

REFERENCES

- [1] “Cardiovascular diseases (CVDs).” Accessed: Oct. 02, 2025. [Online]. Available: [https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-\(cvds\)](https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds))
- [2] “Cardiovascular diseases.” Accessed: Oct. 02, 2025. [Online]. Available: https://www.who.int/health-topics/cardiovascular-diseases#tab=tab_1
- [3] N. Arsani, N. Wahyuni, N. N. M. Agustini, and M. Budiawan, “Deteksi Dini dan Pencegahan Penyakit Kardiovaskular,” *Proceeding Senadimas Undiksha*, vol. 1, no. 1, pp. 663–668, 2022.
- [4] N. T. Srinivasan and R. J. Schilling, “Sudden Cardiac Death and Arrhythmias,” *Arrhythm. Electrophysiol. Rev.*, vol. 7, no. 2, p. 111, 2018, doi: 10.15420/AER.2018:15:2.
- [5] “Indonesian Heart Rhythm Society |.” Accessed: Jan. 12, 2026. [Online]. Available: <https://inahrs.or.id/news/satu-dekade-inahrs-an-overview-and-outlook>
- [6] D. Kardiologi and K. Vaskular, “Mengatasi Aritmia, Mencegah Kematian Mendadak* Yoga Yuniadi,” *Mencegah Kematian Mendadak*, vol. 139, no. 3, 2017, doi: 10.23886/ejki.5.8192.
- [7] S. Agrawal and A. Gupta, “Fractal and EMD based removal of baseline wander and powerline interference from ECG signals,” *Comput. Biol. Med.*, vol. 43, no. 11, pp. 1889–1899, Nov. 2013, doi: 10.1016/J.COMPBIOMED.2013.07.030.
- [8] I. WIJAYANTO, I. WIJAYANTO, A. HUMAIRANI, A. RIZAL, and S. HADIYOSO, “Klasifikasi Sinyal EKG menggunakan Ciri Statistik dan Parameter Hjorth dengan SVM dan k-NN,” *ELKOMIKA: Jurnal Teknik Energi Elektrik, Teknik Telekomunikasi, & Teknik Elektronika*, vol. 10, no. 1, p. 132, Jan. 2022, doi: 10.26760/elkomika.v10i1.132.
- [9] G. A. L. Silva, P. H. L. Silva, G. J. P. Moreira, L. S. Freitas, J. C. Gertrudes, and E. J. S. Luz, “A SYSTEMATIC REVIEW OF ECG ARRHYTHMIA CLASSIFICATION: ADHERENCE TO STANDARDS, FAIR EVALUATION, AND EMBEDDED FEASIBILITY”.

- [10] S. Śmigiel, K. Pałczyński, and D. Ledziński, “ECG Signal Classification Using Deep Learning Techniques Based on the PTB-XL Dataset,” *Entropy* 2021, Vol. 23, Page 1121, vol. 23, no. 9, p. 1121, Aug. 2021, doi: 10.3390/E23091121.
- [11] D. Kim *et al.*, “A novel hybrid CNN-transformer model for arrhythmia detection without R-peak identification using stockwell transform,” *Scientific Reports* 2025 15:1, vol. 15, no. 1, pp. 7817-, Mar. 2025, doi: 10.1038/s41598-025-92582-9.
- [12] Y. Ansari, O. Mourad, K. Qaraqe, and E. Serpedin, “Deep learning for ECG Arrhythmia detection and classification: an overview of progress for period 2017–2023,” *Front. Physiol.*, vol. 14, p. 1246746, Sep. 2023, doi: 10.3389/FPHYS.2023.1246746/FULL.
- [13] R. Hu, J. Chen, and L. Zhou, “A transformer-based deep neural network for arrhythmia detection using continuous ECG signals,” *Comput. Biol. Med.*, vol. 144, p. 105325, May 2022, doi: 10.1016/J.COMPBIOMED.2022.105325.
- [14] Y. Nie, N. H. Nguyen, P. Sinthong, and J. Kalagnanam, “A TIME SERIES IS WORTH 64 WORDS: LONG-TERM FORECASTING WITH TRANSFORMERS”.
- [15] Y. Ansari, O. Mourad, K. Qaraqe, and E. Serpedin, “Deep learning for ECG Arrhythmia detection and classification: an overview of progress for period 2017–2023,” *Front. Physiol.*, vol. 14, p. 1246746, Sep. 2023, doi: 10.3389/FPHYS.2023.1246746/FULL.
- [16] A. E. M. Atwa, E. S. Atlam, A. Ahmed, M. A. Atwa, E. M. Abdelrahim, and A. I. Siam, “Interpretable Deep Learning Models for Arrhythmia Classification Based on ECG Signals Using PTB-X Dataset,” *Diagnostics*, vol. 15, no. 15, p. 1950, Aug. 2025, doi: 10.3390/DIAGNOSTICS15151950.
- [17] S. Chopannejad, A. Roshanpoor, and F. Sadoughi, “Attention-assisted hybrid CNN-BILSTM-BiGRU model with SMOTE-Tomek method to detect cardiac arrhythmia based on 12 - lead electrocardiogram signals,” *Digit. Health*, vol. 10, Jan. 2024, doi: 10.1177/20552076241234624.

