CM-SHARE: Development, Integration, and Adoption of an Electronic Health Record–Linked Digital Health Solution to Support Care for Diabetes in Primary Care

James B. Jones,[1] Shuting Liang,[1] Hannah M. Husby,[1] Jake K. Delatorre-Reimer,[1] Cory A. Mosser,[1] Andrew G. Hudnut,[1] Kevin Knobel,[1] Karen MacDonald,[2] and Xiaowei S. Yan[1]

■ **IN BRIEF** Chronic conditions such as diabetes are largely managed by primary care providers (PCPs), with significant patient self-management. This article describes the development, pilot testing, and fine-tuning of a Web-based digital health solution to help PCPs manage patients with cardiometabolic diseases during routine office encounters. It shows that such products can be successfully integrated into primary care settings when they address important unmet needs and are developed with input from end-users.

Managing chronic cardiometabolic (CM) conditions is challenging for both patients and their primary care providers (PCPs). Annually, patients typically spend <1% of their waking hours with their PCP; the rest of the time, patients are on their own, making daily decisions about diet, exercise, and medications. Patients implement a care plan in the context of daily life and become, in effect, their own primary caregiver (1). Despite a proliferation of digital health applications (apps), devices, and programs designed to help patients in this role, outcomes have proven to be suboptimal, suggesting that the health care system has yet to identify the best way to help patients succeed in this self-care role.

PCPs face a different but related set of challenges. Chronic conditions, particularly CM problems and comorbidity, are common and can comprise a substantial portion of a PCP's panel (2). Although the average length of a patient visit has increased somewhat in the past two decades (3), so, too, have the administrative and documentation burdens PCPs face (4,5). Indeed, there is increasing pressure on PCPs to do more work in the same or less time, including answering patients' and caregivers' electronic and phone messages, communicating test results, completing medication refills, and providing cross-coverage for other providers.

Although electronic health records (EHRs) were expected to transform the way care is delivered (6,7) by improving quality, safety, and efficiency, the reality is that EHRs have increased the burden of administrative, data-collection, and "desktop medicine" work borne by health care providers (8–10). There is growing concern about provider burnout (11–14). In fact, some are calling for a modification to the Institute for Healthcare Improvement's so-called "triple aim" of population health, patient experience, and cost, believing that a fourth aim focused on provider well-being is essential to address burnout (15).

One way to address the needs of both patients and health care providers is to help them do more with less, by developing better tools that allow both providers and patients to do their respective jobs more efficiently. The purpose of this article is to describe the development, integration, and uptake of a digital health

[1]Sutter Health Research, Development & Dissemination, Walnut Creek, CA

[2]AstraZeneca, Wilmington, DE

Corresponding author: James B. Jones, JonesJB@sutterhealth.org

solution called *CM-SHARE*, that was designed to help PCPs manage patients with chronic CM conditions. We describe the process of engaging PCPs to fully understand the challenges they face in caring for patients with CM conditions, the design of *CM-SHARE* to address these challenges, the implementation of this digital health solution in the primary care setting, and its adoption and usage over time.

Methods

Overview

This work represents the pilot phase of a large research collaboration between Sutter Health and AstraZeneca, part of which focuses on developing innovative tools (i.e., *CM-SHARE*) for patients with CM conditions. We followed a research and development framework that included a discovery phase, in which pain points were investigated and a solution was scoped; a build-and-iterate phase, in which a prototype was developed, implemented, and improved; and a spread phase, in which the solution was modified and introduced to new settings. Throughout these phases, goals and metrics were set and tracked to evaluate the solution. This process guided the development and evaluation of *CM-SHARE* and is described in detail in the sections that follow. The early impact of the tool on care delivery outcomes (e.g., PCP time spent searching for information) and patient health outcomes (e.g., changes in A1C) will be presented in subsequent articles as longitudinal evaluation of *CM-SHARE* continues. The project was approved by the Sutter Health institutional review board.

Setting

Sutter Health is a large nonprofit health system that serves >3 million patients in northern California. Sutter Health's medical network includes 272 primary care clinics and ~5,500 physicians, 195 specialty care ambulatory care practices, 29 urgent care clinics, 24 hospitals, 35 outpatient surgery centers, 6 cardiac centers, 9 cancer centers, 5 trauma centers, and an array of ancillary clinical services. All of Sutter Health's medical facilities use the Epic EHR (Epic Systems, Verona, WI). *CM-SHARE* was piloted in two primary care clinics with six PCPs.

