Remote Health Monitoring Patients with Hypertension

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1 BACKGROUND AND SIGNIFICANCE

Blood pressure is the force of blood pushing against the walls of your arteries. Throughout the day, it is normal for blood pressure to fluctuate. However, when it stays high for an extended period, it is referred to as Hypertension. Hypertension can lead to many complications, such as heart failure, dementia, aneurysm, stroke, heart attack ("High blood pressure," n.d.). The difficulties related to hypertension lead patients to be admitted to the hospital, which costs about $20,000 (Ellison, 2018).

1.1 Problem

When left uncontrolled, Hypertension patients are at risk of long-term health complications, expensive hospital admissions, or death. It is estimated that nearly one in two adults in the United States has Hypertension, about 108 million people ("Hypertension Prevalence in the U.S," 2020). Figure 1 indicates that about 76% of hypertension patients have uncontrolled blood pressure status, which leaves many people untreated.
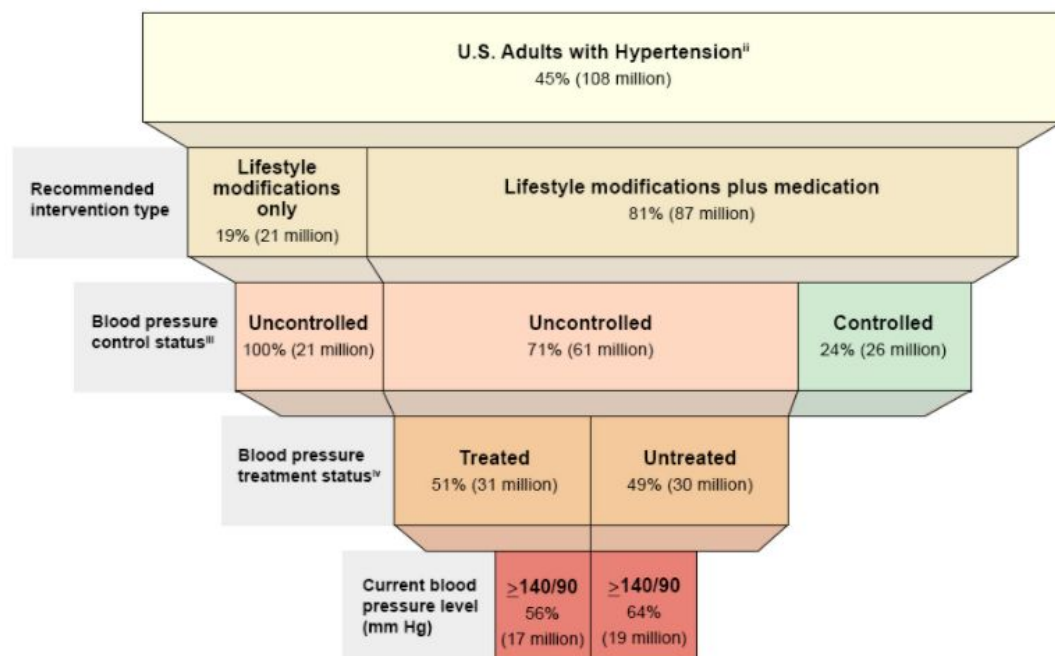

Figure 1 — Estimated Hypertension Prevalence, Treatment, and Control Status.
Source: Million Hearts.

1.2 Proposed Solution/Idea

Doctors can monitor their patient's blood pressure throughout the day remotely to reduce the patient's risks of complications. Providers or health insurance companies can send hypertension patients a package with an IoT blood pressure monitor. There will be an application available to download on the patient's mobile device. The application will remind the patient to measure their blood pressure twice daily - once in the morning before eating, drinking, taking medications, and once in the evening ("Get the most out of home blood pressure monitoring," 2020). The health monitoring application will retrieve the blood pressure measurements and store the data into a database. The database will be connected to Tableau and display analytics for the nurse(s) to examine daily. The Tableau dashboards will allow the nurse(s) to determine if a patient needs a doctor's visit, is reaching an alarming point, dictate early warning signs for complications, or decide what works/does not work for the patient.

