MedDash - Decoding Health Metrics to Enhance Patient Care

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Abstract

Our project aims to address a critical yet often neglected aspect of healthcare: the effective utilization of daily health data in patients. Despite the richness of information contained in everyday health metrics, these data often go underutilized, leaving significant insights into patient health patterns untapped. Although there are many patient dashboards, this specific dashboard is highly personalized and helps them look into specific or overall metrics. Our objective is to bridge this gap through the development of an innovative daily tracking dashboard, especially for patients whose diseases are undiagnosed and rare. This dashboard is designed to enable users to effectively visualize, comprehend, and monitor vast quantities of daily health data. This dashboard not only aids patients in recognizing normal and irregular health patterns but also provides clinicians with a comprehensive view of patients' daily health statuses, complementing traditional medical tests. The significance of this project lies in its potential to transform everyday health data into a valuable asset for both patients and healthcare providers. By highlighting patterns and anomalies in daily health metrics, the dashboard can enhance patient self-awareness and inform clinical decision-making. This approach marks a paradigm shift in patient-centered care, where everyday health data becomes a significant component in diagnosis and treatment strategies.

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1 Introduction

The main issue in the healthcare industry revolves around - How to deal with data to make it usable and accessible? In an article analysis of the healthcare industry written in the HealthLeaders, it stated that "while digital records may be plentiful, there is a deep lack of usability and integration that makes that data useful to improve the entire health care system and make it more effective." Markovich (2023) Thus our project aims to contribute towards solving this issue.

Currently, patients have data across multiple platforms such as data from Apple Health, Oura Rings, etc. In addition to data scattered across several sources, there are large quantities of data that do not even make it to a medical dashboard for patients and doctors to see, despite its importance in understanding daily patterns. A problem arises as these data are all in separate platforms and/or missing and this makes it difficult to analyze the separate but related data to help patients. Our goal is to create a user-friendly platform that consolidates data from multiple platforms to run analysis on the consolidated data. The data we are using comes from three patients from the clinic, Measures Wellness, founded by Dr. Michael Kurisu.

The previous work we are building off of acknowledged how current healthcare systems suffer from fragmented Electronic Health Records (EHR) and a lack of standardization, impeding effective personalized medicine. Other previous works had an aim to fill this gap and build a patient timeline dashboard integrating data from various sources into one easy-to-understand dashboard Brye et al. (2023). The development process involved standardizing wearable data, like Apple Watch and EHR data, with tools like Python, Pandas, and Tableau for their interactive visualization capabilities. The result of their work was a novel dashboard offering a view of health metrics and facilitating patient engagement with their daily life data. However, despite successful data integration, modeling, and analysis previous efforts still struggled to adhere to HIPAA regulations and integrate EHRs without compromising patient privacy.

Building upon their prior work that highlighted the challenges of fragmented EHR and non-standardized healthcare systems, we aim to advance a more patient-centric dashboard for broad use. This dashboard will enhance the initial version by increasing patient data volume, improving interactivity and graphical analysis, and conducting deeper data analyses to aid comprehension and data digestion for patients and clinicians.

2 Methods

We collaborated with six BioEngineering students and divided our collective team into two specialized groups to streamline our efforts and ensure efficiency in our approach. The first group was dedicated to data intake and integration. Their primary responsibility was to gather and consolidate a wide range of health data from various sources and APIs. They also focused on creating the framework of the dashboard website and managed the user login credentials and data. The second group focused on data exploration, analysis, and visualization. Their task was to delve deep into the data, uncovering trends and patterns that could provide meaningful insights into patient health.

With weekly meetings with Dr. Michael Kurisu and his team, we gained insight into user needs and tried to personalize the dashboards and make them more user-beneficial. This helped us make the exploratory data analysis more specific and targeted.

During the beginning of this quarter, the primary focus of the data integration team was the meticulous examination and implementation of fetching data using the Vital API and the login system. The primary objective was the establishment of a user-centric login infrastructure, allowing seamless connectivity of user devices to the Vital API seamlessly integrated within our medical dashboard. Subsequent to user authentication, the Vital API would autonomously generate a distinct token for each user, facilitating the provision of rudimentary visualizations predicated upon the respective device data.

The integration of the API into our dashboard necessitated adept handling of both frontend and backend components, compounded by the adoption of two unfamiliar programming languages. In light of these impediments, a strategic meeting transpired with specialists affiliated with Vital to deliberate upon the utilization of the Vital API for the retrieval of patient data. Meeting with Priyanshi (a member in Dr. Kurisu's team) enabled our group to successfully extract data directly from Vital through the exclusive utilization of the provided user token from our local.

By using React.js and Node.js, we have designed and deployed a login system for individual users. This login system is seamlessly integrated with MongoDB, an online database, thereby affording exclusive access to users' data based on their account and password. Upon successful authentication, users gain access to personalized data visualization derived from their wearable device metrics, thus enhancing their interactive experience.Following consultations with Dr. Kurisu's team, the consensus leaned towards the adoption of AWS EC2 as our cloud service provider. The instantiation of an instance from AWS EC2 was executed, complemented by the establishment of a connection between a Jupyter Notebook and Ubuntu. This configuration allows all members of our group to access patient data online, fostering automatic synchronization of code amongst the collaborative efforts within the group.

