September 20, 2019
Taipei, Taiwan

Artificial Intelligence and New Technologies in Health Care: Better? Worse? Same?

IHI-BMJ Asia Pacific Forum
on Quality and Safety in Health Care

Donald M. Berwick MD, MPP, FRCP
President Emeritus and
Senior Fellow, IHI

Laennec's Stethoscope

Dr. John Forbes, 1821

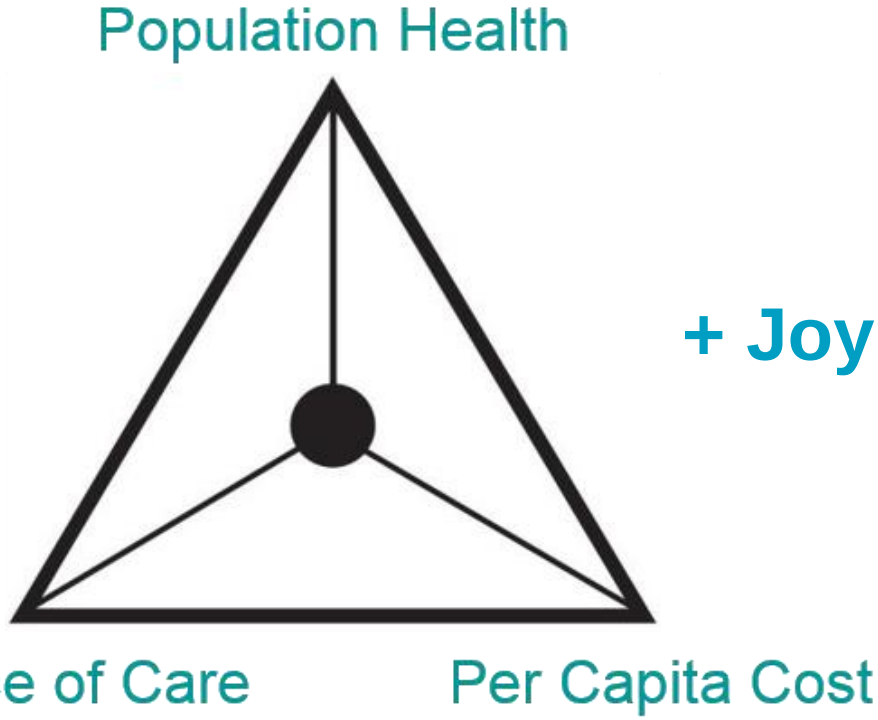
“That it will ever come into general use, notwithstanding its value, I am extremely doubtful; because its beneficial application requires much time, and gives a good deal of trouble both to the patient and the practitioner; and because its whole hue and character is foreign, and opposed to all our habits and associations.”

St. Peter's Square

All improvement is change.

Not all change is improvement.

The IHI Triple Aim / Quadruple Aim



+ Joy in Work

Dr. David Classen

IT Disruptors

1. Telemedicine
2. Telehealth
3. Electronic Health Records
4. Self-Care Supports
5. Artificial Intelligence – “AI”
6. Machine Learning – “ML”
7. Mobile Health Applications

Telemedicine—A Key to E-Power

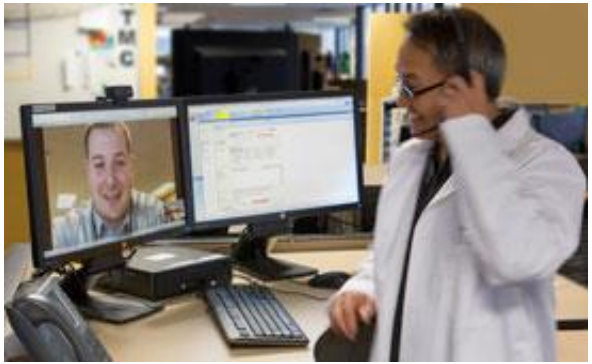
Telemedicine is the provision of healthcare services via Information and Communications Technology (ICT) supporting a goal of overcoming geographical separation of patient and/or provider(s).

- **Tele-Visit**
  - Use of ICT to conduct provider visits with patients (a.k.a. e-visits) from remote sites
- **Tele-Consult**
  - Use of ICT by two or more providers to consult about a patient (with or without the patient present)
- **Tele-Monitoring**
  - Use of ICT for the patient to collect and transmit vital clinical data (such as weight, blood pressure, blood sugar levels, and activity) from home or other locations to be viewed as needed by providers

(Thanks to Dr. David Classen)

Kaiser Permanente

- *“For the first time, last year, we had over 110 million interactions between our physicians and our members.”* - Bernard Tyson, CEO, Kaiser Permanente
- 52% of interactions were done via:
  - Smartphone
  - Videoconferencing
  - Kiosks,
  - Other technology tools

