

Editorial

Selfies in Cardiovascular Medicine: Welcome to a New Era of Medical Diagnostics

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This editorial refers to ‘Feasibility of Using Deep Learning to Detect Coronary Artery Disease Based on Facial Photo’ by S.Lin et al.¹

Medical research has seen major advances during the past few years, particularly as big data has emerged in biomedical research². The presence of large registries with wealth of data available offers unique opportunities for the deployment of artificial intelligence (AI)-powered technologies, for diagnosis and prognosis of disease³. Implementation of AI technology to the day-to-day clinical practice has already began, with emerging applications using it to interpret medical images, read pathology slides, analyse electrocardiograms, track vital signs and many others⁴.

In the field of cardiology, AI -mainly deep learning- has been used primarily in electrocardiogram (ECG) automated interpretation. The first machine-read ECGs emerged almost 40 years ago and naturally lacked accuracy, with the latest deep neural networks reporting accuracy equivalent, if not better than, that of cardiologists in classifying a broad range of distinct arrhythmias⁵. In echocardiography, convolutional neural networks have been reported to accurately predict structural cardiac disease with reported c-statistics above 0.85⁶. The recent spurt in computed tomography and magnetic resonance medical imaging has brought these two imaging modalities at the forefront of cardiovascular diagnostics with a big rise in AI and deep learning research being published around them⁷. Neural networks have been trained to accurately segment the anatomy of the human heart⁸, whereas studies from large registries are reporting coronary artery disease detection algorithms using unsupervised approaches from chest CT imaging data⁹. AI technology is also being utilised for prognostic evaluation of cardiovascular disease and residual risk identification, harnessing the combined strengths of computed tomography, radiomics, and machine learning¹⁰.

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27 In this issue of the European Heart Journal, Lin et al¹ draw our attention yet again on images
28 in cardiology, this time not the usual type of medical imaging from ultrasound, CT or MRI we
29 are accustomed to. Rather their study focuses on facial images in an effort to explore, dissect
30 and present the potential they may have in our battle against coronary artery disease. The
31 authors deploy a large training set of 5,216 individuals to develop their deep learning algorithm
32 which is tested in a group of 1,013 individuals predominantly of Han Chinese ethnicity
33 recruited in tertiary centres across China. All patients underwent a standardised protocol for
34 acquisition of facial images and a coronary computed tomography angiography (CCTA) was
35 used as the reference method for dichotomising the cohort in groups of coronary artery disease
36 (CAD) presence, defined as occlusion higher than 50%. The algorithm yielded an area under
37 the curve (AUC) of 0.73 (95% CI 0.699-0.761), sensitivity of 0.80, and specificity of 0.54 in
38 the test group. Interestingly, the algorithm outperformed scores typically used in assessing
39 CAD pre-test probability, marking it according to the authors as a promising successor to the
40 CAD consortium clinical score model or its older predecessor the Diamond-Forrester model¹¹.
41 In further analyses, it was found that the algorithm had excellent ability in discriminating
42 between the two sexes, but moderate accuracy in predicting hypertension, hyperlipidemia, or
43 diabetes, while the part of the face that contributed the most to the algorithm's predictions
44 seemed to be the cheek.

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46 Overall, the study by Lin et al highlights a new potential in medical diagnostics. Facial
47 appearance has long been identified as a marker of cardiovascular risk, with features such as
48 male pattern baldness, earlobe crease, xanthelasmata, and skin wrinkling being the most
49 common predictors¹². However, these past approaches require human intervention to evaluate
50 and analyse the images. The robustness of Lin et al's approach lies in the fact that their deep

learning algorithm requires simply a facial image as the sole data input, rendering it highly and easily applicable at large scale (take home figure). Effective screening tools are highly sought after, given that optimal selection of populations that benefit from more specialised testing is crucial to disease management and prognosis, as well as beneficiary to healthcare systems from a monetary aspect. Using selfies as a screening method can enable a simple yet efficient way, to filter the general population towards more comprehensive clinical evaluation. Such an approach can also be highly relevant to regions of the globe that are underfunded and have weak screening programmes for cardiovascular disease. A selection process that can be done as easily as taking a selfie will allow for a stratified flow of people that are fed in healthcare systems for first-line diagnostic testing with CCTA. Indeed, the “high risk” individuals could have a CCTA, which would allow reliable risk stratification with the use of the new, AI-powered methodologies for CCTA image analysis¹⁰.

There are still though a few points for consideration that make a practical application of the current algorithm challenging. The low specificity of the method raises a concern regarding false positive results that may confuse both patient and clinician and eventually overload the system with redundant and unnecessary testing. The authors admit to this in the limitation section proposing the use of their algorithm in its current form in target populations who have a relatively high CAD risk. In any case, the study population is extremely small to allow extraction of safe conclusions, and external validation cohorts will be needed to test the validity of the algorithm. Furthermore, it should be noted that in the present study CAD was defined as presence of more than 50% stenosis in one major coronary vessel evaluated in coronary CT angiography. This may be a simplistic and rather crude classification as it pools in the non-CAD group individuals that are truly healthy, but also people who have already developed the disease but are still at early stages (which might explain the low specificity observed). In

addition, the test group was significantly different to the training group with overall lower percentages of cardiac and lifestyle risk factors, which might explain the lower diagnostic accuracy of standard scores (CAD consortium clinical score and Diamond-Forrester model), and overestimate the difference in performance compared to the deep learning model. The photo preprocessing used may be another issue for consideration; resolution was reduced to 256×256 pixels, which hinders the detection of fine facial features, such as arcus lipoides, that may play a role in the diagnostic accuracy of the model. Moreover, proper external validation of deep learning models in populations that are independent is needed to ascertain their use and functionality. Here, the use of the test group that was recruited from the same centres as the training group provides a first indication of the robustness of the algorithm, however application of the algorithm in cohorts recruited from different centres or even countries will provide more concrete evidence. Finally, in a time era that observes a record surcharge in cosmetic surgery, we should keep in mind that artificial facial alterations may severely discredit such screening tools.

