

## LISTADO DE PUBLICACIONES SOBRE INTELIGENCIA ARTIFICIAL EN CARDIOLOGÍA (PubMed)

### Metodología

Se realizó una búsqueda de publicaciones en la base de datos PubMed por dos grupos de términos, tomando todas las publicaciones de los últimos 5 años completos y de enero a marzo 2019 (ambos meses inclusive), que contuvieran en el título o *abstract* uno o más términos del grupo 1 y uno o más términos del grupo 2.

- Grupo 1: “machine learning”, “deep learning”, “neural network”, “neural network(s)”, convolutional, “artificial intelligence”.
- Grupo 2: cardiac, cardiology, "heart failure", coronary, ventricle, aortic, atrial, fibrillation, myocardium, pericardium, endocardium, "heart disease", cardiotoxicity, arrhythmia, ischemic.

La instrucción al buscador de PubMed fue:

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("machine learning"[Title/Abstract] OR "deep learning"[Title/Abstract] OR "neural network"[Title/Abstract] OR "neural networks"[Title/Abstract] OR convolutional[Title/Abstract] OR "artificial intelligence"[Title/Abstract]) AND (cardiac[Title/Abstract] OR cardiology[Title/Abstract] OR "heart failure"[Title/Abstract] OR coronary[Title/Abstract] OR ventricle[Title/Abstract] OR aortic[Title/Abstract] OR atrial[Title/Abstract] OR fibrillation[Title/Abstract] OR myocardium[Title/Abstract] OR pericardium[Title/Abstract] OR endocardium[Title/Abstract] OR "heart disease"[Title/Abstract] OR cardiotoxicity[Title/Abstract] OR arrhythmia[Title/Abstract]) OR ischemic[Title/Abstract])
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De la lista inicial obtenida (1.111 publicaciones) se realizó un filtrado manual por revisión por pares (JSP, PLS) para excluir las publicaciones de revisión y no estrictamente relacionadas con el área de la cardiología. La lista de publicaciones originales final (673 publicaciones) se clasificó en 5 áreas, en función de la aparición de los siguientes términos en título y *abstract* y la revisión de cada artículo:

- Arritmias: arrhythmia, fibrillation, ECG
- Cardiopatía Isquémica: risk, ischem\*, hemodynam\*, acute
- Insuficiencia cardíaca: insufficiency, failure, transplant
- Imagen cardíaca: image, imaging, MR, MRI, CT, CTA, tomography, echocard\*
- Otros: cardiotoxicity, pericardium, myocardium, endocard\*, disease, surgery, surgical, percutaneous, structural, congenital, hypertension, systolic, perfusion.

**Tabla 1 del material adicional**

Publicaciones inteligencia artificial en arritmias cardiacas

Referencia	Título	Modalidad	Observación
Li et al. (2014) <sup>1</sup>	Ventricular fibrillation and tachycardia classification using a machine learning approach	ML	Identificación de fibrilación ventricular o taquicardia ventricular a partir de datos del ECG
Das et al. (2014) <sup>2</sup>	ECG Beats Classification Using Mixture of Features	DL	Clasificación en 5 tipos de latidos a partir de datos del ECG
Mahajan et al. (2014) <sup>3</sup>	Performance of an automatic arrhythmia classification algorithm: comparison to the ALTITUDE electrophysiologist panel adjudications	ML	Clasificación y adjudicación de episodios arrítmicos en portadores de DAI
Caravaca et al. (2014) <sup>4</sup>	Application of machine learning techniques to analyse the effects of physical exercise in ventricular fibrillation	ML, DL	Análisis de la influencia del ejercicio previo durante eventos de fibrilación ventricular en un modelo animal
Daqrouq et al. (2014) <sup>5</sup>	Neural network and wavelet average framing percentage energy for atrial fibrillation classification	DL	Clasificación de fibrilación auricular
Ebrahimzadeh et al. (2014) <sup>6</sup>	A novel approach to predict sudden cardiac death (SCD) using nonlinear and time-frequency analyses from HRV signals	ML, DL	Predictor de muerte súbita a partir de análisis de la variabilidad de frecuencia cardiaca en el ECG
Behar et al. (2014) <sup>7</sup>	A comparison of single channel fetal ECG extraction methods	DL	Estimación de la frecuencia cardiaca fetal a partir de la monitorización de mujeres embarazadas
Li et al. (2014) <sup>8</sup>	A machine learning approach to multi-level ECG signal quality classification	ML	Clasificación de arritmias a partir del ECG
Sunkaria et al. (2014) <sup>9</sup>	An ANN-based HRV classifier for cardiac health prognosis	ML	Clasificador de salud cardiovascular basada en análisis de variabilidad de frecuencia cardiaca en el ECG
Prakosa et al. (2014) <sup>10</sup>	Cardiac electrophysiological activation pattern estimation from images using a patient-specific database of synthetic image sequences	ML	Estimación de los patrones de activación electromecánica a partir del análisis de contractilidad

Beudel et al. (2014) <sup>11</sup>	Small-world characteristics of EEG patterns in post-anoxic encephalopathy	DL	Predicción de encefalopatía anóxica a partir del análisis de electroencefalogramas tras parada cardiaca resucitada
Nguyen et al. (2014) <sup>12</sup>	Neural network approach for non-invasive detection of hyperglycemia using electrocardiographic signals	DL	Clasificación de estados de hiperglucemia o normoglucemia a partir del análisis electrocardiográficos
Wander et al. (2014) <sup>13</sup>	A combined segmenting and non-segmenting approach to signal quality estimation for ambulatory photoplethysmography	ML	Optimización de la medida de frecuencia cardiaca a partir de ondas ópticas de sistemas de monitorización móviles
Juhola et al. (2014) <sup>14</sup>	On computation of calcium cycling anomalies in cardiomyocytes data	ML	Clasificación de señales para detectar picos en las corrientes de Ca <sup>2+</sup> en cardiomiocitos
Kennedy et al. (2015) <sup>15</sup>	Using Time Series Analysis to Predict Cardiac Arrest in a PICU	ML	Modelo de predicción de parada cardiaca en pacientes pediátricos ingresados en unidades de críticos
Kora et al. (2015) <sup>16</sup>	Improved Bat algorithm for the detection of myocardial infarction	ML	Sistema de detección de infarto de miocardio utilizando en análisis de ECG
Naseri et al. (2015) <sup>17</sup>	Electrocardiogram signal quality assessment using an artificially reconstructed target lead	DL	Optimización de las señales electrocardiográficas resultantes del datatón: Computing-in-Cardiology Challenge 2011
Attin et al. (2015) <sup>18</sup>	Electrocardiogram characteristics prior to in-hospital cardiac arrest	ML	Predictores de parada cardiaca resucitada en el ECG
Zhang et al. (2015) <sup>19</sup>	Automatic recognition of cardiac arrhythmias based on the geometric patterns of Poincaré plots	ML	Clasificador automático de arritmias cardiacas
He et al. (2015) <sup>20</sup>	Combining multiple ECG features does not improve prediction of defibrillation outcome compared to single features in a large population of out-of-hospital cardiac arrests	ML, DL	Predicción de éxito de desfibrilación combinando múltiples variables
Lillo-Castellano et al. (2015) <sup>21</sup>	Symmetrical compression distance for arrhythmia discrimination in cloud-based big-data services	ML	Clasificación de arritmias en la nube a partir de datos de DAI procedentes de la plataforma SCOOP

Tanantong et al. (2015) <sup>22</sup>	False alarm reduction in BSN-based cardiac monitoring using signal quality and activity type information	ML	Reducción de falsas alarmas en la monitorización de las unidades de críticos
Ravens et al. (2015) <sup>23</sup>	Application of the RIMARC algorithm to a large data set of action potentials and clinical parameters for risk prediction of atrial fibrillation	ML	Clasificación preoperatoria del ritmo cardiaco
Jiang et al. (2015) <sup>24</sup>	Noninvasive reconstruction of cardiac transmembrane potentials using a kernelized extreme learning method	ML	Reconstrucción de los potenciales transmembrana cardíacos a partir de los potenciales de superficie corporal
Kiranyaz et al. (2016) <sup>25</sup>	Real-Time Patient-Specific ECG Classification by 1-D Convolutional Neural Networks	DL	Sistema rápido y preciso de clasificación y control de ECG
Rosier et al. (2016) <sup>26</sup>	Personalized and automated remote monitoring of atrial fibrillation	ML	Sistema de filtrado de alertas en fibrilación auricular según su importancia clínica
Rad et al. (2016) <sup>27</sup>	Automatic cardiac rhythm interpretation during resuscitation	ML	Sistema de interpretación automática del ritmo cardiaco en la parada cardíaca
Shandilya et al. (2016) <sup>28</sup>	Integration of Attributes from Non-Linear Characterization of Cardiovascular Time-Series for Prediction of Defibrillation Outcomes	ML	Sistema para predecir el éxito de la desfibrilación eléctrica
Yu et al. (2016) <sup>29</sup>	A new method without reference channels used for ventricular fibrillation detection during cardiopulmonary resuscitation	DL	Sistema de detección de fibrilación ventricular que clasifica los artefactos que se producen durante las maniobras de RCP
Mert (2016) <sup>30</sup>	ECG feature extraction based on the bandwidth properties of variational mode decomposition	ML, DL	Sistema de clasificación de arritmias
Elhaj et al. (2016) <sup>31</sup>	Arrhythmia recognition and classification using combined linear and nonlinear features of ECG signals	ML, DL	Sistema de clasificación de arritmias
Zahid et al. (2016) <sup>32</sup>	Patient-derived models link re-entrant driver localization in atrial fibrillation to fibrosis spatial pattern	ML	Utilización de modelos auriculares para probar la hipótesis que los modelos de fibrilación auricular por reentrada son propios de regiones con patrones de fibrosis específicos

Pant et al. (2016) <sup>33</sup>	Efficient compressive sensing of ECG segments based on machine learning for QRS-based arrhythmia detection	ML	Telemonitorización de arritmias basado en en análisis del QRS
Ansari et al. (2016) <sup>34</sup>	Suppression of false arrhythmia alarms in the ICU: a machine learning approach	ML	Supresión de falsas alarmas por arritmias en unidades de críticos
Eerikainen et al. (2016) <sup>35</sup>	Reduction of false arrhythmia alarms using signal selection and machine learning	ML	Clasificación de alarmas por arritmias en verdaderas o falsas
Figuera et al. (2016) <sup>36</sup>	Machine Learning Techniques for the Detection of Shockable Rhythms in Automated External Defibrillators	ML	Clasificación de ritmos desfibrilables a partir de ECG y holters para mejorar los desfibriladores externos automáticos
Immanuel et al. (2016) <sup>37</sup>	T-wave morphology can distinguish healthy controls from LQTS patients	DL	Análisis automático de la onda T para clasificar pacientes con síndrome de QT largo frente a controles
Li et al. (2016) <sup>38</sup>	Integrated Machine Learning Approaches for Predicting Ischemic Stroke and Thromboembolism in Atrial Fibrillation	ML	Predicción de ictus cardioembólico y tromboembolismo pulmonar en pacientes con fibrilación auricular
Nemati et al. (2016) <sup>39</sup>	Monitoring and detecting atrial fibrillation using wearable technology	ML	Identificación de fibrilación auricular a partir de dispositivos electrónicos de pulsera
Xiong et al. (2016) <sup>40</sup>	A stacked contractive denoising auto-encoder for ECG signal denoising	DL	Desarrollo de un filtro para evitar artefactos electrocardiográficos
Yanting et al. (2016) <sup>41</sup>	Risk prediction for cardiovascular disease using ECG data in the China kadoorie biobank	ML	Clasificación de patologías cardíacas y predicción de riesgo a partir del ECG
Zhang et al. (2016) <sup>42</sup>	In silico prediction of hERG potassium channel blockage by chemical category approaches	ML	Identificación de alertas de prolongación del QT por bloqueo del gen del canal hERG para la valoración de nuevos fármacos
He et al. (2016) <sup>43</sup>	Combining Amplitude Spectrum Area with Previous Shock Information Using Neural Networks Improves Prediction Performance of Defibrillation Outcome for Subsequent Shocks in Out-Of-Hospital Cardiac Arrest Patients	DL	Predicción del éxito de desfibrilación

Lancaster et al. (2016) <sup>44</sup>	Improved Prediction of Drug-Induced Torsades de Pointes Through Simulations of Dynamics and Machine Learning Algorithms	ML	Predicción de aparición de torsión de puntas en el desarrollo de fármacos
Khan et al. (2016) <sup>45</sup>	A cardiac electrical activity model based on a cellular automata system in comparison with neural network model	ML, DL	Modelo del comportamiento autómatas celular
Alqaraawi et al. 2016 <sup>46</sup>	Heart rate variability estimation in photoplethysmography signals using Bayesian learning approach	ML	Algoritmo para estimar la frecuencia cardíaca por fotoplethysmografía para dispositivos electrónicos de muñeca
Kalidas et al. 2016 <sup>47</sup>	Cardiac arrhythmia classification using multi-modal signal analysis	ML	Clasificador de alarmas para identificar falsas alarmas a partir de monitorización de intensivos resultado del datatón: Physionet/Computing in Cardiology 2015 Challenge
Lee et al. (2016) <sup>48</sup>	Prediction of Ventricular Tachycardia One Hour before Occurrence Using Artificial Neural Networks	DL	Predictor de la aparición de taquicardia ventricular en pacientes monitorizados en unidades de críticos
Abdul-Kadir et al. (2016) <sup>49</sup>	Dynamic ECG features for atrial fibrillation recognition	ML, DL	Clasificador de fibrilación auricular
Erem et al. (2016) <sup>50</sup>	Extensions to a manifold learning framework for time-series analysis on dynamic manifolds in bioelectric signals	ML	Explorar la estructura geométrica de la integración temporal de ECG y electroencefalogramas
Kurzendorfer et al. (2016) <sup>51</sup>	Cryo-Balloon Catheter Localization Based on a Support-Vector-Machine Approach	ML	Localización automática de catéteres de crioablación
Evangelista et al. (2017) <sup>52</sup>	Predicting adherence to use of remote health monitoring systems in a cohort of patients with chronic heart failure	ML	Identificación de pacientes con insuficiencia cardíaca candidatos a utilizar sistemas de monitorización remota
Giffard-Roisin et al. (2017) <sup>53</sup>	Noninvasive Personalization of a Cardiac Electrophysiology Model From Body Surface Potential Mapping	ML	Modelo predictivo de la respuesta a diferentes condiciones de estimulación
Li et al. (2017) <sup>54</sup>	Genetic algorithm for the optimization of features and neural networks in ECG signals classification	DL	Clasificación de señales a partir del ECG

Mjahad et al. (2017) <sup>55</sup>	Ventricular Fibrillation and Tachycardia detection from surface ECG using time-frequency representation images as input dataset for machine learning	ML, DL	Clasificador automático de arritmias ventriculares utilizando imágenes
Okutucu et al. (2017) <sup>56</sup>	Data mining experiments on the Angiotensin II-Antagonist in Paroxysmal Atrial Fibrillation (ANTIPAF-AFNET 2) trial: 'exposing the invisible'	ML	Predictores clínicos de aparición de fibrilación auricular
Acharya et al. (2017) <sup>57</sup>	A deep convolutional neural network model to classify heartbeats	DL	Clasificación de arritmias basado en la identificación de diferentes latidos cardiacos
Arvanaghi et al. (2017) <sup>58</sup>	Fusion of ECG and ABP signals based on wavelet transform for cardiac arrhythmias classification	DL	Clasificación de hasta 5 tipos de ritmo cardiaco
Tripathy et al. (2017) <sup>59</sup>	Automated detection of heart ailments from 12-lead ECG using complex wavelet sub-band bi-spectrum features	ML	Clasificación de arritmias, infarto, y bloqueo de rama a partir del ECG de 12 derivaciones
Luo et al. (2017) <sup>60</sup>	Patient-Specific Deep Architectural Model for ECG Classification	DL	Clasificador automático de la imagen tiempo-frecuencia electrocardiográfica
Li et al. (2017) <sup>61</sup>	High-Performance Personalized Heartbeat Classification Model for Long-Term ECG Signal	DL	Clasificador de arritmias cardiacas a partir de ECG
Pandit et al. (2017) <sup>62</sup>	A lightweight QRS detector for single lead ECG signals using a max-min difference algorithm	DL	Algoritmo para clasificar arritmias basado en una derivación electrocardiográfica
Rad et al. (2017) <sup>63</sup>	ECG-Based Classification of Resuscitation Cardiac Rhythms for Retrospective Data Analysis	ML, DL	Clasificación automática de los ritmos resucitables
Zhou et al. (2017) <sup>64</sup>	Premature ventricular contraction detection combining deep neural networks and rules inference	DL	Detección de extrasístoles ventriculares
Kiranyaz et al. (2017) <sup>65</sup>	Personalized Monitoring and Advance Warning System for Cardiac Arrhythmias	DL	Sistema de clasificación de arritmias cardiacas
Mustaqeem et al. (2017) <sup>66</sup>	Wrapper method for feature selection to classify cardiac arrhythmia	ML	Clasificador de arritmias cardiacas a partir de ECG



Wang et al. (2017) <sup>67</sup>	An integrated anti-arrhythmic target network of a Chinese medicine compound, Wenxin Keli, revealed by combined machine learning and molecular pathway analysis	ML	Predicción del efecto antiarrítmico del Wenxin Keli (medicina china patentada) sobre el uso de la quinidina en modelo animal
Sadrawi et al. (2017) <sup>68</sup>	Arrhythmia Evaluation in Wearable ECG Devices	DL	Algoritmo clasificador de arritmia en dispositivos electrónicos comparado con otros algoritmos previos
Lemkaddem et al. (2017) <sup>69</sup>	An autonomous medical monitoring system: Validation on arrhythmia detection	ML	Plataforma para clasificación de arritmias
Liu et al. (2017) <sup>70</sup>	Precision Cohort Finding with Outcome-Driven Similarity Analytics: A Case Study of Patients with Atrial Fibrillation	ML	Identificación de pacientes en fibrilación auricular con bajo riesgo de ictus cardioembólico
Sharifi et al. (2017) <sup>71</sup>	Development of models for predicting Torsade de Pointes cardiac arrhythmias using perceptron neural networks	DL	Desarrollo de un modelo estructura-actividad que se pueda utilizar como una prueba temprana para detectar el potencial proarrítmico (torsión de puntas) en candidatos a fármacos
Sahoo et al. (2017) <sup>72</sup>	ECG beat classification using empirical mode decomposition and mixture of features	DL	Clasificador de seis tipos de arritmias
Lenning et al. (2017) <sup>73</sup>	Real-Time Monitoring and Analysis of Zebrafish Electrocardiogram with Anomaly Detection	ML	Estudio monitorización electrocardiográfica en pez cebra con inteligencia artificial
Clifford et al. (2017) <sup>74</sup>	AF Classification from a Short Single Lead ECG Recording: the PhysioNet/Computing in Cardiology Challenge 2017	ML, DL	Identificación de ritmo sinusal frente a fibrilación auricular o artefactos en el datatón: PhysioNet/Computing in Cardiology Challenge 2017
Yu et al. (2017) <sup>75</sup>	[Research on malignant arrhythmia detection algorithm using neural network optimized by genetic algorithm]	DL	Algoritmos para detección automática de arritmias ventriculares que se puedan aplicar a desfibriladores
Ferrer-Albero et al. (2017) <sup>76</sup>	Non-invasive localization of atrial ectopic beats by using simulated body surface P-wave integral maps	ML	Agrupación espacial y clasificación de focos auriculares ectópicos mediante el uso del mapa integral de la onda P de la superficie corporal

Li et al. (2017) <sup>77</sup>	Modeling of the hERG K <sup>+</sup> Channel Blockage Using Online Chemical Database and Modeling Environment (OCHEM)	ML	Modelo predictivo de prolongación de QT a partir del efecto de otros fármacos publicados en la literatura en relación con la inhibición de los canales de potasio hERG
Yildirim et al. (2018) <sup>78</sup>	Arrhythmia detection using deep convolutional neural network with long duration ECG signals	DL	Clasificación de arritmias cardiacas basada en el análisis de señales electrocardiográficas de larga duración
Marzec et al. (2018) <sup>79</sup>	Device-measured physical activity data for classification of patients with ventricular arrhythmia events: A pilot investigation	ML	Predicción de aparición de taquicardia ventricular a partir de sujetos con holter implantable
Iqbal et al. (2018) <sup>80</sup>	Deep Deterministic Learning for Pattern Recognition of Different Cardiac Diseases through the Internet of Medical Things	DL	Clasificación de fibrilación auricular e infarto de miocardio combinando actividades cardiacas predefinidas con conjunto de datos fusionados
Yao et al. (2018) <sup>81</sup>	Arrhythmia Classification from Single Lead ECG by Multi-Scale Convolutional Neural Networks	DL	Clasificador de arritmias a partir de una única derivación electrocardiográfica
Nguyen et al. (2018) <sup>82</sup>	Deep Feature Learning for Sudden Cardiac Arrest Detection in Automated External Defibrillators	DL, ML	Algoritmo para la detección de TV/FV a partir de la señal electrocardiográfica
Liu et al. (2018) <sup>83</sup>	Classification of Heart Diseases Based On ECG Signals Using Long Short-Term Memory	DL	Clasificación de patologías cardiacas a partir del ECG utilizando secuencias temporales
Yu et al. (2018) <sup>84</sup>	QRS Detection and Measurement Method of ECG Paper Based on Convolutional Neural Networks	DL	Detección automática del QRS a partir de imágenes
Malik et al. (2018) <sup>85</sup>	A machine learning approach to reconstruction of heart surface potentials from body surface potentials	DL	Reconstrucción de potenciales cardiacos de superficie a partir de potenciales de superficie corporales
He et al. (2018) <sup>86</sup>	LiteNet: Lightweight Neural Network for Detecting Arrhythmias at Resource-Constrained Mobile Devices	DL	Sistema de detección de arritmias para dispositivos móviles
Lee et al. (2018) <sup>87</sup>	Heart Rate Estimated from Body Movements at Six Degrees of Freedom by Convolutional Neural Networks	DL	Estimación de la frecuencia cardiaca a partir de movimiento torácico respiratorio
Yildirim (2018) <sup>88</sup>	A novel wavelet sequence based on deep bidirectional LSTM network model for ECG signal classification	DL	Clasificación de ritmo sinusal, extrasistolia ventricular, latido estimulado, bloqueo de rama izquierda y rama derecha.

