network Diagrams
- Offer Rate
- Market Penetration

2.1. Dashboards

Dashboards are interactive, easily modifiable cross-sectional views of inputted metrics [9]. In utilizing this tool, we were able to make our data presentation more dynamic and to disseminate critical knowledge in real-time for stakeholders to engage with and understand the adoption-related data.

[2] https://www.uhn.ca/PatientsFamilies/myUHN

2.2. Moving Averages

Moving averages are defined as "smooth data" or "bending trendlines" in using the average over a specified period of time to lessen or eliminate the impact of outliers in a data set [10]. By visualizing and interpreting data in a smoothed fashion, we are able to identify and account for anomalies, capturing adoption more accurately. Anomalies identified in our adoption data were national or statutory holidays, and not the hypothesized seasonality. For each national or statutory holiday, the appearance of the data would indicate a great increase/high adoption. However, this increase is not reflective of an increase in registrations, but rather a significant decrease in the number of codes offered to patients that day. With this consideration, a moving average would be more informative than the traditional, annual or cumulative adoption rate.

We determined that using a 90-day average is a suitable period of time whereby it is short enough to show a trend signal, yet long enough to 'smooth out' anomalies (Fig 1). Notably, this 90-day moving average for adoption rates demonstrates that the total registrations were proportional to the number of codes offered to patients. Similar to adoption rate, we used a 90-day average to track total registrations at each site. With this metric, we were able to identify significant actionable trends that were otherwise not seen when analyzing the monthly or yearly aggregates.

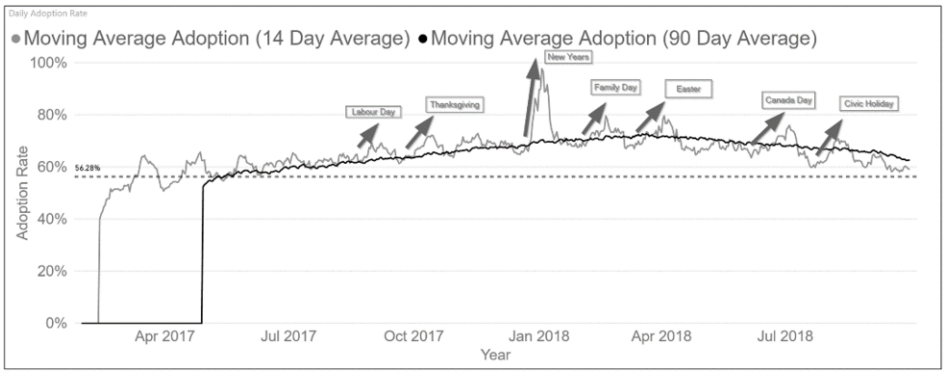

Figure 1. Adoption Rate – 'Smooth' 90-Day versus 14-Day Moving Average.

2.3. Network Diagram

Although informative, moving averages for adoption rates and total registrations do not speak to who myUHN users are, what proportion of clinic visitors are myUHN users, and the frequency in which clinics are accessed. Through an exploratory data analysis process in which two separate datasets (myUHN system activity and clinical visit data) were compared in multiple combinations and variations, we learned that myUHN users were patients who came to UHN more frequently than non-users and that there are several highly connected clinics with significant patient overlap within the network.

We used a network diagram to understand the interconnectivity between clinic populations and to see this relationship between myUHN patients and the clinics they access (Fig 2). To understand this figure, imagine each line as being a patient who had

an appointment at a particular clinic. The circles are the clinics themselves, where the size of the circle represents the number of patients who accessed this clinic. This patient could have had attended multiple appointments at multiple clinics; hence, the proximity between each of the circles.

This imaginative figure visualizes at a very high level which clinics are common to various groups of patients. By supplementing the operations team knowledge and expertise about how the patient flow works, we strive to deliver very focused efforts to increase the awareness of myUHN in highly connected environments. A great benefit in utilizing this tool is the removal of technical and statistical aspects of the analysis from the ideation process, so that all team members may engage with the data, and over time better integrate findings to make more effective, actionable plans.

