*BMC Proceedings* 2025, **19**(Suppl 8):11
https://doi.org/10.1186/s12919-025-00324-6

BMC Proceedings

**MEETING ABSTRACTS** **Open Access**

# Proceedings of the 2nd edition of the International e-Health Forum 2024

**Casablanca, Morocco. 30-31 October 2024**

Published: 15 April 2025

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## I1

### Introduction of the 2nd edition of the International e-Health Forum 2024-Morocco

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*BMC Proceedings 2025*, **19(8):** I1

This proceeding compiles the oral and poster presentations, the abstracts of the four finalists for the Best Thesis Award in e-health and the final declarations of the 2nd edition of the International e-Health Forum 2024.
Held under the High Patronage of His Majesty King Mohammed VI of Morocco, this second edition took place on October 30–31, 2024, at Mohammed VI University of Health Sciences in Casablanca, under the theme: "The Digital Health Era: Towards Quality Care for All." The event reflects Morocco's steadfast commitment to advancing the digital transformation of its healthcare system.
Co-organized by the Mohammed VI Foundation for Health Sciences (FM6SS) and the e-Health Innovation Center (CleS) of Mohammed V University in Rabat, in partnership with the Ministry of Health and Social Protection, the forum brought together experts, policymakers, and international thought leaders, highlighting the dynamism and potential of Morocco's digital health ecosystem.
The event featured renowned international speakers, ministers, and senior government officials from various countries, alongside leaders of prominent international organizations such as WHO, Africa CDC, and Smart Africa. It also welcomed executives from leading technology companies and pioneering healthtech startups, enriching discussions with diverse perspectives and expertise.
Designed to encourage innovation, knowledge sharing, and strategic networking, the forum included high-level plenary sessions on artificial intelligence in healthcare, specialized masterclasses on medical simulation, a health innovation hackathon, and an exhibition of state-of-the-art technological solutions. Strategic partnerships were formalized through agreements signed during the event, complemented by the launch of the inaugural Sport-Health-Tech initiative, which underscored the interdisciplinary impact of digital technology in health.
With over 6,000 visitors, 150 B2B meetings, 180 speakers (including 40 international experts), and representation from 27 countries, this second edition exceeded expectations. It produced significant outcomes for digital health in Morocco and beyond, inspiring stakeholders, strengthening strategic alliances, and paving the way for transformative advancements in e-health across Africa.

## S1

### Sleep, Sedation and Heart rhythm Control and Monitoring using Electrophysiological Signals Processing and Artificial Intelligence Algorithms

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#### Background

For a long time, patients have visited hospitals for diagnosis and treatment. Such processes are often impossible without the use of medical devices. Some diseases require continuous monitoring to detect the exact onset of health abnormalities. In this context, our thesis focused on three interactive healthcare fields. The first, which is our main contribution, involves electroencephalogram (EEG) signal acquisition and processing for the purpose of sleep and sedation detection. The second area of contribution focuses on optimizing an implantable cardiac device for arrhythmia control and monitoring. The third contribution

pertains to the development of a telemedicine platform aimed at reducing the spread of COVID-19.

**Materials and Methods**

To conduct our research, we began by cleaning EEG signals using various methods and filters in MATLAB software [1], including wavelet and other traditional filters. Next, we classified sleep depth using artificial intelligence (AI) algorithms applied to EEG signals [2]. The final phase of this project involved developing a Brain-Computer Interface system to monitor and control the depth of anesthesia (DOA) [3]. We trained and tested our algorithms using EEG signals from the PhysioNet ATM Database.

In the cardiology domain, we proposed enhancements to the Implantable Cardioverter Defibrillator (ICD) to improve features and precision, using LabVIEW software [4]. Our third contribution involved developing a telemedicine platform to help reduce the spread of COVID-19 [5]. For this, we utilized a pulse sensor, laptops, and smartphones to record, monitor, and analyze patients' vital parameters.

**Results**

Through several in-vitro trials for sleep depth detection, we were able to extract statistics on sleep quality. For automatic anesthesia, we achieved significant results, such as avoiding overdoses and reducing the administered dosage, thereby ensuring patient safety during surgery.

In the cardiology field, we developed an adaptive heart rhythm system for patients. In the telemedicine domain, our contribution enabled real-time statistics to track confirmed and recovered COVID-19 cases. Additionally, our telemedicine platform supported governmental decision-making, including implementing total or partial lockdowns.

**Conclusion**

Finally, during our thesis, we carried out several demonstrations, simulations and in-vitro trials to develop real proof-of-concept solutions. However, there are areas for further improvement, such as conducting in-vivo tests and collaborating with diverse contributors to enhance healthcare accessibility for everyone, everywhere.

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## S2

## Big Data and Artificial Intelligence in the Medical Field: Application to the diagnosis of pulmonary, cardiovascular, and ocular diseases

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**Background**

The era of Big Data and Artificial Intelligence (AI) has radically transformed the way information is collected, processed, and utilized. Big Data represents the vast reservoir of data generated by digital interactions, while AI provides the capability to make sense of this data, extracting knowledge and making intelligent decisions [1]. This synergy between Big Data and AI is opening doors to innovation in nearly every aspect of life, particularly in the medical field.

**Materials and Methods**

This thesis delves deeply into the advantages, challenges, and implications of utilizing Big Data and AI in the medical domain, with a focus on improving diagnostics, clinical decision making, and healthcare, while considering fundamental ethical and regulatory issues. By presenting specific case studies, the research illustrates how AI is revolutionizing disease diagnosis. Concrete examples demonstrate how AI is used to detect diseases such as pulmonary, cardiovascular, and ocular illnesses, thereby increasing diagnostic accuracy and improving clinical outcomes. Indeed, our contributions include the development of models based on Convolutional Neural Networks (CNNs) for the segmentation and classification of medical images obtained from disease-specific datasets, such as Pediatric CXR for pneumonia diseases, the MIT-BIH Arrhythmia Dataset, DRISHTI-GS and RIM-ONE for ocular diseases.

**Results**

Standard metrics were used to evaluate the performance of all the models, including those developed for pneumonia classification [2], cardiac arrhythmia classification [3], model for coronary artery segmentation based on U-Net [4], and a CNN model for glaucoma segmentation and classification [5]. The results of these efforts represent groundbreaking innovations that substantially enhance the diagnostic capabilities of medical experts, enabling them to make more accurate and efficient clinical decisions.

**Conclusion**

In conclusion, this thesis explores Big Data's revolutionary role in medical data analysis. It underscores the growing importance of AI in medicine, especially in disease diagnosis. The thesis shows AI's impact on clinical practices and discusses the future of this rapidly evolving technology. Indeed, this work opens new perspectives in the field of medical imaging and the application of AI in medicine, emphasizing the need for careful evaluation of the impact of these technologies on medical practice.

**Acknowledgements**

We would like to thank all the contributing authors for their efforts and dedication during the preparation of this research work, particularly Dr. Benayad Nsiri, the thesis supervisor, as well as the members of Cedoc ST2I for their invaluable support and guidance.

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## S3

### Computer aided diagnosis: Automatic early cancer detection based on computer vision techniques

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**Background**
Computer Aided Diagnosis (CAD) is becoming more widely used in the identification and detection of a wide range of abnormalities discovered during various imaging modalities. The primary goal of CAD systems is to improve diagnostic accuracy and reduce diagnostic time, whereas the overall goal of CAD systems is to locate lesions and characterize their characteristics. The primary use of CAD systems is to detect abnormalities in the human body. Among these, tumor detection is the most common use since missed basic screening leads to cancer. The primary purpose of CAD systems is to detect anomalous indicators that a human professional might miss. Breast cancer, lung cancer, colon cancer, prostate cancer, bone metastases, coronary artery disease, congenital heart defect, abnormal brain detection, Alzheimer's disease, and diabetic retinopathy are all diagnosed with CAD.
**Materials and Methods**
This thesis focuses on the design and implementation of medical imaging analysis systems that employ digital image processing tools and artificial intelligence approaches to find abnormality features, categorize them, and offer visual confirmations to experts. Preprocessing, segmentation, feature extraction, and classification are some of the stages addressed by our suggested CAD systems. The suggested systems exhibit some advanced approaches in medical imaging. The first method aims to automatize classifying dermoscopic images containing skin lesions into benign or malignant. Therefore an improved deep learning-based solution with a Convolutional Neural Network is proposed. Regularization, dropout, and data augmentation are used to avoid the CNN model over-fitting. The second method is an improvement of the first one, the method proposes a combined deep learning architecture to identify pneumonia in chest radiography images. Where AMF is used for image enhancement, then a regularized CNN is employed for features extraction. Finally, Long Short Term Memory is utilized as a classifier. The last approach presents an end-to-end 2D attention residual U-Net (AttResUNet) system, which integrates attention mechanism and residual units into U-Net for further polyp and bleeding segmentation performance enhancement. To reduce irrelevant areas in an input image while emphasizing salient features, AttResU-Net inserts a sequence of attention units among related down-sampling and up-sampling steps.
**Results**
On the other hand, the residual block propagates information across layers, allowing for constructing a deeper neural network capable of solving the vanishing gradient issue in each encoder. This improves the channel inter-dependencies while lowering the computational cost.
**Conclusion**
Extensive experiments using real medical imaging datasets have demonstrated that the proposed systems perform effectively.

**Acknowledgements**
This work was partially supported by the Ministry of National Education, Vocational Training, Higher Education and Scientific Research, the Ministry of Industry, Trade and Green and Digital Economy, the Digital Development Agency (ADD), and the National Center for Scientific and Technical Research (CNRST). Project number: ALKHAWARIZMI/2020/20.

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## S4

### Computer vision and deep learning based retinopathy diagnosis

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**Background**
The increasing global prevalence of type 2 diabetes and its complications, such as diabetic retinopathy (DR), necessitates improved diagnostic tools. This research leverages advancements in computer vision and deep learning to enhance the early detection and management of these conditions. Optical Coherence Tomography (OCT) imaging serves as a foundation for this investigation, offering detailed retinal analysis.
**Materials and Methods**
The study employed machine learning algorithms and deep neural networks to predict type 2 diabetes and diagnose DR. The datasets included clinical records and OCT images. A total of 207,130 OCT images were analyzed for DR classification, and feature selection was optimized using Neighborhood Component Analysis (NCA). A custom Convolutional Neural Network (CNN) architecture and Grad-CAM were utilized for model interpretability. Furthermore, an NSL-MHA-CNN model integrated neural structure learning with multi-head attention to enhance resilience against adversarial attacks. Performance was evaluated using metrics such as accuracy, sensitivity, and the Area Under the ROC Curve (AUC).
**Results**
The predictive models demonstrated significant accuracy in diabetes diagnosis, with deep learning models outperforming traditional approaches. The custom CNN achieved an accuracy of 0.80 and an AUC of 0.87 after nine epochs. Grad-CAM provided visual insights into the model's decision-making process, highlighting critical regions for DR detection. The NSL-MHA-CNN model exhibited robustness under adversarial conditions. Additionally, the proposed segmentation architecture for OCT images achieved superior performance compared to state-of-the-art models, particularly in delineating retinal layers and fluids.
**Conclusion**
This research underscores the potential of integrating deep learning and OCT imaging for effective diabetes and DR diagnosis. The introduction of advanced models, such as NSL-MHA-CNN, addresses both accuracy and security concerns in medical imaging. These findings advocate for the broader adoption of AI-driven diagnostics to enhance patient outcomes and streamline clinical workflows.

