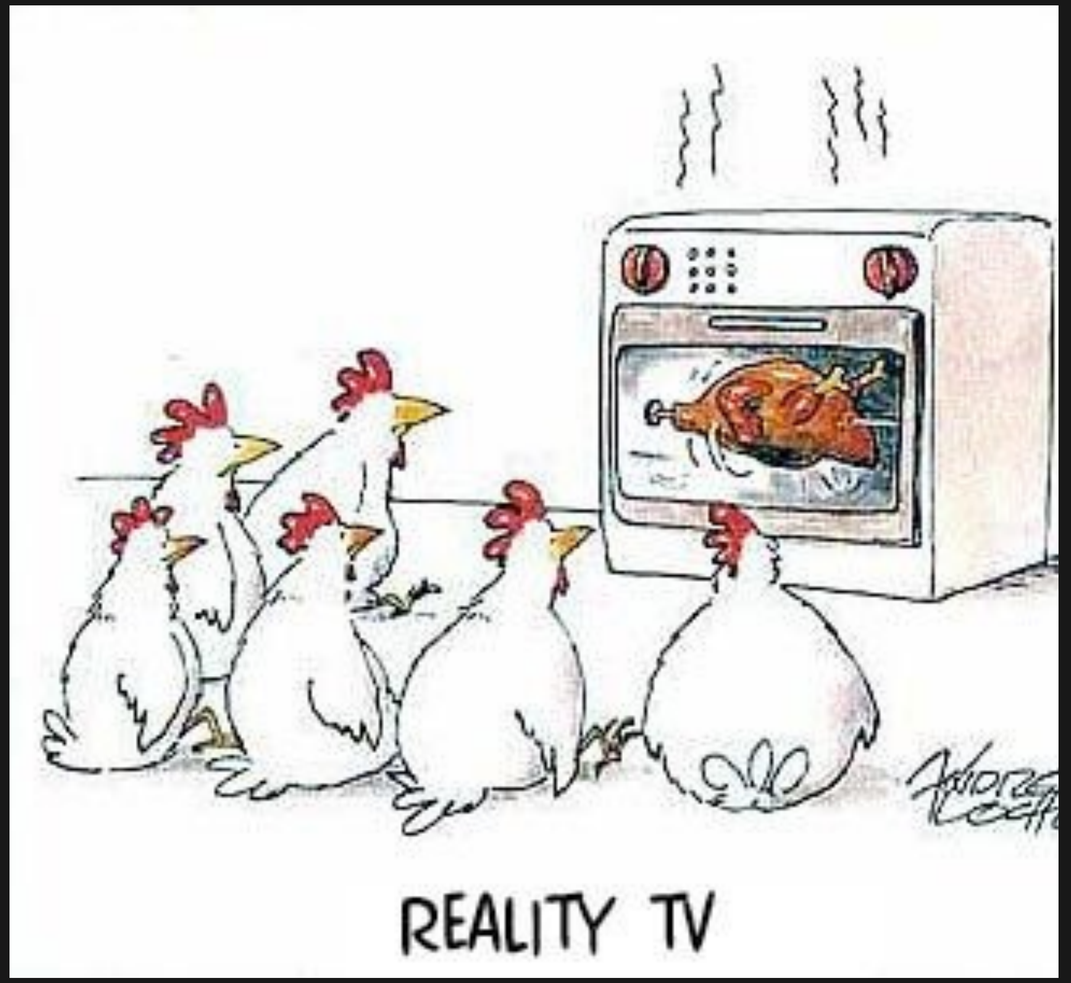
THE FUTURE OF HEALTHCARE

CHALLENGES AND BARRIERS

- rapid increase in lifestyle disease resulting in massive future demands on system
- demographic challenge - more boomers, fewer workers to support massive uptick in spending
- resultant massive supply / demand imbalance
- combined with the ‘continual politics of uncertainty’
- expectation gap likely to increase scope of challenge



ANTHEM HEALTH

“....WHAT DO WE DO TO REDUCE THE COST OF CARE?”