Sengupta et al. (2018) <sup>89</sup>	Prediction of Abnormal Myocardial Relaxation From Signal Processed Surface ECG	ML	Predicción de la relajación anormal miocárdica a partir de la señal de superficie electrocardiográfica
Mustaqeem et al. (2018) <sup>90</sup>	Multiclass Classification of Cardiac Arrhythmia Using Improved Feature Selection and SVM Invariants	ML	Clasificador en 16 tipos de arritmias cardiacas a partir de análisis electrocardiográficos
Sadr et al. (2018) <sup>91</sup>	A low-complexity algorithm for detection of atrial fibrillation using an ECG	DL	Modelo de predicción de fibrilación auricular basado en el análisis de intervalos RR
Mathews et al. (2018) <sup>92</sup>	A novel application of deep learning for single-lead ECG classification	DL	Clasificación de ECG de una sola derivación
Godoy et al. (2018) <sup>93</sup>	Atrial Fibrosis Hampers Non-invasive Localization of Atrial Ectopic Foci From Multi-Electrode Signals: A 3D Simulation Study	ML	Analizar el efecto de la fibrosis auricular sobre los sistemas de mapeo de superficie en la predicción de focos ectópicos auriculares
Shaik et al. (2018) <sup>94</sup>	Protein phenotype diagnosis of autosomal dominant calmodulin mutations causing irregular heart rhythms	ML	Algoritmo para diagnosticar cambios en las propiedades fenotípicas, de estabilidad y de unión del canal Ca <sup>2+</sup> de las mutaciones causantes de síndromes arrítmicos
Dobkowska-Chudon et al. (2018) <sup>95</sup>	Detecting cerebrovascular changes in the brain caused by hypertension in atrial fibrillation group using acoustocerebrography	ML	Comparación de la señal de acustocerebrografía en pacientes con fibrilación auricular con y sin hipertensión arterial
Parvaneh et al. (2018) <sup>96</sup>	Analyzing single-lead short ECG recordings using dense convolutional neural networks and feature-based post-processing to detect atrial fibrillation	DL	Detección de fibrilación auricular en una sola derivación electrocardiográfica
Bollepalli et al. (2018) <sup>97</sup>	Robust Heartbeat Detection from Multimodal Data via CNN-based Generalizable Information Fusion	DL	Fusión de la información de múltiples señales (fundamentalmente ECG)
Warrick et al. (2018) <sup>98</sup>	Ensembling convolutional and long short-term memory networks for electrocardiogram arrhythmia detection	DL	Identificación de fibrilación auricular en el ECG
Faust et al. (2018) <sup>99</sup>	Automated detection of atrial fibrillation using long short-term memory network with RR interval signals	DL	Detección automática de fibrilación auricular utilizando los intervalos RR

Xu et al. (2018) <sup>100</sup>	Atrial Fibrillation Beat Identification Using the Combination of Modified Frequency Slice Wavelet Transform and Convolutional Neural Networks	DL	Identificación automática de fibrilación auricular
Amezquita-Sanchez et al. (2018) <sup>101</sup>	A Novel Wavelet Transform-Homogeneity Model for Sudden Cardiac Death Prediction Using ECG Signals	DL	Predicción de muerte súbita a partir del análisis del ECG
Rubin et al. (2018) <sup>102</sup>	Densely connected convolutional networks for detection of atrial fibrillation from short single-lead ECG recordings	DL	Identificación de fibrilación auricular a partir de una derivación electrocardiográfica
Bond et al. (2018) <sup>103</sup>	Automation bias in medicine: The influence of automated diagnoses on interpreter accuracy and uncertainty when reading electrocardiograms	ML	Interpretación automática de trazados electrocardiográficos
Attia et al. (2018) <sup>104</sup>	Noninvasive assessment of dofetilide plasma concentration using a deep learning (neural network) analysis of the surface electrocardiogram: A proof of concept study	DL	Evaluación de los cambios morfológicos electrocardiográficos asociados al uso de dofetilide
Budzianowski et al. (2018) <sup>105</sup>	Predictors of atrial fibrillation early recurrence following cryoballoon ablation of pulmonary veins using statistical assessment and machine learning algorithms	ML	Predicción de nueva aparición de fibrilación auricular tras crioblación a partir de datos bioquímicos y clínicos
Kropf et al. (2018) <sup>106</sup>	Cardiac anomaly detection based on time and frequency domain features using tree-based classifiers	ML	Método combinado de análisis de señales electrocardiográficas durante el datatón: CinC 2017
Zhao et al. (2018) <sup>107</sup>	ECG authentication system design incorporating a convolutional neural network and generalized S-Transformation	DL	Sistema para la autenticación de señales electrocardiográficas
Blecker et al. (2018) <sup>108</sup>	Early Identification of Patients With Acute Decompensated Heart Failure	ML	Identificación de pacientes hospitalizados con insuficiencia cardiaca aguda
Cikes et al. (2018) <sup>109</sup>	Machine learning-based phenogrouping in heart failure to identify responders to cardiac resynchronization therapy	ML	Identificación de pacientes respondedores a resinscronización cardiaca a partir de datos clínicos y ecocardiográficos

Heam et al. (2018) <sup>110</sup>	Neural Networks for Prognostication of Patients With Heart Failure	DL	Predicción de la situación evolución clínica funcional de pacientes con insuficiencia cardiaca a partir de datos de la ergoespirometría
Kalscheur et al. (2018) <sup>111</sup>	Machine Learning Algorithm Predicts Cardiac Resynchronization Therapy Outcomes: Lessons From the COMPANION Trial	ML	Identificación de pacientes respondedores a terapia de resincronización cardiaca y predicción de sucesos cardiovasculares
Sodmann et al. (2018) <sup>112</sup>	A convolutional neural network for ECG annotation as the basis for classification of cardiac rhythms	ML, DL	Mejorar la estimación del tipo de ritmo cardiaco a partir del ECG
Xu et al. (2018) <sup>113</sup>	Towards End-to-End ECG Classification with Raw Signal Extraction and Deep Neural Networks	DL	Clasificación de arritmias cardiacas utilizando datos brutos electrocardiográficos
Yang et al. (2018) <sup>114</sup>	Automatic recognition of arrhythmia based on principal component analysis network and linear support vector machine	ML, DL	Combinación de ambos métodos de inteligencia artificial para filtrar artefactos y clasificar arritmias automáticamente desde el ECG
Fan et al. (2018) <sup>115</sup>	Multiscaled Fusion of Deep Convolutional Neural Networks for Screening Atrial Fibrillation From Single Lead Short ECG Recordings	DL	Identificación de fibrilación auricular a partir de una derivación única electrocardiográfica
Plesinger et al. (2018) <sup>116</sup>	Parallel use of a convolutional neural network and bagged tree ensemble for the classification of Holter ECG	ML, DL	Detección automática de arritmias a partir de datos de holter tras el datatón PhysioNet/CinC Challenge 2017
Das et al. (2018) <sup>117</sup>	Unsupervised heart-rate estimation in wearables with Liquid states and a probabilistic readout	DL	Estimación de la frecuencia cardiaca en dispositivos electrónicos
Xiang et al. (2018) <sup>118</sup>	Automatic QRS complex detection using two-level convolutional neural network	DL	Detección automática de complejos QRS
Tison et al. (2018) <sup>119</sup>	Passive Detection of Atrial Fibrillation Using a Commercially Available Smartwatch	DL	Detección de fibrilación auricular a partir de datos de dispositivos de muñeca
Lyon et al. (2018) <sup>120</sup>	Distinct ECG Phenotypes Identified in Hypertrophic Cardiomyopathy Using Machine Learning Associate With Arrhythmic Risk Markers	ML	Identificación de distintos fenotipos de miocardiopatía hipertrófica familiar basados en el análisis del ECG y caracterizar las diferencias clínicas y anatómicas con Rm

Gliner et al. (2018) <sup>121</sup>	An SVM approach for identifying atrial fibrillation	ML	Algoritmo para identificar fibrilación auricular basado en el pico de la onda R
Faganel et al. (2018) <sup>122</sup>	A topological approach to delineation and arrhythmic beats detection in unprocessed long-term ECG signals	ML	Algoritmo basado en principios topológicos (teoría de Morse) para detectar latidos arrítmicos en el ECG
Clerx et al. (2018) <sup>123</sup>	Predicting changes to INa from missense mutations in human SCN5A	ML	Estudio de simulación mecanicista con resultados no consistentes en la predicción de cambios en el canal de Na secundarios a mutaciones del gen SCN5A
Lawson et al. (2018) <sup>124</sup>	Slow Recovery of Excitability Increases Ventricular Fibrillation Risk as Identified by Emulation	ML	Simulación de escenarios electrofisiológicos para investigar el papel de la variabilidad en la densidad y cinética de los canales iónicos en el comportamiento arrítmico impulsado por rotor
He et al. (2018) <sup>125</sup>	Automatic Detection of Atrial Fibrillation Based on Continuous Wavelet Transform and 2D Convolutional Neural Networks	DL	Sistema automático de detección de fibrilación auricular basado en características tiempo-frecuencia del ECG
Ebrahimzadeh et al. (2018) <sup>126</sup>	Prediction of paroxysmal Atrial Fibrillation: A machine learning based approach using combined feature vector and mixture of expert classification on HRV signal	ML	Identificación de fibrilación auricular de datos del ECG utilizando una combinación de algoritmos
Isasi et al. (2018) <sup>127</sup>	A Machine Learning Shock Decision Algorithm for use during Piston-driven Chest Compressions	ML	Algoritmo para mejorar la RCP con decisiones sobre ritmos a desfibrilar y compresiones en el LUCAS2
Xie et al. (2018) <sup>128</sup>	Bidirectional Recurrent Neural Network And Convolutional Neural Network (BiRCNN) For ECG Beat Classification	DL	Clasificación automática de latidos cardiacos desde el ECG
Miyatani et al. (2018) <sup>129</sup>	Denoising Autoencoder-based Modification of RRI data with Premature Ventricular Contraction for Precise Heart Rate Variability Analysis	DL	Mejora en la estimación de la variabilidad de frecuencia cardiaca evitando contabilizar latidos prematuros
Khamis et al. (2018) <sup>130</sup>	Detection of Atrial Fibrillation from RR Intervals and PQRST Morphology using a Neural Network Ensemble	DL	Algoritmo para detector fibrilación auricular establecido en el datatón: PhysioNet Computing in Cardiology Challenge 2017

Zhou et al. (2018) <sup>131</sup>	Premature Ventricular Contraction Detection from Ambulatory ECG Using Recurrent Neural Networks	DL	Detección de extrasistolia ventricular
Hernandez et al. (2018) <sup>132</sup>	Atrial Fibrillation Detection in Short Single Lead ECG Recordings Using Wavelet Transform and Artificial Neural Networks	DL	Detección automática de fibrilación auricular
Anwar et al. (2018) <sup>133</sup>	Arrhythmia Classification of ECG Signals Using Hybrid Features	ML	Clasificación automática de arritmias cardíacas
Rizwan et al. (2018) <sup>134</sup>	AF detection from ECG recordings using feature selection, sparse coding, and ensemble learning	ML	Clasificación automática de fibrilación auricular resultante del datatón: 2017 PhysioNet Challenge
Yang et al. (2018) <sup>135</sup>	Localization of Origins of Premature Ventricular Contraction by Means of Convolutional Neural Network From 12-Lead ECG	DL	Identificación de extrasistolia ventricular a partir de ECG de 12 derivaciones
Xia et al. (2018) <sup>136</sup>	Detecting atrial fibrillation by deep convolutional neural networks	DL	Detección de fibrilación auricular
Kamaleswaran et al. (2018) <sup>137</sup>	A robust deep convolutional neural network for the classification of abnormal cardiac rhythm using single lead electrocardiograms of variable length	DL	Clasificador de arritmias a partir de una derivación electrocardiográfica
Deng et al. (2018) <sup>138</sup>	Extracting cardiac dynamics within ECG signal for human identification and cardiovascular diseases classification	DL	Sistema dinámico de clasificación de patologías cardíacas a partir del ECG
Zhong et al. (2018) <sup>139</sup>	A deep learning approach for fetal QRS complex detection	ML, DL	Sistema de detección de complejos QRS fetales
Hajimolahoseini et al. (2018) <sup>140</sup>	Inflection point analysis: A machine learning approach for extraction of IEGM active intervals during atrial fibrillation	ML	Algoritmo de detección de fibrilación auricular mediante el análisis de intervalos intracardiacos
Xiong et al. (2018) <sup>141</sup>	ECG signal classification for the detection of cardiac arrhythmias using a convolutional recurrent neural network	DL	Sistema para clasificar arritmia desarrollado a partir del datatón: 2017 PhysioNet/Computing in Cardiology (CinC) Challenge

Mena et al. (2018) <sup>142</sup>	Mobile Personal Health Monitoring for Automated Classification of Electrocardiogram Signals in Elderly	ML	Sistema de monitorización móvil del ECG diseñado para personas mayores
Teijeiro et al. 2018 <sup>143</sup>	Abductive reasoning as a basis to reproduce expert criteria in ECG atrial fibrillation identification	ML, DL	Identificación automática de fibrilación auricular a partir del datatón: 2017 PhysioNet/CinC Challenge
Poh et al. (2018) <sup>144</sup>	Diagnostic assessment of a deep learning system for detecting atrial fibrillation in pulse waveforms	DL	Identificación de fibrilación auricular a partir de ondas de pulso en pletismografía
Oh et al. (2018) <sup>145</sup>	Automated diagnosis of arrhythmia using combination of CNN and LSTM techniques with variable length heart beats	DL	Detección de patrones electrocardiográficos diferentes con RR variables
Kumar et al. (2018) <sup>146</sup>	Heart rate monitoring and therapeutic devices: A wavelet transform based approach for the modeling and classification of congestive heart failure	ML	Monitorización de la frecuencia cardiaca a partir de la detección del QRS del electrocardiograma
Savalia et al. (2018) <sup>147</sup>	Cardiac Arrhythmia Classification by Multi-Layer Perceptron and Convolution Neural Networks	DL	Identificación de diferentes arritmias a partir del ECG
McGillivray et al. (2018) <sup>148</sup>	Machine learning methods for locating re-entrant drivers from electrograms in a model of atrial fibrillation	ML	Modelo celular para ubicar los rotors en fibrilación auricular de forma automática usando mediciones indirectas de ECG
G et al. (2018) <sup>149</sup>	Classification of ECG beats using deep belief network and active learning	DL	Modelo para identificar arritmias a partir de QRS aislados del ECG
Ma et al. (2018) <sup>150</sup>	A novel real-time computational framework for detecting catheters and rigid guidewires in cardiac catheterization procedures	ML	Sistema para distinguir catéteres de guía de otros artefactos similares en la radioscopia durante procedimientos de electrofisiología
Zhu et al. (2018) <sup>151</sup>	A lightweight piecewise linear synthesis method for standard 12-lead ECG signals based on adaptive region segmentation	DL	Sistema para reconstrucción en un ECG de 12 derivaciones a partir de 3 derivaciones (I, II, V <sub>2</sub> )
Wu et al. (2018) <sup>152</sup>	A Comparison of 1-D and 2-D Deep Convolutional Neural Networks in ECG Classification	DL	Clasificación del electrocardiograma entre normal y anormal



Nagaraj et al. (2018) <sup>153</sup>	The revised Cerebral Recovery Index improves predictions of neurological outcome after cardiac arrest	ML	Predicción del daño por encefalopatía anóxica tras la muerte súbita recuperada a partir del análisis de electroencefalogramas
Nanayakkara et al. (2018) <sup>154</sup>	Characterising risk of in-hospital mortality following cardiac arrest using machine learning: A retrospective international registry study	ML	Predicción de mortalidad en pacientes ingresados con muerte súbita resucitada
Akca et al. (2018) <sup>155</sup>	Is There Any Difference in Risk Factors between Male and Female Patients in New-Onset Atrial Fibrillation after Coronary Artery Bypass Grafting?	ML	Algoritmo de predicción de entrada en fibrilación auricular tras cirugía de pontaje aorto coronario
Kwon et al. (2018) <sup>156</sup>	An Algorithm Based on Deep Learning for Predicting In-Hospital Cardiac Arrest	DL	Predicción de parada cardíaca intrahospitalaria
Sbrollini et al. (2019) <sup>157</sup>	Serial electrocardiography to detect newly emerging or aggravating cardiac pathology: a deep-learning approach	DL	Detección de patologías cardíacas en fase temprana o avanzada a partir de electrocardiografía seriada
Erdenebayar et al. (2019) <sup>158</sup>	Automatic Prediction of Atrial Fibrillation Based on Convolutional Neural Network Using a Short-term Normal Electrocardiogram Signal	DL	Predicción automática de fibrilación auricular basada en redes neuronales convolucionales aplicadas a electrocardiogramas de corto plazo
Biswas et al. (2019) <sup>159</sup>	CorNET: Deep Learning Framework for PPG-Based Heart Rate Estimation and Biometric Identification in Ambulant Environment	DL	Estimación del pulso cardíaco basado en PPG a través de deep learning con dispositivos <i>wireless</i> en escenarios ambulatorios
Hannun et al. (2019) <sup>160</sup>	Cardiologist-level arrhythmia detection and classification in ambulatory electrocardiograms using a deep neural network	DL	Detección y clasificación de arritmias en escenarios ambulatorios
Bhattacharya et al. (2019) <sup>161</sup>	Identifying Ventricular Arrhythmias and Their Predictors by Applying Machine Learning Methods to Electronic Health Records in Patients With Hypertrophic Cardiomyopathy (HCM-VAr-Risk Model)	ML	Identificación y predicción de arritmias ventriculares en pacientes de cardiomiopatía hipertrófica basada en registros clínicos electrónicos

Attia et al. (2019) <sup>162</sup>	Screening for cardiac contractile dysfunction using an artificial intelligence-enabled electrocardiogram	DL	Detección de disfunción de la contractilidad cardiaca a través de deep learning aplicado a señal electrocardiográfica
Gradolewski et al. (2019) <sup>163</sup>	A Wavelet Transform-Based Neural Network Denoising Algorithm for Mobile Phonocardiography	DL	Eliminación de ruido en señales fonocardiográficas
Karaoğuz et al. (2019) <sup>164</sup>	The quality of ECG data acquisition, and diagnostic performance of a novel adhesive patch for ambulatory cardiac rhythm monitoring in arrhythmia detection	ML	Inteligencia artificial para la evaluación de dispositivos Holter
Lozoya et al. (2019) <sup>165</sup>	Model-Based Feature Augmentation for Cardiac Ablation Target Learning From Images	DL	Modelo para la generación automática de datos para la mejora de algoritmos deep learning de clasificación de pacientes candidatos a ablación cardiaca por radiofrecuencia
Oliveira et al. (2019) <sup>166</sup>	Geometrical features for premature ventricular contraction recognition with analytic hierarchy process based machine learning algorithms selection	ML	Machine learning para la detección de características geométricas de contracción ventricular prematura
Coult et al. (2019) <sup>167</sup>	Ventricular Fibrillation Waveform Analysis During Chest Compressions to Predict Survival From Cardiac Arrest	ML	Análisis de formas de onda de fibrilación ventricular durante compresiones torácicas para la predicción de supervivencia tras parada cardiaca
Gordon et al. (2019) <sup>168</sup>	PVC Detection Using a Convolutional Autoencoder and Random Forest Classifier	DL	Detección de contracciones ventriculares prematuras con redes neuronales convolucionales
Sutton et al. (2019) <sup>169</sup>	PhysOnline: An Open Source Machine Learning Pipeline for Real-Time Analysis of Streaming Physiological Waveform	ML	PhysOnline: plataforma de machine learning código abierto para el análisis en tiempo real de electrocardiogramas
Cazeau et al. (2019) <sup>170</sup>	Statistical ranking of electromechanical dyssynchrony parameters for CRT	ML	Clasificación estadística de parámetros de desincronización electromecánica para aplicación de terapias de resincronización cardiaca

Alqudah et al. (2019) <sup>171</sup>	Developing of robust and high accurate ECG beat classification by combining Gaussian mixtures and wavelets features	ML	Clasificación de señales electrocardiográficas
Xie et al. (2019) <sup>172</sup>	A compound heterozygosity of Tecrl gene confirmed in a catecholaminergic polymorphic ventricular tachycardia family	ML	Identificación de genes responsables de taquicardia ventricular

DL: *deep learning* (aprendizaje profundo); ML: *machine learning* (aprendizaje automático).

