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Virtual assistant service for patients and caregivers

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ABSTRACT

A major healthcare cost is the lack of strict adherence to, or outright non-compliance with, medicines and medical schedule by patients. The techniques disclosed herein assist patients by automatically performing routine healthcare-related tasks, e.g., reminding patients to take medications at appropriate times; ordering prescription refills at pharmacies; scheduling and managing medical appointments; tracking and charting their vital statistics, e.g., blood glucose, blood pressure, heart rate, etc.; asking for and logging patient symptoms, etc. The virtual personal assistant uses a machine learning model to adapt itself to the particulars of the patient. The virtual personal assistant may interface with the patient in one or more ways, e.g., using a voice-interface, a touchscreen-based graphical user interface, etc. Caregivers can advantageously use techniques described herein to better manage a patient's health. In this manner, the patient enjoys a better quality of life and faces better health outcomes with reduced healthcare costs.

KEYWORDS

medication adherence; patient reminder; virtual personal assistant; symptom tracker

BACKGROUND

Successful treatment of disease with prescription medicines requires consistent use of the medicines as prescribed. Nonadherence to medicines is a major health care cost and quality problem. Numerous studies show that high rates of nonadherence are directly related to poor clinical outcomes, high healthcare costs, and lost productivity. The cost of nonadherence has been estimated at hundreds of billions of dollars annually, including costs from avoidable hospitalizations, nursing home admissions, and premature deaths. Seven in ten Americans take at

least one prescription drug, and nearly thirty percent of patients fail to fill prescriptions, including patients with chronic conditions. Adherence to therapy is especially important for management of chronic diseases, such as diabetes, heart disease and cancer. Research shows that despite conclusive evidence that medication and therapy can substantially improve life expectancy and quality, patients continue to not have medications as directed.