REALITY CHECK

- The typical Alzheimer patient is disabled for 9 to 20 years – and this will increase to 40- to 50 years as medical advances continue
- RFID, programmable coffee mugs, shoes, plates -- smart devices, reminding patient how to “interact with life”

REALITY CHECK

- Number of patients with dementia / Alzheimer’s set to double to 66 million by 2030 - and to 115 million by 2050!
- Spending could increase from $15 billion today to $153 billion by 2050
- average cost for dementia $287,038 over five years

“POWERING IT ARE TWO 32-BIT PROCESSORS, THREE MICROPHONES, 12 TACTILE SENSORS COVERING MOST OF ITS FUR, TOUCH-SENSITIVE WHISKERS AND A SYSTEM OF MOTORS THAT SILENTLY MOVE ITS PARTS. THEY ALLOW PARO TO RECOGNIZE VOICES, TRACK MOTION AND "REMEMBER" BEHAVIOURS THAT ELICIT POSITIVE RESPONSES FROM PATIENTS”

It’s not a stuffed animal, it’s a $6,000 medical device, Wall Street Journal

NEW ZEALAND STUDY

ON THE GROUND RESEARCH

- Loneliness scores decreased in the Paro group, increased in the non-Paro group
- residents with Paro had more verbal communication
- Skepticism of tech with hi-tech industry, but demographics ultimately come into play

“WHAT WE DID FOR HEART HEALTH IN THE 20TH CENTURY, WE CAN DO FOR BRAIN HEALTH IN THE 21ST CENTURY

- Dr. Deepak Chopra, integrative medicine advocate

“AT THE RATE RESEARCH LIKE ATALA'S IS PROGRESSING, SCIENTISTS PREDICT THAT REPLACEMENT ORGANS WILL BE A REALITY WITHIN YEARS, NOT DECADES.

(Wake Forest Institute for Regenerative Medicine)

"VIDEO GAMES DESIGNED AS DIGITAL MEDICINE WILL REVOLUTIONIZE HOW WE TREAT COGNITIVE DISORDERS. IN THE NEXT DECADE, WE'LL PRESCRIBE TECHNOLOGY ALONGSIDE—OR INSTEAD OF—DRUGS FOR CONDITIONS LIKE ADHD AND ALZHEIMER'S."

- Dr. Adam Gazzaley, UCSF neuroscientist

"I BELIEVE THAT WITHIN THE NEXT DECADE, WE'LL SEE DRUG DELIVERY SYSTEMS THAT CAN PRECISELY TARGET DISEASED CELLS, DRAMATICALLY REDUCING SIDE EFFECTS AND IMPROVING EFFICACY OF TREATMENTS.

- Dr. Robert Langer, MIT Professor and biomedical engineering pioneer

"I THINK IT'S REASONABLE TO ANTICIPATE THAT IN THE NEXT FEW YEARS, WE WILL BE ABLE TO ENGINEER IMMUNITY TO MOST INFECTIOUS DISEASES AND REVERSE MANY ASPECTS OF AGING."

- Dr. George Church, Harvard geneticist

“CRISPR GENOME EDITING TECHNOLOGY WILL TRANSFORM MEDICINE IN THE NEXT DECADE, ALLOWING US TO NOT JUST TREAT BUT ACTUALLY CURE GENETIC DISEASES AT THEIR SOURCE."

- Dr. Jennifer Doudna, Nobel Prize winner for CRISPR

"WE WILL TRANSITION FROM REACTIVE MEDICINE TO PROACTIVE MEDICINE. WITHIN 10 YEARS, EACH PATIENT WILL BE SURROUNDED BY A VIRTUAL CLOUD OF BILLIONS OF DATA POINTS THAT WILL ENABLE US TO OPTIMIZE WELLNESS AND MINIMIZE DISEASE."

- Dr. Leroy Hood, co-founder of the Institute for Systems Biology

"BY THE 2030'S, WE WILL CONNECT OUR NEOCORTEX TO THE CLOUD. THIS WILL EXPAND OUR MEMORY, COGNITIVE CAPABILITIES, AND ALLOW US TO DIRECTLY INTERFACE WITH ARTIFICIAL INTELLIGENCE."

- Ray Kurzweil, futurist and Google's Director of Engineering

GROWTH OF KNOWLEDGE

(EXPONENTIAL!)

- 3,672 articles about adult coronary heart-disease in 2004
- @15 minutes per, it would take 115 eight hour days to read
- 1 of 12,000 “known diseases”
- acceleration with medical procedures and treatments, pharmaceuticals and bio-materials, medical technologies and devices, diagnostics and methodologies

Coronary Artery Disease and Its Risk Factors

Leveraging Shared Genetics to Discover Novel Biology

Thomas Quertermous, Erik Ingelsson

Coronary artery disease (CAD) is the world-wide leading cause of death not only in high-income countries but also increasingly in developing countries.[1] Although death rates from CAD have decreased in most high- and middle-income countries in the past 2 decades, there are worrying signs of a lessening trend in the United States,[2] and the dramatic increases of world-wide obesity[3] and diabetes mellitus[4] prevalences emphasize the need for improved preventive and therapeutic strategies to battle these major public health problems. Human genetic studies can offer leads toward such improved strategies, both by providing better ways of identifying individuals at increased risk for CAD (risk stratification) and by informing the scientific community about novel biology, pathways, and potential targets for development of the next generation of pharmaceutical drugs.