**Tabla 2 del material adicional**

Publicaciones inteligencia artificial en cardiopatía isquémica

Referencia	Título	Modalidad	Observación
Liu et al. (2014) <sup>173</sup>	Prediction of adverse cardiac events in emergency department patients with chest pain using machine learning for variable selection	ML	Predicción de sucesos adversos en unidades de dolor torácico
Kumar et al. (2014) <sup>174</sup>	Classification of atherosclerotic and non-atherosclerotic individuals using multiclass state vector machine	ML	Clasificación entre individuos con o sin enfermedad coronaria
Alshurafa et al. (2014) <sup>175</sup>	Remote health monitoring: predicting outcome success based on contextual features for cardiovascular disease	ML	Determinación del riesgo cardiovascular a partir del análisis de factores de riesgo y otros parámetros clínicos
Zellweger et al. (2014) <sup>176</sup>	A new memetic pattern based algorithm to diagnose/exclude coronary artery disease	ML	Algoritmo para excluir enfermedad coronaria
Guidi et al. (2014) <sup>177</sup>	A machine learning system to improve heart failure patient assistance	ML, DL	Clasificación de gravedad de insuficiencia cardiaca
Liu et al. (2014) <sup>178</sup>	Risk stratification for prediction of adverse coronary events in emergency department chest pain patients with a machine learning score compared with the TIMI score	ML	Predicción de síndrome coronario agudo en las unidades de dolor torácico
Nakajima et al. (2015) <sup>179</sup>	Diagnostic Performance of Artificial Neural Network for Detecting Ischemia in Myocardial Perfusion Imaging	DL	Diagnóstico automático de cardiopatía isquémica
Chen et al. (2015) <sup>180</sup>	Using Blood Indexes to Predict Overweight Statuses: An Extreme Learning Machine-Based Approach	ML	Este estudio explora una nueva técnica que utiliza mediciones de sangre y bioquímicas para reconocer la condición de sobrepeso; y por ende riesgo cardiovascular
Panahiazar et al. (2015) <sup>181</sup>	Using EHRs for Heart Failure Therapy Recommendation Using Multidimensional Patient Similarity Analytics	ML	Individualización del tratamiento médico en insuficiencia cardiaca

Panahiazar et al. (2015) <sup>182</sup>	Using EHRs and Machine Learning for Heart Failure Survival Analysis	ML	Predicción de mortalidad en pacientes con insuficiencia cardiaca
Torii et al. (2015) <sup>183</sup>	Risk factor detection for heart disease by applying text analytics in electronic medical records	NLP	Detección de patología cardiovascular identificando factores de riesgo cardiovascular en el análisis de textos
Arsanjani et al. (2015) <sup>184</sup>	Prediction of revascularization after myocardial perfusion SPECT by machine learning in a large population	ML	Predicción de revascularización coronaria a partir de datos clínicos y de SPECT
Drenos et al. (2015) <sup>185</sup>	Networks in Coronary Heart Disease Genetics As a Step towards Systems Epidemiology	ML	Predicción de enfermedad coronaria a partir de múltiples datos que incluyen polimorfismos genéticos
Roberts et al. (2015) <sup>186</sup>	The role of fine-grained annotations in supervised recognition of risk factors for heart disease from EHRs	NLP	Identificación automática de factores de riesgo cardiovascular a partir de textos
Poddar et al. (2015) <sup>187</sup>	Automated diagnosis of coronary artery diseased patients by heart rate variability analysis using linear and non-linear methods	ML	Diagnóstico automático de enfermedad coronaria a partir del análisis de la variabilidad de frecuencia cardiaca
Sladojevic et al. (2015) <sup>188</sup>	Data Mining Approach for in-Hospital Treatment Outcome in Patients with Acute Coronary Syndrome	ML	Predicción de riesgo en el síndrome coronario agudo sometido a revascularización percutánea
Yang et al. (2015) <sup>189</sup>	A hybrid model for automatic identification of risk factors for heart disease	NLP	Identificación automática de factores de riesgo cardiovascular a partir de textos consecuencia del datatón i2b2/UTHealth NLP Challenge
Jonnagaddala et al. (2015) <sup>190</sup>	Identification and Progression of Heart Disease Risk Factors in Diabetic Patients from Longitudinal Electronic Health Records	NLP	Identificación automática de factores de riesgo cardiovascular a partir de textos
Chen et al. (2015) <sup>191</sup>	An automatic system to identify heart disease risk factors in clinical texts over time	NLP	Identificación automática de factores de riesgo cardiovascular a partir de textos
Isma'eel et al. (2016) <sup>192</sup>	Artificial neural network modeling enhances risk stratification and can reduce downstream testing for patients with suspected acute coronary syndromes, negative cardiac biomarkers, and normal ECGs	DL	Uso de redes neuronales artificiales para mejorar la estratificación de riesgo y la predicción de isquemia miocárdica

Tylman et al. (2016) <sup>193</sup>	Real-time prediction of acute cardiovascular events using hardware-implemented Bayesian networks	ML	Sistema de apoyo en la estimación del estado general de un paciente y riesgo de eventos cardiovasculares
Churpek et al. (2016) <sup>194</sup>	Multicenter Comparison of Machine Learning Methods and Conventional Regression for Predicting Clinical Deterioration on the Wards	ML	Algoritmo de detección para identificar pacientes críticamente enfermos en plantas de hospitalización
Wiharto et al. (2016) <sup>195</sup>	Intelligence System for Diagnosis Level of Coronary Heart Disease with K-Star Algorithm	ML	Sistema para predecir enfermedad coronaria
Hoyt et al. (2016) <sup>196</sup>	Digital Family History Data Mining with Neural Networks: A Pilot Study	DL	Sistema basado en redes neuronales para predecir riesgo de padecer diabetes, hipertensión o enfermedad coronaria
Araki et al. (2016) <sup>197</sup>	A new method for IVUS-based coronary artery disease risk stratification: A link between coronary & carotid ultrasound plaque burdens	ML	Evaluación de riesgo coronario mediante la combinación de la escala de grises de placas ateroscleróticas por IVUS y gorsor íntima-media carotidea
Araki et al. (2016) <sup>198</sup>	PCA-based polling strategy in machine learning framework for coronary artery disease risk assessment in intravascular ultrasound: A link between carotid and coronary grayscale plaque morphology	ML	Sistema de evaluación de riesgo utilizando el análisis de morfología de placas de ateroma
Celutkiene et al. (2016) <sup>199</sup>	Combination of single quantitative parameters into multiparametric model for ischemia detection is not superior to visual assessment during dobutamine stress echocardiography	ML	Modelo para detectar isquemia miocárdica durante la ecocardiografía de estrés
Motwani et al. (2016) <sup>200</sup>	Machine learning for prediction of all-cause mortality in patients with suspected coronary artery disease: a 5-year multicentre prospective registry analysis	ML	Sistema de predicción de mortalidad en pacientes con sospecha de cardiopatía isquémica sometidos a TC coronario
Afarideh et al. (2016) <sup>201</sup>	Complex association of serum alanine aminotransferase with the risk of future cardiovascular disease in type 2 diabetes	DL	Evaluación de la asociación prospectiva entre los niveles séricos ALT y enfermedad cardiovascular en diabéticos tipo 2 usando redes neuronales

Liu et al. (2016) <sup>202</sup>	Beatquency domain and machine learning improve prediction of cardiovascular death after acute coronary syndrome	ML	Evaluación de la frecuencia y dominios de frecuencia en la predicción de riesgo tras un síndrome coronario agudo
Ross et al. (2016) <sup>203</sup>	The use of machine learning for the identification of peripheral artery disease and future mortality risk	ML	Algoritmo para predecir mortalidad a partir de pacientes sometidos a angiografía coronaria
Lopez-de-Andres et al. (2016) <sup>204</sup>	Predictors of in-hospital mortality following major lower extremity amputations in type 2 diabetic patients using artificial neural networks	DL	Predicción de mortalidad en pacientes diabéticos sometidos amputados
Hu et al. (2016) <sup>205</sup>	Utilizing Chinese Admission Records for MACE Prediction of Acute Coronary Syndrome	ML	Predicción de sucesos adversos cardiovasculares tras síndrome coronario agudo
Narain et al. (2016) <sup>206</sup>	Cardiovascular risk prediction: a comparative study of Framingham and quantum neural network based approach	DL	Predicción del riesgo cardiovascular comparado con el score clásico de Framingham
Spertus et al. (2016) <sup>207</sup>	Assessing Hospital Performance After Percutaneous Coronary Intervention Using Big Data	ML	Evaluación mortalidad en pacientes sometidos a revascularización percutánea
Mirian et al. (2016) <sup>208</sup>	A Hybrid ANN-GA Model to Prediction of Bivariate Binary Responses: Application to Joint Prediction of Occurrence of Heart Block and Death in Patients with Myocardial Infarction	DL	Predicción de muerte o bloqueo AV en pacientes con infarto de miocardio
Orphanou et al. (2016) <sup>209</sup>	DBN-Extended: A Dynamic Bayesian Network Model Extended With Temporal Abstractions for Coronary Heart Disease Prognosis	DL	Predicción de enfermedad coronaria
Berikol et al. (2016) <sup>210</sup>	Diagnosis of Acute Coronary Syndrome with a Support Vector Machine	ML	Clasificación de síndrome coronario agudo en unidades de dolor torácico en urgencias
Verma et al. (2016) <sup>211</sup>	A Hybrid Data Mining Model to Predict Coronary Artery Disease Cases Using Non-Invasive Clinical Data	ML	Predicción de enfermedad coronaria a partir de datos clínicos

McRae et al. (2016) <sup>212</sup>	Programmable Bio-nanochip Platform: A Point-of-Care Biosensor System with the Capacity To Learn	ML	“Point of care” nanochip en combinación con algoritmos computacionales para el diagnóstico de infarto agudo de miocardio y otras enfermedades
Karimi et al. (2017) <sup>213</sup>	A Combination of Constitutive Damage Model and Artificial Neural Networks to Characterize the Mechanical Properties of the Healthy and Atherosclerotic Human Coronary Arteries	DL	Predicción de remodelado de las fibras de colágeno de las arterias coronarias
Schafer et al. (2017) <sup>214</sup>	Titin-truncating variants affect heart function in disease cohorts and the general population	ML	Asociación de variantes del gen de titina con variables clínicas y de imagen en el desarrollo de miocardiopatía dilatada en humanos y modelos animales
Arabasadi et al. (2017) <sup>215</sup>	Computer aided decision making for heart disease detection using hybrid neural network-Genetic algorithm	DL	Modelo para diagnosticar enfermedad coronaria
Podda et al. (2017) <sup>216</sup>	Prediction of high on-treatment platelet reactivity in clopidogrel-treated patients with acute coronary syndromes	ML, DL	Predicción de reactividad plaquetaria en pacientes que reciben clopidogrel tras síndrome coronario agudo
Alghamdi et al. (2017) <sup>217</sup>	Predicting diabetes mellitus using SMOTE and ensemble machine learning approach: The Henry Ford Exercise Testing (FIT) project	ML	Predicción de diabetes en pacientes sin enfermedad coronaria o insuficiencia cardiaca conocidas sometidos a prueba de esfuerzo
Gao et al. (2017) <sup>218</sup>	Changes and classification in myocardial contractile function in the left ventricle following acute myocardial infarction	ML	Identificación de incremento de la tensión en la pared ventricular izquierda como signo indirecto de aumento en la demanda contráctil de los segmentos adyacentes al infarto
Shah et al. (2017) <sup>219</sup>	Association of Multiorgan Computed Tomographic Phenomap With Adverse Cardiovascular Health Outcomes: The Framingham Heart Study	ML	Riesgo de enfermedad cardiaca (infarto, ictus o muerte cardiovascular) en participantes del estudio Framingham sometidos a TC tóracoabdominal
Oguz et al. (2017) <sup>220</sup>	Genotype-driven identification of a molecular network predictive of advanced coronary calcium in ClinSeq <sup>®</sup> and Framingham Heart Study cohorts	ML, DL	Predictor de encontrar calcio coronario



Hu et al. (2017) <sup>221</sup>	Acute Coronary Syndrome Risk Prediction Based on GRACE Risk Score	ML	Estimación de riesgo en el síndrome coronario agudo comparado con el score GRACE
Karimi et al. (2017) <sup>222</sup>	A combination of experimental and numerical methods to investigate the role of strain rate on the mechanical properties and collagen fiber orientations of the healthy and atherosclerotic human coronary arteries	DL	Predicción de la alteración del ángulo de las fibras de colágeno en arterias coronarias ateroscleróticas
Lee et al. (2017) <sup>223</sup>	Physiome approach for the analysis of vascular flow reserve in the heart and brain	ML	Algoritmo automático para estimar la reserva de flujo coronario a partir de datos existentes de simulación fisiómica
Weng et al. (2017) <sup>224</sup>	Can machine-learning improve cardiovascular risk prediction using routine clinical data?	ML	Predicción del primer evento cardiovascular a 10 años, estimado el riesgo cardiovascular
Forssen et al. (2017) <sup>225</sup>	Evaluation of Machine Learning Methods to Predict Coronary Artery Disease Using Metabolomic Data	ML	Predicción de enfermedad coronaria a partir de datos metabolómicos
Takeuchi et al. (2017) <sup>226</sup>	Novel Risk Assessment Tool for Immunoglobulin Resistance in Kawasaki Disease: Application Using a Random Forest Classifier	ML	Algoritmo para predecir la resistencia del tratamiento con inmunoglobulina en la enfermedad coronaria de Kawasaki en niños
Buchan et al. (2017) <sup>227</sup>	Automatic prediction of coronary artery disease from clinical narratives	NLP	Predicción de enfermedad coronaria a partir del análisis de texto de historias clínicas
Wallert et al. (2017) <sup>228</sup>	Predicting two-year survival versus non-survival after first myocardial infarction using machine learning and Swedish national register data	ML	Predicción de mortalidad tras infarto agudo de miocardio con datos procedentes del registro SWEDEHEART
Ambale-Venkatesh et al. (2017) <sup>229</sup>	Cardiovascular Event Prediction by Machine Learning: The Multi-Ethnic Study of Atherosclerosis	ML	Predicción de sucesos cardiovasculares en comparación con scores de riesgo cardiovascular clásicos
Basu et al. (2017) <sup>230</sup>	Development and validation of Risk Equations for Complications Of type 2 Diabetes (RECODe) using individual participant data from randomised trials	ML	Predicción de sucesos cardiovasculares en diabéticos a partir de datos demográficos, clínicos, comorbilidades, medicación y biomarcadores

Shouval et al. (2017) <sup>231</sup>	Machine learning for prediction of 30-day mortality after ST elevation myocardial infraction: An Acute Coronary Syndrome Israeli Survey data mining study	ML	Predicción de mortalidad a 30 días en pacientes con infarto agudo de miocardio con elevación del segmento ST y comparación con scores clásicos
Kim et al. (2017) <sup>232</sup>	Neural Network-Based Coronary Heart Disease Risk Prediction Using Feature Correlation Analysis	DL	Predicción de riesgo cardiovascular comparado con otros scores clásicos
El-Askary et al. (2017) <sup>233</sup>	Remote sensing observation of annual dust cycles and possible causality of Kawasaki disease outbreaks in Japan	DL	Modelo predictivo de brotes para la enfermedad de Kawasaki con el objetivo final de pronosticar e intervenir de forma temprana utilizando un sistema de alerta temprana
Huang et al. (2017) <sup>234</sup>	MACE prediction of acute coronary syndrome via boosted resampling classification using electronic medical records	ML	Predicción de sucesos cardiovasculares adversos en pacientes con síndrome coronario agudo
Isma'eel et al. (2018) <sup>235</sup>	Artificial neural network-based model enhances risk stratification and reduces non-invasive cardiac stress imaging compared to Diamond-Forrester and Morise risk assessment models: A prospective study	DL	Predicción de enfermedad coronaria en sujetos sometidos a test de isquemia
Tao et al (2018) <sup>236</sup>	Magnetocardiography based Ischemic Heart Disease Detection and Localization using Machine Learning Methods	ML	Algoritmo de localización automática de isquemia miocárdica a partir del análisis de la onda T
Hae et al. (2018) <sup>237</sup>	Machine learning assessment of myocardial ischemia using angiography: Development and retrospective validation	ML	Sistema para predecir territorios isquémicos
Shi et al. (2018) <sup>238</sup>	Vulnerable Plaque Recognition Based on Attention Model with Deep Convolutional Neural Network	DL	Identificación de placas vulnerables con datos provenientes del datatón 2017 CCCV-IVOCT Challenge
Pieszko et al. (2018) <sup>239</sup>	Machine-learned models using hematological inflammation markers in the prediction of short-term acute coronary syndrome outcomes	ML	Algoritmo de predicción de sucesos adversos en el síndrome coronario agudo utilizando marcadores inflamatorios

van Rosendaal et al. (2018) <sup>240</sup>	Maximization of the usage of coronary CTA derived plaque information using a machine learning based algorithm to improve risk stratification; insights from the CONFIRM registry	ML	Predicción del riesgo cardiovascular con la información del árbol coronario de 16 segmentos derivada de TC y comparación con escalas convencionales
Duggal et al. (2018) <sup>241</sup>	Survival outcomes post percutaneous coronary intervention: Why the hype about stent type? Lessons from a healthcare system in India	ML	Algoritmo para predecir sucesos cardiovasculares tras el intervencionismo percutáneo coronario
Alizadehsani et al. (2018) <sup>242</sup>	Non-invasive detection of coronary artery disease in high-risk patients based on the stenosis prediction of separate coronary arteries	ML	Algoritmo de identificación de enfermedad coronaria que especifica arteria coronaria afectada
Xiao et al. (2018) <sup>243</sup>	A Deep Learning Approach to Examine Ischemic ST Changes in Ambulatory ECG Recordings	DL	Identificador de cambios en el ST para detectar isquemia precoz
Rose et al. (2018) <sup>244</sup>	Double robust estimation for multiple unordered treatments and clustered observations: Evaluating drug-eluting coronary artery stents	ML	Evaluación de stents farmacológicos a través de datos heterogéneos
Dozio et al. (2018) <sup>245</sup>	Plasma fatty acid profile as biomarker of coronary artery disease: a pilot study using fourth generation artificial neural networks	DL	Papel diagnóstico de los ácidos grasos en el diagnóstico de la enfermedad coronaria
Steele et al. (2018) <sup>246</sup>	Machine learning models in electronic health records can outperform conventional survival models for predicting patient mortality in coronary artery disease	ML	Predicción de muerte en la enfermedad coronaria
Zellweger et al. (2018) <sup>247</sup>	A new non-invasive diagnostic tool in coronary artery disease: artificial intelligence as an essential element of predictive, preventive, and personalized medicine	ML	Estimación del riesgo coronario en comparación con el score de Framingham
Body (2018) <sup>248</sup>	Acute coronary syndromes diagnosis, version 2.0: Tomorrow's approach to diagnosing acute coronary syndromes?	ML	Identificación de síndrome coronario agudo en el dolor torácico en urgencias

Yahyaie et al. (2018) <sup>249</sup>	Use of Internet of Things to Provide a New Model for Remote Heart Attack Prediction	DL	Modelo predictivo para sucesos cardiacos adversos siguiendo el concepto "Internet of Things" es decir dispositivos con acceso a internet que permite estratificación inmediata
Brown et al. (2018) <sup>250</sup>	Does Twitter language reliably predict heart disease? A commentary on Eichstaedt et al. (2015a)	ML	Análisis de las expresiones utilizadas en Twitter (categorizadas como buen o mal lenguaje) y su asociación con mortalidad isquémica
McAllister et al. (2018) <sup>251</sup>	Combining deep residual neural network features with supervised machine learning algorithms to classify diverse food image datasets	DL	Clasificación por imagen del tipo de comida para control dietético en pacientes diabéticos o con riesgo cardiovascular
Zhang et al. (2018) <sup>252</sup>	Predicting Locations of High-Risk Plaques in Coronary Arteries in Patients Receiving Statin Therapy	ML	Predicción de localización y tipo de placa aterosclerótica coronaria en pacientes de alto riesgo con estatinas
Huang et al. (2018) <sup>253</sup>	A Regularized Deep Learning Approach for Clinical Risk Prediction of Acute Coronary Syndrome Using Electronic Health Records	DL	Estratificación clínica en pacientes con síndrome coronario agudo
Tan et al. (2018) <sup>254</sup>	Application of stacked convolutional and long short-term memory network for accurate identification of CAD ECG signals	DL	Detección automática de signos de isquemia miocárdica a partir de señales electrocardiográficas
Margulis et al. (2018) <sup>255</sup>	Combining Desorption Electrospray Ionization Mass Spectrometry Imaging and Machine Learning for Molecular Recognition of Myocardial Infarction	ML	Modelo para diferenciar infarto de miocardio por espectrometría de masas en modelo animal murino
Yang et al. (2018) <sup>256</sup>	Multi-dimensional proprio-proximus machine learning for assessment of myocardial infarction	ML	Clasificación de grado de infarto en regiones del ventrículo izquierdo basado en información extraída de resonancia magnética
Kigka et al. (2018) <sup>257</sup>	A Machine Learning Approach for the Prediction of the Progression of Cardiovascular Disease based on Clinical and Non-Invasive Imaging Data	ML	Predicción de enfermedad coronaria a partir de datos clínicos y de imagen

