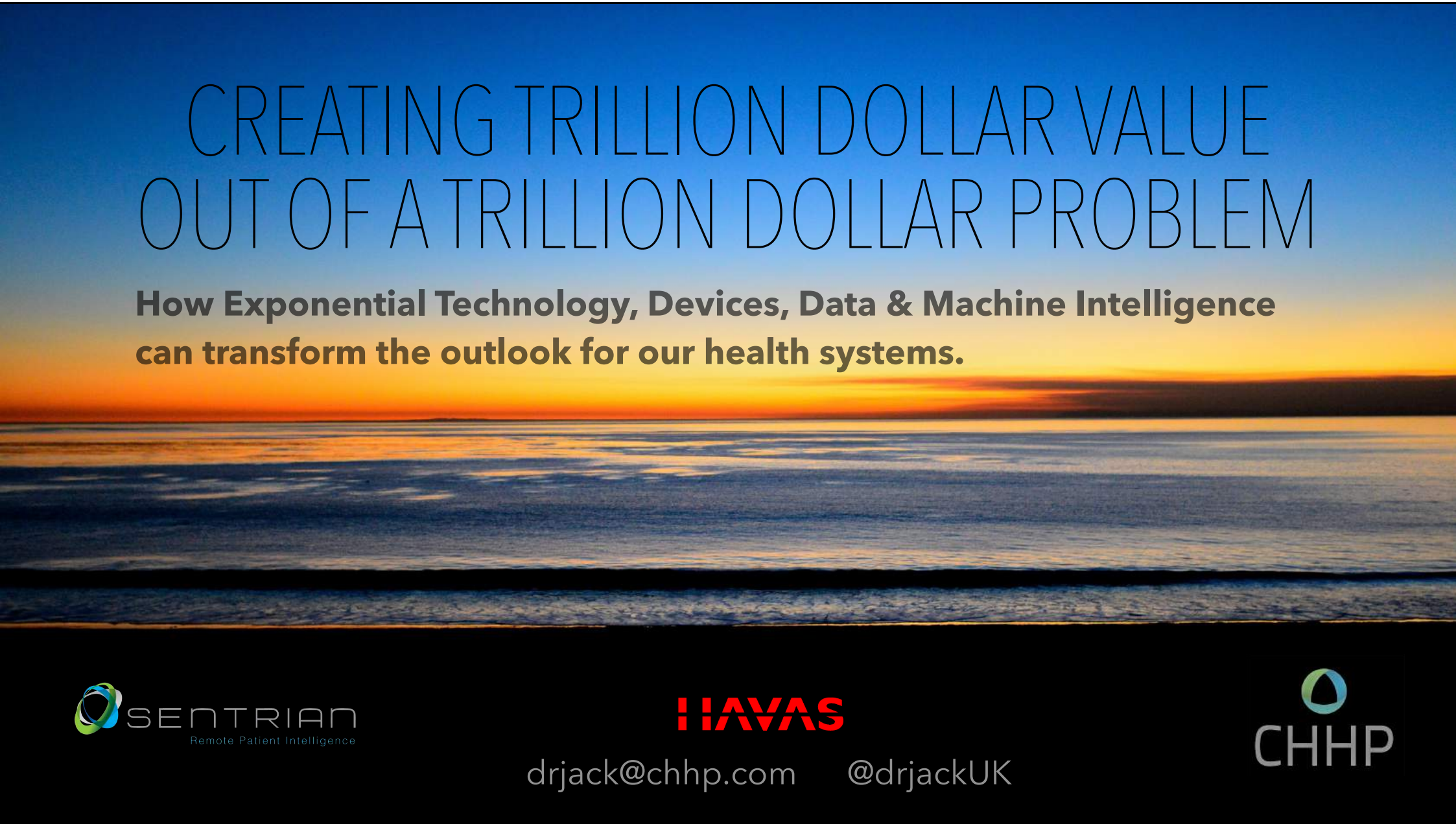
CREATING TRILLION DOLLAR VALUE
OUT OF A TRILLION DOLLAR PROBLEM
How Exponential Technology, Devices, Data & Machine Intelligence
can transform the outlook for our health systems.
SENTRIAN
Remote Patient Intelligence
HAVAS
CHHP
drjack@chhp.com
@drjackUK

AIR NEW ZEALAND

google.com
Web
Images
Google
Unknown - Use precise location
Settings
Privacy
Terms
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Business
About

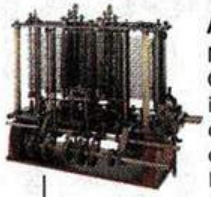
1 The accelerating pace of change ...

Agricultural Revolution ← 8,000 years → Industrial Revolution ← 120 years → Light-bulb ← 90 years → Moon landing ← 22 years → World Wide Web ← 9 years → Human genome sequenced

2 ... and exponential growth in computing power ...

Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

COMPUTER RANKINGS
By calculations per second per $1,000



Analytical engine
Never fully built, Charles Babbage's invention was designed to solve computational and logical problems

Colossus
The electronic computer, with 1,500 vacuum tubes, helped the British crack German codes during WW II

UNIVAC I
The first commercially marketed computer, used to tabulate the U.S. Census, occupied 943 cu. ft.

Apple II
At a price of $1,298, the compact machine was one of the first massively popular personal computers

Power Mac G4
The first personal computer to deliver more than 1 billion floating-point operations per second

Hollerith Tabulator
IBM Tabulator
National Ellis 3000
Zuse 2
Zuse 3
ENIAC
BINAC
IBM SSEC
EDVAC
Whirlwind
Datamatic 1000
IBM 1620
DEC PDP-4
IBM 1130
DEC PDP-10
Data General Nova
Intellec-8
IBM PC
Compaq Deskpro 386
Pentium PC
Pentium II PC
Dell Dimension 8400
Mac Pro
Nvidia Tesla GPU & PC

ELECTROMECHANICAL — RELAYS — VACUUM TUBES — TRANSISTORS — INTEGRATED CIRCUITS

1900 1920 1940 1960 1980 2000 2011 2020 2045

10^{26} 0.00001 100,000 10,000,000,000 10^{15} 10^{20} 10^{26}

3 ... will lead to the Singularity

2045
Surpasses brainpower equivalent to that of all human brains combined

Surpasses brainpower of human in 2023

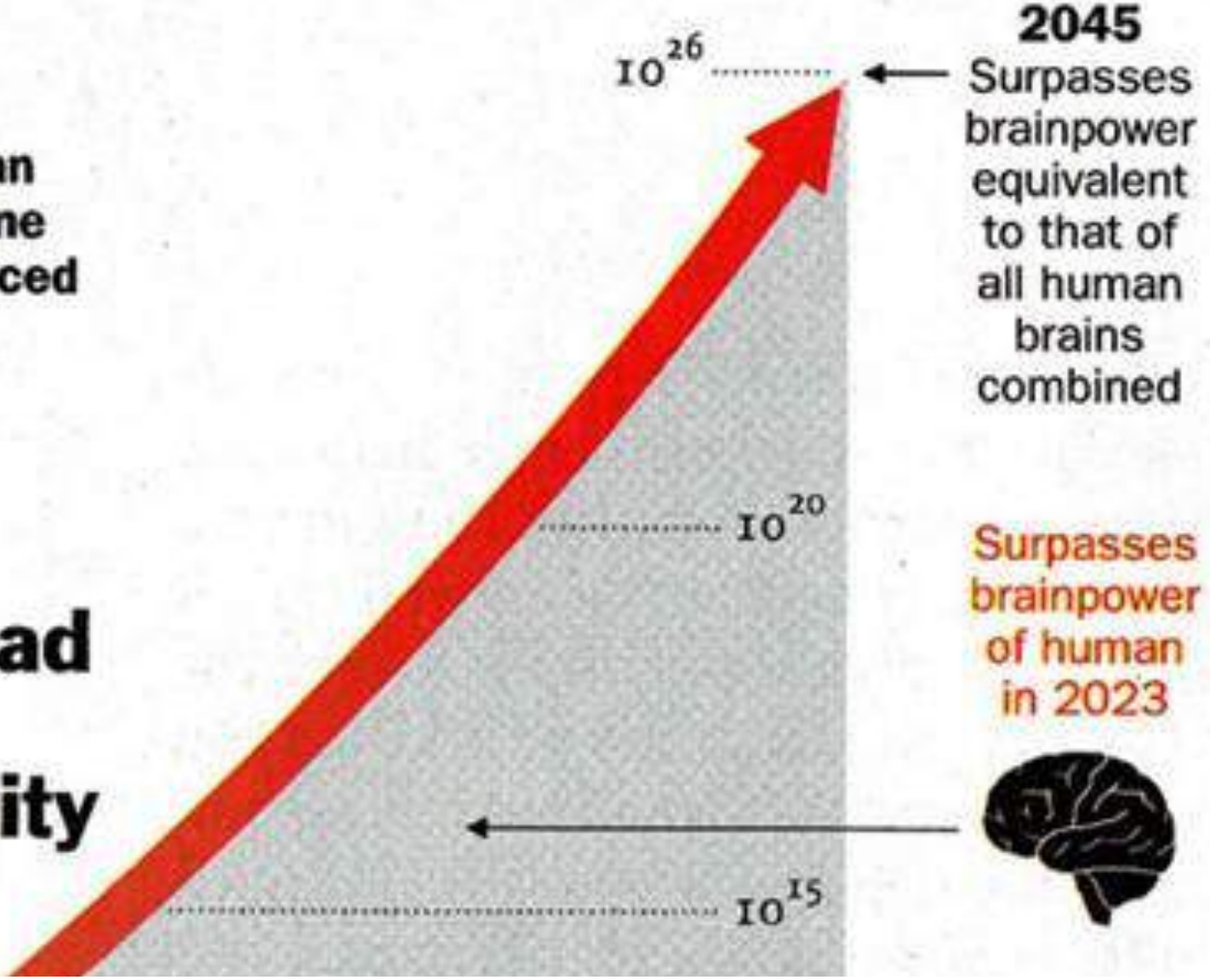
Surpasses brainpower of mouse in 2015

ld
e
b

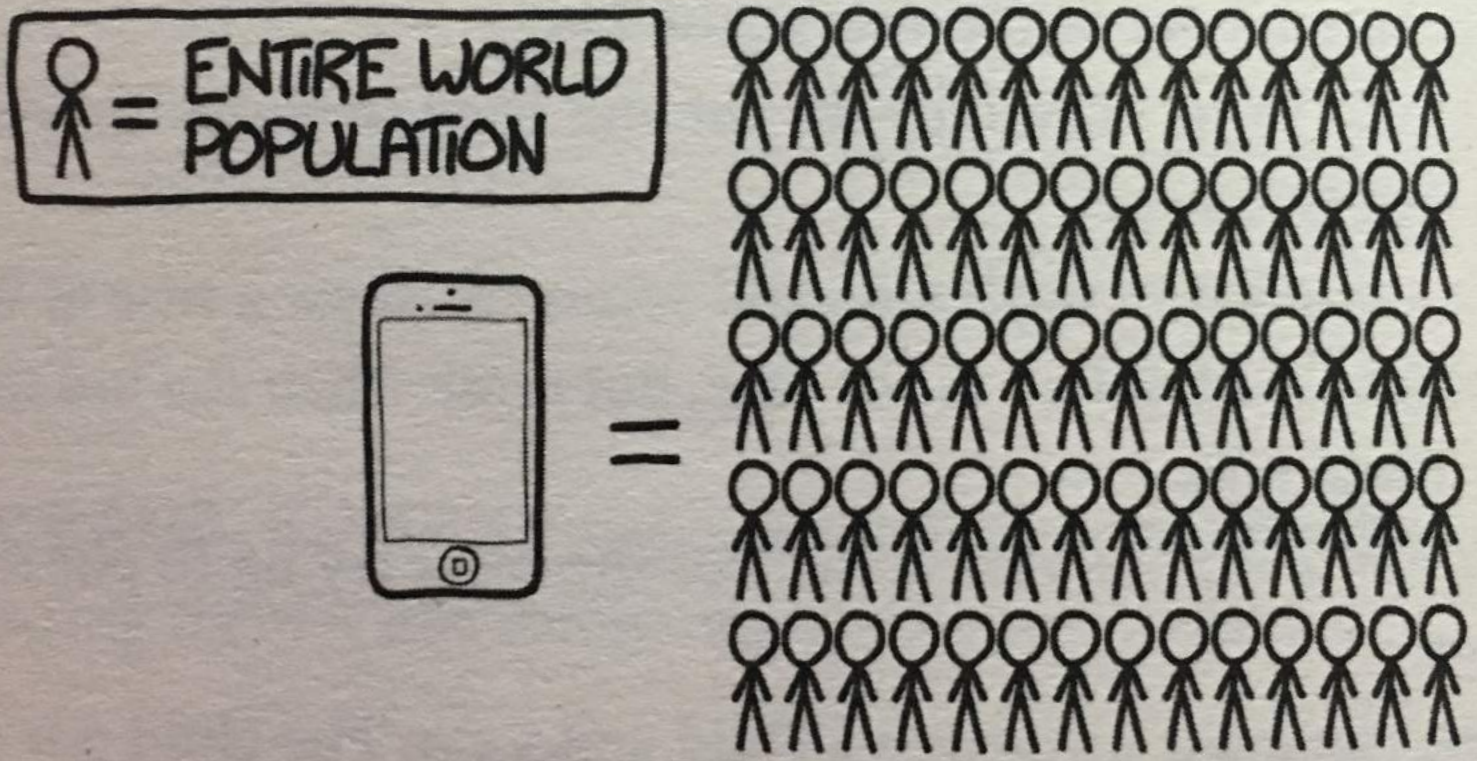
9 years

Human genome sequenced

3 ... will lead to the Singularity



desktop PC chip would increase that ratio to 1500.

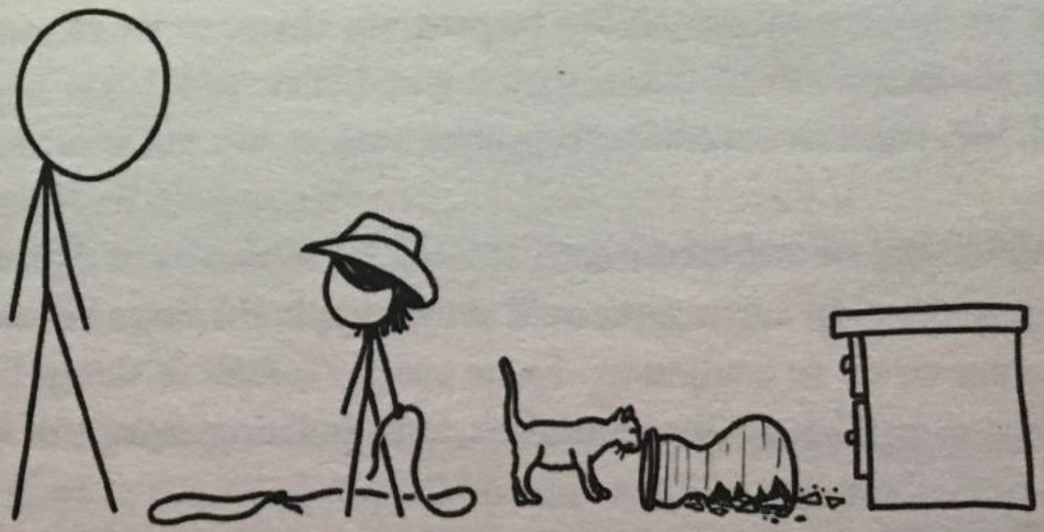


So, what year did a single typical desktop computer surpass the combined proc-
ing power of humanity?

_____

omputing power
l achieve if the
ulation stopped
doing right now
calculations?
ompare to a
omputer
one?

It's easy, though getting harder every day, to invent tasks that a single human can do faster than all the computers in the world. Humans, for example, are probably still far better at looking at a picture of a scene and guessing what just happened:



To test this theory, I sent this picture to my mother and asked her what *she* thought had happened. She immediately replied,[2] "The kid knocked over the vase and the cat is investigating."

She cleverly rejected alternate hypotheses, including:

- The cat knocked over the vase.
- The cat jumped out of the vase at the kid.
- The kid was being chased by the cat and tried to climb up the dresser

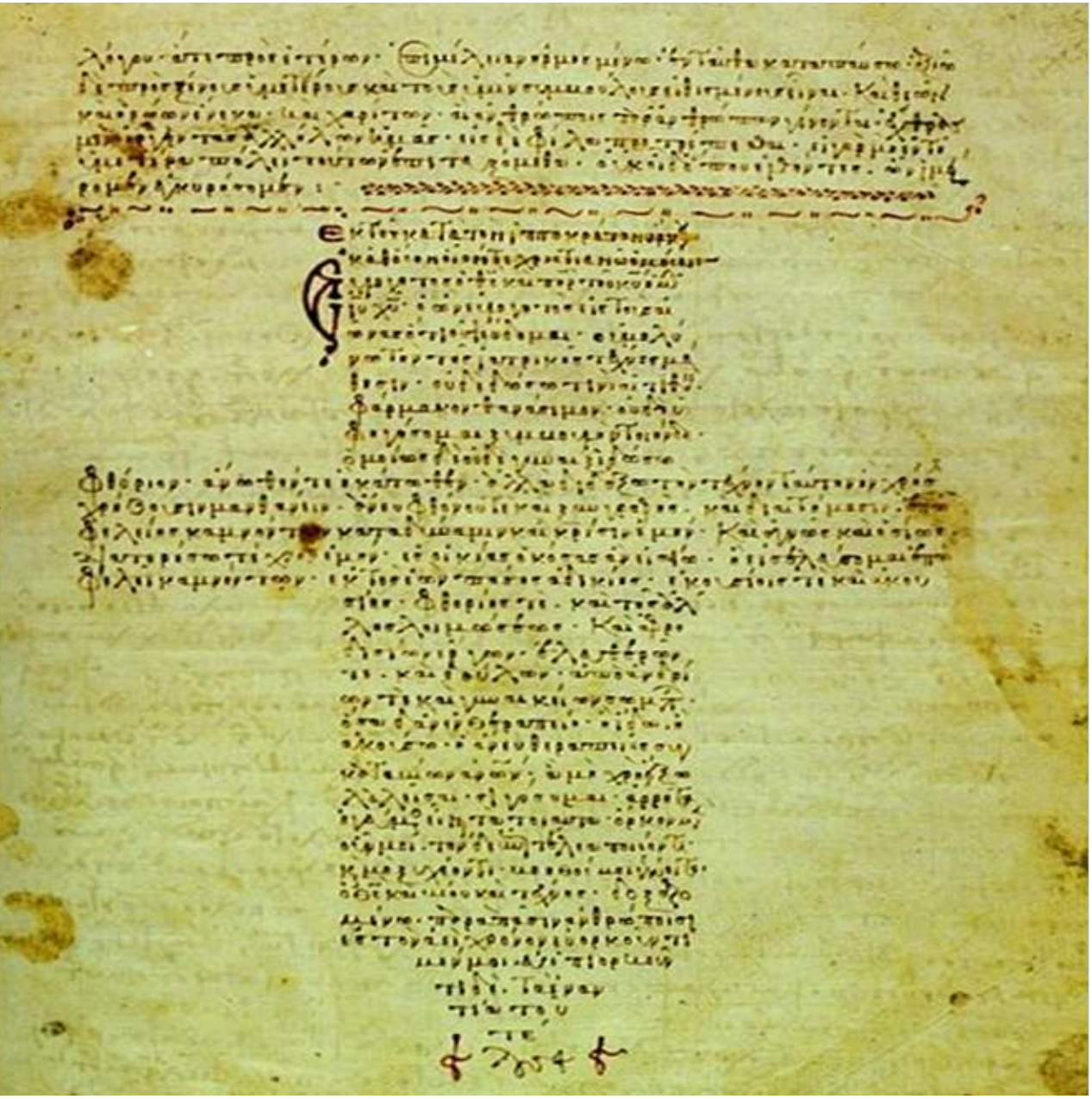
100 YEARS AGO

WAXTITE
Kellogg's
TOASTED
CORN
FLAKES
W.K. Kellogg

TODAY

DEEPMIND
$1,000,000
Who is Bram Stoker?
$ 17,973
$200,0
$5600

100 YEARS ON?



Oath of Hippocrates

I swear by Apollo, the Physician, and Aesculapius and health and all-heal and all the Gods and Goddesses that, according to my ability and judgment, I will keep this oath and stipulation:

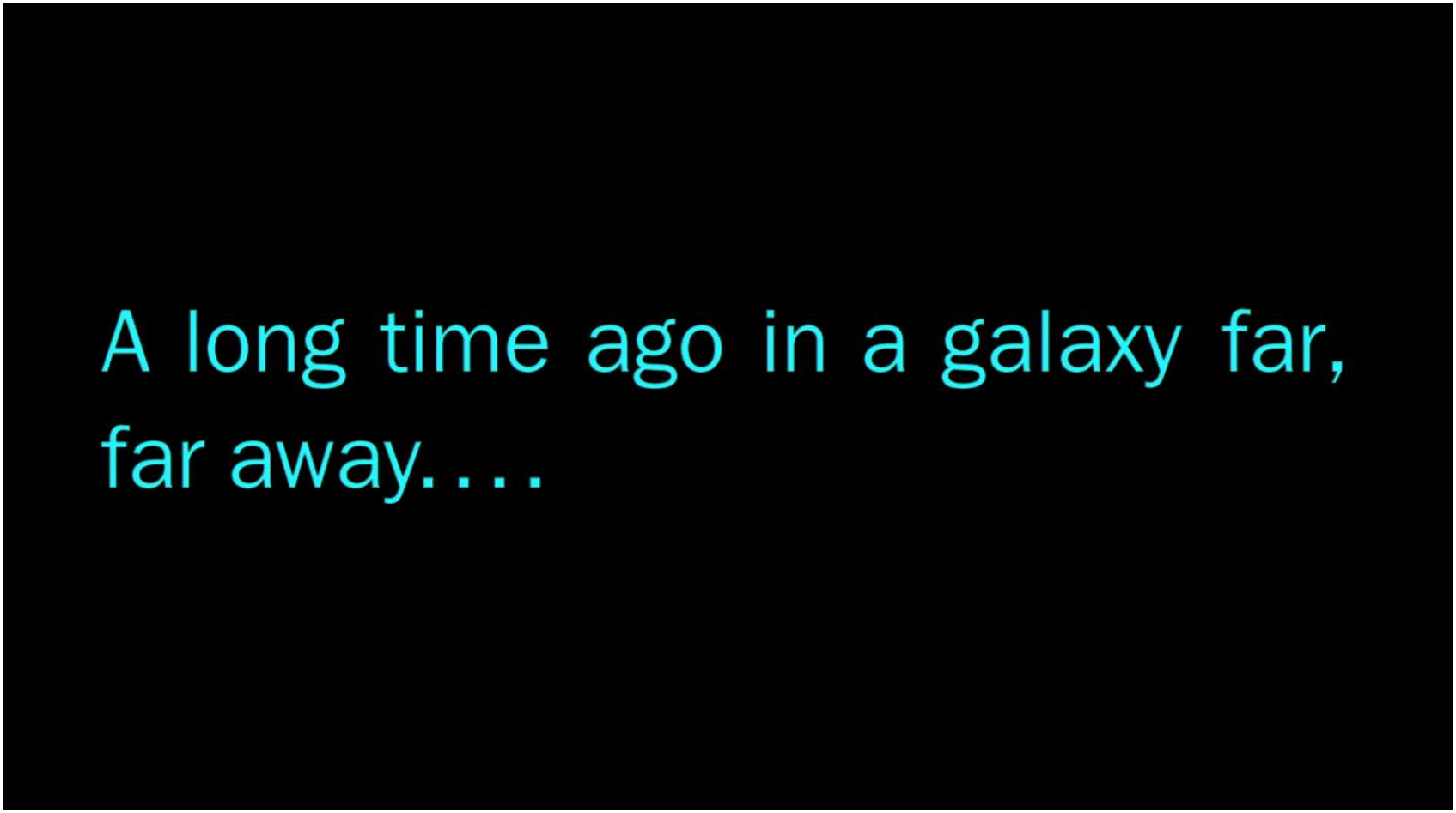
To reckon him who taught me this art equally dear to me as my parents, to share my substance with him and relieve his necessities if required: to regard his offspring as on the same footing with my own brothers, and to teach them this art if they should wish to learn it, without fee or stipulation, and that by precept, lecture and every other mode of instruction, I will impart a knowledge of the art to my own sons and to those of my teachers, and to disciples bound by a stipulation and oath, according to the law of medicine, but to none others.