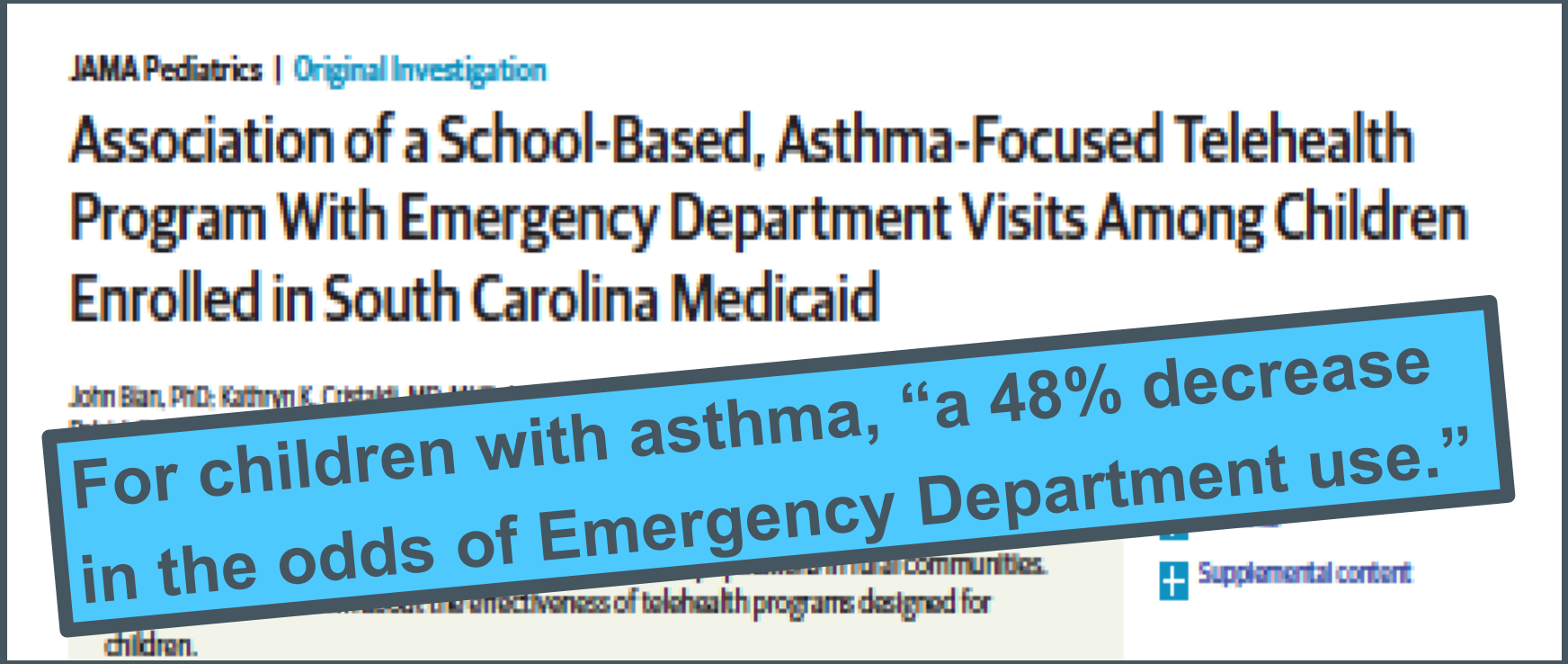


Source: Kokalitcheva, Kia. “More Than Half of Kaiser Permanente's Patient Visits Are Done Virtually,” Fortune. 6 Oct 2016.


TELADOC®

School-Based Telehealth

JAMA Pediatrics, September 9, 2019




Project
ECHO®
SCHOOL
OF MEDICINE

Arora S., Thornton K., Murata G., et al. *N Eng J Med*. 2011;364(23):2199-207.

Project ECHO

IAP Clinic Participation Sites

Project ECHO

ECHO Treatment Outcomes: Equal to University Medical Center

Hepatitis C Outcome	ECHO	UNMH	P-value
	N=261	N=146	
Minority	68%	49%	P<0.01
SVR (Cure) Genotype 1	50%	46%	NS
SVR (Cure) Genotype 2/3	70%	71%	NS

SVR=sustained viral response

Arora S, Thornton K, Murata G. NEJM 2011; 364:23

ECHO now reaching a breadth of areas

- Antimicrobial Stewardship
- Autism
- Behavioral Health
- Bone Health
- Cancer
- Cardiology
- Chronic Lung Disease
- Chronic Pain
- Crisis Intervention
- Diabetes and Endocrinology
- Education
- Geriatrics
- Good Health and Wellness in Indian Country
- Hepatitis
- High-Risk Pregnancy
- HIV/AIDS
- Infectious Disease
- Integrated Addictions & Psychiatry
- Laboratory Medicine
- LGBT Health
- Opioid Use Disorder
- Palliative Care
- Pediatrics
- Prison Peer Education
- Quality Improvement
- Rheumatology
- Sexually Transmitted Diseases
- Trauma-Informed Care
- Tuberculosis


Recording

Effects of EHR on Physicians' Time

Annals of Internal Medicine®

LATEST ISSUES CHANNELS CME/MOC IN THE CLINIC JOURNAL CLUB WEB EXCLUSIVES AUTHOR INFO

THIS ISSUE | NEXT ARTICLE ›

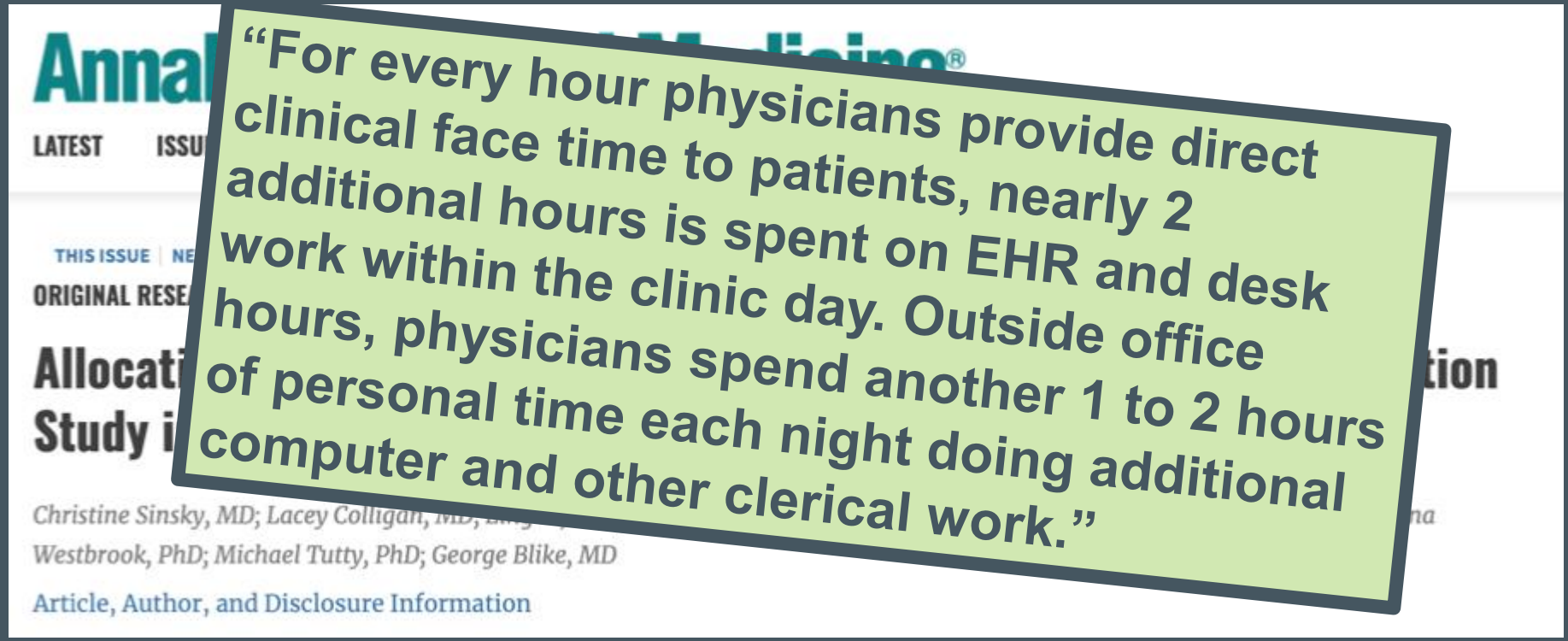
ORIGINAL RESEARCH | 6 DECEMBER 2016

Allocation of Physician Time in Ambulatory Practice: A Time and Motion Study in 4 Specialties