Design and Development

We applied a user-centered design approach to ensure that the solution met users' needs associated with the management of CM conditions. Our first step was to convene a group of six PCPs as clinical advisors for the project, including a medical director of research, an EHR champion (i.e., a physician EHR expert with accountability for training other physicians), and two other physician leaders. These PCPs were actively involved throughout the design and development process, working closely with the research team (epidemiologists, biostatisticians, and health outcomes and digital health researchers) and the technology team (software architects, engineers, and programmers).

We conducted in-depth interviews with each PCP to obtain insights on the pain points in care delivery for patients with CM conditions, and then explored possible options to solve these issues. Insights from interviews were augmented with workflow shadowing with the PCPs and their care teams to identify clinical and administrative tasks being performed before, during, and after office visits. The research team then mapped out the clinic workflow between each PCP and care team, with each task or "job" defined and the corresponding challenges identified. The consolidated findings from interviews and workflow shadowing guided the creation of requirements for a digital health solution and a series of mock-ups depicting what the solution would look like in practice.

The requirements and mock-ups were iteratively modified based on feedback from PCPs and patients, resulting in the initial design of *CM-SHARE* (version 1.0). We then organized design sessions, during which PCPs, patients, researchers, and the technology team discussed the visual layout and interactive design of the app, refined solution requirements, and translated requirements into feature specifications. Following the principles of agile development, the technology team then built version 1.

Middleware infrastructures (e.g., customized app programming interfaces) were also developed to connect the solution to the Epic EHR to ensure that the data displayed were up-to-date and accurate. Creation of middleware infrastructure allowed for updates to be made with minimal reliance on EPIC/vendor code and was intended to enhance future portability. The app evolved through three major development cycles and releases (versions 1.0, 2.0, and 3.0), during which major features were added with each release. Minor bug fixes and enhancements from user feedback were addressed in smaller batches in minor releases (versions 2.1 and 3.1).

Pilot and Integration

The first version of *CM-SHARE* was piloted in two Sutter Health clinics starting in April 2016. In-person group training sessions with PCPs and their care teams were conducted at each clinic site before the app went live. Although the app was originally designed for use with patients with CM conditions, the decision of whether to use it during patient encounters was left entirely to the discretion of each PCP. Throughout the pilot phase, PCPs were not given specific instructions regarding when or how to use the app, but rather were asked to explore and decide how to best integrate the solution into their workflow.

During the first few days after *CM-SHARE* went live in clinic, the research and development teams visited the clinics to provide hands-on support for PCPs, capture bugs

reported by users, and collect feedback on usability. The research and development team members had routine end-of-day gatherings to review all issues and feedback collected each day and to prioritize issues in need of addressing. All high-priority bugs were addressed the same day they were reported. Other bugs and enhancement requests were addressed and later released into production in small batches. PCPs were notified of each pending release of enhancements and fixes.

Evaluation

Initial evaluation of *CM-SHARE* focused on assessing whether and how the app was used. First, we used web-log data paired with EHR encounter data to assess overall adoption and usage (i.e., without regard to whether patients had CM disease) over time between 26 April 2016 and 31 December 2017. Second, to identify factors associated with the launch of *CM-SHARE* among the target population of patients with one or more CM conditions, we performed an exploratory analysis using a logistic regression model and EHR data for a subset of patients who met the inclusion criteria. Finally, we conducted qualitative interviews with PCPs and patients, as well as PCP group discussions, to gain in-depth understanding of PCPs' and patients' experiences with *CM-SHARE*.

Because *CM-SHARE* was designed for patients with CM conditions, we classified encounters in three ways. First, encounters with CM patients were defined as those encounters in which patients met our criteria for having at least one of three CM-related conditions (i.e., diabetes, hypertension, and dyslipidemia). Second, CM-related encounters were defined as those in which the encounter was coded with a CM-related diagnosis code in any position. Third, CM-related primary diagnosis encounters were defined as an encounter with a CM-related diagnosis listed as the primary diagnosis (i.e., a CM-related condition was listed first in the encounter diagnosis list). This classification method was used as a proxy for identifying visits during which it was increasingly likely that patients' CM conditions would be discussed and that *CM-SHARE* would be launched to facilitate these discussions.

Adoption and Usage

In this article, we present adoption and usage data for the period of 26 April 2016 to 31 December 2017. Web-log data were leveraged to track launches and other discrete user activities (e.g., each feature "clicked on" or used within the app). Patients' scheduled encounters in the EHR were matched to the encounter data and user actions in the app's web-log database. A launch was defined as a click on the EHR link that opens the app in a browser window. We calculated the percentage of encounters during which *CM-SHARE* was launched relative to the total number of scheduled encounters for each provider on a weekly and monthly basis. A linear regression model was applied to the monthly launch rate, and the slope of the regression model (i.e., coefficient to the time [month] and standard error) was estimated to represent the trend of usage over time.

