

Promoting Health Equity and Continuity of Care through Implementation of a No-Show Prediction Model

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Abstract. Healthcare appointment no-shows are a universal and costly problem that cause substantial negative consequences for patients, providers, and health systems. These missed appointments lead to inefficiencies, financial losses, and reduced access to care for other patients, while patients themselves experience disruptions in continuity of care and poorer health outcomes. Existing interventions, such as generic reminder texts or no-show fees, have limited success in sustainably reducing no-show rates, particularly for marginalized populations. However, advancements in data collection, electronic health records (EHR), and predictive analytics offer new solutions. This paper examines a health informatics approach that combines both predictive modeling to identify patients at high risk for no-shows and targeted reminder calls as a means for reducing no-show rates. A case study of an outpatient rehabilitation organization in Canada facing over \$2 million in direct annual loss demonstrates a financial savings opportunity of over \$400,000 per year and improved care continuity through this approach. By integrating predictive models into EHR workflows, healthcare organizations can proactively mitigate no-shows, promoting both operational efficiency and health equity.

Keywords. Health informatics, health equity, no-show, missed appointment, predictive analytics, machine learning, prediction model, no-show prediction, worker's compensation, workman's compensation

1. Introduction

No-shows, or when a patient misses a scheduled healthcare appointment without prior notice, are a universal phenomenon across healthcare systems throughout the world [1]. When patients are unable to attend scheduled healthcare appointments, there are a multitude of negative consequences. For healthcare organizations and health systems, no-shows result in an inefficient use of provider time and resources, reduced access to care for other patients, direct financial losses for the organization, and downstream constraints on the healthcare system [2]. Yet because no-shows are considered a result of a patient's own behavior, what is underappreciated is the effect on the patient themselves. When patients are unable to attend a scheduled appointment, this represents a missed opportunity for necessary care. No-shows disrupt a patient's continuity of care, increase their risk for adverse events, and contribute to poorer health outcomes, all which impact health equity and timely access to care [2].

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There is an extensive body of international literature studying the phenomena of no-shows in healthcare [1-3]. What has been well established is that no-shows represent more than a mere scheduling mishap on behalf of a patient. No-shows are a complex behavioral phenomenon with numerous contributing or correlating factors, including social determinants of health, communication challenges, transportation and accessibility barriers, work or childcare obligations, mental health factors like fear or anxiety, and varying levels of health literacy [1, 3]. No-shows are often disproportionately represented amongst marginalized groups and can be an indicator of when a patient is facing challenges prioritizing their health [2]. Therefore, no-shows do not happen at random. They are a predictable outcome that are the result of numerous identifiable root causes [4, 5]. A thoughtful solution for mitigating no-shows must consider these underlying factors to be effective.

The financial ramifications of no-shows are often the clearest and most direct consequence for healthcare systems and organizations. For example, studies estimate that no-shows cost the U.S. healthcare system over \$150 billion per year [4]. At an individual clinic level, no-shows can be an even more pervasive and costly problem. No-shows can cost a single physician medical practice up to \$150,000 each year in direct losses [6]. When considering costs to the patient, provider, and healthcare system, it was accurately described in the Canadian Medical Association Journal [7]: “*When patients miss appointments, everyone pays.*”

Previous strategies for addressing patient no-shows have often been ineffective or inefficient. For example, individual reminder calls from administrative staff, while effective for patient engagement, are time-consuming and tedious for larger practices [5]. Automated calls, emails, or text messages, while operationally efficient, are inconsistent at improving attendance rates because generic messages do not address individualized concerns [1]. Overbooking appointment slots is a common practice for clinics with high no-show rates but has been known to perpetuate wait times and contribute to rates of burnout [1, 8]. Finally, policies such as monetary fees or fines to dissuade patients from no-showing take a punitive approach that can diminish the patient-provider relationship, perpetuate inequitable access to care, and further distance a patient from their care teams [2]. These compensatory approaches aim to offset the operational costs of no-shows yet fail to truly empower patients by supporting their ability to attend.