**Acknowledgements**
Praise be to Almighty God for granting me the faith and perseverance to complete this challenging journey.
I extend my heartfelt gratitude to my supervisors, Dr. Tmiri Amal and Dr. Cherradi Bouchaib, for their unwavering guidance, support, and encouragement, as well as to my colleagues and family for their invaluable contributions and prayers. Finally, I am deeply thankful to everyone who supported and motivated me throughout this endeavor.

## O1

### 4-lead ECG With A SmartWatch : Is It Reliable?

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**Background**
Recent technological advancements have enabled the creation of new wearable devices like smartphones and smartwatches (SW). These devices offer a variety of services to users through various software applications installed on either the smartphone or the smartwatch. Among these services, health monitoring has become a new trend [1]. The SW can record a single-lead Electrocardiogram (ECG), which is sufficient for screening or diagnosing rhythm and conduction disorders, especially during episodes of cardiac symptoms, though it is insufficient for detecting ischemic diseases and cardiomyopathies [2].
**Materials and Methods**
In this context, the aim of the study is to analyse whether the use of several leads using a connected watch is reliable in comparison with a standard ECG. For this purpose, 140 patients were recruited for the study. Initially, a 12-lead ECG was followed by a four-lead SW-ECG, using the Withings Scanwatch device, under the same resting conditions. The four-lead SW-ECG included an Einthoven DI lead placed on the left wrist. Additionally, three Wilson-type leads were recorded: V1 in the fourth right parasternal intercostal space, V3 in the fifth intercostal space along the midclavicular line, and V6 in the fifth intercostal space along the left midaxillary line, with the right index finger on the crown and the left hand holding the right wrist.
**Results**
In total, 700 ECG recordings were collected and analyzed statistically. Of the patients, 97% successfully obtained an ECG using the SW. The probability of similarity of SW and 12-lead ECG results according to subgroups in each lead studied revealed a rate of between 70 and 85% for all leads combined for rhythm disorders. Good results were observed for repolarisation and cardiac conduction disorders, with correlation values of around 78%. For normal ECGs, the probability of similarity was 100%.
**Conclusion**
Our results confirm existing data on the high similarity between SW and standard 12-lead ECG [3]. The results obtained are very encouraging, and the current work aims to develop a decision support system based on machine learning techniques for improved detection of cardiac anomalies using SW-ECG recordings as input data [4].

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## O2

### Advancing AI-driven thematic analysis in qualitative research: a comparative study of ChatGPT o1-preview and five generative AI models on cutaneous leishmaniasis data

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**Background**
Thematic analysis is a key method in qualitative research for identifying patterns in data. It is time-consuming and requires special expertise [1]. The advent of artificial intelligence (AI), particularly large language models, offers the prospect of automating and enhancing various qualitative analysis processes [2,3]. This study aims to assess the efficacy of AI-driven thematic analysis in qualitative research, focusing on the psychological impact of cutaneous leishmaniasis scars.
**Materials and Methods**
Data comprising 448 quotes from a primary study [4], were analyzed using six generative AI models (ChatGPT o1-preview, ChatGPT-4o, Claude 3.5 Sonnet, NotebookLM, Gemini Advanced Ultra, Llama 3.1 405B) and manual coding by an experienced qualitative researcher. The analysis was conducted in three phases:
Phase 1A: Analysis of the accuracy of qualitative coding of student responses. Phase 1B: Analysis of the accuracy of qualitative coding of responses from students affected by cutaneous leishmaniasis, comparing them by gender.
Phase 1C: Analysis of the significance level between the responses of students affected by cutaneous leishmaniasis, comparing them by gender across the analysis methods used. Phase 2: Qualitative summary of themes and sub-themes. Phase 3: Comparative analysis of the sub-themes' accuracy in the synthesis by AI-supported models B, C, D, E, F, and G compared to the reference analysis.
Agreement was assessed using Jamovi software to calculate Cohen's Kappa. Python was employed to calculate Jaccard's index and measure similarity.
**Results**
Several AI models exhibited comparable or superior performance to manual analysis in terms of consistency. The AI models demonstrated excellent internal and improved external consistency compared to the reference in the subgroup analysis. Applying AI-powered methods resulted in a notable reduction in the time required for qualitative data analysis compared to manual methods. Combinations of models, particularly those including Gemini Advanced Ultra and Claude 3.5 Sonnet, yielded high Jaccard index scores, indicating strong similarity with the reference results. Notably, ChatGPT o1-preview alone emerged as the leading model for more accurate and comprehensive qualitative analyses.
**Conclusion**
The application of AI-driven thematic analysis offers significant advantages in efficiency and consistency, with certain models demonstrating superior performance to manual analysis. Next-generation AI generative models hold the potential to perform high-quality qualitative analysis.

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## O3

### Integrating AI and genomic data for enhanced diagnostics in hereditary hearing loss

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**Background**
Hearing loss (HL) is the most common sensory impairment, affecting 1 in 500 newborns, with genetic factors responsible for about 50% of cases [1]. Hereditary hearing loss (HHL) is genetically diverse, involving pathogenic variants across multiple genes, and is divided into syndromic and non-syndromic forms [2]. Recent advances in next-generation sequencing (NGS) have improved our understanding of HHL, enabling more accurate diagnoses and potential treatments [3]. However, the vast number of variants identified presents a challenge in distinguishing disease-causing variants from benign ones, necessitating the use of advanced computational tools and bioinformatics methods to prioritize variants and accurately determine their clinical relevance.
**Materials and Methods**
Next-generation sequencing (NGS) was performed on Moroccan families suspected of having hereditary hearing loss (HHL). Several bioinformatics tools, including AI-based platforms like CADD (Combined Annotation Dependent Depletion) and MutationTaster, were used to assess the functional and pathogenic impact of the identified variants. These AI-driven tools played a crucial role in evaluating variant pathogenicity, helping to prioritize those most likely to contribute to HHL.
**Results**
Sequencing analysis identified both known and novel variants in over 50% of the families across various hereditary hearing loss (HHL)-related genes. Utilizing AI tools to interpret the pathogenicity of these variants significantly enhanced the diagnostic process, resulting in a higher diagnosis rate within our cohort. This AI-driven approach yielded deeper insights into variant pathogenicity, which were crucial for providing personalized care to affected patients and their families.
**Conclusion**
Our findings underscore the critical role of combining AI with genomic data to improve diagnostic accuracy and patient outcomes, particularly in genetically heterogeneous conditions such as hereditary hearing loss. The continued use of AI in genomic diagnostics holds great potential for enabling more personalized, predictive, and precise healthcare, reflecting a significant advancement in the diagnosis and management of hereditary hearing loss and other complex genetic disorders.

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## O4

### Transformer-based approaches to skin cancer detection using smartphone images

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**Background and objective**
Skin cancer is one of the world's most important public health problems, with millions of new cases reported every year. Recent advances in artificial intelligence, particularly deep learning, may offer solutions to improve screening and early, accurate detection of this deadly disease. The aim of this research project is to propose a deep learning method to automate the analysis of smartphone images of the skin to identify signs of cancer. The aim of this approach is to provide dermatologists with a high-performance assistance tool, improving the sensitivity and specificity of diagnosis and facilitating the rapid identification of suspicious lesions. By combining the power of deep learning with accessible imaging, this technology could help save lives by making screening faster and more accessible to a greater number of patients.
**Methods**
In the study, we evaluated the effectiveness of using the Vision Transformer to detect cancer-relatedskin pathologies. Specifically, we studied six different categories of skin lesions: actinic, basal cell carcinoma,melanoma, nevus, squamous cell carcinoma, and seborrheic keratosis. The data contained a total of 2298 imagescaptured by smartphones at various resolutions, covering each lesion type. Images were predefined by resizing to a standard size of 224 x 224 pixels, and category labels were encoded for all skin cancer types. Data augmentation was applied to unbalanced training image categories. Finally, model performance was assessed by quantitative parameters such as accuracy, precision, sensitivity, specificity, F1 score and area under the ROC-AUC curve.
**Results**
The results show that the Vision Transformer (ViT) model performed satisfactorily in classifying skinlesions. The model achieved overall accuracy of 83% and specificity of 93%. With positive precision of 84% andrecall of 83%, the F1-score was also 83%. Finally, the area under the ROC curve (ROC-AUC) was 95%.
**Conclusion**
This study demonstrates that the Vision Transformer model is effective in detecting cancer-relatedskin lesions, with an accuracy of 83% and a specificity of 93%. These results suggest that integrating deep learning into dermatological screening could improve the identification of suspicious lesions and facilitate early diagnosis, thus contributing to the fight against skin cancer.

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## O5

### Evaluating Retinal Image Quality in Diabetic Retinopathy Using a Multiclass Machine Learning Model

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*BMC Proceedings 2025*, **19(8):** O5

**Background**
Diabetic retinopathy is a leading cause of vision loss. Retinal imaging provides a non-invasive way to assess the retina, but image quality greatly impacts diagnostic accuracy. As a result, there is growing interest in developing robust image quality assessment methods to enhance the reliability of diabetic retinopathy screening.
**Materials and Methods**
In this study, we utilized the EyePACS dataset in conjunction with quality labels from the EyeQ GitHub repository [1] which classify images as "good," "usable," or "rejected." The proposed model processes retinal images through a series of preprocessing steps, including resizing, grayscale conversion, application of a surface mask, and background removal. Following these steps, dual feature extraction is performed, beginning with the extraction of generic features [2] and subsequently generating saliency maps[3].
The extracted features are then normalized, combined, and classified using three classifiers: Support Vector Machine (SVM), Random Forest, and XGBoost. Performance metrics, including accuracy, F1 score and the confusion matrix are then computed to evaluate the model's effectiveness.
**Results**
Among the three classifiers evaluated, XGBoost demonstrated the most encouraging results for assessing retinal image quality, achieving an accuracy of 86.40%.
**Conclusion**
This study presents a three-class quality assessment method for retinal images, reducing the likelihood of misclassifying usable images as poor quality compared to binary approaches. The results demonstrate that our approach exhibits a similarity to state-of-the-art methods in the assessment of retinal image quality, a finding that is not insignificant.