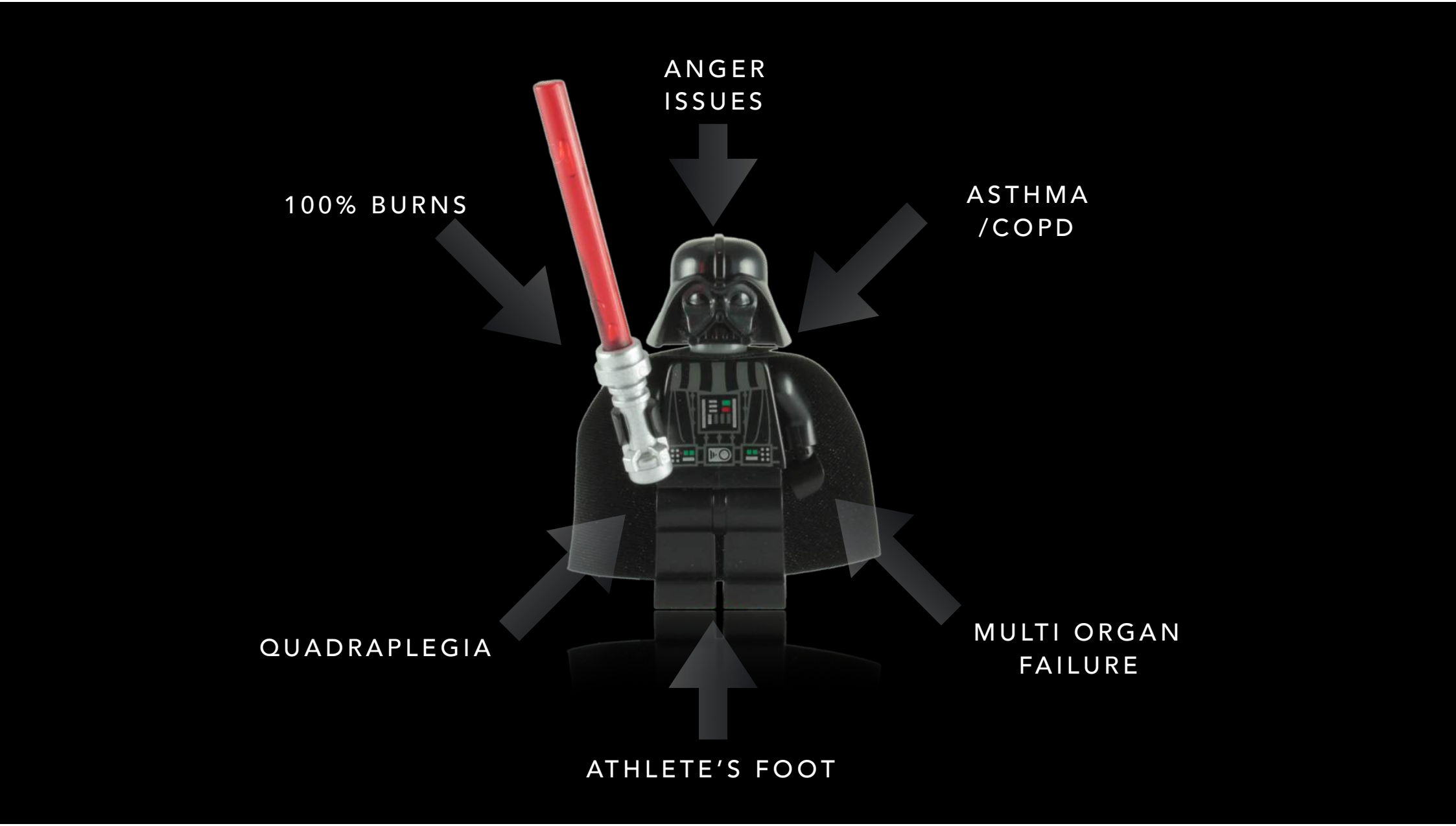
I will follow that method of treatment which, according to my ability and judgment, I consider for the benefit of my patients, and abstain from whatever is deleterious and mischievous. I will give no deadly medicine to anyone if asked, nor suggest any such counsel; furthermore, I will not give to a woman an instrument to produce abortion.

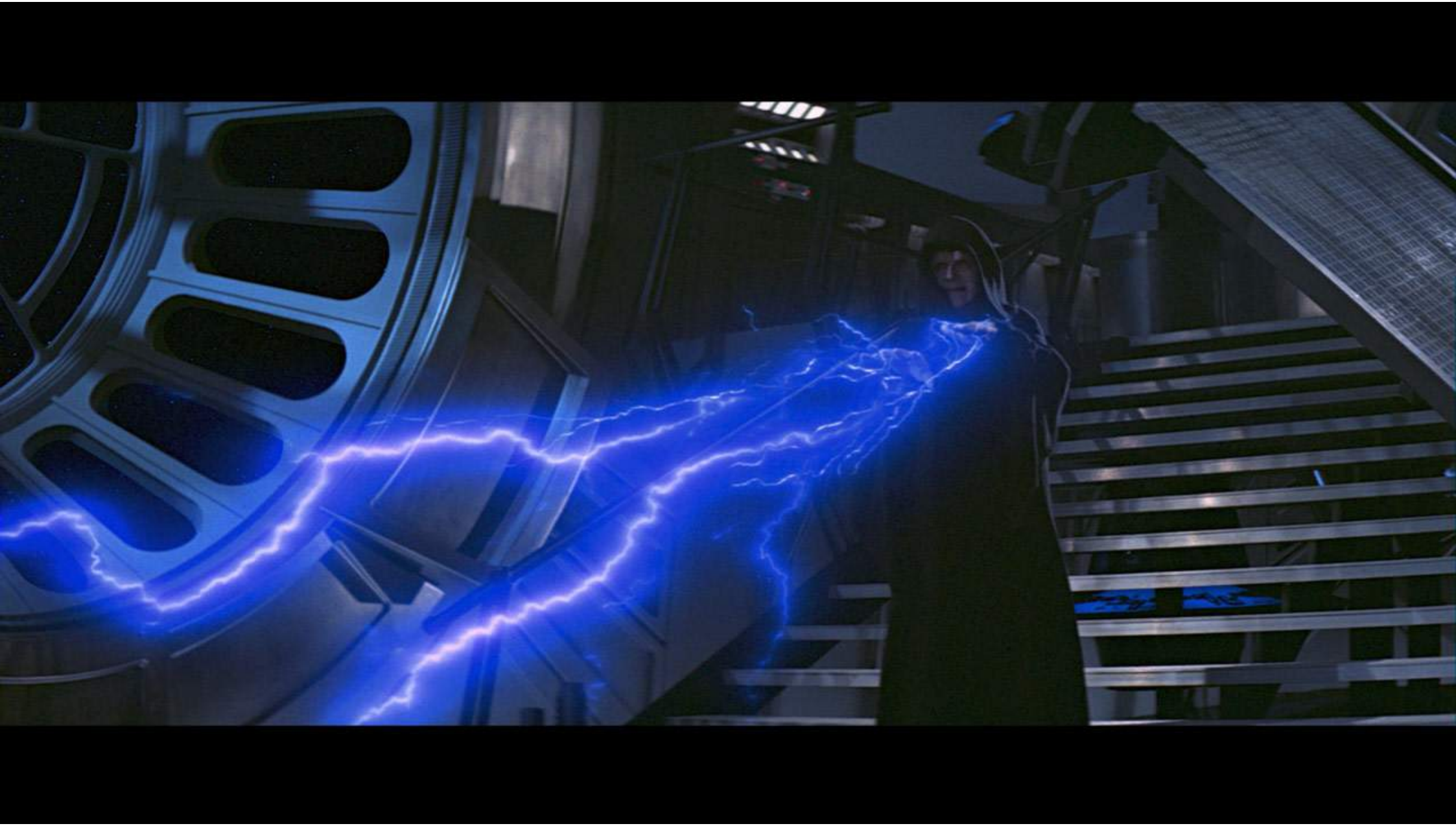
With Purity and with Holiness I will pass my life and practice my art. I will not cut a person who is suffering with a stone, but will leave this to be done by practitioners of this work. Into whatever houses I enter I will go into them for the benefit of the sick and will abstain from every voluntary act of mischief and corruption; and further from the seduction of females or males, bond or free.

Whatever, in connection with my professional practice, or not in connection with it, I may see or hear in the lives of men which ought not to be spoken abroad I will not divulge, as reckoning that all such should be kept secret.

While I continue to keep this oath unviolated may it be granted to me to enjoy life and the practice of the art, respected by all men at all times but should I trespass and violate this oath, may the reverse be my lot.


A long time ago in a galaxy far,
far away....


ANGER
ISSUES
100% BURNS
ASTHMA
/COPD
QUADRAPLEGIA
MULTI ORGAN
FAILURE
ATHLETE'S FOOT



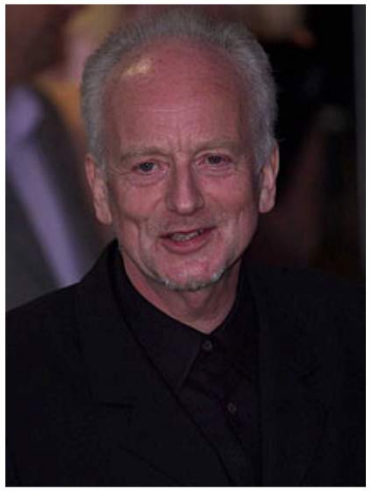
The Telegraph

Star Wars Emperor Ian McDiarmid tells his ambulance to wait until he finishes West End play

An award-winning actor who played the evil Emperor in the Star Wars movies was taken ill on stage but instructed an ambulance to wait until the performace had finished before being leaving for hospital.

By Nick Allen
8:51AM BST 24 Oct 2008

Ian McDiarmid, 64, began suffering from dizzy spells towards the end of the play but concealed his condition so well that the audience didn't notice and critics later gave him glowing reviews.



Ian McDiarmid is a highly distinguished stage actor

Backstage staff feared he was suffering a heart attack and called an ambulance ten minutes before the performance was due to end. It arrived seven minutes later.

But the heroic actor finished his performance and then took the curtain call at the Gielgud Theatre in London's West End before getting in the ambulance.

McDiarmid had been playing the Father in Luigi Pirandello's Six Characters in Search of an Author.

He is a highly distinguished Scottish stage actor but is most famous for his Hollywood role as the Emperor Palpatine in George Lucas's Star Wars films.

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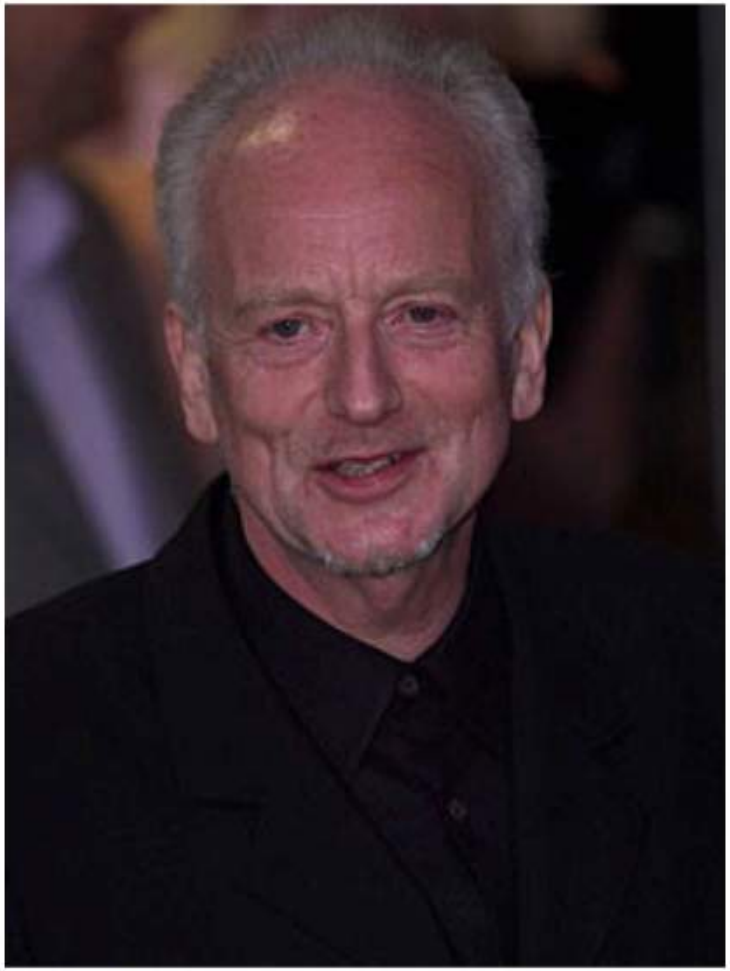
How about that?
News »
Celebrity news »

In Politics

Pictures of the week



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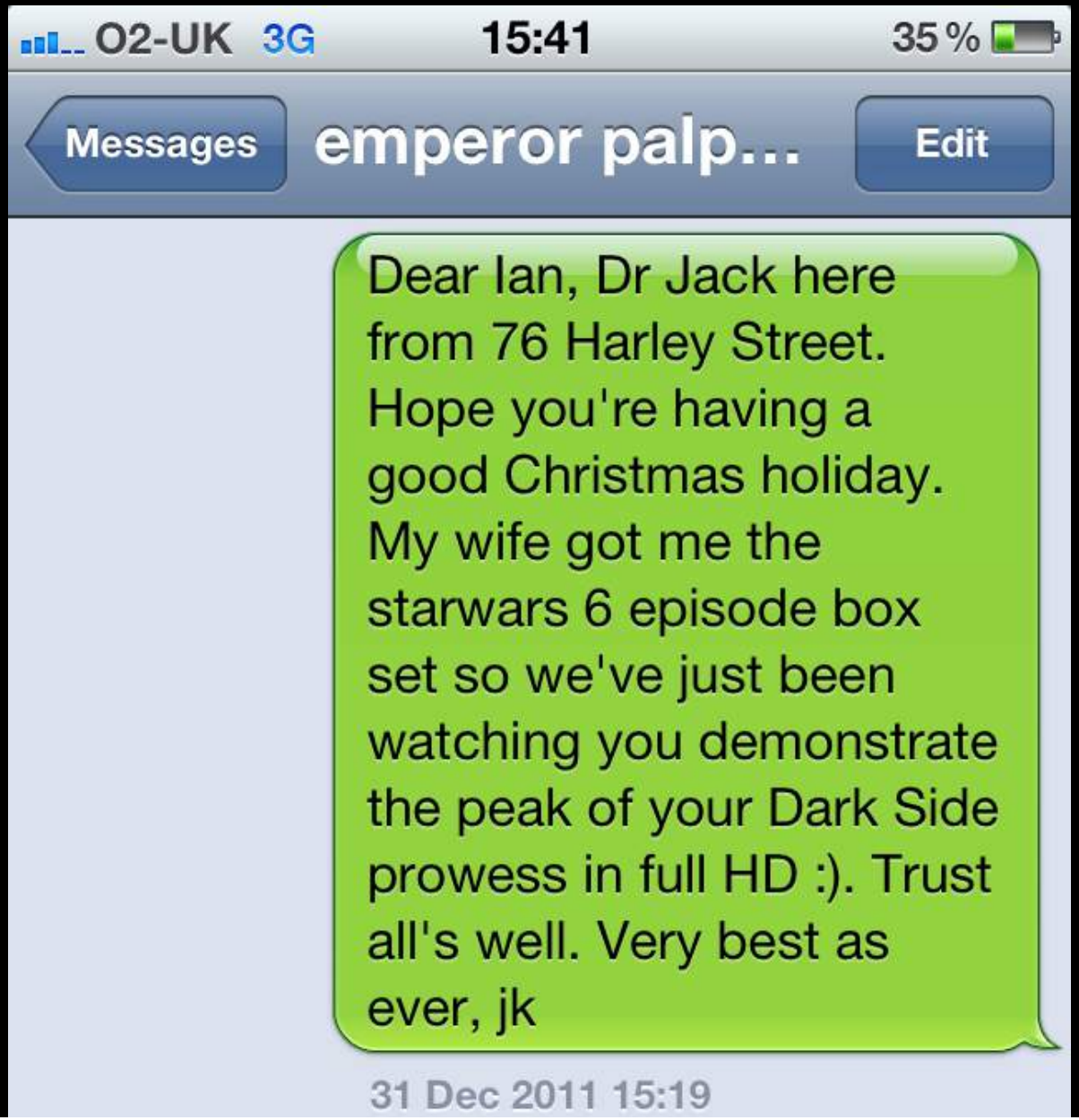
Email
LinkedIn
+1 0

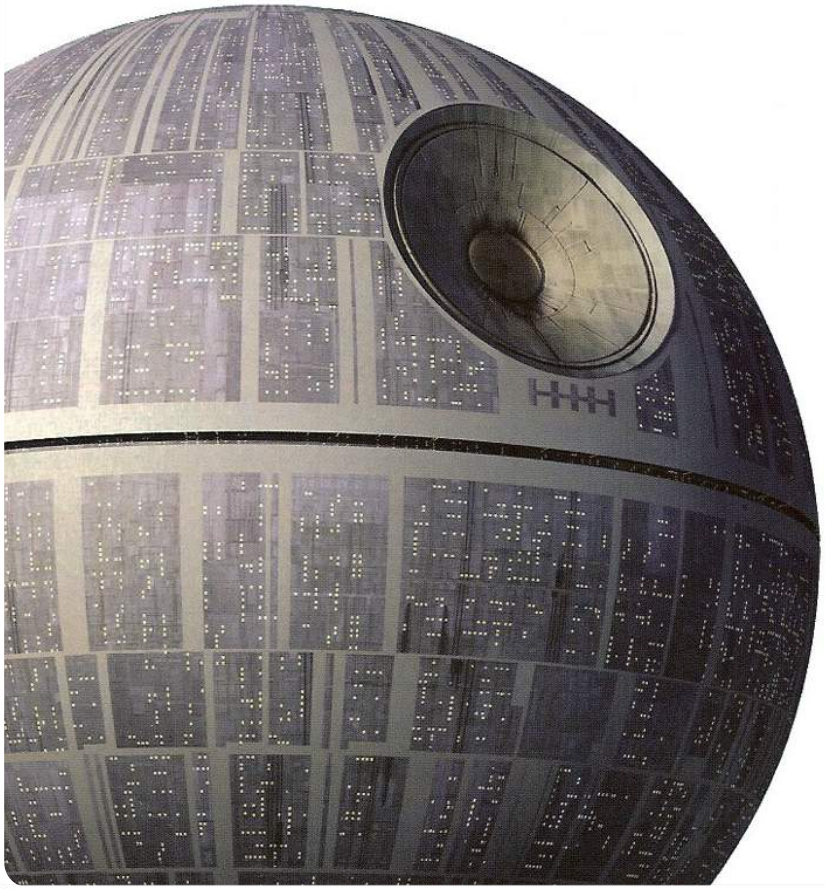
How about that?

News »
Celebrity news »

In Politics

Pictures of the week


O2-UK 3G
15:41
35 %
Messages
emperor palp...
Edit
Dear Ian, Dr Jack here from 76 Harley Street. Hope you're having a good Christmas holiday. My wife got me the starwars 6 episode box set so we've just been watching you demonstrate the peak of your Dark Side prowess in full HD :). Trust all's well. Very best as ever, jk
31 Dec 2011 15:19

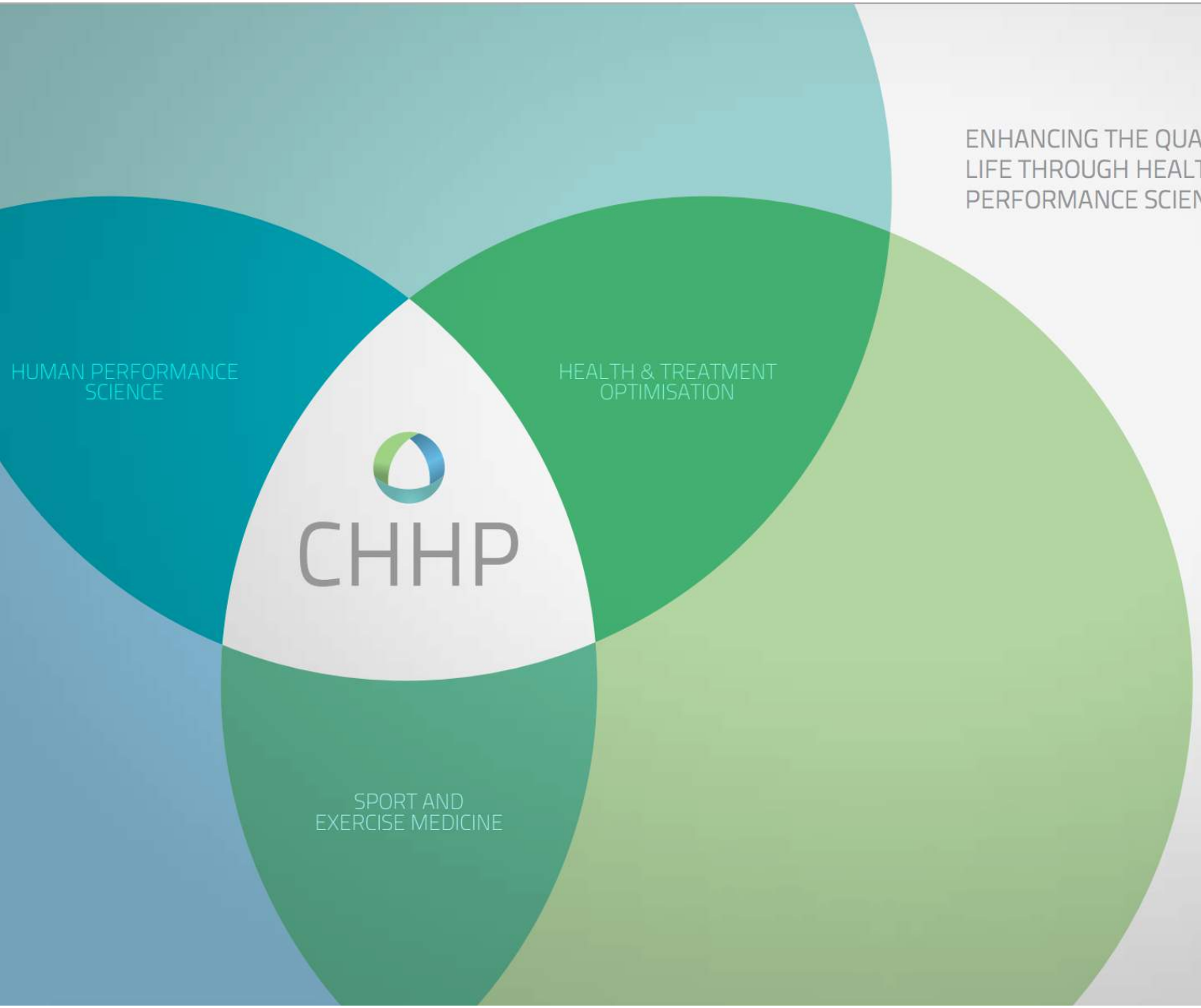


DR JACK KREINDLER
IMPERIAL PHYSICIAN

MEDICAL WING
FLOOR 201,045
DS 90210
THE DEATH STAR

(JUST PAST CATERING)

@drjackuk
phantom.medic@gmail.com



ENHANCING THE QUALITY OF LIFE THROUGH HEALTH AND PERFORMANCE SCIENCE.

HUMAN PERFORMANCE SCIENCE

The CHHP Performance Team is housed in a state-of-the-art facility for the assessment of human performance. Our world leading team of specialists operate a range of clinics providing a bespoke service for clients across the performance spectrum from patient to elite athlete. This highly individual approach; using the latest research and technology ensures performance optimisation whatever your goal.

HEALTH & TREATMENT OPTIMISATION

The Centre for Health and Human Performance (CHHP) provides the best in personalised medical care. Our consultant physicians and surgeons are leaders in their fields, internationally recognised for their clinical expertise and research. The unique multidisciplinary care approach provides the very best opinions and access to the most advanced treatment to optimise health for our clients.

