“STUDY OF SERUM MAGNESIUM LEVELS IN ELDERLY WITH ACUTE MYOCARDIAL INFARCTION”

By

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Dissertation submitted to BLDE University, Vijayapura

In partial fulfillment of the requirements for the award of the degree of

DOCTOR OF MEDICINE

IN

GENERAL MEDICINE

Under the guidance of

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Dr. JAIRAJ V. BOMMAN

LIST OF ABBREVIATIONS USED

Mg^{2+}: Magnesium

TRPM: Transcellular Transporter Transient Receptor Potassium Channel Melastatin Membrane

ATP: Adenosine Triphosphate

DNA: Deoxyribonucleic Acid

RNA: Ribonucleic Acid

CSF: Cerebrospinal Fluid

AAS: Atomic Absorption Spectrometry

SIADH: Syndrome Of Inappropriate Anti Diuretic Hormone

ECG: Electrocardiography

$MgSO_4$: Magnesium Sulphate

LDL: Low Density Lipoprotiens

ROS: Reactive Oxygen Species

IL-1: Interleukin 1

NF-kB: Nuclear Factor-kB

PGI_2: Prostaglandin I_2

ABSTRACT

AIM: This study was to explore the status of serum magnesium among elderly patients with acute myocardial infarction (AMI) as a means to monitor the possibility of complications and outcome.

MATERIAL and METHODS: This was a cross-sectional prospective study carried out in 100 patients aged 60 years and more, admitted in our hospital ICCU with a diagnosis of Acute Myocardial Infarction. History collection, clinical examination, ECG, echocardiography, laboratory investigations were performed as a part of work up and all the patients were treated accordingly. The risk factors for MI were also recorded. The patients were followed up for 5 days of in hospital stay, and were observed for development of complications and the outcome during discharge was also noted. Serum magnesium was estimated by Calmagite method from each sample and was correlated with site of lesion the occurrence of complications.

RESULTS: The 66% of patients were aged between 60-69 years age group, with a male predominance of 56%. The most common addictive habit was smoking in 14% of patients followed by tobacco chewing in 13% of patients. The most common presentation was typical chest pain in 66% of patients and the 34% patients had atypical presentation. Acute MI with ST segment elevation was present in 69% of patients. Inferolateral wall hypokinesia was the commonest type seen on echocardiography. The mean serum magnesium levels in our study group was 2.0 mg/dl. The complications were higher in hypomagnesemia group 10%, followed by normomagnesemia group 8% and least with hypermagnesemia 2%. The over all

mortality was higher with high serum magnesium levels, which makes it 50% of total mortality.

CONCLUSION: The rate of arrhythmic complications were higher with hypomagnesemia followed by normomagnesemia

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INTRODUCTION

Despite a significant reduction in the overall age adjusted mortality rates due to cardiovascular diseases in the last 2-3 decades, acute myocardial infarction continues to be the leading cause of mortality especially in people older than 65 years (WHO).

The possibility of suffering acute myocardial infarction in elderly (>60yrs.) age group is 8 times higher than in people of a less advanced age. More than 50% of in-hospital mortality from acute myocardial infarction occurs in subjects older than 60 years.

Incidence and prevalence of acute myocardial infarction progressively increases with age. In US over 60% of acute myocardial infarction occurs in patients of 65 years of age or older.

South Asians elderly have highest rate of coronary artery diseases around the globe.

Magnesium (Mg^{2+}) is a critical cofactor in more than 300 intracellular enzymatic processes, many of which are integrally involved in mitochondrial function, energy production maintenance of trans-sarcolemmal ionic gradients, cell volume control, and resting membrane potential. Magnesium is a cardio protective element because of its beta adrenoreceptor blocking action, anti platelet action and slowing the conduction in cardiac conducting system.

The ion stabilizing effect of magnesium helps in maintaining stable intra and extracellular concentrations of other electrolytes, various studies have documented significant alterations in Mg^{2+} and other electrolytes in patients with acute myocardial infarction.

The cardiovascular consequences of magnesium deficiency in animal and clinical studies have been summarized by Seeling and include multifocal necrosis with calcium accumulation in mitochondria in a pattern reminiscent of myocardial ischaemia and catecholamine induced cardiomyopathy, atherogenesis, a heightened tendency to platelet aggregation, increased coronary and peripheral vascular resistances, sinus tachycardia and repolarisation abnormalities, and ventricular tachyarrhythmias.

OBJECTIVE OF STUDY:

1. To find relation between serum Magnesium levels and patients with Acute Myocardial Infarction in elderly.
2. To know the rate of complications in elderly having Acute Myocardial Infarction and Magnesium levels.

REVIEW OF LITERATURE

INTRODUCTION

In the earth crust magnesium (Mg^{2+}) is the eighth common element.[1,2]

The biologically available magnesium is present mainly in the hydrosphere i.e, the water source, like ocean and rivers. [3]

In vertebrates (humans) it is the fourth most abundant cation, also forms the second most abundant intracellular cation following potassium. [4,5,6]

In human body, 99 percent of magnesium compound is within the bones, muscles and non-muscular soft tissues, mainly fat [7]. It acts as a cofactor for more than 300 enzymatic reactions. [8,9]

Magnesium plays a pivotal role in prevention and treatment of many diseases. It has been found that low serum magnesium levels is associated with Many chronic diseases and inflammatory diseases, which includes type 2 diabetes mellitus, hypertension, insulin resistance, asthma, alzheimer's disease and many more. [10]

STRUCTURE OF MAGNESIUM

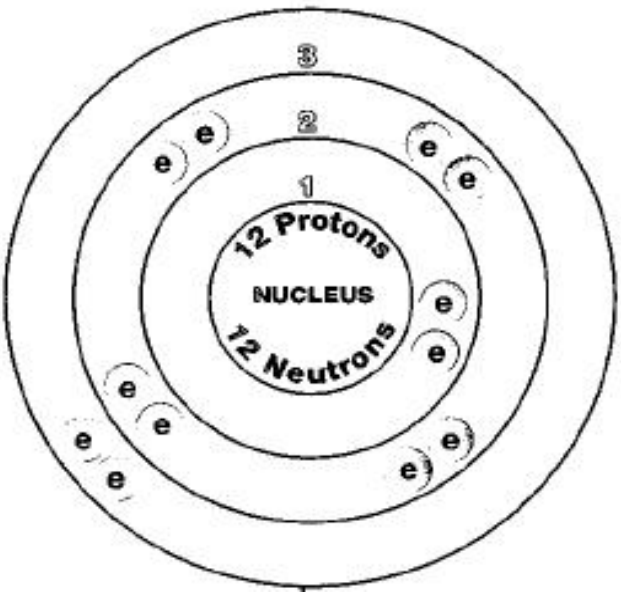

Figure 1. Chemical Structure Of Magnesium

HISTORY [11]

A farmer named Henry Wicker at Epsom in England in 1618, found that the cows owned by him refused to drink the water fed by him taken from well which was found to be due to bitter taste. He also noticed that the same water instead helped in early healing of superficial wounds which was eventually recognized to be magnesium sulphate by Dr Nehemiah Grew in 1697 which is known as Epsom salts.

The magnesium was discovered as an element in 1755 by Joseph Black a Scotish Chemist, which was later isolated by Sir Humphry Davy(1778-1829) in 1808 from Magnesia [$Mg_3SO_4O_{10}(OH)_2$]. Davy named it as Magnium after its isolation.

In 1920 Willey Glover Denis, showed that magnesium is present in blood plasma of human body. Magnesium deficiency in humans was first reported by Arthur Hirschfelder and Victor Haury in 1934.

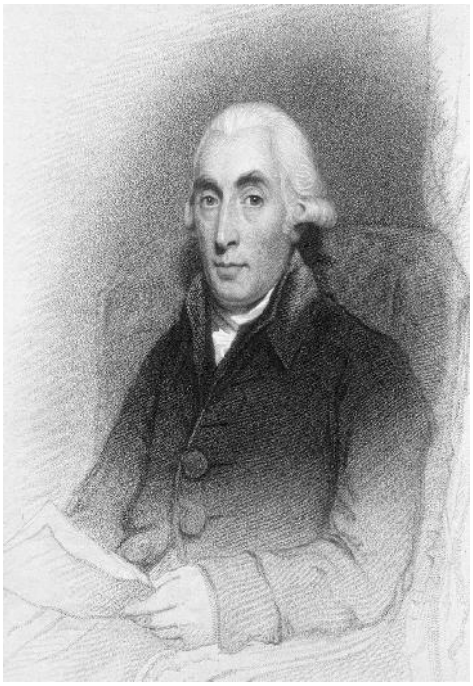

Figure 2 (A) Henry Wicker The Farmer **(B) Joseph Black Scotish Chemist**

METABOLISM

The concentration of Magnesium (Mg^{2+}) is maintained within normal limits by interaction between the Intestine, Kidney and Bone. As the blood concentration of Mg^{2+} falls, it is increased by increasing the absorption through gut and it's main store, the Bone and when excess it is calibrated and excreted through kidney and faeces. [12]

In the gut, Magnesium is absorbed in small intestine mainly by jejunum and ileum by passive paracellular mechanism i.e, through small spaces between the cells which acts by electrochemical gradient and other pathway is Transcellular pathway, with Transcellular Transporter Transient Receptor Potassium Channel Melastatin Membrane (TRPM) 6 & 7 which contributes less but plays pivotal role. [13] The Mg^{2+} stores in body determine the rate of absorption and excretion and the content of magnesium in food is inversely proportional to absorption. [14,15]

The concentration of Mg^{2+} is mainly maintained by Kidney by filtration and reabsorption. The reabsorption from the filtrate produced by glomeruli occurs mainly at proximal convoluted tubule (PCT) which absorbs around 60-70% and partly by distal nephrons when the concentrations are low. [15,16]

Totally around 95% of Mg^{2+} is reabsorbed and only 3-5% is excreted through kidney. [15,16]

Diets rich in fibres, increased intake of calcium and phosphates hinders the absorption of magnesium through the gut.

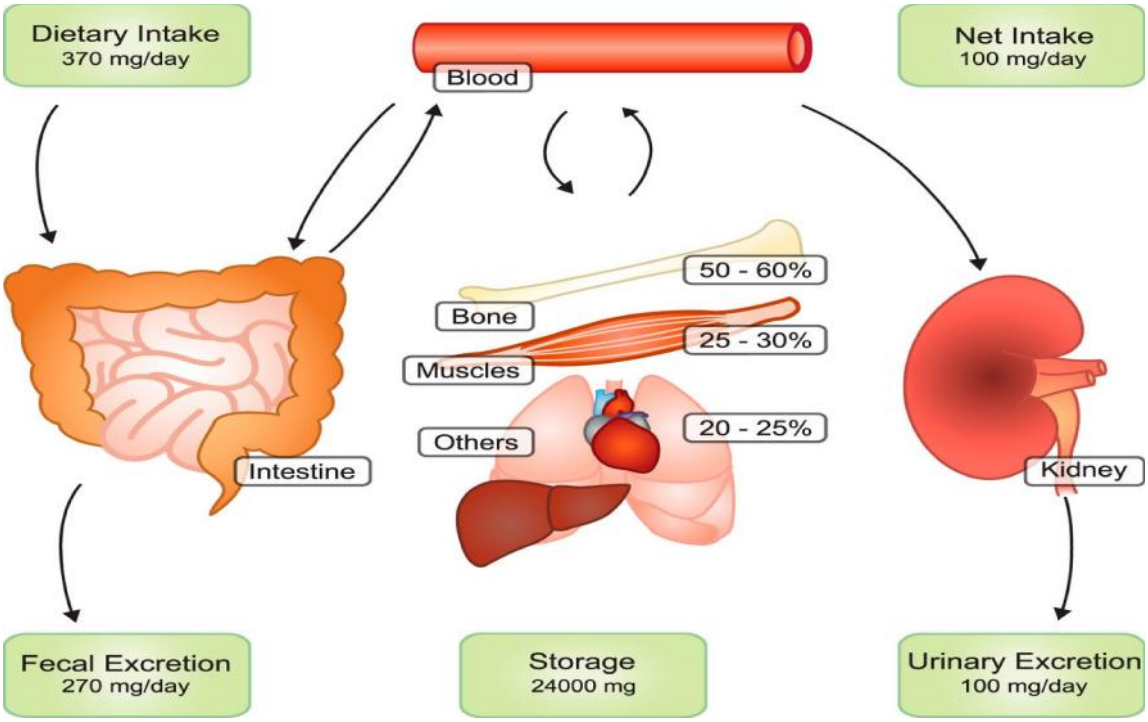

Figure 3: Magnesium Metabolism

FUNCTIONS OF MAGNESIUM

Magnesium has many physiological roles in different parts of the body like -

1. At Cellular Level – it acts as direct enzyme activator including the reactions which produce ATP. [17]
2. Metabolic – it has structural function in synthesis of DNA, RNA and many of the proteins.[17]
3. Muscular System – it acts as calcium antagonist, as it competes for the binding site and inhibits muscle contraction, its also competes for neurotransmitter release.[9]
4. Enzymes – hexokinase, Na^{+}-K^{+} ATPase, creatine kinase, protein kinase, and cyclase are important enzymes carrying out many of the important cellular functions which are dependent on magnesium.[9]
5. Structural functions – it helps in maintaining the structure of proteins, polyribosomes, nucleic acids, and the mitochondria.[9]

Magnesium acts as an important cofactor for many of the enzymes involved in phosphate metabolism, and it gets coupled with phosphate causing the aerobic energy production by oxidative phosphorylation and the anaerobic energy production by glycolysis which is mediated by magnesium, and it acts indirectly by forming Mg^{2+}-ATP complex or acts directly as an enzyme activator for the enzymes involved in glycolysis. [9,18-21]

It also has role in nerve conduction, contraction of muscle and also acts in maintaining the rhythm of heart by active transport of calcium and potassium ions across the cell membrane. It plays an important role in production of glutathione, a

potent intracellular antioxidant in human body, which is synthesized by Adenosine Triphosphate dependent pathway and this needs magnesium.[9,18-21]

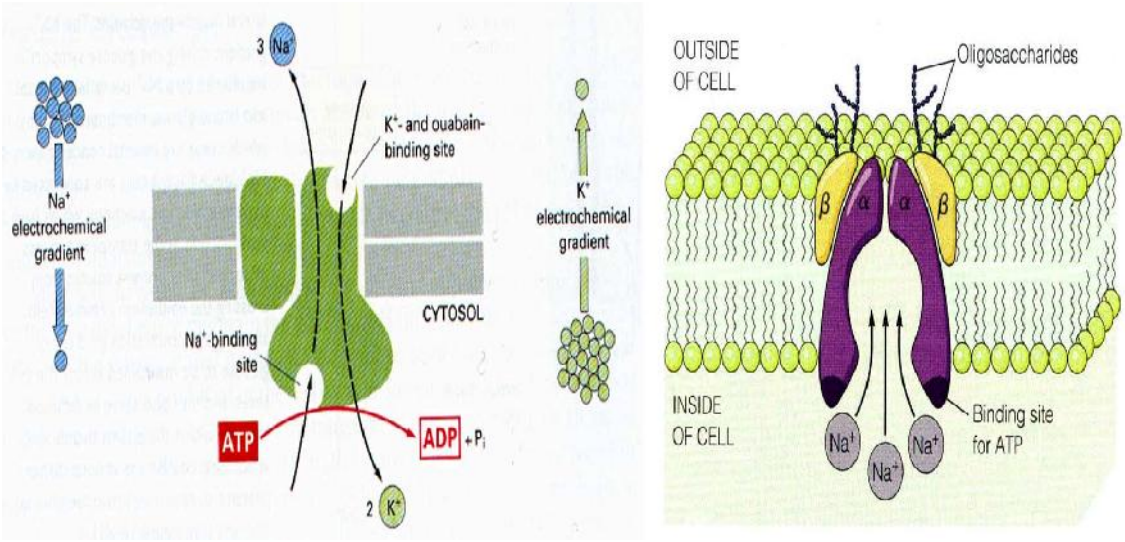

Figure 4: Na^+/K^+ ATPase Cellular Structure

DISTRIBUTION OF MAGNESIUM IN BODY [9]

The magnesium content in normal adult is around 1,000 mmol (22-26 gm). Out of which bone comprises 60%, skeletal muscle around 20%, soft tissues like fat and others constitute around 19% and the extracellular fluid contains less than 1% of total body magnesium.