Our network diagram illustrates that clinics/areas with high adoption also had greater patient overlap with other clinics/areas. From this, we learned two facets to inform adoption strategy:

1. Our initial adoption strategy was limited and did not leverage patient flow, as UHN patients, regardless of portal usage, visited more than one clinic/area across multiple sites.
2. 33.8% of myUHN registration occurred on the day they received the code. This is reasonable as information burden is a common occurrence when patients visit hospitals. Since we are not electronically reminding patients to complete myUHN registration after they are given a code, the data displayed in the network diagram shows the high-traffic, linked clinics/areas. The network diagram can be used as guidance, for clinics with the greatest overlap. These areas, in our case, Imaging, are encouraged to re-offer myUHN codes to patients, resulting in a higher re-issue rate. The number of code re-issues to patients has increased from 8.5% to 19.2% as a result of the operations team gaining leadership support to actively promote the portal and performing in-service staff training in these high-traffic, linked areas.

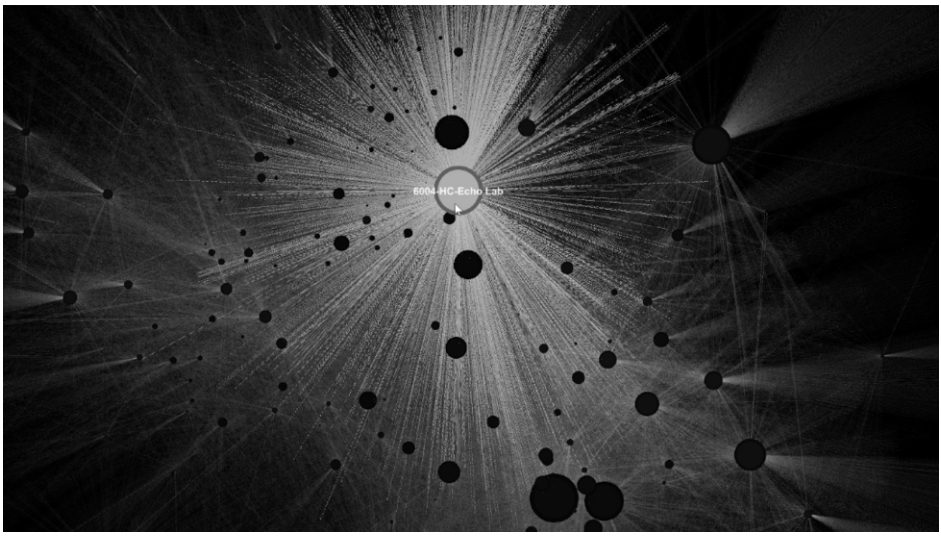

Figure 2. Network Diagram of Adoption Rate Distribution Across UHN Clinics/Areas.

2.4. Offer Rate and Market Penetration

To determine what proportion of the clinic populations were myUHN users, we used offer rate and "market" penetration. Offer rate is the percentage of registration codes offered to non-myUHN users (total number of registration codes offered to patients over total number of non-myUHN users). This term is commonly referred to as 'capture' or 'conversion' rate [11]. "Market" penetration is the proportion of myUHN users that have visited a particular care site or clinic within the hospital network (Fig 3). This information allows us to gauge what percentage of each clinic's population have yet to sign-up and use the portal. By using "market" penetration as a key metric, we are able to determine the carrying capacity of each clinic/area. Carrying capacity is the ability of our environment (current human resources, technology limitations and support infrastructure) to issue registration codes and to support patient demand without adding additional resources. As the market penetration approaches its maximum carrying capacity, the growth rate, in this case, incremental growth in registrations drastically slows as the proportion of myUHN users in a clinic's population increases (i.e. logistic growth). Knowing these metrics could elucidate any clinics that may not be promoting the portal and help guide myUHN operations efforts, including environmental scans, before using resources and delivering additional staff trainings. In time, high-traffic and interconnected clinics may develop a more standardized process in their clinic workflow to ensure registration codes are offered more consistently.