Singh et al. (2018) <sup>258</sup>	Effective heart disease prediction system using data mining techniques	DL	Sistema de predicción de enfermedad coronaria a partir de datos como edad, sexo, presión arterial, colesterol y obesidad.
Haro Alonso et al. (2018) <sup>259</sup>	Prediction of cardiac death after adenosine myocardial perfusion SPECT based on machine learning	ML	Predicción de muerte cardiovascular a partir de datos clínicos y de SPECT
Naushad et al. (2018) <sup>260</sup>	Machine learning algorithm-based risk prediction model of coronary artery disease	ML	Modelo predictivo de enfermedad coronaria y porcentaje de estenosis
Stuckey et al. (2018) <sup>261</sup>	Cardiac Phase Space Tomography: A novel method of assessing coronary artery disease utilizing machine learning	ML	Determinación del rendimiento diagnóstico del análisis del TC en el espacio espacial en pacientes con dolor torácico remitidos para angiografía coronaria
Good et al. (2018) <sup>262</sup>	Temporal Performance of Laplacian Eigenmaps and 3D Conduction Velocity in Detecting Ischemic Stress	ML	Detección de isquemia aguda por el análisis automático electrocardiográfico en modelo animal
Chen et al. (2018) <sup>263</sup>	A Meta-Prediction of Methylenetetrahydrofolate-Reductase Polymorphisms and Air Pollution Increased the Risk of Ischemic Heart Diseases Worldwide	ML	Análisis entre los polimorfismos de la metileno tetrahidrofolato reductasa y el riesgo de enfermedad coronaria
Öman et al. (2019) <sup>264</sup>	3D convolutional neural networks applied to CT angiography in the detection of acute ischemic stroke	DL	Detección de lesiones isquémicas en angiografías por tomografía computarizada
Heo et al. (2019) <sup>265</sup>	Machine Learning-Based Model for Prediction of Outcomes in Acute Stroke	ML	Predicción de evolución de pacientes infarto agudo basado en modelos machine learning
Vallée et al. (2019) <sup>266</sup>	Coronary heart disease diagnosis by artificial neural networks including aortic pulse wave velocity index and clinical parameters	DL	Clasificación de riesgo de enfermedad coronaria con redes neuronales artificiales a partir de datos clínicos y velocidades de pulso aórtico
Balanescu et al. (2019) <sup>267</sup>	A Cancer Paradox: Machine-Learning Backed Propensity-Score Analysis of Coronary Angiography Findings in Cardio-Oncology	ML	Evaluación del riesgo de enfermedad cardiovascular en pacientes oncológicos
Zabihollahy et al. (2019) <sup>268</sup>	Convolutional neural network-based approach for segmentation of left ventricle myocardial scar from 3D late gadolinium enhancement MR images	DL	Segmentación de lesiones en el miocardio del ventrículo izquierdo en imágenes por resonancia magnética con realce tardío de gadolinio

Yu et al. (2019) <sup>269</sup>	The best predictor of ischemic coronary stenosis: subtended myocardial volume, machine learning-based FFRCT, or high-risk plaque features?	ML	Comparativa de predictores de estenosis coronaria con isquemia, con FFRCT basada en machine learning, entre ellos
Vernon et al. (2019) <sup>270</sup>	Utilizing state-of-the-art "omics" technology and bioinformatics to identify new biological mechanisms and biomarkers for coronary artery disease	ML	Utilización del estado del arte en tecnologías ómicas, bioinformática y machine learning para la identificación de nuevos mecanismos y biomarcadores de enfermedad coronaria
Chen et al. (2019) <sup>271</sup>	Prediction of cardiovascular outcomes with machine learning techniques: application to the Cardiovascular Outcomes in Renal Atherosclerotic Lesions (CORAL) study	ML	Predicción de diagnósticos. Aplicación al estudio CORAL (Cardiovascular Outcomes in Renal Atherosclerotic Lesions)
Li et al. (2019) <sup>272</sup>	Unhealthy Behaviors, Prevention Measures, and Neighborhood Cardiovascular Health: A Machine Learning Approach	ML	Identificación de predictores de enfermedad coronaria e infarto a partir de datos poblacionales, geográficos y de hábitos saludables
Freiman et al. (2019) <sup>273</sup>	Unsupervised abnormality detection through mixed structure regularization (MSR) in deep sparse autoencoders	DL	Detección automática de lesiones
Goto et al. (2019) <sup>274</sup>	Artificial intelligence to predict needs for urgent revascularization from 12-leads electrocardiography in emergency patients	ML	Inteligencia artificial para la predicción de revascularizaciones urgentes a partir de electrocardiografía de 12 señales en pacientes en unidades de emergencia
Pieszko et al. (2019) <sup>275</sup>	Predicting Long-Term Mortality after Acute Coronary Syndrome Using Machine Learning Techniques and Hematological Markers	ML	Predicción de mortalidad a largo plazo tras síndrome coronario agudo
Cho et al. (2019) <sup>276</sup>	Angiography-Based Machine Learning for Predicting Fractional Flow Reserve in Intermediate Coronary Artery Lesions	ML	Cálculo de la reserva fraccional de flujo en coronarias con lesiones intermedias basado en angiografía
Duan et al. (2019) <sup>277</sup>	Utilizing dynamic treatment information for MACE prediction of acute coronary syndrome	DL	Predicción de síndrome coronario agudo a partir de registros clínicos electrónicos

Bazylev et al. (2019) <sup>278</sup>	[Predictors of early occlusion of coronary bypass grafts in patients with extremely low ejection fraction]	ML	Identificación de predictores de oclusión de bypasses coronarios en pacientes con fracción de eyección severamente deprimida
Adela et al. (2019) <sup>279</sup>	Serum protein signature of coronary artery disease in type 2 diabetes mellitus	ML	Identificación de biomarcadores proteínicos de enfermedad coronaria en pacientes de diabetes tipo 2
Sharma et al. (2019) <sup>280</sup>	Patient Phenotypes, Cardiovascular Risk, and Ezetimibe Treatment in Patients After Acute Coronary Syndromes (from IMPROVE-IT)	ML	Fenotipado, estratificación de riesgo y tratamiento en pacientes de síndrome coronario agudo

DL: *deep learning* (aprendizaje profundo); ML: *machine learning* (aprendizaje automático); NLP: *natural language processing* (procesamiento del lenguaje natural).

**Tabla 3 del material adicional**

Publicaciones inteligencia artificial en insuficiencia cardiaca

Referencia	Título	Modalidad	Observación
Myers et al. (2014) <sup>281</sup>	A neural network approach to predicting outcomes in heart failure using cardiopulmonary exercise testing	DL	Predicción de mortalidad en pacientes con insuficiencia cardiaca crónica a partir de datos de la ergoespirometría
Schmitz et al. (2014) <sup>282</sup>	Identification of genetic markers for treatment success in heart failure patients: insight from cardiac resynchronization therapy	ML	Identificación de respondedores a la terapia de resincronización a partir de datos clínicos y variantes genéticas
Ooi et al. (2014) <sup>283</sup>	Robust aortic valve non-opening detection for different cardiac conditions	ML	Detección automática del grado de apertura valvular aórtico en la optimización de asistencias ventriculares y recuperación miocárdica
Bondar et al. (2014) <sup>284</sup>	Comparison of whole blood and peripheral blood mononuclear cell gene expression for evaluation of the perioperative inflammatory response in patients with advanced heart failure	ML	Predicción de fallo multiorgánico en insuficiencia cardiaca a partir del análisis de genes compartidos por células mononucleares periféricas y sangre total
Summers et al. (2014) <sup>285</sup>	Functionality of empirical model-based predictive analytics for the early detection of hemodynamic instability	ML	Simulador computacional de inestabilizaciones hemodinámicas
Guidi et al. (2015) <sup>286</sup>	A multi-layer monitoring system for clinical management of Congestive Heart Failure	ML	Sistema de monitorización remota para pacientes con insuficiencia cardiaca
Nilsson et al. (2015) <sup>287</sup>	The International Heart Transplant Survival Algorithm (IHTSA): a new model to improve organ sharing and survival	ML	Predicción de supervivencia en pacientes trasplantados
Meystre et al. (2015) <sup>288</sup>	Heart Failure Medications Detection and Prescription Status Classification in Clinical Narrative Documents	ML	Identificación de tratamiento médico en pacientes con insuficiencia cardiaca



Xu et al. (2015) <sup>289</sup>	Multi-objective optimization of pulsatile ventricular assist device hemocompatibility based on neural networks and a genetic algorithm	DL	Optimización de la hemocompatibilidad de las asistencias ventriculares
Alonso-Betanzos et al. (2015) <sup>290</sup>	Exploring Guidelines for Classification of Major Heart Failure Subtypes by Using Machine Learning	ML	Clasificación del tipo de insuficiencia cardiaca (con FE reducida o preservada) determinando el punto de corte ideal de la FE
Mohammadzadeh et al. (2015) <sup>291</sup>	Chronic Heart Failure Follow-up Management Based on Agent Technology	ML	Monitorización de insuficiencia cardiaca
Liu et al. (2015) <sup>292</sup>	Blood pressure and heart rate from the arterial blood pressure waveform can reliably estimate cardiac output in a conscious sheep model of multiple hemorrhages and resuscitation using computer machine learning approaches	ML	Estimación del gasto cardiaco en un modelo animal
Steventon et al. (2016) <sup>293</sup>	Effect of telehealth on hospital utilisation and mortality in routine clinical practice: a matched control cohort study in an early adopter site	ML	Sistema de monitorización en domicilio en pacientes con insuficiencia cardiaca
Sideris et al. (2016) <sup>294</sup>	A flexible data-driven comorbidity feature extraction framework	ML	Sistema no supervisado para predecir evolución en una cohorte extensa que incluye pacientes con insuficiencia cardiaca
Hou et al. (2016) <sup>295</sup>	[Investigation into Feasibility of Congestive Heart Failure Diagnosis Based on Analysis of Very Short-term Heart Rate Variability]	DL	Análisis de la variabilidad de la frecuencia cardiaca en el diagnóstico de insuficiencia cardiaca
Blecker et al. (2016) <sup>296</sup>	Comparison of Approaches for Heart Failure Case Identification From Electronic Health Record Data	ML	Desarrollo de un algoritmo que utilizando datos clínicos identifica pacientes con insuficiencia cardiaca
Karanasiou et al. (2016) <sup>297</sup>	Predicting adherence of patients with HF through machine learning techniques	ML	Sistema de predicción de adherencia terapéutica en pacientes con insuficiencia cardiaca
Altan et al. (2016) <sup>298</sup>	A new approach to early diagnosis of congestive heart failure disease by using Hilbert-Huang transform	DL	Clasificación de pacientes con insuficiencia cardiaca o enfermedad coronaria a partir de datos del ECG

Mortazavi et al. (2016) <sup>299</sup>	Analysis of Machine Learning Techniques for Heart Failure Readmissions	ML	Predicción de reingresos hospitalarios en insuficiencia cardiaca
Farhan et al. (2016) <sup>300</sup>	A Predictive Model for Medical Events Based on Contextual Embedding of Temporal Sequences	ML	Modelo predictivo combinando diferentes variables (diagnóstica, prescripciones, test laboratorios) aplicado a la insuficiencia cardiaca
Argerich et al. (2016) <sup>301</sup>	Evaluation of periodic breathing in respiratory flow signal of elderly patients using SVM and linear discriminant analysis	ML	Identificación de insuficiencia cardiaca mediante el análisis de la amplitud del patrón respiratorio
Ng et al. (2016) <sup>302</sup>	Early Detection of Heart Failure Using Electronic Health Records: Practical Implications for Time Before Diagnosis, Data Diversity, Data Quantity, and Data Density	ML	Predicción de insuficiencia cardiaca en atención primaria
Tsai et al. (2016) <sup>303</sup>	Length of Hospital Stay Prediction at the Admission Stage for Cardiology Patients Using Artificial Neural Network	DL	Predicción de la estancia hospitalaria en tres patologías: insuficiencia cardiaca, infarto de miocardio y aterosclerosis coronaria
Masetic et al. (2016) <sup>304</sup>	Congestive heart failure detection using random forest classifier	ML, DL	Diagnóstico de insuficiencia cardiaca a partir de datos electrocardiográficos
Buzaev et al. (2016) <sup>305</sup>	Artificial intelligence: Neural network model as the multidisciplinary team member in clinical decision support to avoid medical mistakes	DL	Predicción de éxito de revascularización (quirúrgico vs. Percutáneo) en pacientes con enfermedad coronaria
Choi et al. (2017) <sup>306</sup>	Using recurrent neural network models for early detection of heart failure onset	DL	Sistema para mejora en el diagnóstico inicial de insuficiencia cardiaca
Frizell et al. (2017) <sup>307</sup>	Prediction of 30-Day All-Cause Readmissions in Patients Hospitalized for Heart Failure: Comparison of Machine Learning and Other Statistical Approaches	ML	Predicción de rehospitalizaciones en insuficiencia cardiaca
Shameer et al. (2017) <sup>308</sup>	Predictive Modeling of Hospital Readmission Rates Using Electronic Medical Record-Wide Machine Learning: A Case-Study Using Mount Sinai Heart Failure Cohort	ML	Predicción de reingresos hospitalarios en insuficiencia cardiaca

Katz et al. (2017) <sup>309</sup>	Phenomapping for the Identification of Hypertensive Patients with the Myocardial Substrate for Heart Failure with Preserved Ejection Fraction	ML	Algoritmo de identificación de pacientes hipertensos que puedan desarrollar insuficiencia cardiaca con función ventricular conservada
Zhang et al. (2017) <sup>310</sup>	Automatic Methods to Extract New York Heart Association Classification from Clinical Notes	NLP	Identificación de la clase funcional a partir de notas en la historia electrónica
Sanchez-Martinez et al. (2017) <sup>311</sup>	Characterization of myocardial motion patterns by unsupervised multiple kernel learning	ML	Caracterización automática de los patrones de respuesta al estrés en la insuficiencia cardiaca con fracción de eyección preservada
Meystre et al. (2017) <sup>312</sup>	Congestive heart failure information extraction framework for automated treatment performance measures assessment	NLP	Optimización del tratamiento médico de la insuficiencia cardiaca utilizando sistemas de reconocimiento automático de texto
Gleeson et al. (2017) <sup>313</sup>	ECG-derived spatial QRS-T angle is associated with ICD implantation, mortality and heart failure admissions in patients with LV systolic dysfunction	ML	Algoritmo de predicción pronóstica en pacientes con insuficiencia cardiaca con fracción de eyección entre 31-40% evaluando la relación entre el ángulo espacial QRS-T
Xing et al. (2017) <sup>314</sup>	Machine-Learning-Assisted Approach for Discovering Novel Inhibitors Targeting Bromodomain-Containing Protein 4	ML	Predicción de la probabilidad que un compuesto sea un inhibidor de la proteína 4 que contiene bromodominio (BRD4) implicada en la patogénesis de la insuficiencia cardiaca
Iborra-Egea et al. (2017) <sup>315</sup>	Mechanisms of action of sacubitril/valsartan on cardiac remodeling: a systems biology approach	ML	Sistema <i>in silico</i> para conocer los mecanismos de acción del sacubitrilo-valsartán
Oskouie et al. (2017) <sup>316</sup>	Differences in Repolarization Heterogeneity Among Heart Failure With Preserved Ejection Fraction Phenotypic Subgroups	ML	Diferenciación entre diferentes grupos de insuficiencia cardiaca con fracción de eyección preservada en función de la heterogeneidad de la repolarización electrocardiográfica

Steinhoff et al. (2017) <sup>317</sup>	Cardiac Function Improvement and Bone Marrow Response -: Outcome Analysis of the Randomized PERFECT Phase III Clinical Trial of Intramyocardial CD133+ Application After Myocardial Infarction	ML	Identificación de respondedores a terapia celular tras infarto de miocardio y mala función ventricular
Al-Mallah et al. (2017) <sup>318</sup>	Using Machine Learning to Define the Association between Cardiorespiratory Fitness and All-Cause Mortality (from the Henry Ford Exercise Testing Project)	ML	Predicción de mortalidad a 10 años en una cohorte de pacientes que fueron sometidos a prueba de esfuerzo
Myers et al. (2017) <sup>319</sup>	Machine Learning Improves Risk Stratification After Acute Coronary Syndrome	ML	Predicción mortalidad en el síndrome coronario agudo sin elevación del segmento ST
van der Ster et al. (2017) <sup>320</sup>	Support Vector Machine Based Monitoring of Cardio-Cerebrovascular Reserve during Simulated Hemorrhage	ML	Algoritmo para predecir parámetros hemodinámicos que facilitarían la detección del shock hipovolémico
Wenhu et al. (2017) <sup>321</sup>	A CHF detection method based on deep learning with RR intervals	DL	Detección de insuficiencia cardiaca basada en el análisis de la variabilidad de frecuencia cardiaca
Mustaqeem et al. (2017) <sup>322</sup>	A statistical analysis based recommender model for heart disease patients	ML	Modelo predictivo de enfermedad coronaria y recomendaciones medicamentosas
Sakr et al. (2017) <sup>323</sup>	Comparison of machine learning techniques to predict all-cause mortality using fitness data: the Henry ford exercise testing (FIT) project	ML	Predicción de mortalidad utilizando datos provenientes de ergometría
Au-Yeung et al. (2018) <sup>324</sup>	Development and validation of warning system of ventricular tachyarrhythmia in patients with heart failure with heart rate variability data	ML	Algoritmo para predecir arritmias ventriculares utilizando la variabilidad de la frecuencia cardiaca en pacientes con DAI procedentes del estudio SCD-HeFT
Wang et al. (2018) <sup>325</sup>	CHF Detection with LSTM Neural Network	DL	Clasificación de insuficiencia cardiaca a partir de la variabilidad de la frecuencia cardiaca
Zhang et al. (2018) <sup>326</sup>	Congestive Heart Failure Detection Via Short-Time Electrocardiographic Monitoring For Fast Reference Advice In Urgent Medical Conditions	DL, ML	Clasificación de insuficiencia cardiaca utilizando intervalos RR, variabilidad frecuencia cardiaca y datos clínicos

McKinley et al. (2018) <sup>327</sup>	Impact of a Pharmacist-Led Intervention on 30-Day Readmission and Assessment of Factors Predictive of Readmission in African American Men With Heart Failure	ML	Sistema de predicción de reingreso por insuficiencia cardiaca en afro-americanos sometidos a un sistema de adherencia e intervención farmacológica
Xiao et al. (2018) <sup>328</sup>	Readmission prediction via deep contextual embedding of clinical concepts	DL	Modelo de predicción de reingresos hospitalarios en pacientes con insuficiencia cardiaca
Wang et al. (2018) <sup>329</sup>	Mortality prediction system for heart failure with orthogonal relief and dynamic radius means	ML	Sistema de predicción de mortalidad en insuficiencia cardiaca
Mahajan et al. (2018) <sup>330</sup>	Predicting Risk of 30-Day Readmissions Using Two Emerging Machine Learning Methods	ML	Predicción de reingreso en paciente con insuficiencia cardiaca
Rasmy et al. (2018) <sup>331</sup>	A study of generalizability of recurrent neural network-based predictive models for heart failure onset risk using a large and heterogeneous EHR data set	DL	Predicción de insuficiencia cardiaca
Lindholm et al. (2018) <sup>332</sup>	Bioimpedance and New-Onset Heart Failure: A Longitudinal Study of >500 000 Individuals From the General Population	ML	Establecer nuevos factores de riesgo de insuficiencia cardiaca para un diagnóstico precoz y tratamiento preventivo
Kwon et al. (2018) <sup>333</sup>	RetainVis: Visual Analytics with Interpretable and Interactive Recurrent Neural Networks on Electronic Medical Records	DL	Sistema interactivo para la predicción de riesgo basado en códigos médicos individuales usado en insuficiencia cardiaca
Kakarmath et al. (2018) <sup>334</sup>	Validating a Machine Learning Algorithm to Predict 30-Day Re-Admissions in Patients With Heart Failure: Protocol for a Prospective Cohort Study	ML	Predicción rehospitalización en pacientes con insuficiencia cardiaca
Tabassian et al. (2018) <sup>335</sup>	Diagnosis of Heart Failure With Preserved Ejection Fraction: Machine Learning of Spatiotemporal Variations in Left Ventricular Deformation	ML	Análisis del tiempo, amplitud y deformación ventricular izquierda durante el ciclo cardiaco como criterios diagnósticos de insuficiencia cardiaca con función sistólica preservada
Bose et al. (2018) <sup>336</sup>	Using Unsupervised Machine Learning to Identify Subgroups Among Home Health Patients With Heart Failure Using Telehealth	ML	Identificación de usuarios ideales para monitorización domiciliaria con insuficiencia cardiaca

