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Synthetic Datasets for Myocardial Infarction Based on Actual Datasets

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ABSTRACT

Healthiness is the maximum unique aspect in human existence. However, because of numerous facts like unhealthy diets, bodily inaction, high blood pressure, smoking habits, and many others. Health sicknesses are growing day by day. Among them coronary heart diseases are the essential causes of loss of life. Threat elements like excessive blood strain, excessive blood cholesterol, abnormal pulse rate, diabetes, consuming habits, age being a prime aid for occurring heart illnesses. Due to the lack of accurate scientific assist structures which can be capable enough to find hidden styles of medical records and are expecting sicknesses, humans not able to understand the prevalence of diseases in advance.

Every year we lose approximately millions of people due to myocardial infarction (MI) in India. This makes it of utmost importance to predict not only MI but early MI as well. Looking at this huge number guided the right path to work on. At the initial stage of research, the real data is collected from hospitals. This dataset is not sufficient to give to the model. Providing limited information restricts the learning of the model leading to compromised results. To overcome the issue, a new path was to be taken by feeding synthetic data in order to provide information in bulk to the model. Generation of synthetic data required a lot of research from the previous research, internet and expertise. After all the discussions and study, range for different parameters were noted for early MI, MI and NON-MI which formed a base to produce synthetic datasets. Machine leaning model works better on large number of datasets. Dataset is prepared under the guidance of medical doctors and a huge study is done on research paper. There is an urgent need of preparing datasets on MI. As the datasets available is very old datasets and it is not an Indian also. And lots of death in India happened due to heart attack. The information available on media is not a recent one about the patients. In this research the datasets of 453 patients are collected from rural area. Based on this dataset, steps are shown to create synthetic datasets.

Keywords: Synthetic datasets, Early MI, MI, NON-MI, Actual datasets.

1. INTRODUCTION

Most people die due to diverse heart illnesses. Its miles considered one of the predominant preventable diseases that motive greater than 12 million deaths each year [1]. Risk factors that increase the probability of heart illnesses categorized as modifiable and non-modifiable risk elements. Modifiable risk elements along with excessive blood stress, abnormal blood lipids, diabetes, weight problems, and many others, etc. are preventable. Non-modifiable factors together with advancing age, sex, consuming habits, family records, and many others are uncontrollable [2,3]. The use of the corresponding values of those danger factors there is numerous algorithms used in predicting the risk of happening heart diseases. Even though there is a large number of risk factors, whilst predicting the occurrences of coronary heart diseases use only some of them.

This paper aimed on providing the synthetic datasets on myocardial infarction based on research papers, expertise experiences. The motivation of the work is lack of information available freely and very difficult to access patient's data from hospitals. Large datasets are required to learn model accurately. It is also important to predict early MI to save life of several. Datasets are gathered from various hospitals. But this much data is not sufficient to feed to model. Therefore, the need of preparation of synthetic datasets is utmost important.

Heart diseases are one of the most preventable diseases that causes millions of deaths in the world today. So, preventing the occurrence of MI is much important in order to reduce number of deaths. This study has given steps to find

synthetic datasets for MI, NON-MI and Early MI.