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## O6

### Shaping Digital Health in Africa: Evidence of Leapfrogging Digital Transformation in Morocco

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**Background**
With a healthcare market reaching $70 billion, Artificial Intelligence (AI) technologies have the potential to serve as critical drivers of economic growth, value creation, and transformation. AI advancements play a role in aiding income and middle-income nations (LMICs), facilitating advancements in the digital era. However, several barriers must be overcome to achieve the benefits achieved by their high-income counterparts. This study explores how Moroccan healthcare organizations can leapfrog their efforts into digital health to improve patient care, optimize operations, and make informed decisions while accounting for cultural and societal norms and government stewardship.
**Materials and Methods**
We carried out a multiple qualitative case study based on semi-structured interviews with 35 key informants holding leadership positions in healthcare organizations who were dealing directly or indirectly with the digital directions of their organization's different regions (e.g., hospital administrators, medical doctors, government leaders).
The US IRB and The Moroccan Ministry of Foreign Affairs approved this research. Reflexivity statement: Our research teams comprised interdisciplinary teams of young and senior researchers active in data analytics, the medical field, and PhD candidates.
**Results**
Our finding shows that Moroccan healthcare organizations are actively embarking on a transformative journey in healthcare technologies in both the public and private sectors. We've pinpointed five obstacles hindering progress in digitization initiatives. Namely (1) attitude, (2) inadequate allocation of resources, (3) the urban-rural disparity, (4) compartmentalization or "silos," and (5) absence of uniformity. These barriers suggest the need for inclusive representativity and participative decision-making processes, effective change management to overcome resistance to change and ensure ownership of agreed-upon comprehensive digital healthcare solutions, reduced fragmentation during policy implementation, and smooth data sharing and interoperability. Our main contribution resides in developing a digitalization AI change management framework that accounts for public and private partnerships, digital transformation, and context-specific conditions for the sustainability of AI digital solutions in Morocco.
**Conclusion**
This study represents an initial framework that may guide efforts toward developing appropriate digital and AI strategies for Morocco. Our context-specific recommendation might help healthcare executives, policymakers, and educators to fine-tune their policy implementation processes to the context of Moroccan employees and co-design suitable AI strategies in line with existing legislative and institutional frameworks.
**Acknowledgments**
Dr. Rachida Parks gratefully acknowledges the financial support for this research from the Fulbright U.S. Scholar Program, which the U.S. Department of State and MACECE sponsors. The author holds responsibility for its contents. They may not reflect the official perspectives of the Fulbright Program, the U.S. government, or MACECE. The authors are also thankful to all those who participated in our in-depth interviews as well as the IeHEALTHF review committee.

## O7

### LungDx AI: A Multiclass Deep Learning Platform for Pulmonary Disease Detection and Diagnosis

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*BMC Proceedings 2025*, **19(8):** O7

**Background**
Pulmonary diseases like tuberculosis (TB), viral pneumonia, COVID-19, and lung opacity continue to challenge global healthcare, especially in regions where access to advanced diagnostic tools is limited. Traditional diagnostic methods that depend on radiologists often struggle with accuracy, consistency, and efficiency in resource-limited settings. Many AI tools, while valuable, tend to focus on specific conditions and rarely address diseases like TB, which remains a significant issue in low-resource countries. However, AI-powered platforms are emerging as essential tools, enhancing diagnostic precision and easing the workload of healthcare professionals in such environments.
**Materials and Methods**
We present LungDx AI, an innovative deep learning platform that supports the multiclass classification of pulmonary diseases, including TB, viral pneumonia, COVID-19, and lung opacity. Built on the DenseNet121 architecture, LungDx AI processes both chest X-ray and CT scan images, using advanced feature extraction techniques to optimize disease detection. The platform integrates data from large, publicly available datasets and is designed for real-time clinical application. It is equipped with a user-friendly interface that supports integration into hospital information systems (HSI), making it highly accessible, even in technologically underserved environments.
**Results**
LungDx AI demonstrated high diagnostic performance, achieving an accuracy of 87.33%, with precision at 89.05% and recall at 87.33%. The platform is particularly effective in diagnosing TB and other pulmonary conditions, providing a more comprehensive diagnostic solution compared to many existing AI tools that often focus on a single condition, such as COVID-19 or pneumonia. LungDx AI's capacity to handle both X-ray and CT scan data makes it adaptable to various clinical demands, including those in regions with high TB prevalence and limited access to sophisticated medical technologies.
**Conclusion**
Unlike many AI-based diagnostic systems that concentrate on detecting single conditions, LungDx AI distinguishes itself by offering a multiclass solution that includes TB detection, a critical need in countries with high infection rates. The platform enhances diagnostic accuracy, reduces radiologist workloads through automation, and provides real-time visual aids to support clinical decision-making. This research highlights the innovative nature of LungDx AI, as it not only broadens diagnostic capabilities but also offers a versatile tool that can be easily deployed in diverse healthcare environments. Future enhancements will focus on expanding the system's ability to detect additional conditions, such as lung cancer, by refining its opacity analysis. Currently undergoing clinical validation, LungDx AI is positioned to play a pivotal role in the future of AI-driven medical diagnostics.

**Acknowledgements**
This study was conducted with the expertise of the Faculty of Medicine, Pharmacy and Dental Medicine of Fez, USMBA and CHU Hassan II of Fez. We acknowledge the Radiation Oncology Department, Oncology Hospital of Hassan II University Hospital for their valuable input, as well as the academic guidance provided by the Faculty throughout the research process.

## O8

### Large-Scale Digital Maturity Assessment in Germany and Its Learnings for Morocco

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**Background**
The Hospital Future Act, launched by the German government, represents a major €4.3 billion investment in enhancing the digital maturity of hospitals. The centerpiece of this initiative, the "DigitalRadar" project, is a comprehensive evaluation framework developed to measure the effectiveness and impact of this significant digitization funding. Having completed its second round of assessments, DigitalRadar has set a new global standard for national-level digital maturity evaluations.
**Materials and Methods**
This presentation will outline the methodologies and analytical approaches used in the DigitalRadar project. We will examine its structured, data-driven assessment model and discuss the metrics used to evaluate digital transformation across hospital systems. Emphasis will be placed on its relevance for health policy and research, particularly in understanding the relationship between digital maturity, hospital quality, and financial performance.
**Results**
The findings of DigitalRadar highlight key factors contributing to successful digital transformation, including leadership engagement, strategic alignment, and targeted funding allocation. These outcomes not only guide health policy development in Germany but also provide a robust framework for other countries pursuing similar digitization goals.
**Conclusion**
The presentation will translate the lessons learned from Germany's DigitalRadar into actionable recommendations for Morocco's national digitization strategy. Strategic insights on measurement techniques, success factors, and sustainable implementation pathways will be shared, offering a roadmap for enhancing the digital maturity of Moroccan hospitals in alignment with international best practices.

## O9

### Evaluating Partial Middle Ear Filling for Cholesteatoma Diagnosis based on temporal bone CT scan Using Supervised Machine Learning models

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**Background**
Middle ear cholesteatoma, an inflammatory condition marked by destructive processes, poses diagnostic challenges, particularly in differentiating it from Chronic Suppurative Otitis Media (CSOM). Accurate diagnosis is crucial for appropriate surgical planning. With the advancement of Artificial intelligence, Machine Learning models are used to process medical data in order to assist physicians by reducing diagnosis errors. Currently, there is a trend in medical literature exploring the utility of those tools using medical field data. In this study, we explored the diagnostic value of partial middle ear filling on temporal bone CT scan for identifying cholesteatoma using supervised machine learning models.
**Methods**
This observational case-control study retrospectively analyzed temporal bone CT scans from 212 patients. Using supervised machine learning models, including k-Nearest Neighbors (kNN), Neural Networks, Logistic Regression, and Support Vector Machine (SVM). The study assessed the diagnostic value of partial middle ear filling for middle ear cholesteatoma identification. Limitations such as dataset imbalance and data complexity were also managed.
**Results**
kNN and Neural Networks exhibited superior diagnostic performance, as reflected by high F1 and AUC scores. While Logistic Regression and

SVM also yielded strong results, their performance was slightly below that of the leading models. Additionally, inconsistencies in the robustness of the kNN model were identified and thoroughly investigated. The Random Forest model, however, was determined to be less appropriate for this specific dataset structure.

**Conclusion**

The study highlights the effectiveness of supervised machine learning models in diagnosing cholesteatoma. Addressing data imbalance and variability in CT scans was crucial for model performance's optimization. Further research is needed to refine these models and explore their integration into clinical practice.

## O10

### Enhancing Breast Cancer Recurrence Prediction across Treatment Scenarios with Weighted Cox Mixtures

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**Background**

Breast cancer treatment ideally includes personalized combinations of surgery, radiation, chemotherapy, and endocrine therapy. The recurrence risk of breast cancer is highly dependent on the successful execution of these personalized treatment plans. However, predicting recurrence is particularly challenging due to multiple factors, including tumor biology, treatment efficacy, and individual patient responses. Current models for recurrence prediction [1] are often based on clinical and pathological features but fail to capture the complexity of treatment interactions and patient-specific factors. Additionally, these models typically rely on homogeneous datasets, limiting their applicability to diverse populations and contributing to disparities in cancer care. To address this, we propose a weighted Cox mixtures model [2] that integrates treatment plans and clinical data to estimate recurrence risk, aiming to reduce disparities in prediction accuracy across different populations.

**Methods**

Data was collected from two diverse populations: the Mayo Clinic Enterprise in the US and the National Institute of Oncology in Morocco. These cohorts comprise females diagnosed with primary breast cancer, categorized into seven treatment combinations. The Cox mixtures model was enhanced through the integration of three weighting methodologies: Inverse Probability of Treatment Weighting, Adaptive Weights using focal loss, and Prioritizing Subgroups by assigning higher weights to specific groups. These techniques aim to address population-specific disparities by improving the model's adaptability to diverse treatment responses and healthcare settings.

**Results**

In the Mayo Clinic cohort, the model with Adaptive Weights demonstrated improved predictive accuracy, with index values ranging from 0.67 to 0.88 across treatment contrasts, outperforming the original Cox model. In the Moroccan cohort, Adaptive Weights also improved predictive performance (C-index values of 0.60 to 0.71), although the smaller sample size led to larger confidence intervals. These results highlight the importance of incorporating digital health tools, such as advanced statistical models, to address disparities in breast cancer outcomes between populations with different healthcare resources and treatment access.

**Conclusion**

By incorporating advanced weighting strategies into the Cox mixtures model, we significantly improved breast cancer recurrence prediction, particularly in underrepresented populations with treatment imbalances. This model demonstrates the potential of digital health approaches to reduce disparities in cancer care by enabling more accurate, personalized predictions across diverse cohorts. Expanding these efforts to include more underrepresented populations will be essential for further reducing healthcare inequalities and improving global breast cancer outcomes.