Christine Sinsky, MD; Lacey Colligan, MD; Ling Li, PhD; Mirela Prgomet, PhD; Sam Reynolds, MBA; Lindsey Goeders, MBA; Johanna Westbrook, PhD; Michael Tutty, PhD; George Blike, MD

Article, Author, and Disclosure Information

Effects of EHR on Physicians' Time



"For every hour physicians provide direct clinical face time to patients, nearly 2 additional hours is spent on EHR and desk work within the clinic day. Outside office hours, physicians spend another 1 to 2 hours of personal time each night doing additional computer and other clerical work."


MedAware™

Machine Learning to Reduce ADE's

Journal of the American Medical Informatics Association, 2019

Research and Applications

Reducing drug prescription errors and adverse drug events by application of a probabilistic, machine-learning based clinical decision support system in an inpatient setting

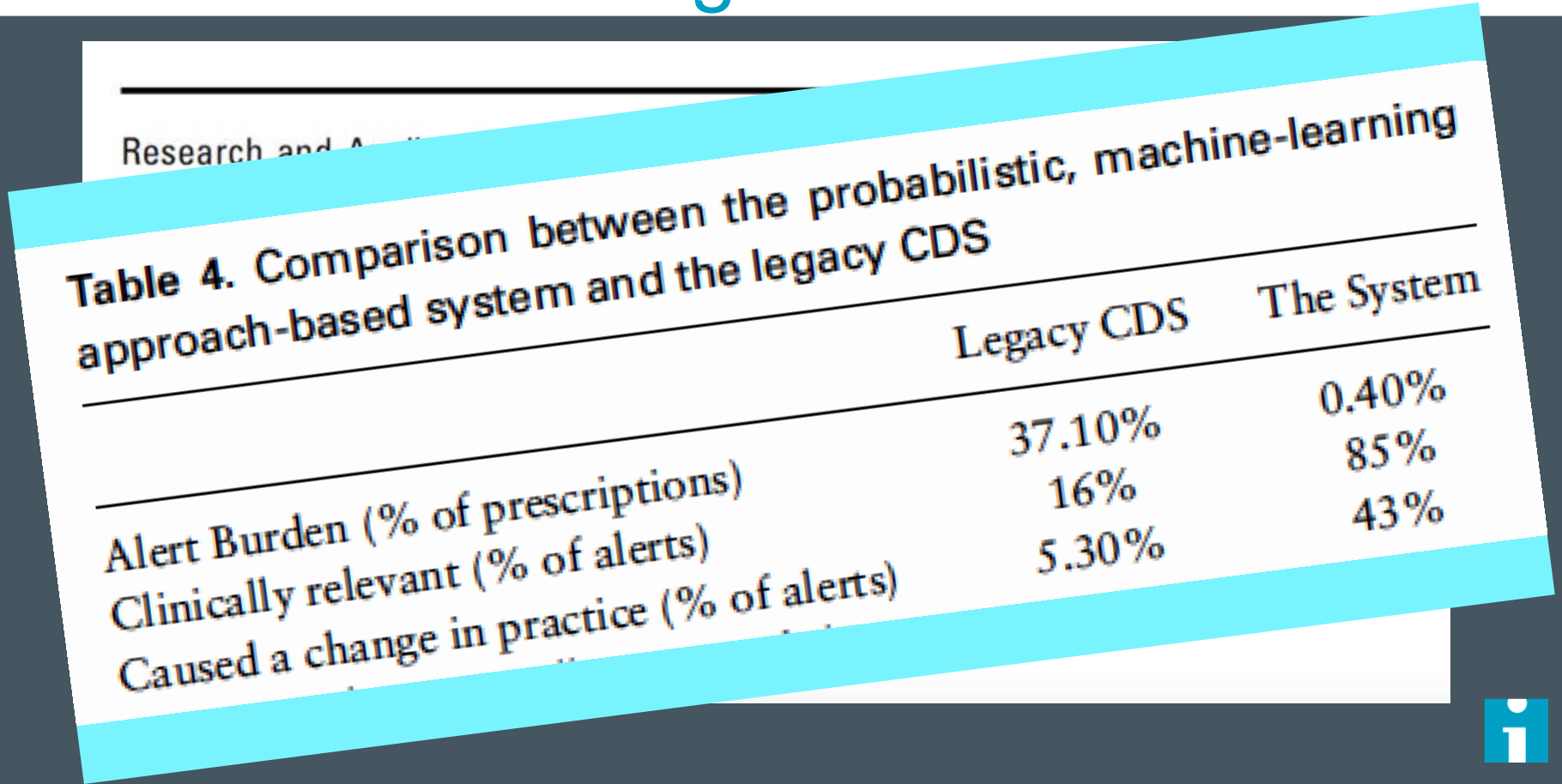
G Segal ,[1] A Segev,[1] A Brom,[1] Y Lifshitz,[1] Y Wasserstrum,[1] and E Zimlichman[2]

[1]Internal Medicine "T," Chaim Sheba Medical Center, Tel-Hashomer, Ramat Gan, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel and [2]Management Wing, Chaim Sheba Medical Center, Tel-Hashomer, Ramat Gan, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

Corresponding Author: Gad Segal, MD, Internal Medicine "T," Tel-Hashomer, 2 Sheba Road, Ramat Gan 5265601, Israel (gad.segal@sheba.health.gov.il)

Received 18 December 2018; Revised 4 June 2019; Accepted 10 July 2019

Machine Learning to Reduce ADE's



Research and A...