Factors Associated With Launch of *CM-SHARE*

To identify factors associated with *CM-SHARE* launch, we used a logistic regression model, stratified by provider, to model the relationship between *CM-SHARE* launch (yes/no) and patient characteristics (CM condition presence, age, sex, race, and new patient status), encounter characteristics (level of service, primary reason for visit, and CM conditions denoted as primary or secondary diagnoses), and clinical characteristics (previous A1C level [<6.5, 6.5–7.9, 8.0–8.9, or ≥9.0% or no A1C value], previous LDL cholesterol level [<100, 100–129, or ≥130 mg/dL or no LDL value], BMI [<25, 25–29, 30–34, or ≥35 kg/m^2], and reason for visit in the previous office visit). Patients included in this analysis had at least one office visit with one of the PCPs between 1 June 2016 and 30 June 2017 and had at least one CM condition in the pre-observational period (1 April 2014 to 30 March 2016). The version of *CM-SHARE* was also included in the model. Odds ratios (ORs) with 95% CIs were estimated for each factor (Table 1), and factors that met statistical significance (P ≤0.05) were reported. The analysis was conducted using SAS version 9.3 software (SAS Institute, Cary, N.C.).

PCP and Patient Experience

We conducted semi-structured interviews with the PCPs ~1 month after each release of the app. The focus of the interviews was to understand why, when, and for which patients PCPs used the tool and what features of it they used, as well as PCPs' perceptions of its impact on provider-patient interaction and overall care delivery. Group discussions were held periodically for 60–90 minutes each, in which individual and aggregate usage data were shared with PCPs to understand reasons behind the usage numbers and trends.

We also conducted interviews with eight patients immediately after their completed office visits to understand their experiences with the app. Patient interviews were conducted between December 2016 and March 2017, after the second major release of *CM-SHARE*.

All interviews and group sessions were transcribed verbatim. A thematic analysis approach was employed. Three research staff members coded the transcripts separately and met to validate themes. Coded data were organized into thematic categories and summaries and interpreted in conjunction with the quantitative data.

Results

Design and Development

The iterative design and development process resulted in three key goals for the app, addressed incrementally by three major releases. Version 1.0 went live in April 2016 and focused

TABLE 1. Logistic Regression Model Results: Statistically Significant Factors Associated With Launch of *CM-SHARE* Base on Encounter Data From 1 June 2016 to 30 June 2017

Factors	OR (CI)
Patient A1C: 8–9 versus ≤6.5%	2.901 (2.201–3.823)
Primary encounter diagnosis: diabetes versus non-CM	2.640 (2.191–3.182)
Primary encounter diagnosis: hypertension versus non-CM	2.438 (1.962–3.029)
Patient A1C: >6.5 and <8.0 versus ≤6.5%	2.412 (1.995–2.915)
Patient A1C: ≥9 versus ≤6.5%	2.375 (1.754–3.216)
Primary encounter diagnosis: dyslipidemia versus non-CM	2.329 (1.596–3.400)
Secondary encounter diagnosis: CM versus non-CM	2.109 (1.802–2.467)
App version: version 3 versus version 1	1.425 (1.072–1.896)
Race: Asian versus white	1.412 (1.085–1.836)
Sex: male versus female	1.361 (1.179–1.572)
Number of CM conditions: 3 versus 1	1.356 (1.070–1.718)
Prior office visit reason: CM-related versus non-CM	1.155 (1.004–1.329)
Encounter level of service: level 3 versus level 5 or higher*	3.077 (1.20–7.94)

Level of service (LOS) is the Centers for Medicare & Medicaid Services standardized level of evaluation and management services performed in an office visit for billing purposes. LOS level is based on the complexity level of the visit, with 1 being the least complex and 5 the most complex, requiring more time for evaluation and management (30).

on providing efficient access to critical patient data, reducing the time PCPs spend clicking and searching for relevant information in the EHR. Version 2.0 went live in October 2016 with the aim of equipping PCPs with tools to engage and educate patients about their conditions and health behaviors. Version 3.0 went live in May 2017 and focused on providing actionable data and alerts to help PCPs address quality and care gaps. Each version was released with improved design and functionality. Here, we highlight four features in Version 3.0 that have attracted the highest usage and were reported in qualitative analyses to have the most value.