**Acknowledgement**

This manuscript is partially supported by the Fulbright program and NCI 1U01CA269264-01 (PI Banerjee):Flexible NLP toolkit for automatic curation of outcomes for breast cancer patients.

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## O11

### The contribution of artificial intelligence in diagnosis and therapy

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*BMC Proceedings 2025*, **19(8):** O11

**Background**

Artificial intelligence (AI) has been studied across three key medical domains: breast cancer screening, radiotherapy, and emergency department management.

**Materials and Methods**

We approached this thematic with different studies. In the first, 322 images from MIAS and the ThirdOpinion.ai simulator were used to evaluate supervised and unsupervised AI approaches in interpreting mammographic images. In the second, radiotherapy was explored, where reinforcement learning optimized organ contouring and dosimetry. A comparison between conventional radiotherapy and AI-based adaptive radiotherapy was conducted at Clinique 16 Novembre in Rabat with four prostate cancer patients over one month. The second part compared the performance of Unity and Ethos technologies. The third study was a quantitative analysis conducted in two emergency radiology departments in Rabat (Military and Avicenne Hospitals) on 200 patients with fractures. Over two months, it assessed the impact in high-pressure environments.

**Results**

In the first study, key parameters such as entropy, correlation, compactness, and surface area were analyzed to distinguish between benign and malignant calcifications. Benign calcifications had a compactness below 6.8, while malignant cases reached up to 24. Surface area ranged from 10 to 173 for benign calcifications, compared to 583 for malignant ones. Malignant calcifications exhibited a contrast closer to 1, with 8 to 48 regions, while benign calcifications had a contrast near 0 and no more than 6 regions. For further clinical insights, BI-RADS was added to the simulator's unsupervised model. For the prostate radiotherapy study, results showed that in conventional treatment, 30% of the rectum received 220 cGy by the 8th and 9th sessions. AI-based adaptive radiotherapy significantly reduced the dose-volume peak in the rectum to below 17%. For the bladder, adaptive radiotherapy limited exposure to under 30%, compared to over 34% with conventional treatment. The third study evaluated emergency departments where initial imaging used standard X-rays. Since AI imaging was not available, radiologists had to perform a second X-ray for

patients. In 85% of shoulder fractures, 100% of knee fractures, and more than 95% of hip fractures, a repeat CT scan was required for confirmation. As a result, patients face increased exposure, higher healthcare costs, and slower patient flow.

**Conclusions**

The study highlights the significant impact of AI in improving accuracy, efficiency, and personalization across medical applications. However, ethical and regulatory challenges, including data re-identification risks and patient confidentiality concerns, emphasize the need for robust technical solutions and clear frameworks to ensure responsible AI use in healthcare.

**Acknowledgements**

I would like to express my gratitude to my students, whom I had the honor of supervising as their thesis advisor, for their hard work on their final-year projects (PFE), which indirectly contributed to the results of this study. Special thanks go to Esbyay M. and Mezoine H. for their work on "Artificial Intelligence Applied to Fracture Detection"; Khalfaoui Hassani B. and Jaoulany H. for their contribution to "The Role of AI in Mammography"; Bourra O. and Sadki M. for their work on "Adaptive Radiotherapy in Prostate Cancer Treatment"; and Krabch A., the physicist, for his support in the radiotherapy aspect of the study.

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## P1

### Computational screening and antibacterial Evaluation of natural products Targeting OmpW in *Acinetobacter baumannii*

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*BMC Proceedings 2025*, **19(8):** P1

**Background**

The rise of multidrug-resistant *Acinetobacter baumannii* infections highlights the urgent need for new therapeutic strategies. Outer membrane protein W (OmpW) in *A. baumannii* has emerged as a promising target for addressing these infections.

**Materials and Methods**

This study aimed to identify natural compounds with potent antibacterial activity against *A. baumannii* by leveraging machine learning-based quantitative structure-activity relationship (QSAR) models and structure-based virtual screening. A comprehensive library of 11,648 natural compounds was screened using QSAR models trained on a ChEMBL dataset comprising over 7,000 compounds with reported minimal inhibitory concentration (MIC) values against *A. baumannii* [1]. The top candidates from the QSAR analysis were subsequently evaluated through virtual screening against the OmpW protein target. *In silico* pharmacokinetic profiling assessed the drug-likeness of these compounds, focusing on ADMET (absorption, distribution, metabolism, excretion, and toxicity) characteristics.

**Results**

Curcuminoids, particularly demethoxycurcumin, emerged as promising leads, showing binding energies between −7.8 and −7.0 kcal/mol and strong interactions with OmpW [1]. Its antibacterial efficacy was confirmed through in vitro experiments, including microdilution assays and time-kill curve analyses against multiple *A. baumannii* strains. Demethoxycurcumin demonstrated significant activity both as a standalone treatment and in combination with colistin, showing efficacy across all tested strains. Target specificity was validated using an OmpW-deficient mutant strain, where the absence of OmpW reduced the compound's effectiveness, reinforcing its role as the primary binding target [1]. Moreover, demethoxycurcumin was found to impair *A. baumannii's* ability to interact with host cells, indicating a potential anti-virulence mechanism.

**Conclusion**

This study highlights demethoxycurcumin as a strong candidate for further development as an antibacterial agent, combining machine learning and virtual screening to identify novel treatments for *A. baumannii* infections.

**Acknowledgements**

This work was co-funded by the Consejería de Universidad and Investigación e Innovación de la Junta de Andalucía (grant ProyExcel_00116) and funded by the Instituto de Salud Carlos III, Subdirección General de Redes y Centros de Investigación Cooperativa, Ministerio de Economía, and Industria y Competitividad (grant PI19/01009), cofinanced by the European Development Regional Fund (A way to achieve Europe, Operative Program Intelligent Growth 2014 to 2020). Y.B. is supported by ERASMUS+ Student Mobility for Traineeships.

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## P2

### Redefining Cystoscopy with AI: Bladder Cancer Diagnosis Using an Efficient Hybrid CNN-Transformer Model

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*BMC Proceedings 2025*, **19(8):** P2

**Background and medical context**

Bladder cancer ranks among the top 10 most diagnosed cancers worldwide and is among the most expensive cancers to treat due to its high recurrence rates which require lifetime follow-ups. The primary tool for diagnosis and follow-up is cystoscopy, which is a procedure that allows the doctor to visualize and examine the internal surface of the bladder. This procedure is operator dependent, as it directly relies on doctors' expertise and interpretation. Therefore, every year, numerous cases are either undiagnosed or misdiagnosed and treated as urinary infections. In fact, estimates suggest that white-light cystoscopy fails to detect 10% to 20% of bladder tumors. To overcome these limitations, automated tools that improve diagnostic accuracy and reduce operator variability are critically needed. Moreover, for practical implementation in clinical environments, such tools must be lightweight, capable of real-time inference, and deployable on the edge in resource constrained medical settings without requiring extensive computational resources.

**Methods**

To address the need for accurate and efficient bladder cancer detection, we propose a hybrid CNN-Transformer architecture. CNNs capture local features, while the transformer focuses on modeling global dependencies. Our model incorporates dual attention gates, which fuse self-attention and spatial attention mechanisms to enhance feature selection and ensure both fine grained detail extraction and global context understanding. To further reduce complexity, depth-wise separable convolutions are used in both the encoder and decoder. The transformer block is designed to operate without positional encodings and is placed at the bottleneck of the U-shaped network to efficiently process compressed representations of the input images. This design ensures the model remains lightweight, making it suitable for real-time inference and deployment in resource-constrained medical environments.

**Results**

The proposed hybrid model was trained and validated on a diverse cystoscopy dataset, compiled with the Urology Department at the Mohammed V Military Hospital. It achieved an Intersection over Union (IoU) of 85.7%, a Dice coefficient of 92%, and an accuracy of 96.9%. Despite its lightweight design with only 0.36 million parameters, the model outperforms larger architectures, demonstrating both high accuracy and computational efficiency, making it suitable for real-time clinical deployment.

**Conclusion**

In conclusion, the hybrid CNN-Transformer model provides an efficient, accurate solution for computer aided bladder cancer detection. Its lightweight architecture enables real-time application in resource-constrained clinical settings while improving diagnostic accuracy and reducing operator variability, making it a valuable tool for enhancing early detection and patient care.

## P3

### Lung Cancer Prediction Using XGBoost: A Python-Based Machine Learning Approach

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**Background**

Lung cancer is one of the leading causes of mortality worldwide, with early diagnosis being crucial for improving survival rates. Machine learning (ML) algorithms can assist clinical decision-making by predicting the likelihood of lung cancer in patients based on specific risk factors.

**Materials and Methods**

In this study, we employed the XGBoost classifier to predict lung cancer presence in a dataset comprising 309 patients, of whom 271 were diagnosed with lung cancer (147 women and 162 men), with ages ranging from 21 to 87 years. The dataset included various patient characteristics, including gender, age, smoking history, and other features, to train and test an XGBoost classifier using Python. Data preprocessing involved label encoding and feature scaling. We split the data into training (80%) and testing (20%) sets and applied SHAP (Shapley Additive exPlanations) values to interpret how individual features influenced the model's prediction outcomes. Model performance was evaluated across multiple classification thresholds by assessing accuracy, precision, recall, and F1 scores, focusing on optimizing the F1 score for both classes (presence or absence of lung cancer).

**Results**

The model achieved its best performance at a threshold of 0.2, with an accuracy of 98.39%. At this threshold, the F1 score for patients diagnosed with lung cancer (class 1) was 0.99, and for those without (class 0), it was 0.67. The average F1 score across both classes was 0.83, indicating the model's strong ability to correctly classify patients with lung cancer. SHAP analysis further revealed the most influential features in the model's decision-making, with age and smoking habits showing the most significant impact. Notably, higher feature values were strongly associated with increased lung cancer risk, while lower values (in blue) reduced the risk.

**Conclusion**

Our XGBoost classifier demonstrated high predictive performance in identifying lung cancer in this patient cohort, with significant contributions from age, smoking history, and other demographic factors. The SHAP values provided valuable insights into the model's decision process, highlighting the key risk factors for lung cancer. These findings not only underscore the potential of ML models in enhancing early detection but also offer hope for improving clinical decision-making in lung cancer diagnosis.

**Acknowledgements**

We would like to express our sincere gratitude to Dr. Mai Abdou Salifou Karimoune for her guidance and expertise in oncology and palliative care at Cheikh Zaid Hospital.

## P4

### Revolutionizing medical education with augmented and virtual reality: Advancing training and learning

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**Background**

The integration of Augmented Reality (AR) and Virtual Reality (VR) into medical education is revolutionizing how complex medical concepts and procedures are taught. These technologies provide immersive and interactive learning environments, significantly improving students' comprehension and retention of knowledge. This study explores the specific impact of AR and VR on health sciences education, emphasizing their role in enhancing both theoretical and practical training.