2. LITERATURE SURVEY ON PARAMETERS RANGE OF MYOCARDIAL INFARCTION

Table 1: Input features and their ranges

Parameters	Early MI(Angina)	MI	Non-MI
Age	i. >35 and average age 62 ii. <35 if diabetic, high bp, smoking, high cholesterol In both sexes [4][5] iii. 45 to 60 -By Expertise (India)	i. 30-39 age(15%) ii. 40-49 age male (17.5%) iii. 50-59 age male (22.5%) iv. 60 & above age (37.5%) v. 61 & above age (7.5%) in female vi. 60 plus more cases in female then men [12]	i. <35 should consider more ii. 35–65 more MI (Incidence rate of MI) iii. Median age for MI-53 iv. 84-88% young age for non-MI. v. 90-95 % <40 age for non-MI. [22]
Gender	i. 57.3 ± 18.72[6] male ii. 62.9 ± 23.84 [6] female iii. >45 more in male [2] iv. >35-54 more in female [2] v. More in female [6]	Mentioned above	i. Both male females can consider equally as per expertise.
ECG changes	i. 50% has normal ECG [7] ii. Changes occur always by expertise.	i. Always Yes as per expert's opinion [13]	i. Some other disease causes ECG changes in non-MI patients [23] ii. No as per the expertise for non-MI patients.
CKMB	No Changes in CK-MB is suggested by expertise	i. CK-MB first appears 4-6 hours after symptom onset [14] ii. Changes in CK-MB is always suggested by expertise.	i. Elevated in non-cardiac conditions such as skeletal muscle injury, hypothyroidism, chronic renal failure, and severe exercise [24] ii. No changes suggested in non-MI patients as per the expertise.
Trop-I	No Changes is suggested by expertise	i. In myocardial infarction. raised troponin levels indicate cardiac muscle cell death [14][15]	i. There is a myriad of potential diseases with troponin release, including acute pulmonary embolism, heart failure, myocarditis, and end stage renal disease [25] ii. No changes in Trop-I in non-MI patients as per the expertise. iii. Hypothesis is based on actual datasets. [Refer table-2]
LAD, LCA, RCA Left anterior descending (LAD), Left coronary artery (LCA), Right coronary artery (RCA)	i. >70% blockages [8] ii. It may be up to 100% by expertise iii. <50% multiple arteries	i. LAD only (59.5%) ii. LAD and LCA (2.5%) iii. LAD and RCA (12.7%) iv. LAD, LCA and RCA (10.1%) [16] v. Blockages 95% to 100 Percentage by expertise opinion.	0-50% blockages hypothesis made with the concern of expertise and dataset available.
Systolic	i. Range of systolic blood pressure is 130-180[9]	i. Range of systolic blood pressure is 139-180 or higher mmHg [17]	i. For age group 26-30 systolic value is 113.5 ii. For age group 31-35 systolic value is 110.5 iii. For age group 36-40 systolic value is 112.5 iv. For age group 41-45 systolic value is 115.5 v. For age group 46-50 systolic value is 199.5 vi. For age group 51-55 systolic value is 125.5 vii. For age group 56-60 systolic value is 129.5

			viii. For age group 61-65 systolic value is 143.5[26] ix. 90-170 form dataset available
Diastolic	i. Range of diastolic blood pressure is 80-120[9]	i. Range of diastolic blood pressure is 90-120 0r higher mmHg [17]	i. For age group 26-30 diastolic value is 71.5 ii. For age group 31-35 diastolic value is 72.5 iii. For age group 36-40 diastolic value is 74.5 iv. For age group 41-45 diastolic value is 78.5 v. For age group 46-50 diastolic value is 80.5 vi. For age group 51-55 diastolic value is 80.5 vii. For age group 56-60 diastolic value is 79.5 viii. For age group 61-65 diastolic value is 76.5[27] ix. 60-90 from dataset.
Chest pain type	i. Mostly Chronic [10] ii. Sometimes acute by experts iii. Sometimes no pain by experts	i. Mostly acute [18] ii. Sometime chronic by expertise	i. Non cardiac pain occurs. That may be muscular pain, reflex esophagitis, acidity etc. by expertise.
Diabetic	i. 86% diabetic patients for angina [11]	i. Major risk factor ii. More in female then men [19]	As per the actual dataset the hypothesis is made.
Cholesterol	i. Total cholesterol range is 160-250mg (From Actual datasets)	i. >240mgfor MI (>60 age) ii. 200-239 mg same in men and women for MI (age 50-59) iii. Mean value is 171 in Maharashtra [20] [21]	i. For age group 30-39 is 185.5±41.9mg ii. For age group 40-49 is 182.5±44.7mg iii. For age group 50-59 is 172.2±47.6mg iv. For age group 60-69 is 161.7±46.0 v. For age group 70-79 is 156.7±45.8mg [28] vi. 160-318mg from dataset

Table.1. shows parameters range which is collected after rigorous studies on range of input parameters, discussed with the expertise, parameters range is decided. Input features are explained as follows.

2.1 Age

When one or more of the coronary arteries become constricted or obstructed, angina develops. Or it may come on suddenly. Although angina more usually affects middle-aged or older guys, it can afflict both sexes and people of all ages. Besides age and diabetes, risk factors include a history of hypertension, smoking, or high cholesterol [4].