Michalik et al. (2018) <sup>337</sup>	An interactive assistant for patients with cardiac implantable electronic devices: A study protocol of the LUCY trial	ML	Diseño de un estudio multicéntrico para encontrar un modelo predictivo que identifique beneficiarios de un seguimiento de dispositivos implantables en pacientes con insuficiencia cardiaca
Seah et al. (2018) <sup>338</sup>	Chest Radiographs in Congestive Heart Failure: Visualizing Neural Network Learning	DL	Diagnóstico de insuficiencia cardiaca a partir de la clasificación de radiografías de tórax convencionales
Kashihara (2018) <sup>339</sup>	Nonlinear System Identification Based on Convolutional Neural Networks for Multiple Drug Interactions	DL	Predicción de la respuesta hemodinámica a agentes inotrópicos y vasodilatadores
Etemadi et al. (2018) <sup>340</sup>	Wearable ballistocardiogram and seismocardiogram systems for health and performance	ML	Estimación automática del gasto cardiaco, contractilidad y presión arterial con dispositivos móviles
Dogan et al. (2018) <sup>341</sup>	Integrated genetic and epigenetic prediction of coronary heart disease in the Framingham Heart Study	ML	Predicción de enfermedad coronaria utilizando información del estudio Framingham que incluye datos genéticos
Inan et al. (2018) <sup>342</sup>	Novel Wearable Seismocardiography and Machine Learning Algorithms Can Assess Clinical Status of Heart Failure Patients	ML	Clasificación en estados de descompensación de insuficiencia cardiaca utilizando dispositivos móviles y la respuesta de la frecuencia cardiaca al ejercicio submáximo
Medved et al. (2018) <sup>343</sup>	Improving prediction of heart transplantation outcome using deep learning techniques	DL	Predicción de mortalidad en el trasplante cardiaco y comparación con scores clásicos
Yoon et al. (2018) <sup>344</sup>	Personalized survival predictions via Trees of Predictors: An application to cardiac transplantation	ML	Algoritmo de predicción pronóstica en pacientes trasplantados
Samad et al. (2018) <sup>345</sup>	Predicting deterioration of ventricular function in patients with repaired tetralogy of Fallot using machine learning	ML	Predicción de deterioro ventricular derecho en pacientes con tetralogía de Fallot
Guaricci et al. 2018 <sup>346</sup>	CarDiac MagnEtic Resonance for Primary Prevention Implantable CardioVerter DebrillAtor ThERapy international registry: Design and rationale of the DERIVATE study	ML	Diseño de estudio que pretende mejorar la selección de pacientes con insuficiencia cardiaca que se beneficiarán del implante de DAI

Sanchez-Martinez et al. (2018) <sup>347</sup>	Machine Learning Analysis of Left Ventricular Function to Characterize Heart Failure With Preserved Ejection Fraction	ML	Clasificación de insuficiencia cardiaca con FE preservada frente a sujetos sanos a partir del análisis automático de la función del ventrículo izquierdo en reposo y ejercicio
Nirschl et al. (2018) <sup>348</sup>	A deep-learning classifier identifies patients with clinical heart failure using whole-slide images of H&E tissue	DL	Clasificador para detectar insuficiencia cardiaca a partir de imágenes de biopsias endomiocárdicas teñidas con hematoxilina-eosina
Ahmad et al. (2018) <sup>349</sup>	Machine Learning Methods Improve Prognostication, Identify Clinically Distinct Phenotypes, and Detect Heterogeneity in Response to Therapy in a Large Cohort of Heart Failure Patients	ML	Identificación de distintos fenotipos de pacientes con insuficiencia cardiaca y la heterogeneidad en la respuesta al tratamiento
Golas et al. (2018) <sup>350</sup>	A machine learning model to predict the risk of 30-day readmissions in patients with heart failure: a retrospective analysis of electronic medical records data	ML	Modelo predictivo de reingreso hospitalario a 30 días en pacientes con insuficiencia cardiaca
Zhang et al. (2018) <sup>351</sup>	Discovering and identifying New York heart association classification from electronic health records	NLP	Identificación de la clase funcional en pacientes sometidos a terapia de resincronización cardiaca
Puyol et al. (2018) <sup>352</sup>	Regional Multi-view Learning for Cardiac Motion Analysis: Application to Identification of Dilated Cardiomyopathy Patients	ML	Clasificación automática de pacientes con miocardiopatía dilatada
Sahl et al. (2019) <sup>353</sup>	Multiscale characterization of heart failure	ML	Caracterización multiescala de pacientes de insuficiencia cardiaca
Awan et al. (2019) <sup>354</sup>	Machine learning-based prediction of heart failure readmission or death: implications of choosing the right model and the right metrics	ML	Predicción de riesgo de readmisión o muerte en pacientes de insuficiencia cardiaca
Przewlocka-Kosmala et al. (2019) <sup>355</sup>	Contribution of Cardiovascular Reserve to Prognostic Categories of Heart Failure With Preserved Ejection Fraction: A Classification Based on Machine Learning	ML	Clasificación de pacientes de insuficiencia cardiaca con fracción de eyección preservada

Maragatham et al. (2019) <sup>356</sup>	LSTM Model for Prediction of Heart Failure in Big Data	DL	Redes neuronales LSTM (long short term memory) y big data para la predicción de insuficiencia cardiaca
Al'Aref et al. (2019) <sup>357</sup>	Determinants of In-Hospital Mortality After Percutaneous Coronary Intervention: A Machine Learning Approach	ML	Identificación de predictores de mortalidad intrahospitalaria tras intervención coronaria percutánea
Chung et al. (2019) <sup>358</sup>	Unsupervised classification of multi-omics data during cardiac remodeling using deep learning	DL	Clasificación no supervisada de datos multi-ómicos durante el proceso de remodelación cardiaca
Wang et al. (2019) <sup>359</sup>	Detection of Congestive Heart Failure Based on LSTM-Based Deep Network via Short-Term RR Intervals	DL	Detección de pacientes de insuficiencia cardiaca congestiva
Li et al. (2019) <sup>360</sup>	Time Series Characteristics of Serum Branched-Chain Amino Acids for Early Diagnosis of Chronic Heart Failure	ML	Identificación de biomarcadores para el diagnóstico temprano de insuficiencia cardiaca crónica

DL: *deep learning* (aprendizaje profundo); ML: *machine learning* (aprendizaje automático); NLP: *natural language processing* (procesamiento del lenguaje natural).



**Tabla 4 del material adicional**

Publicaciones inteligencia artificial en imagen cardiaca

Referencia	Título	Modalidad	Observación
Sheet et al. (2014) <sup>361</sup>	Joint learning of ultrasonic backscattering statistical physics and signal confidence primal for characterizing atherosclerotic plaques using intravascular ultrasound	ML	Caracterización tisular de placas de ateroma a partir de imágenes de IVUS
Sun et al. (2014) <sup>362</sup>	A computer-aided diagnostic algorithm improves the accuracy of transesophageal echocardiography for left atrial thrombi: a single-center prospective study	DL	Identificación de trombo en orejuela izquierda a partir del ecocardiograma transesofágico
Takx et al. (2014) <sup>363</sup>	Automated coronary artery calcification scoring in non-gated chest CT: agreement and reliability	ML	Cuantificación automática del score de calcio coronario en pacientes con cáncer sometidos a TC
Afshin et al. (2014) <sup>364</sup>	Regional assessment of cardiac left ventricular myocardial function via MRI statistical features	ML	Segmentación automática del ventrículo izquierdo a partir de imágenes de RM
Sheet et al. (2014) <sup>365</sup>	Hunting for necrosis in the shadows of intravascular ultrasound	ML	Clasificación automática de imágenes de placa de ateroma proveniente de IVUS
Yamak et al. (2014) <sup>366</sup>	Non-calcified coronary atherosclerotic plaque characterization by dual energy computed tomography	ML, DL	Caracterización de la placa de ateroma a partir del análisis de los píxeles procedentes de TC
Wei et al. (2014) <sup>367</sup>	Computerized detection of noncalcified plaques in coronary CT angiography: evaluation of topological soft gradient prescreening method and luminal analysis	ML	Detección de placas coronarias vulnerables a partir de imágenes del TC
Sankaran et al. (2014) <sup>368</sup>	Real-time sensitivity analysis of blood flow simulations to lumen segmentation uncertainty	ML	Estimación en tiempo real de simulaciones del flujo coronario
Ralovich et al. (2014) <sup>369</sup>	6DoF catheter detection, application to intracardiac echocardiography	ML	Detección de catéteres intracardiacos para mejorar la fusión de imágenes
Otaki et al. (2015) <sup>370</sup>	Relationship of epicardial fat volume from noncontrast CT with impaired myocardial flow reserve by positron emission tomography	ML	Relación entre volumen de grasa epicárdica medido por TC y reserva de flujo miocárdico alterada cuantificada por PET

Xiong et al. (2015) <sup>371</sup>	Myocardial perfusion analysis in cardiac computed tomography angiographic images at rest	ML	Determinación de la perfusión miocárdica a partir de imágenes de TC
Gopalakrishnan et al. (2015) <sup>372</sup>	cMRI-BED: A novel informatics framework for cardiac MRI biomarker extraction and discovery applied to pediatric cardiomyopathy classification	ML	Caracterización automática miocárdica a partir de RM
Zha et al. (2015) <sup>373</sup>	3-D Stent Detection in Intravascular OCT Using a Bayesian Network and Graph Search	ML	Análisis e identificación automática de stents a partir de imágenes de OCT
Sankaran et al. (2015) <sup>374</sup>	Fast Computation of Hemodynamic Sensitivity to Lumen Segmentation Uncertainty	ML	Segmentación automática coronaria
Kang et al. (2015) <sup>375</sup>	Structured learning algorithm for detection of nonobstructive and obstructive coronary plaque lesions from computed tomography angiography	ML	Clasificación de lesiones coronarias a partir de TC
Born et al. (2015) <sup>376</sup>	Stent Maps--Comparative Visualization for the Prediction of Adverse Events of Transcatheter Aortic Valve Implantations	ML	Predicción de leak paravalvular tras el implante percutáneo de prótesis aórtica
Dey et al. (2015) <sup>377</sup>	Relationship Between Quantitative Adverse Plaque Features From Coronary Computed Tomography Angiography and Downstream Impaired Myocardial Flow Reserve by <sup>13</sup> N-Ammonia Positron Emission Tomography: A Pilot Study	ML	Estimación cuantitativa de la placa de ateroma y la disfunción vascular coronaria a partir del TC y PET
Macedo et al. (2015) <sup>378</sup>	A bifurcation identifier for IV-OCT using orthogonal least squares and supervised machine learning	ML	Clasificación de las imágenes de OCT para identificar bifurcaciones coronarias
Emad et al. (2015) <sup>379</sup>	Automatic localization of the left ventricle in cardiac MRI images using deep learning	DL	Localización automática del ventrículo izquierdo en imágenes de eje corto por RM
Knackstedt et al. (2015) <sup>380</sup>	Fully Automated Versus Standard Tracking of Left Ventricular Ejection Fraction and Longitudinal Strain: The FAST-EFs Multicenter Study	ML	Análisis automatizado de las imágenes ecocardiográficas y estimación reproducible de fracción de eyección y <i>strain</i> longitudinal

Shalev et al. (2016) <sup>381</sup>	Classification of calcium in intravascular OCT images for the purpose of intervention planning	DL	Método para la clasificación automática de calcio en imágenes de OCT
Nam et al. (2016) <sup>382</sup>	Automated detection of vessel lumen and stent struts in intravascular optical coherence tomography to evaluate stent apposition and neointimal coverage	DL	Algoritmo que utiliza imágenes de intensidad en la OCT para la detección automática del stent
Moghaddasi et al. (2016) <sup>383</sup>	Automatic assessment of mitral regurgitation severity based on extensive textural features on 2D echocardiography videos	ML	Patrones para clasificar el grado de insuficiencia mitral
Yu et al. (2016) <sup>384</sup>	The Potential of Computational Fluid Dynamics Simulation on Serial Monitoring of Hemodynamic Change in Type B Aortic Dissection	DL	Modelos de simulación de dinámica de fluidos computacional en la monitorización del cambio hemodinámico de la disección aórtica tipo B
Leni et al. (2016) <sup>385</sup>	Development of a 4D numerical chest phantom with customizable breathing	DL	Aplicación que simula la posición y volumen de pulmones, corazón y esófago en cada ciclo respiratorio
Ma et al. (2016) <sup>386</sup>	An SPCNN-GVF-based approach for the automatic segmentation of left ventricle in cardiac cine MR images	DL	Modelo autocorrector para la segmentación automática del ventrículo izquierdo
Zhou et al. (2016) <sup>387</sup>	Watertight modeling and segmentation of bifurcated Coronary arteries for blood flow simulation using CT imaging	DL	Segmentación y construcción de la geometría de las arterias coronarias a partir de imágenes de TC para aplicar directamente en la simulación del flujo coronario sanguíneo
Ciampi et al. (2016) <sup>388</sup>	Computer-aided detection of intracoronary stent in intravascular ultrasound sequences	ML, DL	Sistema automático para la detección de stents intracoronarios a partir de secuencias de imágenes de IVUS
Narula et al. (2016) <sup>389</sup>	Machine-Learning Algorithms to Automate Morphological and Functional Assessments in 2D Echocardiography	ML	Diferenciación automática entre miocardiopatía hipertrófica familiar y corazón de atleta utilizando datos ecocardiográficos
Norlem et al. (2016) <sup>390</sup>	Automatic pericardium segmentation and quantification of epicardial fat from computed tomography angiography	ML	Segmentación del pericardio y cuantificación de grasa epicárdica

Nasr-Esfahani et al. (2016) <sup>391</sup>	Vessel extraction in X-ray angiograms using deep learning	DL	Reconstrucción árbol coronario a partir de angiografía
Alzubiedi et al. (2016) <sup>392</sup>	Pharmacogenetic-guided Warfarin Dosing Algorithm in African-Americans	ML, DL	Algoritmo para dosificación de warfarina
Rodrigues et al. (2016) <sup>393</sup>	A novel approach for the automated segmentation and volume quantification of cardiac fats on computed tomography	ML, DL	Cuantificación y diferenciación de la grasa epicárdica y mediastínica a partir de imágenes de TC
Avendi et al. (2016) <sup>394</sup>	A combined deep-learning and deformable-model approach to fully automatic segmentation of the left ventricle in cardiac MRI	DL	Segmentación automática del ventrículo izquierdo a partir de RM utilizando datos del datatón MICCAI 2009
Itu et al. (2016) <sup>395</sup>	A machine-learning approach for computation of fractional flow reserve from coronary computed tomography	ML	Determinación automática de la FFR a partir de imágenes de TC
Wong et al. (2016) <sup>396</sup>	Regional infarction identification from cardiac CT images: a computer-aided biomechanical approach	ML	Identificación automática de infarto de miocardio a partir de imágenes de TC
Wolterink et al. (2016) <sup>397</sup>	Automatic coronary artery calcium scoring in cardiac CT angiography using paired convolutional neural networks	DL	Cuantificación automática del score de calcio coronario a partir de imágenes de TC
Lungu et al. (2016) <sup>398</sup>	Diagnosis of pulmonary hypertension from magnetic resonance imaging-based computational models and decision tree analysis	ML	Clasificador de hipertensión pulmonar a partir de datos de RM
Hagenah et al. (2016) <sup>399</sup>	Prediction of individual prosthesis size for valve-sparing aortic root reconstruction based on geometric features	ML	Predicción preoperatoria del tamaño de las prótesis quirúrgicas en posición aórtica a partir de datos ecocardiográficos
Liang et al. (2017) <sup>400</sup>	Machine learning-based 3-D geometry reconstruction and modeling of aortic valve deformation using 3-D computed tomography images	ML, DL	Método computacional para reconstruir anatómicamente las geometrías en 3D de la válvula aórtica a partir de imágenes de TC

Su et al. (2017) <sup>401</sup>	An artificial neural network method for lumen and media adventitia border detection in IVUS	DL	Algoritmos de aprendizaje para la detección de los límites de la luz y márgenes vasculares en imágenes de IVUS
Dawes et al. (2017) <sup>402</sup>	Machine Learning of Three-dimensional Right Ventricular Motion Enables Outcome Prediction in Pulmonary Hypertension: A Cardiac MR Imaging Study	ML, DL	Modelo de supervivencia que utiliza el movimiento cardíaco 3D en pacientes con hipertensión pulmonar
Avendi et al. (2017) <sup>403</sup>	Automatic segmentation of the right ventricle from cardiac MRI using a learning-based approach	DL	Segmentación automática del ventrículo derecho a partir de imágenes de RM
Yu et al. (2017) <sup>404</sup>	Segmentation of Fetal Left Ventricle in Echocardiographic Sequences Based on Dynamic Convolutional Neural Networks	DL	Segmentación automática ecocardiográfica del ventrículo izquierdo
Liao et al. (2017) <sup>405</sup>	Estimation of the Volume of the Left Ventricle From MRI Images Using Deep Neural Networks	DL	Segmentación del ventrículo izquierdo y cálculo de volumen con datos del datatón: Second Annual Data Science Bowl
Betancur et al. (2017) <sup>406</sup>	Automatic Valve Plane Localization in Myocardial Perfusion SPECT/CT by Machine Learning: Anatomic and Clinical Validation	ML	Definición del plano valvular mitral durante la segmentación por SPECT utilizando datos de TC
Freiman et al. (2017) <sup>407</sup>	Improving CCTA-based lesions' hemodynamic significance assessment by accounting for partial volume modeling in automatic coronary lumen segmentation	ML, DL	Algoritmo automático de segmentación de la luz coronaria a partir de TC utilizando datos del datatón MICCAI 2012
Wang et al. (2017) <sup>408</sup>	Detecting Cardiovascular Disease from Mammograms With Deep Learning	DL	Detección de calcio intracoronario a partir de imágenes de mamografía para identificar enfermedad coronaria
Rodrigues et al. (2017) <sup>409</sup>	Machine learning in the prediction of cardiac epicardial and mediastinal fat volumes	ML	Cuantificación automática grasa epicárdica y mediastínica a partir de TC
Lian et al. (2017) <sup>410</sup>	An automatic segmentation method of a parameter-adaptive PCNN for medical images	DL	Segmentación automática que integran en uno varios pasos utilizados habitualmente
Tan et al. (2017) <sup>411</sup>	Convolutional neural network regression for short-axis left ventricle segmentation in cardiac cine MR sequences	DL	Segmentación ventricular izquierda en eje corto a partir de imágenes de RM

Larroza et al. (2017) <sup>412</sup>	Differentiation between acute and chronic myocardial infarction by means of texture analysis of late gadolinium enhancement and cine cardiac magnetic resonance imaging	ML	Diferenciación entre infarto de miocardio agudo y crónico a partir de RM
Mazo et al. (2017) <sup>413</sup>	Classification of cardiovascular tissues using LBP based descriptors and a cascade SVM	ML	Clasificación automática de tejidos cardiovasculares basada en su composición
Molaei et al. (2017) <sup>414</sup>	Deep Convolutional Neural Networks for left ventricle segmentation	DL	Segmentación del ventrículo izquierdo en RM
Yang et al. (2017) <sup>415</sup>	Convolutional Neural Network for the Detection of End-Diastole and End-Systole Frames in Free-Breathing Cardiac Magnetic Resonance Imaging	DL	Identificación automática tanto de la diástole como la sístole en imágenes de RM de respiración libre
Duguay et al. (2017) <sup>416</sup>	Coronary Computed Tomographic Angiography-Derived Fractional Flow Reserve Based on Machine Learning for Risk Stratification of Non-Culprit Coronary Narrowings in Patients with Acute Coronary Syndrome	ML	Evaluación pronóstica del FFR determinado por TC en pacientes con síndrome coronario agudo
Nakajima et al. (2017) <sup>417</sup>	Diagnostic accuracy of an artificial neural network compared with statistical quantitation of myocardial perfusion images: a Japanese multicenter study	DL	Diagnóstico a partir de imágenes de gated-SPECT
Mengdi et al. (2017) <sup>418</sup>	Fibroatheroma identification in Intravascular Optical Coherence Tomography images using deep features	DL	Identificación de fibroateroma a partir de imágenes de OCT
Yu et al. (2017) <sup>419</sup>	Determination of Fetal Left Ventricular Volume Based on Two-Dimensional Echocardiography	DL	Cuantificación de volumen ventricular izquierdo fetal por ecocardiografía
Jeganathan et al. (2017) <sup>420</sup>	Artificial intelligence in mitral valve analysis	ML	Evaluación automática de la válvula mitral a partir de imágenes de ecocardiografía transesofágica
Ngo et al. (2017) <sup>421</sup>	Combining deep learning and level set for the automated segmentation of the left ventricle of the heart from cardiac cine magnetic resonance	DL	Segmentación automática del ventrículo izquierdo a partir de imágenes de RM