**Materials and Methods**

A systematic review was conducted, analyzing literature from January 2007 to September 2023, sourced from databases including PubMed, Scopus, and Google Scholar. Sixty-two studies were selected based on their relevance to AR/VR applications in medical education. The focus was on evaluating how these technologies improve learning outcomes, particularly in anatomy education, surgical training, and clinical simulations.

**Results**

The analysis demonstrates that AR and VR significantly enhance medical education by providing students with detailed 3D visualizations and interactive simulations. These tools improve the understanding and retention of complex anatomical structures and procedural techniques. In surgical training, AR/VR technologies reduce learning curves and enhance procedural accuracy, particularly in minimally invasive surgeries. However, challenges such as high costs, technological

limitations, and the need for standardized integration into curricula remain significant barriers to broader adoption.

**Conclusion**

AR and VR technologies are essential in modernizing medical education, offering immersive and interactive experiences that surpass traditional teaching methods. To fully harness their potential, it is crucial to address existing challenges, including cost reduction, technological improvements, and the development of standardized educational frameworks. Future research should focus on expanding the application of these technologies across various medical disciplines and validating their effectiveness through clinical trials. Collaboration between educators, healthcare professionals, and technologists is key to successfully integrating AR and VR into health sciences education.

## P5

### AI-Powered Ligand-Based design targeting YCK1 and YCK2 in Saccharomyces cerevisiae: implications for modulating kinase signaling pathways in drug discovery

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**Background**

Protein kinases are essential regulators of signaling pathways that control cell growth and morphogenesis. In humans, the Epidermal Growth Factor Receptor (EGFR) is a key target in cancer therapy due to its role in tumor proliferation. In Saccharomyces cerevisiae, YCK1 and YCK2, casein kinase I isoforms, are implicated in analogous signaling pathways that regulate cell polarity and division. Studying these kinases can provide insights into the modulation of kinase signaling pathways, contributing to the discovery of novel kinase inhibitors. This study employs LiGAN, an AI-driven ligandbased design tool, to identify potential inhibitors of YCK1 and YCK2, with implications for kinase modulation in drug discovery.

**Materials and Methods**

The structures of YCK1 and YCK2 were modeled using bioinformatic tool Alphafold 2, followed by AIdriven ligand-based design using LiGAN. LiGAN generates ligand structures that fit into predicted binding pockets by applying advanced deep learning algorithms to structural and ligand data. These AI-generated ligands were docked into the active sites of YCK1 and YCK2 to predict their binding affinity and interaction profiles. The top predicted ligands were synthesized and tested in vitro using Saccharomyces cerevisiae cultures to evaluate their impact on cell morphology and growth. Molecular docking simulations and dynamic modeling were performed to confirm ligand binding and assess stability in the active site.

**Results**

The AI-driven ligand-based design using LiGAN identified several promising small molecules that exhibited high predicted affinity for YCK1 and YCK2. In vitro assays revealed that these compounds modulated kinase activity, leading to observable changes in yeast cell morphology and division patterns. The results suggest that these compounds have the potential to inhibit kinase signaling pathways, providing a basis for further optimization. The integration of AI-driven ligand design significantly accelerated the discovery process, allowing for rapid refinement of potential inhibitors.

**Conclusion**

This study underscores the utility of AI-driven methodologies, specifically LiGAN, in facilitating the discovery of novel kinase inhibitors. By targeting YCK1 and YCK2 in Saccharomyces cerevisiae, we have identified potential modulators of kinase signaling pathways that may serve as leads for drug discovery targeting human kinases such as EGFR. Future research will focus on optimizing these compounds and exploring their potential as therapeutic agents in cancer and other diseases involving dysregulated kinase activity.

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## P6

### Evaluation of machine learning algorithm for recognition of malaria infection using complete blood count

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**Introduction**

A crucial problem in laboratory practice is the morphological detection of red blood cells infected with malaria parasites. Currently, there aren't many automated technologies that can distinguish malaria from other red blood cell inclusions. The goal of this work is to create a machine learning technique that can distinguish malaria and non-malaria patients.

**Materials and methods**

In this 4-year retrospective study, blood samples were collected from January 2018 to January 2022 and analyzed with a total of 561 patients. The samples were sent to the parasitology laboratory for testing for the presence of malaria by thick drop and blood smear. The two groups (malaria + and malaria -) were compared. Characteristics included laboratory variables (white blood cell count, hemoglobin, platelet count, AST, ALT, urea, creatinine and CRP). The two groups were compared by univariate analysis using the Mann-Whitney test for quantitative variables and the Chi-squar test for categorical variables. Variables significantly associated with malaria were included in the machine learning algorithm (Random forest, K-Nearest Neighbors, Decision Three, Neural Network, Naïve Bayes, Logistic Regression, Gradient Boosting, AdaBoost, Support Vector Machine).

**Results**

The respective accuracies of the used models (Gradient Boosting=76.3%, Random forest=75.9%, Logistic Regression=69.5%, Decision Three=67.1%, Neural Network=66.9%, Naïve Bayes=64.8%, Support Vector Machine=63.7%, K-Nearest Neighbors=62.7%, AdaBoost=61.1%).

**Conclusion**

Machine learning-based models and AI methods driven by blood counts promise timely medical care and improved patient outcomes with less use of resources and associated costs.

## P7

### Harnessing robotics and tele-rehabilitation technologies to reduce health disparities in rehabilitation care

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**Background**

Disparities in access to rehabilitation services continue to be a challenge, particularly in underserved populations. Robotics and tele-rehabilitation technologies have emerged as potential solutions to improve accessibility and provide personalized care, addressing these disparities in a meaningful way.

**Materials and Methods**

Robotic systems enhance rehabilitation by delivering adaptive, real-time therapies tailored to individual patient needs. These systems are particularly beneficial for patients with mobility challenges or those in remote areas, ensuring consistent and personalized therapy. Tele-rehabilitation platforms, although still evolving, offer the advantage of remote patient monitoring, allowing for immediate feedback and precise adjustments to care plans. Since 2019, the University Hospital of Rabat (CHU) has integrated an advanced robotic platform within its rehabilitation program, demonstrating these technologies' practical applications and benefits.

**Results**

Early results from the implementation of robotic systems at the CHU of Rabat indicate significant improvements in care access and patient outcomes. Patients have experienced enhanced therapy personalization and notable gains in mobility and functional independence. The exploration of tele-rehabilitation has shown promise in further expanding care access, particularly benefiting those in rural or underserved areas.

**Conclusion**

Robotics and tele-rehabilitation technologies mark substantial progress in digital health, offering transformative potential to address health disparities. By improving access to rehabilitation services and personalizing treatment plans, these innovations are bridging gaps in care. The experience at the University Hospital of Rabat underscores the advantages of robotics, while ongoing developments in tele-rehabilitation hold considerable promise for future enhancements in patient care.

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## P8

### The digital maturity of a hospital for the successful integration of the electronic patient record: the case of a public hospital

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**Objective**

The aim of this study is to analyze the digital maturity of a public hospital, with a view to the successful integration of an electronic patient record. The notion of digital maturity is seen as the extent to which hospitals are supported by digital technology.

**Methods**

Based on a literature review of the most widely used methods for studying the digital maturity ofhealthcare organizations, we adopted a model of digital maturity in hospitals based on five dimensions: strategy, governance and management, technology, staff and patient-centered care. A qualitative study was conducted through semi-directive interviews with the administrative, medical and nursing staff of a public hospital in the Rabat-Salé-Kenitra region.

**Results**

The results of the interviews with healthcare professionals revealed that the hospital's efforts to integrate the electronic patient record are helping to improve its digital maturity. The hospital's strategy is in line with that of the Ministry of Health and Social Protection, but implementation of the electronic patient record is hampered by a lack of monitoring and support, as well as insufficient human and technical resources. Administrative staff are in favor of this transformation, while doctors, particularly the most senior, are reluctant because of the technical constraints and the lack of appropriate in-service training.

**Conclusion**

The study highlights the challenges that need to be overcome to improve the digital maturity of the study hospital. These challenges include strengthening governance, improving digital infrastructure, ongoing staff training and motivating medical teams. Recommendations are proposed for overcoming these obstacles and successfully integrating the electronic patient record, an essential element in the digitalization of healthcare in Morocco.

## P9

### Security and Confidentiality in Medical Information Systems: Challenges and Solutions

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**Introduction**

The digitalization of healthcare through medical information systems (MIS) has transformed patient data management, enabling improved access, storage, and retrieval of electronic health records (EHRs). However, these advancements also introduce significant concerns about the security and confidentiality of sensitive patient information. The rise in cyberattacks, data breaches, and unauthorized access to health data highlights the need for robust security measures. This review explores the technological solutions and regulatory frameworks designed to protect medical data, alongside challenges posed by human factors in ensuring the security of MIS.

**Methods**

This review is based on an analysis of recent literature from 2015 to 2023, focusing on studies that address the security and confidentiality of MIS. Sources were gathered from academic databases such as PubMed, IEEE Xplore, and Google Scholar. The literature was examined to identify common technological approaches like encryption, access control, and blockchain, as well as the role of legal frameworks such as the Health Insurance Portability and Accountability Act (HIPAA) and the General Data Protection Regulation (GDPR). Additionally, studies that discuss human factors, such as training and compliance issues among healthcare professionals, were included.

**Results**

The review identifies that encryption, secure access control systems, and blockchain are pivotal in enhancing the security of health data. These technologies safeguard data integrity by limiting unauthorized access, securing data transmission, and ensuring confidentiality. However, technological solutions alone cannot fully address security risks.

Human errors, including non-compliance with privacy regulations, insufficient training, and poor security awareness, are common causes of data breaches. Moreover, while regulatory frameworks like HIPAA and GDPR are critical in setting data protection standards, many healthcare organizations struggle to meet these compliance requirements, creating potential vulnerabilities.

**Conclusion**

While MIS offer clear benefits for healthcare efficiency, they also introduce complex security and confidentiality challenges. Technological advancements in encryption and access control help mitigate risks, but human factors remain a critical point of failure. Enhancing healthcare worker training, fostering a culture of compliance, and ensuring strict adherence to regulatory frameworks are essential for strengthening the security of medical information systems. Continuous improvement and monitoring of both technological and regulatory approaches are vital to protecting patient data in an evolving digital landscape.

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## P10

**AI-driven virtual screening for combatting antibiotic resistance: a promising therapeutic approach**

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**Background**

The rise of multi-resistant and pan-resistant enterobacteria, particularly against beta-lactam antibiotics, presents a severe threat to global health. The primary mechanism of resistance is the production of beta-lactamases, enzymes that hydrolyze the beta-lactam ring, rendering the antibiotics ineffective. Inhibiting these enzymes could be a promising strategy for overcoming antibiotic resistance.