1.3 Complexity and Effort

Remote health monitoring is a feasible solution for everyone - the doctor can help the patient in a more personalized way, and the patient's condition will be controlled. Also, this solution is significantly cheaper than hospital admission. Part of the challenge will be finding a manufacturer that produces accurate and easy-to-use blood pressure cuffs. However, there are several highly rated devices in the market. Due to the technological solutions involved, there is a learning curve for both the patient and the provider. There will be documentation, user manuals, and video tutorials to help users understand how to use them. The manufacturer should provide user support should the patients have issues with the blood pressure monitor. Unfortunately, there is a significant risk for cybersecurity attacks when utilizing IoT technologies, and especially when dealing with sensitive health data, there need to be security regulations set in place. The provider organization and the manufacturer will need to collaborate and ensure that the necessary security blocks are present. Patients should also have the latest application updates, which can be enforced by having automatic updates. The application that pairs with the Bluetooth blood pressure cuff will require the patient to have a smartphone (to download the app). Some people may not own smartphones, especially elderly patients who are not as technically advanced. Given these circumstances, it is worth the investment in the patient's health to provide them with a smartphone device. The device will be locked, so they can only access the health monitoring application. One of the biggest challenges is if a patient does not measure their blood pressure twice per day as instructed. This scenario will make it difficult for a doctor to curate a treatment plan for the patient. Although the application has notifications, some people may not be compelled to measure their blood

pressure. A nurse can call the patient to ensure they are doing fine and their devices are working correctly. The missing measurements will be put into the database as "null."

1.4 Discussion

A doctor's office visit is simply not enough to diagnose a patient with hypertension. Some common causes of high blood pressure spikes can be caffeine, smoking, stress or anxiety, and underlying health issues ("6 Facts About High Blood Pressure", n.d.), leading to misdiagnosis. Most hypertension treatments include lifestyle modifications such as exercise, eating less sodium and more potassium, and reducing stress ("24-Hour Ambulatory Blood Pressure Monitoring", n.d.). However, most people need medication to intervene. Doctors must understand the discrepancy between in-office and out-of-office blood pressure measurements due to the medical implications of a hypertension diagnosis (Ogedegbe et al., 2008). About 15-30% of patients with elevated blood pressure measurements have been misdiagnosed with hypertension; this is called 'white coat hypertension.' The opposite can occur where a patient's blood pressure measurement is normal at the doctor's office but elevated at home, referred to as 'masked hypertension.' Lastly, there is 'sustained hypertension,' which relates to the patients whose blood pressure readings are elevated at the doctor's office or home - this could be linked to underlying conditions. There is a 24-hour Bluetooth ambulatory blood pressure monitor that can monitor a patient's blood pressure at all hours of the day to provide a more accurate diagnosis ("24-Hour Ambulatory Blood Pressure Monitoring", n.d.). A Bluetooth ambulatory blood pressure monitor should be considered for future development since it will give healthcare providers better insight into the patient's blood pressure. This device can be especially beneficial to pregnant women with hypertension (Correia, Vidal, Alexandra, Leitão, 2018) and monitoring a patient's blood pressure due to prescriptions they are taking ("24-Hour Ambulatory Blood Pressure Monitoring", n.d.).

2 DEMONSTRATION

The analytic dashboards will help healthcare providers offer quality care for their patients. I utilized Tableau to demonstrate how these dashboards would be helpful. I added the Tableau visuals into Jupyter Notebook and then hosted them on GitHub Pages. My work can be found here: https://honya99.github.io/. Figure 2 demonstrates a blood pressure chart that shows the range of systolic and diastolic measurements that patient's with hypertension fall in - this is vital information while conducting my visuals.
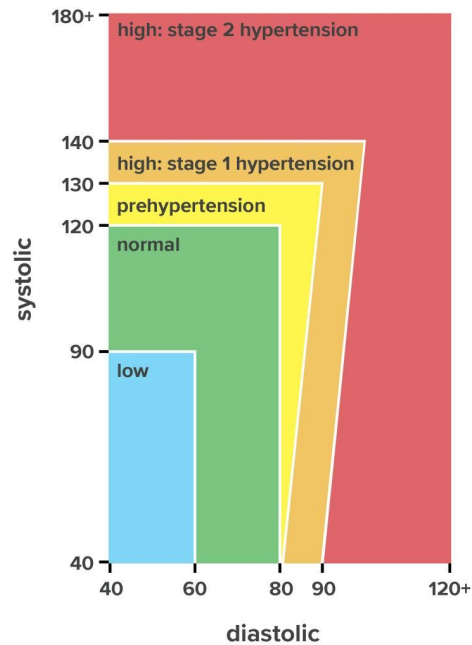
Blood Pressure Chart

Figure 2 — Blood Pressure Chart. Source: Medical News Today.