Article, see p 83

In this issue of *Circulation Research*, LeBlanc et al[4] have applied an innovative statistical approach to existing large-scale meta-analyses of genome-wide association studies (GWAS) of CAD and risk factors for CAD to enable discovery of novel disease loci.[4] By combining results on association of CAD loci from the Coronary Artery Disease Genome Wide Replication and Meta-Analysis (CARDIoGRAM) plus The Coronary Artery Disease (C4D) Consortium (CARDIoGRAMplusC4D)[5] with results on CAD risk factors from other consortia, they report 67 novel CAD loci, of which 42 were not previously reported using a traditional, unconditional false discovery rate. In addition, they provide eQTL (expression quantitative trait loci) evidence for 32 of these 67 loci, and ingenuity pathway analysis of these associations shows enrichment of pathways involved in inflammation and lipid metabolism. By using this novel approach of combining publically available meta-analyses of GWAS, they show a large extent of shared genetic determinants between these cardiovascular risk factors and CAD. This underlines the shared polygeneticity of these traits and further emphasizes the popularly accepted view that complex traits are determined by a large number of common genetic variants and that many of these variants can be shared between traits that are known to be strongly correlated. In other words, the phenotypic correlations are accompanied by genetic correlations.

Their pathway findings showing an enrichment for pathways known to be central to atherosclerosis pathophysiology, as well as the list of novel loci, supports the robustness of their methodology by providing biologically plausible results. For example, in the list of novel loci, we find nearest genes—not to be taken as conclusive evidence of being the causal genes—that are extensively investigated in relation to coronary heart disease, such as *VEGF*[6] and *HMGCR*,[7] as well as genes that have been implicated more recently, such as *CXCR4*[8] and *NGF*.[9]

The authors make the point that components of the metabolic syndrome show a large degree of polygenic overlap with CAD, in particular, low-density lipoprotein-cholesterol. However, low-density lipoprotein-cholesterol is usually not considered to be a part of the metabolic syndrome—not in the original derivation of the concept,[10] or in different efforts to formalize it by World Health Organization[11] and National Cholesterol Education Program.[12] Also, the dyslipidemia that tends to cluster with obesity and insulin resistance is characterized by high triglycerides and low high-density lipoprotein-cholesterol. Nonetheless, low-density lipoprotein-cholesterol is definitely among the most important risk factors for CAD and is a key factor in atherosclerosis development, so it is reasonable to include low-density lipoprotein-cholesterol among the traits investigated for polygenic overlap with CAD.

Perhaps the most interesting feature of this work is the identification of CAD variants that were also associated with type 2 diabetes mellitus. The present study identified 21 novel loci based on conditional analyses of type 2 diabetes mellitus and CAD. The large degree of polygenic overlap between these 2 traits is an important and novel observation because although it should be expected based on phenotypic observations, it stands in stark contrast to what was reported in the original CARDIoGRAMplusC4D article. In that work, no overlap of loci was reported between CAD and type 2 diabetes mellitus.[5] A plausible reason for this discrepancy is that the analyses in the CARDIoGRAMplusC4D study used a relatively naive approach where the degree of overlap was determined by the number of genome-wide significant CAD loci that showed an association with type 2 diabetes mellitus (and other traits) at a Bonferroni-corrected threshold. Using that approach, none of the CAD loci were associated with type 2 diabetes mellitus, fasting glucose or insulin, whereas the more advanced approach presented in the current article uncovered a large number of novel CAD by joint analyses with type 2 diabetes mellitus, underlining their shared genetic determinants.