**Materials and Methods**

This study applied an AI-driven virtual screening approach to a database of 6,100 compounds to identify potential inhibitors of resistance proteins. Molecular docking was performed using AutoDock Vina to assess binding affinities, followed by Molecular Dynamics (MD) simulations to evaluate the stability of the top candidate compounds. ADMET (Absorption, Distribution, Metabolism, Excretion, and Toxicity) properties were predicted using admet AI to assess drug-likeness and pharmacokinetics. All simulations were carried out under standard conditions, and Root Mean Square Deviation (RMSD), Root Mean Square Fluctuation (RMSF), and hydrogen bonding were analyzed to verify stability.

**Results**

Among the screened compounds, Voucapone exhibited the highest binding affinity (-11.458 kcal/mol), outperforming the commercial beta-lactam inhibitor, clavulanic acid (-6.8 kcal/mol). MD simulations confirmed the stability of Voucapone, with favorable RMSD, RMSF, and H-bond profiles under the simulated conditions. ADMET predictions suggested that the compound adheres to all drug-likeness rules and demonstrates suitable pharmacokinetic properties.

**Conclusion**

This study highlights the potential of AI-assisted virtual screening and molecular dynamics as powerful tools in the search for novel inhibitors of beta-lactamase enzymes. Voucapone shows promise as a candidate for therapeutic development against beta-lactamase-producing, antibiotic-resistant enterobacteria. Further in vitro and in vivo studies are warranted to confirm these findings and advance the compound's development as a new therapeutic option.

## P11

**The digital transformations of hospitals: redefining healthcare roles**

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**Background**

The digital transformation of hospitals has become integral to improving healthcare systems by leveraging advanced technologies to enhance patient care, optimize operations, and increase data management capabilities. This shift incorporates technologies such as electronic medical records (EMRs), telemedicine, artificial intelligence (AI), and the Internet of Things (IoT), impacting healthcare delivery at multiple levels. This review examined the impacts of these technologies on hospital operations, patient care, and healthcare research, focusing on the real-world implementation of digital tools in hospitals worldwide.

**Methods**

A literature review was conducted using PubMed-Medline as the primary database, focusing on recent articles published between 2023 and 2024 that discussed digital innovations in hospital settings, using the search terms "smart hospitals", "digital innovation", and "digital transformation". A total of 454 articles were initially screened based on titles and abstracts, after which 43 full-text articles were selected for in-depth analysis. The articles were evaluated based on technological innovations, implementation strategies, and impacts on healthcare delivery and patient outcomes, specifically in hospital settings.

**Results**

The reviewed literature highlighted several critical areas of digital transformation in hospitals. The adoption of EMRs was widely implemented, enhancing data accessibility and decision-making processes. AI and big data analytics were applied in diagnostics, predictive healthcare, and personalized medicine. Robotics, especially with 5G networks, has enabled remote surgeries, significantly improving access to specialized care. Telemedicine and mobile health (mHealth) technologies saw widespread use, especially in response to the COVID-19 pandemic, facilitating remote patient monitoring and consultations. IoT solutions, such as in-body sensors and smart devices, provided innovative means for continuous health monitoring and automation in hospitals. Cloud computing solutions have streamlined data storage and sharing, facilitating real-time analysis for both clinical care and research. Despite these advancements, key challenges such as data security, interoperability between systems, and the digital divide in healthcare settings were consistently noted.

**Conclusion**

The digital transformation of hospitals offers immense potential for improving healthcare outcomes, operational efficiency, and patient engagement. However, to fully realize the benefits of these technologies, hospitals must address challenges related to data security, interoperability, and the cost of implementation. As hospitals continue to adopt AI, IoT, and other digital innovations, they are becoming more efficient and patient-centered, paving the way for a more connected and data-driven healthcare future.

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## P12

### Development of a Dichotomy for Information Scientist to Communicate AI Initiatives

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**Background**
The goal of any AI initiative is to have a useful output in the form of a product, a key performance indicator, or a simple metric. In the process of getting this output, one must curate the data to allow the AI algorithm to perform at its best. However, certain AI processes are implementable while other analytical processes exposed the limitations of analytics in healthcare delivery. Essentially, some processes "make the machine happy" while other processes "make the machine sad." While research has focused on the algorithmic side of AI, few studies focused on developing a common dichotomy. This study offers a dichotomy for information scientists in communicating what types of AI and analytic initiatives are possible to the end-user.
**Methods**
Our interdisciplinary team of data scientists, medical doctors, and juris doctor used an inductive approach (bottom-up thematic analysis) case study methodology using an interpretive philosophy. The use of an interpretative methodology allowed us to investigate emerging use cases of AI in the US healthcare system while accounting for their medical, legal and ethical implications. We conducted qualitative interviews with 32 key decision-makers in healthcare organizations across the United States including hospital systems, payers, pharmaceutical, healthcare consulting, healthcare reporting institutes, and government agencies.
**Results**
Our major finding conceptualizes a binary framework of a Happy Machine and Sad Machine to illustrate the aspects that lead to success and failure of analytic initiatives in healthcare. An AI initiative's implementation ability was increased when the data was machine readable, easily measurable, pre-programmed, and automatable. However, in a healthcare setting, the Machine becomes Sad as the intentions of healthcare delivery pushes against its constraints of delivering its goal of a useful output. Although this dichotomy of a Happy Machine vs a Sad Machine may describe a technology-centric approach in AI implementation, ineffective delivery (i.e., a Sad Machine) can have negative impacts by delaying patient care. This approach aims to encourage a collaborative effort among stakeholders to enhance AI applications, ensuring they are patient-centric and contribute positively to patient outcomes.
**Conclusion**
Implementation of AI initiatives in healthcare is a multidisciplinary effort. Each stakeholder will have a different data analytics baseline knowledge. This simple dichotomy of a Happy and Sad Machine may find use in communicating the feasibility of AI projects to management and clinicians. The framework creates a useful starting point in designing AI to encourage collaboration through a simple shared language.

**Acknowledgements**
The authors are grateful to Frank H. Netter MD School of Medicine Capstone Funding and Quinnipiac School of Business. The authors are also thankful to all those who participated in our in-depth interviews as well as the IeHEALTHF review team.

## P13

### Onset prediction of ci-DME on UWF images using fine-tuned ResNet with class balanced focal loss

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**Background**
Diabetic macular edema (DME) is a common complication of diabetes, where fluid accumulates in the macula, the part of the retina responsible for central vision. This fluid buildup leads to blurred or distorted vision. Center involved DME (ci-DME) is a more severe form, as it affects the central subfield of the macula, significantly increasing the risk of vision impairment. While optical coherence tomography (OCT) is the standard imaging technique for detecting ci-DME, its high cost and limited availability in resource-constrained settings restrict its use. Ultra-Wide-Field Color Fundus Photography (UWF-CFP) provides a more accessible alternative for predicting the onset of ci-DME, making it a valuable tool in such settings [1].
**Materials and Methods**
This study explores three deep learning approaches for predicting the development of ci-DME within a year, based solely on UWF-CFP images. The Deep Diabetic Retinopathy Image Dataset (DeepDRiD) [2] in which ci-DME labels were generated based on diabetic retinopathy (DR) severity, was used for training and validation. The first approach fine-tuned ResNet-101 with two fully connected layers and cross-entropy as the loss function. The second approach utilized InceptionV3 with three fully connected layers and a class-balanced focal loss (CBFL) [3,4], to address class imbalancement in the dataset. The final approach fine-tuned ResNet-152, using three fully connected layers and class-balanced focal loss, alongside data augmentation to improve model robustness.
**Results**
The models were evaluated using metrics such as Area Under the Curve (AUC), F1-Score, and Expected Calibration Error (ECE). ResNet-101 achieved an AUC of 0.73, but struggled with class imbalance, resulting in an F1-Score of 0.0, and an ECE of 0.12. InceptionV3, also achieving an AUC of 0.73, showed significant improvement in F1-Score (0.57) by incorporating CBFL, with an ECE of 0.17. ResNet-152, enhanced with data augmentation and CBFL, delivered the best performance with an AUC of 0.79, an F1-Score of 0.65, and the lowest ECE of 0.11.
**Conclusion**
Predicting ci-DME onset using UWF-CFP images presents a promising, cost-effective alternative to OCT, particularly in resource-limited environments. Among the three tested approaches, ResNet-152 with data augmentation and class-balanced focal loss demonstrated the best overall performance, underscoring the potential of deep learning methods for early intervention in ci-DME cases.

**Acknowledgements**
This work was supported by ALPHASTRA, who provided resources and technical assistance. Their contribution has been invaluable to the completion of this research.

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## P14

### Understanding Breast Cancer Causes through Causal Knowledge Graph Analysis

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**Background**
Breast cancer is a disease affecting an increasing number of women worldwide. Numerous studies have been conducted to identify the causes of this illness [1]. By consolidating the efforts of researchers into a unified structure called a knowledge graph, it becomes possible to represent the collective knowledge and expertise on this serious health issue. The next step is to effectively leverage these knowledge graphs to gain deeper insights into the complex interactions underlying breast cancer.
Biomedical knowledge graphs have become essential tools in medical research, as they allow for the structuring, organization, and linking of vast amounts of biomedical data. A knowledge graph represents biomedical entities (such as genes, proteins, drugs, etc.) and the relationships between them (e.g., inhibition, activation, association with disease). This approach enables a more comprehensive understanding of the interconnectedness of various biomedical factors.
However, biomedical knowledge graphs are often complex and heterogeneous, involving various types of nodes and relationships. One of the main challenges is identifying causal paths within these graphs, which can reveal key interactions, such as those between genes and diseases or drugs and proteins. Identifying such paths is crucial for tasks like drug discovery and understanding the underlying biological mechanisms of diseases.
**Materials and Methods**
Using the Semeddb Knowledge Graph [2], constructed from PubMed publications, we applied a random walk algorithm [3,4] to identify the most probable causal paths. To enhance this algorithm, we introduced a novel approach where the walker can simultaneously traverse multiple paths by creating an "avatar" to explore alternative paths. This approach is particularly innovative in biomedical graphs, as biological entities often influence multiple targets simultaneously. We refer to this modified method as Avatar Random Walk (ARW).
**Results and Conclusion**
Our approach identified the causal path "Human Papillomavirus Causes Neoplasm Causes Breast Cancer" as the most probable, highlighting the importance of understanding complex biological interactions and their contributions to disease development. This result enhances our comprehension of the multifaceted nature of breast cancer and underscores the potential of advanced computational methods in unraveling the intricate web of causality in biomedical research.
In future work, we aim to expand our analysis to uncover additional levels of causality, further enriching our understanding of the origins of cancer and paving the way for targeted prevention and treatment strategies.

