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Qualitative Assessment of Implementation of a Discharge Prediction Tool Using RE-AIM Framework

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Abstract. The implementation process in the routine clinical care of a new predictive tool based on machine learning algorithms has been investigated using the RE-AIM framework. Semi-structured qualitative interviews have been conducted with a broad range of clinicians to elucidate potential barriers and facilitators of the implementation process across five major domains: Reach, Efficacy, Adoption, Implementation, and Maintenance. The analysis of 23 clinician interviews demonstrated a limited reach and adoption of the new tool and identified areas for improvement in implementation and maintenance. Future implementation efforts of machine learning tools should support the proactive engagement of a wide range of clinical users since the very initiation of the predictive analytics project, provide higher transparency of the underlying algorithms, employ broader onboarding of all potential users on a periodic basis, and collect feedback from clinicians on an ongoing basis.

Keywords. Clinical decision support, implementation science, machine learning

1. Introduction

Clinical decision support (CDS) tools powered by artificial intelligence and embedded into electronic health records (EHR) are considered disruptive technologies. Their integration into practice has sometimes been slow and problematic. Even considering numerous reports of the benefits of CDS, when evidence meets the realities of practice [1,2], successful deployment and adoption can be threatened. Several clinical decision support tools driven by machine learning algorithms have been recently implemented into routine clinical practice at the Mount Sinai Health System (MSHS). These algorithms were embedded into Epic EHR and made available for daily use by clinical staff caring for hospitalized patients. One of these algorithms is a 48-hr discharge prediction tool (48DPT) which allows forecasting discharge dates for hospitalized patients based on discrete clinical data available in the EHR. The 48DPT is currently being used by hospitalist service during daily interdisciplinary rounds. However, the actual uptake of the 48DPT, its acceptance by clinical staff for routine clinical care, and its perceived and documented impact on care quality are unknown. Implementation science posits RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) framework as a validated means to assess the implementation of complex

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interventions in health care [3]. The goal of this project was to conduct a systematic evidence-based assessment of the implementation of the 48-hr Discharge Prediction Tool using the RE-AIM Framework.

2. Methods

A purposive sample comprised healthcare providers at MSHS (e.g., attending faculty physicians, residents, advanced practice nurses, staff nurses, social workers, and hospitalists). We attempted to include a sample with a wide range of expertise and years of experience in hospital care. At the beginning of each interview, verbal consent was collected. Each interview took approximately 30 minutes and was professionally transcribed verbatim. To instruct the interview process, a moderator guide was developed based on five dimensions of the RE-AIM framework [3]. A thematic analysis was conducted to identify, analyze, and report the themes that emerged from the participant's responses. The analysis was guided by the RE-AIM framework and followed the six-step process proposed by Braun and Clarke [4]. The study was approved by the MSHS IRB.

3. Results

The semi-structured interviews were conducted on three medical units with 23 participants, including sixteen hospitalists, four of whom are unit medical directors (UMD), four social workers (SW), two case managers (CM), and one nurse manager (NM). The analysis ended up with 120 codes and 25 themes. The themes describe the current situation and rising challenges of the 48DPT implementation. Four of the themes (providing training, increasing awareness, improving integration, and improving accuracy) demonstrate the participants' most frequently mentioned resolutions and suggestions to improve the long-term usage of 48DPT. In the following framework, each theme was presented with the number of unique participants who mentioned it.

The **Reach dimension** of this analysis focused on the targeted users who were aware of and used the 48DPT. Four major themes were identified, i.e., awareness, use frequency, user cohorts, and patient representativeness. *Awareness:* This theme indicates if a participant had heard of 48DPT. 14 participants reported that they were aware of this tool, including two UMDs, two CMs, two SWs, and 8 attendings, mostly affiliated with a specific medical unit at Mount Sinai Hospital (KCC unit); whereas 5 reported that they had never heard of this tool. *Use frequency:* This theme indicates if a participant was a frequent user. Out of the 14 participants who were aware of 48DPT, 7 reported frequent use at a team level, including 2 CM, 2 SW, 1 UMD, and 2 hospitalists (i.e. frequent users). Among these frequent users, 6 reported a daily frequency. In comparison, the other 16 participants, 9 of whom were hospitalists, reported a rare or no use of 48DPT at either team or individual level (i.e., no/rare user). *User cohorts:* This theme reflects participants' perception of frequent and non-frequent users of 48DPT. 12 participants perceived that 48DPT had potential benefits and was specifically used by a few types of roles, including CMs, SWs, and unit medical directors. In comparison, 3 participants stressed that 48DPT was not their focus on everyday routine (i.e., an NM, a SW, and a hospitalist). *Patient's representativeness:* This theme corresponds to questions regarding the use of 48DPT varied by patient-related factors. 14 participants observed no differences in using 48DPT

in terms of patients' related factors, whereas 5 reported differences in terms of patients' age, and disease severity.

