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Original Research Paper

Cardiology

RISK ASSESSMENT, STRATIFICATION AND PREDICTIVE VALUE OF CORONARY ARTERY DISEASE FOR INDIANS IN THE FUTURE: THE "MEDLIMA" APPROACH

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ABSTRACT

Objectives: The purpose of this paper and "MedLima" (MedLima means medical file in Latin) app is to analyze the data for 600 Indian Cardiac Patients and define a new metric for good health indicators by coining a 10-point scale for cardiac health. The app will serve as a medium for patients to utilize the 10-point scale for basic self-diagnosis, and as a motivator to maintain good health. It also serves as a repository for data on key health indicators which can be contributed to by doctors and other healthcare providers.

Methodology: This is a retrospective study for which the data of 600 patients was collected with the help of a hospital over a period of time. The data consists of multiple health indicators. Each indicator is assigned a point value according to degree of correlation with CAD. We also propose new "safe" and "risk" zones for some of the indicators like Cholesterol, BMI and Triglycerides, which have been derived from our data specifically for the Indian population and may differ from both conventional lab reports and the update provided by the American Heart Association for cardiac health every year.

KEYWORDS :

Introduction

It is health that is real wealth and not pieces of gold and silver. – Mahatma Gandhi

In a developing country like India, good health has been one of the most major concerns, and there has consequently been a rapid growth in the health sector over the past few decades. While the number of primary healthcare providers has increased substantially, so has the number of cardiac patients in India, and it is projected that India's burden of cardiac disease will have surpassed any other country by 2020. There are an estimated 40 million cardiac patients in India, and a staggering 17.5 million deaths per year due to cardiac diseases every year. The Global Burden of Disease study estimate of age-standardized Cardiovascular Disease death rate of 272 per 100,000 population in India is higher than the global average of 235 per 100,000 population.[1] And yet, there is still a lack of basic knowledge required for patients to self-diagnose or know when to schedule their heart check-up.

Another big gap which exists for patients and attendants is the lack of a centralized data repository to store health records over a period of time, the existence of which would not only allow patients easy access to their records at all times, but would also allow them to monitor their progress by looking at their previous records. Earlier this year, Nandan Nilekani said, *"Data is the new oil."* This statement can only be actualized if the data which is collected is used to its full potential, and Bioinformatics utilizes the power of data-analytics to allow us to build a healthier society.

This represents the core philosophy behind the "MedLima" app, to build a healthy society and increase health awareness and social outreach, by creating a centralized data platform for patients which not only stores, but also provides keen insight on the records.

Health Point Average (HPA) – 10-point magic

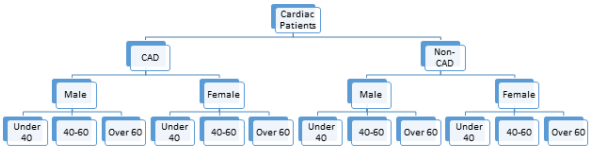
Since social outreach is one of the fundamental principles behind "MedLima", it is necessary that the patients are able to understand what their key health indicators like cholesterol, blood sugar etc. actually represent. It therefore becomes critical to define a new scale which I have coined as the "Health Point Average" or HPA. It provides the patient with a Cardiac Health rating on a scale of 0-10, with 0 representing healthy. The ratings represent the level of cardiac health of the patient as explained below:

1. 8-10: shows the need for drastic changes in lifestyle and a need to consult with a cardiologist.
2. 4-7: indicates average health with scope for improvement.
3. 0-4: represents the healthy band of patients who will remain fit by taking minimum precautions.

The next sections deal with the investigation of individual characteristics and their assigned point values, according to the analysis of the data collected for 600 patients while beta-testing the app.

The Data

Realizing that there was a need for more analysis of data for the Indian (or South Asian) Cardiac patients, the raw data obtained from the beta-tests was structured to create the following hierarchy:



CAD- Coronary Artery Disease

Health Indicators

Cardiac health is associated with certain key indicators and the following are the ones which will be analyzed in this study:

1. **Total Cholesterol**
2. **BMI**
3. **Diabetes Mellitus**
4. **Hypertension**
5. **Smoking history**
6. **Triglycerides**

Each indicator is assigned point values from 0-1 or 0-2 according to correlation with CAD.

The ranges have been found using median and mean along with standard deviation for each subset of data, and then comparing for CAD and non-CAD.