Snapshot View
Snapshot is the default view when launching *CM-SHARE* (Figure 1). It provides an intuitive overview of patient-specific data gathered from different areas within the patient chart that are critical to review at the point of care for patients with CM conditions. These data include most recent A1C value, vital signs, health maintenance items, medication adherence percentages, and 10-year risk scores. Bringing all the critical infor-

mation together in a single snapshot view saves PCPs time in searching for these data in the EHR. *CM-SHARE* presents color-coded icons that use a guidelines-based, traffic light metaphor: the color red indicates overdue or significantly out of range, orange indicates due soon or out of range, and green indicates not due or within normal range. The snapshot view was designed to allow PCPs to assess patients in <30 seconds and identify patient-specific gaps that need immediate attention, without requiring any additional clicks. From our analysis of web-log data, in 29% of all encounters in which *CM-SHARE* was launched, no additional clicks were made in the app.

Graphs Feature
The Graphs feature was designed to accommodate the need to educate patients with varying degrees of health literacy. To access a graph, PCPs click on the desired laboratory or vital sign component to bring up the graph in a modal window. Contrasting colors and larger text presentations enhance visibility. To give PCPs a more comprehensive view of a patient's health, *CM-SHARE* overlays

graphs of laboratory data (e.g., A1C values), weight, and related medication dispensations, thus giving PCPs the visual tools needed to explain the relationships among these variables and their implications on a patient's health (Figure 2). Based on web-log data, the graphs were accessed in 25% of all encounters in which the app was launched and an additional click was made within the app.

Medication Dispensing History Feature
During the design phase, PCPs expressed concern that medication order data in the EHR is difficult to find and interpret. *CM-SHARE* leverages medication dispensing data provided by a third-party vendor to visualize patients' medication dispensing history. An intuitive graph shows the quantity of supply (in days) picked up by the patient at participating pharmacies, represented across a visual timeline with suspected gaps in supply coverage specifically identified in red. (See Figure 2 for an overlay of medication dispensing with the Graphs view).