DESCRIPTION

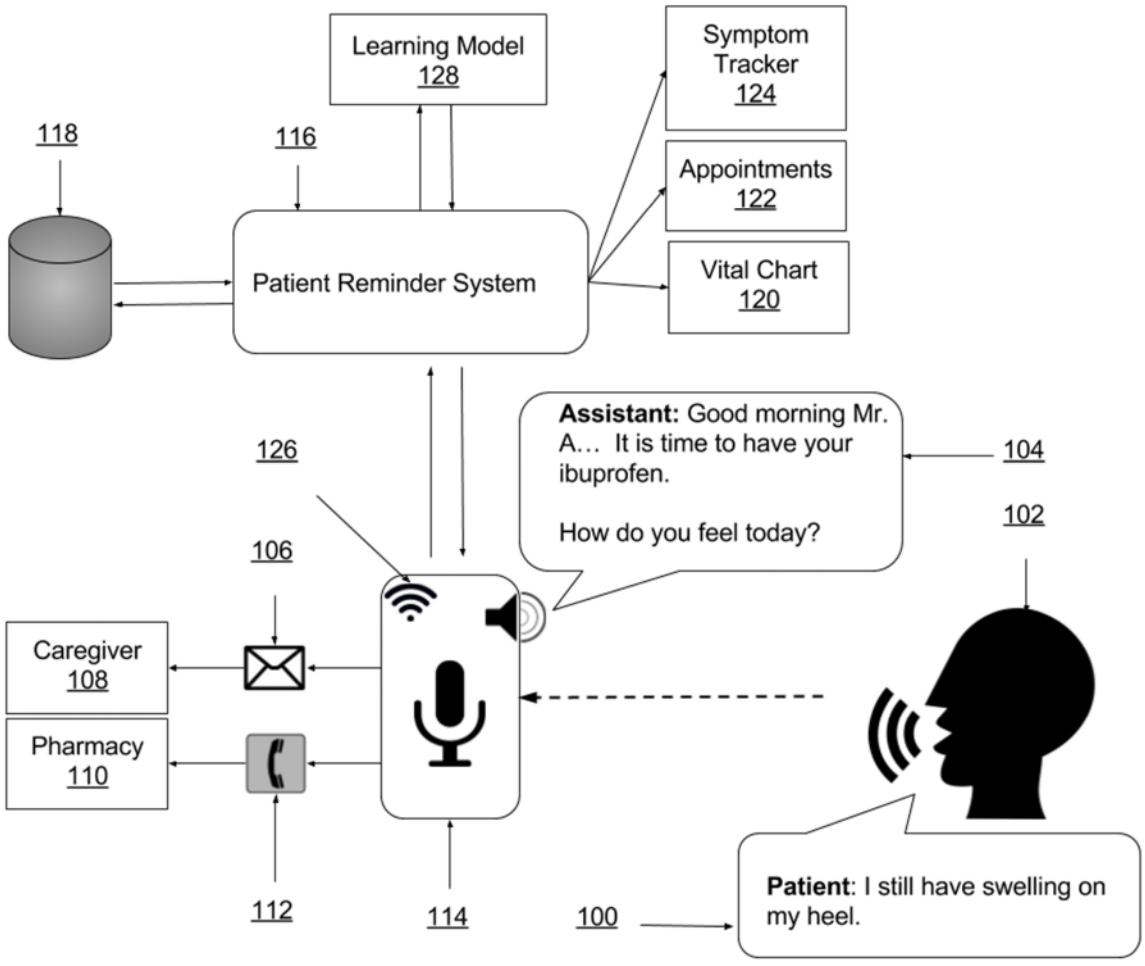

Fig. 1: Example framework of an automated patient reminder system

Techniques of this disclosure enable a patient to better adhere to a prescription schedule. Many of the human and economic costs associated with non-adherence are thereby avoided. Fig.

1 shows an example of the techniques as disclosed herein. User (102) is a patient interacting, for example through a voice interface (104), with a virtual personal assistant (114). The virtual personal assistant is a software agent that is installed in, for example, a smartphone, a laptop, smart speakers, IoT devices, etc. The virtual personal assistant application is connected, for example via a wireless network (126), to a patient reminder system (116).

The patient reminder system is coupled to a database server (118) for logging various data as provided by the user. The database is accessible by the user or authorized caregiver or physician through voice commands, mobile application, website, etc. The patient reminder system is also coupled to a learning model (128) which learns and adapts to the particular needs, characteristics and idiosyncrasies of the patient. With the prior consent and permission of the patient, the learning model gleans information relating to the patient's condition by analyzing ongoing conversations between patient and virtual personal assistant. With the prior consent and permission of the patient, the virtual personal assistant also accesses the patient's online profiles, web-sites, calendar, medical records, etc.

In the example of Fig. 1, the virtual personal assistant makes an inference, based on, for example the patient's medical records, that it is time to take medication. After exchanging some pleasantries, the virtual personal assistant reminds the patient to have the morning medication. The patient's response (100) contains information about his condition, which the virtual personal assistant duly records. This dialogue between the patient and the virtual assistant is continued on a day-to-day basis, at fixed times or times determined by the virtual assistant based on available patient data.

When appropriate, the patient reminder system communicates with the caregiver (or physician) (108), pharmacy (110), etc. using email (106), telephone (112), or other form of

communication. In this manner, the caregiver or physician can track the patient's progress, vital signs, pattern of symptoms, adherence to medication, etc. Similarly, with prior consent and permission of the patient, the pharmacy can automatically be called for a prescription refill when needed. Further actions needed to complete the ordering process, e.g., scheduling a pick-up time, or coordinating a delivery (e.g., setting the shipping time, etc.) are taken by the patient reminder system. The virtual assistant updates the patient reminder system with the patient's vitals and logs the times when the patient took his medication.

This technique can be extended to other types of reminders, e.g., reminders for appointments, prescription pick-up, etc. The format for reminders is customizable. The virtual personal assistant send notes to physicians/caregivers, and schedules or re-schedules new appointments (122) as required. Reminding the patient to measure his vitals and logging it in the patient reminder system enables charting of the patient's vitals (120), which in turn is provided to the patient's authorized caregiver or physician.

Patients often forget to mention a new symptom, simply due to the time lag between occurrence of symptom and visit to physician. The virtual personal assistant addresses this problem by recording a patient's symptoms in the symptom tracker (124). For example, in Fig. 1, the virtual personal assistant asks the patient to report his feelings ("How do you feel today?") and records in the patient reminder system the patient's symptoms, which is stated to be a swelling in the heel. The virtual personal assistant asks the patient at a regular interval how he is feeling and logs the response, thereby helping the caregiver or physician give the patient a better diagnosis and proactive care. Patients can also proactively talk to the virtual personal assistant asking it to log a symptom when it occurs. Patterns that arise in the history of symptoms are analyzed by the machine learning model to gain insight into the nature of the patient's disease.