The magnesium available for exchange is contributed by bone and skeletal tissues like muscle, liver accounting for 30% and 20-30% respectively. Around 20% of the serum magnesium is bound to proteins, out of which 60-70% with albumin and the rest with globulin. And, around 65% is ionized and remaining serum magnesium is bound to various anions like the phosphate and citrate.

Magnesium accounts for approximately 1.1 mmol/L in cerebrospinal fluid (CSF), and 55% of this is free and 45% bound.

Most of the intracellular magnesium is bound to the compounds like ATP, proteins, RNA, DNA and some part of it is also sequestered into the mitochondria and endoplasmic reticulum, and only around 0.5-5% is free and ionized.

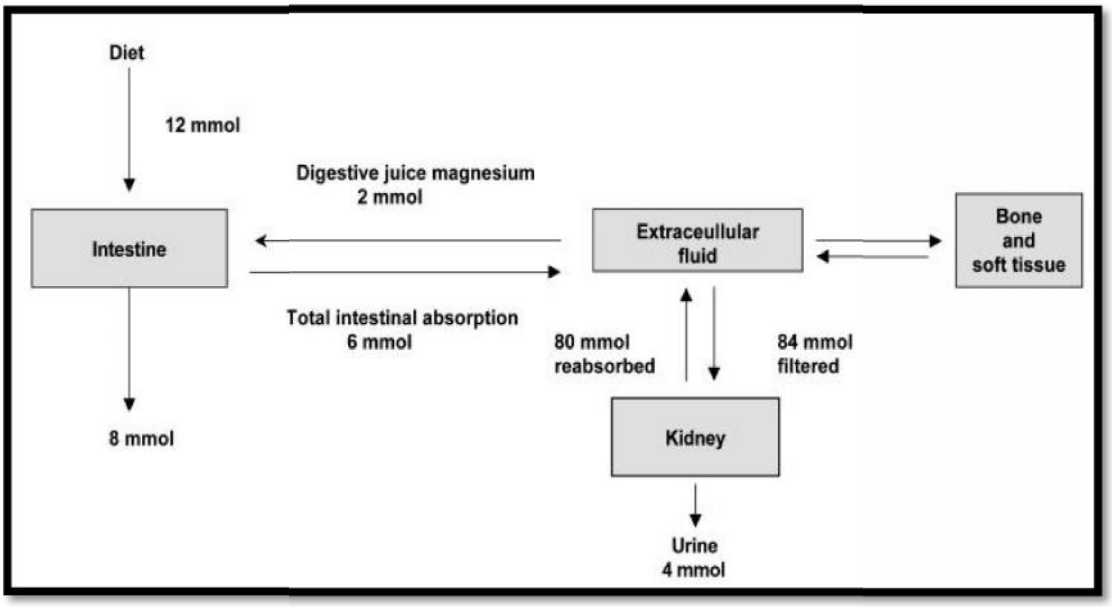

Figure 5: Distribution Of Magnesium In Body

SOURCES AND DAILY REQUIREMENTS

Magnesium is a naturally available product, it is present mainly in the hydrosphere i.e, water.[10,14]

1. Water forms one of the naturally occurring source.
2. Chlorophyll i.e, Green leafy vegetable, spinach (high content)
3. Legumes
4. Whole grains or unprocessed cereals
5. Sea foods, fish
6. Nuts
7. Fruits, like banana, avocado

Figure 6: Dietary Sources Of Magnesium

Hard water constitutes more magnesium than the soft water, and thus hard water fulfills the requirement better than soft water.[22,23,24]

Water accounts for around 10 percent of daily magnesium intake.[25]

With time, the essence of calcium consumption has increased leading to increased calcium intake, which has produced relative magnesium deficiency.[26]

It has been found that vitamin-D deficiency or its altered metabolism occurring in the renal diseases like chronic renal disease, decreases serum calcium levels, which has direct effect on magnesium absorption leading to decreased serum magnesium.[27,28]

RECOMMENDED DIETARY ALLOWANCE

Intake of up to 5 mg/kg/day is insufficient to maintain the equilibrium hence, 6 mg/kg/day in normal status (300 – 360 mg/day) [24] and 7-10 mg/kg/day is considered to be adequate when the person is under physical or emotional stress.[29,30]

METHODS OF ASSESSMENT OF MAGNESIUM LEVELS

Magnesium is present in various tissues and its measurement in respective tissues is possible by different methods.

Magnesium is measured in following tissues

1. **Serum –** The total body magnesium is not represented by the serum magnesium, instead it reflects the concentration in interstitial fluid and bone [8,31] , as the serum magnesium forms 0.3 percent of total body magnesium.[32]

   The serum magnesium levels are affected by heamolysis, concentration of bilirubin, exertion, third trimester of pregnancy and also there is intra individual variability found in healthy adults.[33,34,35]

   The normal serum magnesium levels in healthy adults lies between 1.70 and 2.55 mg/dl, done by using Calmagite method.[36]

2. **Red Blood Cells –** the magnesium in RBC's doesn't correlate well with the status of total serum magnesium.
3. **Leucocytes –** magnesium content within leucocytes correlates more better with the skeletal and cardiac magnesium content.[37]
4. **Muscles –** the assessment of magnesium levels in muscles is most expensive and is also an invasive procedure, hence not preferred.[38]

Renal excretion of magnesium – magnesium excretion through the kidney act as a circadian rhythm. It is helpful to measure the renal loss of magnesium which may be due to drugs (loop diuretics) or congenital anomalies (bartter's syndrome).[39] Normal 60 - 210 mg/24 hours.[36]

Free magnesium levels in body is measured by using following methods,

1. Fluorescent Probes – this method uses Mag-Fura 2 as fluorescent, not useful as it also binds to calcium.[40]
2. Ion-Selective Electrodes, and Nuclear magnetic Resonance Spectroscopy which uses atomic absorption spectroscopy (AAS) and Metallochrome Dyes are used to measure the free magnesium levels.[40]

SERUM MAGNESIUM LEVELS IN ELDERLY

The serum magnesium levels in elderly has been studied widely and found to be marginally low and not clearly deficient when compared to adult where serum magnesium levels are above the lower margin of normal levels.

The exact magnesium requirement per day still has to be systematically investigated and hence fixed magnesium consumptions could not be made in elderly.[41,42]

The main reason for low serum magnesium levels in elderly in comparison to adults is postulated to be due to.[43]

1. Low magnesium intake, which accounts for major portion for low levels.

2. Decreased intestinal absorption

3. Increased urinary loss

4. Stress, the add on factor for low levels of serum magnesium among elderly, which acts as a predisposing factor.

The availability of magnesium in bone decreases with age and hence may not be available during magnesium deficiency in elderly.[43]

HYPOMAGNESEMIA

It seems easy to define hypomagnesemia, but primarily accurate tests for the assessment of Mg^{2+} status are still lacking.[44]

Patients with serum Mg^{2+} levels less than 1.7 mg/dl were considered to be hypomagnesemic.[36]

Chronic Mg^{2+} deficiency, where in plasma Mg^{2+} levels may be in borderline or within normal range, but total body Mg^{2+} are low and have increased risk of Atherosclerosis, Hypertension and Myocardial Infarction.[45] The clinical features of hypomagnesaemia develops, when serum magnesium levels fall below 1.2 mg/dl.

As the homeostasis of serum magnesium is maintained by intestinal absorption, bone stores and renal excretion, any alteration in these parameters causes hypomagnesaemia and it is also produced due to redistribution of serum magnesium.

CAUSES

DECREASED DIETARY INTAKE- Malnutrition secondary to poor intake specially in elderly and parenteral administration of nutrients without magnesium.

GASTROINTESTINAL – malabsorption, severe or chronic diarrhoea, prolonged nasogastric suctioning, surgeries like bowel resection and/or bypass surgeries.[6,9,39]

RENAL- congenital tubular defects, acquired tubular defects (causing impaired magnesium reabsorption).

ENDOCRINE- primary and secondary hyperaldosteronism, hungry bone syndrome, hyperparathyroidism, syndrome of inappropriate anti diuretic hormone (SIADH), in Diabetes mellitus due to osmotic diuresis causing excess magnesium loss in urine.[9]

DRUGS – loop diuretics, aminoglycosides, cisplatin, amphotericin B, omeprazole.[46,47]

OTHERS- stress, chronic alcoholism, severe burns.

Hypomagnesaemia produced secondary to redistribution occurs due to shift of magnesium from ECF to bones or/and into the cells, which occurs following refeeding syndrome or correction of metabolic acidosis.

CLINICAL FEATURES

NEROMUSCULAR- here it produces symptoms like generalised weakness, fine tremors involving the upper limbs and a further decrease may produce seizures, altered behavior which is due to increased electrical activity in brain.[46].

Signs like fasciculations, Chvostek's sign and Trousseau's sign which are though non specific, as are also seen in hypocalcaemia [39].

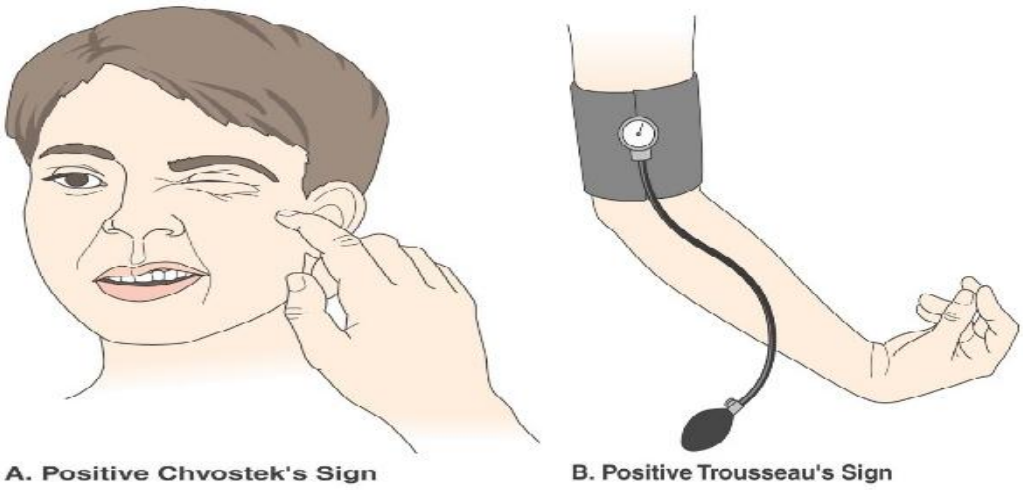

Figure 7: Signs of hypomagnesemia, Chvostek's Sign and Trousseau's Sign

CARDAIC- the changes produced here are mainly recorded in the ECG which shows arrhythmias; AF and ventricular tachyarrythmia being more common.[39]

CNS- a chronic deficiency produces depression, agitation, and a sudden severe decrease produces seizures.

METABOLIC- associated hypocalcaemia, hypokalaemia is seen in severe hypomagnesemia.[48]

ECG CHANGES

Minimal deficiency - short PR interval, little shortening of QT interval, short QRS and negative T waves.

Severe deficiency – sinus T wave, peak T wave and ST depressions.

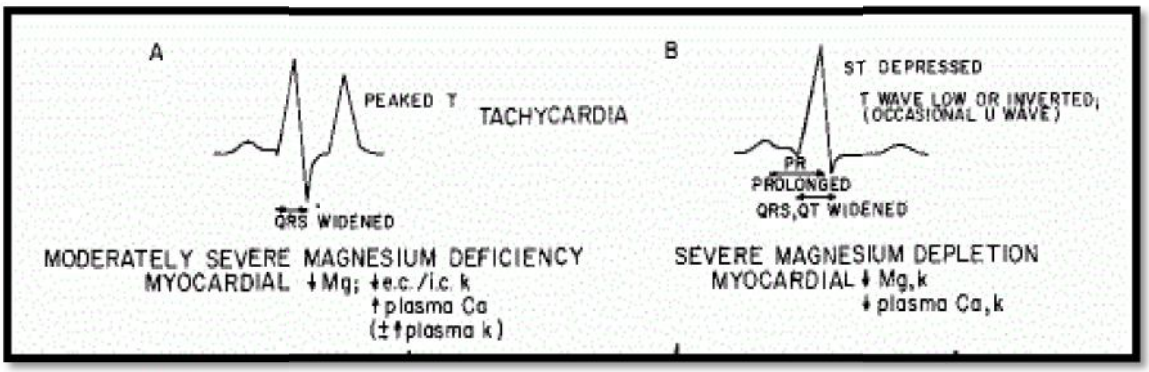

Figure 8: ECG Changes In Hypomagnesemia

TREATMENT

Magnesium supplementation is given as magnesium sulphate ($MgSO_4$). Magnesium Sulphate is available as powder and also as 10% and 50% solutions.