35-50 years of smoking, dyslipidemia, and hypertension are major risk factors in the young. You're more likely to get angina if a family member has coronary artery disease or has had a heart attack. Men and women over the age of 45 and 55 are at a higher risk than younger people [5].

People with an average age of 62 years, who have moderate to severe degrees of angina [6].

As age increases, the incidence of acute myocardial infarction also increases, but the percentage of patients in the age group 30 - 39 is also alarming. Less frequency of smoking or ignorance regarding a consultation to the hospital could be the cause of it, particularly in the female gender. As per expertise opinion, that female is protected by estrogen. After menopause, MI occurs in females mostly. [12]

For non-MI patients, the age factor may be considered less than 35. The hypothesis is to consider both ages which are considered in early MI and MI. Indians have a median age of 53 when they have their first heart attack. The incidence of CAD in young Indians is about 12%–16%. About 5%–10% of heart attacks occur in Indian men and women younger than 40 years. Age for non-MI is considered as per the incidence of MI [22].

2.2 Gender

Women have a similar or slightly higher prevalence of angina than males across time and at different ages, regardless of diagnostic and treatment techniques, in nations with significantly variable myocardial infarction rates. In 2003 Indian mean age 52.5, 27/930 prevalence=2.6(female), 6/626 prevalence=1.0(male) [7].
Female and male gender is not defined this can conclude that both male-female genders can consider for non-MI equally.

2.3 ECG changes

Approximately 50% of patients with angina pectoris have normal findings after a resting ECG.
However, anomalies such as evidence for past MI, intraventricular conduction delay, varied degrees of atrioventricular block, arrhythmias, or ST-T–wave alterations may be detected. [7] In a myocardial infarction transmural ischemia develops. In the first hours and days after the onset of myocardial infarction, several changes can be observed on the ECG. First, large peaked T waves (or hyperacute T waves), then ST elevation, then negative T waves, and finally pathologic Q waves develop [13]. By expertise experience, there are always changes in ECG if MI happened.
Other than acute MI, the typical ECG alterations might be detected in other situations. For example, patients with previous MI and left ventricular aneurysms may have persistent ST elevations resulting from dyskinetic wall motion, rather than from acute myocardial injury [7]. The ECG changes may be no for non-MI patients.

2.4 CK-MB

CK-MB is first detected 4-6 hours after the onset of symptoms, peaks at 24 hours, and then returns to normal in 48-72 hours. However, its release kinetics can assist in diagnosing reinfarction if levels rise after initially declining following acute MI [14].
CK-MB is a useful biomarker for detecting acute MI as it has a relative specificity for cardiac tissue but can still become elevated in non-cardiac conditions such as skeletal muscle injury, hypothyroidism, chronic renal failure, and severe exercise. In this situation, the CK-MB changes may occur [24]. The actual percentage to consider CK-MB changes for the non-mi patients can get after discussing with physiotherapist, endocrinologist, nephrologist. In this research, we are considering actual data collected from the hospitals. There are no changes seen in these parameters if the ECG reading is normal. As per the hypothesis made from the real dataset these two readings are considered yes if ECG changes are considered yes for the same patients.

2.5 TROP-I

Increased blood levels of the cardiac protein isoform troponin have been found to be a biomarker for heart diseases, the most common of which is myocardial infarction. Raised troponin levels indicate cardiac muscle cell death as the enzyme is released into the blood upon injury to the heart [15].
The existence of myocardial damage, but not the underlying cause, is indicated by an increase in cTn (cardiac-specific type of troponin). Hence, besides acute myocardial infarction (AMI), there is a myriad of potential diseases with troponin release, including acute pulmonary embolism, heart failure, myocarditis, and end-stage renal disease [25].

2.6 LAD, RCA, LCA

In general, stable anginal symptoms will not develop unless there is greater than 70% stenosis of a major epicardial coronary vessel (left anterior descending, circumflex, or right coronary artery). Multiple tandem stenosis can, at times, cause angina, even if the obstruction is less than 50% [8].
One of the major and catastrophic manifestations of coronary atherosclerosis is myocardial infarction. This is a common contributor to mortality and morbidity worldwide. For example, the incidence of coronary atherosclerosis has doubled during the past three to four decades in India and will soon emerge as the single largest disease accounting for almost one-third of all deaths in India. Multiple vessels in men are more than in women [16].