Abdolmanafi et al. (2017) <sup>422</sup>	Deep feature learning for automatic tissue classification of coronary artery using optical coherence tomography	ML, DL	Clasificación automática de las capas arteriales coronarias a partir de imágenes de OCT provenientes de niños con Kawasaki
Tabassian et al. (2017) <sup>423</sup>	Machine learning of the spatio-temporal characteristics of echocardiographic deformation curves for infarct classification	ML	Análisis automático de los perfiles temporales de las curvas de deformación segmentaria del ventrículo izquierdo y sus interrelaciones para poder identificar cambios en su mecánica y función
Yang et al. (2017) <sup>424</sup>	3D Motion Modeling and Reconstruction of Left Ventricle Wall in Cardiac MRI	DL	Modelado de movimiento 3D y análisis de la pared del ventrículo izquierdo en imágenes de RM
Wolterink et al. (2017) <sup>425</sup>	Generative Adversarial Networks for Noise Reduction in Low-Dose CT	DL	Optimización de imágenes TC adquiridas con dosis bajas de radiación
Xue et al. (2017) <sup>426</sup>	Direct Multitype Cardiac Indices Estimation via Joint Representation and Regression Learning	DL	Estimación del índice cardíaco a partir de imágenes de RM
Salem Omar et al. (2017) <sup>427</sup>	Artificial Intelligence-Based Assessment of Left Ventricular Filling Pressures From 2-Dimensional Cardiac Ultrasound Images	ML, DL	Estimación automática de las presiones de llenado del ventrículo izquierdo a partir de imágenes ecocardiográficas
Zahnd et al. (2017) <sup>428</sup>	Contour segmentation of the intima, media, and adventitia layers in intracoronary OCT images: application to fully automatic detection of healthy wall regions	ML	Segmentación y clasificación automática de arterias coronarias sanas o enfermas a partir de imágenes de OCT
Solecki et al. (2017) <sup>429</sup>	What is the optimal anatomic location for coronary artery pressure measurement at CT-derived FFR?	ML	Distancia óptima tras la estenosis coronaria donde estimar la FFR en TC coronario
Banchhor et al. (2017) <sup>430</sup>	Wall-based measurement features provides an improved IVUS coronary artery risk assessment when fused with plaque texture-based features during machine learning paradigm	ML	Predicción del riesgo sumando las características de la pared y la textura de la placa medidas por IVUS
Tesche et al. (2017) <sup>431</sup>	Coronary Computed Tomographic Angiography-Derived Fractional Flow Reserve for Therapeutic Decision Making	ML	Predicción de FFR a partir de TC comparada con estudio invasivo angiográfico

Yong et al. (2017) <sup>432</sup>	Linear-regression convolutional neural network for fully automated coronary lumen segmentation in intravascular optical coherence tomography	DL	Segmentación coronaria a partir de imágenes de OCT
Dangi et al. (2018) <sup>433</sup>	Cine Cardiac MRI Slice Misalignment Correction Towards Full 3D Left Ventricle Segmentation	DL	Segmentación del ventrículo izquierdo
Wardziak et al. (2018) <sup>434</sup>	Coronary CTA enhanced with CTA based FFR analysis provides higher diagnostic value than invasive coronary angiography in patients with intermediate coronary stenosis	ML	Valoración de la predicción de estenosis coronaria mediante análisis de FFR en el TC coronario
Zhang et al. (2018) <sup>435</sup>	Fully Automated Echocardiogram Interpretation in Clinical Practice	DL	Segmentación cardíaca automática de imágenes ecocardiográficas para cuantificar volúmenes, masa ventricular izquierda, FEVI, y <i>strain</i> longitudinal
Abdolmanafi et al. (2018) <sup>436</sup>	Characterization of coronary artery pathological formations from OCT imaging using deep learning	DL	Modelo para la caracterización del tejido coronario en la enfermedad de Kawasaki procedente de imágenes de OCT
Mazo et al. (2018) <sup>437</sup>	Transfer learning for classification of cardiovascular tissues in histological images	DL	Reconocimiento y clasificación automática de tejidos y órganos
Yao et al. (2018) <sup>438</sup>	An Adaptive Seismocardiography (SCG)-ECG Multimodal Framework for Cardiac Gating Using Artificial Neural Networks	DL	Sistema que utiliza ECG y sismocardiografía para mejorar adquisición y reducir la exposición a la radiación en el TC
van Hamersvelt et al. (2018) <sup>439</sup>	Deep learning analysis of left ventricular myocardium in CT angiographic intermediate-degree coronary stenosis improves the diagnostic accuracy for identification of functionally significant stenosis	DL	Análisis miocárdico del ventrículo izquierdo a partir del TC de pacientes con enfermedad coronaria para identificar lesiones funcionalmente significativas
Yang et al. (2018) <sup>440</sup>	Multiview Sequential Learning and Dilated Residual Learning for a Fully Automatic Delineation of the Left Atrium and Pulmonary Veins from Late Gadolinium-Enhanced Cardiac MRI Images	DL	Método para segmentación de la aurícula izquierda y venas pulmonares a partir de imágenes de RM con gadolinio



Moccia et al. (2018) <sup>441</sup>	Development and testing of a deep learning-based strategy for scar segmentation on CMR-LGE images	DL	Segmentación de cicatrices en ventrículo izquierdo a partir de imágenes de RM
Masuda et al. (2018) <sup>442</sup>	Machine-learning integration of CT histogram analysis to evaluate the composition of atherosclerotic plaques: Validation with IB-IVUS	ML	Caracterización de la placa coronaria con análisis de histograma de la angiografía coronaria por TC en comparación con el método de corte convencional
Kolluru et al. (2018) <sup>443</sup>	Deep neural networks for A-line-based plaque classification in coronary intravascular optical coherence tomography images	DL	Clasificador de tipos de placas de ateroma coronarias a partir de OCT
Zreik et al. (2018) <sup>444</sup>	A Recurrent CNN for Automatic Detection and Classification of Coronary Artery Plaque and Stenosis in Coronary CT Angiography	DL	Clasificación de tipo de placa coronaria y gravedad a partir de imágenes de TC
Tesche et al. (2018) <sup>445</sup>	Coronary CT Angiography-derived Fractional Flow Reserve: Machine Learning Algorithm versus Computational Fluid Dynamics Modeling	ML	Comparación de la determinación de reserva de flujo fraccional derivada de la angiografía por TC o angiografía
Toth et al. (2018) <sup>446</sup>	3D/2D model-to-image registration by imitation learning for cardiac procedures	DL	Creación de modelos anatómicos a partir de TC para el diagnóstico, planificación y orientación de procedimientos terapéuticos
Yu et al. (2018) <sup>447</sup>	CT morphological index provides incremental value to machine learning based CT-FFR for predicting hemodynamically significant coronary stenosis	ML	Algoritmo para diferenciar funcionalmente las lesiones coronarias observadas en TC con referencia al FFR
Slomka et al. (2018) <sup>448</sup>	Rationale and design of the REgistry of Fast Myocardial Perfusion Imaging with NExt generation SPECT (REFINE SPECT)	ML, DL	Diseño de un registro multicéntrico con datos clínicos e imágenes de SPECT para analizar con inteligencia artificial
Jin et al. (2018) <sup>449</sup>	Left Atrial Appendage Segmentation Using Fully Convolutional Neural Networks and Modified Three-Dimensional Conditional Random Fields	DL	Segmentación automática de la orejuela izquierda
Zheng et al. (2018) <sup>450</sup>	3-D Consistent and Robust Segmentation of Cardiac Images by Deep Learning With Spatial Propagation	DL	Segmentación cardiaca desde la base al ápex del corazón procedente de RM

Hu et al. (2018) <sup>451</sup>	Diagnostic performance of machine-learning-based computed fractional flow reserve (FFR) derived from coronary computed tomography angiography for the assessment of myocardial ischemia verified by invasive FFR	DL	Comparativa diagnóstica de FFR (fracción de reserva de flujo) determinada por TC vs. Invasiva
Wong et al. (2018) <sup>452</sup>	Building medical image classifiers with very limited data using segmentation networks	DL	Segmentación automática y clasificación de diferentes estructuras (tórax, aorta, arteria pulmonar)
Cano-Espinosa et al. (2018) <sup>453</sup>	Automated Agatston Score Computation in non-ECG Gated CT Scans Using Deep Learning	DL	Cuantificación automática del score de Agatston
Parikh et al. (2018) <sup>454</sup>	Decision Tree Based Classification of Abdominal Aortic Aneurysms Using Geometry Quantification Measures	DL	Cuantificación automática de aneurismas de aorta abdominal
Gessert et al. (2018) <sup>455</sup>	Automatic Plaque Detection in IVOCT Pullbacks Using Convolutional Neural Networks	DL	Detección automática de placas de ateroma a partir de imágenes de OCT
Dormer et al. (2018) <sup>456</sup>	Heart Chamber Segmentation from CT Using Convolutional Neural Networks	DL	Segmentación cámaras cardíacas a partir de imágenes de TC
Garcia et al. (2018) <sup>457</sup>	Diagnostic performance of an artificial intelligence-driven cardiac-structured reporting system for myocardial perfusion SPECT imaging	ML, DL	Sistema automático de análisis de los 17 segmentos cardíacos del SPECT comparado con la cuantificación manual
Bai et al. (2018) <sup>458</sup>	Automated cardiovascular magnetic resonance image analysis with fully convolutional networks	DL	Análisis automático funcional a partir de RM
Xu et al. (2018) <sup>459</sup>	Direct delineation of myocardial infarction without contrast agents using a joint motion feature learning architecture	DL	Desarrollo de un sistema de segmentación del miocardio y caracterización tisular
Sulas et al. (2018) <sup>460</sup>	Automatic Recognition of Complete Atrioventricular Activity in Fetal Pulsed-Wave Doppler Signals	DL	Identificación de las características más importantes de la ecocardiografía-Doppler fetal para el diagnóstico temprano de cardiopatías fetales

Duchateau et al. (2018) <sup>461</sup>	Model-Based Generation of Large Databases of Cardiac Images: Synthesis of Pathological Cine MR Sequences From Real Healthy Cases	ML, DL	Diferenciación automática de secuencias cardíacas patológicas de secuencias reales sanas
Ouzir et al. (2018) <sup>462</sup>	Motion Estimation in Echocardiography Using Sparse Representation and Dictionary Learning	ML, DL	Estimación automática de la movilidad cardíaca a partir de imágenes ecocardiográficas 2D
Luo et al. (2018) <sup>463</sup>	Multi-Views Fusion CNN for Left Ventricular Volumes Estimation on Cardiac MR Images	DL	Estimación automática de los volúmenes del ventrículo izquierdo
Mannil et al. (2018) <sup>464</sup>	Texture Analysis and Machine Learning for Detecting Myocardial Infarction in Noncontrast Low-Dose Computed Tomography: Unveiling the Invisible	ML, DL	Detección de infarto de miocardio en imágenes de T de baja dosis de radiación sin contraste
Dey et al. (2018) <sup>465</sup>	Integrated prediction of lesion-specific ischaemia from quantitative coronary CT angiography using machine learning: a multicentre study	ML	Predicción de FFR a partir de imágenes de TC
Larroza et al. (2018) <sup>466</sup>	Texture analysis of cardiac cine magnetic resonance imaging to detect nonviable segments in patients with chronic myocardial infarction	ML	Identificación automática de segmentos miocárdicos no viables a partir de RM
Kolluru et al. (2018) <sup>467</sup>	Voxel-based plaque classification in coronary intravascular optical coherence tomography images using decision trees	ML	Clasificación de tipos de placas por voxels obtenidos de OCT de arterias coronarias de cadáveres
Schlemper et al. (2018) <sup>468</sup>	A Deep Cascade of Convolutional Neural Networks for Dynamic MR Image Reconstruction	DL	Reconstrucción de imágenes a partir de RM
Betancur et al. (2018) <sup>469</sup>	Prognostic Value of Combined Clinical and Myocardial Perfusion Imaging Data Using Machine Learning	ML	Predictor pronóstico combinando datos clínicos y de SPECT
Zreik et al. (2018) <sup>470</sup>	Deep learning analysis of the myocardium in coronary CT angiography for identification of patients with functionally significant coronary artery stenosis	DL	Identificación de isquemia miocárdica a partir de TC de pacientes con enfermedad coronaria
Nakajima et al. (2018) <sup>471</sup>	Artificial neural network retrained to detect myocardial ischemia using a Japanese multicenter database	DL	Detección automática de isquemia miocárdica usando SPECT

Dormer et al. (2018) <sup>472</sup>	Convolutional Neural Networks for the Detection of Diseased Hearts Using CT Images and Left Atrium Patches	DL	Modelo para identificar enfermedad estructural cardiaca a partir de TC convencionales
Shao et al. (2018) <sup>473</sup>	Texture analysis of magnetic resonance T1 mapping with dilated cardiomyopathy: A machine learning approach	ML	Diagnóstico de miocardiopatía dilatada a partir de parámetros del T1 en resonancia magnética
Dong et al. (2018) <sup>474</sup>	A Combined Fully Convolutional Networks and Deformable Model for Automatic Left Ventricle Segmentation Based on 3D Echocardiography	DL	Segmentación del ventrículo izquierdo a partir de imágenes 3D ecocardiográficas
Betancur et al. (2018) <sup>475</sup>	Deep Learning Analysis of Upright-Supine High-Efficiency SPECT Myocardial Perfusion Imaging for Prediction of Obstructive Coronary Artery Disease: A Multicenter Study	DL	Predicción de enfermedad coronaria tras análisis combinado de SPECT en posiciones semivertical y supina
Shibutani et al. (2018) <sup>476</sup>	Accuracy of an artificial neural network for detecting a regional abnormality in myocardial perfusion SPECT	DL	Cuantificación automática de la extensión y gravedad de la isquemia miocárdica a partir de imágenes de SPECT
Narang et al. (2018) <sup>477</sup>	Machine learning based automated dynamic quantification of left heart chamber volumes	ML	Algoritmo automático para el análisis volumétrico de datos ecocardiográficos 3D en la medición precisa de volúmenes de ventrículo y aurícula izquierdos
Hasegawa et al. (2018) <sup>478</sup>	[Automated Classification of Calcification and Stent on Computed Tomography Coronary Angiography Using Deep Learning]	DL	Reconocer automáticamente calcificaciones o stents en las arterias coronarias y diferenciarlas de arterias normales a partir de imágenes de TC
Abdolmanafi et al. (2018) <sup>479</sup>	Intra-slice motion correction of intravascular OCT images using deep features	DL	Corrección del movimiento para el análisis automático de las variaciones de volumen y formas de imágenes en OCT
Du et al. (2018) <sup>480</sup>	Direct Segmentation-based Full Quantification for Left Ventricle via Deep Multi-task Regression Learning Network	DL	Segmentación del ventrículo izquierdo, pero en lugar de usar imágenes crudas, se crea un contorno segmentado para estimar los índices cardiacos
Mastrodicasa et al. (2018) <sup>481</sup>	Artificial intelligence machine learning-based coronary CT fractional flow reserve (CT-FFRML): Impact of iterative and filtered back projection reconstruction techniques	DL	Algoritmo de reconstrucción a partir de imágenes de TC para estimar el FFR

Jun et al. (2018) <sup>482</sup>	Automated detection of vulnerable plaque in intravascular ultrasound images	ML, DL	Clasificación de placa vulnerable a partir de imágenes de IVUS
Huang et al. (2018) <sup>483</sup>	Coronary Artery Segmentation by Deep Learning Neural Networks on Computed Tomographic Coronary Angiographic Images	DL	Segmentación automática de la luz arterial coronaria a partir de imágenes de TC
Que et al. (2018) <sup>484</sup>	CardioXNet: Automated Detection for Cardiomegaly Based on Deep Learning	DL	Sistema de identificación automática de cardiomegalia en la radiografía de tórax convencional
Nasr-Esfahani et al. (2018) <sup>485</sup>	Left Ventricle Segmentation in Cardiac MR Images Using Fully Convolutional Network	DL	Segmentación automática del ventrículo a partir de imágenes de resonancia magnética
Omar et al. (2018) <sup>486</sup>	Automated Myocardial Wall Motion Classification using Handcrafted Features vs a Deep CNN-based mapping	ML, DL	Clasificación automática de la motilidad cardiaca a partir de ecocardiografía
Leng et al. (2018) <sup>487</sup>	Computational Platform Based on Deep Learning for Segmenting Ventricular Endocardium in Long-axis Cardiac MR Imaging	DL	Segmentación automática endocárdica de ventrículos izquierdo y derecho
Ostvik et al. (2018) <sup>488</sup>	Real-Time Standard View Classification in Transthoracic Echocardiography Using Convolutional Neural Networks	DL	Automatización en la secuencia de trabajo y adquisición de planos en ecocardiografía
Xue et al. (2018) <sup>489</sup>	Extraction of Aortic Knuckle Contour in Chest Radiographs Using Deep Learning	DL	Segmentación automática del botón aórtico
Kang et al. (2018) <sup>490</sup>	Cycle Consistent Adversarial Denoising Network for Multiphase Coronary CT Angiography	DL	Optimización de la adquisición de imágenes de TC obtenidas con baja radiación
Lossau et al. (2018) <sup>491</sup>	Motion artifact recognition and quantification in coronary CT angiography using convolutional neural networks	DL	Optimización del movimiento en la adquisición de imágenes de TC
Zhang et al. (2018) <sup>492</sup>	Automatic Assessment of Full Left Ventricular Coverage in Cardiac Cine Magnetic Resonance Imaging with Fisher Discriminative 3D CNN	DL	Segmentación ventricular izquierda de base a ápex a partir de imágenes de RM

Huang et al. (2018) <sup>493</sup>	Enhancing the prediction of acute kidney injury risk after percutaneous coronary intervention using machine learning techniques: A retrospective cohort study	ML	Modelo predictivo de daño renal tras administración de contraste en el intervencionismo percutáneo
Nous et al. (2018) <sup>494</sup>	Comparison of the Diagnostic Performance of Coronary Computed Tomography Angiography-Derived Fractional Flow Reserve in Patients With Versus Without Diabetes Mellitus (from the MACHINE Consortium)	ML	Estimación de FFR a partir de imágenes de TC comparativo entre diabéticos y no diabéticos
Kwon et al. (2018) <sup>495</sup>	Deep learning for predicting in-hospital mortality among heart disease patients based on echocardiography	DL	Modelo predictivo de mortalidad intrahospitalaria a partir de datos ecocardiográficos durante la hospitalización
von Knebel Doeberitz et al. (2018) <sup>496</sup>	Coronary CT angiography-derived plaque quantification with artificial intelligence CT fractional flow reserve for the identification of lesion-specific ischemia	DL	Estimación de FFR a partir de imágenes de TC
Han et al. (2018) <sup>497</sup>	Incremental role of resting myocardial computed tomography perfusion for predicting physiologically significant coronary artery disease: A machine learning approach	ML	Predicción de isquemia miocárdica a partir de imágenes de miocardio y coronarias por TC
Isgum et al. (2018) <sup>498</sup>	Automatic determination of cardiovascular risk by CT attenuation correction maps in Rb-82 PET/CT	ML	Cuantificación automática del calcio score coronario a partir de PET/TC
Baessler et al. (2018) <sup>499</sup>	Subacute and Chronic Left Ventricular Myocardial Scar: Accuracy of Texture Analysis on Nonenhanced Cine MR Images	ML	Clasificación e identificación de tejido cardíaco como isquémico/necrótico a partir de imágenes de RM
Oktay et al. (2018) <sup>500</sup>	Anatomically Constrained Neural Networks (ACNNs): Application to Cardiac Image Enhancement and Segmentation	DL	Sistema de segmentación que incorpora las propiedades anatómicas globales de la anatomía subyacente en diferentes patologías cardíacas