In mild hypomagnesemia, treatment is done by giving oral Magnesium Sulphate 2gm thrice a day. And in severe hypomagnesemia i.e, less than 1.2 mg/dl, treatment with 2gm of magnesium sulphate intravenously slow over ten minutes and then followed by 10ml of 50% magnesium sulphate in 500ml normal saline for 3 days.

Along with this, underlying cause and associated hypokalaemia, hypocalcaemia if present, need to be corrected.

HYPERMAGNESEMIA

As mentioned earlier Kidney plays a vital role in Magnesium homeostasis, hence in renal impairment the kidneys are unable to excrete the excess magnesium leading to Hypermagnesemia.[49]

Serum magnesium levels more than 3.0 mg/dl is considered to be hypermagnesemia.

ETIOLOGY

Chronic kidney disease – when the compensatory mechanism are inadequate.

Excessive oral Mg^{2+} salts or drugs like laxatives and antacids.[50,51]

Iatrogenic, when magnesium sulphate is given as antiepileptic in eclampsia.[46,52]

CLINICAL FEATURES [44]

Generalized features like nausea, vomiting, cutaneous flushing are the early features.[53]

Cardiac manifestations like hypotension which is due to peripheral vasodilation, bradyarrhythmias and in severe cases cardiac asystole is seen.[53]

Neuromuscular dysfunctioning like drowsiness, respiratory depression, hypotonia, diminished knee jerk often first elicitable sign when serum magnesium levels is more than 2.5 mg/dl and later areflexia when the levels are more than 5.0 mg/dl and coma in severe cases.[54]

The absence of knee jerk can be taken as a diagnostic sign of hypermagnesemia.[39]

ECG CHANGES

Bradycardia or prolonged PR interval, QRS and QT intervals, complete heart blocks and AF which are all not specific to hypermagnaesemia.[53]

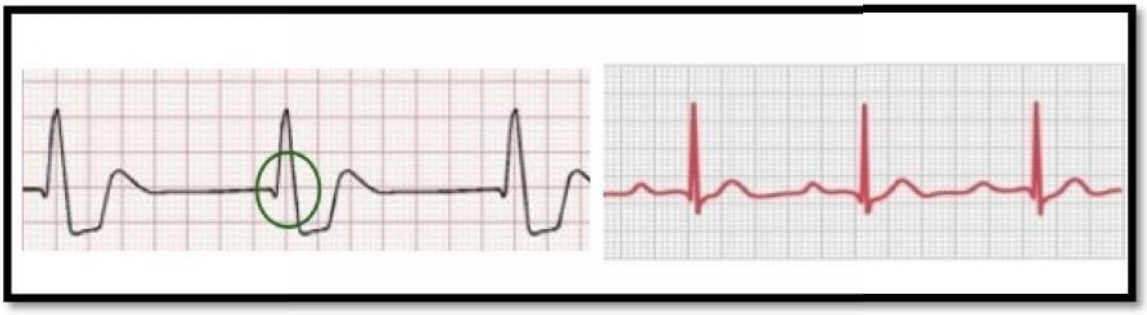

Figure 9: ECG Changes In Hypermagnesemia

TREATMENT

Eliminating the source of magnesium is first mode of treatment.

When the renal function is intact, injection furosemide can be used and when its impaired dialysis is the treatment of choice.

To correct acute manifestations like hypotension or cardiac bradyarrhythmias, intravenous calcium gluconate 10 - 20 ml slowly over 10 minutes is effective.

ROLE OF MAGENSIUM IN MYOCARDIAL INFARCTION

It has been studied since long years, and found that magnesium has a role in the pathogenesis of atherosclerosis and thus myocardial infarction.

Abraham et al, presented a pioneering paper showing association between low magnesium and myocardial infarction in 1970.[55]

The increased risk of myocardial infarction due to low serum magnesium is proposed to be due to strong anti inflammatory role of magnesium which indirectly inhibits initiation of atherosclerosis, lowers the lipid levels, and also reduces free reactive oxygen species (ROS), which all together initiate atherosclerosis.[56,57]

It also prevents blood clotting by reducing platelet aggregation and is a strong vasodilator.[58]

Low magnesium levels directly affect the endothelial behavior, the effects of it are due to decreased endothelial proliferation, decreased CDC 25B and increased Interleukin-1 (IL-1) and vascular cell adhesion molecule 1 (VCAM-1), which leads to atherosclerosis. This effect add to pro-inflammatory, pro-thrombotic and pro-atherogenic environment.[59]

In many experiments it has been found that early treatment with magnesium intravenously limits the infarct size and the possible mechanisms are as proposed [60]

1. It decreases the vulnerability of injured myocardium to the oxygen derived free radicals.
2. Decreases intracellular calcium levels by inhibiting influx of calcium ions.

3. The balancing of increased oxygen demand by reducing the sinus rate and also by lowering the arterial pressure
4. Coronary vasodilatation
5. Inhibiting platelet aggregation and thus thrombus formation.

High magnesium dietary consumption has been found to reduce the coronary artery calcification and thus can be considered as protective in preventing acute myocardial infarction.

Atherosclerosis is produced due to endothelial dysfunctioning which results in increased adherence of leucocytes, excessive secretion of chemokines and increase permeability to lipids into the cells and enhanced oxidation of low density lipoprotiens (LDL), and stimulation and proliferation of smooth muscle cells into the intima and also activation of platelets which all together leads to atherosclerosis [60].

The oxidised lipoproteins, like very low density lipoproteins and low density lipoproteins, which are produced due to peroxidation of lipoproteins which is enhanced by low magnesium levels and the by products so produced are toxic to myocardial cells, as they initiate atherosclerosis and also propagates atherosclerosis [61].

Thus deficiency of magnesium is involved in dysfunctioning of endothelium and also acts as an important add on factor for increase in lipid concentration in the atheromatous plaque.[62]

Magnesium contributes to the synthesis of nitric oxide within the endothelial cells and reduce the vascular tone and prevent the occurrence of hypertension, which is a known risk factor for atherosclerosis and thus myocardial infarction.[63]

Magnesium deficiency found to increase the free radicals which are toxic to endothelial cells.[64]

The small and medium sized arteries are affected by hypomagnesemia, by producing lesions like thickening of intima, localised edema and depolarisation of calcium and lipids which contribute the formation of atherosclerosis.[65]

The hypercoaguability secondary to hypomagnesemia is due to the fact that magnesium inhibits prothrombin, thrombin, coagulation factors like 5, 7 and 9 which are must for the initiation and progression of clot formation.[66]

It has also been found that the oxidative stress produced in the endothelial cells leading to increase in reactive oxygen species (ROS) and thus cytotoxicity of the endothelial cells is enhanced by the deficiency of magnesium.[67,68,69]

The ROS which act on the endothelial cells produce a permanent inflammation which is shown by increased Nuclear Factor-kB (NF-kB) activity. As Nuclear Factor-kB (NF-kB) regulates Interleukin-1 (IL-1), tumour necrosing factor-alpha transcription, which acts as a pro-inflammatory cytokine, triggering the localized inflammation resulting in recruitment of monocytes and proliferation of smooth muscle cells which is further exacerbated by increase in matrix metaloproteases 2 and 9, this increase in matrix metaloproteases is markedly influenced by low magnesium.[70,71]

Thus hypomagnesaemia produces atherosclerosis, vascular thrombosis and/or vascular calcification.[1]

Magnesium helps in prevention of myocardial infarction and the possible action predicted is magnesium induced relaxation of endothelial and smooth muscle cells of heart and vasculature.[72,73,74]

The vasodilatation property of magnesium also helps in reducing the blood pressure which is a known risk factor for Myocardial Infarction and thus indirectly reduce the risk of myocardial infarction, it does so by reducing the expression of endothelin-1 which is most potent vasoconstrictor, and magnesium also increases Prostaglandin I_2 (PGI_2) which is a well known vasodilator.[75-78]

It has also been postulated by Iseli et al, that decrease in magnesium increases intracellular calcium levels and thus increases the duration of contraction of heart and vascular smooth muscle cells and there by leading to ischaemia and hypertension respectively.[79]

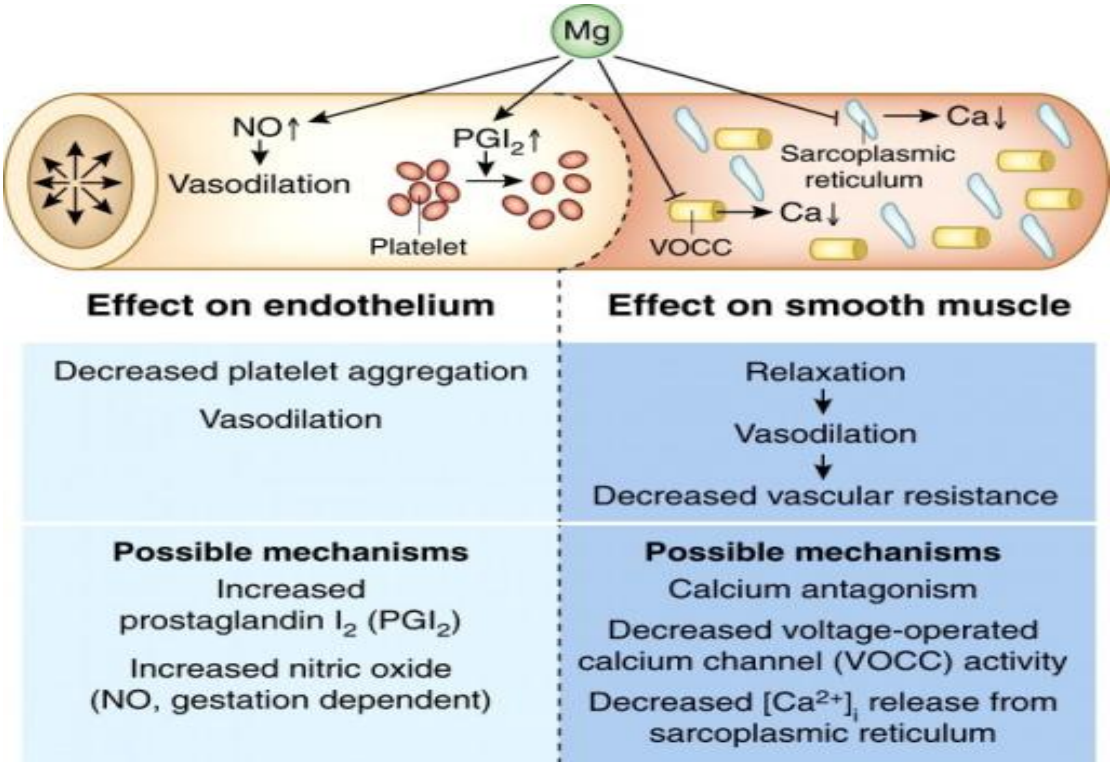

Figure 10: Role of Magnesium In Myocardial Infarction

ROLE OF MAGNESIUM IN ARRHYTHMIAS

In 1935, Dr Zevillinger, first reported that Mg^{2+} has anti-arrhythmic effects.[80] Magnesium doesn't inhibit arrhythmias by itself *per se,* but it does by altering the cardiac potentials by interfering with the calcium and potassium channels, as magnesium, regulates their activity.[81,82]

The myocardial cells and other cell's action potential is determined by the electrical activity acting across the cell membrane which in turn is regulated by electrochemical gradient across the cell membrane.[83]

The depolarisation and repolarisation is brought by the transmembrane movement of electrolytes like sodium, potassium, and calcium, which monitor the action potential.[84]

The resting action potential of cell membrane is maintained by the Na^+/K^+ ATPase pump, which causes efflux of sodium and influx of potassium against the concentration gradient, utilising adenosine triphosphate (ATP) by phosphorylation and Magnesium acts as a co factor for this reaction, and without which the reaction cannot be taken place.[85-89]

Hence, reduction in magnesium or hypomagnesaemia alters/hinders the activity of Na+/K+ ATPase pump leading to accumulation of sodium within the cell and potassium out of the cell. The accumulated sodium is exchanged with the calcium within the cell, resulting in transient depolarisation of cell membrane and repetitive arrhythmias.[85-89]

Serum potassium mainly regulates the depolarisation, repolarisation of cellular membrane and also the automation of myocardial conducting cells like the purkinje fibre cells.[90]

Decrease in the extracellular potassium in the conductive cells of purkinje fibres results in prolongation of phase 4 of action potential and thus increasing the automation and occurrence of arrhythmias. And the flow of potassium into the cell during phase 4 of action potential is dependent on serum magnesium. Decrease in magnesium results in decreased influx of potassium.[65]

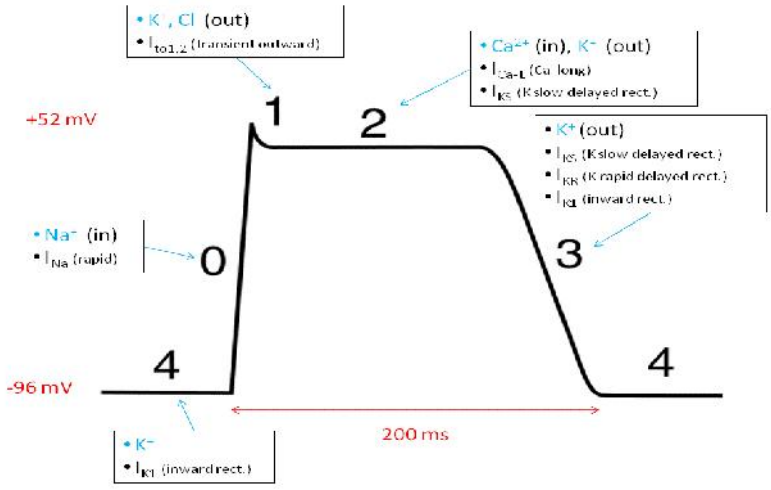

Figure 11: Action Potential of Cardiac Myocyte

Similarly, the inward flow of calcium during the 2nd phase if action potential occurring through the L-type of calcium channels is dependent on serum magnesium. Increase in serum magnesium acts on the slow L-type of calcium channels and decrease the flow of calcium into cells, and there by producing longer refractory period and increased propagation through the AV Node, thus magnesium acts a calcium channel blocker, producing bradycardia.[65]

With this it is predicted that magnesium has rate limiting activity and hypomagnesaemia can cause increase in heart rate and severe hypomagnesaemia can cause arrhythmias.[65]

Decrease in serum magnesium has been found to be associated, as a risk factor for occurrence of prolongation of QTc interval (Seeling 1969) and supplementation of magnesium even in patients with normal serum magnesium levels has found to decrease the QTc interval.[91]

QTc is produced due to low resting membrane potential which is produced by the low serum magnesium levels, which not directly but indirectly decreases the potassium concentration within the cell and thus the resting membrane potential leading to QTc prolongation, which can be initiation for arrhythmias.[92]