The **Efficacy dimension** measures the impacts of 48DPT on the predefined outcomes, i.e., prediction accuracy, length of stay (LOS), initiating discharge process, and clinical patient outcomes. In addition, it also covers the participants' perceptions of such impacts in comparison with humans and Discharge Today (DT). *Accuracy (Medical readiness):* Because many participants used "accuracy" to explain the predefined outcome "effectiveness in identifying medical readiness", we thus used the accuracy to describe the codes related to such outcome. A participant reported that the prediction of 48DPT was accurate, and another participant showed trust in the 48DPT result. There were 5 participants who gave a range of estimated accuracy of 60-80%. In comparison, 6 participants reported that 48DPT was not consistently accurate; 3 participants reported that follow-up human validations were necessary. *LOS:* The theme investigates the impacts of 48DPT on the shortening of the patient's length of stay. 9 participants reported that the use of 48DPT didn't decrease LOS, and none of the participants stated that 48DPT did decrease LOS. *Initiating the discharge process:* This theme represents participants' perceptions of the efficacy of 48DPT in initiating a discharge process. 10 participants reported that 48DPT was helpful in initiating a discharge process. *Clinical care/patient outcomes:* This theme represents participants' perceptions of the efficacy of 48DPT in improving clinical care or patient outcomes. 6 participants considered that 48DPT had improved the outcomes. *Comparison with Humans:* This theme demonstrated the comparison made between 48DPT with the human judgment of discharge readiness. 3 participants reported that 48DPT was more or equally accurate than human judgment, and another two observed that the results were consistent with human judgment. In comparison, 10 participants reported that 48DPT was less accurate than humans or that the prediction was inconsistent with human judgment. 5 participants reported a tendency to trust humans instead of 48DPT, and only 1 participant showed trust in the prediction results of 48DPT. *Comparison with DT:* This theme indicates the comparison made between 48DPT with DT. There were 21 participants who were familiar with and used DT, and four of them showed a strong preference for using DT to 48DPT. 3 participants stressed that they used DT because their teams used it; it was multidisciplinary and team-coordinated. When it came to functionality, 5 participants recognized the differences between the 48DPT and DT. 3 participants appreciated its automated prediction function, which released them from manual data input. 8 considered the two to be functionally redundant. In addition, 5 participants considered DT to be more useful and accurate. 9 participants pointed out that DT considered patients' social factors in a discharge process, and 4 added that DT provided context information about a discharge of a patient, lacking in 48DPT.

The **Adoption dimension** addressed questions regarding the practices of using 48DPT at individual and unit levels and user acceptability in terms of different specialties and levels of experience in clinics. *Intended usage:* This theme reflects the participant's thoughts if 48DPT was used as intended. 7 confirmed that the 48DPT was used as intended, but 3 disagreed. *Usage at the unit level:* This theme captures participants' thoughts regarding the variety of 48DPT usage across different units. 6 participants reported that the use of 48DPT varied across the unit. The difference primarily lies in the use frequency. *Acceptability at an individual level:* This theme shows participants' reactions and responses to the use of 48DPT in the patient discharge workflow. 4 participants thought that the attitudes were varied in terms of physician's roles, whereas 3 didn't think there were differences. Also, 2 observed that the attitudes were varied in

terms of time in clinics where the younger practitioners would be more open to adopting the use of 48DPT. 4 didn't observe any variations. In addition, 2 clinicians showed a willingness to use 48DPT and perceived it to be useful in facilitating the patient discharge process.

The **Implementation dimension** focuses on the predisposing and enabling factors for a successful implementation. In this analysis, 2 themes were associated with the predisposing factors, i.e., perceived usefulness and easiness to use, computer skills, while 4 were associated with the enabling factors, i.e., involvement in the development process, integration into existing workflow, system transparency, and user training. *Perceived usefulness and easiness-to-use (Predisposing):* This theme represents participants' perceptions of the utility and easiness-to-use of 48DPT. 7 thought 48DPT to be useful. Some believed it would be especially useful for practitioners, SW, and sicker patients. 3 thought that 48DPT was accessible and intuitive to use. In contrast, 2 participants thought that 48DPT was not useful, and 5 were unsure. *Computer skills (Predisposing):* This theme reflects participants' thoughts about technical proficiency for 48DPT. 12 participants reported that 48DPT required basic computer skills. 2 reported that it required intermediate skills. *Involvement in the development process (Enabling):* This theme addresses participants' observations of involvement in the development process at both individual and team levels. Only 1 UMD reported that he/she was involved in the development process, whereas 18 participants were not involved. 6 participants reported the interdisciplinary team was involved in the development process, and 3 reported that the team wasn't involved. *Integration into existing workflow (Enabling):* This theme addressed the integration of 48DPT into the existing patient discharge workflow. 4 participants reported that the tool was well-integrated, and 1 reported it was somewhat integrated, whereas 11 participants disagreed that the tool was integrated. *Transparency (Enabling):* This theme describes the existing challenges caused by the lack of system transparency to the participants. 10 participants reported a lack of knowledge about how 48DPT works and its accuracy in predicting medical readiness. *Training (Enabling):* This theme covers the codes related to the shortage of training provided for users on using 48DPT. 12 participants reported a lack of training on how to access, use, and integrate 48DPT. The major concern reported by 9 participants was not being able to interpret the result. Another 5 reported uncertainty about which training to take and how it should be provided. 1 SW reported no training needed.