- [18] “Kardiovaskular (Pengertian, Sebab, dan Contoh Penyakit).” Accessed: Jan. 09, 2026. [Online]. Available: <https://labcito.co.id/kardiovaskular-pengertian-sebab-dan-contoh-penyakit/>
- [19] A. Handayani, D. Kardiologi, and K. Vaskular, “Sistem Konduksi Jantung,” *Buletin Farmatera*, vol. 2, no. 3, pp. 116–123, Oct. 2017, doi: 10.30596/BF.V2I3.1197.G1269.
- [20] “Elektrokardiogram (EKG) - Gejala, Penyebab, dan Pengobatan.” Accessed: Jan. 09, 2026. [Online]. Available: <https://www.halodoc.com/kesehatan/elektrokardiogram-ekg>
- [21] “048 How to Read an Electrocardiogram (ECG/EKG) | Interactive Biology, with Leslie Samuel.” Accessed: Jan. 09, 2026. [Online]. Available: <https://interactivebiology.com/2265/048-how-to-read-an-electrocardiogram-ecgekg/>
- [22] F. D. Ratnasari, B. Y. D. Mandicky, Y. S. Kartika, and M. E. Ferisa, “ANALISIS DETAK JANTUNG ABNORMAL MENGGUNAKAN FAST FOURIER TRANSFORM (FFT) PADA DATA EKG PTB DENGAN IMPLEMENTASI PYTHON,” *Kohesi: Jurnal Sains dan Teknologi*, vol. 8, no. 1, pp. 51–60, May 2025, doi: 10.2238/NA68DP86.
- [23] P. Kligfield *et al.*, “Recommendations for the standardization and interpretation of the electrocardiogram: Part I: The electrocardiogram and its technology: A scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Cl...,” *Circulation*, vol. 115, no. 10, pp. 1306–1324, Mar. 2007, doi: 10.1161/CIRCULATIONAHA.106.180200;ISSUE:ISSUE:DOI.
- [24] G. A. Andika, A. Sukohar, and A. Yonata, “Management of Arrhythmia: Atrial Fibrillation,” *Medical Profession Journal of Lampung*, vol. 11, no. 3, pp. 247–252, Oct. 2021, doi: 10.53089/MEDULA.V11I3.309.
- [25] Y. Yuniadi, “Mengatasi aritmia, mencegah kematian mendadak,” *eJournal Kedokteran Indonesia*, vol. 5, no. 3, pp. 46–139, 2017, Accessed: Oct. 10, 2025. [Online]. Available: <https://www.academia.edu/download/58317794/227864-mengatasi-aritmia-mencegah-kematian-mend-c9ba84c4.pdf>