Table 4. Comparison between the probabilistic, machine-learning approach-based system and the legacy CDS

	Legacy CDS	The System
Alert Burden (% of prescriptions)	37.10%	0.40%
Clinically relevant (% of alerts)	16%	85%
Caused a change in practice (% of alerts)	5.30%	43%

Table 4. Comparison between the probabilistic, machine-learning approach-based system and the legacy CDS

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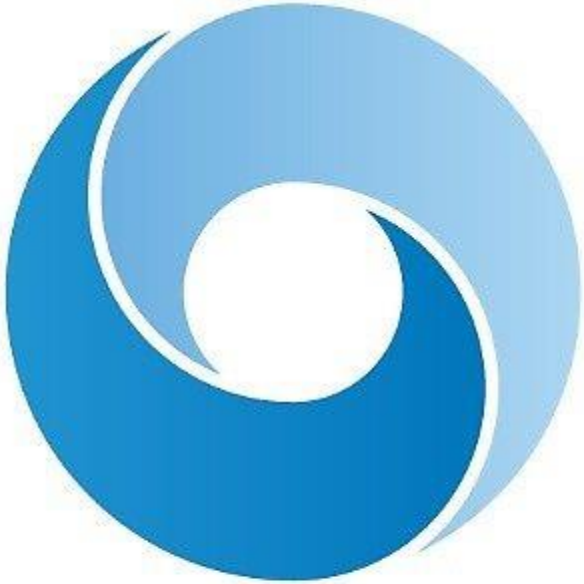
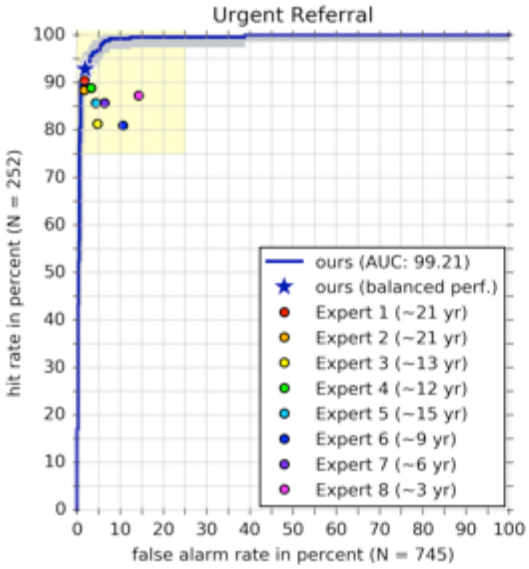
DeepMind

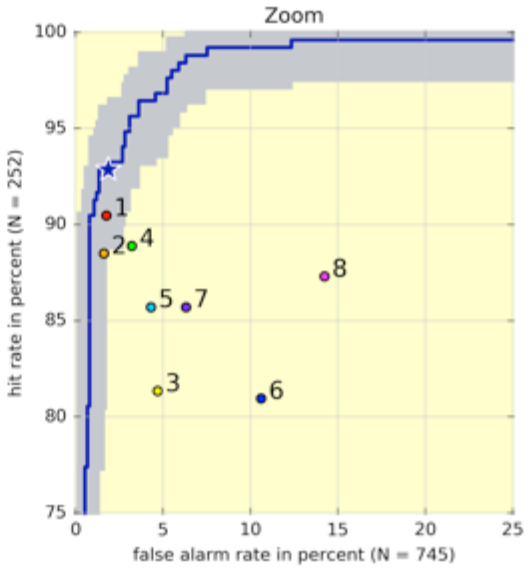
Deep Mind Beats World Champion in “Go”

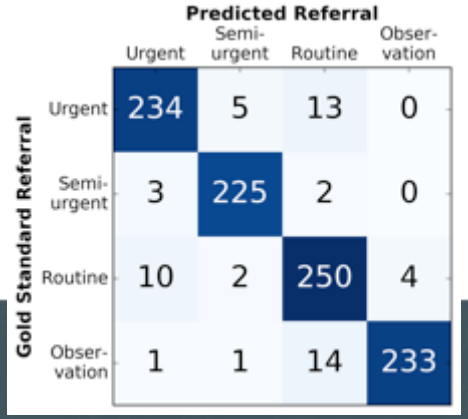


Google DeepMind

Recent scientific progress in AI







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NEWS

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Health

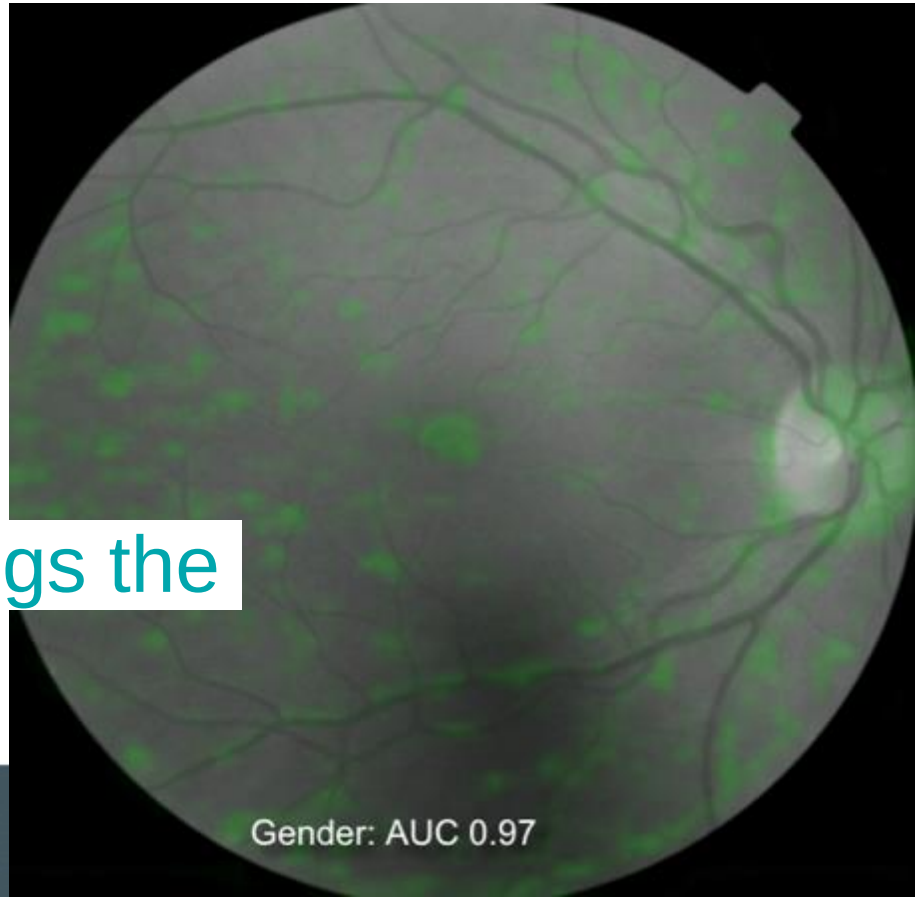
Artificial intelligence 'did not miss a single urgent case'