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

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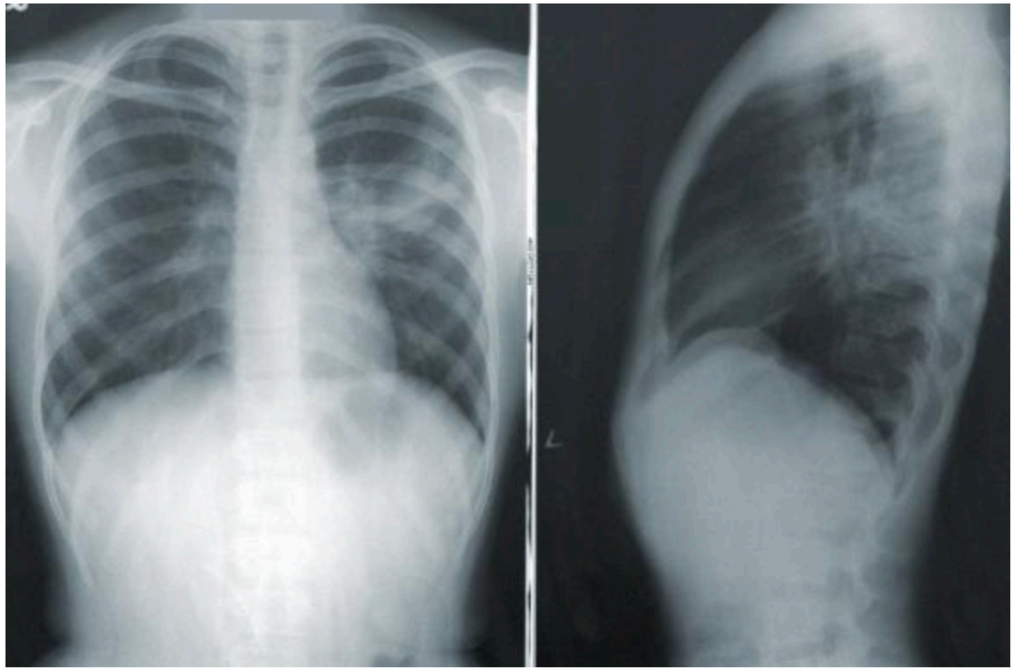
THE ACCELERATION OF LIFE SCIENCES

"THE SCIENCE BEHIND THE SCIENCE"

- ✓ medical image analysis
- ✓ personalized medicine
- ✓ medical device connectivity
- ✓ medical device monitoring
- ✓ disease diagnosis
- ✓ advanced patient monitoring
- ✓ digital twin / surgical planning
- ✓ chronic disease management
- ✓ medical chatbots
- ✓ medical research acceleration

New AI model calculates risk of heart attack or stroke using a single X-ray

Michael Walter | *November 28, 2022* | *X-ray*



Researchers have developed a new artificial intelligence (AI) model capable of predicting a patient's 10-year risk of death from a heart attack or stroke—all with a single chest X-ray. The group behind this work, which includes radiologists, cardiologists and AI specialists, shared its findings at RSNA 2022 in Chicago.

REAL TIME CONFIRMATION OF BRAIN HEMORRAGE AT 97% ACCURACY

University of California Irvine Study

AI ALREADY ACCURATE AT 94% FOR PREDICTING 50 OPTICAL DISEASES

NEW CAREERS

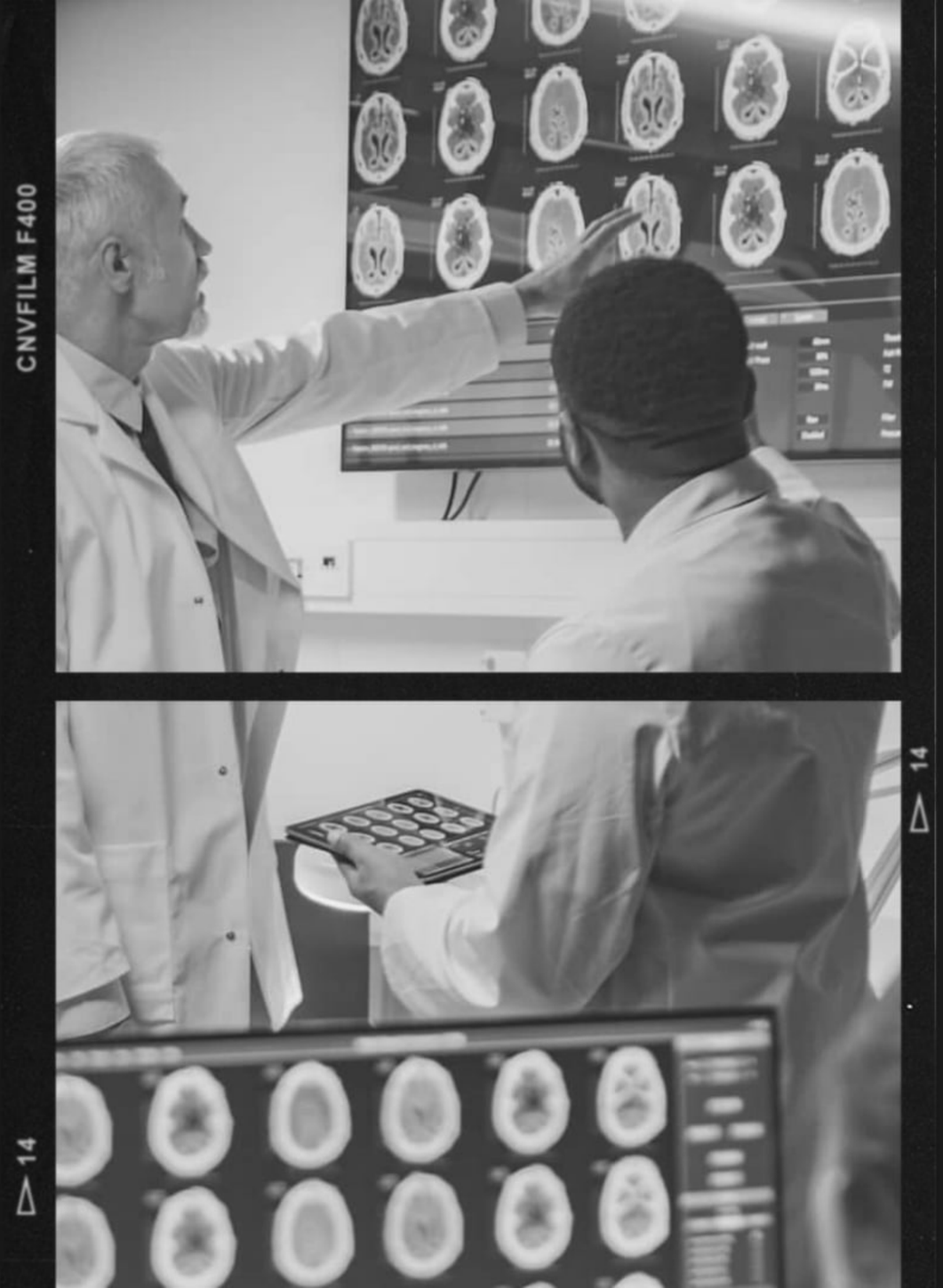
- Predictive community healthcare dashboard managers
- Robotic pharmaceutical therapy coordinators
- Cognitive home technology system integrators
- AI integration specialist
- Human-machine interaction designer