This key feature, added late in version 2, enabled PCPs to have data-driven conversations with patients
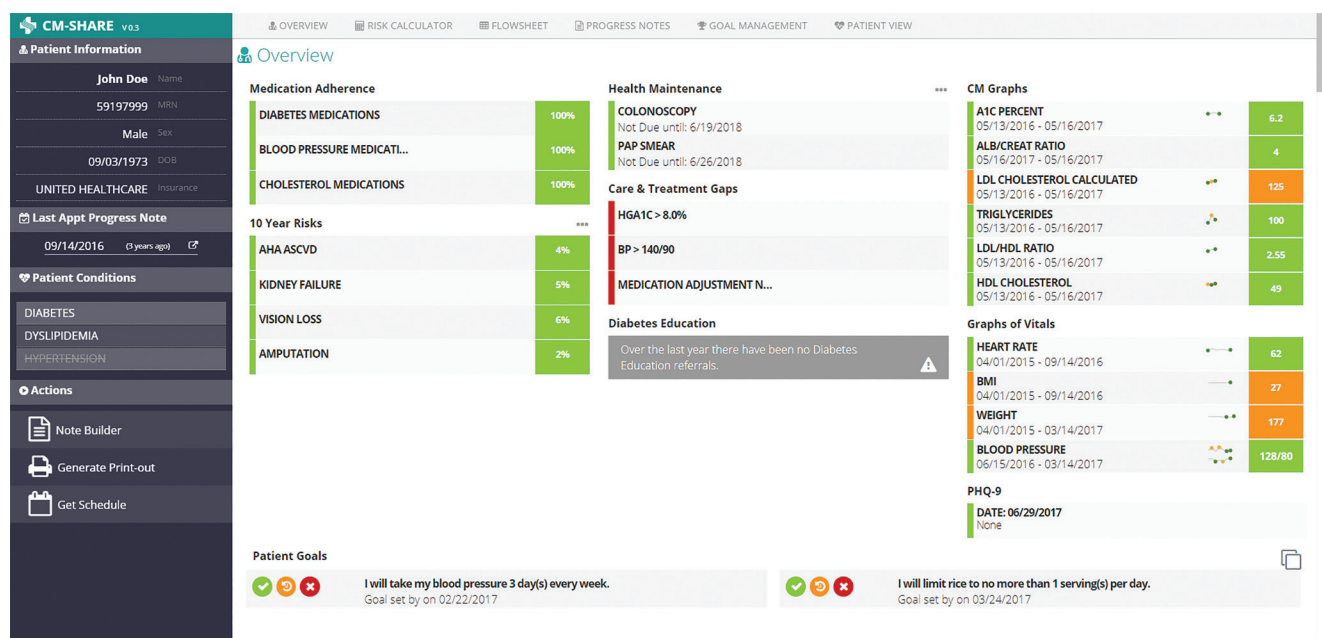
FIGURE 1. *CM-SHARE* Snapshot view, with 10-year Risk Calculator at the bottom.
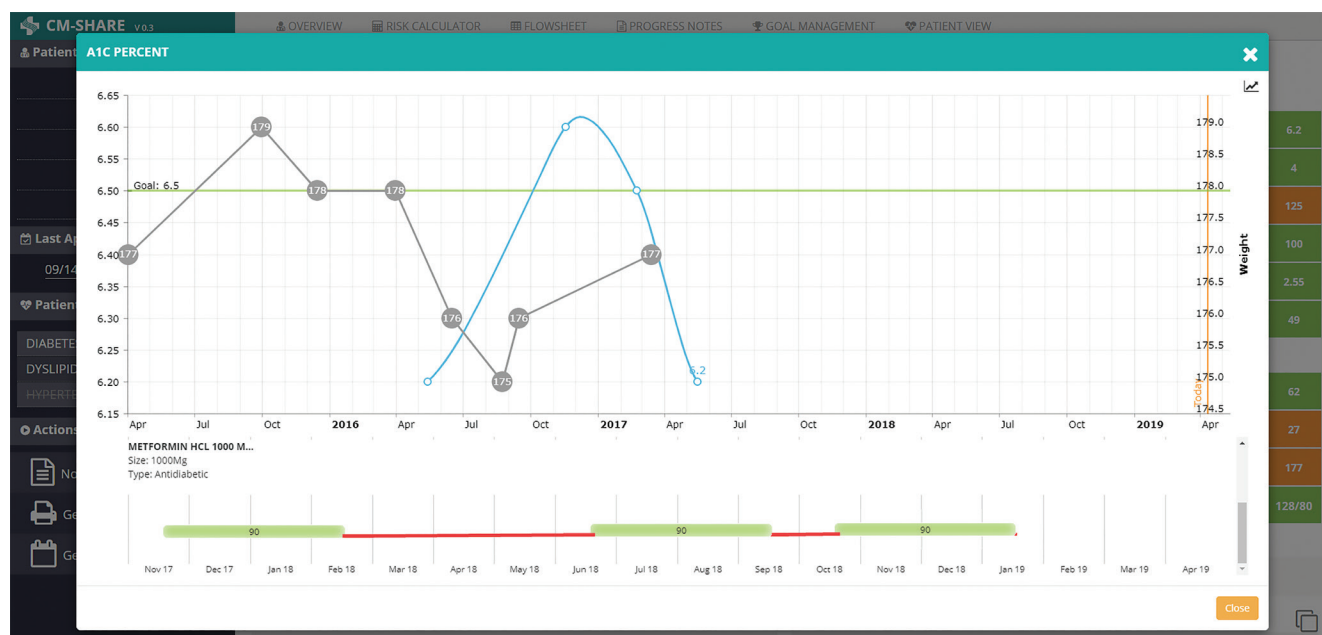

FIGURE 2. C*CM-SHARE* Graph view, with overlayed medication adherence information.

about adherence to their treatment plans. Based on web-log data, these medication dispensing graphs were accessed in 4% of all encounters in which the app was launched and an additional click was made.

Qualitatively, PCPs mentioned in interviews that patients' aggregate medication adherence percentages that are displayed in the Snapshot view (Figure 1) are usually sufficient and that they only clicked on the medication dispensing feature when they wanted to address adherence issues with specific patients. A more detailed analysis of the characteristics of patients for whom the medication dispensing view was clicked will come in a future publication.

Risk Calculators Feature
Personalized risk calculators (Figure 1), which calculate a patient's 10-year risk of a cardiac event, kidney failure,

vision loss, and amputation, are tools that PCPs use to educate and encourage patients to act on actionable factors to reduce risks. The inputs are automatically pulled from the patient EHR chart to the calculators but are editable so PCPs can model risk scores with any value, helping patients understand factors that affect their risks and aiding PCPs and patients in jointly setting treatment goals. The risk calculators were accessed in 12% of all *CM-SHARE* encounters that included an additional click.

Pilot and Integration

Easy and efficient access to data is a major goal of *CM-SHARE*. To accomplish this goal, the app has been seamlessly integrated with Sutter Health's EHR system (Epic) via an embedded hyperlink (also known as an "Epic magic button"), in the Epic Visit Navigator bar. When clicked, the button opens the app in the computer's default web browser and displays the Snapshot view for that specific patient. The app leverages the EHR user's and patient's credentials associated with the encounter number so that PCPs can access the app without additional login steps.