AI in Medical Imaging

nature biomedical engineering

ARTICLE

Prediction of cardiovascular risk factors from retinal fundus photographs via deep learning



These approaches see things the human eye can’t

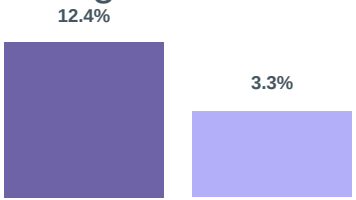
Evaluation Results: Machine Learning Detects Acute Kidney Injury Long before Human Experts

Improved process + outcomes

Alerts reviewed in median of

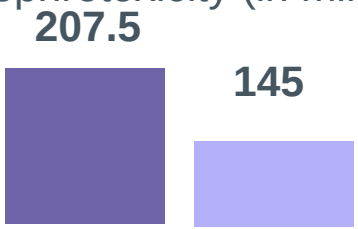
14 min

Unrecognised AKI cases



-9.1%

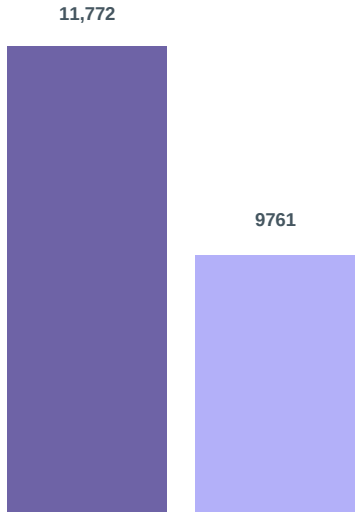
Median time to treatment of nephrotoxicity (in min)



-30.1%

Reduced costs

Mean total cost of care (GBP)



-17%

Enhanced Experience

“Being able to look up the blood results for anyone in the hospital wherever you are is unparalleled. **It must save at least a couple of hours in a day**.”

“I have noticed patients who have flagged up on the app that the clinical management has been poor up to that point. When we get involved, or the renal team get involved, that management changes. **It has definitely saved people’s lives.**”

About Aidoc

- Developed at Sheba Medical Center as an AI solution that supports radiologist decisions - helping them prioritize life threatening cases and expedite patient care
- One of the first AI solutions validated and deployed in scale.
- Current products (Head and C-spine) are FDA and CE marked, and deployed at 16 medical facilities in the US and Europe in less than 8 months.
- Based in Tel Aviv, over 50 employees, recently included in the TIME magazine 50 genius companies list

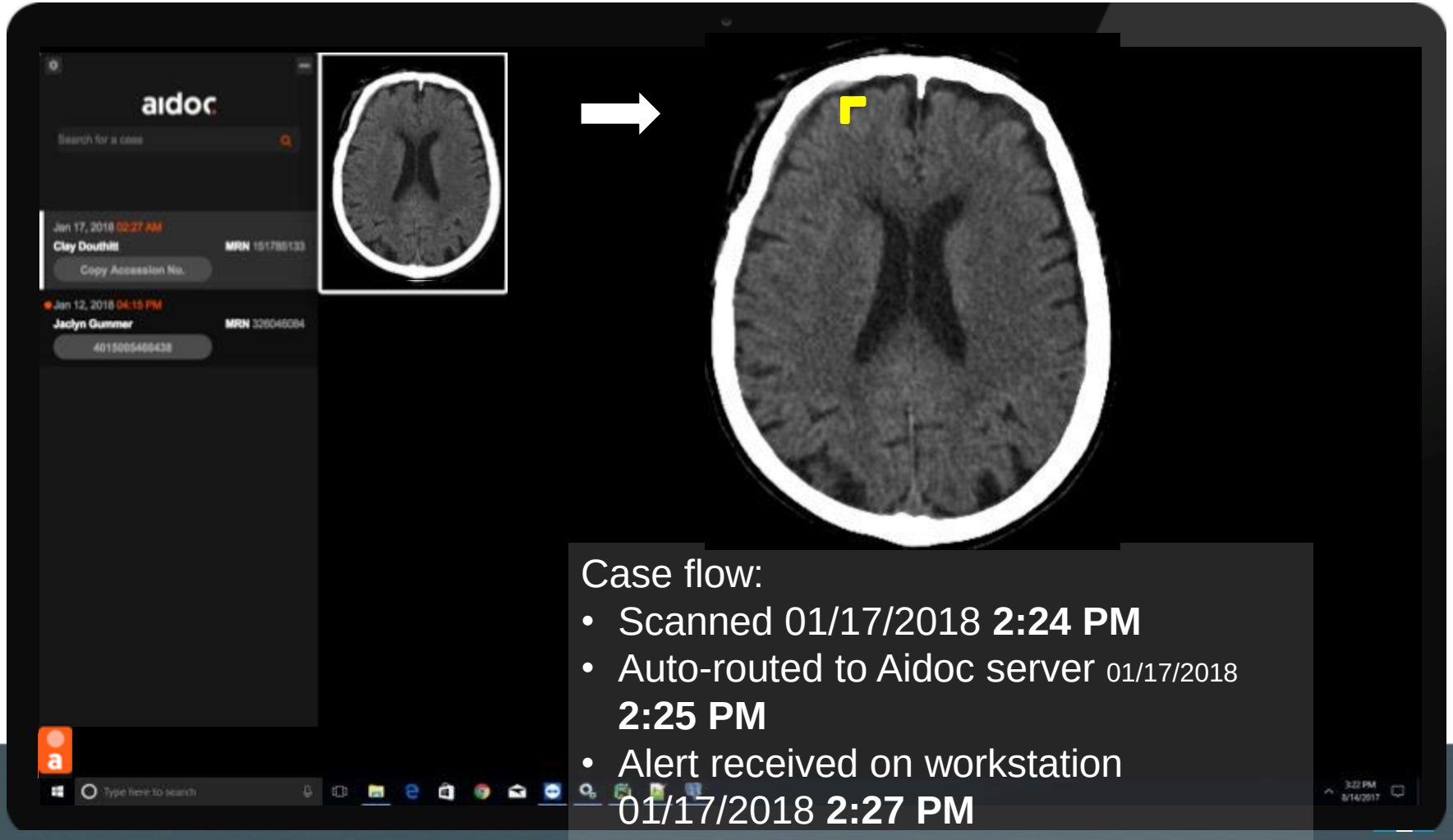
Always-on AI – “has the radiologist’s back”

