Innovations in Telemedicine for Chronic Disease Management

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Abstract

Background: Types of diseases like diabetes, BP and heart diseases in chronic diseases also lead to high mortality rates in the world. The only way that advocates of telemedicine have found to be able to monitor a patient frequently instead of having to spend huge amounts of time visiting physically is through the use of this technology. The advancements like the current use of AI and wearable technologies can be said to encourage optimal outcomes of chronic disease management. In this series 100 patients with chronic conditions were followed for six months using wearable technology and telemedicine through artificial intelligence. The findings pointed towards an improvement of the quality of patents on the wards. There was a mean reduction in blood glucose level of 12.5 mg/dL (SD = 4.2, $p < 0.01$ and mean reduction in systolic blood pressure of 8.3 mmHg (SD = 3.1, $p < 0.05$). The advancements in telemedicine especially wearable devices and Artificial intelligence (AI) analytics have shown an improvement in chronic diseases. These technologies do not only increase the efficiency of health interventions and improve the health status of the population but also make patients happier due to the possibility of timely individual interventions.

Keywords: Telemedicine, chronic illness, wearables, artificial intelligence.

Introduction

Cardiovascular disease, diabetes, chronic respiratory disease, and cancer continue to be leading causes of morbidity and mortality, as well as a major cause of healthcare expenditures. Most of the time they are chronic and may therefore need lifelong care, with close supervision and changes in behaviors, to avoid evolution to worse status. The conventional care delivery model of chronic care has relied on door lazy visits to clinics for patients with chronic diseases, which has been inconvenising both timely and financially draining to the patients and the healthcare facilities. Telemedicine is a new and promising model of healthcare delivery system which has enormous advantages for the treatment of chronic diseases through home telemonitoring and telecare 1, 2. Telemedicine is the practice of using telecommunications technology in both the provision and receiving of healthcare services at a distance, and has been growing in the United States over the last decade. It enables patients to talk with doctors, nurses and other clinician concerned through video calls, telephone or by message thus diminishing the face to face appointments. But in recent past, advancements in telemedicine have shifted towards the use of wearable devices, artificial intelligence and the mobile health for improved chronic disease tracking and management 3, 4. Real-time monitoring with devices like smart watches, ongoing glucose monitor and much more enables the watches in keeping check on necessary health aspects. They can facilitate push of information to healthcare providers so as to enhance timely action and tailored management 5. Data analytics is another core application area of AI in telemedicine for the chronic diseases by processing enormous quantities of collected patient data and produced precise predictive results on the condition's progressions or further complications 6. This, in turn, can enable clinicians to identify early biomarkers of disease worsening in order to treat the patient faster and more efficiently. It has shown that telemedicine can be useful in the control of chronic diseases in several research works. For instance, a systematic review of the effectiveness of telemedicine has indicated that telemedicine interventions enhance glycemic control in patient with diabetes, minimise hospital admission among patients with heart failure and also lessen blood pressure among hypertensive patients 7, 8. Also, the study shows that telemedicine has the overall positive impacts on patients' satisfaction and activity rates due to availability factors 9. These outcomes have been complimented by the adoption of telemedicine coupled with artificial intelligence that has brought accuracy in diagnosing a disease or formulating a treatment plan 10. However, the use of telemedicine in the management of chronic diseases comes with some problems as will be discussed below. Data privacy, technology challenges, and distribution all represent major challenges that still exist today 11. Additionally, while several authors demonstrated improvements in patient status as a result of telemedicine interventions, additional research is required to establish the sustained benefit of these innovations in terms of patient status and costs 12. Therefore, in this study, we propose to assess the utility of telemedicine innovations especially the wearable devices and its analytics in the context of chronic diseases. In particular, the effect of such technologies on clinical effectiveness and patient satisfaction among subjects with diabetes and hypertension will be evaluated. Thus, the goal of the present study, which aims at analyzing the patient data gathered through the use of telemedicine technology, is to better understand applicability of such technologies in improving chronic disease management.

Material and Methodology

The current study targeted 100 diabetic and hypertensive patients. Patients participating in the study had to join a telemedicine program that would use wearable technology and AI analysis. The intervention was carried out for 6 months in which patients' health indicators that include blood glucose level, blood pressure, and heart rate were monitored from a distance. Interactions included sharing information with healthcare providers in real-time, and feedback on treatment, or additional input, was relayed through the telemedicine application. Therefore, it is essential that all assessments were made both at the initial time point and again at the three- and six-month follow-up assessments. For the comparison of the mean scores in the status measures reflects differences in health over time, paired t-tests were used.

Data Collection

Patient data was extracted from portable wearable devices connected with the central telemedicine system. The primary health indices that were taken included blood glucose levels for blood sugar levels, systolic blood pressure for pressure and pulse rate of the heart. Information was properly archived according to the instituted HIPAA standards and hence the patient information privacy was safeguarded.

Statistical Analysis

Differences were analyzed using the SPSS software version 24.0 (IBM Corp., Armonk, NY). Analysis of the findings used paired t-tests to assess the change between the baseline and post-test on each measure of health. $P < 0.05$ was threshold for the statistical significance. It was possible to calculate the means and standard deviations to demographically describe the data of the subjects.

Results

In the current study, 100 patients were recruited, and 90 returned for the six months follow up. Baseline fasting blood glucose value was 145.6 mg/dL (SD = 8.2) with a statistically significant improvement at 6 months to an average of 132.1 mg/dL (SD = 6.9) $p < 0.01$. Systolic BPA had a decrease in the mean by 8.2 mmHg (SD = 1.0) from 138.4 (SD =9.1) at baseline to 130.2 (SD = 7.3) at the end of study ($p = 0.05$). Similar to blood pressure readings, analyses of heart rate showed a significance where mean count dropped down from 82 bpm (Standard Deviation = 5.5) to 76 bpm (Standard Deviation = 4.9) in six months. Further, 85% of the patients indicated better satisfaction level and overall participation in the telemedicine program. The feedback system which incorporated the use of Artificial Intelligence got a lot of support from the clients for many reasons but chiefly because of the development of unique treatment plans in addition to timely interventions where necessary.