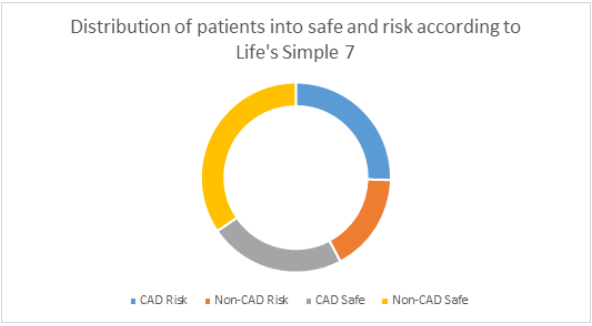
Cholesterol

Cholesterol is a fat-like substance which is naturally manufactured by our liver and is present in all cells of our body. It is essential to produce hormones, vitamin D and other substances and controlled levels of cholesterol are highly beneficial. However, intake of foods like dairy, meat, and, most harmfully, items with trans-fats induces the liver to produce higher levels of cholesterol which can be extremely harmful.

High cholesterol levels have a direct correlation with Coronary Artery Disease (CAD). A high percentage of the patients whose records were collected had high cholesterol. While comparing the

data for non-CAD and CAD patients, it was noticed that there was a certain trend forming. For our study, new safe and risk zones were defined for total cholesterol levels which differ from the statistics presented by the American Heart Association for their "Life's Simple 7" initiative. [2]

According to Life's Simple 7, patients with cholesterol under 200 are in the safe zone. However, the following distribution of NON-CAD and CAD patients from our study into safe and risk zones according to Life's Simple 7, shows that 100 patients who did not have surgery were under risk, while 138 who underwent CAD were risk free. This means that the American scales aren't perfectly applicable to the Indian population.



Cholesterol has been assigned a 0-2 scale instead of 0-1 since there is an intermediate level, and our data showed that approximately 70% patients who had angioplasty had high cholesterol levels.

The following is the scale which has been defined for calculating the HPA, with a score of 0 representing good cholesterol level:

a. Male <40:
   i.0: 143-182
   ii.1: 182-207
   iii.2: >207
b. Male 40-60
   i.0: 149-194
   ii.1: 194-231
   iii.2: >231
c. Male >60
   i.0: 148-185
   ii.1: 185-232
   iii.2: >232
d. Female <40
   i.0: 130-181
   ii.1: 181-230
   iii.2: >230
e. Female 40-60
   i.0: 153-196
   ii.1: 196-241
   iii.2: >241
f. Female >60
   i.0: 144-182
   ii.1: 200-240
   iii.2: >240

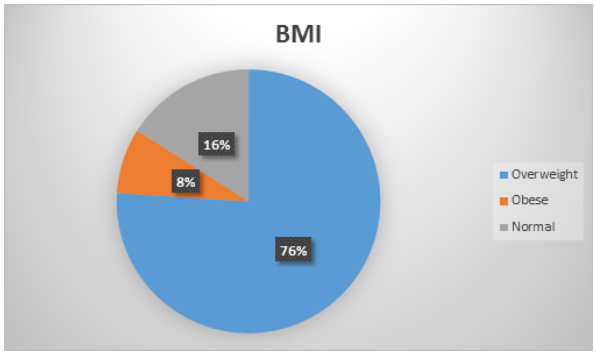
BMI

Body Mass Index or Quintelet Index is defined as the weight of a person divided by the square of the height (in m). It is a measure for obesity which is an extremely important factor for assessing cardiac risk. According to the World Health Organization (WHO), obesity is one of the most common, yet among the most neglected, public health problems in both developed and developing countries.

The prevalence of obesity has been rapidly increasing in India over the past decade. According to a recent study, approximately 135 million people in India are overweight in accordance with the WHO guidelines (>25 kg/m^2). [3]

WHO guidelines define two risk zones, i.e. Overweight (BMI: >25) and Obese (BMI: >30), and close to **76% of patients had BMI >25 in our study, making it a very important factor.** [4]

It is observed that the average Indian person has higher BMI levels than the threshold for being overweight according to conventional guidelines, possibly owing to consumption of high levels of fat in the form of butter/ghee daily, coupled with the rise of a sedentary lifestyle amongst the youth. Studies have shown that these factors have a considerable effect on BMI (and therefore cardiac health) of Indian women. [5] **However, only a very small portion (close to 8%) of the patients were obese while 16% of people were of normal weight.**



The 0-2 scale which has been derived from our data is as follows:

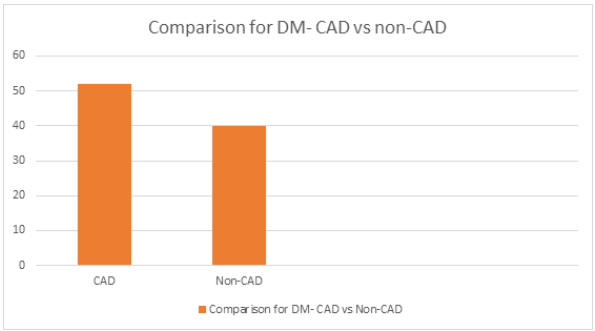
1) Male <40
   i)0: <24
   ii)1: 24-27
   iii)2: >27
2) Male 40-60
   i)0: <25
   ii)1: 25-28
   iii)2: >28
3) Male >60
   i)0: <25
   ii)1: 25-29
   iii)2: >29
4) Female <40
   i)0: <22
   ii)1: 22-23
   iii)2: >23
5) Female 40-60
   i)0: <26
   ii)1: 26-29
   iii)2: >29
6) Female >60
   i)0: <25
   ii)1: 25-30
   iii)2: >30

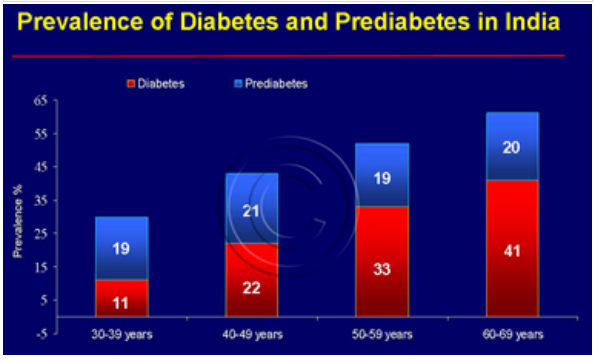
This shows that risk increases as BMI moves towards the threshold for obesity, especially for those aged >40.

Diabetes Mellitus

Diabetes is a chronic medical condition due to which either the pancreas stop producing insulin, or the body's ability to handle sugar is impaired. This leads to raised blood sugar levels. Diabetes is fast gaining the status of a potential epidemic in India with more than 62 million diabetic individuals currently diagnosed with the disease. Indians are genetically predisposed to the development of coronary artery disease due to dyslipidaemia and low levels of high density lipoproteins; these determinants make Indians more prone to development of the complications of diabetes at an early age (20-40 years) compared with Caucasians (>50 years) and indicate that diabetes must be carefully screened and monitored regardless of patient age within India. [6]

In our study, diabetes showed a very high correlation with angioplasty as close to 51% of CAD patients had diabetes while only 40% of non-CAD patients had diabetes. It is a binary indicator with a score of 2 for presence of diabetes and a score of 0 for absence of diabetes.





Source: CADI Research Centre

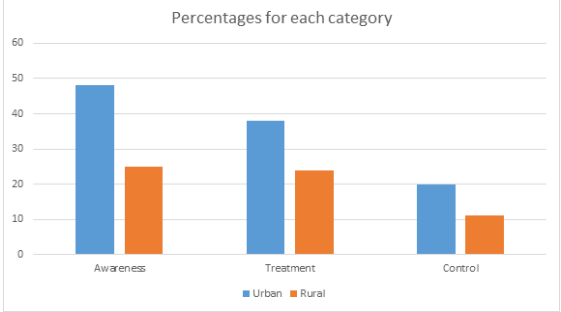
Hypertension

Hypertension (HTN or HT), also known as high blood pressure (HBP), is a long-term medical condition in which the blood pressure in the arteries is persistently elevated.

High blood pressure (HBP) is ranked as the third most important risk factor for attributable burden of disease in south Asia (2010). Hypertension (HTN) exerts a substantial public health burden on cardiovascular health status and healthcare systems in India.[7]

According to a study, about 33% urban and 25% rural Indians are hypertensive. Of these, 25% rural and 42% urban Indians are aware of their hypertensive status. Only 25% rural and 38% of urban Indians are being treated for hypertension. One-tenth of rural and one-fifth of urban Indian hypertensive population have their BP under control.[8]

Hypertension does not show any symptoms and thus it is extremely important for regular health check-ups to be scheduled. In our study, close to 65% of CAD patients were hypertensive, while 60% of total patients had HT. This shows that the risk factor associated with Hypertension is very high for the Indian population. On our scale, 0 indicates absence for Hypertension while 2 indicates presence.