Recent advancements in data collection, electronic health records (EHR), and predictive analytics have created new opportunities to address this complex issue. From a data technology standpoint, one study by Yang et al. [1] recognized the opportunity to promote health equity by predicting no-shows using machine learning. Another study by Shah et al. [5] demonstrated that targeted reminder calls to patients at high-risk for no-shows could be a time-efficient solution for improving no-show rates. The following case study analyzes the design of a health informatics solution that merges these two approaches: insights gained from predictive modelling and targeted reminder calls as a means for reducing no-shows, increasing continuity of care and promoting health equity.

2. Methods

The ideal setting for implementing this health informatics solution is an organization with high historical no-show rates that uses a fee-for-service reimbursement model. For these stakeholders (e.g. physicians, managers, executive leadership, etc.), there is a clear financial benefit to reducing no-show rates and minimizing business loss. Furthermore,

large organizations that see a high volume of visits per year and bill a high amount per visit (e.g. physician specialists) have the greatest potential for recouping financial losses associated with no-shows. Lastly, though perhaps most importantly, organizations that serve a high proportion of marginalized, medically complicated, or otherwise complex patient populations are best positioned to benefit from this solution by increasing equitable access to care. A multi-center outpatient rehabilitation organization associated with a large, metropolitan hospital in Canada was selected as a case study for designing this solution. The physician specialist clinics for managing complex worker's compensation claims were used as the primary setting of focus, as these clinics are considered high impact in terms of claims management, highly resource intensive in terms of service delivery, and associated with high financial ramifications for each no-show.

3. Solution

The ideal solution for this project design leverages three primary components: 1. The vast array of data collected and stored in the EHR that correlate with no-show likelihood 2. Predictive modeling to analyze historical data and calculate a no-show probability for each scheduled appointment 3. Integration with existing systems and processes to inform workflow redesign. There are two main options for selecting a solution for this organization. The first option is building or purchasing a product from a third-party vendor in the market. The second option is licensing a solution with the organization's current EHR vendor. Although the first option may yield greater potential for solution customization or using advanced technology (e.g. machine learning), it is not recommended due to the drawbacks of increased project time and cost, interoperability challenges, and less workflow integration. The proposed solution is the second option: licensing a solution with the organization's current EHR vendor, Epic (Epic Systems Corporation). While this option may involve less opportunity for customization, it provides the benefit of interoperability, workflow integration, utilizing existing EHR licensing and technology, and leveraging existing vendor relations.

Epic's Cognitive Computing Models are a library of predictive models designed to analyze EHR data and produce actionable insights for healthcare teams using Epic. These models use statistical methods to predict the probability of future events by testing the correlation between historical data and a desired predicted outcome (e.g. no-shows). Epic's "Risk of Patient No-Show" (version 2) is a predictive model that uses a cloud-based, random forest model to calculate the probability of no-show for scheduled outpatient appointments (implementation assumes access to Nebula, Epic's cloud services platform). This model analyzes a feature set of over 20 variables in the EHR found to strongly correlate with no-shows, including visit type, appointment time, visit lead time, and previous no-show rate. During an initial pilot period, the generic parent model is localized to an organization's patient population through a process of performance validation. The model's parameters are fine-tuned based upon the organization's unique characteristics to achieve predictive accuracy. The model's output is displayed on a scheduling dashboard within the EHR as a percentage next to each appointment, allowing insights to be readily viewable to scheduling teams. By leveraging a no-show prediction system that is embedded within the EHR, healthcare organizations can implement a solution integrated into existing workflows to proactively identify

patients at risk of missing appointments and implement targeted interventions to improve attendance rates.

4. Implementation & Workflow Redesign

In the current state, the organization of focus for this project is budgeted to see over 21,000 physician specialist appointments per year and had an average no show rate of 7% year-to-date, equating to over 1,400 no-shows per year and an annual direct financial loss of over \$2.1 million. Currently for these clinics, appointment reminders are based upon registration with the organization's patient portal. Two days prior to a physician clinic, an administrator screens the schedule to determine which patients are registered for the patient portal. Those who *are* registered for the patient portal receive an automated reminder email. Those who are *not* registered for the patient portal receive a reminder phone call from the administrator. In the current state, up to 80% of patients *are* registered on the patient portal and therefore only receive an automated reminder email, yet many of these patients still no-show their appointment. The problem with the current state is that registration on the portal is not the greatest indicator of who requires a reminder call versus not. Additionally, there is a missed opportunity to provide additional support to patients at high risk for no-showing in order to support their ability to attend.