The six PCPs involved in app development use three different practice workflows: three PCPs' practices use a "traditional" model of care, in which the medical assistant (MA) prepares a patient for a visit and then leaves the exam room before the PCP enters; two PCPs use a "scribe" model in which an MA scribe simultaneously documents in the EHR on a separate laptop within the exam room while the PCP interacts with the patient; and one PCP employs a "team" model, in which an MA helps to prepare a patient and works side by side with the PCP to document in the EHR during the initial part of the visit before leaving the exam room for the PCP and patient to interact privately. PCPs practicing with both the traditional and scribe models of care report that they most often launched *CM-SHARE* at the beginning of a visit, when they felt there was a need and sufficient time to address CM-related issues. The PCP with a team care model had the MA launch *CM-SHARE* on a separate monitor for almost every patient visit, regardless of the presence of CM conditions, to identify and assess gaps in care.

Evaluation

Adoption and Usage
Between 27 April 2016 and 31 December 2017, *CM-SHARE* was used for 3,874 unique patients, representing 8,836 primary care office visits among the six pilot PCPs. The mean age of these patients was 65 years; 51% were >65 years of age, whereas 22% were 56–65 years of age. Eighty-two percent (*n* = 3,161) had at least one CM condition; 30% had diabetes, 70% had hypertension, and 64% had dyslipidemia. On average, the app was launched in 35% of all primary care encounters for patients with a CM condition, 46% of encounters with patients who had a CM condition (diabetes, hypertension, or dyslipidemia) listed as a diagnosis, and 61% of encounters in which diabetes was listed as a primary diagnosis. For patients with diabetes with a previous A1C value >8.0%, the launch rate was 73%. As shown in Figure 3, usage has remained relatively stable over the course of 20 months, which was confirmed by a trend test (slope = 0.01, standard error = 0.14, *P* = 0.11), and slightly increased as the solution evolved across three releases.

Factors Associated With *CM-SHARE* Launch
As is shown in Table 1, logistic regression model results indicated that encounter- and patient-related factors explain the majority of the variation in use of the app. Launch of the app was significantly associated with a CM condition as the primary reason for the clinical visit (OR 2.6, 2.3, and 2.4 for diabetes, dyslipidemia, and hypertension, respectively), elevated A1C >6.5% (OR 2.9 for 8–9%, 2.3 for >9%, and 2.4 for 6.5–8.0%), patients having all three CM conditions (OR 1.3), male sex (OR 1.3), and Asian race (OR 1.4 vs. white).
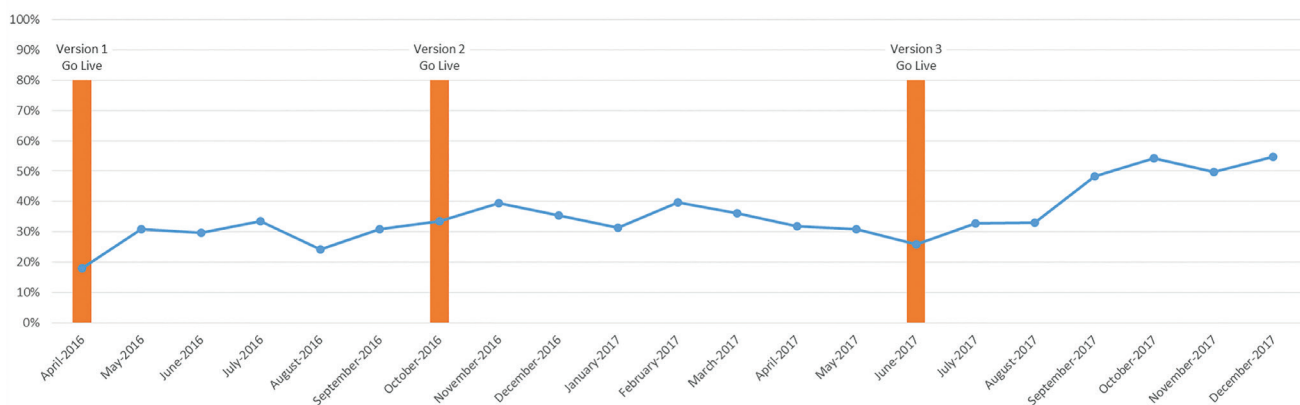

FIGURE 3. Launch rate of *CM-SHARE* for patients with CM conditions in all primary care encounters.