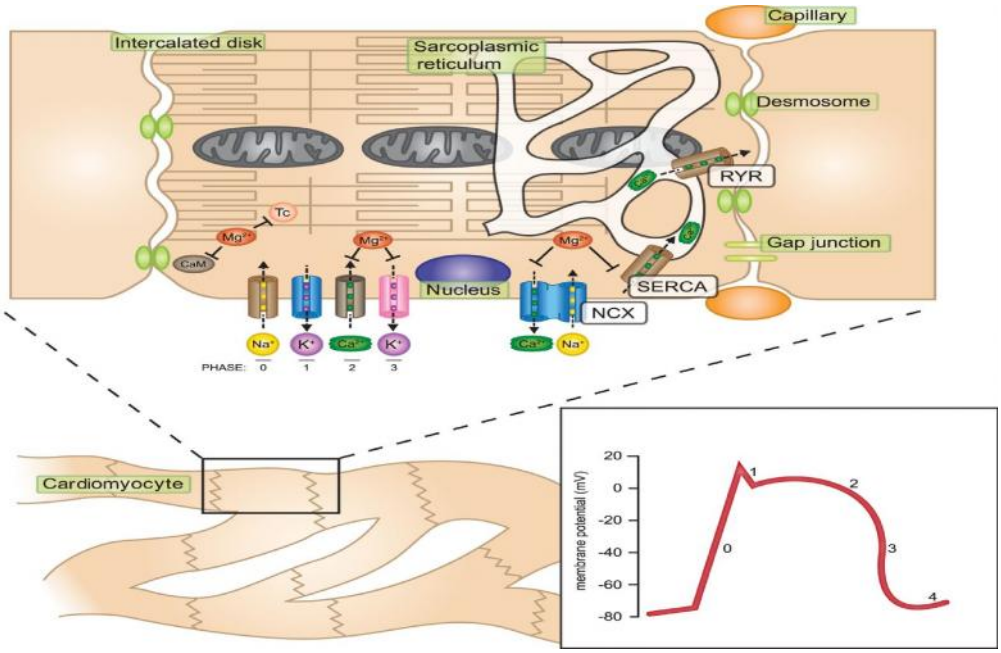

Figure 12: Role of Magnesium In Arrhythmias At Cellular Level

MAGNESIUM IN HEART FAILURE

Heart failure is hypothesized to be produced mainly due to endothelial dysfunctioning which acts as the main initiating and propagating factor for heart failure.[93]

It has been observed that removal of magnesium from the disrupted endothelium produces vasoconstriction and this was confirmed by restoration of vascular tone on replacement of magnesium into the endothelium.[94]

Magnesium is thus implicated to reduce the systemic vascular resistance, mean arterial pressure, and also found to reduce coronary vasoconstriction and thus increase the coronary blood flow, and increases the cardiac index.[95,96,97]

It has been found that treatment with 400 mg of oral Magnesium Sulphate b.i.d for 3 months improved the outcome in patients with heart failure.[98]

SCREENING FOR SERUM MAGNESIUM LEVELS

Magnesium is a micronutrient, with the dietary allowance that can be met by the daily food we consume. The magnesium in body is still found to be low, which is due to the factors which interfere with its absorption from the gut like the drugs and in elderly the main reason being decreased consumption and which is added up by stress.

Magnesium has been implicated as a contributing factor in many diseases and the identification and correction of low magnesium has improved the outcome (evidenced by LIMIT-2 study). As it is also evidenced that patients admitted in Intensive Care Unit (ICU) and having low serum magnesium levels had poor outcome with increased mortality.

Hence, screening for all the patients, especially patients with myocardial infarction, elderly patients with or without myocardial infarction, should be screened and diagnosed as routine for low serum magnesium levels even though they are asymptomatic, and treated accordingly with intravenous magnesium in severe hypomagnesaemia and with oral supplementation in mild to moderate hypomagnesaemia.

MERITS AND DEMERITS OF MAGNESIUM SUPPLEMENTATION

It has been shown that low serum magnesium levels predispose to arrhythmias, and studies were conducted to check the effect and out come after correction of the hypomagnesaemia.

A study named, Leicester Intravenous Magnesium Interventional Trail (LIMIT-2), that had 2316 patients and were treated with magnesium, and it showed a short term decrease in mortality by 24% and the incidence of left ventricular failure was found to be reduced by 25%, along with 25% reduction in long term mortality.

An another study named, Fourth International Study if Infarct Survival (ISIS-4), which constituted 58,500 subjects, and were intervened with magnesium supplementation, and this large study showed no advantage with magnesium therapy in both short term and long term complications and mortality.

A recent study named Magnesium In Coronaries (MAGIC), which included 6,000 high risk patients and this study too did not show any benefits.

The difference in results among these studies were concluded to be because of variation in the type of study design.

CONCLUSION

Magnesium being a trace element, forms an important cation in human body, as it has a major contribution in many of the physiological functions occurring in human body.

It has also been proposed that serum magnesium levels decrease with increasing age and the elderly (>60 years) are at high risk for hypomagnesemia, due to the decreased intake and second factor being stress and others like chronic medications.

Low magnesium is proposed to be a risk factor for occurrence of many systemic diseases like diabetes mellitus, hypertension, dyslipidaemia. Low magnesium is also implicated in the propagation of atherosclerosis as it increases serum triglyceride levels, increases reactive oxygen species, and also increases platelet aggregation, which all together acts as an initiating factor for atherosclerosis and thus progressing to cause myocardial infarction. Low magnesium levels is also involved in complications like arrhythmias (ventricular tachycardia, torse de pointes, conduction blocks) heart failure following myocardial infarction.

The intervention for the same with intravenous and oral magnesium is found to be beneficial, and the beneficial effects were also seen in LIMIT-2 study, favoring magnesium supplementation, but other studies like ISIS-4, MAGIC which showed no additional benefits, but also no adverse outcomes, but these studies vary in study design.

Hence, in all elderly patients with myocardial infarction who are at higher risk than adults should always undergo for screening of serum magnesium levels irrespective of clinical features and ECG changes.

In patients with low serum magnesium levels correction with oral supplementation in mild to moderate hypomagnesaemia and in with intravenous magnesium in severe hypomagnesaemia should be done. It may be followed by oral supplementation as a long term treatment.

MATERIALS AND METHODS

SOURCE OF DATA:

The patients attending the medicine OPD and admitted to ICCU in _____ who fulfill the inclusion criteria between September 2016 to August 2017.

SAMPLE SIZE:

The prevalence value of Acute Myocardial infarction is 27%[13] at 95% confidence level and 5% acceptable error, the sample size is 100.

$$n = \frac{Z_{\alpha}^{2} \times p(1-p)}{e^{2}}$$

where,

Z_{α} = Z value at 95% Confidence Level

p = Prevalence Rate

e = Acceptable Error

STATISTICAL ANALYSIS:

Data will be presented

Diagrammatically

Mean ±SD

METHOD OF COLLECTION OF DATA

STUDY DESIGN

A cross sectional study.

METHOD OF COLLECTION OF DATA

A detailed history, general physical examination, systemic examination and investigations will be performed on all patients who fulfill the inclusion criteria, both sex who are admitted in ICU in _____ _____between January 2016 and April 2017.

INCLUSION CRITERIA:

1. Patients aging >60 years with Acute Myocardial Infarction are selected on basis of history, examination, ECG changes and Biochemical markers for MI.

EXCLUSION CRITERIA:

1. Hepatitis of any cause and past history of Hepatitis.
2. On drugs like

   Diuretics: Loop diuretics, Thiazide diuretics.

   Antibiotics: Aminoglycosides, Amphotericin, Pentamidine, Gentamycin, Tobramycin.

   Others : Digitalis, Adrenergics.
3. Chronic malnutrition
4. Crohn's disease
5. Past History of Myocardial Infarction
6. Cirrhosis of liver
7. Age < 60 years.

LABORATOTARY

Serum Magnesium is detected by CALMAGITE METHOD

PRINCIPLE : Magnesium combines with Calmagite in an alkaline medium to form a red coloured complex. Interference of calcium and proteins is eliminated by the addition of specific chelating agents and detergents. Intensity of the colour formed is directly proportional to the amount of magnesium present in the sample.

Magnesium + Calmagite ----------> Red Coloured Complex.

Normal Value: 1.7 – 2.55 mg/dL (For all ages and sex)

INVESTIGATIONS

All the subjects are subjected to the following investigations

1. CBC
2. URINE –ALBUMIN, SUGAR AND MICROSCOPY
3. S.SODIUM AND S. POTTASIUM
4. S.CREATININE
5. RBS
6. ECG
7. CARDIAC BIOMARKERS-TROP T/ CPK-MB
8. 2D ECHO / DOPPLER
9. FASTING LIPID PROFILE
10. SERUM MAGNESIUM ON ADMISSION

RESULTS

A study of serum magnesium levels in elderly with acute myocardial infarction was done in all the patients > 60 years of age, admitted in ICCU of _____ from September 2015 to August 2017

AGE DISTRIBUTION

A total of 100 patients were included in the study group, and were grouped with an age frequency of 10 years and found to have, patients aged between 60-69 were 66%, patients between the age 70-79 were 17%, patients between the age 80-89 were 14%, and one patient aged more than 90 years.

AGE	n	%
60-69	66	66
70-79	17	17
80-89	14	14
≥90	03	03
Total	100	100

Table 1: Distribution of Cases By Age

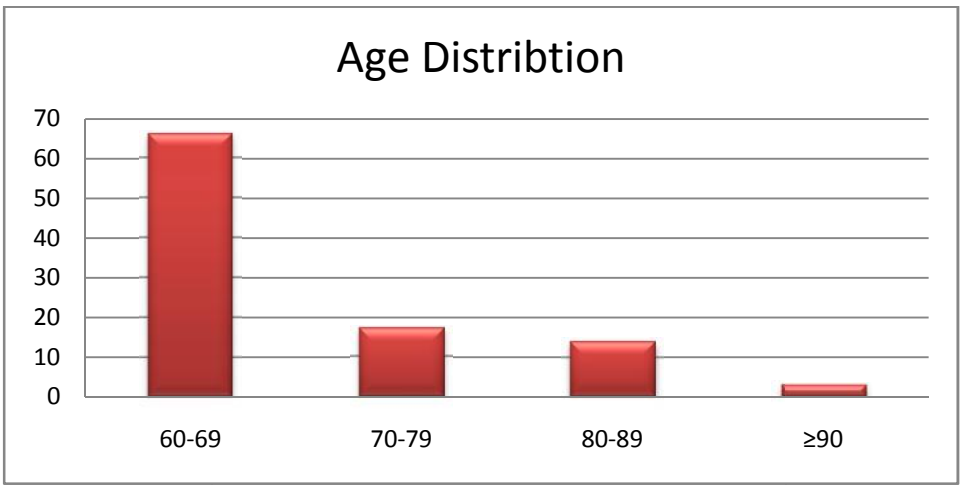

Figure 13: Distribution of Cases By Age

SEX DISTRIBUTION

Out of 100 patients 56% were male and 44% were female.

SEX	n	%
Male	56	56
Female	44	44
Total	100	100

Table 2: Distribution of Cases By Sex

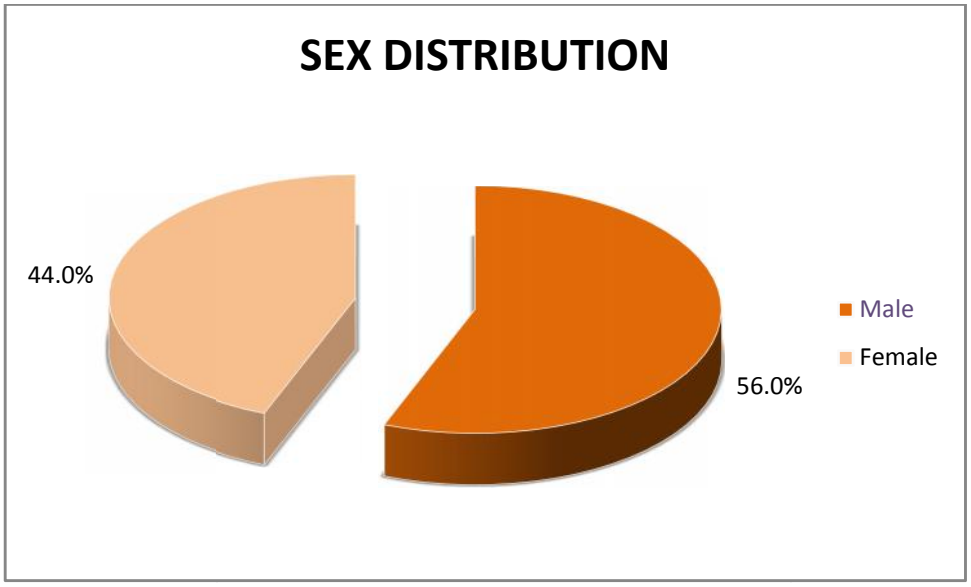

Figure 14: Distribution of Cases By Sex

HABITS

HABITS	<1.8 (low)		1.8-2.5 (normal)		>2.5 (high)		Total	p value
	n	%	n	%	n	%		
ALCOHOL	0	0.0	1	1.7	0	0.0	1	
SMOKER	3	10.0	10	16.9	1	9.1	14	
SMOKER &TOBACOO	0	0.0	1	1.7	0	0.0	1	0.716
TOBACCO	2	6.7	8	13.6	3	27.3	13	
TOBACCO & ALCOHOL	0	0.0	1	1.7	0	0.0	1	

Table 3: Distribution of Cases According To Habits

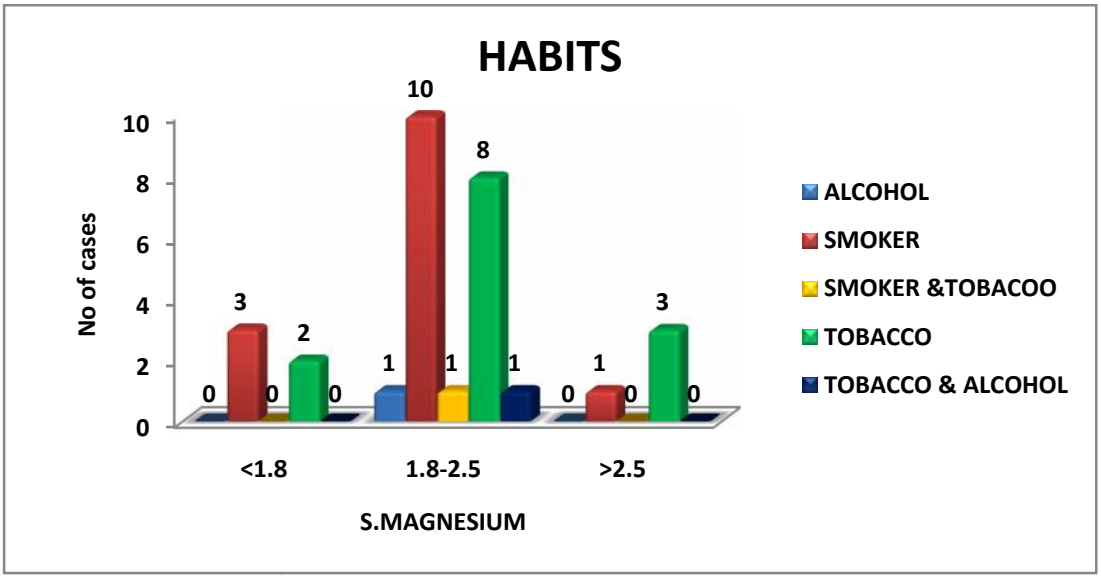

Figure 15: Distribution of Cases According To Habits

The study group of 100 elderly participants were grouped based on the addictive habits. A total of 30 patients had addictive habits. The most common habit noted was smoking and was present in 14 patients, among which low serum magnesium was present in three patients, normal serum magnesium levels was present in ten patients and one had high serum magnesium levels. Tobacco chewing was noted in 13 patients, among which low serum magnesium was present in two patients, normal serum magnesium levels was present in eight patients and eight had high serum magnesium levels. Alcohol consumption was present in one patient and his serum magnesium levels were within normal limits. Dual habits like smoking with tobacco chewing and alcohol with tobacco chewing, were present in one patient each and both group had normal serum magnesium levels.