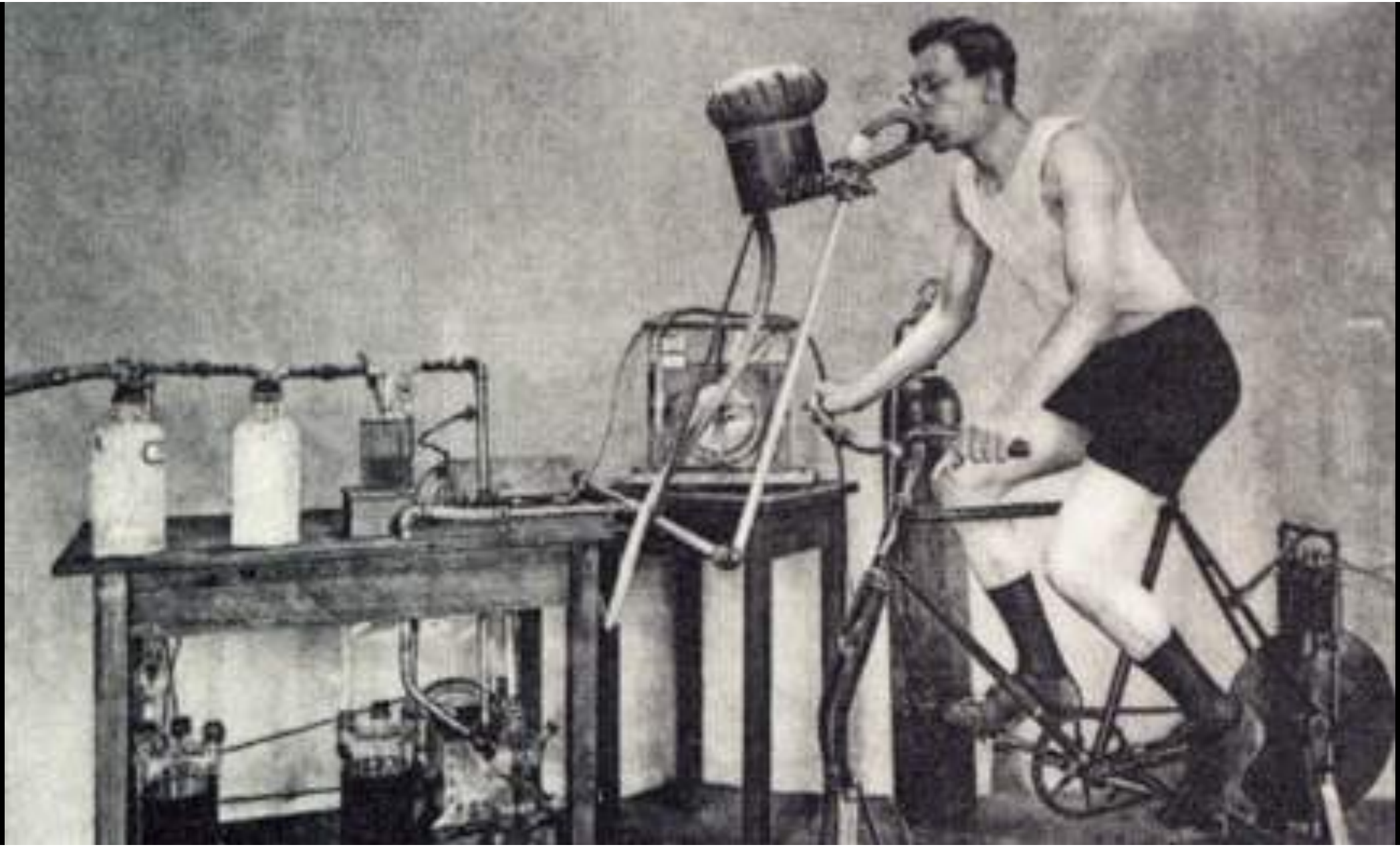
SPORT AND EXERCISE MEDICINE

CHHP provides the best in sport and exercise medicine under one roof. The team of world leading specialists take an individualised approach to every problem providing bespoke solutions across the exercise spectrum from first time exercisers to Olympic medallists. The state-of-the-art facilities combined with specialists from medicine, physiotherapy, soft tissue therapy and rehabilitation work as an inter-disciplinary team to solve sport and exercise related issues rapidly returning our clients to optimal health and performance, whatever your goal.

HUMAN PERFORMANCE SCIENCE

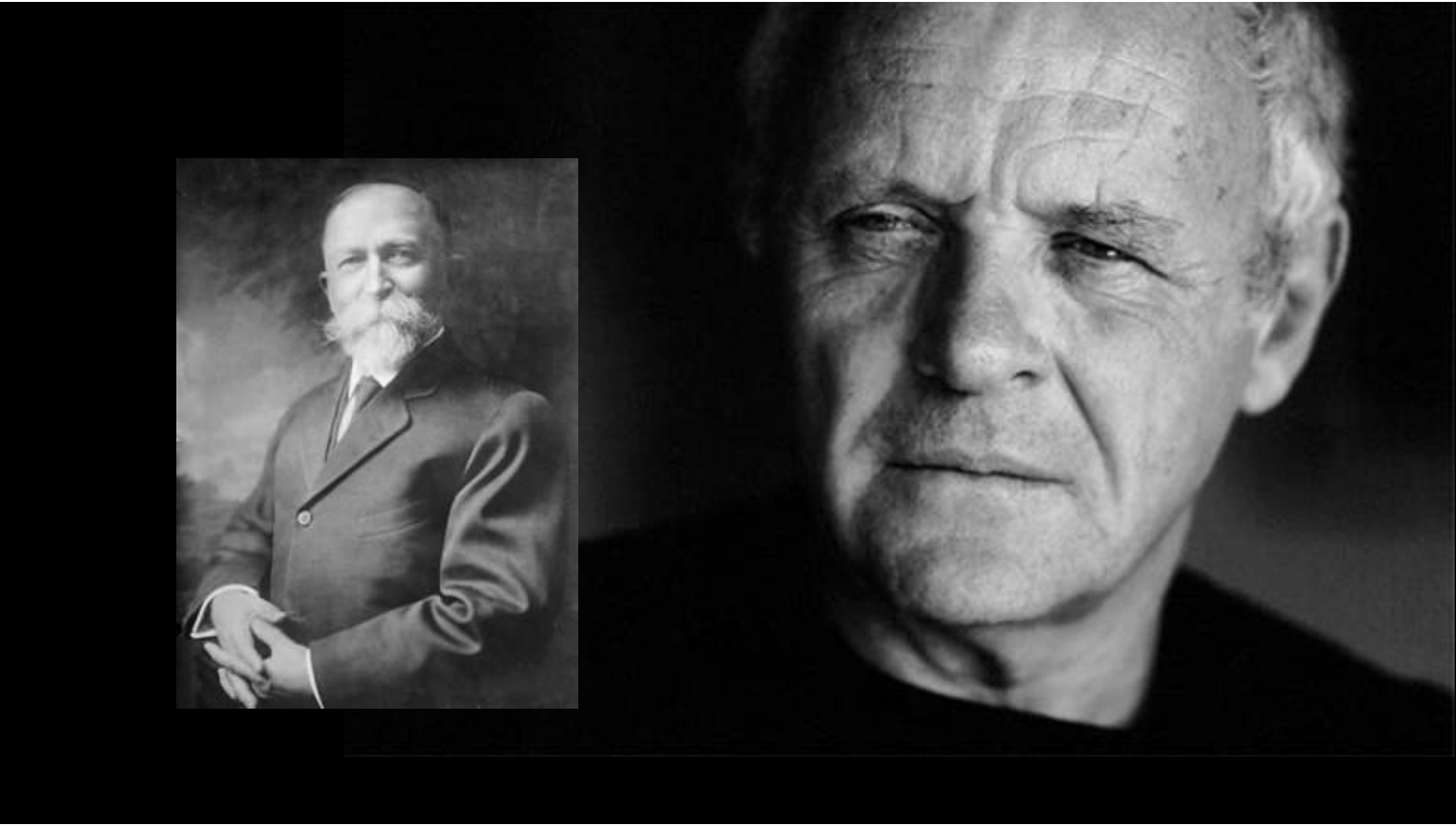
DOCTORS AND SCIENTISTS SAID THAT BREAKING THE FOUR-MINUTE MILE WAS IMPOSSIBLE, THAT ONE WOULD DIE IN THE ATTEMPT. THUS, WHEN I GOT UP FROM THE TRACK AFTER COLLAPSING AT THE FINISH LINE, I FIGURED I WAS DEAD.

Roger Bannister



#GreattobeBAck
BRITISH
victoRIOus

Oliver



CENSORED
CENSORED
CENSORED
CENSORED
CENSORED
AGE
HEIGHT
WEIGHT
TEAM
MMA
34
LIGHT HEAVY
3 - 0 - 0
DR JACK KREINDLER
VS
NICK CHAPMAN

REST

ICE

COMPRESSION

ELEVATION

RA
MF 0.86
TI 160.0
TR 4780.0
TE 32.0
TA 03:45
BW 161.0
p2 M/NORM/DIS2D
A3/IR
c:FL:BO1.2:SP3.5
tir2d1_8 / 148

SERIOUSLY...

CHHP

CENTRE FOR HEALTH &
HUMAN PERFORMANCE

CHP

WELCOME TO
BASE CAMP LABORATORY

CHHP
CENTRE FOR HEALTH & HUMAN PERFORMANCE

Surgery: Impaired functional Capacity is Associated with All-Cause Mortality

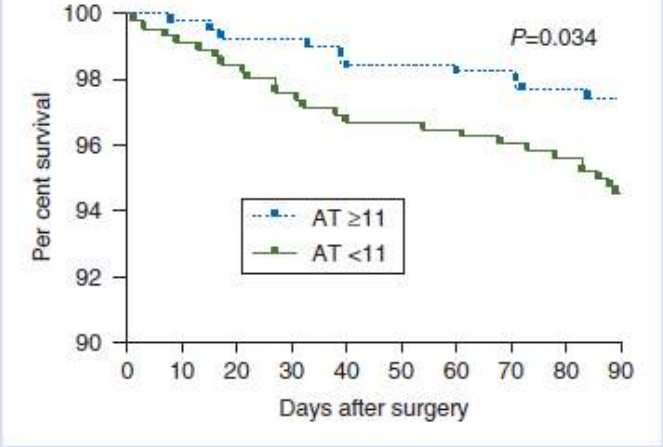


Fig 2 Kaplan–Meier curve for 90 day survival for AT ≥ 11 ml kg^{-1} min^{-1} compared with AT <11 ml kg^{-1} min^{-1}. Survival at 90 days was significantly greater in patients with an AT of 11 ml kg^{-1} min^{-1} or greater ($P=0.034$).

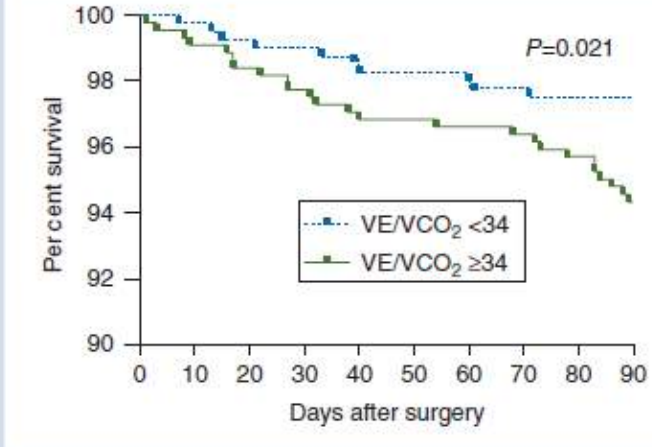
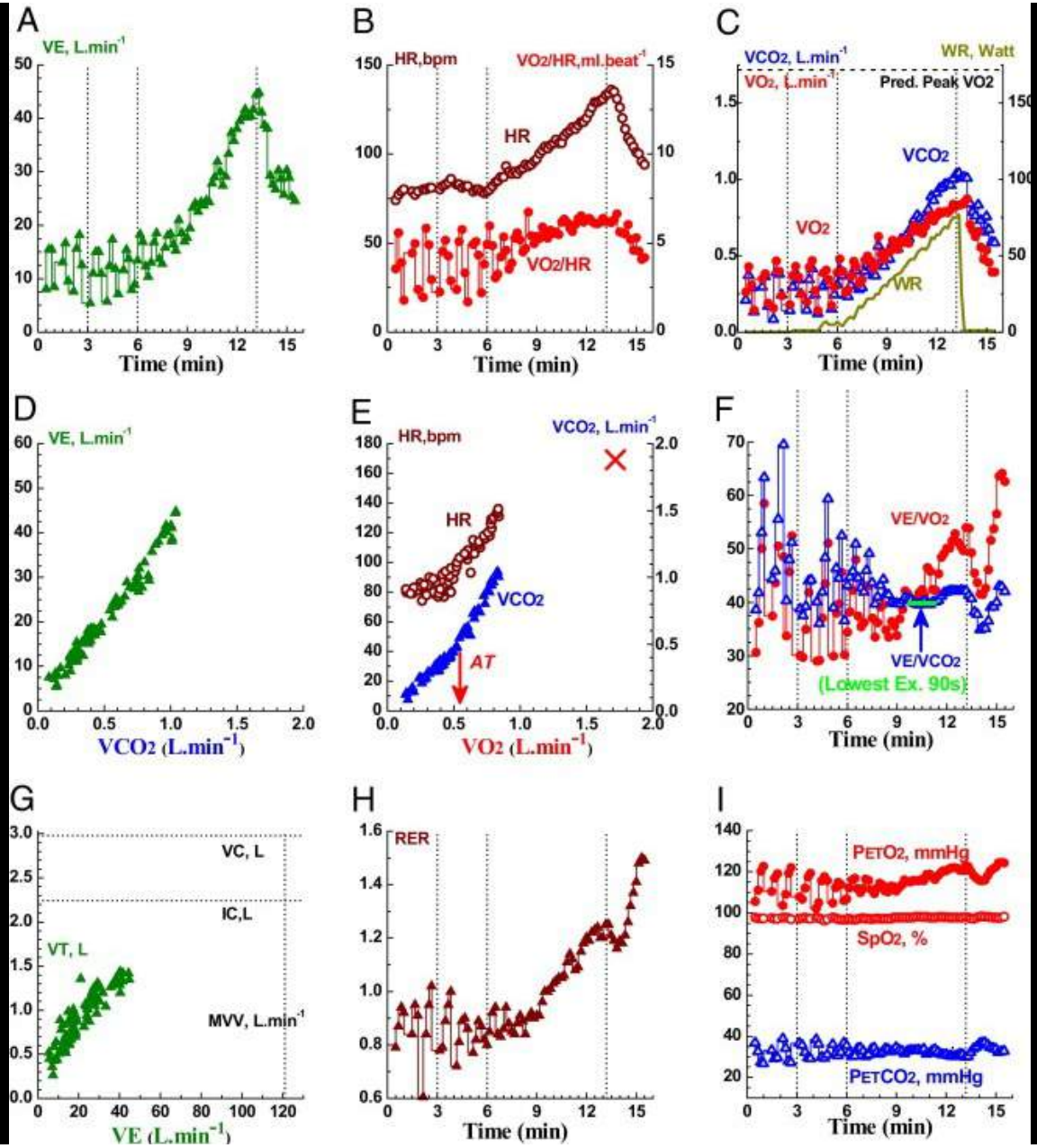
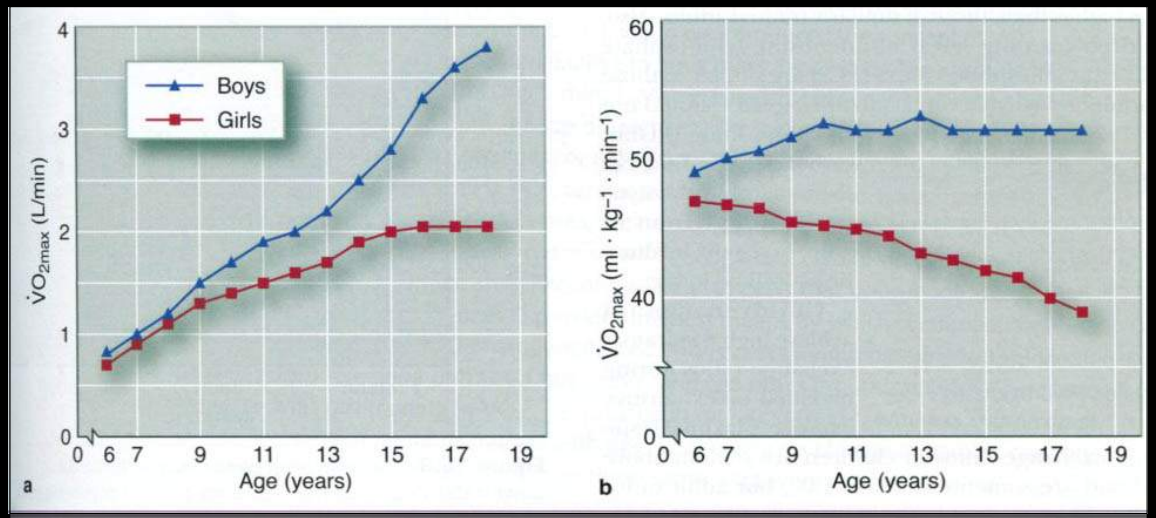


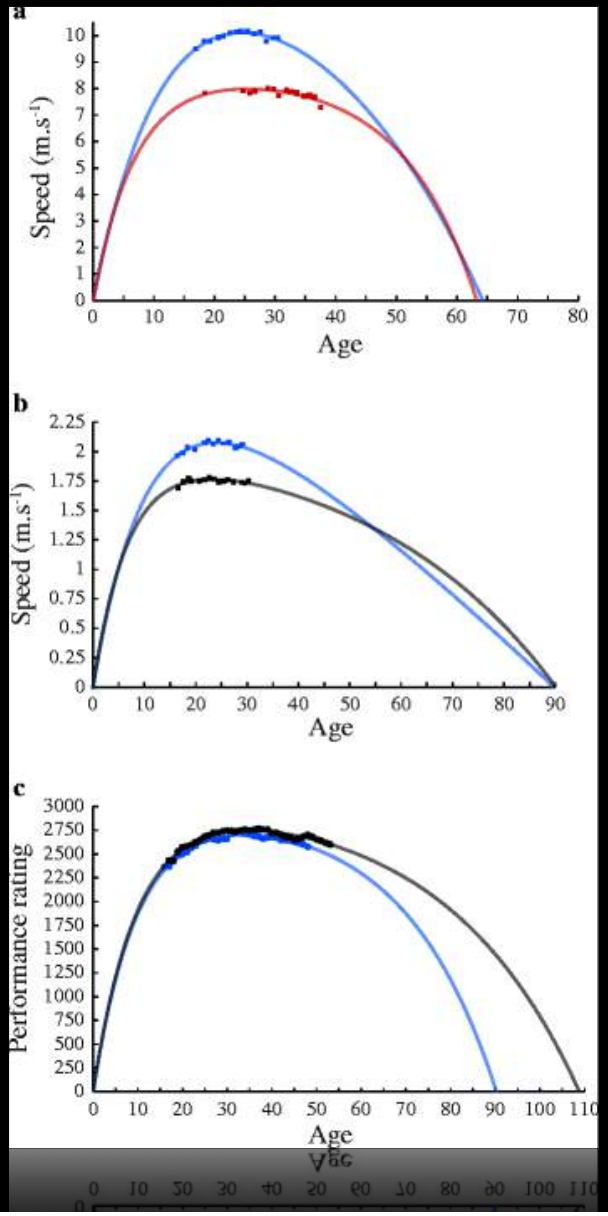
Fig 3 Kaplan–Meier curve for 90 day survival for VE/VCO_2 <34 compared with VE/VCO_2 >34. Survival at 90 days was significantly greater in patients with VE/VCO_2 <34 ($P=0.021$).

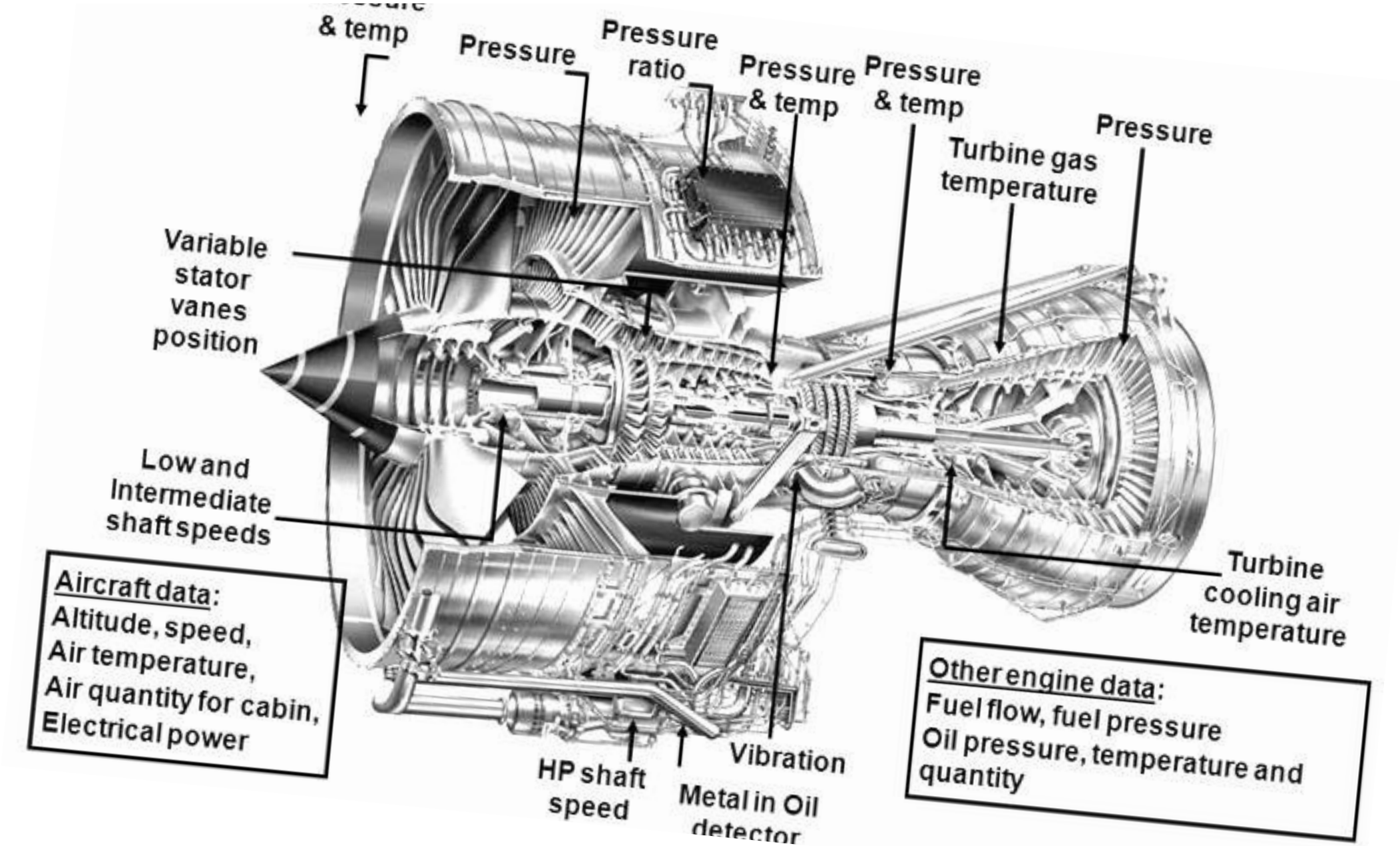
Wilson, T., Davies, S., Yates, J. & Stone, M. Br J Anaesth 2010;105:297-303


A
VE, L.min-1
Time (min)
B
HR,bpm
VO2/HR,ml.beat-1
HR
VO2/HR
Time (min)
C
VCO2, L.min-1
VO2, L.min-1
WR, Watt
Pred. Peak VO2
VCO2
VO2
WR
Time (min)
D
VE, L.min-1
VCO2 (L.min-1)
E
HR,bpm
VCO2, L.min-1
HR
VCO2
AT
VO2 (L.min-1)
F
VE/VO2
VE/VCO2
(Lowest Ex. 90s)
Time (min)
G
VC, L
IC,L
VT, L
MVV, L.min-1
VE (L.min-1)
H
RER
Time (min)
I
PETO2, mmHg
SpO2, %
PETCO2, mmHg
Time (min)

WTF!?