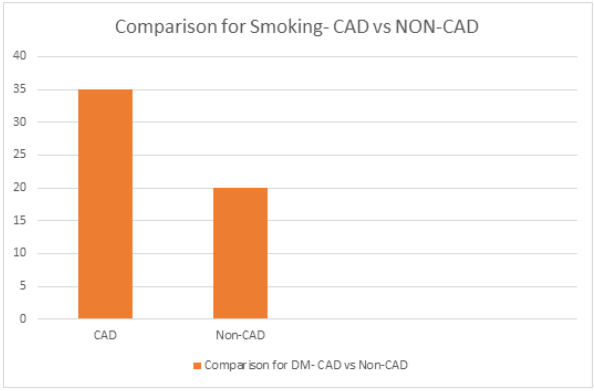
Meta-analysis of hypertension awareness, treatment and control in Indian urban and rural populations.[9]

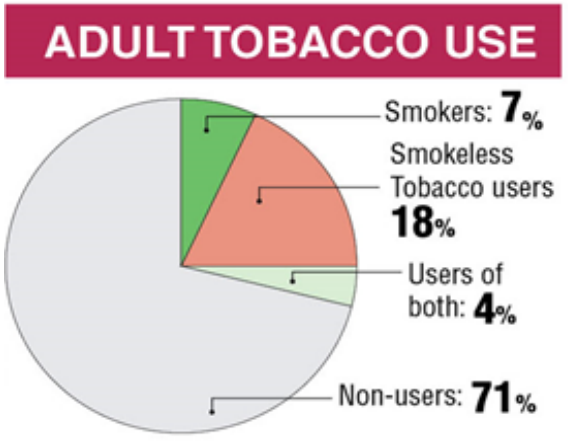
Smoking History

Smoking is a worldwide major cause of preventable morbidity and mortality. About 17% smokers in the world live in India. Presently, nearly 2200 people per day and 9 lacs every year die in India due to tobacco related diseases. The Health Ministry has estimated that 40% of India's health problems stem from tobacco use. The health and lifestyle factors, together with the genetic makeup of an individual, determine the response to these changes. Heavy smoking is the commonest cause of ischemic heart disease and death in the 30 – 40 years of age group, who are likely to be free from other myocardial risk factors.

Smoking affects the cardiovascular system by several mechanisms. The haemodynamic effects of smoking appear to be mediated by nicotine. Such effects cause an increase in the myocardial work. Nicotine increases the cardiac output by increasing both the heart rate and the myocardial contractility.[10]

Analyzing the data from our patients, it was found that 35% of CAD patients are smokers whereas only 20% of NON-CAD patients are smokers. However, since only 30% of the patients are smokers, the risk factor associated with smoking is lower on our scale and has been assigned a risk vale of 1 and safe value 0. This may be attributed to the recent decrease in tobacco use in India as was shown by a recent study which showed a decline of 33% in tobacco users amongst the youth.[11]





Source: CAGS-II

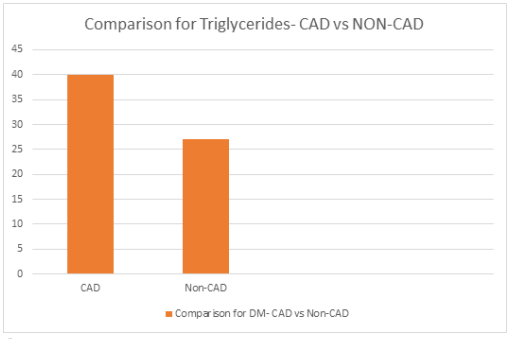
Triglycerides

Triglycerides are a type of fat found in our blood. Our body uses them for energy. We need some triglycerides for good health, but high triglycerides raise the risk of heart disease.[12]

According to conventional standards, close to 40% of CAD

patients had high triglycerides as opposed to the 27% of NON-CAD patients who had high triglycerides. However, it is observed from our data that levels lower than the standard guidelines may also present risk and thus the scale derived is as follows:

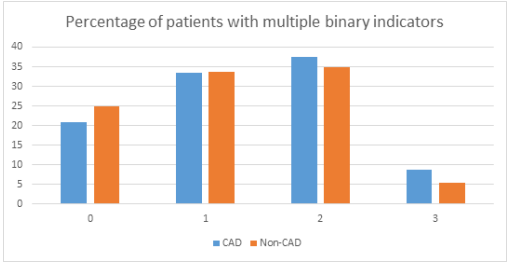
1) Male <40
   i)0: <157
   ii)1: >157
2) Male 40-60
   i)0: <133.5
   ii)1: >133.5
3) Male >60
   i)0: <109
   ii)1: >109
4) Female <40
   i)0: <127
   ii)1: >127
5) Female 40-60
   i)0: <138.5
   ii)1: >138.5
6) Female >60
   i)0: <150
   ii)1: >150