CLINICAL PRESENTATION

TYPICAL/ATYPICAL	n	%
TYPICAL	66	66
ATYPICAL	34	34
TOTAL	100	100

Table 4: Distribution of Cases According To Clinical Presentation

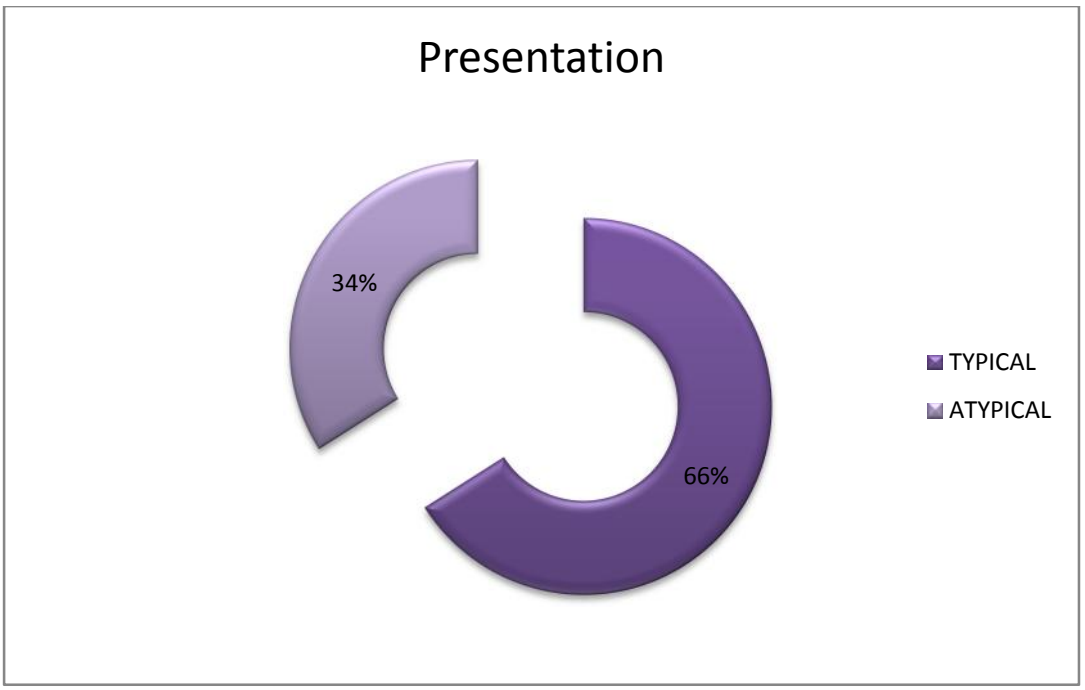

Figure 16: Distribution of Cases According To Clinical Presentation

TYPICAL/ ATYPICAL	<1.8 (low)		1.8-2.5 (normal)		>2.5 (high)		Total	p value
	n	%	n	%	n	%		
TYPICAL	21	31.8	40	60.6	05	7.6	66	0.334
ATYPICAL	09	26.5	19	55.9	06	17.6	34	
TOTAL	30		59		11		100	

Table 5: Clinical Presentation and serum magnesium levels

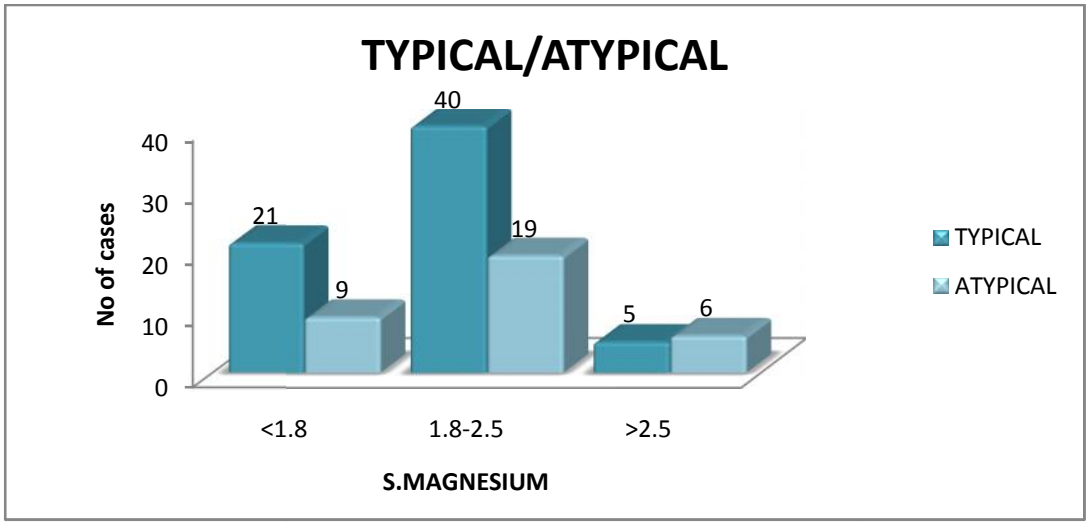

Figure 17: Clinical Presentation and serum magnesium levels

The study group admitted in ICCU were classified based on the symptoms with which they presented during admission as typical (classical chest pain of myocardial infarction) and atypical. It was found that 66% patients presented with classical chest pain and were grouped under typical presentation and the 34% were grouped as atypical presentation.

Among the 66 patients with typical presentation 31.8% patients had low serum magnesium, normal serum magnesium was present in 60.6% and high serum magnesium levels in 7.6% patients.

In the second group with atypical presentation, low serum magnesium was present in 26.5% patients, normal serum magnesium in 55..9% patients and high serum magnesium levels was present in 17.6% patients, making it 26.5%, 55.9%, 17.6% respectively.

ECG CHANGES AND CORRELATION WITH SERUM MAGNESIUM

ECG Changes	n	%
STEMI	69	69
NSTEMI	31	31
TOTAL	100	100

Table 6: ECG changes

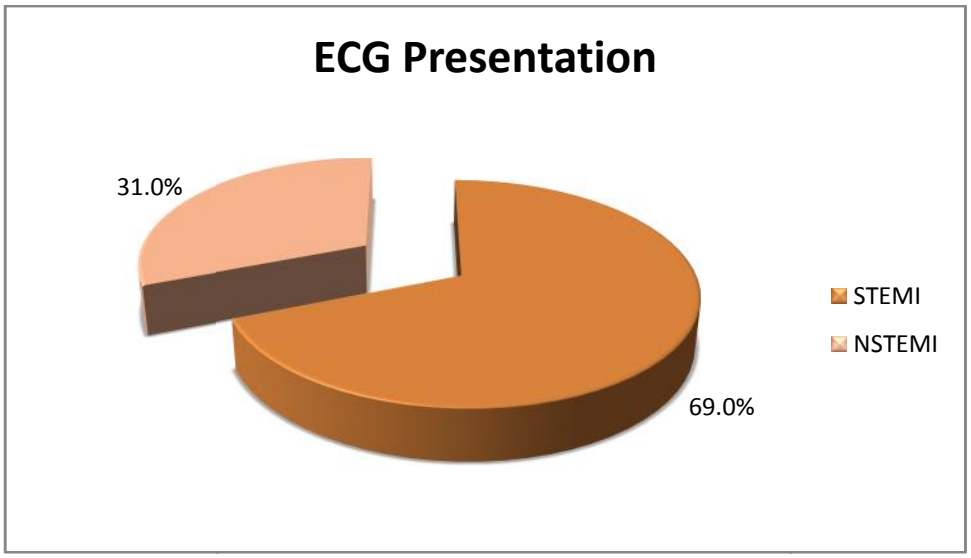

Figure 18: ECG changes

ECG	<1.8 (low)		1.8-2.5 (normal)		>2.5 (high)		Total	p value
	n	%	n	%	n	%		
STEMI	20	29.0	42	60.9	07	10.1	69	0.837
NSTEMI	10	32.3	17	54.8	04	12.9	31	
TOTAL	30		59		11		100	

Table 7: ECG changes and correlation with serum magnesium

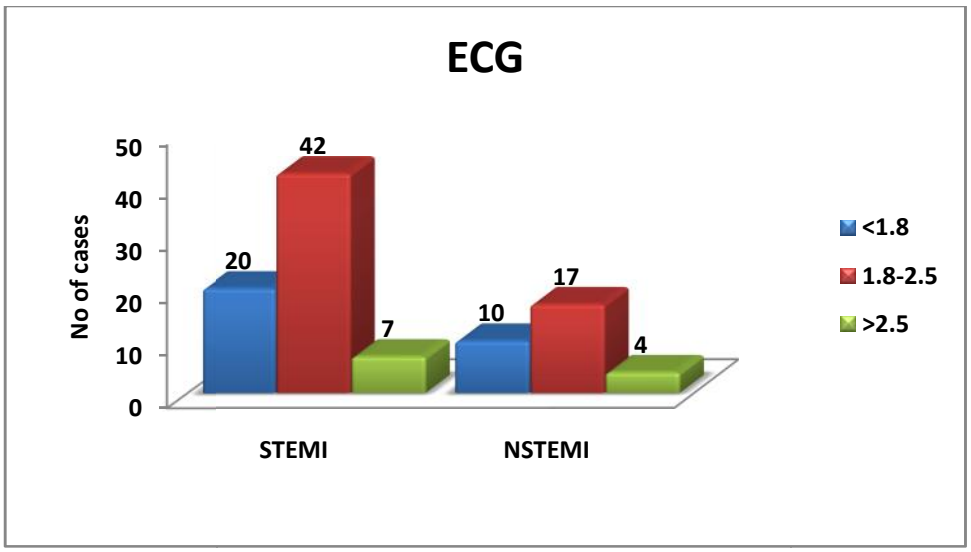

Figure 19: ECG Changes And Correlation With Serum Magnesium

The patients were classified into ST elevation myocardial infarction (STEMI) and Non ST elevation myocardial infarction (NSTEMI) based on the ECG changes. ST elevation was seen in 69% and Non ST elevation in 31%. Among the STEMI group, low serum magnesium was present in 20 patients, was within normal range in 42 patients and high serum magnesium levels was present in 7 patients making it, 29.0%, 60.9% and 10.1% respectively. The NSTEMI group had 10 patients with low serum magnesium levels, normal serum magnesium levels was present in 17 patients. and high serum magnesium levels was present in 4 patients making it, 32.3%, 54.8% and 12.9 % respectively.

ECHOCARDIOGRAPHY FINDINGS AND CORRELATION WITH SERUM MAGNESIUM

Echocardiography Changes	n	%
ANTERIOR WALL	27	27
ANTEROLATERAL WALL	19	19
INFERIOR WALL	14	14
INFEROLATERAL WALL	30	30
GLOBAL	07	07
ECHOCARDIOGRAPHY NOT DONE	03	03
TOTAL	100	100

Table 8: Echocardiographic Changes

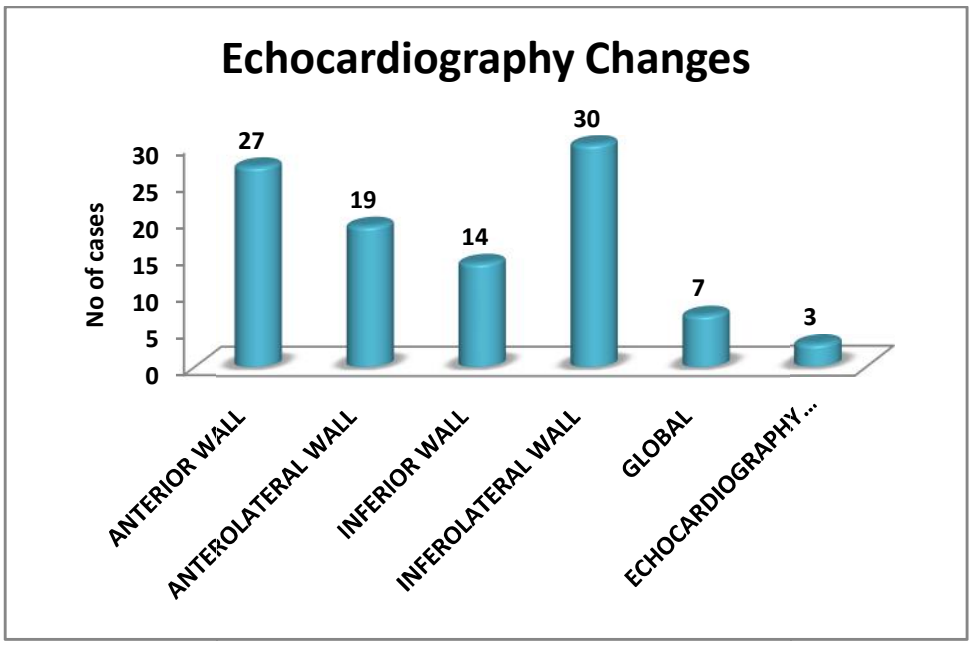

Figure 20: Echocardiographic Changes

The region of the heart involved was made out by bedside Echocardiography. The findings were grouped as anterior wall, anterolateral wall, inferior wall, inferolateral wall, and global, which included 27, 19, 14, 30 and 7 patients respectively. Three patient's echocardiography could not be done as they had succumbed.