Boys
Girls
$\dot{V}O_{2max}$ (L/min)
$\dot{V}O_{2max}$ (ml · kg^{-1} · min^{-1})
Age (years)
a
b


a
Speed (m.s^{-1})
Age
b
Speed (m.s^{-1})
Age
c
Performance rating
Age


& temp
Pressure
Pressure ratio
Pressure & temp
Pressure & temp
Turbine gas temperature
Pressure
Variable stator vanes position
Low and Intermediate shaft speeds
Turbine cooling air temperature
Aircraft data:
Altitude, speed,
Air temperature,
Air quantity for cabin,
Electrical power
HP shaft speed
Metal in Oil detector
Vibration
Other engine data:
Fuel flow, fuel pressure
Oil pressure, temperature and quantity

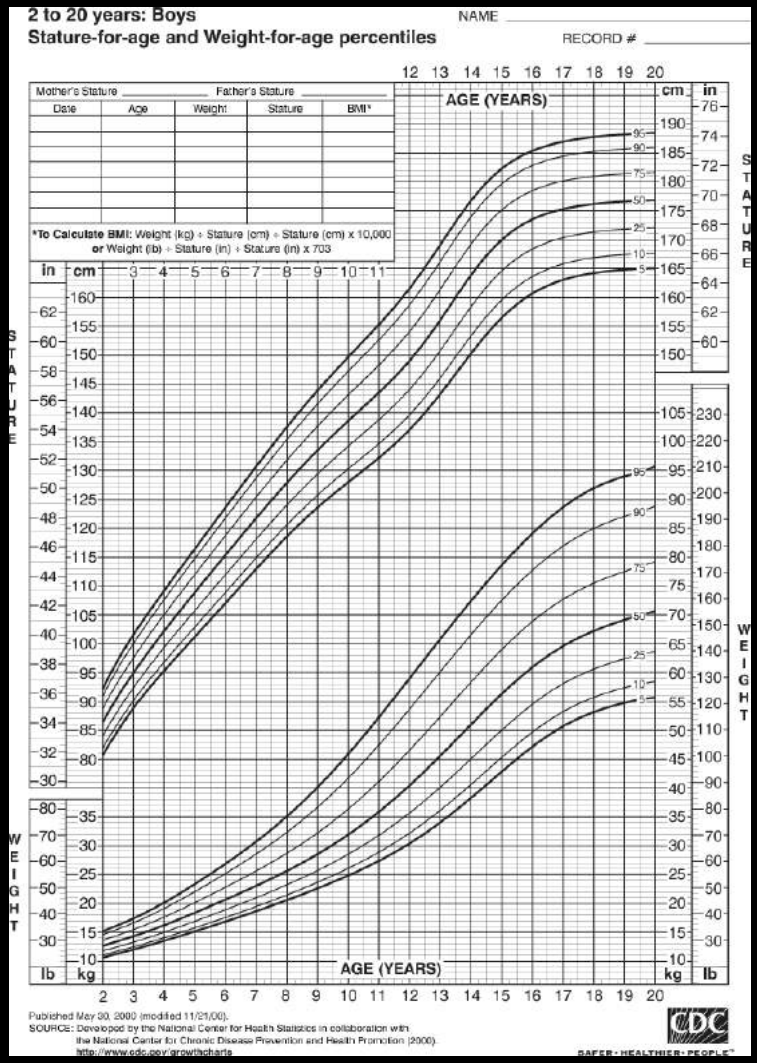
AIR NEW ZEALA

2 to 20 years: Boys

NAME _____

Stature-for-age and Weight-for-age percentiles

RECORD # _____



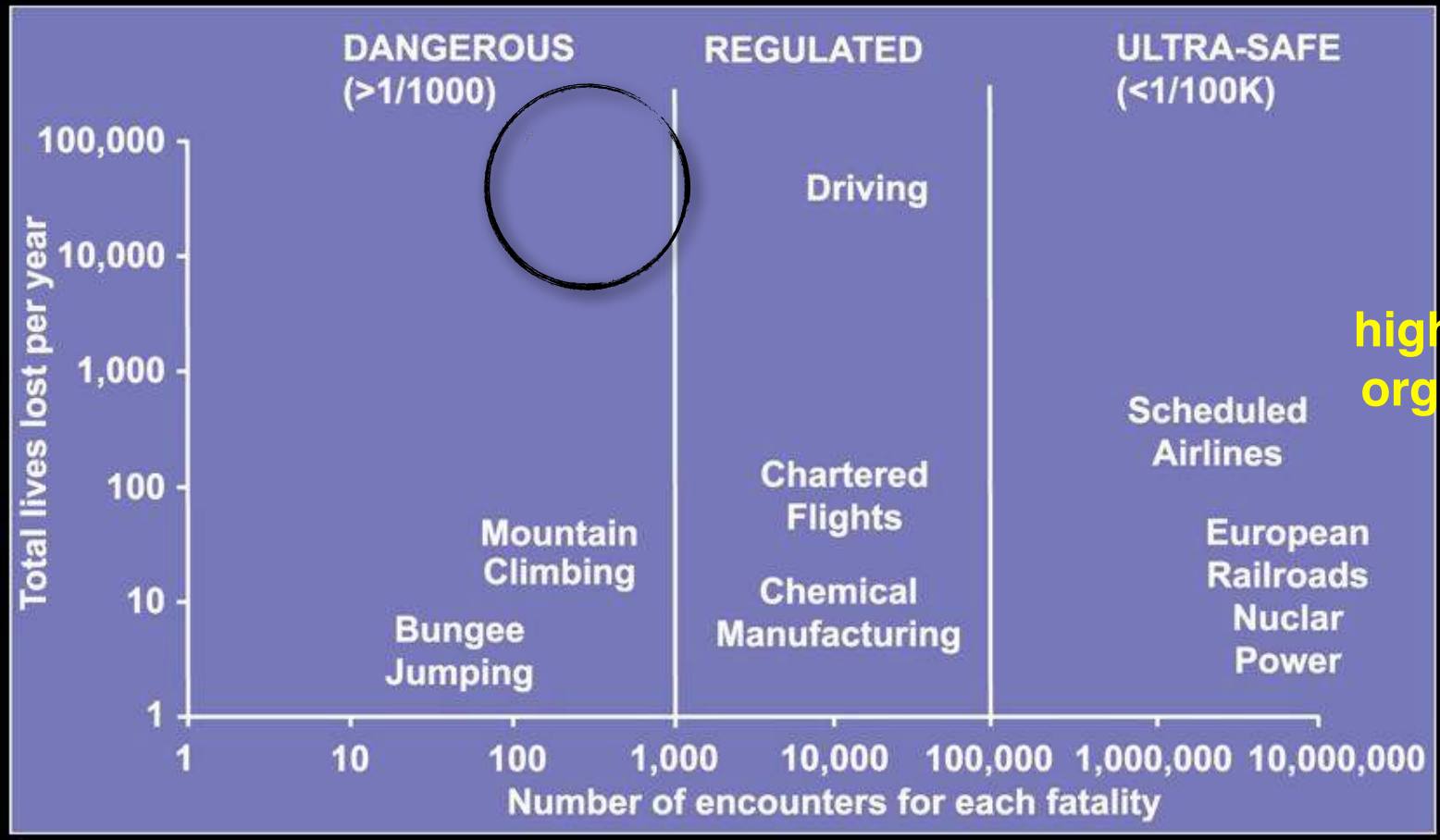
Published May 30, 2000 (modified 11/21/00).

SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000). http://www.cdc.gov/growthcharts

SAFER · HEALTHIER · PEOPLE™

Would you get in a plane that hadn't been checked for **half a century?**

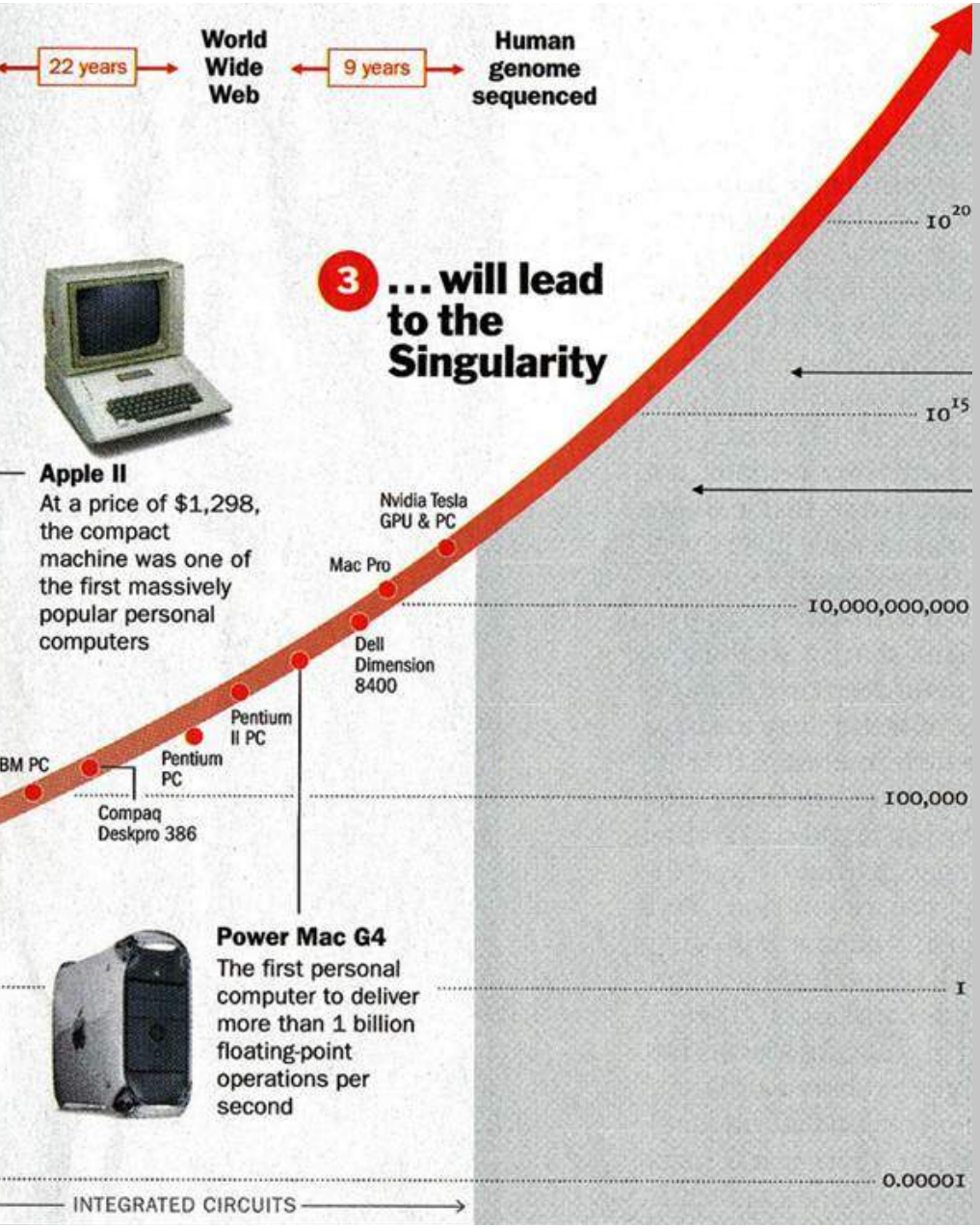
HOW SAFE IS HEALTHCARE?



high-reliability organisations

Singularity University
Futuremed Program February 2012

EXPONENTIAL
Medicine
REIMAGINING THE FUTURE OF HEALTH AND MEDICINE
ExponentialMedicine.com



INCREMENTAL

VS

EXPONENTIAL

INCREMENTAL
MEDICINE

5:10 PM
Carbs
138
mg/dL
Tues, Apr 3, 2012, 5:10 PM EDT
Pre-Dinner
Add Note
Home
Add
Data
Share
Info
138
04/03/12
650
FORA
160
02:03 P
3hr
OK
C
400
350
300
250
200
150
100
50
pexcom
104

i2Dtx
CardioSleeve
Rijuven

why not for all?

UMBRO
17
UMBRO
9
UMBRO
MasterCard

SHEARER
9
SHEARER
9

My Vitals Dashboard

Alan Shearer

Current Vitals

Local Time: 12:19:21 GMT

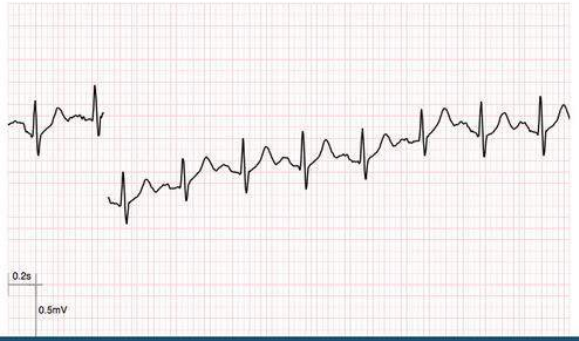
121 BPM HEARTRATE	19 BrPM RESPIRATION	99 % STRESS
39280 STEPS	11271 Cal TOTAL ENERGY EXPENDITURE	489 Cal/hr RATE OF ENERGY EXPENDITURE
33.7 °C SKIN TEMPERATURE	POSTURE	0.0 g ACTIVITY

Current ECG

-1.5mV to 1.5mV | -3.5mV to 3.5mV | -10mV to 10mV

Local Time: 12:19:21 GMT

ECG Time: 12:17:59 GMT



My Vitals Dashboard

Robbie Savage

Current Vitals

Local Time: 12:19:21 PM

102 BPM HEARTRATE	15 BrPM RESPIRATION	89 % STRESS
38186 STEPS	9822 Cal TOTAL ENERGY EXPENDITURE	346 Cal/hr RATE OF ENERGY EXPENDITURE
33.2 °C SKIN TEMPERATURE	POSTURE	0.1 g ACTIVITY

Current ECG

-1.5mV to 1.5mV | -3.5mV to 3.5mV | -10mV to 10mV

Local Time: 12:19:21 PM

ECG Time: 7:17:58 PM

onyx950 (in main/data/Device Types)

JointlyHealth

tree

- main
  - data
    - Clients
    - Admin Users
    - Disease Models
      - COPD
        - workflows
          - satsWorkflow
            - nominal
            - satsDepres
            - satsCritical
        - trackers
          - risingBP
        - statTrackers
          - satsTSA
          - satsWavelet
          - neuralTracker
      - CHF
    - RFI Designs
    - Sensor Data Types
    - Device Types
      - onyx950
      - uc321PBT
      - ua767pbt
      - foraW310b
    - IVR Designs

Details | Test Plan

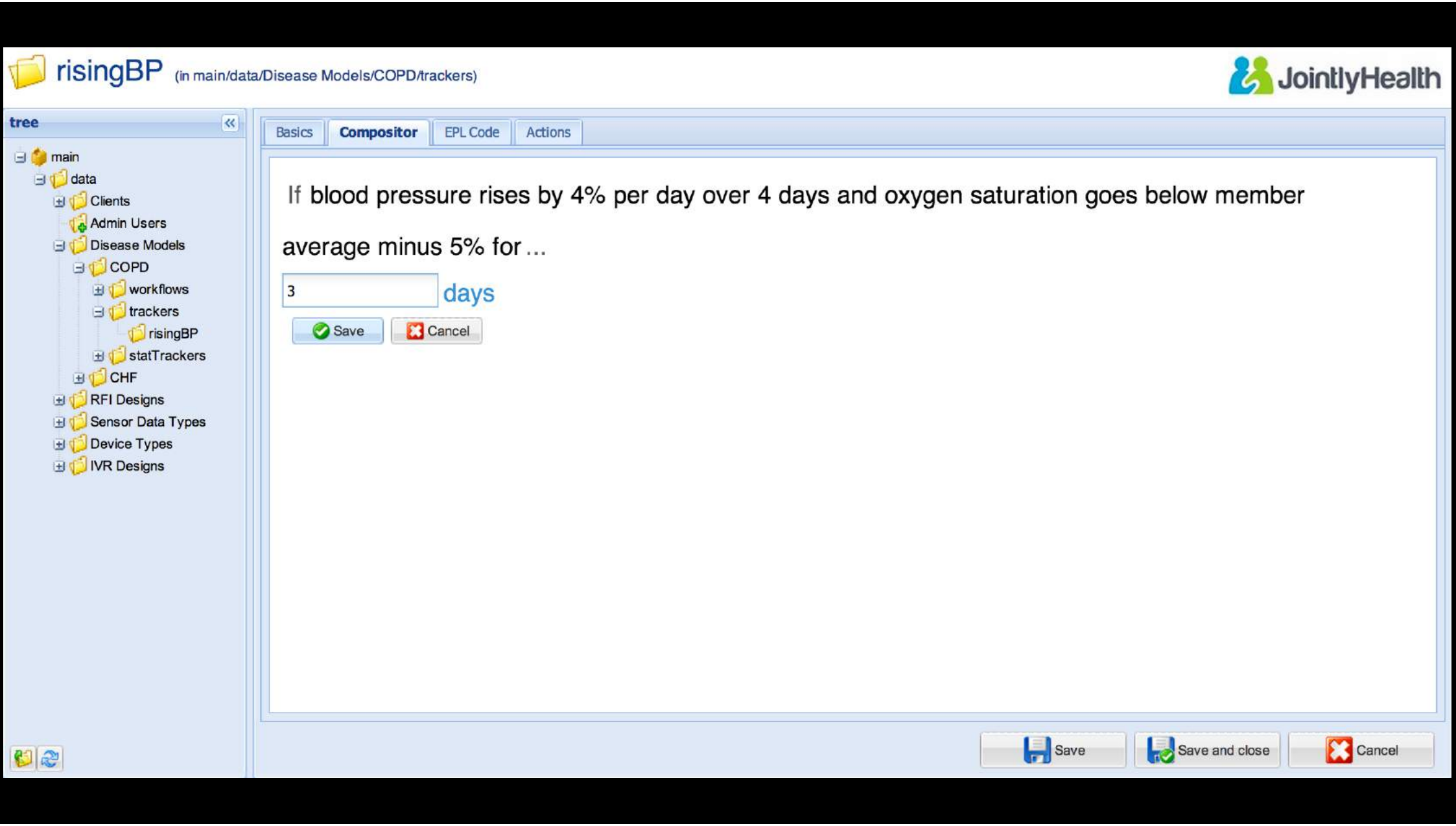
Device name: Onyx II 9560 Pulse Oximeter

Data type
sats
heartRate

Data point: Oxygen Saturation

Regular expression: SpO2=([0-9.]+)\s*%

Image: /site/images/devices/onyx9560.jpg


risingBP (in main/data/Disease Models/COPD/trackers)
JointlyHealth
tree
main
data
Clients
Admin Users
Disease Models
COPD
workflows
trackers
risingBP
statTrackers
CHF
RFI Designs
Sensor Data Types
Device Types
IVR Designs
Basics
Compositor
EPL Code
Actions
If blood pressure rises by 4% per day over 4 days and oxygen saturation goes below member average minus 5% for ...
3
days
Save
Cancel
Save
Save and close
Cancel

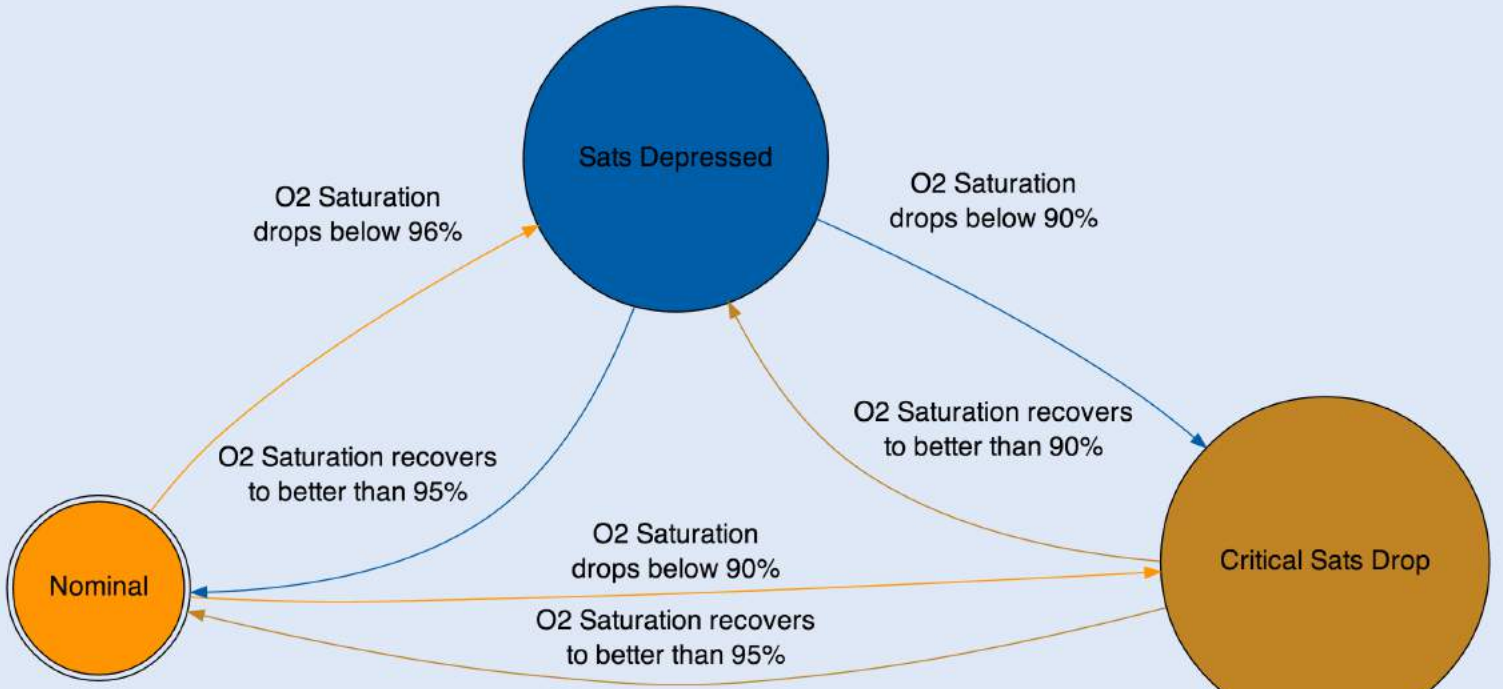
satsWorkflow (in main/data/Disease Models/COPD/workflows)

JointlyHealth

tree

- main
  - data
    - Clients
      - Admin Users
    - Disease Models
      - COPD
        - workflows
          - satsWorkflow
            - nominal
            - satsDepres
            - satsCritical
          - trackers
            - risingBP
          - statTrackers
            - satsTSA
            - satsWavelet
            - neuralTracker
        - CHF
    - RFI Designs
    - Sensor Data Types
    - Device Types
    - IVR Designs

Basics | Diagram | States



Refresh

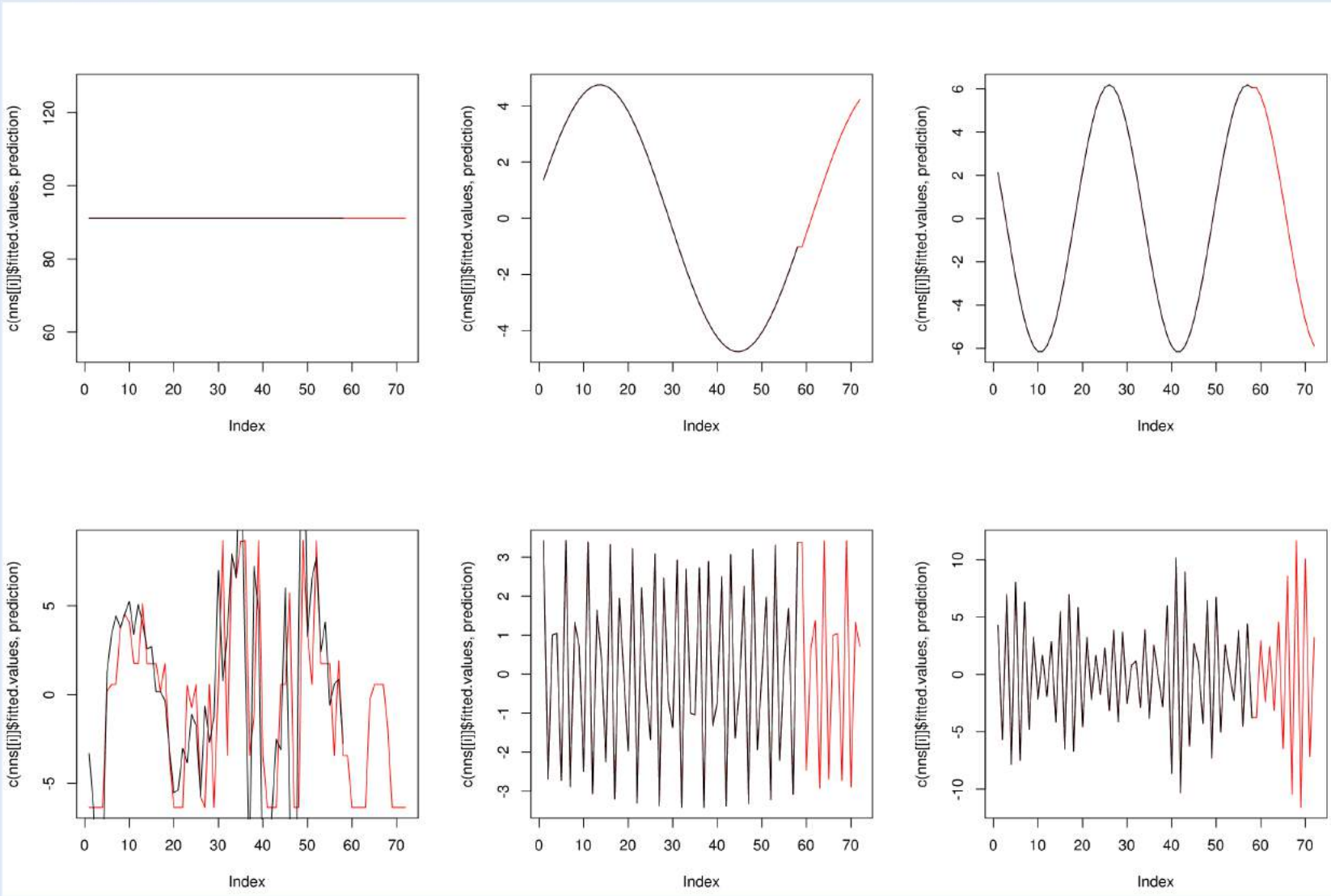
neuralTracker (in main/data/Disease Models/COPD/statTrackers)

JointlyHealth

tree

- main
  - data
    - Clients
    - Admin Users
    - Disease Models
      - COPD
        - workflows
          - satsWorkflow
            - nominal
            - satsDepres
            - satsCritical
        - trackers
          - risingBP
        - statTrackers
          - satsTSA
          - satsWavelet
          - neuralTracker
      - CHF
    - RFI Designs
    - Sensor Data Types
    - Device Types
      - onyx950
      - uc321PBT
      - ua767pbt
      - foraW310b
    - IVR Designs