Xue et al. (2018) <sup>501</sup>	Full left ventricle quantification via deep multitask relationships learning	DL	Cuantificación del ventrículo izquierdo; que tiene en cuenta dos áreas (cavidad y miocardio), espesores regionales de pared, tres dimensiones y fases diastólica y sistólica
Wojnarski et al. (2018) <sup>502</sup>	Machine-learning phenotypic classification of bicuspid aortopathy	ML	Clasificación de diferentes tipos de aortopatía en pacientes con válvula aórtica bicúspide a partir de imágenes de TC
Tan et al. (2018) <sup>503</sup>	Fully automated segmentation of the left ventricle in cine cardiac MRI using neural network regression	DL	Segmentación automática del ventrículo izquierdo a partir de RM
Winther et al. (2018) <sup>504</sup>	v-net: Deep Learning for Generalized Biventricular Mass and Function Parameters Using Multicenter Cardiac MRI Data	DL	Segmentación automática de ventrículos izquierdo y derecho
Lessmann et al. (2018) <sup>505</sup>	Automatic Calcium Scoring in Low-Dose Chest CT Using Deep Neural Networks With Dilated Convolutions	DL	Detección automática de calcificaciones en arteria coronaria, aorta torácica, y válvula aórtica a partir de TC utilizando baja radiación
Betancur et al. (2018) <sup>506</sup>	Deep Learning for Prediction of Obstructive Disease From Fast Myocardial Perfusion SPECT: A Multicenter Study	DL	Predicción de enfermedad coronaria obstructiva a partir de imágenes de perfusión de SPECT
Nakanishi et al. (2018) <sup>507</sup>	Automated estimation of image quality for coronary computed tomographic angiography using machine learning	ML	Evaluación automatizada de imágenes coronarias procedentes de TC y comparación frente al análisis visual
Gernaat et al. (2018) <sup>508</sup>	Automatic quantification of calcifications in the coronary arteries and thoracic aorta on radiotherapy planning CT scans of Western and Asian breast cancer patients	DL	Cuantificación automática de la calcificación de arterias coronarias y aorta torácica a partir de TC para programar radioterapia en cáncer de mama
Lancaster et al. (2018) <sup>509</sup>	Phenotypic Clustering of Left Ventricular Diastolic Function Parameters: Patterns and Prognostic Relevance	ML	Clasificación no supervisada de variables ecocardiográficas para evaluar la disfunción ventricular izquierda diastólica

Baessler et al. (2018) <sup>510</sup>	Texture analysis and machine learning of non-contrast T1-weighted MR images in patients with hypertrophic cardiomyopathy-Preliminary results	ML	Clasificación de la textura del miocardio buscando áreas de fibrosis en miocardiopatía hipertrófica a partir de imágenes de RM sin contraste
Fu et al. (2018) <sup>511</sup>	Segmentation of histological images and fibrosis identification with a convolutional neural network	DL	Segmentación de imágenes histológicas, particularmente aquellas con tinción tricrómica de Masson
Coenen et al. (2018) <sup>512</sup>	Diagnostic Accuracy of a Machine-Learning Approach to Coronary Computed Tomographic Angiography-Based Fractional Flow Reserve: Result From the MACHINE Consortium	ML	Estimación de FFR a partir de TC coronario y comparación frente a estimaciones angiográficas convencionales
Cruz-Aceves et al. (2018) <sup>513</sup>	A Novel Multiscale Gaussian-Matched Filter Using Neural Networks for the Segmentation of X-Ray Coronary Angiograms	DL	Segmentación automática de las arterias coronarias a partir de imágenes angiográficas de fluoroscopia
Vigneault et al. (2018) <sup>514</sup>	Omega-Net (Omega-Net): Fully automatic, multi-view cardiac MR detection, orientation, and segmentation with deep neural networks	DL	Segmentación automática simultánea de píxeles en pacientes con miocardiopatía hipertrófica
Commandeur et al. (2018) <sup>515</sup>	Deep Learning for Quantification of Epicardial and Thoracic Adipose Tissue From Non-Contrast CT	DL	Cuantificación automática de la grasa epicárdica y torácica a partir de imágenes de TC sin contraste
Pavoni et al. (2018) <sup>516</sup>	Convolutional neural network-based image enhancement for x-ray percutaneous coronary intervention	DL	Optimización de las imágenes angiográficas procedentes de fluoroscopia con baja radiación
Al et al. (2018) <sup>517</sup>	Automatic aortic valve landmark localization in coronary CT angiography using colonial walk	ML	Optimización automática de la localización valvular aórtica para implante de TAVI a partir de imágenes TC angiográfico
Qin et al. (2018) <sup>518</sup>	Convolutional Recurrent Neural Networks for Dynamic MR Image Reconstruction	DL	Reconstrucción automática de imágenes de RM de alta calidad
Chen et al. (2018) <sup>519</sup>	Correlated Regression Feature Learning for Automated Right Ventricle Segmentation	DL	Segmentación automática del ventrículo derecho a partir de imágenes de RM



Wang et al. (2018) <sup>520</sup>	Neural network fusion: a novel CT-MR Aortic Aneurysm image segmentation method	DL	Segmentación de imagen multimodal; RM y TC
Green et al. (2018) <sup>521</sup>	3-D Neural denoising for low-dose Coronary CT Angiography (CCTA)	DL	Reconstrucción automática de la anatomía coronaria por TC reduciendo las dosis de radiación
Strange et al. (2018) <sup>522</sup>	The National Echocardiography Database Australia (NEDA): Rationale and methodology	ML	Base de datos nacional ecocardiográfica con el objetivo de realizar análisis con inteligencia artificial
Yang et al. (2018) <sup>523</sup>	Neural multi-atlas label fusion: Application to cardiac MR images	DL	Segmentación multiatlas y multifusión a partir de imágenes de RM
Zotti et al. (2018) <sup>524</sup>	Convolutional Neural Network with Shape Prior Applied to Cardiac MRI Segmentation	DL	Segmentación de imágenes de eje corto de RM
Fahmy et al. (2018) <sup>525</sup>	Automated Cardiac MR Scar Quantification in Hypertrophic Cardiomyopathy Using Deep Convolutional Neural Networks	DL	Cuantificación automática del tejido fibroso en la miocardiopatía hipertrófica procedente de imágenes de RM
Samad et al. (2018) <sup>526</sup>	Predicting Survival From Large Echocardiography and Electronic Health Record Datasets	ML	Predicción de mortalidad en pacientes sometidos a ecocardiografía
Bratt et al. (2019) <sup>527</sup>	Machine learning derived segmentation of phase velocity encoded cardiovascular magnetic resonance for fully automated aortic flow quantification	DL	Cuantificación automatizada del flujo aórtico a través de la segmentación de resonancias magnéticas con machine learning
Togo et al. (2019) <sup>528</sup>	Cardiac sarcoidosis classification with deep convolutional neural network-based features using polar maps	DL	Clasificación de pacientes con o sin sarcoidosis cardiaca a través de redes neuronales y tomografía computarizada
Curiale et al. (2019) <sup>529</sup>	Automatic quantification of the LV function and mass: A deep learning approach for cardiovascular MRI	DL	Cuantificación de masa y función del ventrículo izquierdo a partir de resonancia magnética
Biswas et al. (2019) <sup>530</sup>	Dynamic MRI using model-based deep learning and STORM priors: MoDL-STORM	DL	Resonancia magnética cardiaca dinámica a través de modelos deep learning
Xiong et al. (2019) <sup>531</sup>	Fully Automatic Left Atrium Segmentation From Late Gadolinium Enhanced Magnetic Resonance Imaging Using a Dual Fully Convolutional Neural Network	DL	Segmentación completa de la aurícula izquierda a través de redes neuronales convolucionales aplicadas a resonancias magnéticas con realce de gadolinio

Bahrami et al. (2019) <sup>532</sup>	Automated selection of myocardial inversion time with a convolutional neural network: Spatial temporal ensemble myocardium inversion network (STEMI-NET)	DL	Selección automática del tiempo de inversión miocárdica en resonancias magnéticas
Goldfarb et al. (2019) <sup>533</sup>	Water-fat separation and parameter mapping in cardiac MRI via deep learning with a convolutional neural network	DL	Mapeado de tejido adiposo en imagen por resonancia magnética cardíaca a través de redes neuronales convolucionales
Du et al. (2019) <sup>534</sup>	Cardiac-DeepIED: Automatic Pixel-Level Deep Segmentation for Cardiac Bi-Ventricle Using Improved End-to-End Encoder-Decoder Network	DL	Segmentación de ventrículos derecho e izquierdo en imagen por resonancia
Khened et al. (2019) <sup>535</sup>	Fully convolutional multi-scale residual DenseNets for cardiac segmentation and automated cardiac diagnosis using ensemble of classifiers	DL	Segmentación y diagnóstico automático de imágenes por resonancia magnética cardíaca a través de redes neuronales convolucionales residuales multiescala
Wang et al. (2019) <sup>536</sup>	A learning-based automatic segmentation and quantification method on left ventricle in gated myocardial perfusion SPECT imaging: A feasibility study	DL	Segmentación automática del ventrículo izquierdo en imagen de perfusión miocárdica SPECT
Duan et al. (2019) <sup>537</sup>	Automatic 3D bi-ventricular segmentation of cardiac images by a shape-refined multi-task deep learning approach	DL	Segmentación 3D biventricular de imágenes por resonancia magnética cardíaca
Priya et al. (2019) <sup>538</sup>	Adaptive Fruitfly Based Modified Region Growing Algorithm for Cardiac Fat Segmentation Using Optimal Neural Network	DL	Segmentación de tejido adiposo cardíaco
Hauptmann et al. (2019) <sup>539</sup>	Real-time cardiovascular MR with spatio-temporal artifact suppression using deep learning-proof of concept in congenital heart disease	DL	Redes neuronales convolucionales para la reconstrucción de resonancias magnéticas cardíacas
Liu et al. (2019) <sup>540</sup>	Multi-sequence myocardium segmentation with cross-constrained shape and neural network-based initialization	DL	Segmentación multisequencia del miocardio

Zhao et al. (2019) <sup>541</sup>	Deep feature regression (DFR) for 3D vessel segmentation	DL	Segmentación 3D de vasos coronarios
De Vos et al. (2019) <sup>542</sup>	A deep learning framework for unsupervised affine and deformable image registration	DL	Registro de secuencias de imágenes por resonancia magnética cardíaca y tomografías de tórax
Wang et al. (2019) <sup>543</sup>	Diagnostic accuracy of a deep learning approach to calculate FFR from coronary CT angiography	DL	Precisión diagnóstica de los enfoques basados en deep learning para el cálculo de la reserva fraccionaria de flujo a partir de tomografía coronaria
Murphy et al. (2019) <sup>544</sup>	Noise-robust bioimpedance approach for cardiac output measurement	DL	Monitorización de parámetros cardíacos de pacientes de insuficiencia cardíaca congestiva
va et al. (2019) <sup>545</sup>	Application of speCtraL computed tomogrAphy to impRove specificity of cardiac compuTed tomographY (CLARITY study): rationale and design	DL	Aplicación de tomografía espectral para mejorar la especificidad en la detección de estenosis de la tomografía computarizada cardíaca
Wu et al. (2019) <sup>546</sup>	Automated anatomical labeling of coronary arteries via bidirectional tree LSTMs	DL	Reconstructor automático del árbol coronario a partir de imágenes de TC
Wolterink et al. (2019) <sup>547</sup>	Coronary artery centerline extraction in cardiac CT angiography using a CNN-based orientation classifier	DL	Predicción de la dirección y diámetro de una arteria coronaria a partir de imágenes de TC
Tao et al. (2019) <sup>548</sup>	Deep Learning-based Method for Fully Automatic Quantification of Left Ventricle Function from Cine MR Images: A Multivendor, Multicenter Study	DL	Cuantificación automática de la función ventricular izquierda a partir de imágenes de resonancia magnética y evaluación multimarca y multicéntrica
Leclerc et al. (2019) <sup>549</sup>	Deep Learning for Segmentation using an Open Large-Scale Dataset in 2D Echocardiography	DL	Segmentación de ecocardiogramas
Volpato et al. (2019) <sup>550</sup>	Automated, machine learning-based, 3D echocardiographic quantification of left ventricular mass	ML	Cuantificación automatizada de masa del ventrículo izquierdo basada en ecocardiografía 3D

DL: *deep learning* (aprendizaje profundo); ML: *machine learning* (aprendizaje automático).

### Tabla 5 del material adicional

Publicaciones inteligencia artificial en otras aplicaciones en cardiología

Referencia	Título	Modalidad	Observación
Goldstein et al. (2014) <sup>551</sup>	Near-term prediction of sudden cardiac death in older hemodialysis patients using electronic health records	ML	Predictor de muerte súbita en pacientes ancianos en hemodiálisis
Ahmad et al. (2014) <sup>552</sup>	Machine learning classification of cell-specific cardiac enhancers uncovers developmental subnetworks regulating progenitor cell division and cell fate specification	ML	Clasificación de las células implicadas en el desarrollo cardiaco en modelo animal
A. Wahab et al. (2014) <sup>553</sup>	Comparing time to adverse drug reaction signals in a spontaneous reporting database and a claims database: a case study of rofecoxib-induced myocardial infarction and rosiglitazone-induced heart failure signals in Australia	DL	Método para evaluar la seguridad cardiovascular en la postcomercialización de fármacos, concretamente rofecoxib y rosiglitazona
Liu et al. (2014) <sup>554</sup>	Improvement of adequate use of warfarin for the elderly using decision tree-based approaches	ML	Mejora en la efectividad del uso de antagonistas de la vitamina K en pacientes ancianos
Perry et al. (2014) <sup>555</sup>	Supervised embedding of textual predictors with applications in clinical diagnostics for pediatric cardiology	NLP, ML	Clasificación de pacientes pediátricos con cardiopatía
Gharehbaghi et (2014) <sup>556</sup>	Detection of systolic ejection click using time growing neural network	DL	Clasificación de los ruidos cardiacos
Elgendi et al. (2014) <sup>557</sup>	Spectral analysis of the heart sounds in children with and without pulmonary artery hypertension	ML	Diagnóstico de hipertensión pulmonar en niños a partir del análisis de ruidos cardiacos a través de fonendoscopios
Elgendi et al. (2014) <sup>558</sup>	Time-domain analysis of heart sound intensity in children with and without pulmonary artery hypertension: a pilot study using a digital stethoscope	ML	Diagnóstico de hipertensión pulmonar en niños a partir del análisis temporales de ruidos cardiacos a través de fonendoscopios

Nouei et al. (2014) <sup>559</sup>	Developing a genetic fuzzy system for risk assessment of mortality after cardiac surgery	ML, DL	Sistema predictivo de mortalidad tras cirugía cardíaca
Gorospe et al. (2014) <sup>560</sup>	Automated grouping of action potentials of human embryonic stem cell-derived cardiomyocytes	ML	Clasificación fenotípica de cardiomiocitos derivados de células humanas embrionarias
LaFaro et al. (2015) <sup>561</sup>	Neural Network Prediction of ICU Length of Stay Following Cardiac Surgery Based on Pre-Incision Variables	DL	Modelo de red neuronal para predecir la duración de la estancia en UCI tras cirugía cardíaca
Economou et al. (2015) <sup>562</sup>	Exploiting expert systems in cardiology: a comparative study	DL	Sistema de clasificación de diferentes patologías cardiovasculares: enfermedad coronaria, hipertensión arterial, fibrilación auricular, insuficiencia cardíaca y diabetes
Han et al. (2015) <sup>563</sup>	The relationship between left ventricle myocardial performance index of healthy women and geographical factors	DL	Relación entre los factores geográficos y el índice de rendimiento del miocardio del ventrículo izquierdo
Huang et al. (2015) <sup>564</sup>	Post-operative bleeding risk stratification in cardiac pulmonary bypass patients using artificial neural network	DL	Predicción de sangrado en pacientes sometidos a pontaje aortocoronario
Nahato et al. (2015) <sup>565</sup>	Knowledge mining from clinical datasets using rough sets and backpropagation neural network	ML	Clasificador de enfermedad cardíaca en general a partir de grandes bases de datos
Wise et al. (2015) <sup>566</sup>	Prediction of in-hospital mortality after ruptured abdominal aortic aneurysm repair using an artificial neural network	DL	Predicción de muerte hospitalaria tras reparación quirúrgica de aneurismas abdominales
Lee et al. (2015) <sup>567</sup>	Machine learning plus optical flow: a simple and sensitive method to detect cardioactive drugs	ML	Detección de efectos cardiotóxicos de fármacos
Mendes et al. (2015) <sup>568</sup>	Predicting reintubation, prolonged mechanical ventilation and death in post-coronary artery bypass graft surgery: a comparison between artificial neural networks and logistic regression models	ML, DL	Predicción de complicaciones tras cirugía de revascularización coronaria

Liu et al. (2015) <sup>569</sup>	Manifold ranking based scoring system with its application to cardiac arrest prediction: A retrospective study in emergency department patients	ML	Predicción de muerte súbita en pacientes en los servicios de emergencias
Luo et al. (2015) <sup>570</sup>	Using Computational Approaches to Improve Risk-Stratified Patient Management: Rationale and Methods	ML	Diseño de estudio para analizar un modelo predictivo de resultado en salud y costes clasificando el riesgo del paciente con diferentes enfermedades crónicas, incluyendo cardíacas
Mohamadipanah et al. (2015) <sup>571</sup>	Predictive Model Reference Adaptive Controller to Compensate Heart Motion in Minimally Invasive CABG Surgery	ML	Modelo para corregir el movimiento cardíaco durante la cirugía mínimamente invasiva
Gharehbaghi et al. (2015) <sup>572</sup>	A Novel Method for Screening Children with Isolated Bicuspid Aortic Valve	ML, DL	Diagnóstico de válvula aórtica bicúspide en niños a partir del análisis de ruidos cardíacos
Elgendi et al. (2016) <sup>573</sup>	The unique heart sound signature of children with pulmonary artery hypertension	ML	Análisis de patrones en la auscultación para identificar niños con hipertensión pulmonar
Bashir et al. (2016) <sup>574</sup>	IntelliHealth: A medical decision support application using a novel weighted multi-layer classifier ensemble framework	ML	Sistema de clasificación validado en diferentes patologías cardíacas
Monsalve-Torra et al. (2016) <sup>575</sup>	Using machine learning methods for predicting inhospital mortality in patients undergoing open repair of abdominal aortic aneurysm	ML	Sistema para predecir mortalidad hospitalaria tras cirugía de aorta abdominal
Sengupta et al. (2016) <sup>576</sup>	Cognitive Machine-Learning Algorithm for Cardiac Imaging: A Pilot Study for Differentiating Constrictive Pericarditis From Restrictive Cardiomyopathy	ML	Algoritmo de diferenciación diagnóstica entre pericarditis constrictiva y miocardiopatía restrictiva
Wang et al. (2016) <sup>577</sup>	ADMET Evaluation in Drug Discovery. 16. Predicting hERG Blockers by Combining Multiple Pharmacophores and Machine Learning Approaches	ML	Modelo predictivo para evaluar el riesgo de cardiotoxicidad en las primeras etapas de diseño de fármacos bloqueadores hERG
Antink et al. (2016) <sup>578</sup>	Reducing false alarms in the ICU by quantifying self-similarity of multimodal biosignals	ML	Sistema de control de alarmas para unidades de críticos

Hu et al. (2016) <sup>579</sup>	Prediction of Clinical Deterioration in Hospitalized Adult Patients with Hematologic Malignancies Using a Neural Network Model	DL	Sistema de predicción de alarmas en la monitorización de parada cardiaca en pacientes en unidades críticos
Seyres et al. (2016) <sup>580</sup>	Identification and in silico modeling of enhancers reveals new features of the cardiac differentiation network	ML	Utilización de inteligencia artificial para identificar factores de transcripción responsables en el desarrollo cardiaco en Drosophila
Hansen et al. (2016) <sup>581</sup>	Identifying Drug-Drug Interactions by Data Mining: A Pilot Study of Warfarin-Associated Drug Interactions	ML	Identificación de interacciones farmacológicas de los antagonistas de vitamina K
Thompson et al. (2016) <sup>582</sup>	Predictive models for mortality after ruptured aortic aneurysm repair do not predict futility and are not useful for clinical decision making	DL	Estudio neutro con un modelo que no mejoraba la predicción de muerte tras cirugía de rotura de aorta abdominal
Waardenberg et al. (2016) <sup>583</sup>	Prediction and validation of protein-protein interactors from genome-wide DNA-binding data using a knowledge-based machine-learning approach	ML	Predicción de las interacciones de la proteína NKX2-5 basadas en datos del genoma completo
Ruiz-Fernandez et al. (2016) <sup>584</sup>	Aid decision algorithms to estimate the risk in congenital heart surgery	ML	Clasificación de riesgo en la cirugía de cardiopatías congénitas
Wolf et al. (2016) <sup>585</sup>	Rationale and methodology of a collaborative learning project in congenital cardiac care	DL	Sistema en red, 5 hospitales,, para mejorar los resultados en cardiopatías congénitas
Tang et al. (2017) <sup>586</sup>	A non-invasive approach to investigation of ventricular blood pressure using cardiac sound features	DL	Determinación de la presión arterial a partir del análisis de ruidos cardiacos
Kario (2017) <sup>587</sup>	Perfect 24-h management of hypertension: clinical relevance and perspectives	ML	Sistema para control ambulatorio de la presión arterial
Flores et al. (2017) <sup>588</sup>	Predicting the physiological response of Tivela stultorum hearts with digoxin from cardiac parameters using artificial neural networks	DL	Predicción de la concentración de digoxina necesaria para obtener la máxima cardioactividad
Schiltz et al. (2017) <sup>589</sup>	Identifying Specific Combinations of Multimorbidity that Contribute to Health Care Resource Utilization: An Analytic Approach	ML	Identificación de enfermedades crónicas, limitaciones funcionales y síndromes geriátricos asociados con costes sanitarios y utilización de recursos hospitalarios