AGE AND SERUM MAGNESIUM LEVELS

AGE	<1.8 (low)		1.8-2.5 (normal)		>2.5 (high)		Total	p value
	n	%	n	%	n	%		
60-69	18	60.0	41	69.5	07	63.6	66	
70-79	04	13.3	11	18.6	02	18.2	17	
80-89	07	23.3	06	10.2	01	9.1	14	0.543
≥90	01	3.3	01	1.7	01	9.1	03	
TOTAL	30	100.0	59	100.0	11	100.0	100	

Table 9: Age and serum magnesium levels

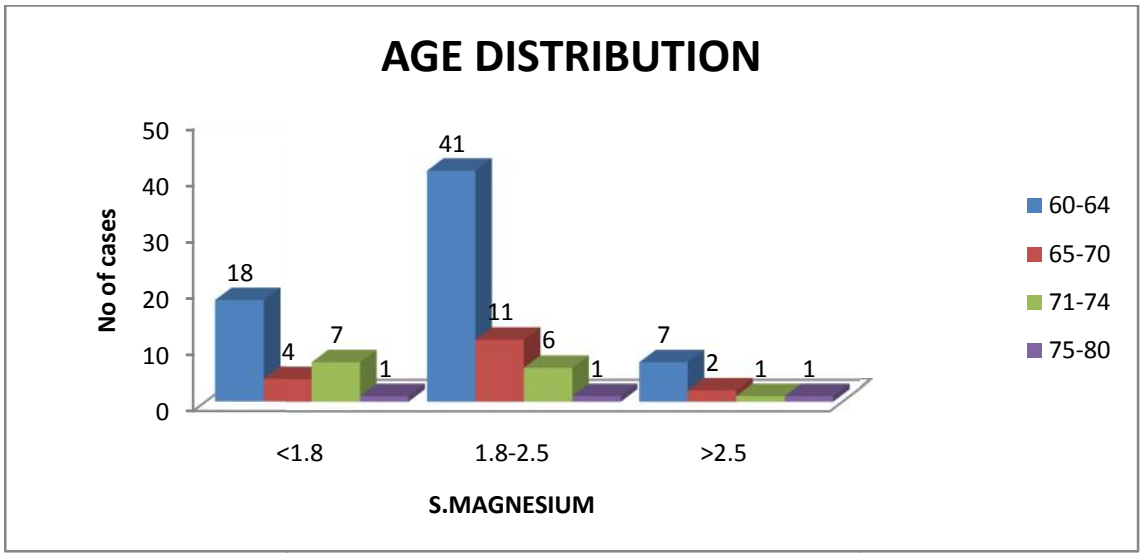

Figure 21: Age and serum magnesium levels

The estimated serum magnesium levels ranged from 1.1 mg/dl to 4.0 mg/dl. Low serum magnesium levels i.e, <1.8 mg/dl was present in 30 patients, 59 patients had normal serum magnesium levels, and 11 patients had high serum magnesium levels i.e, >2.5. The mean serum magnesium levels in our study group was 2.0 mg/dl.

COMPLICATIONS AND SERUM MAGNESIUM LEVELS

COMPLICATIONS	n	%
BRADYARRHYTHMIAS	07	35.0
TACHYARRHYTHMIAS	07	35.0
SINUS BRADYCARDIA	03	15.0
CCF	02	10.0
VENTRICULAR ECTOPICS	01	05.0
TOTAL	20	100.0

Table 10: Over All Complications

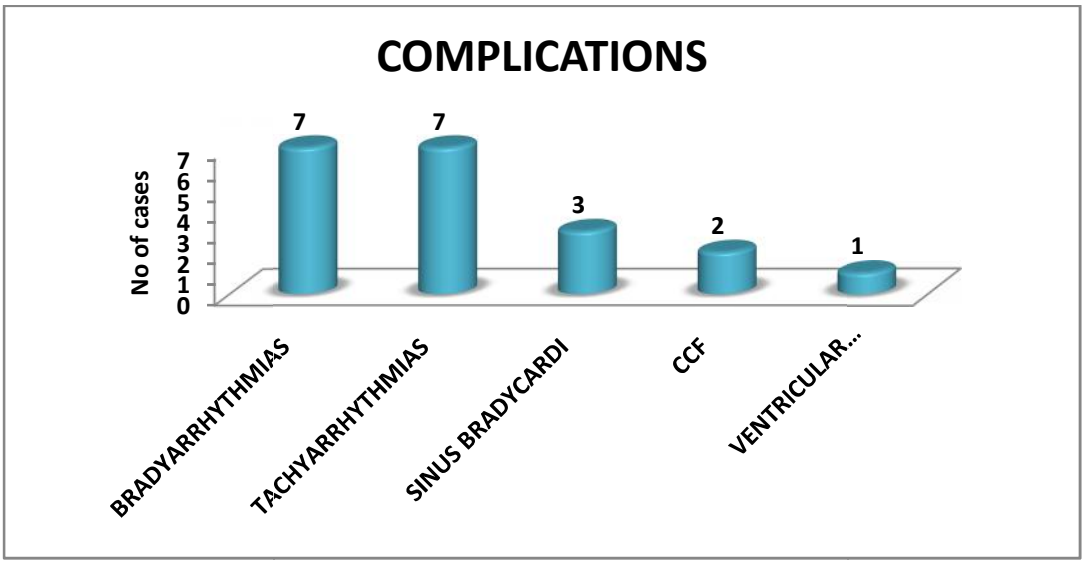

Figure 22: Over All Complications

Out of 100 participants, 20 patients had complications over a duration of 5 days of hospital stay and 80 patients had no complications.

The complications noted were ventricular ectopics in one patient, congestive cardiac failure in two patients, sinus bradycardia in three patients, tachyarrhythmias (ventricular tachycardia, atrial fibrillations) in seven patients, bradyarrhthmias (bundle branch blocks, 1^0, 2^0, 3^0 heart blocks) in seven patients.

COMPLICATIONS	<1.8 (low)		1.8-2.5 (normal)		>2.5 (high)		Total	p value
	n	%	n	%	n	%		
BRADYARRHYTHMIAS	05	50.0	02	25.0	00	00.0	07	0.874
CCF	01	10.0	01	12.5	00	00.0	02	
SINUS BRADYCARDIA	00	00.0	02	25.0	01	50.0	03	
TACHYARRHYTHMIAS	03	30.0	03	37.5	01	50.0	07	
VENTRICULAR ECTOPICS	01	10.0	00	0.0	00	00.0	01	
TOTAL	10	100.0	08	100.0	02	100.0	20	

Table 11: Complications and serum magnesium levels

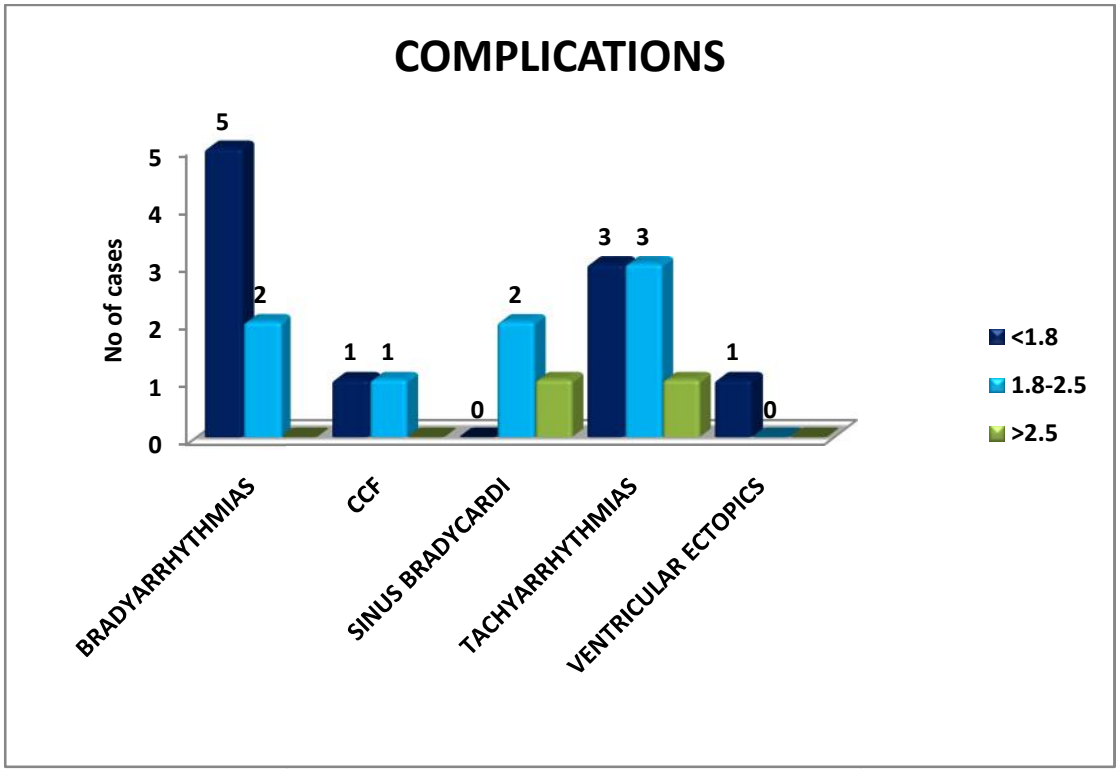

Figure 23: Complications and serum magnesium levels

The study group were distributed with respect to serum magnesium levels, as low, normal and high. Thirty patients had low serum magnesium levels and out of which 11 patients had complications accounting for 36.7%. The other group with normal serum magnesium levels had 59 patients and out which 11 patients had complications which accounts for 18.6% and the third group with high serum magnesium levels had 11 patients out of which 6 patients had got complications accounting for 54.5%.

The complications occurring in patients with low serum magnesium were 10, among which 5 patients had bradyarrhythmias, 3 had tachyarrhythmias and each one had congestive cardiac failure and ventricular ectopics.

The complications occurring in patients with normal serum magnesium were 8, among which 2 had bradyarrhythmias, 3 had tachyarrhythmias, 1 had congestive cardiac failure and another 2 had sinus bradycardia.

The complications occurring in patients with high serum magnesium were 2, among which 1 had tachyarrhythmia and other 1 had bradyarrhythmia.

MORTALITY

REASONS OF DEATH	n	%
CARDIAC FAILURE	1	12.5
VT	1	12.5
CHB	2	25.0
SUDDEN CARDIAC DEATH	4	50.0
TOTAL	8	100

Table 12: Over All Mortality

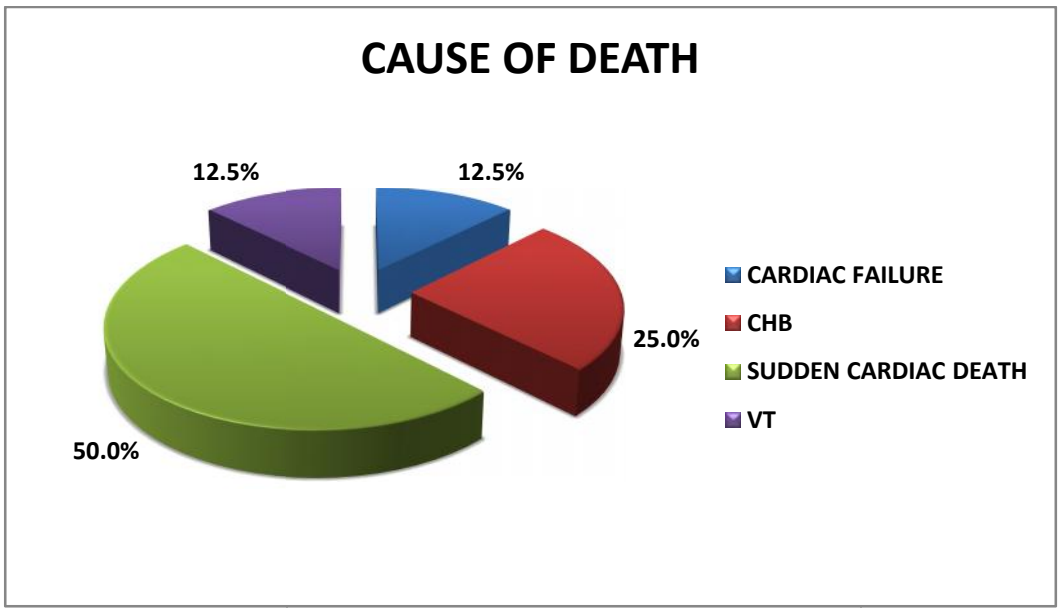

Figure 24: Over All Mortality

Among the 100 patients 8% patients succumbed during the hospital stay. The causes were as follows. The cardiac failure and ventricular tachycardia were noted in one patient each, complete heart block in two patients and four had sudden cardiac death.

Cause of death	<1.8 (low)		1.8-2.5 (normal)		>2.5 (high)		Total	p value
	n	%	n	%	n	%		
CARDIAC FAILURE	1	100.0	0	0.0	0	0.0	1	0.874
CHB	0	0.0	0	0.0	2	50.0	2	
VT	0	0.0	1	33.3	0	0.0	1	
SUDDEN CARDIAC DEATH	0	0.0	2	66.7	2	50.0	4	
TOTAL	1	100.0	3	100.0	4	100.0	8	

Table 13: Mortality and Serum Magnesium Levels

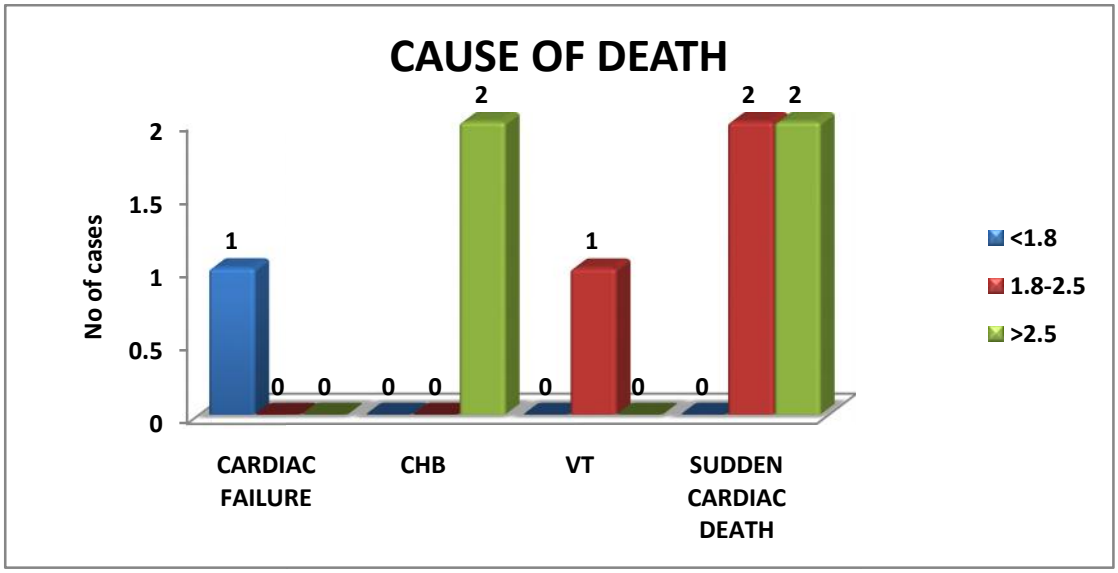

Figure 25: Mortality and Serum Magnesium Levels

On correlating the serum magnesium levels with the cause of death, low serum magnesium levels were present in patients with congestive cardiac failure, patient with ventricular tachycardia had normal levels, both patients with complete heart block had high levels and two patients with sudden cardiac death had normal serum magnesium levels and the other two had high serum magnesium levels.