Basics | R Code | **Test**



Refresh

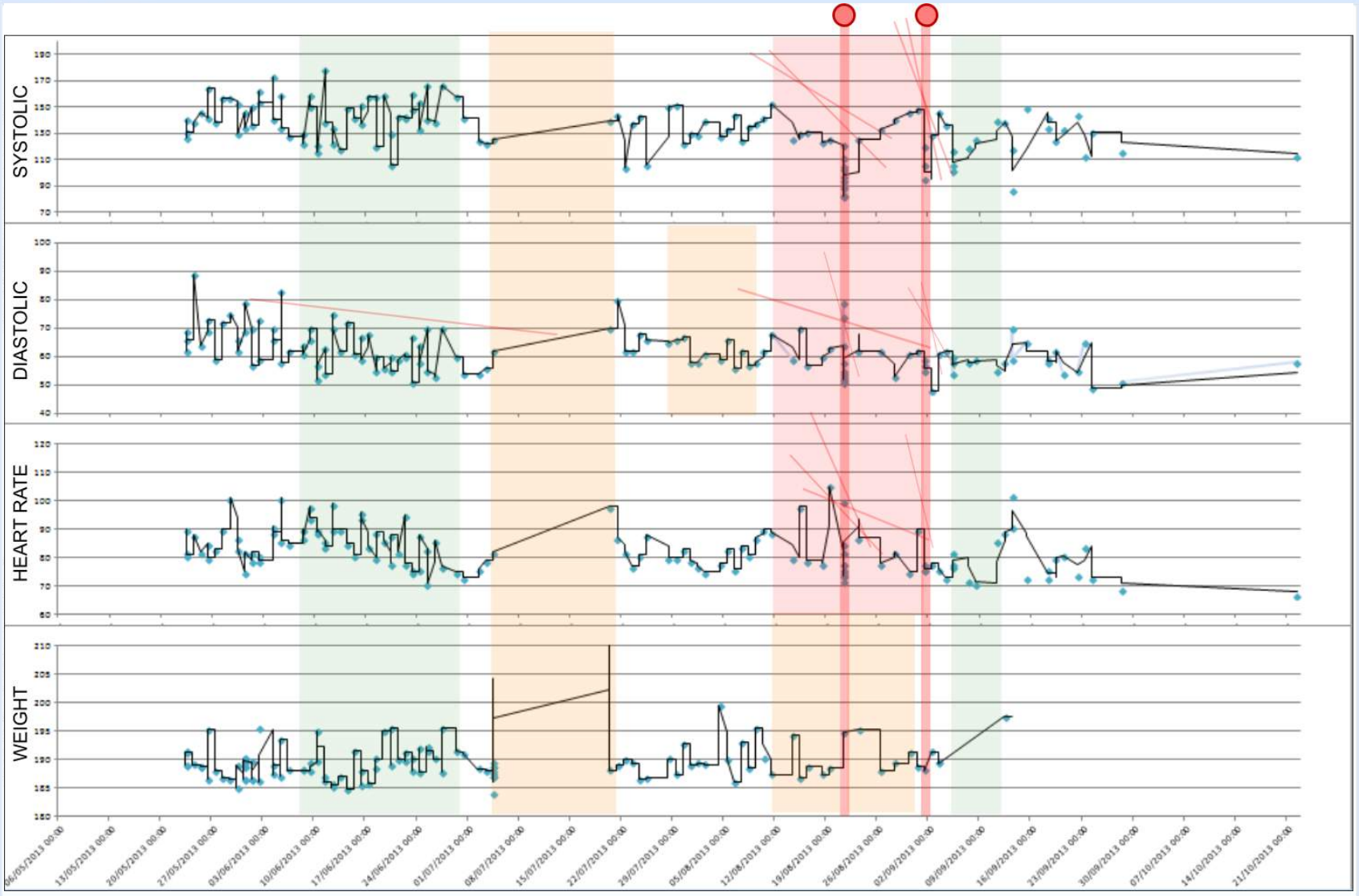
neuralTracker (in main/data/Disease Models/COPD/statTrackers)

JointlyHealth

tree

- main
  - data
    - Clients
      - Admin Users
    - Disease Models
      - COPD
        - workflows
          - satsWorkflow
            - nominal
            - satsDepres
            - satsCritical
        - trackers
          - risingBP
        - statTrackers
          - satsTSA
          - satsWavelet
          - neuralTracker
      - CHF
    - RFI Designs
    - Sensor Data Types
    - Device Types
      - onyx950
      - uc321PBT
      - ua767pbt
      - foraW310b
    - IVR Designs

Basics | R Code | Test



Refresh

JointlyHealth

AWARD-WINNING TECHNOLOGY

Sentrian has been recognized by industry leaders as a pioneer in remote medicine.

FROST & SULLIVAN

2015 TECHNOLOGY INNOVATION AWARD
Remote Patient Monitoring

American Telemedicine Association

2015 PRESIDENT'S AWARD
Innovations in Remote Healthcare

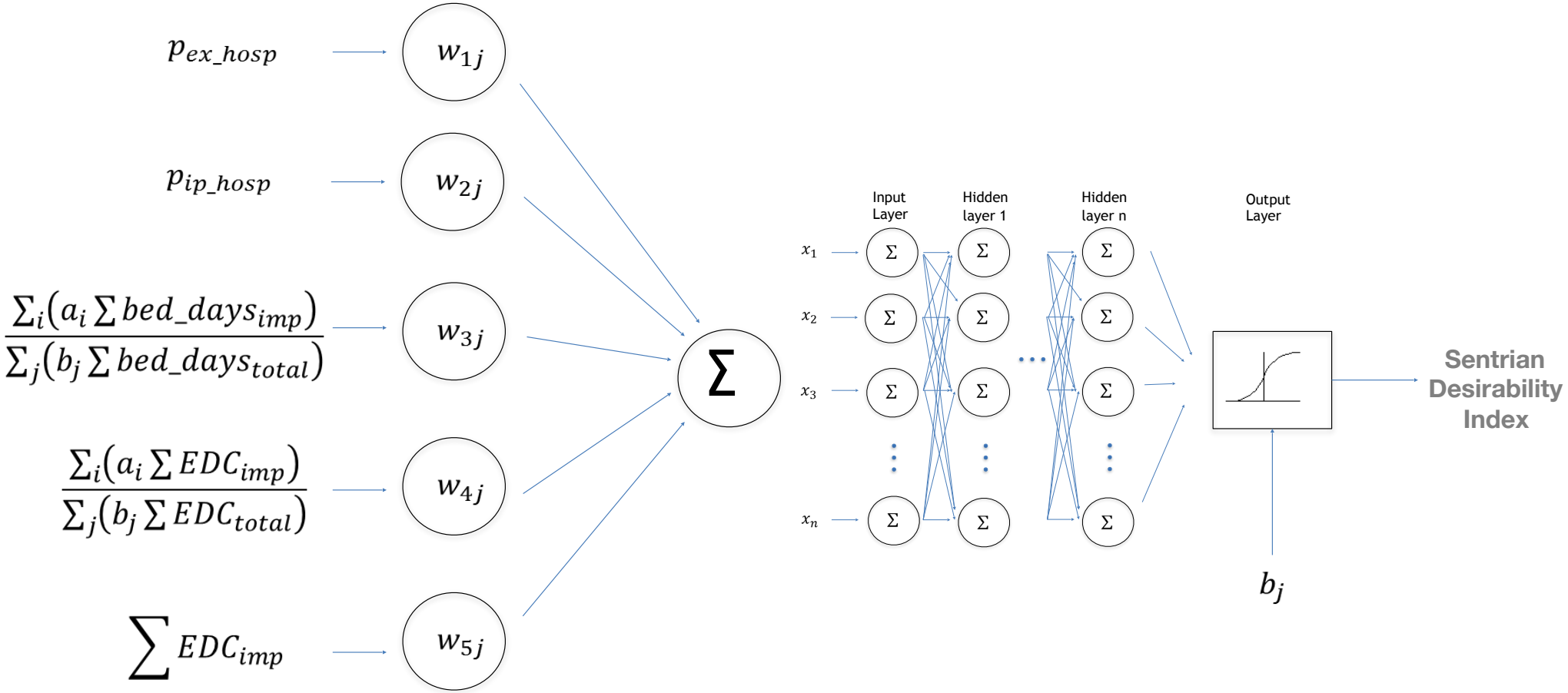
SENTRIAN
Remote Patient Intelligence

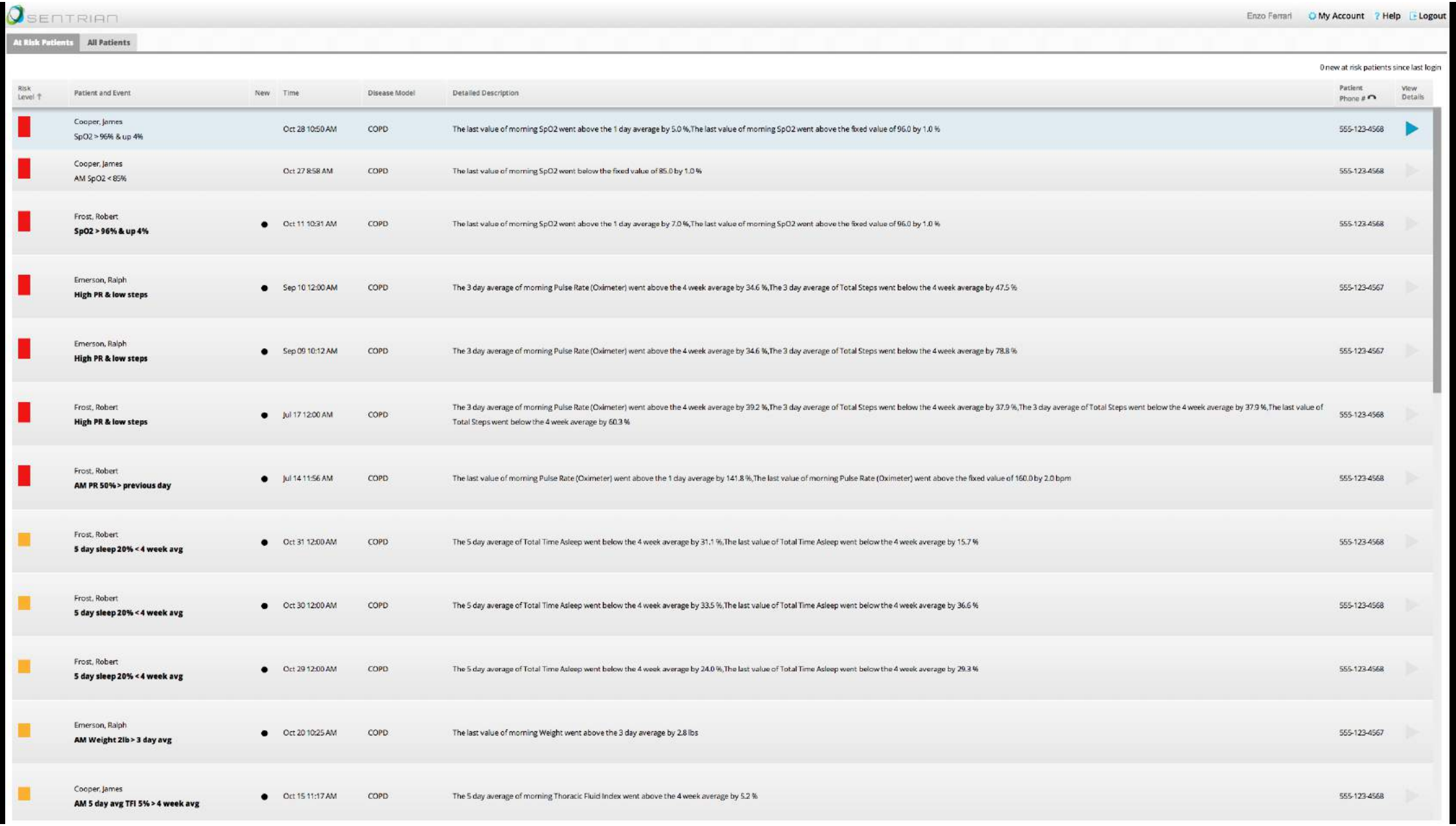
Technology Customers Patients Partners Resources About Us

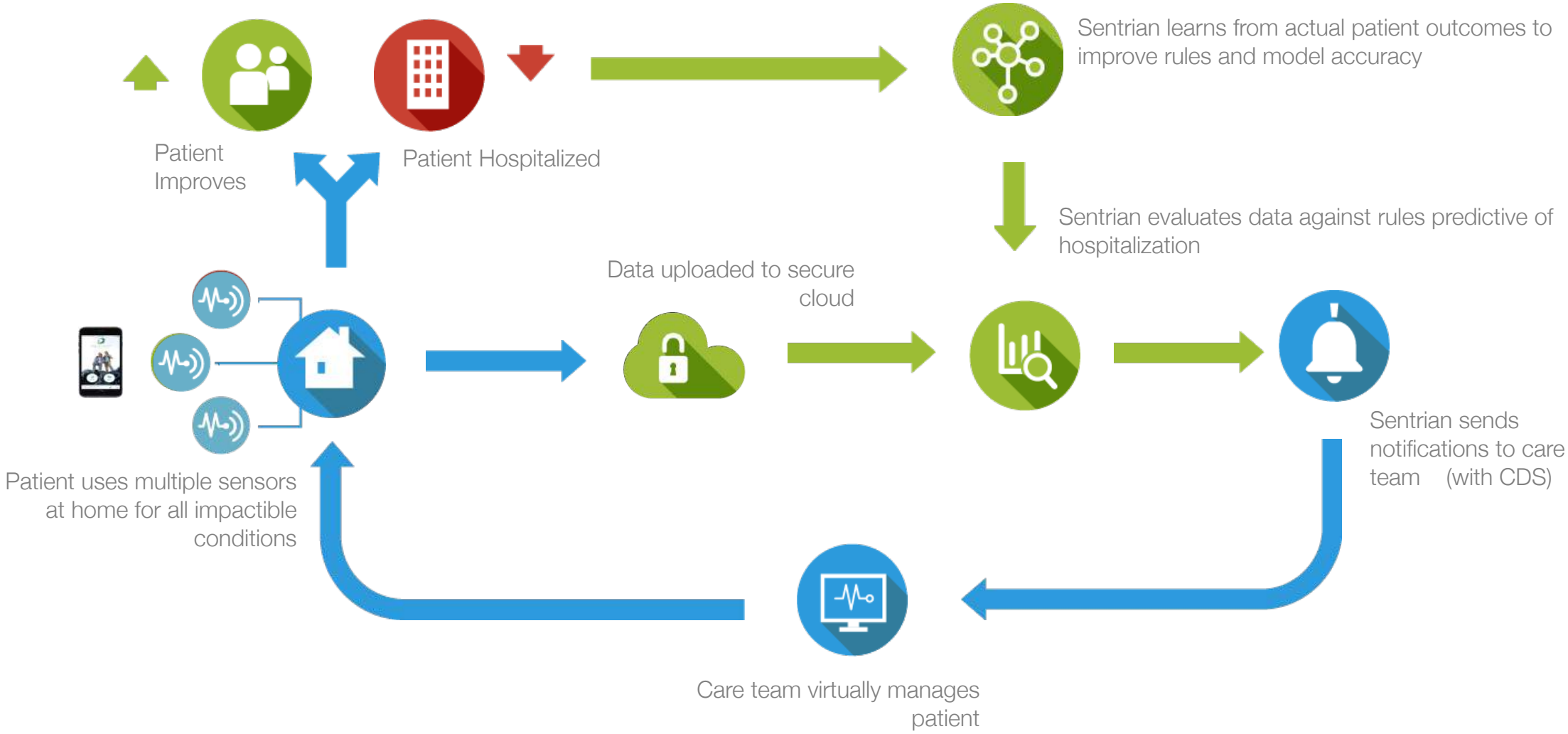
Welcome to Sentrian

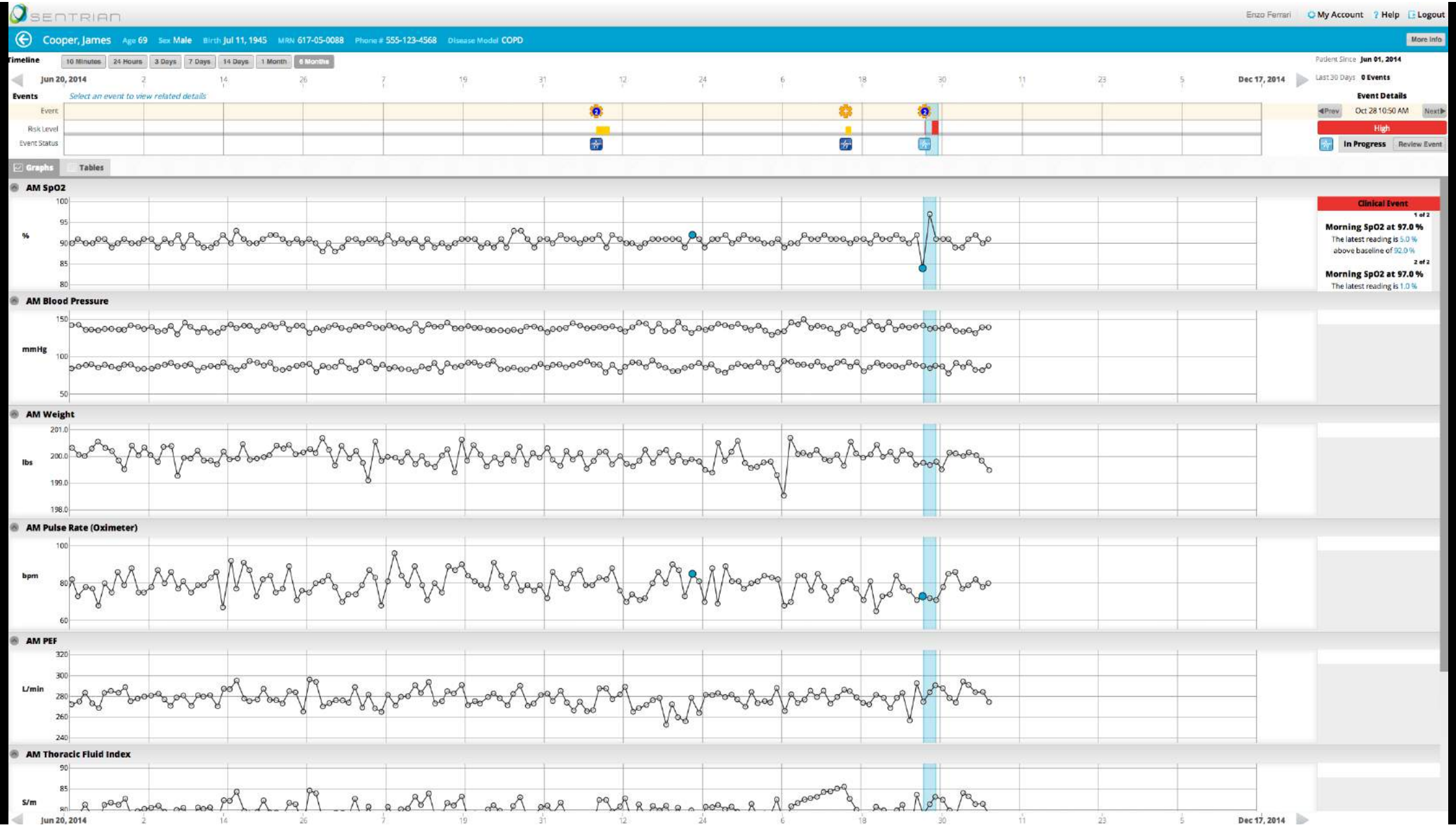
(FORMERLY JOINTLY HEALTH)

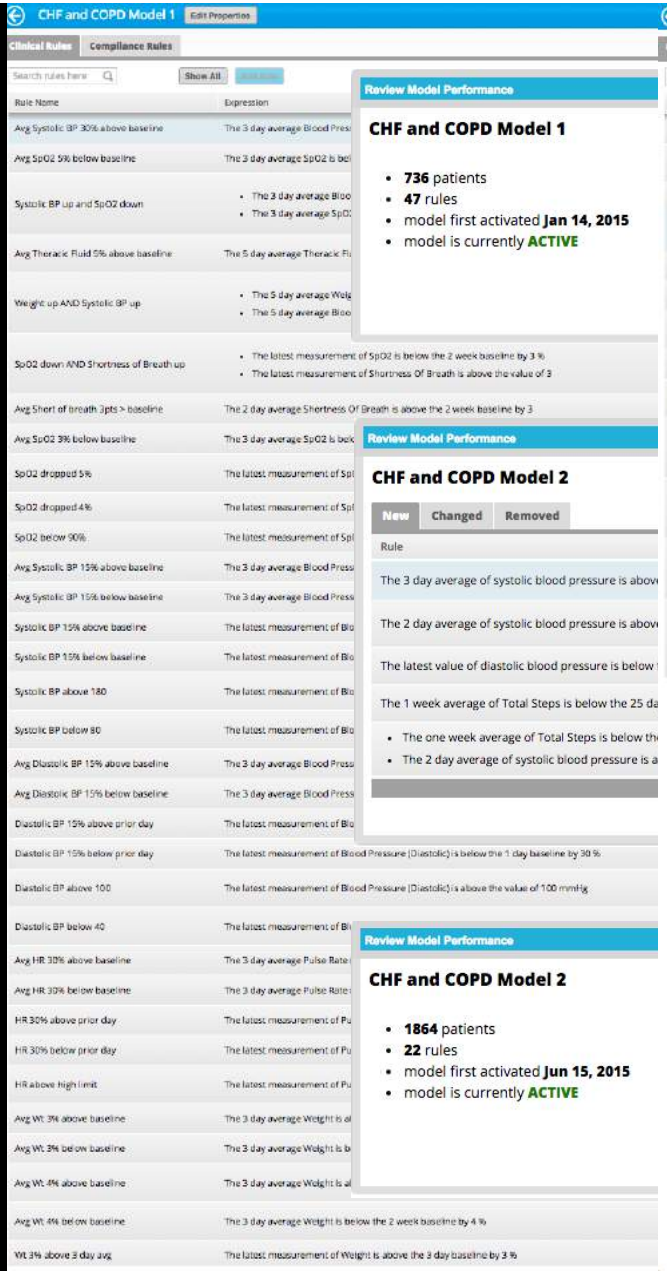
Sentrian, the first Remote Patient Intelligence Company, aspires to eliminate all preventable hospitalization by leveraging the revolution in biosensors and machine learning to remotely detect patient deterioration before problems become acute.