The virtual personal assistant could reside one or more of a number of consumer devices, e.g., as an application within a smartphone, a smart speaker, one or more internet-of-things (IoT) devices, laptop, tablet, a smartwatch, a wearable computer, personal computing device, etc. Various functional blocks of the patient reminder system and/or database and/or machine learning model could reside fully or partially in the consumer device, whilst remaining sections could reside in a server or in a compute cloud.

Example conversations between the patient and the virtual personal assistant follow; these illustrate the interplay between the machine learning model, the data made available to it, and inferences it makes about the patient and his environment.

Example 1

In this example, the virtual assistant is seen to make a log of the patient's symptoms and vital signs. The machine learning model learns of and adapts to the patient's idiosyncrasies.

> **Virtual assistant:** "Hello, Mr. A, it's time to take your diabetes reading and to take your sugar-control pills."
> **Mr. A:** "Thank you. My glucose meter says 110."
> **Virtual assistant:** "Great! I made a note of that. Let's repeat yesterday's dose of the sugar-control pill --- 10 mg of the `green pill' as you refer to it."
> **Mr. A:** "OK, I took the green pill."
> **Virtual assistant:** "Are you still feeling feverish?"
> **Mr. A:** "Yes, it looks I'm running a temperature of 101."
> **Virtual assistant:** "OK, last time paracetamol gave you a stomach upset. Can you take a 100mg dose of ibuprofen (the red pill, as you like to call it)?"
> **Mr. A:** "OK, just did it."
> **Virtual assistant:** "Good, thanks. I've made a note of it, and will remind you of your next dose."

Example 2

In this example, the patient is reminded not only of the appointment but also of the symptoms and patterns thereof, so that he can discuss these with his physician.

> **Virtual assistant:** "Mr. A, it's time to leave for your 4 pm appointment with the doctor. You have asked me to remind you of these three symptoms. Would you like to know more details about when they occurred?"
> **Mr. A:** "Thanks. Could you run them by me just once?"
> **Virtual assistant:** "Sure. Since your last visit yesterday, there was an increased swelling near the fracture. Today morning the swelling decreased, but fever increased. A few hours ago, the redness returned."

Example 3

In this example, the machine learning model gleans information from the patient's online data in order to suggest a good way to schedule his social commitments as well as his medications.

> **Virtual assistant:** "Hi sir. your prescription is due refill, should I ask the pharmacy to refill?"
> **Patient:** "Please do, virtual assistant."
> **Virtual assistant:** "Would you like it to be delivered or would you like to pick it up?"
> **Patient:** "Ummm … I don't know."
> **Virtual Assistant:** "You have your son's graduation at 10 AM and the pharmacy is a 5-minute drive from there."
> **Patient:** "OK, I'll pick it."
> **Virtual Assistant:** "Great, I've ordered it, and it's ready for pick-up. I've added it to your calendar so that you'll be reminded when you finish with the graduation."