"The Big Future"

The Future of Healthcare

We're turning the global healthcare system upside-down with precision-medicine, targetted therapies and accelerated science - fixing people before they are sick rather than after!

https://healthcare.jimcarroll.com



DRUG DISCOVERY

ACCELERATING THE PACE OF PURE SCIENCE

- identify candidate molecules
- earlier disease diagnosis
- ability to look at past trial data sets
- predict patient response to treatments
- faster analysis of massive data sets
- alignment to disruptive ‘real time trial’ trend
- patient recruitment and enrolment
- predictive adverse reaction

“GETTING PATIENT RECRUITMENT RIGHT”

“BOLD GOAL AT ICON”

- 80% of clinical trials fail to meet original enrolment deadlines
- 55% of trials are terminated due to failure to achieve full enrolment
- current clinical trials have a failure rate of 84.6% (“*Trends in Pharmacological Sciences 44(9) 561-572*”)
- Just 3% of US adult cancer patients participate in clinical trials and 40% of those trials fail to get minimum patient enrollment, per Johns Hopkins

OUTCOMES

"EARLY RETURNS"

- 20% reduction in cost of 20 drug development programs at Johnson & Johnson
- 80%. accuracy in predicting trial outcomes - BioPhy, in analyzing 1500 clinical trials
- 10% improvement in clinical trial success rates (research reports)
- 70 to 80% improvement in accuracy in predicting patient response to immunotherapies - GE Healthcare AI models

“IT’S BETTER TO DISRUPT THAT TO BE DISRUPTED!”

(COMPANIES THAT DO NOT YET EXIST….”

Elligo and Avallano launch AI-powered clinical trials platform

myTrialsConnect aids patient recruitment and screens for patient eligibility through medical record reviews and chatbot-based surveys.

Phalguni Deswal | October 27, 2023

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The use of AI can potentially improve patient recruitment and retention for clinical trials. Image credit: SurfsUp / Shutterstock.

CARLSBAD, CALIF., NOV. 7, 2023 /PRNEWSWIRE/ -- AMSETY, A LIVER HEALTH SOLUTIONS START-UP ANNOUNCED THE RELEASE OF ITS NEW ARTIFICIAL INTELLIGENCE-DRIVEN AMSETY CLINICAL RECRUITMENT ENGINE ("ACRE")

“ACRE COMBINES DECISIONAL AI AND MESSAGING TOOLS WITH A PROPRIETARY, SELF-SELECTED DATABASE OF OVER HALF A MILLION USERS TO HELP EFFICIENTLY REACH AND EFFECTIVELY COMMUNICATE WITH LIVER PATIENTS.”