Introduction

**Myocardial infarction** (**MI**), also known as a **heart attack**, occurs when [blood flow](https://en.wikipedia.org/wiki/Hemodynamics) decreases or stops to a part of the [heart](https://en.wikipedia.org/wiki/Heart), causing damage to the [heart muscle](https://en.wikipedia.org/wiki/Cardiac_muscle)[1]. The most common symptom is [chest pain](https://en.wikipedia.org/wiki/Chest_pain) or [discomfort](https://en.wikipedia.org/wiki/Angina) which may travel into the shoulder, arm, back, neck or jaw[1]. Often it occurs in the centre or left side of the chest and lasts for more than a few minutes [1]. The discomfort may occasionally feel like [heartburn](https://en.wikipedia.org/wiki/Heartburn)[1]. Other symptoms may include [shortness of breath](https://en.wikipedia.org/wiki/Shortness_of_breath), nausea, [feeling faint](https://en.wikipedia.org/wiki/Presyncope), a [cold sweat](https://en.wikipedia.org/wiki/Diaphoresis) or [feeling tired](https://en.wikipedia.org/wiki/Fatigue_(medical))[1].  Risk factors include [high blood pressure](https://en.wikipedia.org/wiki/Hypertension), [smoking](https://en.wikipedia.org/wiki/Tobacco_smoking), [diabetes](https://en.wikipedia.org/wiki/Diabetes_mellitus), [lack of exercise](https://en.wikipedia.org/wiki/Lack_of_exercise), [obesity](https://en.wikipedia.org/wiki/Obesity), [high blood cholesterol](https://en.wikipedia.org/wiki/Hypercholesterolaemia), poor diet and excessive [alcohol](https://en.wikipedia.org/wiki/Alcohol_(drug)) intake, among others[2][3]. Myocardial infarctions are generally clinically classified into ST elevation MI (STEMI) and non-ST elevation MI (NSTEMI). These are based on changes to an [ECG](https://en.wikipedia.org/wiki/ECG)[4]. STEMIs make up about 25 – 40% of myocardial infarctions [5]. Worldwide, about 15.9 million myocardial infarctions occurred in 2015[6]. More than 3 million people had an ST elevation MI, and more than 4 million had an NSTEMI[7]. STEMIs occur about twice as often in men as women[8]. In the developed world, the risk of death in those who have had an STEMI is about 10%[9]. Rates of MI for a given age have decreased globally between 1990 and 2010[11].

The main cause behind MI is the obstruction of coronary arteries or sometimes the underlining issue behind the obstruction can be the extreme slow flow of blood[12]. The reason behind the sudden blockage the specific artery is the formation of thrombus[12]. Thrombus refers to a blood clot, atherosclerosis (a condition in which plaque builds in the arteries which are responsible to carry oxygen-rich blood to heart and other parts of body)[12].When heart beats way faster than it is supposed to do or a person is having low blood pressure then there is a great chance of slow blood flow in a coronary artery thus the demand of oxygen is greater than the supply which results in heart attack even without formation of blood clot[12]. The symptoms that develop with each heart attack and the chances of survival solely depend on the location and the extent of coronary artery blockage[12]. Atherosclerosis is the main reason behind major heart attacks all over the globe, the risk factors associated with heart attack and atherosclerosis are basically the same:

1. Hypertension (High blood pressure)[12]
2. Diabetes[12]
3. Smoking[12]
4. Obesity[12]
5. No regular exercise[12]
6. Low level of good cholesterol (high-density lipoprotein[12]
7. Excessive high level of blood cholesterol (hypercholesterolemia)[12]

Various studies were performed for the detection of Myocardial Infarction patients and following observations were drawn.