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## P15

### Implementation of a Digital Drug Repository: MEDIndex

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**Background**
Online access to detailed drug information helps reduce the risks associated with self-medication and improves the quality of prescriptions by healthcare professionals. The MEDIndex project is as a national database centralizing accurate up-to-date information on medications available in Morocco. This database is publicly accessible online and can be integrated into third-party prescription software via APIs. MEDIndex, with its holistic vision, positions itself as a pivotal platform to improve patient care, benefiting healthcare professionals and health insurance providers alike.
**Material and Methods**
The technical design and structuring of the MEDIndex repository followed a rigorous methodology to ensure data reliability. This methodology includes validating reliable sources, adopting international classification and nomenclature, standards, and using international measurement units. Maintenance procedures have also been implemented, such as automated updates, codification of the processes for adding and removing medications, and the integration of indications and adverse effects. In addition, routine quality control procedures and trained qualified staff, members ensure the utmost accuracy of the database.
**Results**
Preliminary results show a significant improvement in the quality and accessibility of drug information for both the general public and healthcare professionals. The enhanced efficacy of MEDIndex has been demonstrated through the evaluation of several performance indicators, including its regular updates, superior comprehensiveness of information, and advanced functions that are absent from other platforms.
**Conclusion**
By facilitating the integration of medication management into healthcare information systems, MEDIndex is expected to significantly transform medical practice and improve chronically ill patients' monitoring in Morocco.

## P16

### Attention Deficit Hyperactivity Disorder Prediction for children

**and adults with eXplainable Artificial Intelligence and Machine Learning**

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**Background**
Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disease having a history dating back for more than two centuries [1]. Its two symptoms are the inattention and hyperactivity/impulsivity. The probability children are affected by this trouble is from 3 to 10 percent and from 4 to 5 percent for the adults [2] . These both categories deal with many difficulties. For example, ADHD children run and move everywhere, can't stand still, have sleep troubles… while ADHD adults can suffer from organization problems, patience, and so on. Moreover, ADHD is most of the time manifested with other diseases called comorbidities such as anxiety, depression, epilepsy, etc…
**Materials and Methods**
To predict ADHD, we used two Datasets; the National Survey for Children's Health (2022) for the children [3] , the ADHD | Mental Health Dataset for the adults [4] , several Machine Learning (ML) algorithms like Logistic Regression, Support Vector Machine, etc… and Explainable Artificial Intelligence (XAI) tool called Shapley Additive Explanations (SHAP).
**Results**
It was found that the Logistic Regression had the highest accuracy (99%) among the other ML methods and the excessive smile/laugh and a lower amount of sleep increase the risk of having ADHD for the children case whereas in the adult case, the XGBoost's accuracy outclassed the other ML techniques (100%) and that the anxiety and depression impact the risk and severity of having this disease.
**Conclusion**
Given the results, we can say that ML and XAI methods contribute to predict ADHD, being the first step for the understanding and helping patients affected by this disorder.

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## P17

**AI-Enhanced Top-K Algorithms for Dynamic and Personalized Heart Failure Treatment Recommendations**

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**Background**
Cardiovascular diseases, particularly heart failure, are a leading cause of death globally for nearly 32% [1–3]. Personalized treatment strategies are crucial for optimal patient care. This study introduces an AI-enhanced hybrid recommendation system utilizing the "Heart Failure Clinical Records" dataset [4] to support clinicians in making informed treatment decisions for heart failure patients.
**Materials and Methods**
Our core component is an AI-optimized Top-K algorithm with neural networks for dynamic treatment ranking. The adaptation allows the system to constantly learn and refine recommendations as new patient data is introduced to fit the best satisfaction of the requirement while ensuring up-to-date and reliable suggestions [5]. We evaluate the system's performance using precision, recall, and F1 scores, comparing it to traditional Top-K algorithms. Our AI approach demonstrates significant improvements, particularly for patients with complex medical histories. This highlights the potential of AI in ameliorating treatment recommendation accuracy.
**Results**
Our novel AI-enhanced Top-Kws algorithm for dynamic treatment ranking in heart failure demonstrates an improved recommendation accuracy for personalized care. Compared to previous work, this approach enhances precision by up to 11%, showcasing its effectiveness. Consequently, the algorithm has the potential for scalability and real-time data integration, allowing for continuous improvement in treatment recommendations.
**Conclusion**
This study presents AI-enhanced Top-K algorithms as a powerful tool for personalized heart failure treatment recommendations systems. Our system offers more accurate and dynamic suggestions by integrating collaborative and content based filtering. Future work will explore scalability, real-time data integration, and further AI refinement to continually improve healthcare recommendations and empower clinicians to make informed decisions.

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## P18

**Rhumato-Ergo Digital: Preventing Musculoskeletal Disorders at Work Through Innovative Ergonomic Solutions**

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**Introduction**
Musculoskeletal disorders (MSDs) are an increasing concern across various workplaces, affecting a wide range of professions. Activities such as lifting heavy loads, prolonged sitting, repetitive movements, and specific tasks like general and dental surgery, laboratory work, or kitchen activities can lead to severe musculoskeletal issues. In response to these challenges, we developed an e-book titled "Rhumato-Ergo Digital: Preventing Musculoskeletal Disorders at Work Through Innovative Ergonomic Solutions," aimed at providing

practical ergonomic guidelines to minimize these disorders by focusing on specific aspects of body ergonomics and posture tailored to various work situations.

**Materials and Methods**

This e-book was created through collaboration among rheumatologists, occupational physicians, and physiotherapists. It includes detailed infographics illustrating specific adjustments for workstations, postural correction techniques, and preventive practices suited to specific contexts such as heavy lifting, prolonged sitting, repetitive tasks, dental surgery, laboratory work, and wiring. The e-book is subtitled in Arabic and French to ensure maximum understanding for a broad audience. It also features voice-over commentary in Moroccan dialect, making the content more accessible and culturally relevant.

**Results**

The e-book provides clear, engaging, and easily understandable visual advice to prevent musculoskeletal disorders (MSDs), supported by infographics and recommendations tailored to each work situation. Initial feedback shows improved understanding and application of ergonomic practices, with significant potential for reducing musculoskeletal disorders in professional settings. User testimonials also confirm enhancements in their comfort and efficiency at work.

**Conclusion**

"Rhumato-Ergo Digital: Preventing Musculoskeletal Disorders at Work Through Innovative Ergonomic Solutions" is a valuable tool for promoting safe and effective work practices. Its dissemination through the social networks of associations such as the Moroccan Association for Research and Assistance to Rheumatism (AMRAR) and the Moroccan Association of People with Polyarthritis and Psoriasis (AMPS) will help reach a wide audience, thereby contributing to the reduction and prevention of musculoskeletal disorders (MSDs). Follow-up studies will be necessary to evaluate the long-term impact of this e-book on workers' health.

## P19

### Application of Machine Learning in Predicting Chronic Obstructive Pulmonary DiseaseAmong Populations Exposed to Biomass Fuels

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*BMC Proceedings 2025*, **19(8):** P19

**Background**

Chronic Obstructive Pulmonary Disease (COPD) is a major public health challenge worldwide, particularly in regions with high exposure to biomass fuels. This study aims to develop a machine learning model to predict the occurrence of COPD in individuals.

**Materials and methods**

This work is based on data from the study "Association between biomass exposure and COPD occurrence in Fez, Morocco: results from the BOLD study". We used several machine learning algorithms, including random forest, decision tree, logistic regression and support vector machines (SVM). The models were trained on features related to demographics, exposure levels, and health outcomes associated with biomass fuel use. Performance metrics including precision, accuracy, recall and F1 score were calculated to evaluate the models.

**Results**

The performance of the models achieved a precision of 0.87 to 0.89, an accuracy of 0.80 to 0.87, a recall of 0.87 to 1.00 and an F1 score of 0.88 to 0.93. These results demonstrate that machine learning algorithms can effectively predict the occurrence of COPD in the studied population as a function of biomass exposure.

**Conclusion**

Our results suggest that machine learning models can serve as valuable tools for predicting COPD risk associated with biomass exposure. This model may aid in early diagnosis and targeted interventionsfor at-risk populations, thereby contributing to improved public health strategies in regions vulnerableto such environmental factors. Further refinement and validation of the model is recommended toimprove its predictive capabilities.

## P20

### AI-driven financial engineering for health disparity reduction: A focus on Health Impact Bonds (HIBs) and Sukuk for financing digital healthcare in Morocco

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*BMC Proceedings 2025*, **19(8):** P20

**Background**

In Morocco, health disparities remain a big global issue, with underserved communities, mostly rural areas, lacking access to adequate healthcare services. The establishment of the Territorial Sanitary Groups system (GSTs) aims to reduce these gaps, however, funding such initiatives poses significant challenges. This project explores the role of Health Impact Bonds (HIBs) and Sukuk (an Islamic financial instrument) in financing digital health projects that target healthcare inequities.

**Materials and Methods**

The study evaluates HIBs and Sukuk as financing mechanisms through a literature review and suggests a quantitative analysis using stochastic modeling. This model simulates various outcomes for investor returns based on different health scenarios, including patient engagement levels, treatment success rates, and healthcare demand fluctuations. The analysis focuses on structuring these bonds to align with the financial and social objectives of both investors and the Moroccan government.

**Results**

Preliminary findings suggest that HIBs can effectively link financial returns to measurable health outcomes, providing an incentive for private investment in healthcare initiatives. Additionally, Sukuk offers an alternative for funding GST projects, compliant with Islamic principles, which raises the likelihood of attracting potential investors from Islamic finance markets. Stochastic modeling results, enhanced by AI, should indicate a wide range of potential returns depending on project success rates and external economic conditions, highlighting both the risk and reward of these instruments.

**Conclusion**

The integration of HIBs and Sukuk into Morocco's healthcare financing structure offers a promising solution for addressing health disparities, particularly in underserved regions. These instruments provide a sustainable way to fund digital health innovations, reduce health inequities, and generate financial returns for investors. Future research should focus on refining the stochastic models and exploring case studies of successful HIB and Sukuk-funded projects.