2.7 Systolic Blood Pressure

Elevated blood pressure is systolic of 120 to 129 and diastolic less than 80. Stage 1 high blood pressure is when systolic is 130 to 139 or diastolic is 80 to 89. Stage 2 high blood pressure is when systolic is 140 or higher or diastolic is 90 or higher.
In this stage, your blood pressure readings exceed 180/120 mm Hg (where systolic BP is higher than 180 mm Hg and diastolic BP is higher than 120 mm Hg) [9] For every 20 mm Hg systolic or 10 mmHg diastolic increase in BP, there is a doubling of mortality from both Ischemic Hear Disease (IHD) and stroke. High BP is common among men below 35 due to stressful life. Studies show 80 percent of people over the age of 65 have high blood pressure. Systolic blood pressure rises as you age and the diastolic number reduces.
After the age of 65, the elasticity of the vascular bed is lost due to atherosclerosis [17]. Normal range of blood pressure is considered for non-MI patients [26]. Some readings are considered from the dataset collected from hospitals. 90-170 systolic is shown in the actual dataset. The hypothesis is made on this reading and included in the synthetic dataset.

2.8 Diastolic Blood Pressure

A normal range of blood pressure is considered for non-MI patients [27]. Some readings are considered from the dataset collected from hospitals. 60-90 diastolic is shown in the actual dataset. The hypothesis is made on this reading and included in the synthetic dataset.

2.9 Chest Pain Type

Angina is chest pain that happens because there isn't enough blood going to part of your body.
It's also known as ischemic chest pain or angina pectoris. With this type, you have chest pain but no coronary artery blockage [10]. Most of the time pain in MI patients is acute. Sometimes it may be chronic as per the expertise opinion. What should be the ratio for acute and chronic is calculated from the actual dataset. Myocardial infarction (MI) refers to tissue death (infarction) of the heart muscle (myocardium) caused by ischemia, that's lack of oxygen delivery to myocardial tissue. it's a kind of acute coronary syndrome, which describes a sudden or short-term change in symptoms associated with blood flow to the heart [18]. There is noncardiac pain occurs in non-MI patients. That may be muscular pain, reflex esophagitis, acidity, etc.

2.10 Diabetic

The longer you live with diabetes, the more likely you are to have heart disease. Here 86% is calculated from the actual dataset gathered from two hospitals. 150 patients' data is considered. 22 patients are nondiabetic and 129 were diabetic patients [11].
Diabetes is a primary risk factor for the development of CAD, with diabetic patients having a greater rate of MI than those who do not. In addition, following a MI, diabetic patients have higher rates of morbidity, mortality, and re-infarction than non-diabetics, with one-year mortality rates of nearly 50% [19].
People with diabetes who do not have CAD by CAG have a modest risk of MI, which is not significantly higher than patients who do not have CAD or diabetes. Diabetic is co-morbidity and it is a precipitating factor.

2.11 Cholesterol

There's a sharp increase in the risk for cardiovascular disease when total cholesterol levels are 240 mg/dl and above.
For people with heart or blood vessel disease, LDL cholesterol should be less than 70 mg/dl. The total Cholesterol range is calculated from the actual dataset gathered from the hospitals. There are 150 patients' data considered for early MI [12]. There's a sharp increase in the risk for cardiovascular disease when total cholesterol levels are 240 mg/dl and above. Goals: Total cholesterol less than 200 mg/dl. LDL cholesterol should be less than 70 mg/dl for those with heart or blood vessel disease [20] [21]. The normal range of total cholesterol is considered [28]. Another range from the actual dataset is considered that is 160-318. Only total cholesterol is considered in this research.