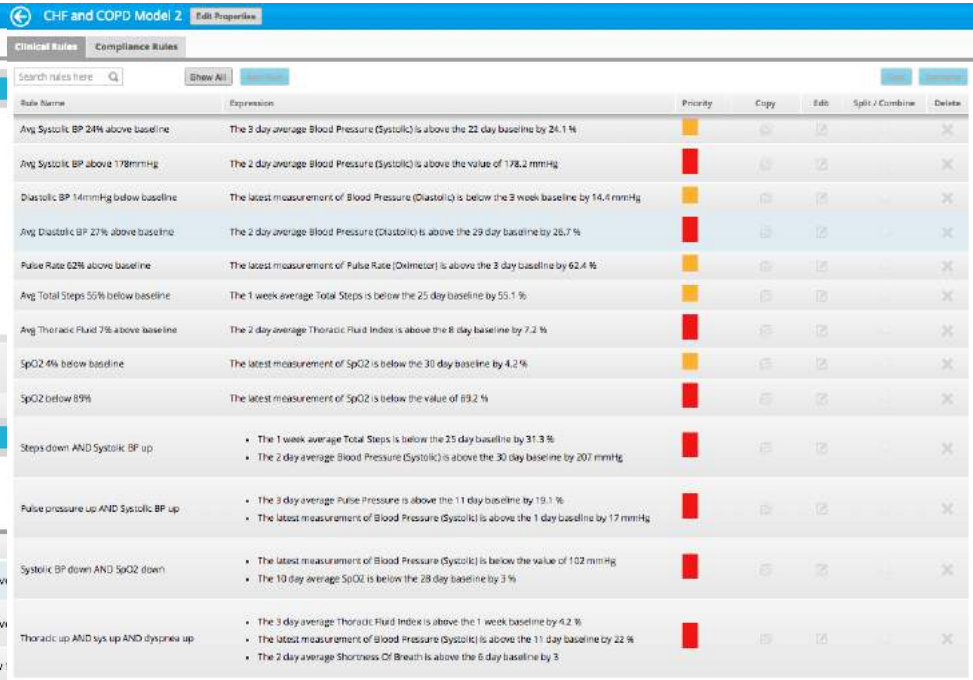

p_{ex_hosp}
p_{ip_hosp}
$\frac{\sum_i (a_i \sum bed\_days_{imp})}{\sum_j (b_j \sum bed\_days_{total})}$
$\frac{\sum_i (a_i \sum EDC_{imp})}{\sum_j (b_j \sum EDC_{total})}$
$\sum EDC_{imp}$
w_{1j}
w_{2j}
w_{3j}
w_{4j}
w_{5j}
$\sum$
Input Layer
Hidden layer 1
Hidden layer n
Output Layer
x_1
x_2
x_3
x_n
b_j
Sentrian Desirability Index

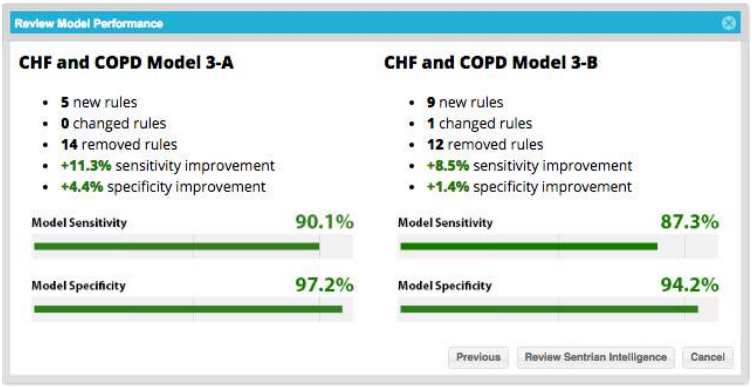

SENTRIAN
Enzo Ferrari
My Account
Help
Logout
At Risk Patients
All Patients
0 new at risk patients since last login
Risk Level
Patient and Event
New
Time
Disease Model
Detailed Description
Patient Phone #
View Details
Cooper, James
SpO2 > 96% & up 4%
Oct 28 10:50 AM
COPD
The last value of morning SpO2 went above the 1 day average by 5.0 %,The last value of morning SpO2 went above the fixed value of 96.0 by 1.0 %
555-123-4568
Cooper, James
AM SpO2 < 85%
Oct 27 8:58 AM
COPD
The last value of morning SpO2 went below the fixed value of 85.0 by 1.0 %
555-123-4568
Frost, Robert
SpO2 > 96% & up 4%
Oct 11 10:31 AM
COPD
The last value of morning SpO2 went above the 1 day average by 7.0 %,The last value of morning SpO2 went above the fixed value of 96.0 by 1.0 %
555-123-4568
Emerson, Ralph
High PR & low steps
Sep 10 12:00 AM
COPD
The 3 day average of morning Pulse Rate (Oximeter) went above the 4 week average by 34.6 %,The 3 day average of Total Steps went below the 4 week average by 47.5 %
555-123-4567
Emerson, Ralph
High PR & low steps
Sep 09 10:12 AM
COPD
The 3 day average of morning Pulse Rate (Oximeter) went above the 4 week average by 34.6 %,The 3 day average of Total Steps went below the 4 week average by 78.8 %
555-123-4567
Frost, Robert
High PR & low steps
Jul 17 12:00 AM
COPD
The 3 day average of morning Pulse Rate (Oximeter) went above the 4 week average by 39.2 %,The 3 day average of Total Steps went below the 4 week average by 37.9 %,The 3 day average of Total Steps went below the 4 week average by 37.9 %,The last value of Total Steps went below the 4 week average by 60.3 %
555-123-4568
Frost, Robert
AM PR 50% > previous day
Jul 14 11:56 AM
COPD
The last value of morning Pulse Rate (Oximeter) went above the 1 day average by 141.8 %,The last value of morning Pulse Rate (Oximeter) went above the fixed value of 160.0 by 2.0 bpm
555-123-4568
Frost, Robert
5 day sleep 20% < 4 week avg
Oct 31 12:00 AM
COPD
The 5 day average of Total Time Asleep went below the 4 week average by 31.1 %,The last value of Total Time Asleep went below the 4 week average by 15.7 %
555-123-4568
Frost, Robert
5 day sleep 20% < 4 week avg
Oct 30 12:00 AM
COPD
The 5 day average of Total Time Asleep went below the 4 week average by 33.5 %,The last value of Total Time Asleep went below the 4 week average by 36.6 %
555-123-4568
Frost, Robert
5 day sleep 20% < 4 week avg
Oct 29 12:00 AM
COPD
The 5 day average of Total Time Asleep went below the 4 week average by 24.0 %,The last value of Total Time Asleep went below the 4 week average by 29.3 %
555-123-4568
Emerson, Ralph
AM Weight 2lb > 3 day avg
Oct 20 10:25 AM
COPD
The last value of morning Weight went above the 3 day average by 2.8 lbs
555-123-4567
Cooper, James
AM 5 day avg TFI 5% > 4 week avg
Oct 15 11:17 AM
COPD
The 5 day average of morning Thoracic Fluid Index went above the 4 week average by 5.2 %
555-123-4568

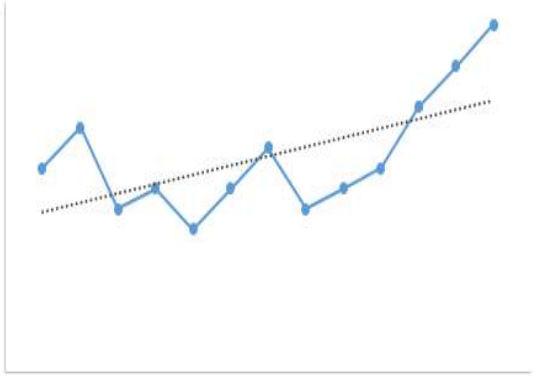

Patient Improves
Patient Hospitalized
Sentrian learns from actual patient outcomes to improve rules and model accuracy
Sentrian evaluates data against rules predictive of hospitalization
Data uploaded to secure cloud
Sentrian sends notifications to care team (with CDS)
Patient uses multiple sensors at home for all impactible conditions
Care team virtually manages patient


SENTRIAN
Enzo Ferrari
My Account
Help
Logout
Cooper, James
Age 69
Sex Male
Birth Jul 11, 1945
MRN 617-05-0088
Phone # 555-123-4568
Disease Model COPD
More Info
Timeline
10 Minutes
24 Hours
3 Days
7 Days
14 Days
1 Month
6 Months
Jun 20, 2014
Dec 17, 2014
Patient Since Jun 01, 2014
Last 30 Days 0 Events
Events
Select an event to view related details
Event
Risk Level
Event Status
Event Details
Prev
Oct 28 10:50 AM
Next
High
In Progress
Review Event
Graphs
Tables
AM SpO2
%
Clinical Event
1 of 2
Morning SpO2 at 97.0 %
The latest reading is 5.0 % above baseline of 92.0 %
2 of 2
Morning SpO2 at 97.0 %
The latest reading is 1.0 %
AM Blood Pressure
mmHg
AM Weight
lbs
AM Pulse Rate (Oximeter)
bpm
AM PEF
L/min
AM Thoracic Fluid Index
S/m
Jun 20, 2014
Dec 17, 2014

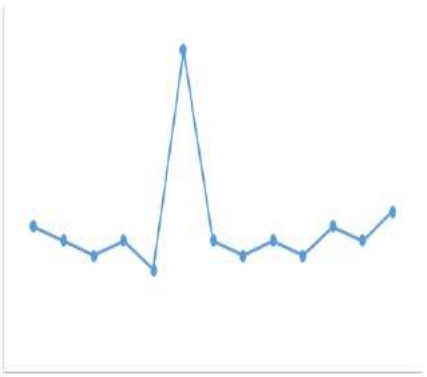

CHF and COPD Model 1
Edit Properties
Clinical Rules
Compliance Rules
Search rules here
Show All
Rule Name
Expression
Avg Systolic BP 30% above baseline
Avg SpO2 5% below baseline
Systolic BP up and SpO2 down
Avg Thoracic Fluid 5% above baseline
Weight up AND Systolic BP up
SpO2 down AND Shortness of Breath up
Avg Short of breath 3pts > baseline
Avg SpO2 3% below baseline
SpO2 dropped 5%
SpO2 dropped 4%
SpO2 below 90%
Avg Systolic BP 15% above baseline
Avg Systolic BP 15% below baseline
Systolic BP 15% above baseline
Systolic BP 15% below baseline
Systolic BP above 180
Systolic BP below 80
Avg Diastolic BP 15% above baseline
Avg Diastolic BP 15% below baseline
Diastolic BP 15% above prior day
Diastolic BP 15% below prior day
Diastolic BP above 100
Diastolic BP below 40
Avg HR 30% above baseline
Avg HR 30% below baseline
HR 30% above prior day
HR 30% below prior day
HR above high limit
Avg Wt 3% above baseline
Avg Wt 3% below baseline
Avg Wt 4% above baseline
Avg Wt 4% below baseline
Wt 3% above 3 day avg
The 3 day average Blood Pressure (Systolic) is above the 22 day baseline by 24.1 %
The 3 day average SpO2 is below the 2 week baseline by 3 %
The 2 day average Shortness Of Breath is above the 2 week baseline by 3
The 3 day average SpO2 is below the 2 week baseline by 4 %
The latest measurement of Blood Pressure (Diastolic) is below the 1 day baseline by 30 %
The latest measurement of Blood Pressure (Diastolic) is above the value of 100 mmHg
The 3 day average Weight is below the 2 week baseline by 4 %
The latest measurement of Weight is above the 3 day baseline by 3 %
Review Model Performance
CHF and COPD Model 1
736 patients
47 rules
model first activated Jan 14, 2015
model is currently ACTIVE
Review Model Performance
CHF and COPD Model 2
New
Changed
Removed
Rule
The 3 day average of systolic blood pressure is abov
The 2 day average of systolic blood pressure is abov
The latest value of diastolic blood pressure is below
The 1 week average of Total Steps is below the 25 da
The one week average of Total Steps is below th
The 2 day average of systolic blood pressure is a
Review Model Performance
CHF and COPD Model 2
1864 patients
22 rules
model first activated Jun 15, 2015
model is currently ACTIVE


CHF and COPD Model 2
Edit Properties
Clinical Rules
Compliance Rules
Search rules here
Show All
Rule Name
Expression
Priority
Copy
Edit
Split / Combine
Delete
Avg Systolic BP 24% above baseline
The 3 day average Blood Pressure (Systolic) is above the 22 day baseline by 24.1 %
Avg Systolic BP above 178mmHg
The 2 day average Blood Pressure (Systolic) is above the value of 178.2 mmHg
Diastolic BP 14mmHg below baseline
The latest measurement of Blood Pressure (Diastolic) is below the 3 week baseline by 14.4 mmHg
Avg Diastolic BP 27% above baseline
The 2 day average Blood Pressure (Diastolic) is above the 29 day baseline by 26.7 %
Pulse Rate 62% above baseline
The latest measurement of Pulse Rate [Oximetor] is above the 3 day baseline by 62.4 %
Avg Total Steps 55% below baseline
The 1 week average Total Steps is below the 25 day baseline by 55.1 %
Avg Thoracic Fluid 7% above baseline
The 2 day average Thoracic Fluid Index is above the 8 day baseline by 7.2 %
SpO2 4% below baseline
The latest measurement of SpO2 is below the 30 day baseline by 4.2 %
SpO2 below 89%
The latest measurement of SpO2 is below the value of 89.2 %
Steps down AND Systolic BP up
The 1 week average Total Steps is below the 25 day baseline by 31.3 %
The 2 day average Blood Pressure (Systolic) is above the 30 day baseline by 207 mmHg
Pulse pressure up AND Systolic BP up
The 3 day average Pulse Pressure is above the 11 day baseline by 19.1 %
The latest measurement of Blood Pressure (Systolic) is above the 1 day baseline by 17 mmHg
Systolic BP down AND SpO2 down
The latest measurement of Blood Pressure (Systolic) is below the value of 102 mmHg
The 10 day average SpO2 is below the 28 day baseline by 3 %
Thoracic up AND sys up AND dyspnea up
The 3 day average Thoracic Fluid Index is above the 1 week baseline by 4.2 %
The latest measurement of Blood Pressure (Systolic) is above the 11 day baseline by 22 %
The 2 day average Shortness Of Breath is above the 6 day baseline by 3

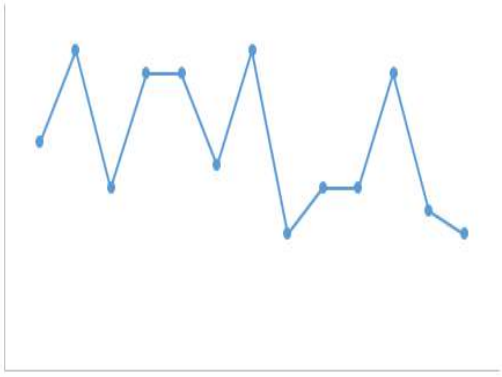

Review Model Performance
CHF and COPD Model 3-A
5 new rules
0 changed rules
14 removed rules
+11.3% sensitivity improvement
+4.4% specificity improvement
Model Sensitivity
90.1%
Model Specificity
97.2%
CHF and COPD Model 3-B
9 new rules
1 changed rules
12 removed rules
+8.5% sensitivity improvement
+1.4% specificity improvement
Model Sensitivity
87.3%
Model Specificity
94.2%
Previous
Review Sentrian Intelligence
Cancel



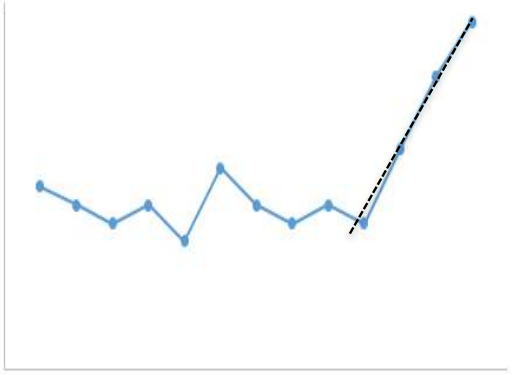
Long term trend



Spike



High variability

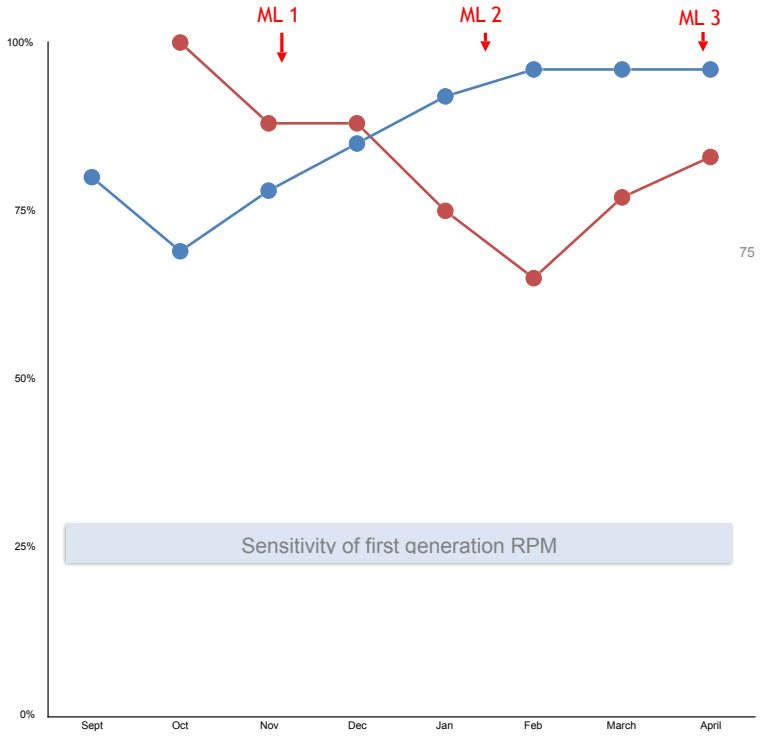


Short term trend

Shift

Low variability

- **Setting**: Medicare advantage health plan with 80,000 members
- **Study Objective:** Determine if Sentrian can remotely detect decompensation predictive of hospitalization earlier and with higher accuracy
- **Patients:** 500 patients with complex chronic disease
- **Duration**: 6,000 patient months
- **No. Biometric Device Measurements:** >200,000
- **Results:** Detected 83% of decompensation with 3% false positives



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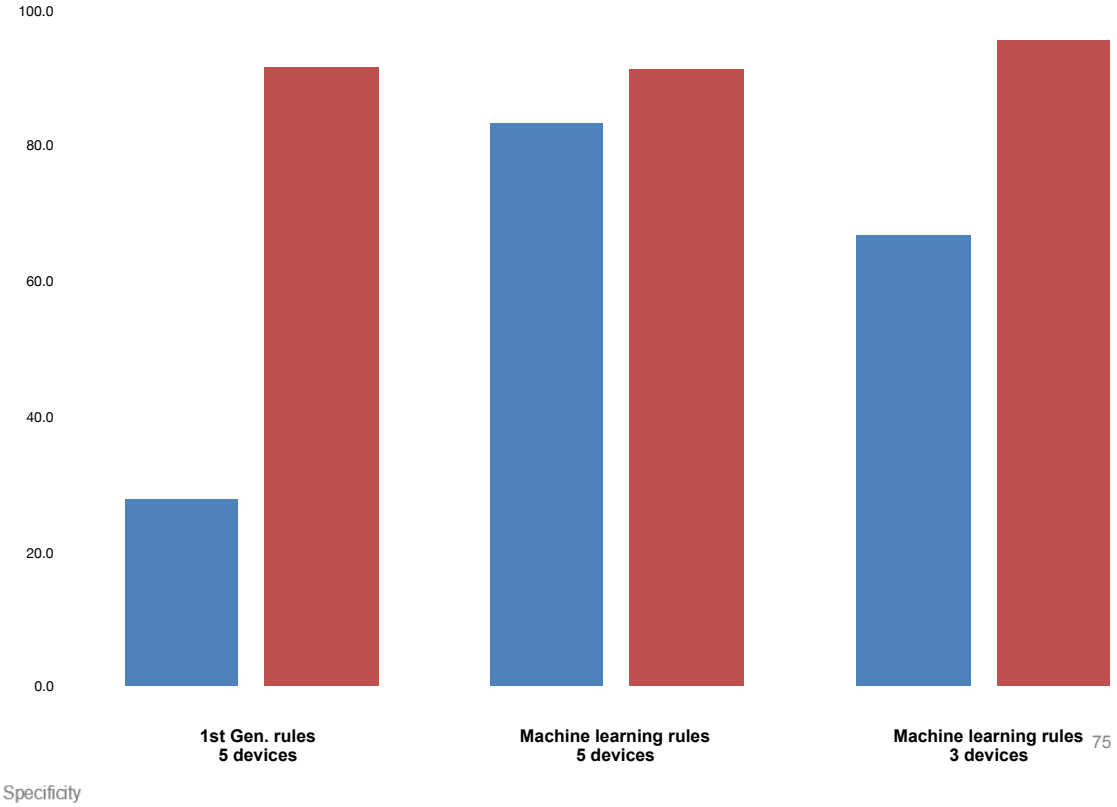
Study Objectives:

- Measure the accuracy of first generation RPM rules Vs Sentrian RPI on multiple streams of biometric data
- Determine the relevant predictability of each device/stream
- Measure the predictability of a new device called CoVA

Results:

- Results: Sentrian machine-learning rules detected health deterioration predictive of hospitalization with 3X the accuracy of 1st generation RPM rules



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Original Paper

Implementation of a Home Monitoring System for Heart Failure Patients: A Feasibility Study

Martin Steven Kohn[1*], MS, MD, FACEP, FACPE; Jeffrey Haggard[1*], BA; Jack Kreindler[1*], MBBS; Kade Birkeland[2*], PharmD; Ilan Kedan[2*], MD, FACC; Raymond Zimmer[2*], MD, FACC; Raj Khandwalla[2*], MD, FACC

[1]Sentrian, San Juan Capistrano, CA, United States
[2]Cedars-Sinai Heart Institute, Beverly Hills, CA, United States
[*]all authors contributed equally

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United States
Phone: 1 949 373 9640
Fax: 1 949 373 4501
Email: marty@sentrian.com

Abstract

Background: Improving the management of patients with complex chronic disease is a substantial undertaking with the simultaneous goals of improving patient outcomes and controlling costs. Reducing avoidable hospitalization for such patients is a step toward both objectives. Some of the deterioration experienced in chronic disease patients occurs outside the view of their clinicians, and before the patient becomes overtly symptomatic. Home monitoring has been used for more than 20 years to detect deterioration earlier so that the patients could be treated before they became ill enough to require hospitalization. Patient participation is an important requirement for successful home monitoring. There has been some concern that patients would be unwilling or unable to engage in a program that collected multiple measurements. The Cedars-Sinai Cardiology Center provides a high-touch, intense management program for patients with congestive heart failure (CHF). A group of their patients were chosen to join a complex, multidevice home monitoring system to see whether such patients would find value in the additional effort.

Objective: The objective of our study was to determine whether patients already actively engaged in a high-touch intensive management program for CHF would take on the additional burden of a complex home monitoring effort.

Methods: A total of 20 patients from the Cedars-Sinai group were enrolled in a monitoring program utilizing 5 different devices. Anonymous surveys were collected from the patients to assess their satisfaction with the program.

Results: In total, 90% (18/20) completed the program, and 61% (11/20) submitted the survey. Among the 18 patients, overall compliance with the requested measurements was 70%. It was found that 73% (8/11) felt better about their health as a result of the program, whereas another 73% (8/11) believed that the care team now had a better picture of their health.

Conclusions: Substantial patient compliance and satisfaction can be achieved in a sophisticated home monitoring program.

(JMIR Res Protoc 2017;6(3):e46) doi:10.2196/resprot.5744

KEYWORDS

heart failure; home monitoring; predictive analytics; patient engagement

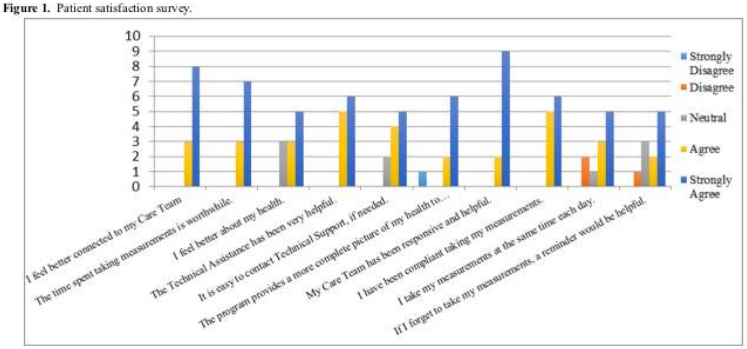
Introduction

The management of chronic disease is a substantial burden, both for the patients and the provider organizations supporting them. In total, 71% of health care expenditures in the United States result from patients with multiple chronic diseases such as congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), and diabetes [1]. A substantial fraction of the cost is generated by repeated hospitalization and emergency department (ED) visits [1]. The incidence of chronic disease continues to grow, in part because of an aging population and improved management of chronic diseases. Better acute coronary

XSL•FO
RenderX

A chi-square contingency table analysis was performed on the response data in Table 2, using Microsoft Excel 2016, version 16.0.6965.2115. It did not quite reach statistical signification, with a *P* value of .12, in part due to lack of independence among the responses. A positive response to one question was likely associated with a positive response to another question.

Figure 1. Patient satisfaction survey.



Discussion

Principal Findings

Several issues arose during the early stages of the project. First, despite what were thought to be careful explanations there was a misunderstanding of wireless and Internet connections among the patients. Several patients claimed they had wireless access when they did not and thus had to be provided with an Internet hot spot (Mifi) to participate. Many of the patients had difficulty with the finger dexterity necessary to close the clasp on the Fitbit. An alcohol-based hand sanitizer was used as a short-acting lubricant to facilitate clasp closure.

A few of the patients relied on a wheeled walker for ambulation. Weight measurements for those patients were unreliable as they were affected by the variations in level of support that each patient needed from the walker. Although we intentionally limited the number of devices requiring active participation by the patients, a few patients initially felt that the measurement process was too complex. The problem seemed to diminish as the patients became more accustomed to the process. Some of the patients had substantially healthier spouses or significant others that provided support and helped the patients with the measurement process. On one hand, there was an advantage to the help provided. However, sometimes the spouse answered questions for the patients or dominated the discussion so that it was difficult to ascertain the patient's level of understanding. It became clear that special care was necessary to ensure that both the patient and the care-giver had the same understanding.

Some of the participants had already been using home monitoring devices such as blood pressure cuffs and weight scales. Some patients were concerned by the different readings from the new devices provided for the study. The team explained that such differences were minor and expected and were not alarming and that data trends were more important. Although each patient was given personal instruction in the use of devices, most benefited from phone support when setting up the monitors. There were several cases of idiosyncratic behaviors, with some patients calling technical support or not wanting to use a particular device, requiring additional support.

Many previous reports on compliance in home monitoring involved the use of one or two devices. We added a regimen with multiple devices to an existing intense, management program that already placed heavy demands upon the patients. We have shown that home monitoring produces additional value in such a comprehensive environment. Compliance in our group was at least comparable with compliance reported in other studies, confirming that a complex home monitoring regimen is feasible [10,11,14,15].

There was a high level of satisfaction among the patients, with strong feelings that the program improved their comfort with their health and left them more connected with their health care team. The sharp demarcation between patients that were either poorly compliant with the measurement schedule or dropped out of the program emphasized the need for a personalized approach to home monitoring. Despite a robust implementation and training program, some patients stopped taking the measurements. Distinguishing between patients who will participate if given extra support from those who will not engage is an important part of implementing a clinically and economically valuable program.