2.1 Data

I created some sample data to visualize the analytic dashboards that the healthcare providers would see. Table 1 demonstrates that each patient is given a unique id.

Table 1— ids table. Source: Honya Elfayoumy

Id	Name	Age	Sex
1	Domonic Mccormack	62	M
2	Anabel Knapp	34	F
3	May Lindsey	55	F
4	Alec Ray	37	M
5	Hanna Martins	76	F

Each patient has unique blood pressure measurements, as shown in table 2.

Table 2 — Example of blood pressure measurement data for patient id 1. Source:
Honya Elfayoumy

Id	Date	Morning Systolic Blood Pressure mmHg	Morning Diastolic Blood Pressure mmHg	Evening Systolic Blood Pressure mmHg	Evening Diastolic Blood Pressure mmHg
1	9/16/2020	132	82	137	85
1	9/17/2020	170	170	172	95
1	9/18/2020	133	133	130	80
1	9/19/2020	145	96	138	89
1	9/20/2020	133	84	170	170
1	9/21/2020	132	82	172	172
1	9/22/2020	138	89	172	172
1	9/23/2020	137	85	132	82

I created a union with each patient's blood pressure measurement table (patients). I produced a Many-to-One relationship between patients and the ids table on the data field 'id' as shown in figure 3.
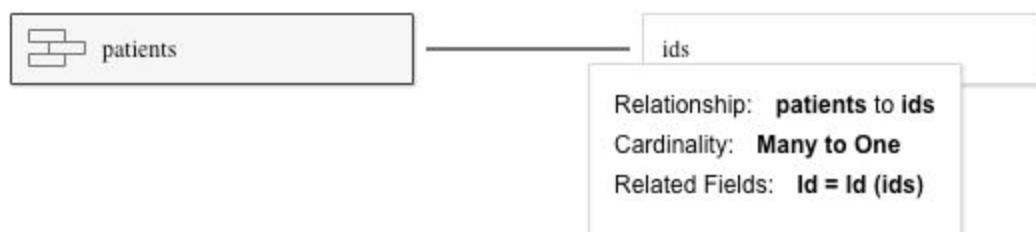