Table 1: Baseline Characteristics of Patients

Characteristics	Values
Age (mean)	56.3 years
Gender (M/F)	55/45
Duration of Disease (years)	7.5 years
Diabetes Type (I/II)	20/80

Table 2: Changes in Blood Glucose Levels

Time	Mean Blood Glucose (mg/dL)	Standard Deviation (SD)	p-value
Baseline	145.6	8.2	-
3 Months	138.2	7.1	<0.05
6 Months	132.1	6.9	<0.01

Table 3: Changes in Systolic Blood Pressure

Time	Mean Systolic BP (mmHg)	Standard Deviation (SD)	p-value
Baseline	138.4	9.1	-
3 Months	133.7	8.4	<0.05
6 Months	130.2	7.3	<0.05

Table 4: Patient Satisfaction and Engagement

Measure	Percentage (%)
Patient Satisfaction	85%
Increased Engagement	90%

Discussion

The study's results reveal that the use of telemedicine as enriched by AI analytic tools and wearable devices has a favourable impact on the clinical conditions of chronic diseases, such as diabetes and hypertension. Reduced level of fasting blood glucose and systolic blood pressure attained at the telemedicine program was statistically significant at $p < .05$, and patients' satisfaction in the program was high. Thus, the results are consistent with prior studies, indicating the effectiveness of the telemedicine approach in Chronic Disease States. Still, there are some aspects and differences that are needed to be discussed with regard to the other articles in the field. A recent work by Polinski et al. has proved that telemedicine interventions work as effectively as our study in facilitating the improvement of glycemic levels among patients with diabetes 13. In our study, the mean self-monitored BG levels fell from 145.6 mg/d1 to 132.1 mg/dL, and according to Polinski et al., the intervention group had a similar decrease of approximately 12 mg/dL in 6 months. This is also self evident by consistency and as such suggests enhanced self management in diabetes care when wearable devices are integrated into the telemedicine platforms to allow for continuous monitoring of a patient's glucose levels and prompt feed back in case of abnormal levels. Just like in prior studies, the effects of telemedicine on hypertension are established. Omboni et al.'s, systematic review documented the telemedicine interventions' impact towards the lowering of the systolic blood pressure and the effect closely resembles what is reflected on this study, where the patients' systolic blood pressure was lowered by 8.2 mmHg over six months 14. There is speculations that the mobility offered by telemedicine; the ease with which blood pressure can be monitored continuously and the subsequent ability to intervene timely contributed immensely to these results. This is supported by work like that of McKinstry et al., where they showed that out of office blood pressure monitoring together with clinician advice on management was superior to routine care in terms of control of hypertension 15. In the same study, we also noted that patients using the telemedicine program also had high satisfaction and actively participating in its use. Satisfaction rates remained high and were close to the results found by Kruse et al., where more than 80% of patients using telemedicine for chronic disease management reported convenience as the major benefit of the technology 16. Furthermore, our results of enhancing patient satisfaction to 90% are supported by Dinesen et al. who revealed that patients who used the telehealth solutions were more compliant with their care, an essential characteristic in chronic illness management 17. One of another importance of the current work is application of different AI tools to make additive prognosis of risks and provide individual treatment program. In his study, Topol has argued that the use of AI can help make chronic disease management more precise 18. The collected amount of data from the individual wearable devices can be entered into the AI algorithms, unveiling patterns characteristic of deterioration and issuing alerts to the clinicians before the situation worsens. These findings indicate that this capability is likely to play a central role in enhancing patients' clinical experiences and outcomes since AI-based approaches are likely to be better timely and tailored than traditional ones. Despite the results observed in the present study, there are some limitations to consider. For instance, while using telemedicine patients in the rural or regions with low health care facility density have challenges of accessing the technology 19. Furthermore, other authors have noted that although privacy was not an exhaustive concern in our research, patients have fears over security of transferring data through telemedicine programmes 20. These issues need to be considered and solved in order to secure the further upliftment of telemedicine solutions. Summing up, our research is also proves the opportunities of the telemedicine with the application of AI and wearable technology in chronic disease management, its positive impact on clinical results and patients' satisfaction. Nonetheless, future directions should be centered in understanding and closing gaps in AI access and continuing to build more secure and useful AI technologies for a more diverse patient population.

Conclusion:

This paper proves the fact that, if implemented in chronic illness management, telemedicine will go hand in hand with the technical advancements of the AI analytics and wearable devices to deliver better clinical outcomes as well as higher levels of satisfaction to the patients. The combination of continuous monitoring and targeted interventions help patients better manage diabetes and hypertension making telemedicine a useful approach to long term chronic disease management.

Limitations:

Some of the study limitations include the following: a small subject sample and the exclusion of rural patients who may have poor access to ICT infrastructure needed for telemedicine. Furthermore, the study was conducted based on the incidence of diabetes and hypertension only, hence; the results cannot be generalized to other chronic diseases.

Future Findings:

Further research studies should investigate ways of reaching out and applying the technology to more cases among clients who are in the needy areas. Other future research should also evaluate the combined effects of artificial interventions and wearable devices in healthcare costs and patients' compliance and prognosis in different chronic illnesses.

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CONFLICT OF INTEREST

None Declared

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Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.