The implementation of this solution involves using model predictions to redesign the reminder call workflow and provide targeted support to patients with demonstrated need. A new role called Enhanced Support Personnel, who are staff specially trained in strategies to improve attendance rates, would be best suited to provide these reminder calls. These enhanced reminder calls would go beyond simply reminding patients of their appointment and provide additional support to patients, such as explaining the purpose of the appointment, helping address barriers to access, and using communication strategies to provide reassurance and mitigate fear or anxiety.

In the future state, rather than screening the schedule for patient portal registration, staff will screen the schedule for no-show probability to determine which appointments exceed an established threshold of no-show risk (e.g. >15% no show probability). The administrator will use this information as decision support for who requires a reminder call versus not – the appointments beneath the threshold would only receive the automated reminder email and those that exceed the threshold receive an enhanced reminder call from Enhanced Support Personnel. By being both selective and data-driven about who receives a reminder call versus not and improving the quality over-the-phone support to patients, this creates a more targeted approach to patient engagement, more efficient use of staff time and resources, and increased likelihood for attendance.

In previous research of similar solutions involving predictive analytics and targeted calls for reducing no-shows, the reductions in relative no-show rates ranged from 10% to as high as 40%. For the business case of this solution, a target relative reduction of 25% was selected. By reducing the current no-show rate of 7% to a target rate of 5%, the organization can realize an annual cost savings opportunity of over \$610,000. When considering the project costs associated with a 12-week project plan to implement this solution, costs were estimated at \$202,000 in Year 1. These costs include project team time, end-user training, and digital support. This equates to a net savings opportunity of over \$408,000 in Year 1. It is worth noting that the net savings opportunity can increase substantially after Year 1 once initial implementation costs are complete and the project

transitions to operations. Furthermore, there is considerable potential for additional net savings if the model is deployed across other service lines throughout the organization or if the volume of physician clinics expands over time.

5. Policy & Governance

There are important policy and governance considerations associated with a solution for mitigating no-shows using predictive analytics. First, an organization must establish that no-show prediction is intended as a means for promoting health equity and supporting patients' ability to attend appointments, rather than compensatory measures like overbooking to compensate for no-show risk. While appealing from an operational standpoint, overbooking is known to diminish the patient and provider experience and perpetuate inequitable access to care. Secondly, the organization must establish that engaging with patients prior to their appointment is seen as an opportunity to empower patients, build trust, provide reassurance, address accessibility barriers, and respect a patient's autonomy to direct their care. Furthermore, there must be safeguards in place to prevent a high no-show probability to lead to discrimination or unequal treatment. This may involve user access controls so that no-show predictions are only viewable to staff whose role necessitates it. From a data quality standpoint, the organization must ensure that historical data regarding no-shows have been collected accurately and uniformly across the organization. This may include establishing a definition of "late cancellation" (e.g. cancelled within 24 hours) and ensuring these visits are included in modeling, as they present similar operational challenges to clinics and likely reflect similar barriers experienced by patients. As with all predictive modeling that analyzes historical patient data, organizations must be intentional about policies that promote transparency, explainability, and bias reduction. The model must be transparent regarding what data it considers and be explainable such that its conclusions can be reasonably understood. Finally, there must be policies to eliminate the potential for models to bias against certain sub-populations, such as racial minorities. This includes ensuring demographic variables are not factored in the model's feature set and that the model's performance is continuously validated over time to prevent bias.

6. Conclusion

The implementation of a no-show prediction model offers a modernized, data-driven approach to addressing the pervasive issue of no-shows in healthcare settings. By leveraging predictive analytics to identify patients at high risk of missing appointments and taking proactive steps to mitigate no-shows, healthcare providers can be more efficient and effective with supporting their patients. Improving attendance rates, especially for marginalized groups or those experiencing barriers to care, can promote more equitable access to medically necessary services, enhance health outcomes, and produce operational efficiencies for an organization and health system. This implementation of a no-show prediction model represents a valuable opportunity for an organization to improve attendance rates, increase continuity of care, promote health equity and deliver tangible business value.

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