Conclusions

Prevalence of Multiple Binary Indicators

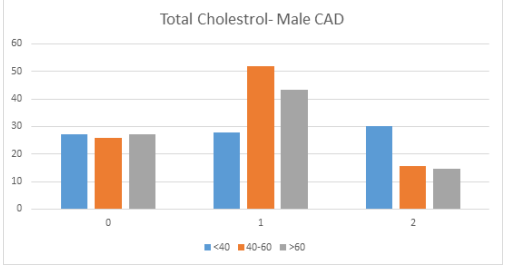
The three binary indicators we have used- Diabetes, Smoking and Hypertension- together determine a very high percentage of risk and are extremely common amongst the Indian population.

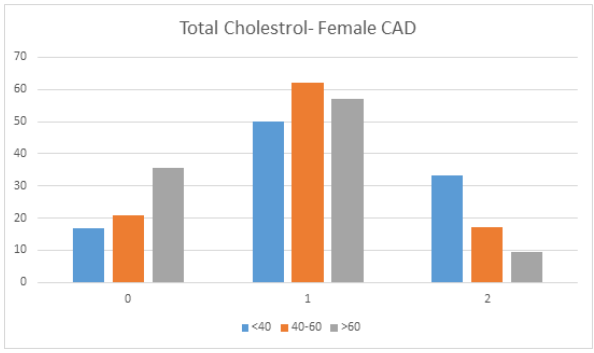


This shows that a very high percentage of people who are treated for or show symptoms of cardiac disease are positive for two of the binary indicators. Moreover, CAD patients have the higher numbers for 2-3 indicators while it is the opposite for 0-1 indicators proving our risk factor hypothesis.

Prevalence of the other indicators

We will now examine how many patients from each of our categories receives a score of 0, 1 or 2 for Total Cholesterol and BMI.

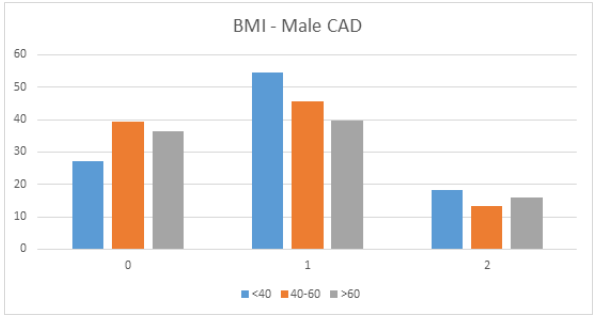


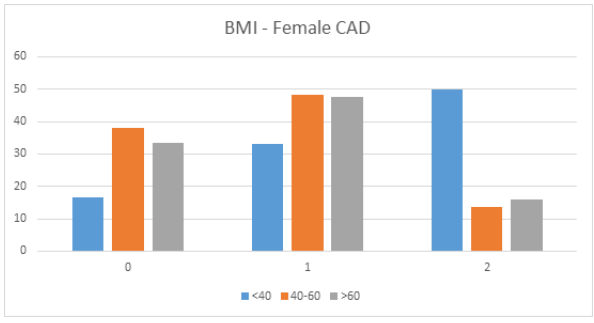


It is apparent from these charts that CAD patients aged less than 40 are most likely to possess a score of 2 for total cholesterol since they need to be at the highest level of risk at a young age to develop cardiac disease.

A majority of the patients in all age bands had a score of 1 which signifies intermediate risk and shows that the average person in our study is at this risk level.

The correlation of our defined scale with CAD is verified by these findings because, on an average, only a fifth of the patients had a healthy score of 0 which shows that a high number of patients who did get surgery were at risk according to our findings.





These findings are consistent with our earlier claim that the average Indian is overweight since a majority of patients are found to be in the intermediate range. Obesity is observed in CAD patients in the highest numbers for those aged <40.

Another interesting result is that females with cardiac disease tend to have a lower BMI level than what is usual to be considered at risk.

Future Study and Revision

While our current data has helped in deriving a satisfactory scale, the future plan is to connect the "MedLima" app to a centralized database to expand the current data. The database would be analyzed automatically and the scale would be revised periodically. There would also be improved analysis tools available to the patients for better diagnosis.

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