Allyn et al. (2017) <sup>590</sup>	A Comparison of a Machine Learning Model with EuroSCORE II in Predicting Mortality after Elective Cardiac Surgery: A Decision Curve Analysis	ML	ML es más preciso en la predicción de mortalidad que el EuroSCORE II en pacientes sometidos a cirugía cardíaca electiva
Wise et al. (2017) <sup>591</sup>	Prediction of Prolonged Ventilation after Coronary Artery Bypass Grafting: Data from an Artificial Neural Network	DL	Identificación de factores preoperatorios asociados a ventilación prolongada e identificación temprana de pacientes que la puedan requerir tras cirugía de pontaje coronario
Pereira et al. (2017) <sup>592</sup>	Automated detection of coarctation of aorta in neonates from two-dimensional echocardiograms	DL	Detección de coartación de aorta utilizando imágenes ecocardiográficas
Li et al. (2017) <sup>593</sup>	An artificial neural network prediction model of congenital heart disease based on risk factors: A hospital-based case-control study	DL	Predicción de cardiopatías congénitas en fetos de mujeres embarazadas
Zhang et al. (2017) <sup>594</sup>	[Research on prediction method of left ventricular blood pressure based on external heart sounds]	DL	Modelo predictivo en perros para determinar la presión ventricular izquierda a partir de los ruidos cardíacos
Gharehbaghi et al. (2017) <sup>595</sup>	A Decision Support System for Cardiac Disease Diagnosis Based on Machine Learning Methods	ML	Sistema para screening de cardiopatías congénitas en niños en atención primaria basado en el análisis de los ruidos cardíacos
Radchenko et al. (2017) <sup>596</sup>	Computer-aided estimation of the hERG-mediated cardiotoxicity risk of potential drug components	DL	Modelo predictivo de cardiotoxicidad de futuros fármacos a través del canal de potasio hERG
Eslamizadeh et al. (2017) <sup>597</sup>	Heart murmur detection based on wavelet transformation and a synergy between artificial neural network and modified neighbor annealing methods	DL	Clasificador de soplos cardíacos
Sudha (2017) <sup>598</sup>	Evolutionary and Neural Computing Based Decision Support System for Disease Diagnosis from Clinical Data Sets in Medical Practice	DL	Identificador de enfermedad cardíaca
Awad et al. (2017) <sup>599</sup>	Early hospital mortality prediction of intensive care unit patients using an ensemble learning approach	ML	Predictor de mortalidad en pacientes ingresados en unidades de críticos



Xiao et al. (2017) <sup>600</sup>	Estimation of aortic systolic blood pressure from radial systolic and diastolic blood pressures alone using artificial neural networks	DL	Estimación de la presión sistólica en aorta a partir de las presiones sistólicas y diastólicas de arteria radial
Indja et al. (2017) <sup>601</sup>	Neural network imaging to characterize brain injury in cardiac procedures: the emerging utility of connectomics	DL	Caracterización de la lesión cerebral isquémica postquirúrgica
Liang et al. (2017) <sup>602</sup>	A machine learning approach to investigate the relationship between shape features and numerically predicted risk of ascending aortic aneurysm	ML	Predicción automática de rotura de aneurismas de aorta ascendente
Abdollahpur et al. (2017) <sup>603</sup>	Detection of pathological heart sounds	ML, DL	Clasificación automática de ruidos cardíacos a partir del datatón PhysioNet/CinC Challenge 2016
No listado autores (2017) <sup>604</sup>	[Quantitative structure-activity relationship model for prediction of cardiotoxicity of chemical components in traditional Chinese medicines]	ML	Predicción de la posible cardiotoxicidad de los componentes químicos de las medicinas tradicionales chinas
Gharehbaghi et al. (2017) <sup>605</sup>	Intelligent Phonocardiography for Screening Ventricular Septal Defect Using Time Growing Neural Network	DL	Clasificación entre comunicación interventricular o insuficiencia valvular aurículo-ventricular a partir de la auscultación cardíaca
Silva et al. (2017) <sup>606</sup>	Combined Thoracic Ultrasound Assessment during a Successful Weaning Trial Predicts Postextubation Distress	ML	Predicción de estrés respiratorio postextubación a partir de datos ecocardiográficos respiratorios, cardíacos y de diafragma
Ebert et al. (2017) <sup>607</sup>	Automatic detection of hemorrhagic pericardial effusion on PMCT using deep learning - a feasibility study	DL	Detección y segmentación de hemopericardio postmortem a partir de TC
Kay et al. (2017) <sup>608</sup>	DropConnected neural networks trained on time-frequency and inter-beat features for classifying heart sounds	DL	Clasificación de ruidos cardíacos en normales o anormales
Kublanov et al. (2017) <sup>609</sup>	Comparison of Machine Learning Methods for the Arterial Hypertension Diagnostics	ML	Clasificación en hipertensión arterial o no a partir del análisis de la variabilidad de la frecuencia cardíaca

Attallah et al. (2017) <sup>610</sup>	Using multiple classifiers for predicting the risk of endovascular aortic aneurysm repair re-intervention through hybrid feature selection	ML, DL	Predicción del riesgo de reintervención en aneurismas de aorta tratados endovascularmente
Liang et al. (2017) <sup>611</sup>	A deep learning approach to estimate chemically-treated collagenous tissue nonlinear anisotropic stress-strain responses from microscopy images	DL	Estimación de las propiedades elásticas del tejido colágeno directamente de imágenes de microscopía para la fabricación de bioprótesis cardiacas
Conant et al. (2017) <sup>612</sup>	Kinase inhibitor screening using artificial neural networks and engineered cardiac biowires	DL	Predicción de cardiotoxicidad de diferentes inhibidores de quinasa utilizados en cáncer
Vivekanandan et al. (2017) <sup>613</sup>	Optimal feature selection using a modified differential evolution algorithm and its effectiveness for prediction of heart disease	DL	Predicción de enfermedad cardiaca a partir de múltiples datos
Lee et al. (2017) <sup>614</sup>	Machine Learning of Human Pluripotent Stem Cell-Derived Engineered Cardiac Tissue Contractility for Automated Drug Classification	ML	Algoritmo de clasificación para predecir la acción mecanicista de una droga cardioactiva desconocida
Bergau et al. (2018) <sup>615</sup>	Machine-Learning Prediction of Drug-Induced Cardiac Arrhythmia: Analysis of Gene Expression and Clustering	ML	Sistema para evaluar la seguridad de medicamentos realizando análisis de expresión de genes
Amiriparian et al. (2018) <sup>616</sup>	Deep Unsupervised Representation Learning for Abnormal Heart Sound Classification	DL	Clasificador para identificar ruidos cardiacos anormales
Dey et al. (2018) <sup>617</sup>	InstaBP: Cuff-less Blood Pressure Monitoring on Smartphone using Single PPG Sensor	ML	Desarrollo de un modelo de predicción para la monitorización de la presión arterial por un solo sensor basado en particiones demográficas y fisiológicas
Thompson et al. (2018) <sup>618</sup>	Artificial Intelligence-Assisted Auscultation of Heart Murmurs: Validation by Virtual Clinical Trial	ML	Algoritmo clasificador de soplos cardiacos
Cai et al. (2018) <sup>619</sup>	In Silico Pharmacoepidemiologic Evaluation of Drug-Induced Cardiovascular Complications Using Combined Classifiers	ML	Desarrollo de modelos <i>in silico</i> para la identificación sistemática de complicaciones cardiovasculares inducidas por fármacos

Pan et al. (2018) <sup>620</sup>	Identifying Patients with Atrioventricular Septal Defect in Down Syndrome Populations by Using Self-Normalizing Neural Networks and Feature Selection	DL	Identificación de canal aurículo-ventricular en el Síndrome de Down
Elgendi et al. (2018) <sup>621</sup>	The Voice of the Heart: Vowel-Like Sound in Pulmonary Artery Hypertension	ML	Análisis de patrones de auscultación para el diagnóstico no invasivo de hipertensión pulmonar
Burghardt et al. (2018) <sup>622</sup>	Neural/Bayes network predictor for inheritable cardiac disease pathogenicity and phenotype	DL	Predictor de cardiopatías familiares y fenotipo a partir del análisis genético
Zhu et al. (2018) <sup>623</sup>	[Left ventricle segmentation in echocardiography based on adaptive mean shift]	ML	Segmentación automática del ventrículo izquierdo en ecocardiografía
Maharlou et al. (2018) <sup>624</sup>	Predicting Length of Stay in Intensive Care Units after Cardiac Surgery: Comparison of Artificial Neural Networks and Adaptive Neuro-fuzzy System	DL	Modelo para predecir estancias en unidades de críticos tras cirugía cardíaca
Liem et al. (2018) <sup>625</sup>	Phrase mining of textual data to analyze extracellular matrix protein patterns across cardiovascular disease	ML	Asociación entre los patrones de proteínas de matriz extracelular y enfermedad cardiovascular a partir de extracción de datos textuales en la literatura
Juhola et al. (2018) <sup>626</sup>	Detection of genetic cardiac diseases by Ca <sup>2+</sup> transient profiles using machine learning methods	ML	Identificación de anomalías en los canales de Ca <sup>2+</sup> para el diagnóstico de cardiopatías familiares
McCarthy et al. (2018) <sup>627</sup>	A clinical and proteomics approach to predict the presence of obstructive peripheral arterial disease: From the Catheter Sampled Blood Archive in Cardiovascular Diseases (CASABLANCA) Study	ML	Sistema para el diagnóstico de enfermedad vascular periférica
Hatib et al. (2018) <sup>628</sup>	Machine-learning Algorithm to Predict Hypotension Based on High-fidelity Arterial Pressure Waveform Analysis	ML	Análisis de las formas de onda de presión arterial para predecir hipotensión
Parreco et al. (2018) <sup>629</sup>	Using artificial intelligence to predict prolonged mechanical ventilation and tracheostomy placement	ML	Identificación de pacientes con ventilación prolongada y necesidad de traqueostomía

Giri et al. (2018) <sup>630</sup>	Increased Plasma Nitrite and von Willebrand Factor Indicates Early Diagnosis of Vascular Diseases in Chemotherapy Treated Cancer Patients	ML	Identificar biomarcadores en plasma de carditoxicidad
Kan et al. (2018) <sup>631</sup>	Handmade trileaflet valve design and validation for patch-valved conduit reconstruction using generalized regression machine learning model	DL	Determinación de los parámetros, incluidos el ancho, longitud y estructura curva, de conductos valvulados
Rösler et al. (2018) <sup>632</sup>	Development and Application of a System Based on Artificial Intelligence for Transcatheter Aortic Prosthesis Selection	ML	Sistema experto para la optimización en la selección de la TAVI a implantar
Luo et al. (2018) <sup>633</sup>	Integrating hypertension phenotype and genotype with hybrid non-negative matrix factorization	ML	Estratificación en pacientes hipertensos a partir de datos feno y genotípicos
Lee et al. (2018) <sup>634</sup>	Derivation and Validation of Machine Learning Approaches to Predict Acute Kidney Injury after Cardiac Surgery	ML	Predicción de fallo renal tras cirugía cardíaca
Luis Ahumadal et al. (2018) <sup>635</sup>	Prediction of One-Year Transplant-Free Survival after Norwood Procedure Based on the Pre-Operative Data	DL	Predicción de mala evolución en niños con ventrículo único hipoplásico sometidos a cirugía de Norwood
Lu et al. (2018) <sup>636</sup>	A Novel Deep Learning based Neural Network for Heartbeat Detection in Ballistocardiograph	DL	Detección automática de latidos cardíacos durante la balistocardiografía (registro de los movimientos producidos por el impacto de la sangre en el corazón y grandes vasos)
Chen et al. (2018) <sup>637</sup>	Artificial Neural Network: A Method for Prediction of Surgery-Related Pressure Injury in Cardiovascular Surgical Patients	DL	Predicción moderada de lesión por presión tras cirugía cardíaca
Aviles-Rivero et al. (2018) <sup>638</sup>	Sliding to predict: vision-based beating heart motion estimation by modeling temporal interactions	ML	Corrección de la movilidad cardíaca en la estimación estructural para emplear en cirugía robótica
Kang et al. (2018) <sup>639</sup>	Cardiac Auscultation Using Smartphones: Pilot Study	DL	Utilización de teléfonos móviles para auscultación cardíaca

Lucia-Valdeperas et al. (2018) <sup>640</sup>	Unravelling the effects of mechanical physiological conditioning on cardiac adipose tissue-derived progenitor cells in vitro and in silico	DL	Análisis del proteoma de células cardíacas derivadas de tejido adiposo
Matam et al. (2018) <sup>641</sup>	Machine learning based framework to predict cardiac arrests in a paediatric intensive care unit : Prediction of cardiac arrests	ML	Patrones (frecuencias cardíaca y respiratoria, presión arterial, saturación) predictores de parada cardíaca en pacientes pediátricos ingresados en unidades de críticos
Jordanski et al. (2018) <sup>642</sup>	Machine Learning Approach for Predicting Wall Shear Distribution for Abdominal Aortic Aneurysm and Carotid Bifurcation Models	ML, DL	Algoritmo de cálculo de la distribución de la tensión de cizallamiento de la pared arterial, como mecanismo esencial en el desarrollo de aterosclerosis
Diaz et al. (2018) <sup>643</sup>	Modeling the control of the central nervous system over the cardiovascular system using support vector machines	ML	Modelos hemodinámicos de predicción del sistema cardiovascular en respuesta a estímulos del sistema nervioso central
Feng et al. (2018) <sup>644</sup>	Study of continuous blood pressure estimation based on pulse transit time, heart rate and photoplethysmography-derived hemodynamic covariates	ML	Estimación continua de la presión arterial
Wacker et al. (2018) <sup>645</sup>	Performance of Machine Learning Algorithms for Qualitative and Quantitative Prediction Drug Blockade of hERG1 channel	ML	Modelo predictivo de cardiotoxicidad para evaluar fármacos con capacidad de bloquear el canal de potasio hERG
Siramshetty et al. (2018) <sup>646</sup>	The Catch-22 of Predicting hERG Blockade Using Publicly Accessible Bioactivity Data	ML	Clasificador de cardiotoxicidad por fármacos sobre el canal hERG con datos de bioactividad extraídos del dominio público
Lu et al. (2018) <sup>647</sup>	Research on Improved Depth Belief Network-Based Prediction of Cardiovascular Diseases	DL	Clasificador de patología cardíaca a partir de datos de pacientes ingresados en unidades de cuidados intensivos
Vervier et al. 2018 <sup>648</sup>	TiSAn: estimating tissue-specific effects of coding and non-coding variants	ML	Discriminación de las variantes relevantes para un tejido de aquellas que no influyen en su función
Bozkurt et al. (2018) <sup>649</sup>	A study of time-frequency features for CNN-based automatic heart sound classification for pathology detection	DL	Clasificación de patología cardíaca en pacientes pediátricos por el análisis de ruidos cardíacos

Messner et al. (2018) <sup>650</sup>	Heart Sound Segmentation-An Event Detection Approach Using Deep Recurrent Neural Networks	DL	Clasificación de patología cardíaca a partir del análisis de primer y segundo ruidos cardíacos con datos procedentes del datatón 2016 PhysioNet/CinC Challenge
Mejia et al. (2018) <sup>651</sup>	Predictive performance of six mortality risk scores and the development of a novel model in a prospective cohort of patients undergoing valve surgery secondary to rheumatic fever	ML	Predicción de riesgo tras cirugía valvular en pacientes con cardiopatía reumática y comparación con scores de riesgo clásicos
Marateb et al. (2018) <sup>652</sup>	Prediction of dyslipidemia using gene mutations, family history of diseases and anthropometric indicators in children and adolescents: The CASPIAN-III study	ML	Diagnóstico de dislipemia usando datos genéticos, familiares y antropométricos en niños y adolescentes
Jalali et al. (2018) <sup>653</sup>	Prediction of Periventricular Leukomalacia in Neonates after Cardiac Surgery Using Machine Learning Algorithms	ML	Predicción de leucomalacia periventricular en neonatos sometidos a cirugía cardíaca
Cai et al. (2019) <sup>654</sup>	Deep Learning-Based Prediction of Drug-Induced Cardiotoxicity	DL	Predicción de cardiotoxicidad inducida por fármacos a través de deep learning
Diller et al. (2019) <sup>655</sup>	Utility of machine learning algorithms in assessing patients with a systemic right ventricle	ML	Evaluación de pacientes con ventrículo derecho sistémico a partir de imagen ecocardiográfica transtorácica
Harford et al. (2019) <sup>656</sup>	A machine learning based model for Out of Hospital cardiac arrest outcome classification and sensitivity analysis	ML	Predicción de paro cardíaco extrahospitalario con modelos machine learning
Blomberg et al. (2019) <sup>657</sup>	Machine learning as a supportive tool to recognize cardiac arrest in emergency calls	ML	Reconocimiento de pacientes en parada cardíaca en llamadas telefónicas de emergencia a través
Melero-Alegria et al. (2019) <sup>658</sup>	SALMANTICOR study. Rationale and design of a population-based study to identify structural heart disease abnormalities: a spatial and machine learning analysis	ML	Diseño de estudio poblacional para la identificación de enfermedades cardíacas estructurales.
Casaclang-Verzosa et al. (2019) <sup>659</sup>	Network Tomography for Understanding Phenotypic Presentations in Aortic Stenosis	ML	Fenotipado de ventrículos izquierdos en respuesta a la aparición de estenosis aórtica

Bello et al. (2019) <sup>660</sup>	Deep learning cardiac motion analysis for human survival prediction	DL	Análisis del movimiento cardíaco para la predicción de supervivencia
Huo et al. (2019) <sup>661</sup>	A machine learning model to classify aortic dissection patients in the early diagnosis phase	ML	Clasificación de pacientes con riesgo de disección de aorta en fases de diagnóstico
Diller et al. (2019) <sup>662</sup>	Machine learning algorithms estimating prognosis and guiding therapy in adult congenital heart disease: data from a single tertiary centre including 10 019 patients	ML	Evaluación pronóstica y terapéutica en pacientes adultos con patologías cardíacas congénitas
Zhao et al. (2019) <sup>663</sup>	Learning from Longitudinal Data in Electronic Health Record and Genetic Data to Improve Cardiovascular Event Prediction	DL	Predicción de eventos cardiovasculares a partir del análisis de registros clínicos electrónicos y datos genéticos
Daghistani et al. (2019) <sup>664</sup>	Predictors of in-hospital length of stay among cardiac patients: A machine learning approach	DL	Identificación de predictores de tiempos de estancia intrahospitalaria de pacientes cardíacos
Sparapani et al. (2019) <sup>665</sup>	Detection of Left Ventricular Hypertrophy Using Bayesian Additive Regression Trees: The MESA	ML	Detección de hipertrofia del ventrículo izquierdo
Pulido et al. (2019) <sup>666</sup>	Blood Pressure Classification Using the Method of the Modular Neural Networks	ML	Clasificación de presiones arteriales
Ibrahim et al. (2019) <sup>667</sup>	A clinical, proteomics, and artificial intelligence-driven model to predict acute kidney injury in patients undergoing coronary angiography	ML	Predicción de daño renal agudo en pacientes sometidos a intervención coronaria percutánea
va et al. (2019) <sup>668</sup>	Prognostic value of CT myocardial perfusion imaging and CT-derived fractional flow reserve for major adverse cardiac events in patients with coronary artery disease	ML	Evaluación de valores pronósticos de imagen de perfusión miocárdica por tomografía y reserva fraccional de flujo a partir de tomografía para la predicción de eventos cardíacos mayores en pacientes con enfermedad coronaria
Ruiz et al. (2019) <sup>669</sup>	Early prediction of critical events for infants with single-ventricle physiology in critical care using routinely collected data	ML	Predicción temprana de eventos críticos en neonatos con ventrículo único

Ris et al. (2019) <sup>670</sup>	Inflammatory biomarkers in infective endocarditis: machine learning to predict mortality	ML	Identificación de biomarcadores de endocarditis
Hsich et al. (2019) <sup>671</sup>	Variables of importance in the Scientific Registry of Transplant Recipients database predictive of heart transplant waitlist mortality	ML	Identificación de características para la predicción de mortalidad en listas de espera a trasplante cardiaco
Emre et al. (2019) <sup>672</sup>	The analysis of the effects of acute rheumatic fever in childhood on cardiac disease with data mining	ML	Análisis de efectos de la fiebre reumática aguda en pacientes infantiles con patologías cardiacas
Sun et al. (2019) <sup>673</sup>	[Radiomics strategy based on cardiac magnetic resonance imaging cine sequence for assessing the severity of mitral value regurgitation]	ML	Evaluación de severidad de insuficiencias mitrales a partir de resonancia magnética cardiaca

DL: *deep learning* (aprendizaje profundo); ML: *machine learning* (aprendizaje automático); NLP: *natural language processing* (procesamiento del lenguaje natural).



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