Speedy diagnostic testing is rapidly becoming an important part of medical practice. Information extracted from analysis of an individual's facial photo utilising the proposed technology can unquestionably benefit the individual, the attending physician and the healthcare system altogether. Early detection of the individuals at risk for coronary artery disease can initiate lifestyle and other personal mitigation approaches, guide medication treatment and inspire a novel approach in diagnostic testing and screening algorithms for the general population. At the same time, such a technology may raise concerns about misuse of information for discriminatory purposes. Unwanted dissemination of sensitive health record data that can easily be extracted from a facial photo, renders technologies such as the one discussed here a significant threat to personal data protection potentially affecting insurance

101 options. Such fears have already been expressed over misuse of genetic data¹³, and should be
102 extensively revisited over the use of artificial intelligence in medicine.

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104 Despite these challenges, the full potential of such novel and out-of-the-box diagnostics lies
105 ahead of us. Deep learning and artificial intelligence in general are slowly claiming the central
106 spot in biomedical research. Combined with advances in technology they will pave the way for
107 highly accurate, personalised diagnostics and revolutionise medicine as we know it.

108 **Conflict of interest:** CA is a founder, shareholder and director of Caristo Diagnostics, a
109 spinout company of the University of Oxford. CA is also director of the Oxford Academic
110 Cardiovascular CT Core lab.

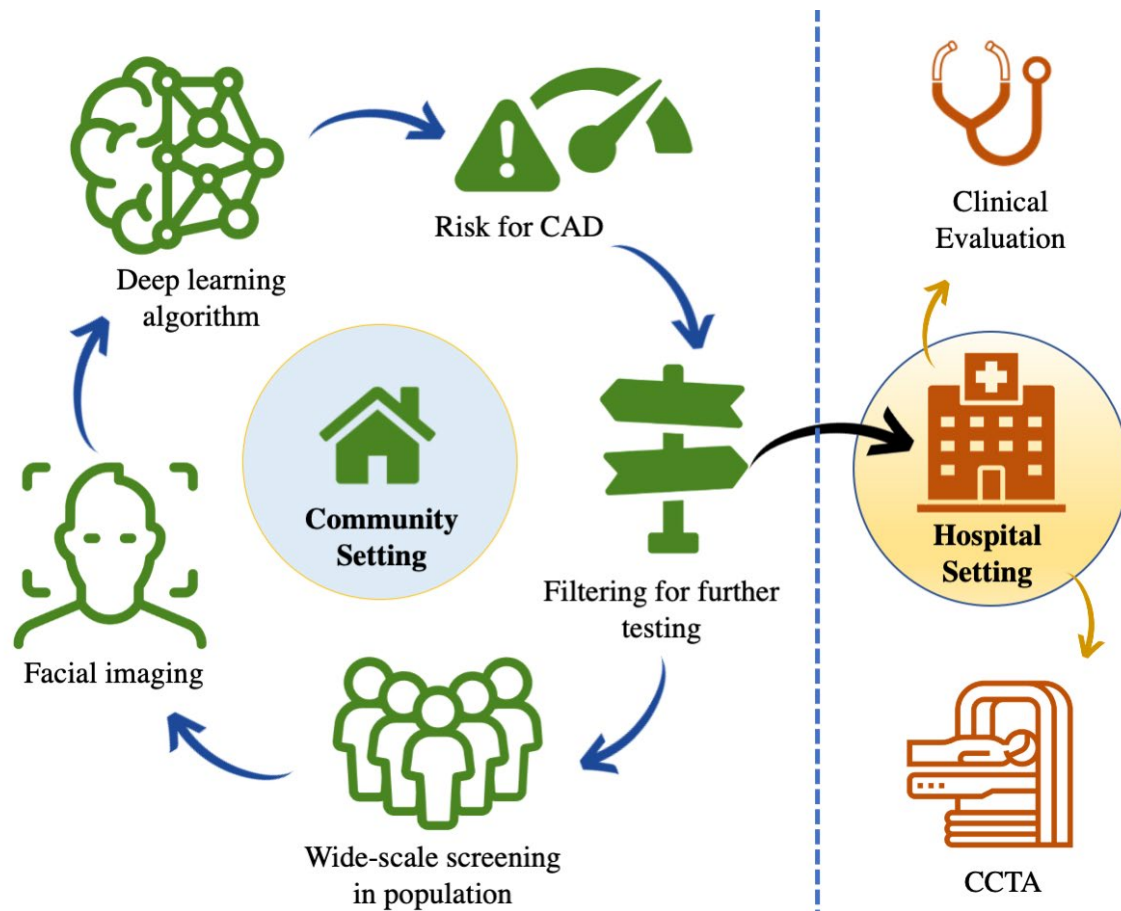
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Figure



Schematic proposal of using face tracking for CAD screening. Outside of the hospital setting facial features can be traced from images using deep learning to compute the risk for CAD. Eligible individuals would then be followed with further screening by clinicians and imaging modalities. CCTA: Coronary Computed Tomography; CAD: Coronary Artery Disease. Vectors taken and used from Noun Project per the Creative Commons Attribution license requirements.