PCP and Patient Experience

A dominant theme that emerged from the semi-structured interviews was the value PCPs found in using the app to facilitate patient education. Five of the six pilot PCPs described using the app for patient education, and four of the PCPs also described using it to reference and verify patients' health information. Most pilot PCPs described the app as offering a new presentation of information they would not otherwise get in the EHR. The pilot PCPs described the app's ability to present data in a way that is easy to visualize, understand, and explain to their patients. Five of the six PCPs mentioned using patients' vital signs and laboratory graphs or personalized risk calculators to show trends and the consequences of health trends to either discourage unhealthy behaviors or reinforce good behaviors.

Semi-structured interviews with eight patients corroborated PCPs' feedback. The main theme that emerged from patient interviews was related to the value of the visual elements of the app. The patients said the app helped them understand or reinforced what the PCP told them. One patient represented the theme well, stating that graphs in the app "made more sense than reading text." Six of the eight patients interviewed reported that it was motivating to see their health trends and progression in the app. One patient described the app as allowing patients to "see where I've been and where I'm going," and another described the app as allowing patients to "see the changes taking place."

In addition, five of the six pilot PCPs reported that using the medication dispensing tool facilitated valuable conversations with patients. The pilot PCPs described these conversations as data-driven and said the tool helped them bypass limitations in data accuracy (i.e., patients' honesty or memory regarding taking medications or providers' ability to easily calculate medication adherence arranged by order data and calendar days). One pilot PCP also described the adherence data as holding both providers and patients accountable for explaining or identifying barriers or side effects preventing patients from picking up or taking their medications. One PCP described the medication adherence data in the app as "opening up the discussion about the reason [patients] are missing their medication and allow[ing] me [as their physician] to have a discussion to make them more compliant."

Discussion

Many digital health products that demonstrate impressive results in clinical trials fail to do so in real-world settings (16). Declining usage over time (17) has been observed in many studies of digital solutions (18), particularly in interventions for which use is not mandatory. In contrast, over the course of a 20-month pilot, we observed a gradual increase in usage of *CM-SHARE* with three major releases in real-world primary care settings. The average 35% overall launch rate across all primary care encounters, and a >60% launch rate in diabetes encounters, indicates a promising initial uptake compared to the 20% usage of a comparable digital health solution (18) and 62% launch rate in an incentivized setting (19).

In our real-world pilot, PCPs were not given specific directions or any incentives to use the app. PCPs voluntarily chose when, for whom, and how to use it in a way that best fit their workflow and patients. Such a voluntary, nondisruptive, and flexible setup allowed PCPs to determine the ideal cases in which the app can address their specific unmet needs. The launch rate of *CM-SHARE* was higher (61%) for patients seeing their PCP for a diabetes-related encounter and was even higher (73%) for patients with an A1C >8%. Likewise, the logistic regression analysis showed that the app was more likely to be used for patients with higher A1C values and comorbidities. Finally, feedback from PCPs also indicated that they selectively use the app to assess, engage, and educate patients who are likely to have more complex diseases (e.g., multiple comorbidities) or who have an uncontrolled A1C. They reported that *CM-SHARE* enabled them to have "data-driven" or "meaningful" conversations on behavior change with these patients.

Collectively, this evidence suggests that *CM-SHARE* addresses a specific unmet need for PCPs in caring for patients with uncontrolled diabetes or more complex CM conditions. Although most EHR systems provide users with the ability to create summaries of information, including graphic displays and trends, this functionality often involves customizations that require user expertise and broad agreement at the department, practice, or system level. *CM-SHARE* is designed to complement the EHR; it is differentiated by its purpose-built focus on visually organizing information that is relevant to a CM-related encounter, minimizing the "hunting and gathering" work that many systems require of physician users. We believe that the purpose-built nature of the app, addressing a high-importance unmet need, is a key contributing factor to the app's high rates of adoption and usage over time. The app's impact on workflow and patients and its ability to spread to new physicians will be the subject of future investigation.

Consistent with the literature on user-centered design and digital health solutions (19–21), this pilot also demonstrated the feasibility and value of applying user-centered design to innovations within primary care. PCPs were intimately involved throughout the design, development, and pilot work to drive engagement from the project's initiation (16). The interviews and workflow shadowing were time- and resource-intensive but essential to understanding the challenges associated with CM care. Designing *CM-SHARE* to tackle these challenges head-on has led to

stronger buy-in and support from PCPs and other stakeholders.