Pulls image from DICOM source

AI analyzes every exam

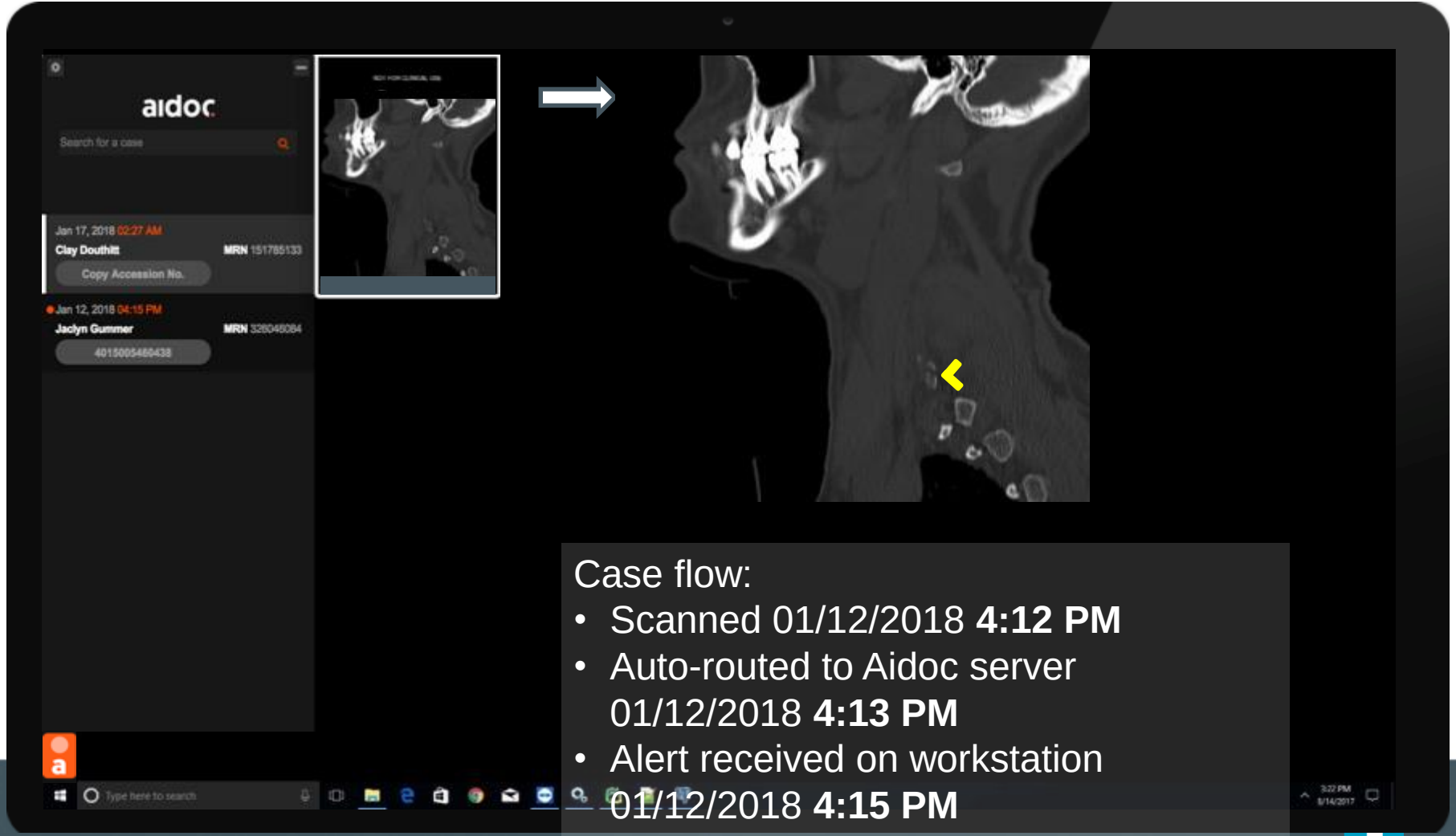
Detects abnormality and prioritizes case

Highlights abnormality for the radiologist in the image



Case flow:

- Scanned 01/17/2018 **2:24 PM**
- Auto-routed to Aidoc server 01/17/2018 **2:25 PM**
- Alert received on workstation 01/17/2018 **2:27 PM**



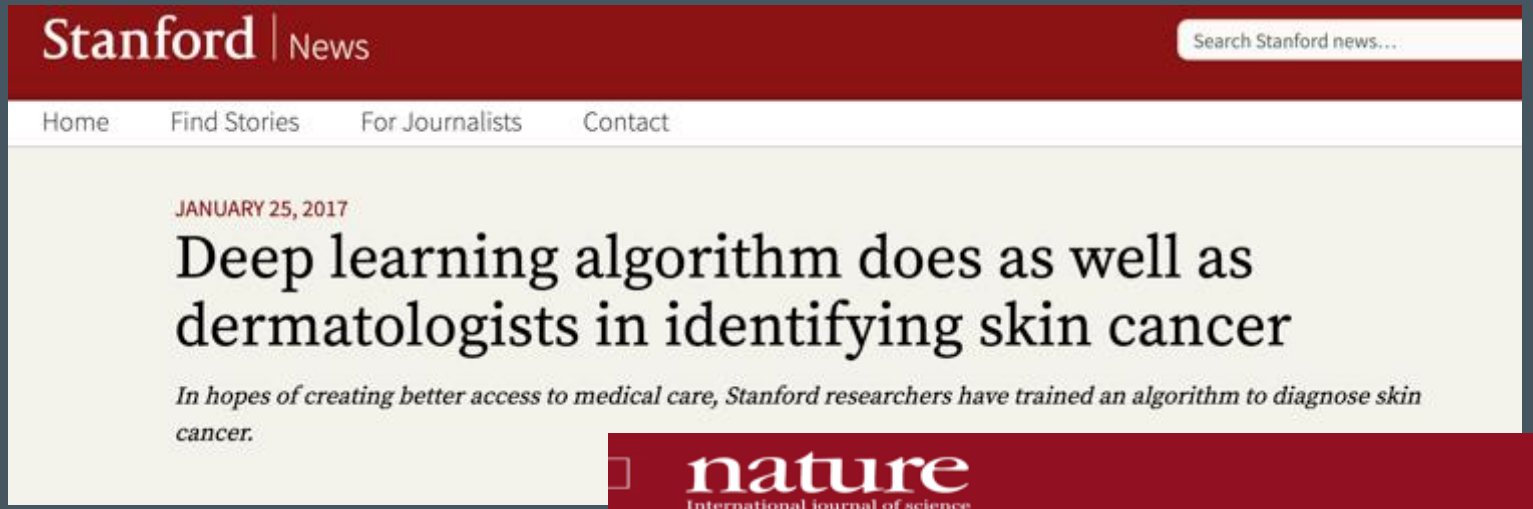
Case flow:

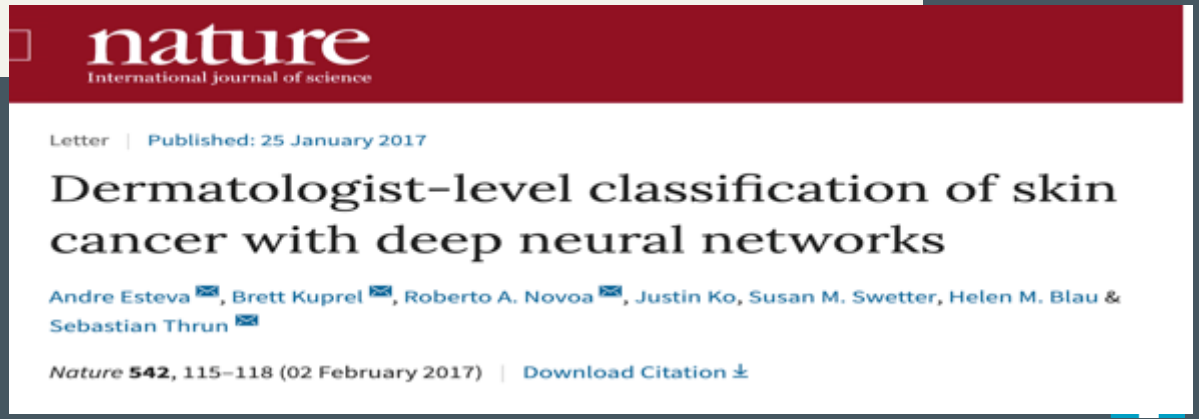
- Scanned 01/12/2018 **4:12 PM**
- Auto-routed to Aidoc server 01/12/2018 **4:13 PM**
- Alert received on workstation 01/12/2018 **4:15 PM**
- Case opened 01/12/2018 **4:15 PM**

AIDoc: Sheba Medical Center Value

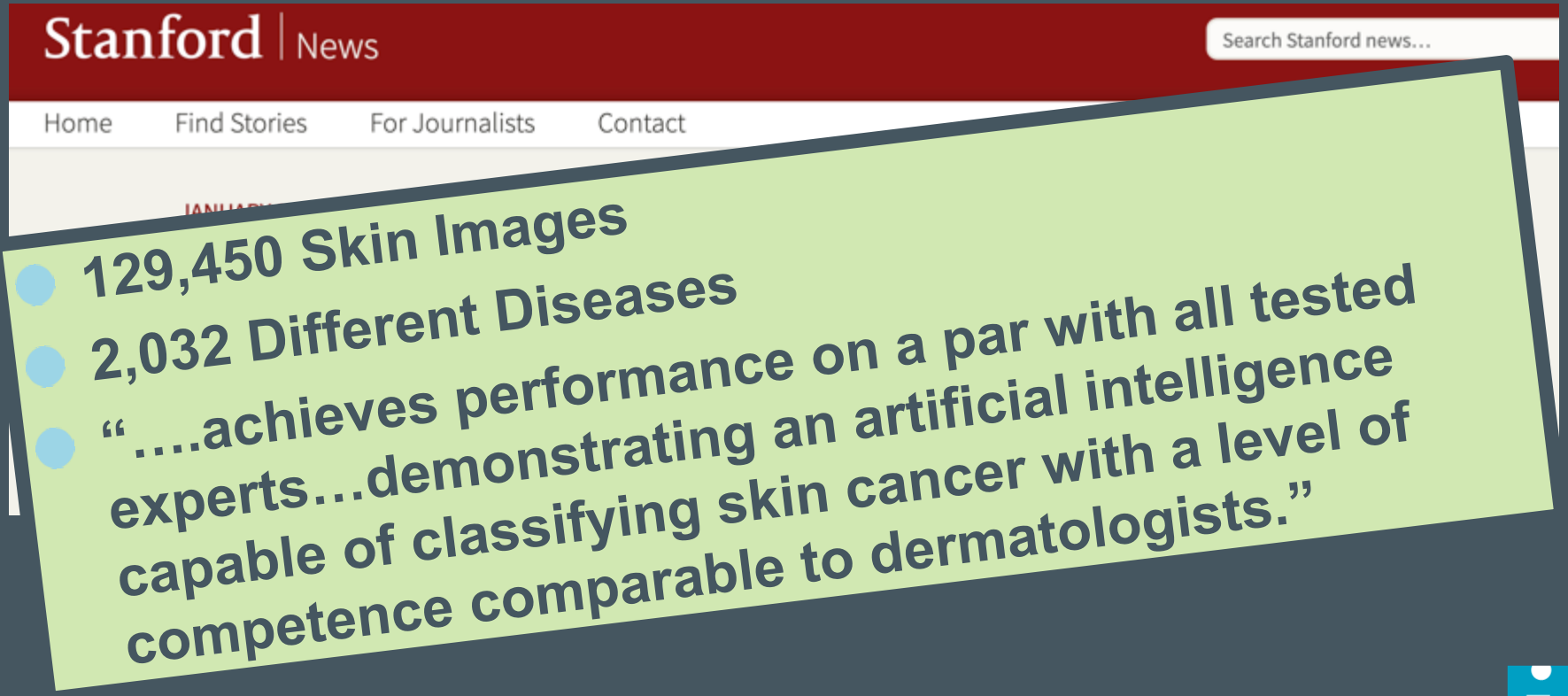
- Clinical outcomes: demonstrated increased resident productivity on 100 studies
- Clinical outcomes: demonstrated potential to reduce 61.4% of turnaround time for positive patients based on monte carlo simulation of a full workflow.
- Data resources: gathered 5000 head & neck scans for algorithm training
- Validation: 94% proven accuracy on 600 studies
- Integration: proved applicability of cloud integration, with Sheba-led penetration test