The **Maintenance dimension** addresses the reinforcement factors for 48DPT to be part of IDR and discharge procedure at Mount Sinai. There were six reinforcement factors derived from codes, burden vs. benefits, continuous support, increasing awareness, improving accuracy, improving integration, and providing training. *Burden vs. Benefits:* This theme shows patients' perceptions of the burdens versus benefits of using 48DPT. 8 participants reported no burden when using the 48DPT. 6 participants considered the use of 48DPT as a type of additional burden which was primarily due to the complexity of the existing patient discharge workflow. 9 participants recognized the benefits of using 48DPT while another 4 did not. *Continuous support:* This theme summarizes the codes regarding the long-term efforts made by the leadership and development team in continuously supporting the use of 48DPT. 11 participants reported no efforts observed from the leadership to receive feedback on the use of 48DPT from users, while 4 reported that the feedback requests were collected in different ways. 9 participants reported that no changes had been made to 48DPT over time; 12 participants reported no effort to improve the use of the 48DPT. 1 UMD reported a lack of follow-up analysis to understand the use of the tool in clinics. *Increasing awareness:* This theme

reflects the participants' suggestions for improving the use of 48DPT by increasing awareness. 11 participants proposed that the team should increase the awareness of the rollout of the 48DPT, especially among the hospitalists, NMS, ID team, and SW. 3 suggested the importance of leadership in promoting the utility of the tool. 2 highlighted the importance of making the users aware of the purpose and utility of the tool. A UMD suggests the consideration of the impacts of rapid employment turnover rate on the dissemination and utility of 48DPT. *Improving accuracy:* This theme reflects the participants' suggestions for improving the use of 48DPT by improving the accuracy of prediction. 6 participants suggested the importance of increasing accuracy for improving the maintenance, and 2 suggested resolving the inconsistency between 48DPT with humans and DT. *Improving integration:* This theme reflects the participants' suggestion for improving the use of 48DPT by facilitating system integration. 3 participants suggested the integration of 48DPT into existing IDR, and another 3 suggested the integration with DT. To optimize the integration, 3 participants suggested considering patients' social factors in the design of 48DPT. 1 participant stressed that 48DPT should simplify and streamline the existing complex workflow instead of imposing additional burdens. *Providing training:* This theme reflects the participants' suggestions for improving the use of 48DPT by providing training sources. 15 participants proposed to receive training regarding the use, access, integration, and interpretation of the 48DPT, which was especially important for frequent users, such as CM, SW, UMD, residents, and hospitalists.

4. Discussion and Conclusion

The analysis of 23 clinician interviews demonstrated a limited reach and adoption of the new tool and identified areas for improvement in implementation and maintenance. Our results concur with previous studies that identified benefits to patients, low-level technical skill requirements, and intended usage as some of the main factors leading to the high acceptance of a clinical decision support tool [5,6]. Lack of accuracy and awareness, as well as lack of accessibility and level of transparency, led to the low acceptance of 48DPT. Future implementation efforts of machine learning tools should support the proactive engagement of a wide range of clinical users since the very initiation of the predictive analytics project, provide higher transparency of the underlying algorithms, employ broader onboarding of all potential users on a periodic basis, and collect feedback from clinicians on an ongoing basis.

References

[1] Han Y, Carcillo J, Venkataraman S, et al. Unexpected mortality after implementation of a commercially sold computerized physician order entry system. Pediatrics. 2005;116(6):1506-12.
[2] Cha E, Golden SH, Finkelstein J. Unanticipated consequences of hospital-based insulin management order sets. Stud Health Technol Inform. 2015;216:939.
[3] Glasgow RE, Harden SM, Gaglio B, et al. RE-AIM Planning and Evaluation Framework: Adapting to New Science and Practice with a 20-Year Review. Front Public Health. 2019;7:64.
[4] Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3(2):77–101.
[5] Bedra M, Hill Golder S, Cha E, et al. Computerized Insulin Order Sets Can Lead to Unanticipated Consequences. Stud Health Technol Inform. 2015;213:53-6.
[6] Kawamoto K, Finkelstein J, Del Fiol G. Implementing Machine Learning in the Electronic Health Record: Checklist of Essential Considerations. Mayo Clin Proc. 2023;98(3):366-369.