|  |  |
| --- | --- |
| Studies | References |
| A total integral of one ECG cycle and T-wave integral were taken as features for the detection of MI and the Time-Domain features computed from the 12-lead ECG signals were explored with Fussy Multi-Layer Perception(FMLP) network to classify the signal as MI ECG signal. | Safdarian, N. , Dabanloo, N. and Attarodi, G. (2014) A New Pattern Recognition Method for Detection and Localization of Myocardial Infarction Using T-Wave Integral and Total Integral as Extracted Features from One Cycle of ECG Signal. *Journal of Biomedical Science and Engineering*, **7**, 818-824. |
| A new multiple instance learning approach is used for the detection of MI. The Hermite functions are used for the decomposition of multi-lead ECG signals and the coefficients obtained are used for the effective detection of MI. The phase space fractal dimension features and artificial neural network classifier are used to train the data to detect MI. | [Li Sun](https://ieeexplore.ieee.org/author/38236826200); [Yanping Lu](https://ieeexplore.ieee.org/author/38519464600); [Kaitao Yang](https://ieeexplore.ieee.org/author/38523866200);[Shaozi Li](https://ieeexplore.ieee.org/author/37336198300); ECG Analysis Using Multiple Instance Learning for Myocardial Infarction Detection. |
| The neuro-fuzzy approach is applied for the diagnosis of the MI patient using multi-lead ECG signals. | [H.L. Lu](https://ieeexplore.ieee.org/author/38022037200); [K. Ong](https://ieeexplore.ieee.org/author/37323328700); [P. Chia](https://ieeexplore.ieee.org/author/37351890400)0 An automated ECG classification system based on a neuro-fuzzy system |
| A hybrid approach based on the hidden Markov models and Gaussian mixture model is proposed to differentiate the MI and normal ECG signals. | [Pei-Chann Chang](https://ieeexplore.ieee.org/author/37573663000); [Jui-Chien Hsieh](https://ieeexplore.ieee.org/author/37393397400); [Jyun-Jie Lin](https://ieeexplore.ieee.org/author/37577604600); [Yen-Hung Chou](https://ieeexplore.ieee.org/author/37567726800); [Chen-Hao Liu](https://ieeexplore.ieee.org/author/37578865400); A Hybrid System with Hidden Markov Models and Gaussian Mixture Models for Myocardial Infarction Classification with 12-Lead ECGs |
| DWT(Discrete wavelet transform) helps in the depiction of the QRS complex of normal and MI subjects | McDarby; G.;;celler, B.G.; Lovell,N.H. characterising the discrete wavelet transform of an ECG signal with simple parameters for use in automated diagnosis. In Proceedings of the 2nd International Conference on Bioelectromagnetism, Melbourne, Australia, 15-18 Feb,1998;pp31-32 |
| QRS complex of ECG signal is extracted with the help of DWT technique and it also helps in detecting MI subject by dealing with QRS complex. | Banerjee, S.; Mitra, M. ECG feature extraction and classification of anteroseptal myocardial infarction and normal subjects using discrete wavelet transform. In Proceedings of the International Conference on Systems in medicine and biology, Kharagpur, India, 16-18 December; pp. 55-60 |
| Sample entropy in FAWT(Flexible analytic wavelet transform) helped in analysing normal and ECG beats | Automated Diagnosis of Myocardial Infraction ECG Signals Using Sample Entropy in Flexible Analytic Wavelet Transform Framework, Mohit Kumar, Ram Bilasa Pachori, U. Rajendra Acharya |
| Baseline wandering and other noise in the ECG signal is separated by pre-processing of the give signal. | Automated Diagnosis of Myocardial Infraction ECG Signals Using Sample Entropy in Flexible Analytic Wavelet Transform Framework, Mohit Kumar, Ram Bilasa Pachori, U. Rajendra Acharya |
|  |  |

References:

1. "What Are the Signs and Symptoms of Coronary Heart Disease?". www.nhlbi.nih.gov. September 29, 2014. Archived from the original on 24 February 2015*. Retrieved 23 February 2015*.
2. Mehta PK, Wei J, Wenger NK (February 2015). ["Ischemic heart disease in women: a focus on risk factors"](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4336825)*.*Trends in Cardiovascular Medicine*.****25****(2): 140–51.*[*doi*](https://en.wikipedia.org/wiki/Digital_object_identifier)*:*[*10.1016/j.tcm.2014.10.005*](https://doi.org/10.1016%2Fj.tcm.2014.10.005)*.*[*PMC*](https://en.wikipedia.org/wiki/PubMed_Central)[*4336825*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4336825)*.*[*PMID*](https://en.wikipedia.org/wiki/PubMed_Identifier)[25453985](https://www.ncbi.nlm.nih.gov/pubmed/25453985)*.*
3. Mendis, Shanthi; Puska, Pekka; Norrving, Bo (2011). [Global atlas on cardiovascular disease prevention and control](http://whqlibdoc.who.int/publications/2011/9789241564373_eng.pdf?ua=1) (PDF) (1st ed.). Geneva: World Health Organization in collaboration with the World Heart Federation and the World Stroke Organization. pp. 3–18. [ISBN](https://en.wikipedia.org/wiki/International_Standard_Book_Number) [978-92-4-156437-3](https://en.wikipedia.org/wiki/Special:BookSources/978-92-4-156437-3). [Archived](https://web.archive.org/web/20140817123106/http:/whqlibdoc.who.int/publications/2011/9789241564373_eng.pdf?ua=1) (PDF) from the original on 2014-08-17.
4. Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD, Katus HA, Lindahl B, Morrow DA, Clemmensen PM, Johanson P, Hod H, Underwood R, Bax JJ, Bonow RO, Pinto F, Gibbons RJ, Fox KA, Atar D, Newby LK, Galvani M, Hamm CW, Uretsky BF, Steg PG, Wijns W, Bassand JP, Menasché P, Ravkilde J, Ohman EM, Antman EM, Wallentin LC, Armstrong PW, Simoons ML, Januzzi JL, Nieminen MS, Gheorghiade M, Filippatos G, Luepker RV, Fortmann SP, Rosamond WD, Levy D, Wood D, Smith SC, Hu D, Lopez-Sendon JL, Robertson RM, Weaver D, Tendera M, Bove AA, Parkhomenko AN, Vasilieva EJ, Mendis S (October 2012). "Third universal definition of myocardial infarction". Circulation. 126 (16): 2020–35.
5. O'Gara PT, Kushner FG, Ascheim DD, Casey DE, Chung MK, de Lemos JA, Ettinger SM, Fang JC, Fesmire FM, Franklin BA, Granger CB, Krumholz HM, Linderbaum JA, Morrow DA, Newby LK, Ornato JP, Ou N, Radford MJ, Tamis-Holland JE, Tommaso CL, Tracy CM, Woo YJ, Zhao DX, Anderson JL, Jacobs AK, Halperin JL, Albert NM, Brindis RG, Creager MA, DeMets D, Guyton RA, Hochman JS, Kovacs RJ, Kushner FG, Ohman EM, Stevenson WG, Yancy CW (January 2013). "2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines". Circulation. 127 (4): e362–425.
6. GBD 2015 Disease Injury Incidence Prevalence Collaborators (October 2016). ["Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015"](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5055577). Lancet. 388 (10053): 1545–1602.
7. *White HD, Chew DP (August 2008).*[*"Acute myocardial infarction"*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1931354)*. Lancet. 372 (9638): 570–84.*
8. O'Gara PT, Kushner FG, Ascheim DD, Casey DE, Chung MK, de Lemos JA, Ettinger SM, Fang JC, Fesmire FM, Franklin BA, Granger CB, Krumholz HM, Linderbaum JA, Morrow DA, Newby LK, Ornato JP, Ou N, Radford MJ, Tamis-Holland JE, Tommaso CL, Tracy CM, Woo YJ, Zhao DX, Anderson JL, Jacobs AK, Halperin JL, Albert NM, Brindis RG, Creager MA, DeMets D, Guyton RA, Hochman JS, Kovacs RJ, Kushner FG, Ohman EM, Stevenson WG, Yancy CW (January 2013). "2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines". Circulation. 127 (4): e362–425.
9. Steg PG, James SK, Atar D, Badano LP, Blömstrom-Lundqvist C, Borger MA, Di Mario C, Dickstein K, Ducrocq G, Fernandez-Aviles F, Gershlick AH, Giannuzzi P, Halvorsen S, Huber K, Juni P, Kastrati A, Knuuti J, Lenzen MJ, Mahaffey KW, Valgimigli M, van 't Hof A, Widimsky P, Zahger D (October 2012). "ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation". European Heart Journal. 33 (20): 2569–619.
10. Moran AE, Forouzanfar MH, Roth GA, Mensah GA, Ezzati M, Flaxman A, Murray CJ, Naghavi M (April 2014). [*"The global burden of ischemic heart disease in 1990 and 2010: the Global Burden of Disease 2010 study"*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4181601). Circulation. 129 (14): 1493–501. [*doi*](https://en.wikipedia.org/wiki/Digital_object_identifier):[*10.1161/circulationaha.113.004046*](https://doi.org/10.1161%2Fcirculationaha.113.004046). [*PMC*](https://en.wikipedia.org/wiki/PubMed_Central) [*4181601*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4181601).
11. Heart attack and myocardial infarction – Harvard Health Publishing, health.harvard.edu