Machine Learning in Dermatology





Machine Learning in Dermatology




onduo

Mobility Is Becoming Ubiquitous

Survey Data Show Increasing Demand and Adoption

84% Of **physicians** who use a **smartphone**

-eMarketer, 2015

Over 4M Daily number of free mHealth app **downloads**

-Mobile Healthcare Today, 2015

61% Of US physicians who view **clinical content** apps 53% view pharma apps

-MedData Group, 2015

68% Of US **adults** who use a **smartphone** in 2016

58% in 2013
35% in 2011

-Pew Research, 2016

58% Of **hospitals** using **mobile-optimized** patient **portals**

-Personal Connected Health Alliance, 2016

$24.3B Size of global health mobility **market** in 2015

Projected to grow at 28.4% CAGR1
-Strawtistics, MRC, 2016

Yet according to HIMSS Analytics, as of September 2016, only:

29% Of US health systems have implemented **tablets and/or smartphones**

44% Of US health systems have **workstations on wheels**

78% Of US health systems have **WLANs**[2]

1) *CAGR = Compound annual growth rate.*
2) *WLANs = Wireless local area networks.*

Sources: HIMSS Analytics; MedData Group; Mobile Healthcare Today; HIMSS Personal Connected Health Alliance; eMarketer; Pew Research.

Remote Patient Self-Monitoring and Support

Patients with chronic conditions need to continually monitor their health by keeping track of key health metrics

- **Internet-enabled telemedicine solutions are ideal for remote patient self-monitoring both at home and for mobile use**
  - At home, a laptop or workstation can be connected to a variety of medical devices that record and send the readings to the home station. The health app is used to store the daily metrics and reminds the patient when to take medications and record vital signs
  - For patients needing a mobile solution, the smartphone can be that personal care assistant providing immediate alerts, reminders, education and care coaching
- **There are many examples of how telemedicine supports patient-self monitoring**
  - In a Kaiser study for hypertensive patients, those using the remote monitoring readers had a 50% increase in the likelihood of blood pressure control
  - In a randomized study in the U.S., diabetic patients using a mobile telemedicine solution reduced their A1C levels by nearly two points
  - A home-based solution for CHF patients showed a 26.7% reduction in outpatient claims, a 40.9% reduction in inpatient claims and a 22.2% reduction in LOS
  - A trial in the United Kingdom reported a 91% decrease in hospitalizations for chronic bronchitis and emphysema patients

Remote Patient Self-Monitoring and Support

Patients with chronic conditions need to continually monitor their health by keeping track of key health metrics

SELF-MONITORING RESULTS…..(Classen)

- Blood pressure control ↑50%
- Diabetics' Hgb A1c ↓2%
- CHF patients' LOS ↓22% and costs ↓27%
- COPD patients' hospitalizations ↓91%

- **Internet-enabled telemedicine solutions are … at home and for mobile use**
  – At … rd
- … had a
  – … patients using a mobile telemedicine solution … by nearly two points
  – A home-based solution for CHF patients showed a 26.7% reduction in outpatient claims, a 40.9% reduction in inpatient claims and a 22.2% reduction in LOS
  – A trial in the United Kingdom reported a 91% decrease in hospitalizations for chronic bronchitis and emphysema patients

The Leverage of Self-Care

Why e-Power Makes Sense:

Nearly all healthcare decisions are already made by patients.

Doctors: 2 hours per year.

Patients: 8,758 hours per year.

(Clayton Christensen et al. The Innovator's Prescription: A Disruptive Solution for Health Care, 2009)

IT Disruptors

- Telemedicine
- Telehealth
- Electronic Health Records
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- Artificial Intelligence – “AI”
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Recurring Themes and Threats

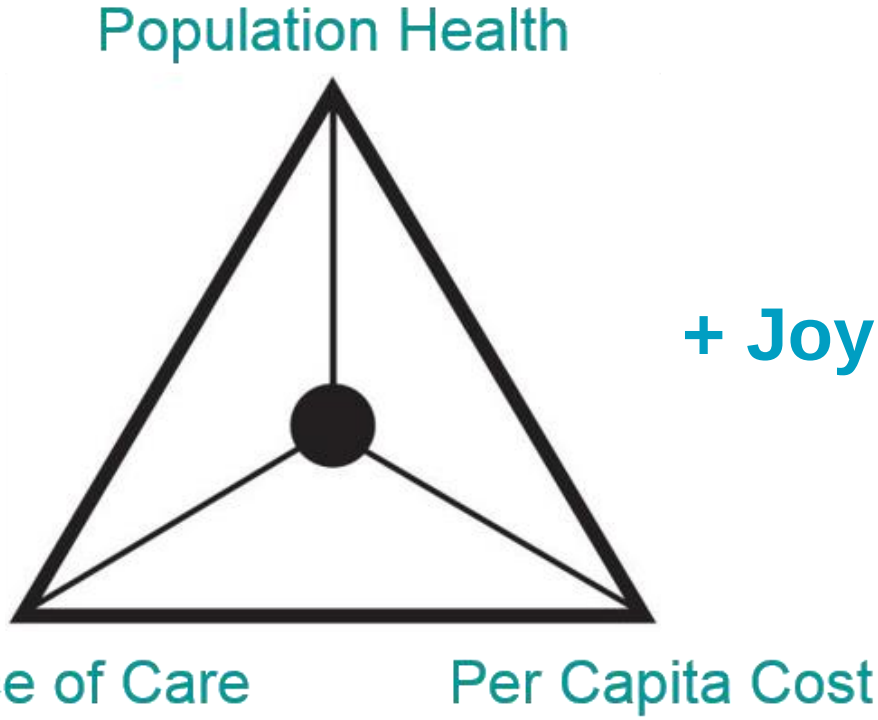
1. Privacy
2. Equity
3. Cost
4. Quality

1. Regulation
2. Evaluation Methods
3. Shift of Power
4. Technocracy

Interrogation of Technology: How to Stay Oriented

1. What is your aim? What is the need? How do you know?
2. How do you know it is an improvement?
3. What does the technology do to the system as a whole?
4. What does this technology do to the health care workforce?
5. Will this technology offer patients what matters to them – one by one? How do you know?
6. What will this technology do to the overall cost of health care as a system? How do you know?

The IHI Triple Aim / Quadruple Aim



+ Joy in Work