DISCUSSION

Our study is a cross sectional study conducted over a period of two years, which includes 100 elderly patients diagnosed with acute myocardial infarction, which includes both ST elevation myocardial infarction and Non ST elevation myocardial infarction.

The serum magnesium levels were obtained from these patients on the day of admission and the values were measured using Calmagite method. The patients were observed over a period of 5 days in our hospital for complications, which includes conduction abnormalities like sinus bradycardia, bradyarrhythmias (conduction blocks), tachyarrhythmias (ventricular tachycardia, supraventricular tachycardia, atrial fibrillation), ventricular ectopics and heart failure. The out come of the patient during discharge was also noted.

The serum magnesium levels were compared for the occurrence of complications and their outcome.

AGE

A study by Savith.A[99], which was a cross sectional study in elderly patients with acute myocardial infarction, have found majority of patients aged between 60-69 years, with mean age of 69.82 years.

Mehta et al[100], showed age frequency predominance between the age group of 70-75 years which was higher than 65-69 year age group, where as our study showed majority of participants aged between 60-69 years, making it 66%.

SEX

A study by Savith.A[99], study showed male predominance over female, with a male to female ratio of 2.57:1, with 72% participants being male. In our study we had similar results with majority of patients being male which makes it 56%.

A study by Ambali A.P et al[101], in the same institution in the year 2007 found that 68% of elderly admitted with myocardial infarction were males.

HABITS

L.H.Bhatia and R.H.Naik[102] , assessed the risk factors for acute myocardial infarction in elderly patients and found that smoking was most common addictive habit and was present in 43.01% of patients.

A study by Savith.A[99], also showed smoking as most common addictive habit and was present in 58% of their study group.

In our study the most common addictive habit noted was smoking in 14% of patients followed by tobacco chewing seen in 13% of patients.

CLINICAL PRESENTATION TO HOSPITAL

Wegner et al[103], conducted a study and categorized patients based on the presenting complaints with which they presented to hospital as typical and atypical presentation and found to have atypical presentation more common ranging from 38-60% in elderly with acute myocardial infarction.

A study by Savith.A [99], showed typical presentation to be more common in 66.3% and atypical presentation being in 20.8%.

The clinical presentation in patients, presenting to our hospital with typical symptoms is 66% which is similar to the study done by Savith.A.

ECG CHANGES

L.H.Bhatia and R.K.Naik[102], found that ST elevation myocardial infarction was present in 52.34% of elderly patients, and Non ST elevation myocardial infarction was present in 36.45% and LBBB in 11.21% .

The study by Savith.A[99], found to have ST elevation myocardial infarction more commoner making it 96% than Non ST elevation myocardial infarction which was seen in only 4% of elderly patients presenting with acute myocardial infarction.

In our study, the ECG changes on admission was more common of ST elevation myocardial infarction making it 69% and 31% patients had Non ST elevation myocardial infarction.

ECHOCARDIOGRAPHY

The study done by Savith.A[99], showed to have higher incidence of inferior wall myocardial infarction and was present in 48% of patients, followed by anterolateral wall MI in 26% patients and anteroseptal wall MI was in 22% of patients.

A study by Ambali A.P et al[101], showed anterior wall myocardial infarction to be more common and was present in 68% of patients.

On the other hand our study showed a higher incidence of inferolateral wall involvement in 37%, followed by anterior wall in 27%, anterolateral wall in 19%, inferior wall in 14% and global hypokinesia in 7% of patients.

SERUM MAGNESIUM LEVELS AT ADMISSION

Abraham et al[104], studied 65 elderly patients with acute myocardial infarction and found to have reduced serum magnesium levels with a mean of 1.70 mg/dl and $p<0.001$ and he compared this results with a control group which had normal serum magnesium levels, with mean of 1.91 mg/dl.

Khan et al[105], studied 50 participants with ischaemic heart disease, which included 25 cases with acute myocardial infarction, acute coronary insufficiency in 15 patients and angina pectoris in 10 Patients, the serum magnesium levels in this study group ranged between 1.5 to 3.0 mg/dl, with a mean of 2.1 mg/dl.

The mean serum magnesium levels in our study group, which had 100 participants with acute myocardial infarction was 2.0 mg/dl, which lies within the normal range.

SERUM MAGNESIUM LEVELS AND COMPLICATIONS

Sachdev et al[106], studied serum magnesium levels in 30 patients with myocardial infarction and found that arrhythmias were more common with the patients having hypomagnesemia, the patients were intervened with magnesium infusion, the occurrence of ventricular tachycardia significantly reduced ($p <0.001$) but the other arrhythmias were unaffected. While, in our study conduction abnormalities, both bradyarrhythmia and tachyarrhythmia were noted in all three groups of serum magnesium levels and 8% of patients belonged to hypomagnesemia group, followed by 7% of patients in normomagnesemia group and only one patient in hypermagnesemia group.

T. Dyckner [107] conducted a similar study and found to have high incidence of ventricular ectopics in patients with hypomagnesemia. Our study also showed similar findings i.e, one patient had ventricular ectopic beats with low serum magnesium

levels. The same study also showed an increase in the incidence of AV Blocks with increase in serum magnesium levels, while in our study patients with third degree AV Block had both hypermagnesemia and normomagnesemia, but no patients with hypomagnesemia had AV Blocks.

MORTALITY

All case mortality was 20% in the study conducted by Ambali A.P et al[101]. And in this study the all case mortality was 8% and half of the patients died i.e, 4% of total had high serum magnesium levels.

CONCLUSION

Our study included a total of 100 participants aging >60 years, with predominant age of presentation being between 60-69 years.

The incidence is more common in elderly male patients than the female patients.

The more common addictive risk factor was smoking followed by tobacco chewing.

Atypical symptoms like easy fatigability, shortness of breath, syncopal attacks and even loose stools is common in elderly patients. Though our study found, chest pain the typical presentation to be more common.

In elderly, myocardial infarction is found incidentally as atypical presentation is common. ECG stands to be the most helpful aid to rule out the same. Our study showed ST elevation myocardial infarction to be more common than Non ST elevation myocardial infarction.

On echocardiographic evaluation the inferolateral wall hypokinesia was most common and global hypokinesia was least.

Serum magnesium is the second most abundant intracellular cation and has pivotal role in preventing initiation and also progression of the atherosclerosis, deficiency of which increases the risk of atherosclerosis. It also has myocardial cell membrane stabilizing potential thus preventing occurrence of arrhythmias. The mean serum magnesium levels of our study group is within the normal range.

The complications like arrhythmias was high with low serum magnesium levels followed by normal magnesium levels, where as the complete heart block were high with hypermagnesemia and normomagnesemia.

The mortality rate was similar with hypermagnesemia and normomagnesemia where as it was low with hypomagnesemia.

By this study, we would like to give an inference that, the clinical presentation of acute myocardial infarction in elderly is many a times non specific, but should always be excluded with the aid of ECG. Though our study showed typical presentation to be more common, the atypical presentation, too, was noted.

Our study also gives an inference that the bradyarrhythmias and tachyarrhythmias are more common with low to normal serum magnesium levels and was very low with high serum magnesium levels.

The rate of mortality was higher with hypermagnesemia patients and the cause was complete heart block and sudden cardiac death, which was also present in patients with normal serum magnesium levels.

Thus, the rate of complications is higher with low to normal magnesium levels but are not fatal where as patients with high serum magnesium levels have high risk mortality.

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ANNEXURE I

ETHICAL CLERANCE CERTIFICATE

ANNEXURE II

CONSENT FORM

TITLE OF RESEARCH: "STUDY OF SERUM MAGNESIUM LEVELS IN ELDERLY WITH ACUTE MYOCARDIAL INFARCTION"

GUIDE :

P.G. STUDENT :

PURPOSE OF RESEARCH:

I have been informed that the purpose of this study is to find out whether there is any association between serum magnesium levels in acute myocardial infarction and elderly.

PROCEDURE:

I understand that I will undergo detailed history, clinical examination and investigations.

RISKS AND DISCOMFORTS:

I understand that there is no risk involved and I may experience mild pain during the above mentioned procedures.

BENEFITS:

I understand that my participation in this study will help to find out whether there is any association between serum magnesium levels in myocardial infarction and elderly.

CONFIDENTIALITY:

I understand that the medical information produced by the study will become a part of hospital record and will be subjected to confidentiality and privacy regulations of hospital. If the data is used for publications the identity of the patient will not be revealed.

REQUEST FOR MORE INFORMATION:

I understand that I may ask for more information about the study at any time.

REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and I may refuse to participate or withdraw from study at any time.

INJURY STATEMENT:

I understand in the unlikely event of injury to me during the study I will get medical treatment but no further compensations.

(Signature of Guardian) (Signature of patient)

(If the patient is conscious, well oriented and fully aware)

WITNESS:

1) 2)

ANNEXURE III

"STUDY OF SERUM MAGNESIUM LEVELS IN ELDERLY WITH ACUTE MYOCARDIAL INFARCTION"

PROFORMA

Name:	**IP. No:**
Age:	**Address:**
Sex:	**Date of Admission:**
Occupation:	**Unit:**
Religion:	

Chief complaints: Chest pain

Site/Location

Type/Character

Radiation

Vomiting

Sweating

Present history:

Typical Presentation or Atypical Presentation

Past history:

History of (H/o) hypertension

H/o myocardial infarction / Angina

H/o diabetes mellitus

H/o hepatitis

H/o drug intake:

Drugs		YES/NO
1) DIURETICS	Loop diuretics, Thiazide diuretics.	
2) ANTIBIOTICS	Aminoglycosides, Amphotericin, Pentamidine, Gentamycin, Tobramycin.	
3) OTHERS	Digitalis, Adrenergics	

H/o a)Recent Trauma, Surgery, Burns

Personal history:

Diet:

Appetite:

Sleep:

Bladder and bowel habits:

Habits:

Family history:

GENERAL PHYSICAL EXAMINATION

Pallor:

Icterus:

Cyanosis:

Clubbing:

Lymphadenopathy:

Edema:

JVP:

VITAL SIGNS:

Pulse rate: Blood pressure:

Temperature: Respiration rate:

SYSTEMIC EXAMINATION

CARDIOVASCULAR SYSTEM:

RESPIRATORY SYSTEM:

PER ABDOMEN EXAMINATION:

CENTRAL NERVOUS SYSTEM:

INVESTIGATIONS:

HAEMATOLOGY –

PATHOLOGY

1)Complete blood count:	
Hb	gm/dl
Total count	cells/cumm
Differential count Neutrophils	%
Lymphocytes	%
Eosinophils	%
Basophils	%
Monocytes	%
Platelet Count	Cells/cumm
ESR	At end of 1st hour.
2)Urine routine	
Urine Ph	
Urine color	
Urine albumin	

Urine sugar	
Urine microscopy RBC’s Pus cells Cast’s Epithelial cells	

BIOCHEMISTRY

1)Random Blood sugar	
2) Serum Creatinine Serum Sodium Serum potassium	
3)FASTING LIPID PROFILE	
Total Cholesterol	
Triglycerides	
HDL-Cholesterol	
LDL-Cholesterol	
VLDL-Cholesterol	
4) CPK-MB/ TROP T	
5) SERUM MAGNESIUM LEVELS AT ADMISSION	

ECG :

2D-ECHO/ DOPPLER :