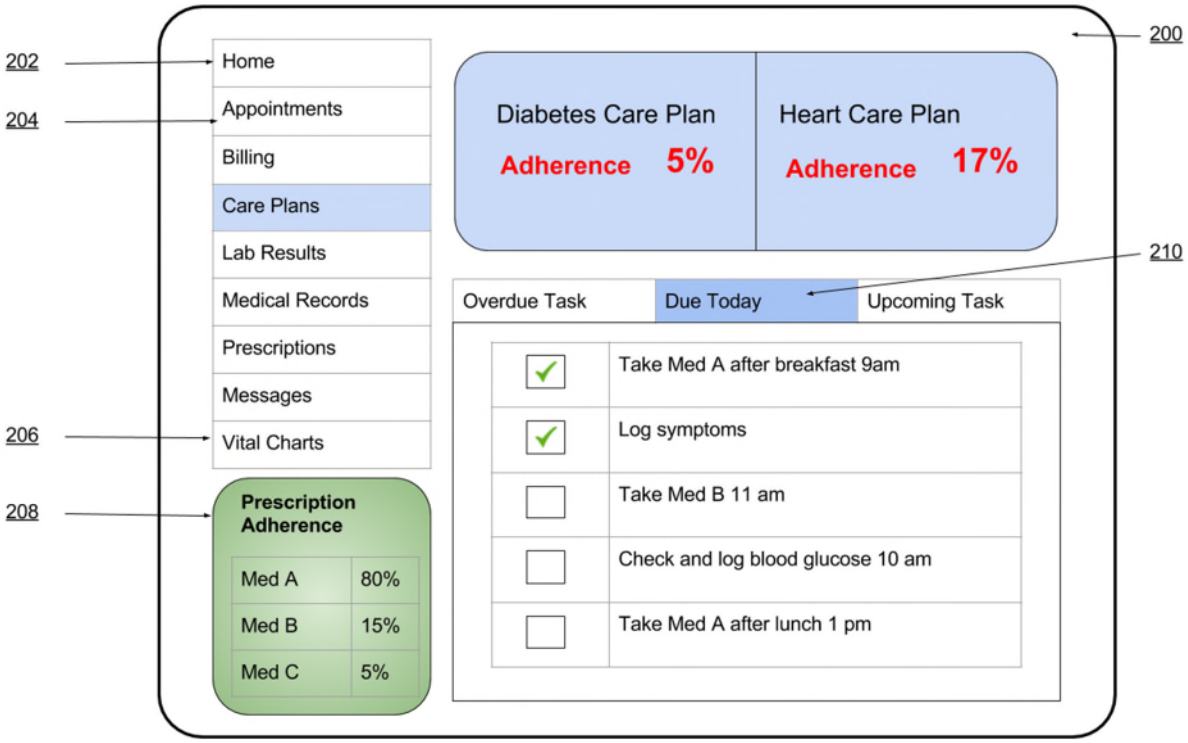

Fig. 2: Example user interface for a patient reminder system

Fig. 2 shows an example of a user interface for a patient reminder system. The patient reminder system (200) is an application that can be accessed from a computer device, e.g., laptop, tablet, smartphone, etc. A patient can retrieve the patient's logs as generated by the virtual personal assistant as well as other logs entered by the patient, caregiver or physician. The caregiver/patient pre-configures the system with the patient's profile, e.g., vitals, expected medicine intake, primary physician's details, patient's contact phone number, emergency contact number, primary caregiver details, frequency of medicine intake, primary conditions / symptoms, etc. These details can be seen under tabs such as home (202). At any point of time, the patient and/or the caregiver, when authorized by the user, can view the patient's appointments (204), prescription adherence information (208), vital charts (206), tasks due today (210), etc.

In situations in which certain implementations discussed herein may collect or use personal information about users (e.g., user data, information about a user's social network, user's location and time at the location, user's biometric information, user's activities and demographic information), users are provided with one or more opportunities to control whether information is collected, whether the personal information is stored, whether the personal information is used, and how the information is collected about the user, stored and used. That is, the systems and methods discussed herein collect, store and/or use user personal information specifically upon receiving explicit authorization from the relevant users to do so. For example, a user is provided with control over whether programs or features collect user information about that particular user or other users relevant to the program or feature. Each user for which personal information is to be collected is presented with one or more options to allow control over the information collection relevant to that user, to provide permission or authorization as to whether the information is collected and as to which portions of the information are to be collected. For example, users can be provided with one or more such control options over a communication network. In addition, certain data may be treated in one or more ways before it is stored or used so that personally identifiable information is removed. As one example, a user's identity may be treated so that no personally identifiable information can be determined. As another example, a user's geographic location may be generalized to a larger region so that the user's particular location cannot be determined.

CONCLUSION

There is a large number of regular medicine takers in the population (both prescription and non-prescription), including a sizeable fraction that takes multiple medications. Patients often forget to take the right medicines at the right time. Caregivers may also lose track of the patient's

medical schedules, and need a system that sends them feedback, tracks adherence and helps with subsequent follow-ups. Improving prescription adherence contributes to better health outcomes and effective chronic care management of patients. In order to encourage patients to use their medicines as directed, health care insurers, employers, caregivers, physicians etc. can use the patient reminder system disclosed herein. Techniques disclosed herein use a virtual personal assistant to remind a patient of his upcoming health related tasks, such as taking medications, scheduling/keeping/rescheduling appointments, measuring and logging vital statistics, filling/refilling prescriptions, tracking symptoms, etc. The logs are all maintained in the patient reminder system that is accessible to the patient and/or the caregiver. The virtual personal assistant also emails or sends notes to caregivers as authorized by the user, thereby allowing caregivers to track the patient's health better and provide proactive care.