Limitations

This was a small study with a group of patients chosen who already had a close relationship with their care providers. The patients were chosen by the staff cardiologists to include patients that had been heavy utilizers of acute health services. However, we cannot exclude bias in that selection process, which might affect the results. It may not be generalizable to a broader group

XSL•FO
RenderX

HEART FAILURE

NEURO-
DEGENERATION

COMPLEX DIABETES

COPD & ASTHMA

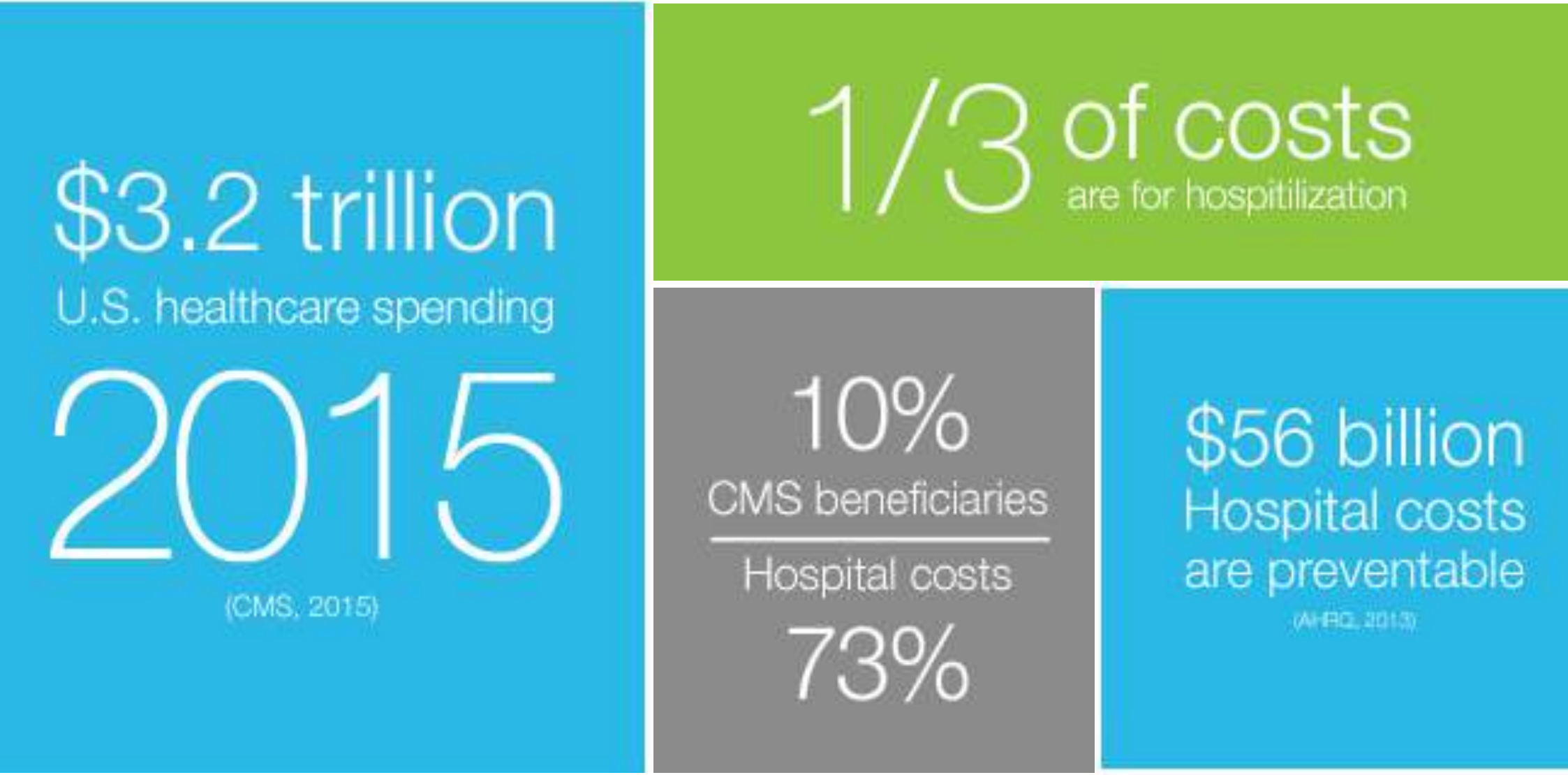
CANCER

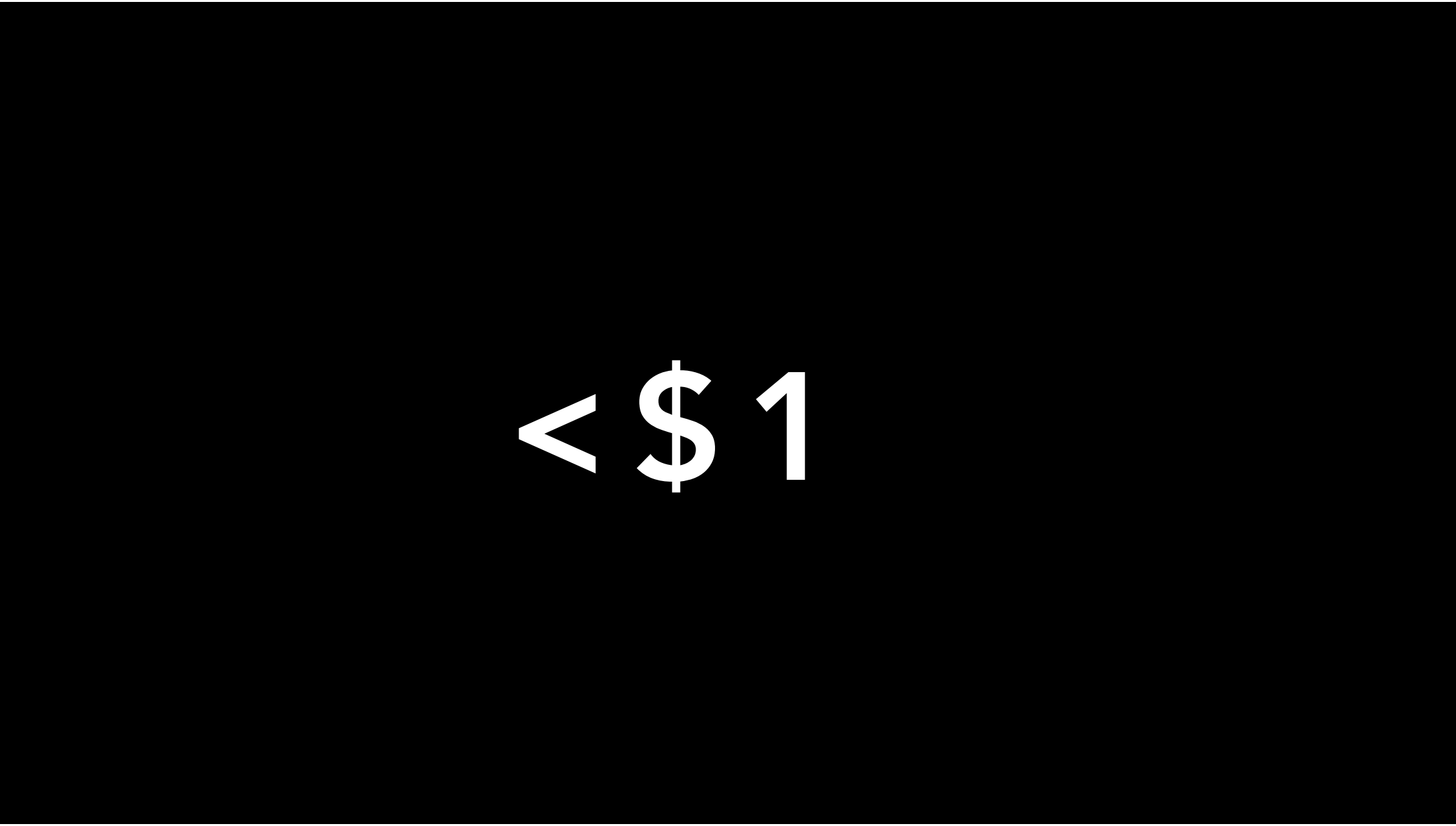
OTHERS?

MSK

MENTAL HEALTH

$1,000,000,000,000


$3.2 trillion
U.S. healthcare spending
2015
(CMS, 2015)
1/3 of costs
are for hospitilization
10%
CMS beneficiaries
Hospital costs
73%
$56 billion
Hospital costs
are preventable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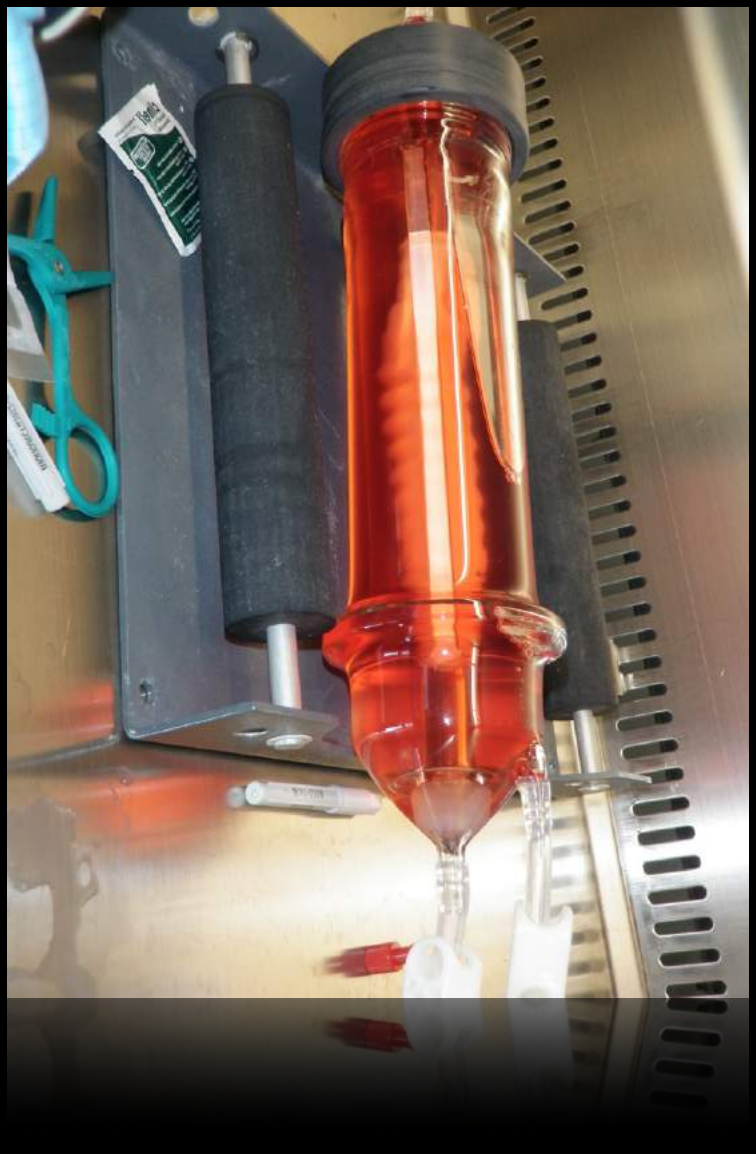
British Isles
SCOTLAND
NORTH SEA
Glasgow
Edinburgh
UNITED
ULSTER
Belfast
DUBLIN
Liverpool
KINGDOM
IRELAND
WALES
Cardiff
Bristol
LONDON
Cork
CELTIC
Southampton
Plymouth
English Channel
Channel-Islands
Le Havre
Seine
SEA
Frisian Is.
NETHERLANDS
Rotterdam
BEL.
Lille
BRUSSELS
PARIS
THINKSTOCK

PROF MARTIN ELLIOTT
MEDICAL DIRECTOR, GOSH, LONDON



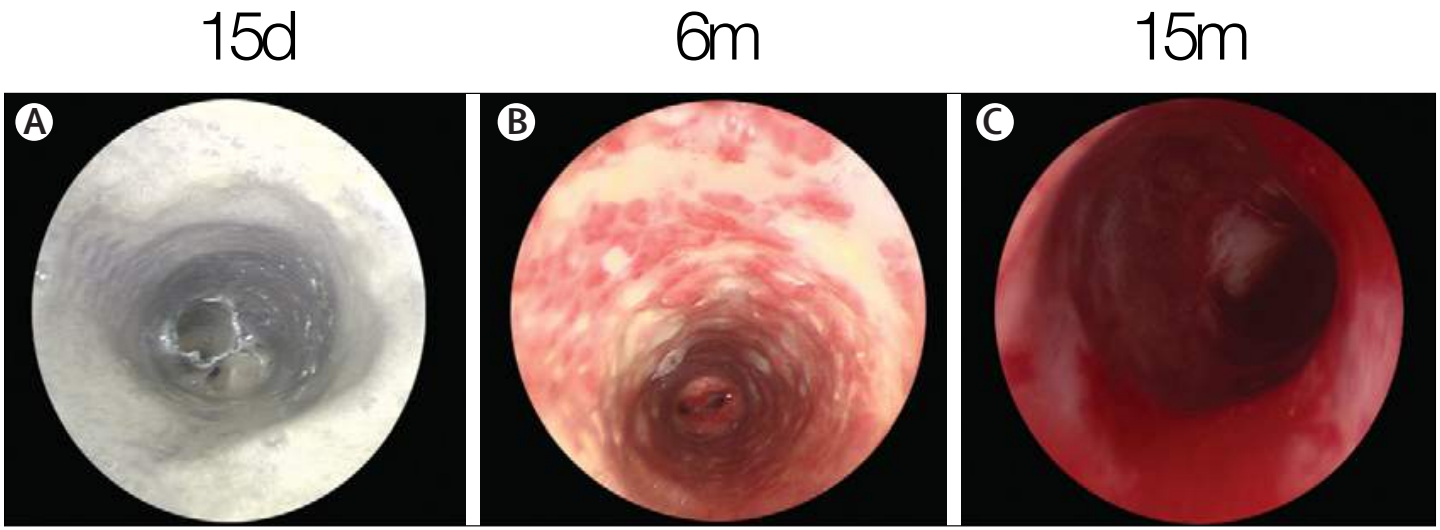


Figure 2: **Bronchoscopic appearances**
(A) Microlaryngobronchoscopy 15 days after the transplant showing a dense web covering the stent and partially occluding the lumen (A), which was cleared by regular bronchoscopies and DNAase. (B) Image at 6 months, showing that reabsorption of the stent (white areas) caused so-called cobblestones of granulation tissue with little normal epithelium. (C) At 15 months after surgery, the graft seemed to be patent, with healthy mucosa.

Elliott, MJ et al
www.thelancet.com Published online July 26, 2012 http://dx.doi.org/10.1016/S0140-6736(12)60737-51

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BROOKINGS
9105

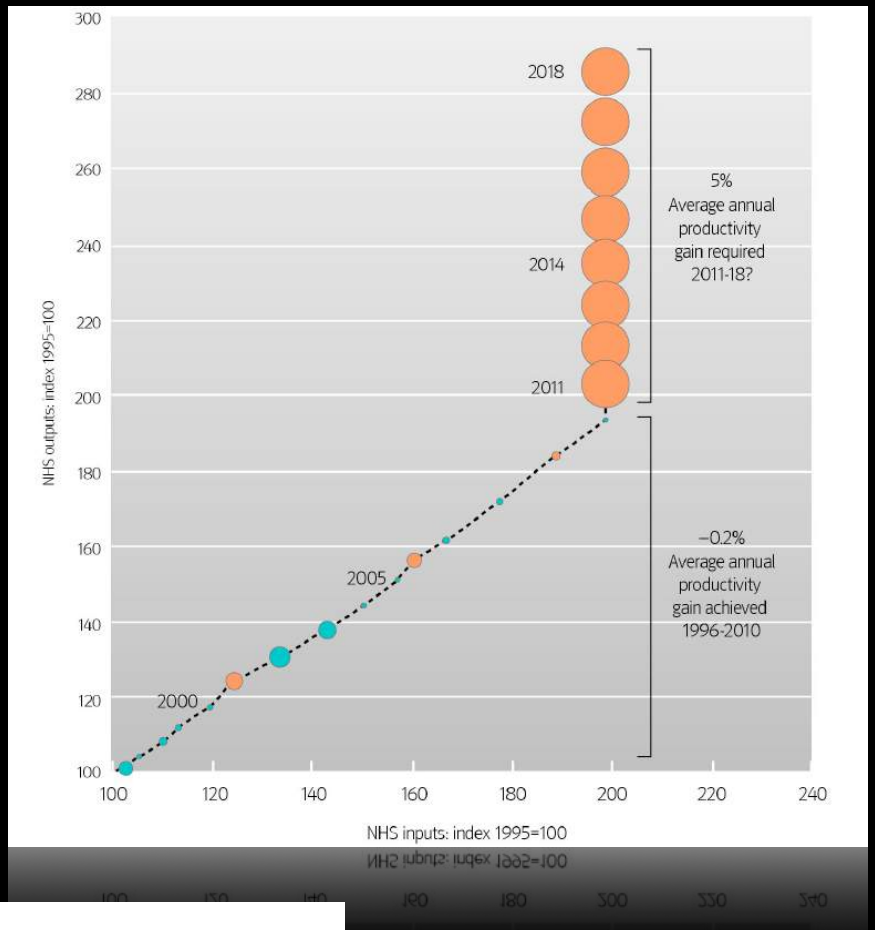
HOW AFFORDABLE IS HEALTHCARE?

Richard Douglas, Department of Health director general of policy, strategy, and finance, has reportedly said that the drive to find further efficiency savings in the NHS will continue after 2015,[1] with the total savings rising from £20bn (€24.6bn; $31bn) to a possible £50bn by 2019-20. His comments are a startling admission of the long term impact on public services of the global financial crisis and ensuing recession.

BMJ

Appleby, J
A Productivity Challenge too far?

BMJ 2012;344:e2416 doi: 10.1136/bmj.e2416 (Published 19 June 2012)



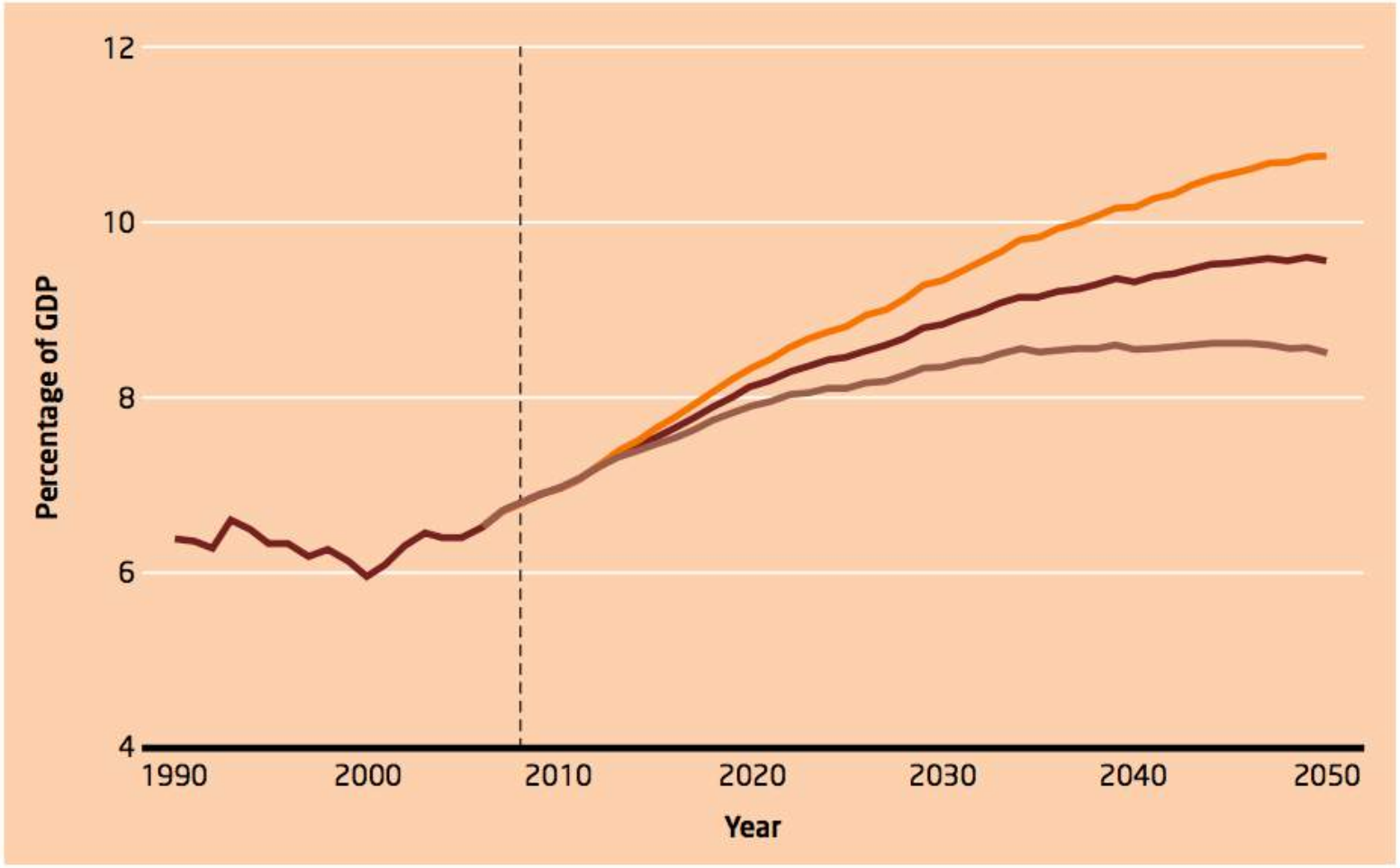
BMJ

Appleby, J
A Productivity Challenge too far?

BMJ 2012;344:e2416 doi: 10.1136/bmj.e2416 (Published 19 June 2012)

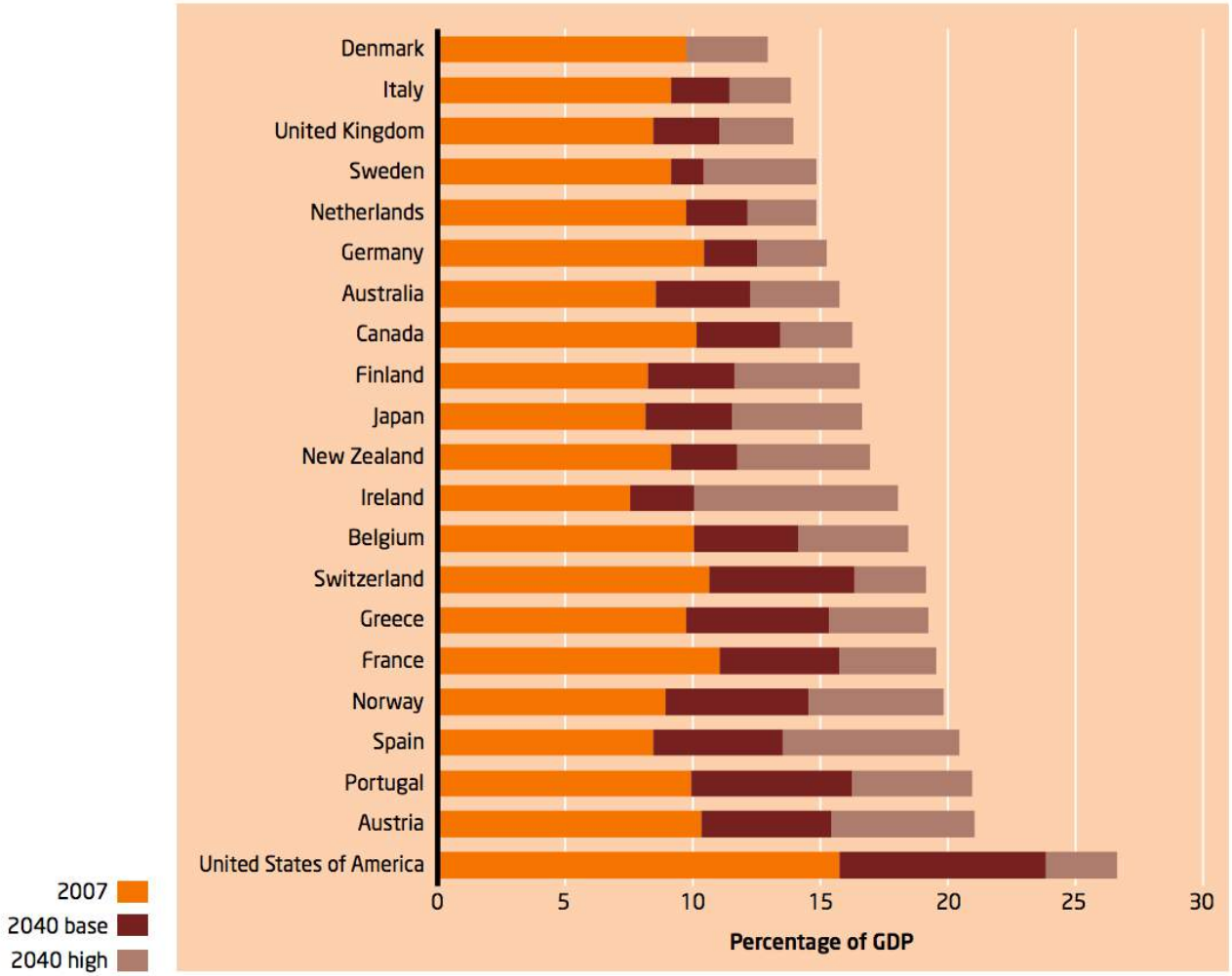
'UNDOABLE'

Figure 12 Three scenarios for future public health care spending in Denmark



Source: Danish Economic Council (2009)

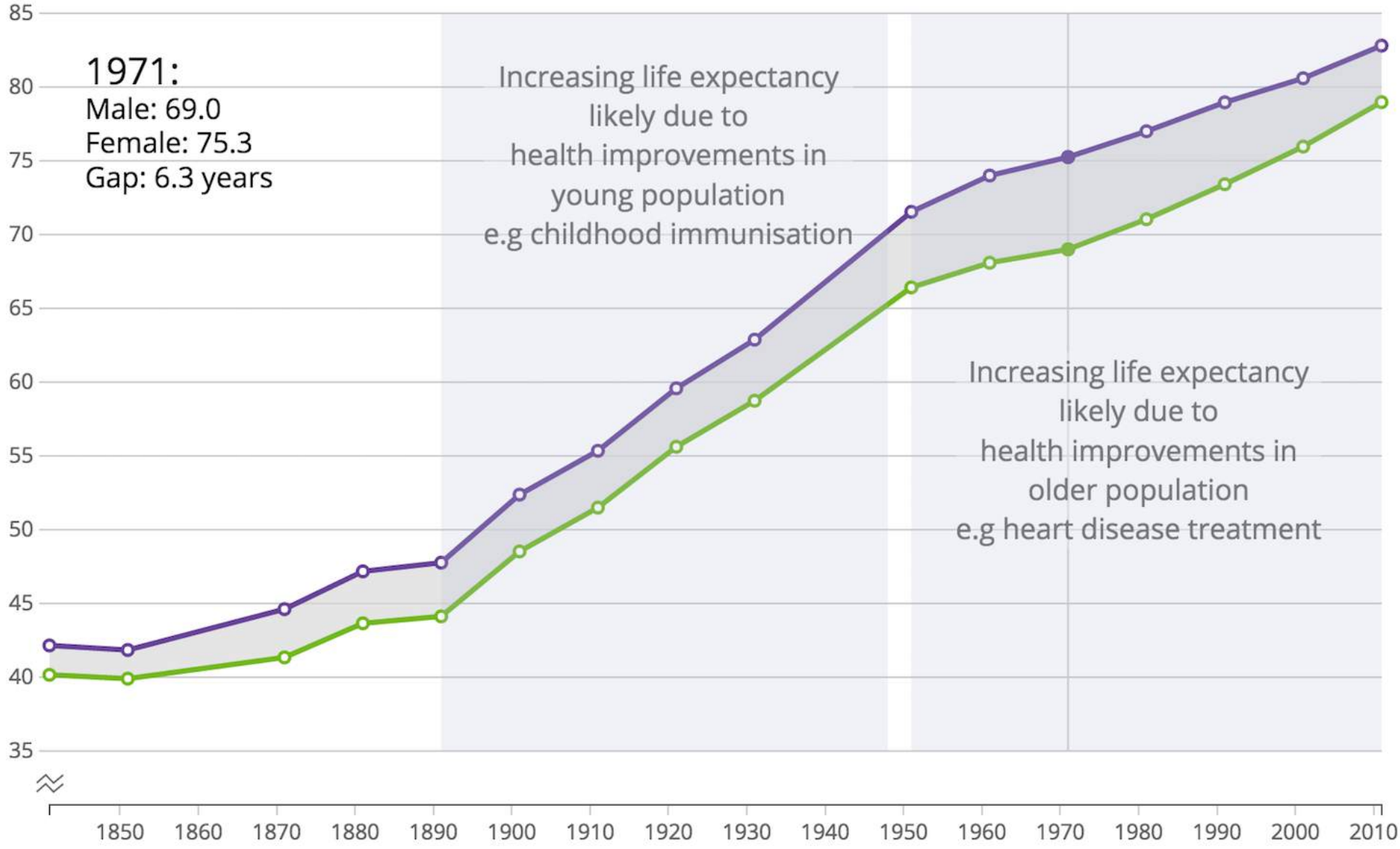
Figure 8 Projected potential growth in health care spending by 2040



Source: Kibasi *et al* (2012)

WHAT CAUSES ALL THIS?