3. PREPARATION OF SYNTHETIC DATASET BASED ON ACTUAL DATASET

Table 2: Synthetic dataset calculation in percentage using actual datasets

Parameters	**Total patients 150 for early MI**	**Total patients 300 for MI**	**Total patients 53 for non-MI (Those having other problem then MI)**
Age	i. <35 age=0.66% ii. >35-60 age=46.66% iii. >60-70 age=47.33% iv. >70-75 age=4.66%	i. <35 age=4% ii. >35-45 age=43.33% iii. >46-55 age=29% iv. >56-65 age=17.33% v. >66-75 age=6.33%	i. 40-50 age=37.73% ii. 51-60 age=30.18% iii. 61-70 age=26.41% iv. 71-75 age=3.77%
Gender	i. 10% female ii. 90% male	i. 10% female ii. 90% male	i. 33.96% female ii. 64.15% male
ECG changes	i. 0.66% no ii. 99.34% yes	i. 100% yes	i. 100% yes This is for 53 patients having other disease then MI. ii. Hypothesis should be made for normal person and no ECG should consider.
CKMB	i. 88% no ii. 12% yes	i. 0.33% no ii. 99.67% yes	i. 15% no ii. 85% yes
Trop-I	i. 88% no ii. 12% yes	i. 0.33% no ii. 99.67% yes	i. 15% no ii. 85% yes
LAD	i. 2.66% has 0% blockages ii. 0.66% has 60% blockages iii. 72.66% has blockages 70 to 90% iv. 23.33% has blockages 95 to 100%	i. 47.66% has 0% blockages ii. 0.66% has 50% blockages iii. 2.33% has 60% blockages iv. 2% has 80% blockages v. 4.66% has 90% blockages vi. 2.66% has 99% blockages vii. 39.33% has 100% blockages	i. 9.43% has 0% blockages ii. 1.88% has 70% blockages iii. 43.33% has 80% blockages iv. 37.73% has 90% blockages v. 5.66% has 100% blockages
LCA	i. 10% has 0% blockages ii. 12% has 40 to 60% blockages iii. 42% has 70 to 80% blockages iv. 26% has 85 to 95% blockages v. 10% has 99 to 100% blockages	i. 35% has 0% blockages ii. 0.33% has 40% blockages iii. 1.66% has 50% blockages iv. 2.33% has 60% blockages v. 0.66% has 70% blockages vi. 2% has 80% blockages vii. 1% has 90% blockages viii. 0.33% has 95% blockages ix. 0.66% has 99% blockages x. 25.33% has 100% blockages	i. 24.52% has 0% blockages ii. 1.88% has 40% blockages iii. 5.66% has 50% blockages iv. 20.75% has 60% blockages v. 9.43% has 70% blockages vi. 15.09% has 80% blockages vii. 20.75% has 90% blockages viii. 1.88% has 100% blockages
RCA	i. 7.33% has 0% blockages ii. 5.33% has 50 to 60% blockages iii. 24% has 70to80% blockages iv. 39.33% has 85 to 95% blockages v. 20.66% has 99 to 100% blockages	i. 51.66% has 0% blockages ii. 0.33% has 40% blockages iii. 3% has 50% blockages iv. 6% has 60% blockages v. 3.66% has 70% blockages vi. 6% has 80% blockages vii. 2% has 90% blockages viii. 0.33% has 95% blockages ix. . 0.66% has 99% blockages x. 25.66% has 100% blockages	i. 28.30% has 0% blockages ii. 1.88% has 40% blockages iii. 5.66% has 50% blockages iv. 9.43% has 60% blockages v. 5.66% has 70% blockages vi. 16.98% has 80% blockages vii. 28.3% has 90% blockages viii. 3.77% has 100% blockages
Systolic	i. 2% has systolic bp range from 90-100. ii. 6.66% has systolic bp range from 110. iii. 82.66% has systolic bp range from 130-140. iv. 8.66% has systolic bp range from 150-160.	i. 0.33% has systolic bp range 80. ii. 3.33% has systolic bp range 90. iii. 43% has systolic bp range 100. iv. 45.66% has systolic bp range 110. v. 0.33% has systolic bp range 120. vi. 3% has systolic bp range 130. vii. 3% has systolic bp range 140. viii. 0.33% has systolic bp range	i. 1.88% has systolic bp range 90. ii. 3.77% has systolic bp range 100. iii. 1.88% has systolic bp range 110. iv. 22.64% has systolic bp range 130. v. 32.07% has systolic bp range 140 vi. 30.88% has systolic bp range