- [26] “Arrhythmias - StatPearls - NCBI Bookshelf.” Accessed: Dec. 17, 2025. [Online]. Available: <https://www.ncbi.nlm.nih.gov/books/NBK558923/>
- [27] “Inilah Jenis-Jenis Aritmia yang Perlu Diketahui.” Accessed: Dec. 17, 2025. [Online]. Available: <https://www.halodoc.com/artikel/inilah-jenis-jenis-aritmia-yang-perlu-diketahui>
- [28] “Arrhythmias - Types | NHLBI, NIH.” Accessed: Dec. 17, 2025. [Online]. Available: <https://www.nhlbi.nih.gov/health/arrhythmias/types>
- [29] “Types of Arrhythmia | Stanford Health Care.” Accessed: Dec. 17, 2025. [Online]. Available: <https://stanfordhealthcare.org/medical-conditions/blood-heart-circulation/arrhythmia/types.html>
- [30] G. A. Andika, A. Sukohar, and A. Yonata, “Management of Arrhythmia: Atrial Fibrillation,” *Medical Profession Journal of Lampung*, vol. 11, no. 3, pp. 247–252, Oct. 2021, doi: 10.53089/MEDULA.V11I3.309.
- [31] “Atrial Fibrillation - What Is Atrial Fibrillation? | NHLBI, NIH.” Accessed: Dec. 18, 2025. [Online]. Available: <https://www.nhlbi.nih.gov/health/atrial-fibrillation>
- [32] “Atrioventricular Block - Gejala, Penyebab, dan Pengobatan -.” Accessed: Dec. 18, 2025. [Online]. Available: <https://www.alodokter.com/atrioventricular-block>
- [33] I. Ahmed, A. Goyal, and L. Chhabra, “Atrioventricular Block,” *StatPearls*, Feb. 2024, Accessed: Dec. 18, 2025. [Online]. Available: <https://www.ncbi.nlm.nih.gov/books/NBK459147/>
- [34] C. Zai and T. Komputer, “IMPLEMENTASI DATA MINING SEBAGAI PENGOLAHAN DATA.”
- [35] G. Lenis, N. Pilia, A. Loewe, W. H. W. Schulze, and O. Dössel, “Comparison of Baseline Wander Removal Techniques considering the Preservation of ST Changes in the Ischemic ECG: A Simulation Study,” *Comput. Math. Methods Med.*, vol. 2017, p. 9295029, 2017, doi: 10.1155/2017/9295029.
- [36] I. Ahmad, “Power Line Noise Reduction in Ecg by Butterworth Notch Filters: A Comparative Study,” Jan. 01, 2013. Accessed: Apr. 17, 2026. [Online]. Available:

- https://www.academia.edu/85361154/Power_Line_Noise_Reduction_in_Ecg_by_Butterworth_Notch_Filters_A_Comparative_Study
- [37] “Documentation — NeuroKit 0.0.39 documentation.” Accessed: Apr. 17, 2026. [Online]. Available: <https://rpanderson-neurokit2.readthedocs.io/en/latest/index.html>
 - [38] P. A. Nugroho, I. Fenriana, and R. Arijanto, “IMPLEMENTASI DEEP LEARNING MENGGUNAKAN CONVOLUTIONAL NEURAL NETWORK (CNN) PADA EKSPRESI MANUSIA,” *ALGOR*, vol. 2, no. 1, pp. 12–20, Nov. 2020, Accessed: Jan. 10, 2026. [Online]. Available: <https://jurnal.ubd.ac.id/index.php/algor/article/view/441>
 - [39] “Apa itu Convolutional Neural Network? | IBM.” Accessed: Jan. 10, 2026. [Online]. Available: <https://www.ibm.com/id-id/think/topics/convolutional-neural-networks>
 - [40] A. Penelitian, E. Y. Hidayat, and D. Handayani, “Penerapan 1D-CNN untuk Analisis Sentimen Ulasan Produk Kosmetik Berdasar Female Daily Review,” *Jurnal Nasional Teknologi dan Sistem Informasi*, vol. 8, no. 3, pp. 153–163, Jan. 2022, doi: 10.25077/TEKNOSI.V8I3.2022.153-163.
 - [41] L. Xiaolin, B. Cardiff, and D. John, “A 1D Convolutional Neural Network for Heartbeat Classification from Single Lead ECG,” *ICECS 2020 - 27th IEEE International Conference on Electronics, Circuits and Systems, Proceedings*, Nov. 2020, doi: 10.1109/ICECS49266.2020.9294838.
 - [42] P. Purwono, A. Ma’arif, W. Rahmانيar, H. I. K. Fathurrahman, A. Z. K. Frisky, and Q. M. ul Haq, “Understanding of Convolutional Neural Network (CNN): A Review,” *International Journal of Robotics and Control Systems*, vol. 2, no. 4, pp. 739–748, 2022, Accessed: Jan. 10, 2026. [Online]. Available: <https://pubs2.ascee.org/index.php/IJRCS/article/view/888/html>
 - [43] D. Normawati and S. A. Prayogi, “Implementasi Naïve Bayes Classifier Dan Confusion Matrix Pada Analisis Sentimen Berbasis Teks Pada Twitter,” *J-SAKTI (Jurnal Sains Komputer dan Informatika)*, vol. 5, no. 2, pp. 697–711, Sep. 2021, doi: 10.30645/J-SAKTI.V5I2.369.
 - [44] “PhysioNet Profile | Kaggle.” Accessed: Dec. 10, 2025. [Online]. Available: <https://www.kaggle.com/organizations/physionet/datasets>