In the beginning of the quarter, we aimed to use Tableau for our dashboard as that was what was used in a previous iteration of this project; however since Tableau requires us to subscribe to its monthly service in order to edit the visualizations on its platform and is more of a financial reporting product like a company's earnings report, the presentation of its data doesn't quite fit the presentation of health data. Therefore, we decided to change our visualization tools from Tableau to Vite with React visualization components. The main focus of the data visualization team this quarter has been to create the website for our dashboard using React and Vite. Vite is a powerful front-end tool to build the environment for health data visualizations and interactions. By using Vite, we can quickly access development with faster build times. We also created a Figma template last quarter, with the help of the BioEngineering students, which represented a rough design for our dashboard. We then started implementing the graphs and other features of this website such as the diary entries and health habit tracker. Our aim is to utilize libraries for the built-in components such as e-charts, calendar, and buttons, etc.

3 Results and Discussion

This quarter, we deployed an AWS EC2 server using the DSC180B course's AWS account. This AWS EC2 server allows us to run cron jobs to fetch data continuously without manually executing the scripts. Another achievement was the successful integration with the Vital API, enabling us to retrieve data for specified periods from patients' wearable devices. This data, encompassing various health parameters, is now directly accessible and storable on our AWS cloud server and MongoDB database. As the patient base expands, this functionality will allow us to seamlessly pull necessary patient data from Vital and store it on the cloud.

Additionally, we integrated the cloud server with Jupyter Notebook to enhance real-time collaboration. This integration enabled team members to simultaneously access, analyze, and manipulate data. The collaborative environment fostered by Jupyter Notebook on the cloud server significantly improved the efficiency of our data analysis and visualization processes.

We also uploaded the data to MongoDB and utilized it as the database for our data pipeline, enabling the extraction and loading of data via the Vital API. Our database structure comprises six distinct collections, all consolidated within a database named "med_dash_user_data." This setup is supported by a cron job hosted on AWS, ensuring efficient data management and real-time processing.

On the data security and access front, we've successfully developed a login system and integrated it with the landing page created by the previous year's Capstone team. This integration allows for user login access to our login system via the existing website. Additionally, all patient health data is now stored in the MongoDB database. This measure enhances data privacy and ensures the integrity of patient information. This system is designed to enhance patient data protection to the desired level.

We created a "Health Analysis" dashboard for data visualization. With the help of React

Echarts, we were able to add some interaction features to our graph: users could switch on and off the line charts so that they could look for specific correlations among data. What's more, Users could also see the exact data with units for each day when they move the cursor on the graph. To let users obtain a deeper understanding of data, we utilized the "DatePicker" component so that the users can choose a specific period for data visualization.

For the "Card" components, we use them to match the line graphs, and at the same time, We allow specialists and doctors to visualize different health data with formulas that are more reflective of the characteristics of the data.

Last but not least, we added a health habit tracker in order to let patients track their personal goals that wouldn't be tracked otherwise. This allows patients to set goals such as drinking a certain amount of water per day or getting exercise a few times a week. They can also update their data all the time and eventually meet the target requirements.

We currently possess data from three distinct patients and additional random data generated through the Vital API. It is hard for us to find the trend by visualizing the limited data we have. However, we utilized different features to do the visualizations, we found that there were some subtle correlations among different features, so the doctors could compare various graphs during the meeting with patients to find the status of the patient's health. With more than one type of visualization shown on the board, we could help doctors save time on searching for relative data, finding the trend of specific features, and noticing potential biomarkers that could signal an illness before any symptoms develop. We currently struggle to define what qualifies as 'normal measurements', making it difficult to understand how much our patient data deviates from the standard.

4 Conclusion

Currently, our dashboard integrates data from multiple sources and combines it into an interactive visualisation dashboard for the patients and for the clinicians. We created a dashboard for a single user with components like health analysis and diary entries. Health analysis allows the patients as well as the clinicians to look at the patients' health trends for specific dates and for specific factors (like step count).

Some of the challenges that we faced as a team during the project were that we could not implement the back-end database for the login system where each user's login details are saved and thus, our current system uses dummy login information. Further, due to ethical and privacy concerns we only had data from 3 patients. Another important technical challenge we faced is that we shifted our visualisation tool from Tableau to React to enhance the visualisations. This shift was challenging as most of learnt React while working on the project.

Finally, the next steps of the project will include incorporating more functionalities into the dashboard, developing the back-end database for multiple user information, predictive analytics, real-time health alerts, and developing a clinician communication portal. It would be helpful to continue talking to patients and doctors and understanding their needs from the dashboard and the features they think are important. We would incorporate their feedback to make it more customer-friendly, accurate, and useful.

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