Aligned with previous lessons learned on diabetes clinical-decision tools (22), *CM-SHARE*'s design of seamless integration with the EHR also contributed to high usage. Embedding the app as a hyperlink within the EHR system gave PCPs freedom to launch the tool whenever and for whomever they deemed fit, with easier integration into their existing workflow. In addition, providing PCPs with periodic reports of their usage via group discussions seemed to also play an important role in maintaining engagement and usage over time. This observation is consistent with the broader literature around leveraging behavioral economic principles to nudge physician behavior changes, such as prescribing statins for patients who meet evidence-based cardiovascular risk guidelines (23–27). The feedback reports might have acted as both a reminder and a psychological reward for using the app.

To further increase the value of *CM-SHARE*, PCPs, researchers, and the technology team collectively have identified a few areas for further development. First, use of the app was volitional, but as we develop more rigorous methods of segmenting patients based on their clinical conditions, needs, and preferences, we can reduce physician burden in identifying patients who might benefit more from a solution like *CM-SHARE* by automatically launching it at the right time. As the literature suggests (19,28), we anticipate that enabling automatic launch of the app would increase adoption and usage as the solution spreads to additional users. Second, while the app's Snapshot view clearly calls attention to clinical parameters that are out of guideline-recommended ranges (e.g., elevated blood pressure levels), clinical guidelines could be further integrated to identify patient-specific gaps in care (e.g., clinical inertia) and facilitate clinical decision-making by recommending treatment options

for identified gaps. Similar available digital health solutions that focus less on health data visualization but offer treatment recommendations based on clinical guidelines regarding cardiovascular risk and CM conditions have proven successful in achieving improved patient outcomes (22,29). Furthermore, although *CM-SHARE* gathers data on a single dashboard, it does not yet accommodate sending data directly back to the EHR, thus limiting PCPs' ability to take action at the time a gap is identified. Finally, an important missing piece from the app is the patient's "voice," which could be captured using patient-reported data collected via questionnaires regarding symptoms, medication adherence, other health behaviors, and personal preferences. Incorporating patient-reported data at the point of care via *CM-SHARE* has great potential to help PCPs identify and address the most important concerns for specific patients and thus provide more personalized care.

Our study had several limitations. First, the exploratory analysis of factors associated with *CM-SHARE* use with EHR data only covered a subset of the total patient population exposed to the app who meet the inclusion criteria. Second, the app was developed and piloted at two primary care clinics within a large health care system, with regular support from the research and technology team. We intentionally made the effort to design and pilot with a limited number of PCPs who represented a mix of physician roles and preferences. The primary qualification to participate in the pilot was a willingness to help the research team understand the problem in detail and to partner to design and test a solution. This investment of time by our pilot users in the design process may have meant that they were more inclined to use the app than PCPs who were not involved; thus, their experiences may not extrapolate to all potential users. This level of technology support is not typical in a health care system. We

do not yet know if we can successfully spread the solution to different primary care settings or to additional users while still replicating the high levels of adoption and use; however, our pilot PCPs have recommended the spread of *CM-SHARE* to their peers. Third, although there was stable use overall among our six users, we did find variation in use among the users that may have been influenced in part by the different practice types (e.g., use of a scribe) affecting integration of the app into each PCP's workflow.

Conclusion

This project provided evidence that a voluntary-use, purpose-built digital health solution such as *CM-SHARE* can be successfully integrated into real-world primary care settings with high adoption and consistent use in caring for patients with CM conditions, and especially those with uncontrolled diabetes. The app addresses an important unmet need of PCPs to engage and educate patients who have more complex or severe conditions. Its successful adoption and integration mainly resulted from the commitment to user-centered design, development, and implementation processes in which PCPs were intimately involved and acted as co-designers. This article demonstrates a successful path to integrating new technology into primary care.

Author Contributions

J.B.J. contributed to the manuscript concept and design, analysis and interpretation of data, writing and editing of the manuscript, and study supervision. S.L. contributed to

the manuscript concept and design, analysis and interpretation of data, and the writing and editing of the manuscript. H.M.H. contributed to the manuscript concept and design, acquisition of data, analysis and interpretation of data, and the writing and editing of the manuscript. J.K.D.-R. contributed to the acquisition of data, analysis and interpretation of data, and the writing of the manuscript. C.A.M. contributed to the acquisition of data and the writing of the manuscript. A.G.H. contributed to the analysis and interpretation of the data and the editing of the manuscript. K.K. contributed to the analysis and interpretation of the data and the editing of the manuscript. K.M. contributed to the editing of the manuscript. X.S.Y. contributed to the manuscript concept and design, analysis and interpretation of data, statistical analysis, writing and editing of the manuscript, and study supervision. J.B.J. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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