- [45] F. Liu *et al.*, “An Open Access Database for Evaluating the Algorithms of Electrocardiogram Rhythm and Morphology Abnormality Detection,” *J. Med. Imaging Health Inform.*, vol. 8, no. 7, pp. 1368–1373, Aug. 2018, doi: 10.1166/JMIHI.2018.2442.
- [46] A. L. Goldberger *et al.*, “PhysioBank, PhysioToolkit, and PhysioNet: components of a new research resource for complex physiologic signals,” *Circulation*, vol. 101, no. 23, 2000, doi: 10.1161/01.cir.101.23.e215.
- [47] A. Apostol and M. Nutu, “Arrhythmia Classification from 12-Lead ECG Signals Using Convolutional and Transformer-Based Deep Learning Models,” Feb. 2025, Accessed: Dec. 10, 2025. [Online]. Available: <https://arxiv.org/pdf/2502.17887>
- [48] R. Katzer and J. Smereck, “Rhythms Presenting with Normal Rate,” *Electrocardiogram in Clinical Medicine*, pp. 441–447, Jan. 2020, doi: 10.1002/9781118754511.ch42.
- [49] K. Tateno and L. Glass, “Automatic detection of atrial fibrillation using the coefficient of variation and density histograms of RR and deltaRR intervals,” *Med. Biol. Eng. Comput.*, vol. 39, no. 6, pp. 664–671, 2001, doi: 10.1007/BF02345439.
- [50] S. Sidhu and J. E. Marine, “Evaluating and managing bradycardia,” *Trends Cardiovasc. Med.*, vol. 30, no. 5, pp. 265–272, Jul. 2020, doi: 10.1016/j.tcm.2019.07.001.
- [51] L. Diaz-Gonzalez *et al.*, “Sinus bradycardia in paediatric athletes,” *Eur. J. Prev. Cardiol.*, vol. 28, no. 10, pp. 1142–1144, Aug. 2021, doi: 10.1177/2047487320932254.
- [52] C. R. Hou, B. Olshansky, D. Cortez, S. Duval, and D. G. Benditt, “Inappropriate sinus tachycardia: an examination of existing definitions,” *EP Europace*, vol. 24, no. 10, pp. 1655–1664, Oct. 2022, doi: 10.1093/europace/euac057.
- [53] R. Shan *et al.*, “Prevalence and risk factors of atrioventricular block among 15 million Chinese health examination participants in 2018: a nation-wide cross-sectional study,” *BMC Cardiovascular Disorders* 2021 21:1, vol. 21, no. 1, pp. 289–, Jun. 2021, doi: 10.1186/s12872-021-02105-3.