Figure 3 - Table relationships. Source: Honya Elfayoumy

2.2 Individual Patient Graph

The individual patient blood pressure measurement graph will show the morning and evening systolic and diastolic measurements. The data in Figure 4 is showing the patient's blood pressure measurements twice a day for eight days. This visual will help healthcare providers see the patient's readings over time and conclude why it could be elevated (food, exercise, medications, etc).
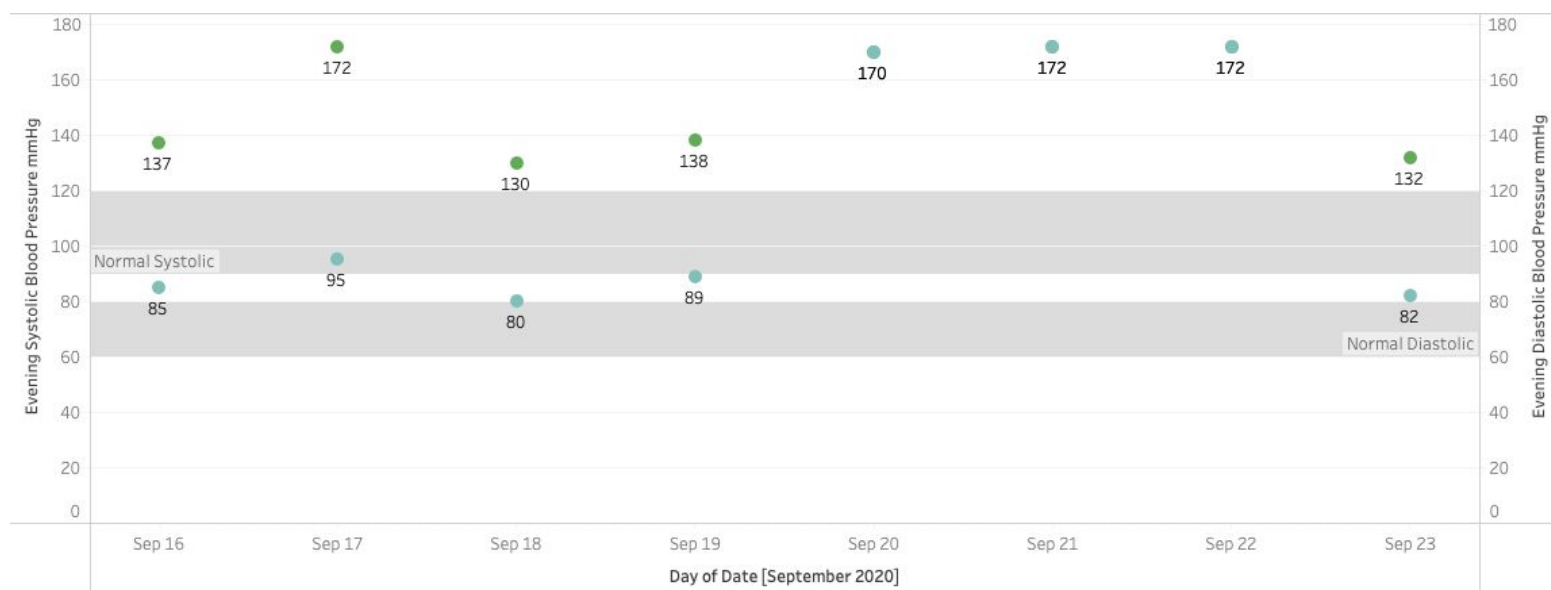
Figure 4 - Individual patient graph example. Source: Honya Elfayoumy

The graph includes a legend to differentiate between the systolic and diastolic blood pressure measurements, shown in figure 5.
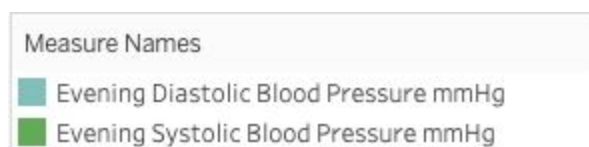

Figure 5 - Color coordinated legend. Source: Honya Elfayoumy

2.2 Multiple Patient Comparison Table

The comparison table will display all (or select) patient's blood pressure measurements. Table 3 demonstrates each patient's morning and evening systolic and diastolic readings. These measurements can be sorted from highest-to-lowest so the healthcare provider can see which patient is at risk given the select day(s).

Table 3 - Table of all patient's blood pressure measurements . Source: Honya Elfayoumy

Day of Date	Name	⫶	Evening Diastolic Bloo..	Evening Systolic Blo.. ⫶	Morning Diastolic Bloo..	Morning Systolic Blood..
September 16, 2020	Hanna Martins		98.00	165.00	84.00	135.00
	May Lindsey		98.00	150.00	84.00	135.00
	Domonic Mccormack		85.00	137.00	82.00	132.00
	Anabel Knapp		87.00	137.00	96.00	144.00
	Alec Ray		85.00	134.00	94.00	165.00

2.3 Conclusion

Hypertension is a condition that continues to affect many people in the United States. Patients who suffer from hypertension do not receive the necessary treatment they need for their condition simply because it is not monitored or controlled by a healthcare provider on a routine basis. Patients with hypertension often end up developing more significant complications that put them at risk of hospital admission or death. Bluetooth-enabled blood pressure cuffs can benefit the health of patients who suffer from hypertension and remove the burden off of physics. Healthcare providers will retrieve the data collected by the Bluetooth monitor and analyze it to ensure they provide the patient with proper care catered to their condition.

3 REFERENCES

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