## P21

### The impact of virtual patient simulation on medical students' learning outcomes: a systematic review

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**Background**
virtual Patient simulation is increasingly viewed as a robust tool in medical education, providing a controlled, experiential environment enabling clinical skills development without risk to patients. As a problem-based learning (PBL) strategy, simulation also offers medical students an interactive method to improve clinical skills, diagnostic reasoning, and confidence in procedural interventions. This systematic review synthesizes available literature on the impact of patient simulation as a PBL method on medical students' learning outcomes.
**Methods**
A systematic review was conducted following the PRISMA guidelines. A comprehensive search was performed in databases including PubMed, Scopus, Web of Science and ScienceDirect. Eligible studies included randomized controlled trials, cohort studies, and observational studies. data were extracted from the remaining seventeen papers by two independent reviewers. Risk of bias was assessed using the Cochrane Risk of Bias tool and Newcastle-Ottawa Scale. A qualitative synthesis of the data was conducted.
**Results**
We analyzed 17 papers on the effects of simulation patient-based learning (SPBL) on medical students. results showed that virtual patients (VPs) significantly enhanced exam scores from 7.66 to 8.37 ($p < 0.0001$) among 160 students. About 80% of participants enjoyed using VPs, valuing the realistic scenarios and feedback, with 87% finding them effective for orthopedic learning. Female students performed slightly better than males, and 65% wanted VPs to remain in the curriculum. Simulation-based learning (SBL) improved communication skills, particularly concerning age-related issues. While SPs in problem-based learning (PBL) improved communication, authenticity, and motivation, they posed challenges in problem identification. Comparisons of simulation-based teaching (SBT) and problem-based discussion (PBD) revealed both methods improved knowledge and skills, but SBT enhanced self-assessed confidence. Platforms like SimMan® and MedicActivTM significantly improved academic performance and student satisfaction. Although SPBL methods showed higher student satisfaction, they did not markedly differ in knowledge retention. The review underscores SPBL's effectiveness in medical education and suggests further research on long-term impacts and curriculum integration.
**Conclusion**
Simulation patient-based learning methods are effective in enhancing medical education. They improve exam scores, communication skills, and clinical performance, with high levels of student satisfaction. Future research should focus on the long-term impact of these methods and their integration into medical curricula to ensure sustainable improvements in medical education.

## P22

### Biotherapies & Digital Therapeutic Education: A Multidisciplinary Program to Develop Your Skills Step by Step

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**Introduction**
Managing patients with chronic inflammatory rheumatism (CIR) on biotherapies requires appropriate therapeutic education. The role of nurses in this process is crucial, especially in helping patients become autonomous actors in their treatment. However, high illiteracy rates and low health literacy complicate the effective implementation of such programs. The aim of this project is to develop a step-by-step audiovisual program detailing the essential skills for autonomous management of biotherapies, distributed via the platforms of the AMRAR (Association Marocaine de Recherche et d'Aide aux Rhumatisants) and AMPS (Association marocaine des patients polyarthritiques et spondyloarthritiques) associations.
**Materials and methods**
A multidisciplinary working group comprising rheumatologists, nurses specializing in rheumatology and biotherapy, and expert patients, developed this program. The content is structured around seven key skills, with each skill broken down into specific headings. These sections include practical visual demonstrations, subtitled in Arabic and French, with commentary in Moroccan dialect to ensure accessibility and comprehension.
**Results**
The program covers skills such as treatment storage, self-injection, used syringe management, and keeping a logbook. It also covers managing side effects, recognizing warning signs, and monitoring treatment efficacy. Each step is clearly explained, enabling patients to gradually acquire the autonomy they need to manage their therapy properly.
**Conclusion**
This audiovisual Therapeutic Education program offers essential support to patients undergoing biotherapy, enabling them to the skills they need to manage their treatment safely. Its distribution via the social social networks of the AMRAR and AMPS associations reaches a wide audience, helping to improve and better management of chronic inflammatory rheumatism.

## P23

### The use of technology in the prevention, diagnosis and monitoring of injuries in team sports: a systematic review

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*BMC Proceedings 2025*, **19(8):** P23

**Background**
The development of various digital methods has enabled researchers to explore the application of technology in team sports injuries. The aim of this study is to analyze the role of digital tools in the prevention, diagnosis and monitoring of injuries in team sports.
**Materials and Methods**
This systematic review was conducted according to the recommendations of the "preferred reporting items for systematic reviews and meta-analysis". The data bases used in this study were: PubMed, Scopus and Web of Science. Systematic reviews and meta-analyses were not included, and the period was indefinite. A total of twentythree studies met the inclusion criteria. Standardized assessment tools were used for the evaluation of the quality of each study, focusing on methodological rigor, sample size, and intervention fidelity.
**Results**
Twenty-three studies were selected. Wearable devices were assessed in eighteen studies. The device that was used for the anterior cruciate ligament prevention is the MVN Lycra suit that contains inertial

measurement units. Head impacts were detected by instrumented mouthguards and instrumented helmets and monitored by the headband mounted SIM-G sensor. The efficacy of X-patch sensors in detecting head impacts was presented in three studies, whereas three other studies showed a lack of reliability of the X-patch in detecting this sport event. The in-ear sensor displayed considerable random error and overestimated head impact exposure. Results about Inertial measurement units included a study which provided reliability in the Sports Related Concussion monitoring inrugby, as well as two other studies that explored the use of these technologies in injuries prevention, for example: the MotusTHROW sleeve. Two other wearable sensors were associated with machine learning in the assessment process.
In addition to wearable devices, a biofeedback system was useful in the anterior cruciate ligament prevention. The diagnosis of the concussive status of athletes was highlighted in a study that explored the potential of the blink reflexometer as well as in another reference about King-Devick Eye Tracking. GPS data and machine learning injury forecaster showed efficacy in soccer injuries prevention. An imaging tool had an important role in identifying baseball players at potential risk of shoulder injuries, and that is the Shear-wave ultrasound elastography.
**Conclusion**
Sports medicine has recently known an undeniable advancement in technologies. This study explored the variousimportant roles of digital tools as well as possible limitations and lack of reliability regarding team sports injuries. Therefore, means of verification should be considered in future research.

## P24

### Blood vessels segmentation of fundus retinal images based on improved Attention U-Net

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**Background**
Ophthalmologists have long focused on studying the retinal vasculature to help diagnose disorders such as Diabetic Retinopathy (DR) among others. Segmenting the structure of retinal vessels from fundus images remains a challenging task due to the large variability of structures and the non-homogeneity of their intensities.
**Methodology**
In this work, we adopted a two-stage methodology to achieve vessel segmentation with an automated manner. First, we begin with a new technique of image processing based on Coarse Scale Filtering with morphological opening and Thresholding techniques to extract the blood vessel structure aiming to produce a new dataset of blood vessel masks. In the second stage, we introduced a U-Net algorithm based on an attention mechanism to improve the quality of vessel segmentation and then to leverage on Deep Learning to extract more information about small vessels and edges of retinal vessels.
**Results**
The proposed method is evaluated on three publicly available datasets as baselines (namely Drive, HRF, and ChaseDB) achieving respectively an accuracy of .94%, .96%, .95% and then applied on our proper dataset of 350 images classified into 7 classes according to specific challenge. A Normalized Cross-Correlation (NCC) is used to verify the similarity of regions between two images with an average correlation of 93%. We deployed both stages in a full stack app to measure the usability, validity and effectiveness of our models.
**Conclusion**
Our proposed method outperforms existing methods and open new opportunity to gather more accurate and labelled data to help carry out new AI models for retinal vessel segmentation.

## P25

### Comparative Performance of Machine Learning Algorithms and Logistic Regression in Predicting survival statut in Acute Care impatients

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**Background and Objective**
The aim of this study was to evaluate the performance of several ML algorithms—logistic regression, neural networks, random forests, and gradient boosting—for predicting 28-day mortality in patients admitted to an acute care unit.
**Methods**
This study followed three main phases: data collection, preprocessing, and modeling. Data on 798 patients from the acute care unit at Ibn Sina University Hospital in Rabat, Morocco, were used to create a predictive model based on 10 clinical variables. The dataset was randomly split, with 80% used for training and 20% for testing. Model performance was optimized through grid search and fivefold cross-validation to avoid overfitting, with hyperparameter tuning applied. Model comparison was based on AUROC, accuracy, F1 score, precision, recall, MCC, and LogLoss, as these metrics are informative for mortality prediction.
**Results**
The cohort's mean age was 57.3 $\pm$ 18.3 years. During fivefold cross-validation on the training data, logistic regression achieved an AUROC of 0.708, accuracy of 0.900, F1 score of 0.143, precision of 0.556, recall of 0.082, MCC of 0.185, and LogLoss of 0.312. Gradient Boosting outperformed other ML models, with an AUROC of 0.752, accuracy of 0.898, F1 score of 0.187, precision of 0.500, recall of 0.115, MCC of 0.204, and LogLoss of 0.306. Both Random Forest (AUROC 0.703) and Neural Network (AUROC 0.684) showed lower performance relative to logistic regression and gradient boosting. In the internal test set, only logistic regression maintained strong performance with an AUROC of 0.711, accuracy of 0.780, F1 score of 0.043, precision of 0.200, recall of 0.024, MCC of -0.002, and LogLoss of 0.507. Gradient Boosting's AUROC was 0.662, accuracy 0.785, F1 score 0.000, precision 0.000, recall 0.000, MCC -0.051, and LogLoss 0.639. Random Forest and Neural Network models exhibited further declines in performance with AUROCs of 0.630 and 0.546, respectively.
**Conclusion**
These findings underscore the potential of simpler models to outperform more complex techniques in clinical settings, suggesting that logistic regression and gradient boosting may be preferred for similar predictive tasks in acute care environments. Further studies are warranted to assess the scalability of these models across diverse clinical populations.

## P26

### Establishement of a self-learning application in medicine

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**Background**
In the context of medical education in Morocco, medical students undergo significant transitions marked by clinical engagement and a demand for flexible, self-guided learning. Addressing this need, we introduced a self-learning medical application to support students

in recording clinical experiences, self-directed learning, and research activities.

**Materials and Methods**

The modelization of the application was conducted using Unified Modeling Language (UML) to ensure a clear design and structure. A prototype was then developed using Glide App, a low-code application development platform.

This application features a user-friendly interface that facilitates structured data entry and organized documentation. Clinical records are anonymized and include password protection to ensure the privacy and confidentiality of patient data.

**Results**

This application takes the form of an electronic portfolio and encompasses three sections: Clinical Records for documenting patient encounters, Self-Learning for accessing educational resources, and Research & Publication for exploring clinical findings. In the Clinical Records section, the e-Portfolio captures patient encounters, including personal reflections on clinical records, initial and differential diagnoses, treatment plans, and patient progress. The application facilitates seamless continuity as patients move between departments, providing a comprehensive overview of their care journey. The Self-Learning section offers access to educational resources across medical, surgical, obstetrics, gynecology, and pediatrics, aligned with the stages of clinical rotation. The Research & Publication section encourages exploration of medical research, serving as a foundation for further studies and scientific articles.

**Conclusion**

The ePortfolio prototype records clinical notes and reflective practices, bridging the gap between department specific knowledge and practical skills while emphasizing research and publication. Considerations for acceptance in the hospital setting, big data processing, and key technical aspects must be addressed during the coding phase to ensure functionality in the clinical environment.

**Acknowledgements**

I would like to express my heartfelt gratitude to Professor Mohamed Mouhaoui, for his invaluable guidance and support throughout this research. I also wish to thank the Modeling and Numerics Team at the Hassania School of Public Works for their collaborative efforts and contributions to this project.

## Publisher's Note