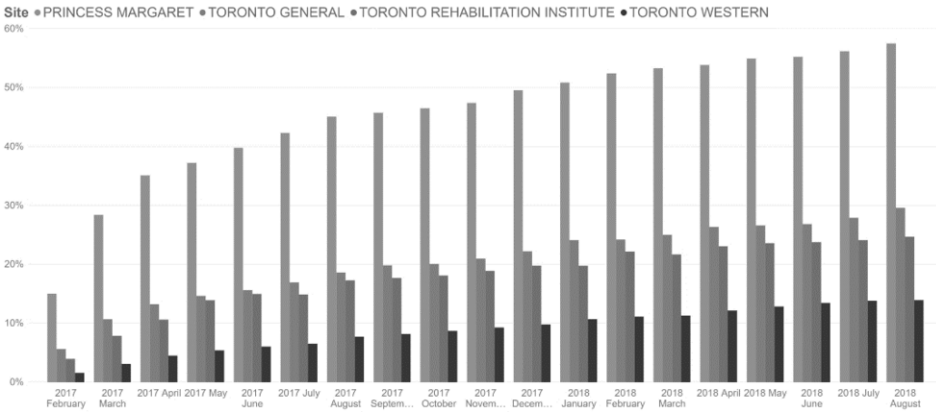

Figure 3. Market Penetration Across Each UHN Site.

3. Conclusion

The adoption rate of myUHN is remarkably higher than the reported average in both large and small-scale health systems in Canada. Data exploration and data-driven strategies appear to indicate further success, yielding significant knowledge about patient flows at UHN service areas. This knowledge can be leveraged to reinforce as well as tactically prioritize and deploy operational management approaches such as patient and staff engagement, training and marketing. The novelty of utilizing these advanced data

mining and analytics tools and techniques provides a very exciting opportunity to fulfill our obligation to all health service users to deliver the highest quality of health care.

References

[1] P. Fraccaro, M. Vigo, P. Balatsouka, I.E. Buchan, N. Peek, S.N. van der Veer. Patient portal adoption rates: a systematic review and meta-analysis. *Stud Health Technol Inform* **245** (2017), 79-83.

[2] B. Gheorghiu, S. Hagens. Use and maturity of electronic patient portals. *Stud Health Technol Inform* **234** (2017), 136-141.

[3] T. Irizarry, A.D. Dabbs, C.R. Curran. Patient portals and patient engagement: a state of the science review. *J Med Internet Res* **17**(6) (2015), e148.

[4] S. de Lusignan, F. Mold, A. Sheikh, Z. Majeed, J.C. Wyatt, T. Quinn, M. Cavill, T.A. Gronlund, C. Franco, U. Chauhan, H. Blakey, N. Kataria, F. Barker, B. Ellis, P. Kozcan, T.N. Arvanitis, M. McCarthy, S. Jones, I. Rafi. Patients' online access to their electronic health records and linked online services: a systematic interpretative review. *BMJ Open* **4** (2014), e006021.

[5] A.L. Silvestre, V.M. Sue, J.Y. Allen. If You Build It, Will They Come? The Kaiser Permanente Model of Online Health Care. *Health Aff(Millwood)* **28**(2) (2009), 334-344.

[6] T. Garrido, B. Raymond, B. Wheatley. Lessons from more than a decade in patient portals. *Health Affairs.* n.p. (2016). Web. 6 Nov. 2018. Retrieved Nov 6, 2018 https://www.healthaffairs.org/do/10.1377/hblog20160407.054362/full/

[7] University Health Network. 2017-18 Year in Review. *University Health Network.* p.42. (2018). Web. 12 Sep. 2018. Retrieved Sep 12, 2018 https://www.uhn.ca/corporate/AboutUHN/Documents/UHN_AR_2018.pdf

[8] K.M. Nazi, C.L. Turvey, D.M. Klein, T.P. Hogan. A decade of veteran voices: examining patient portal enhancements through the lens of user-centered design. *J Med Internet Res* **20**(7) (2018), e10413.

[9] M.A. Badgeley, K. Shameer, B.S. Glicksberg, M.S. Tomlinson, M.A. Levin, P.J. McCormick, A. Kasarskis, D.L. Reich, J.T. Dudley. EHDVis: clinical dashboard development using open-source technologies. *BMJ Open* **6** (2016), e010579.

[10] W.A. Thorp. An intro to moving averages: popular technical indicators. *American Association of Individuals Investors Journal.* n.p. (1999). Web. 12 Sep. 2018. Retrieved Sep 12, 2018 https://www.aaii.com/journal/article/an-intro-to-moving-averages-popular-technical-indicators.touch

[11] K Tomic, A. Berglund, D. Robinson, M. Hjalm-Eriksson, S. Carlsson, M. Lambe, P. Stattin. Capture rate and representativity of the national prostate cancer register of Sweden. *Acta Oncol* **54**(2) (2015), 158-163.