		160 ix. 0.33% has systolic bp range 170.	150 vii. 9.43% has systolic bp range 160.
Diastolic	i. 8.66% has diastolic bp range from 60-70. ii. 0.6% has diastolic bp range 80. iii. 89.33% has diastolic bp range 90. iv. 0.6% has diastolic bp range 100.	i. 75.66% has diastolic bp range 60. ii. 18% has diastolic bp range 70. iii. 1% has diastolic bp range 80. iv. 5.33% has diastolic bp range 90. v. 0.6% has diastolic bp range 100. vi. 0.33% has diastolic bp range 140.	i. 5.66% has diastolic bp range 60. ii. 7.54% has diastolic bp range 70. iii. 9.43% has diastolic bp range 80. iv. 69.81% has diastolic bp range 90.
Chest pain type	i. No pain-2% ii. Chronic-92% iii. Acute-6.66%	i. Chronic-1% ii. Acute-99%	i. No pain-15.09 ii. Chronic-79.24% iii. Acute-5.66%
Diabetic	i. No -14.66% ii. Yes-85.33%	i. No -93.66% ii. Yes-6%	i. No -28.3% ii. Yes-71.69%
Cholesterol	i. 24% has range from 160-170 mg. ii. 44.66% has range from 170-180mg. iii. 28% has range from 190-200mg. iv. 0.66% has range 210mg. v. 1.33% has range from 220-230mg. vi. 0.66% has range 250mg	i. 1.33% has range 160mg. ii. 22.33% has range 170mg. iii. 37% has range 180mg. iv. 20.66% has range 190mg. v. 8.66% has range 200mg. vi. 3.66% has range 210mg. vii. 1.66% has range 220mg. viii. 1% has range 230mg. ix. 4% has range 240mg. x. 1% has range 250mg.	i. 3.37% has range 160mg. ii. 16.98% has range 170mg. iii. 26.41% has range 180mg. iv. 20.75% has range 190mg. v. 11.32% has range 200mg. vi. 7.54% has range 210mg. vii. 1.88% has range 220mg. viii. 5.66% has range 230mg. ix. 3.77% has range 240mg.

4. DISCUSSIONS

Table 2. Shows the calculations of synthetic dataset based on real data for early MI, MI and non-MI patients. After collecting datasets from various hospitals, it is realized that collected data is not enough to feed to machine learning model. To increase the accuracy of model it is utmost requirement of huge datasets. Therefore, synthetic datasets are prepared based on the collected dataset under the guidance of many expertise. All responsible features for Early MI, MI and non-MI such as age, gender, ECG changes, CK-MB, Trop-I, Angiographic parameters (LAD, LCA, RCA), Blood pressure (Systolic, Diastolic), chest pain type, Total Cholesterol etc. are considered. The value of each parameter is calculated based on data collected from hospitals. Valuable inputs are taken from expertise. The calculated range for synthetics datasets is shown in table.2. Based upon above calculations, synthetic range of datasets can be extended as per the calculations.

5. CONCLUSIONS

MI is a major public health problem in India, often impacting the most productive years of an individual's life. The epidemiological transition plays out differently in different regions of India because of varied economic development. This research is done on rural area of Maharashtra. There are many more important parameters which are impacting on the health of man kinds such as smoking, eating habit, stress. But these information's are not available in the datasets gathered from the hospitals. In this research it is found that age between 60-70 is more for early MI, whereas for MI it is 35-45 age group and for non-MI 40-50 age group. It is noticed that Early MI and MI occurs more in male then female. ECG changes in Early MI and MI are always happened and if patients have other disease, then MI may have ECG changes. In normal patients no ECG changes seen. Changes in CK-MB and Trop-I exists in both all patients with varying percentages. But this changes always happened in early MI and MI patients. Angiographic changes are more in LAD as compared to LCA and RCA for early MI and MI patients. Systolic range is 130-140 for early MI and for MI it is in the range of 100. In non-MI patients it is 140 if patients have other disease. Diastolic range is 90 for early MI whereas 60 in MI patients that is low blood pressure counted. Chest pain is chronic in early MI and Acute in MI patients is noticed. More diabetic patients suffered with early MI. Cholesterol range is 170-180 mg in Early MI patients where as 180 mg in MI patients.

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