MASTER CHART

SL.NO	NAME	AGE	SEX	IP. NO	TYPICAL	ATYPICAL	HABITS	PR	BP	RR	S3	CREPTS	HB	RBS	CREATINIE	SODIUM	POTASSIUM	FLP	CPKMB	TROPONIN T	S.AMGNESIUM	STEMI	NSTEMI	ANTERIOR WALL	ANTEROLATERAL WALL	INFERIOR WALL	INFEROLATERAL WALL	GLOBAL	COMPLICATIONS
1	MALLIKARJUN B B	63	M	20387	Y	-	SMOKER	80	140/80	12			15.8	371	0.7	135	4.2	D	258	P	1.8	Y	-	Y	-	-	-	-	-
2	DONDILAL N K	64	M	17737	Y	-	TOBACCO	94	138/88	12			14.1	124	0.6	165	4.2	D	58	-	1.7	Y	-		Y				-
3	MITALAYYA Y H	65	M	19151	-	Y	TOBACCO/ ALC	76	130/74	12			12.9	132	0.6	130	5.2	D	24	P	1.8		Y	Y	-	-	-	-	-
4	BHEERAPPA N P	65	M	14012	Y		-	82	128/74	12			14.3	176	0.9			N	34	N	1.7	Y	-	-	-	Y	-	-	-
5	BABUGOUDA N P	64	M	16425		Y	-	98	122/74	12			13.7	143	0.8	139	4.5	D	48	-	1.6	-	Y	-	-	-	Y	-	-
6	LALSAB I G	80	M	14432		Y	SMOKER	110	120/80	17	P	P	13.3	290	1.6			D	33	P	2.1	Y	-					Y	DEATH
7	MARIAMMA B D	65	F	14843		Y	-	98	110/76	16	P	-	10.5	190	4.7	135	3.9	N	32	N	1.3	Y			Y				
8	TARABAI M P	64	F	13743		Y	-	80	128/84	17	P	P	10.7	169	0.7	143	3.5	D	61	N	2		Y	Y					
9	PARVATI R P	70	F	15564		Y	-	120	130/70	14	-	-	13.6	122	1.4	130	3.8	D	28	P	1.5		Y			Y			
10	YANKAWWA G H	80	F	17831	Y			86	110/70	12			8.2	121	0.7	142	3.4	D	234	P	2.3	Y					Y		
11	LACHU R R	65	M	14902	Y			84	100/60	14			11.5	144	1.2	144	5.7	N	80	N	1.5	Y		Y					
12	MALAKAPPA B N	63	M	13966		Y	TOBACCO	92	120/68	18		P	13.9	158	0.9	147	4.6	D	64	N	2.3	Y						Y	VT, ECTOPICS
13	MALLIKARJUN S P	65	M	13708	Y		SMOKER	86	138/80	14			13	312	1.2	138	5.3	D	55	P	2	Y		Y					SINUS BRADYCARDIA
14	BALASAHAB N Y	60	M	8854	Y		SMOKER	88	118/74	16			13.7		2.6			D		P	2.3	Y					Y		
15	BHEEMABAI G W	65	F	10420	Y			80	130/90	14	P		11.6	105	0.6	140	5.8	D	300	P	2.1	Y				Y			
16	DUNDAPPA M B	72	M	10759	Y		TOBACCO	94	110/78	12			13.6	102	0.7	140	4.7	D		P	2		Y		Y				
17	SIDAPPA D P	60	M	9406	Y		TOBACCO	88	140/100	14			14.9	245	0.6	128	4.3	D	46	P	1.9	Y			Y				
18	GURAPPA B H	85	M	8958		Y		84	128/84	14	P	P	13	119	0.6	132	4.4	N			2.4		Y						Y
19	KAMALABAI H G	60	F	10754		Y		80	130/80	12		P	11.5	269	1.6	142	3.2	D	35	P	2.6	Y		Y					DEATH
20	MALLAMMA M B	60	F	10010		Y		62	80/50	20	P	P	11.1	500	2.5	126	6.4		86	P	2.7	Y				Y			CHB, DEATH
21	MOULASAB H D	62	M	22740	Y			86	110/74	12			16.1	98	0.8	132	4.6	D		P	1.4	Y		Y					TRANSIENT AF
22	SANGAPPA M S	74	M	2355	Y			100	124/78	12			12.5	110	0.8	138	4.2	N	64	N	1.8		Y		Y				
23	SUGALABAI G D	80	F	10811		Y		88	112/70	14			8.8	115	2.5	137	5.8	D		P	2	Y					Y		LBBB
24	SAVITRI R K	65	F	1768	Y			104	80/60	14			10.9	114	0.8	133	3.9	D	34	P	1.7	Y					Y		
25	BASAPPA P K	66	M	6526		Y		82	110/64	14			16.3	249	1.5	133	4.7		49	N	2.1	Y			Y				
26	KAMALABAI K T	62	F	2969	Y			94	138/74	14			7.8	121	1.2	134	4.2	D	57	P	2.3	Y					Y		
27	RAMANNA B	65	M	431	Y		TOBACCO	100	70/50	12			11.3	147	1	138	5.5	D	290	P	1.8		Y				Y		
28	MD ISUF M P	65	M	1767	Y			94	124/64	12			7.5	86	1.5	135	4.2	D	41	P	2		Y		Y				
29	PARVATI B M	77	F	16198	Y			90	114/70	12			10.8	204	0.7	135	4.1	D	16	N	1.5	Y		Y					
30	NINGAPPA A	95	M	15620		Y	TOBACCO	80	120/70	16			13.4	241	1.2	141	4.3	D	39	P	1.8	Y		Y					RBBB, VT
31	SIDAMMA P S	64	F	15206	Y		SMOKER	56	90/60	18		P	9.6	450	2.6	122	6.8	D	129	P	1.2	Y		Y					CARDIAC FAILURE, DEATH
32	SIDAPPA Y W	65	M	4906	Y			88	124/78	12			13.7	126	0.7	143	3.3	D	24	N	2.2	Y		Y					
33	NELAYYA N G	80	M	4177		Y	TOBACCO	74	102/60	16			13.9	79	2	131	3.9	D			1.6	Y							Y

34	S ABDUL P	66	M	4809	Y			94	110/78	14			12.4	144	1.1	131	3.8	D	154	P	1.9	Y		Y					
35	GORABAI K R	70	F	2576	Y			96	170/98	18		P	11.8	224	0.7	140	4	D	238	P	1.9	Y		Y					
36	SUMATI A W	75	F	2353	Y			66	138/90	12			11.1	148	0.9	142	3.8	N	60	N	1.7		Y	Y					1 AV BLOCK
37	DASHARAT C G	70	M	2562	Y		SMOKER	78	132/84	14			12.8	106	1.8	138	3.6	D	58		1.8	Y			Y				
38	BASAPPA P K	75	M	50		Y		70	118/74	12			17.3	231	1	136	4.5	D	55	N	2.1	Y					Y		
39	PARVATI C B	65	F	3085	Y			88	140/90	12			13.4	129	0.6	133	4.3	D	133	P	1.9	Y		Y					
40	BASAPPA M S	83	M	2646	Y			92	160/90	14			12.2	124	0.8	146	3.9	D	52		1.7		Y				Y		
41	VENU C N	62	M	4517	Y			90	126/78	12			12.8	126	0.8	135	4.6	D		P	1.7	Y		Y					
42	RATNABAI S L	80	F	264		Y		34	54/40	14			11.4	225	1.1	138	4.1	D	20	N	2.8	Y					Y		CHB
43	LAXMIBAI R P	65	F	4218	Y			68	122/70	12			11.5	127	0.7	134	4.1	D	300		1.9	Y					Y		
44	ARJUN B R	62	M	15803	Y			84	134/78	16			13.8	128	1.2	138	3.6	D		P	2	Y				Y			
45	APPASAB S P	85	M	25792	Y		SMOKER	62	140/80	12			12.2	124	1	134	3.2	D	38	P	1.3	Y		Y					
46	VISHWANATH S B	65	M	24999	Y		TOBACCO	90	122/70	12			16.1		0.7	138	3.4	D	26	P	2.2	Y		Y					
47	SIDDANGOUDA B S	60	M	25239	Y			82	124/74	14			10	142	0.9	142	4.2	D	68	N	1.8	Y			Y				
48	ANNAPURNA I G	60	F	3992	Y			98	124/78	14			12.4	155	0.7	135	4.5	D	68		1.5		Y					Y	VENTRICULAR ECTOPICS
49	DAYANGOUDA B B	62	M	24220		Y		128	102/60	17		P	14	110	1.2	140	3.6			P	1.9		Y						VT
50	KHITAB N S	66	M	23649	Y		TOBACCO	88	140/70	14			13.1	160	1.2	141	4.3	D	218	P	2.9	Y				Y			
51	BABUGOUDA N P	64	M	16425		Y		98	122/74	12			13.7	143	0.8	139	4.5	D	48		1.6		Y			Y			
52	BORAMMA S A	65	F	22798	Y			84	124/70	14			13.6	118	0.6	133	3.4	D	26	P	2.2	Y		Y					
53	GANGABAI G S	68	F	21447	Y			86	126/74	12			11.3	123	0.7	128	3.2	D	74	N	2.7	Y			Y				
54	SHARDABAI C A	64	F	22728	Y			76	118/76	12			12.4	417	0.9	130	4	D	49	N	1.9	Y					Y		
55	AMMANSIDDA G B	67	M	21856	Y		SMOKER	92	132/68	13			16	91	0.8	134	3.6	D	300	P	3.1		Y				Y		
56	AMANAGOUDA P	65	M	21249	Y		SMOKER	88	114/74	12			13.6		0.8	136	3.5	D	65	P	2.1		Y			Y			
57	BHAGWANTH S B	64	M	17506	Y		SMOKER/TOBACOO	98	128/74	14			13.4		0.8	141	4.6	D	193	P	2.1	Y			Y				
58	VITTAL D H	90	M	22676		Y	SMOKER	76	148/74	14			12.3	124	1.1	134	4.8	D	68	N	1.4		Y		Y				RBBB
59	YEGAPPA B M	66	M	22399	Y			80	120/70	12			12.5	290	0.8	134	6.6	D	54	N	2.1	Y			Y				
60	SHARNAPPA R H	64	M	19887	Y			90	128/74	14			12.9	116	0.7	136	4.3	D		P	2.3	Y		Y					
61	SIDDARAM B M	64	M	18931	Y			88	108/74	14			15.9	96	0.7	142	3.8	D	286	P	1.9	Y						Y	
62	VIDYADAR V N	78	M	20355	Y			98	164/72	14				242	1.5	145	3.6	N	46	P	1.8	Y			Y				
63	CHANNAMMA B B	60	F	19881	Y			78	136/94	14			12.3	190	0.6	129	2.9	D	45	P	1.7		Y						
64	RUKMAWWA M B	65	F	20769	Y			40	50	18			11.1		1.2	142	4.4	D	150	P	2.7	Y					Y		SIUNUS BRADYCARDIA
65	LACHAPPA H H	68	M	20696	Y			90	100/70	14			16.5	110	0.7	143	4	D	27	N	1.6	Y		Y					
66	KULUSMBI B L	85	F	4029		Y		98	128/74	12			13.1	247	1.6	134	4.4	D	138		2.2	Y		Y					
67	SHANTAWWA S H	68	F	18280	Y			94	120/74	14			11.2	480	1.2	139	3.6	D	48	P	4		Y						DEATH
68	LAXMIBAI N Y	72	F	18079		Y		98	118/74	24		P	10.4	183	2.9	135	5.6	D	51	P	2.9		Y			Y			
69	KAMALABAI K D	65	F	16592		Y		88	116/70	14			6.4	191	0.7	144	3.8	D	82	P	2		Y					Y	
70	LAXMIBAI Y P	76	F	16612	Y			88	120/70	16			11.9	125	0.6	144	3.7	D	46	P	2.1	Y					Y		
71	SOMANNA M B	60	M	13303		Y	SMOKER	62	118/70	14			11.8	157	0.8	136	3.8	D	117	P	2		Y				Y		1 AV BLOCK
72	MAHARUDRA B B	60	M	6146		Y		100	120/70	16			14		0.7	128	3.4	D	32	N	1.5	Y		Y					LBBB INCOMPLETE
73	NAGAWWA L G	80	F	2586	Y			86	120/80	14			10.7	102	1.4	142	3.8	D	22	P	1.6		Y		Y				
74	CHANDRAM S P	70	M	3677		Y		88	134/70	16			15.2	76	1	142	4.4	D	35	P	2.2		Y				Y		
75	LAKKAWA Y U	75	F	3436	Y			86	130/80	16			12.4	163	0.6	134	2.8	D		P	1.3	Y		Y					LAFB, VT

76	MALLAWWA D H	66	F	1411		Y		92	70/50	14			8.7	165	1.2	134	4	D		P	1.7		Y				Y		
77	SADAPPA S S	60	M	1295	Y			82	124/80	16			14.2	102	1	132	4.5	D	60	P	1.7	Y					Y		
78	NEELAMMA	80	F	1271	Y			74	112/70	14			10.5	215	0.9				22		1.7	Y					Y		1 AV BLOCK
79	NINGAMMA B K	85	F	2219	Y			88	114/70	14			12.5	154	0.7	138	3.9	D		P	1.7	Y					Y		
80	SANGAPPA B R	64	M	26214		Y		86	114/70	12				135	0.9	140	4.7	D	88	P	2.4	Y				Y			
81	KASTURIBAI B H	62	F	26414	Y			62	108/60	14			13.3	327	0.8	134	4.9	N	35	N	1.8	Y					Y		SINUS BRADYCARDIA
82	BASHASAB H U	60	M	26388	Y		TOBACCO	64	110/64	12			14.3	110	0.6	133	4.4	D	63	N	2.2		Y				Y		
83	SHANTABAI D P	65	F	25748	Y			78	112/64	16	P	P	11.5	145	0.7	144	3.5	D	40	N	1.7	Y					Y		CCF
84	CHANDRABAG B L	65	F	25819	Y			88	132/86	14			13.2	283	0.7	132	5.1	D	80	P	1.9						Y		
85	LAYAPPA S M	64	M	7485		Y	ALCOHOL	70	108/68	14			12.6	95	1.2	130	4.6				2.1	Y					Y		
86	MALLIKARJUN M J	78	M	6033		Y	TOBACCO	94	108/60	18		P	15.7	81	0.7	129	3.5	D		P	1.8		Y				Y		
87	NAGAMMA B I	62	F	2227	Y			120	120/80	12			13.7	287	0.6	138	4.2	D		P	1.8	Y					Y		
88	APPANNA M S	74	M	3486	Y		SMOKER	80	128/64	14			13.7	203	0.6	134	4.4	N	44	N	1.8	Y				Y			
89	GURUBAI S P	80	F	24618		Y		84	100/70	14		P	9.7	188	1.2	137	3.6	D	125	P	1.1	Y					Y		CCF, VT
90	BAYAWWA S I	65	F	25005		Y		118	104/74	14			11	159	0.6	132	3.8	D	72	P	1.9	Y					Y		
91	YANKAWWA G H	80	F	17831	Y			80	124/78	14			8.2	121	0.7	142	3.4	D	234	P	2.3	Y					Y		
92	TAMANNA D G	90	M	23838		Y	TOBACCO	98	120/78	18		P	10.4	132	1	137	4.5	D	40	N	2.8	Y		Y					
93	SHARAWWA Y T	60	F	20731	Y			84	124/78	12			12.9	180	0.7			D	79	P	2.5		Y			Y			LBBB, DEATH
94	MALLAPPA S N	65	M	20212	Y		SMOKER	68	128/72	12	P		14.2	194	0.8	140	3.4		17	N	2.1	Y				Y			
95	KEMPAYYA R H	65	M	20657	Y			86	176/74	12			13.6	447	0.8	135	4.5	D	64	N	1.9		Y				Y		
96	BASAMMA S M	60	F	21186	Y			100	138/74	14			11.7	330	0.6	144	3.5	D	249	P	1.5	Y				Y			LBBB, 1 AV BLOCK
97	GOURABAI K RATHOD	70	F	21134		Y		90	112/78	16		P	10.5	192	0.8	140	3.5	D	20	N	1.9		Y	Y					VENTRICULAR ECTOPICS, CCF
98	DARAKABAI D G	60	F	27056	Y			88	108/70	16			11.6	158	0.8	138	3.9	D	27	N	2	Y		Y					
99	NEELKANTAYYA S H	72	M	27516		Y	TOBACCO	122	100/80	16	P	P	10.1	332	1.4	139	4.8	D	30	P	3.3		Y						AF WITH CCF
100	HANMANTH M P	65	M	27519	Y		SMOKER	88	120/80	12			11.8	122	1.2	136	4.7		45	P	2.4	Y							VT, DEATH