OUR BIOLOGY


1971:
Male: 69.0
Female: 75.3
Gap: 6.3 years
Increasing life expectancy likely due to health improvements in young population e.g childhood immunisation
Increasing life expectancy likely due to health improvements in older population e.g heart disease treatment
85
80
75
70
65
60
55
50
45
40
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1850
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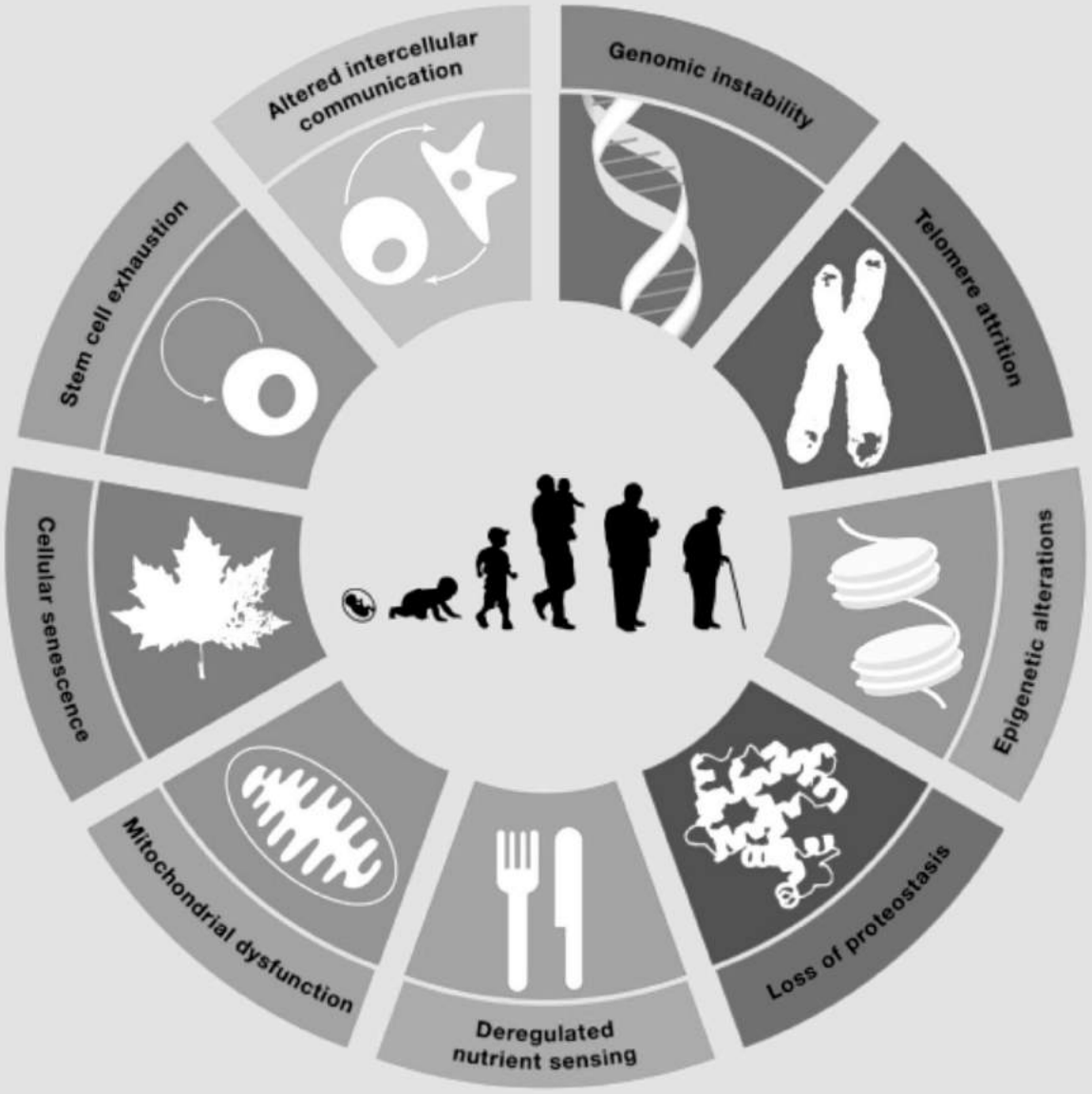
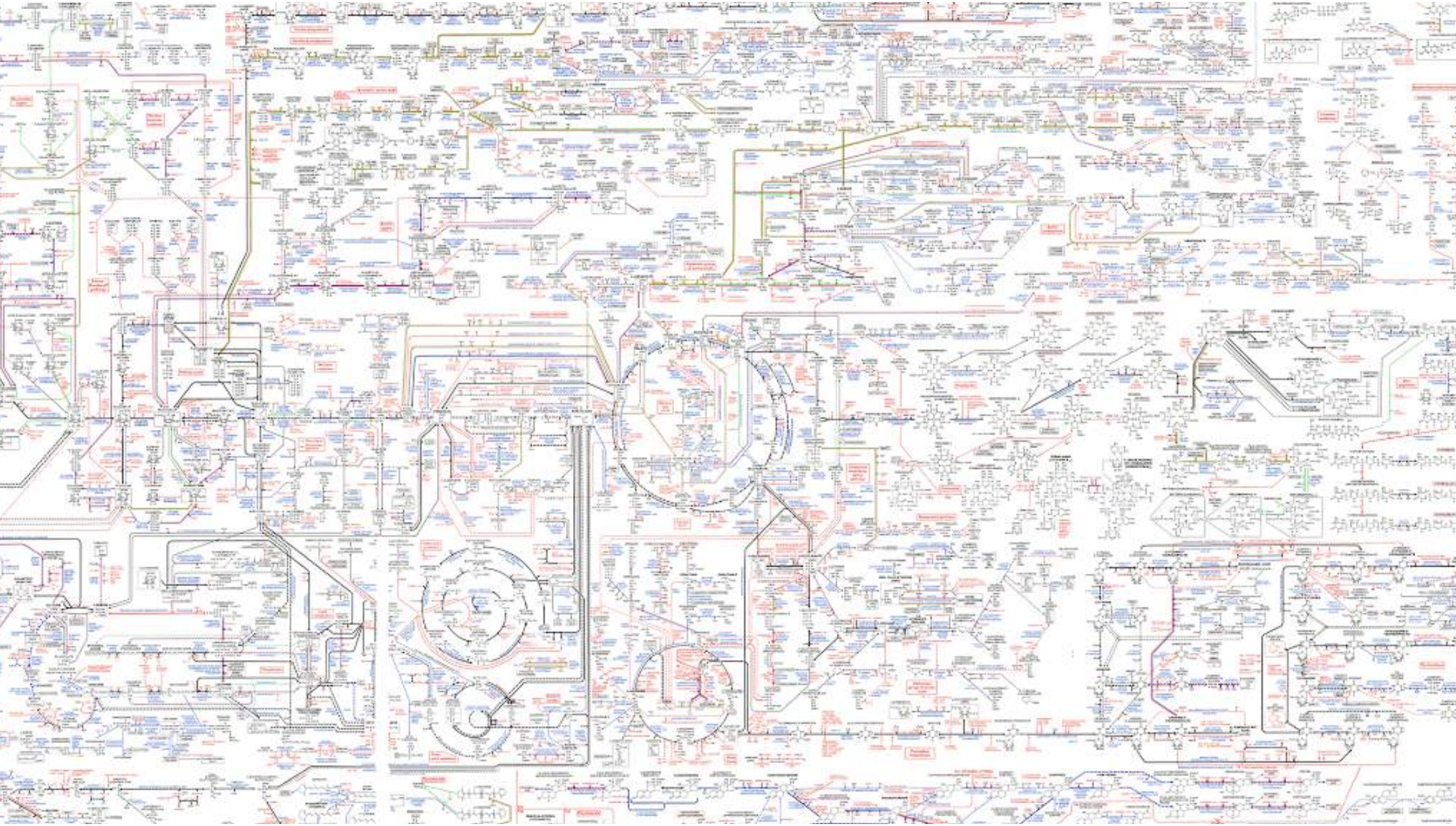
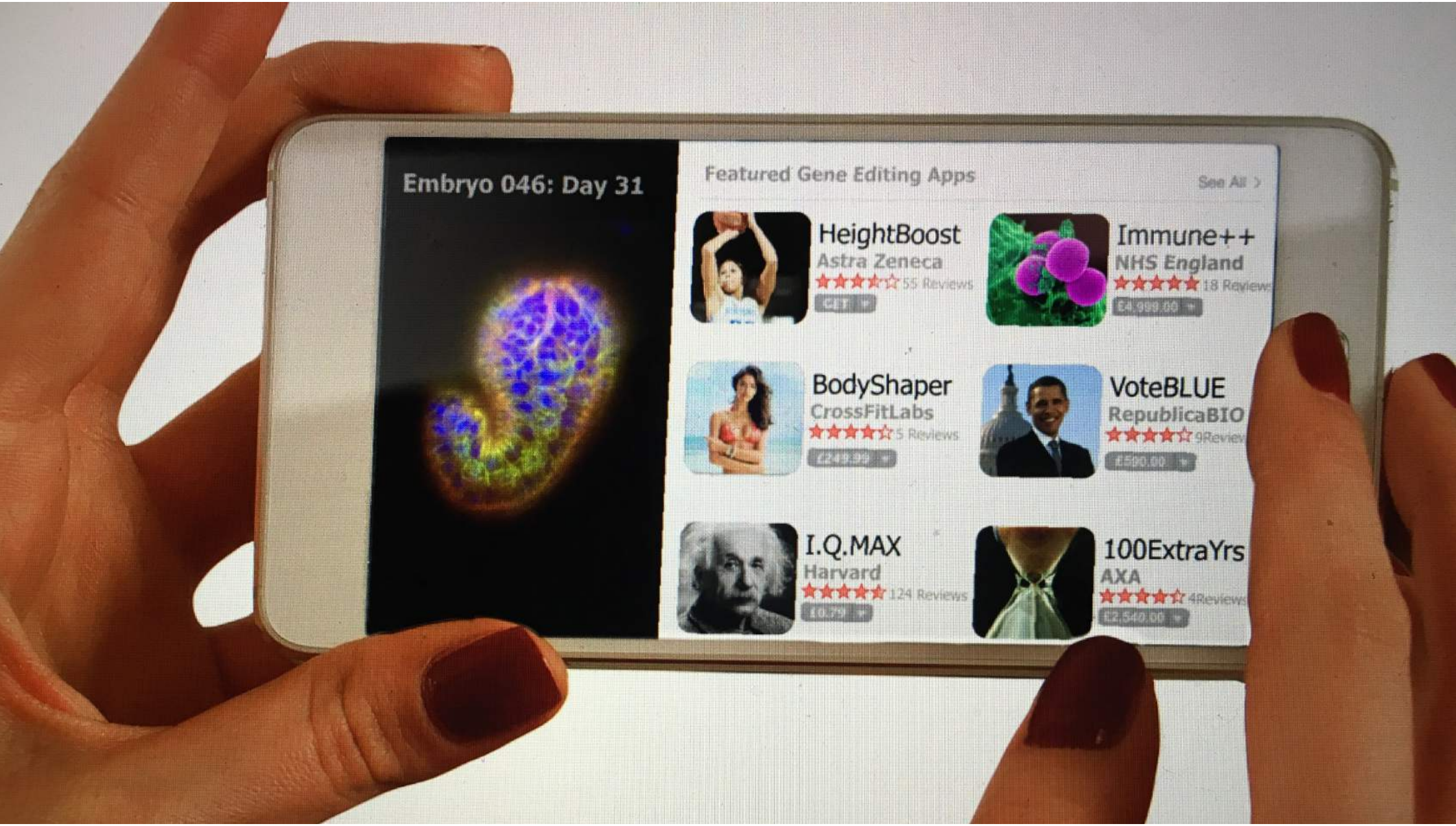
2000
2010


Altered intercellular communication
Genomic instability
Telomere attrition
Epigenetic alterations
Loss of proteostasis
Deregulated nutrient sensing
Mitochondrial dysfunction
Cellular senescence
Stem cell exhaustion

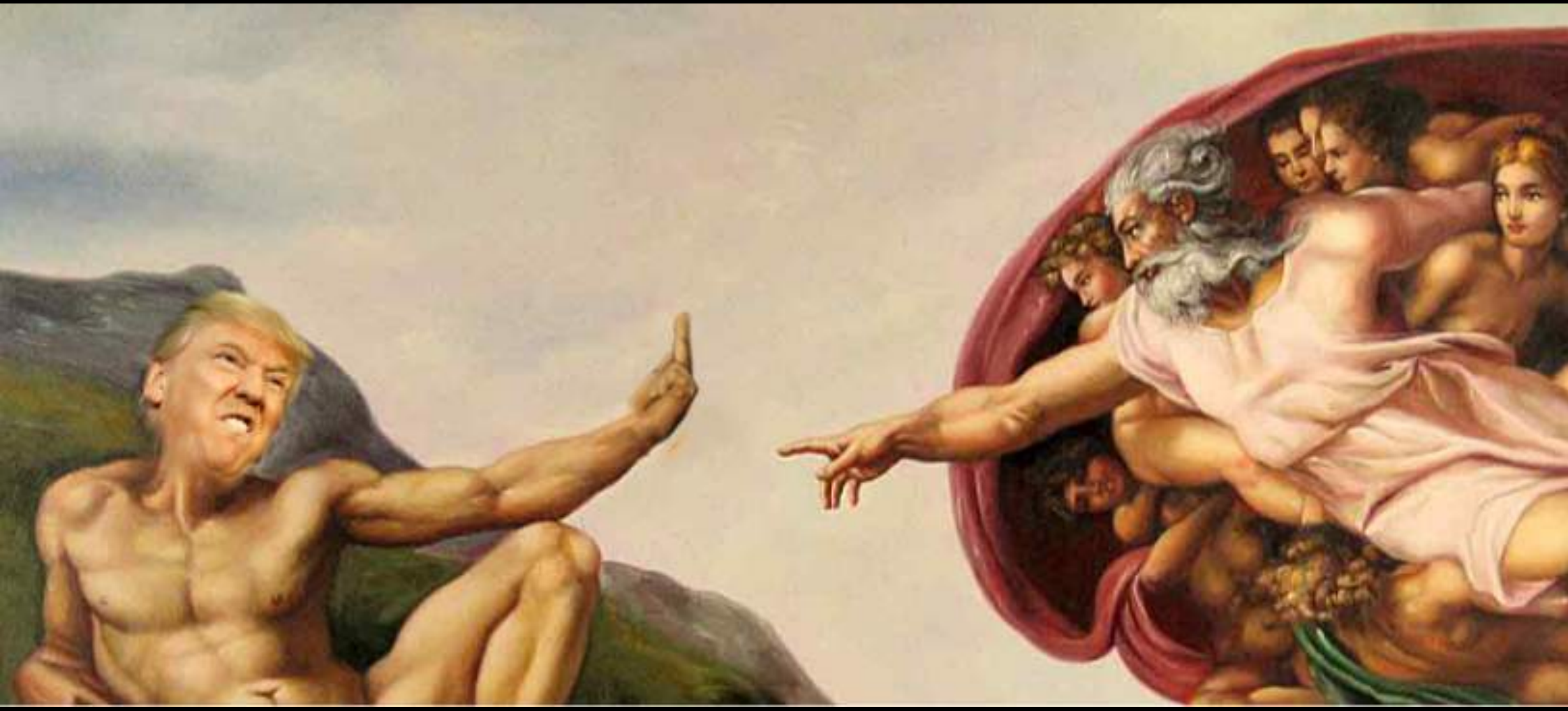


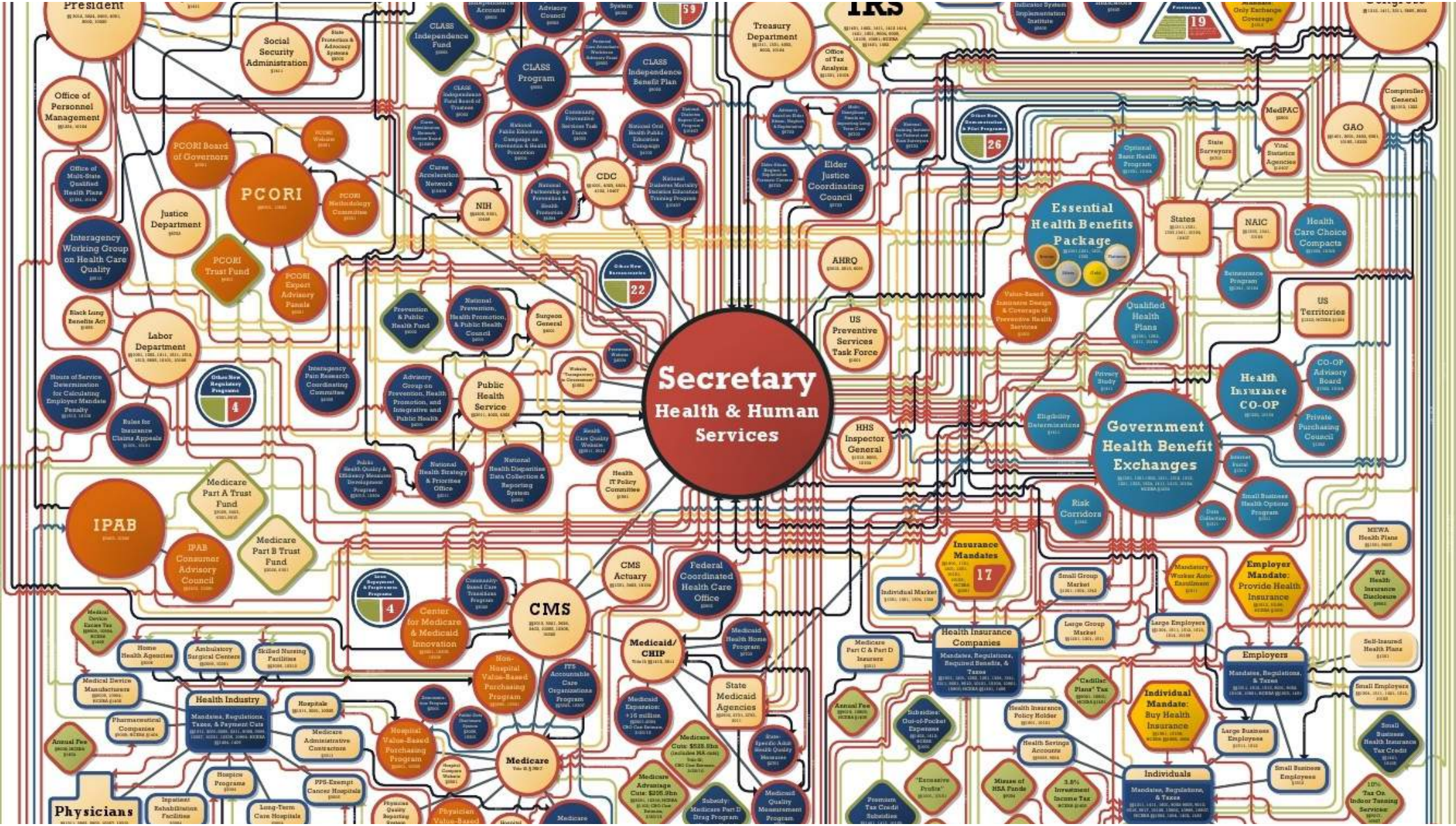

Embryo 046: Day 31
Featured Gene Editing Apps
See All
HeightBoost
Astra Zeneca
55 Reviews
Immune++
NHS England
18 Reviews
BodyShaper
CrossFitLabs
5 Reviews
VoteBLUE
RepublicaBIO
I.Q.MAX
Harvard
124 Reviews
100ExtraYrs
AXA
4Reviews

OUR BIOLOGY

+

OUR INDUSTRY




Secretary
Health & Human Services
President
Social Security Administration
Office of Personnel Management
PCORI
PCORI Board of Governors
PCORI Methodology Committee
PCORI Trust Fund
PCORI Expert Advisory Panels
Justice Department
Interagency Working Group on Health Care Quality
Black Lung Benefits Act
Labor Department
Hours of Service Determination for Calculating Employer Mandate Penalty
Rules for Insurance Claims Appeals
Interagency Pain Research Coordinating Committee
IPAB
IPAB Consumer Advisory Council
Medicare Part A Trust Fund
Medicare Part B Trust Fund
CLASS Independence Fund
CLASS Program
CLASS Independence Benefit Plan
Community Prevention Services Task Force
National Public Education Campaign on Prevention & Health Promotion
National Oral Health Public Education Campaign
Cures Acceleration Network
NIH
CDC
National Partnership on Prevention & Health Promotion
National Diabetes Mortality Statistics Education Training Program
Prevention & Public Health Fund
National Prevention, Health Promotion, & Public Health Council
Surgeon General
Advisory Group on Prevention, Health Promotion, and Integrative and Public Health
Public Health Service
National Health Strategy & Priorities Office
National Health Disparities Data Collection & Reporting System
Health IT Policy Committee
Health Care Quality Website
Treasury Department
IRS
Office of Tax Analysis
Elder Justice Coordinating Council
AHRQ
US Preventive Services Task Force
HHS Inspector General
Essential Health Benefits Package
States
NAIC
Health Care Choice Compacts
Reinsurance Program
US Territories
Qualified Health Plans
Value-Based Insurance Design & Coverage of Preventive Health Services
Privacy Study
Eligibility Determinations
Government Health Benefit Exchanges
Health Insurance CO-OP
CO-OP Advisory Board
Private Purchasing Council
Small Business Health Options Program
Risk Corridors
Data Collection
MedPAC
GAO
Comptroller General
State Surveyors
Vital Statistics Agencies
Optional Basic Health Program
Insurance Mandates
17
Individual Market
Small Group Market
Large Group Market
Health Insurance Companies
Mandates, Regulations, Required Benefits, & Taxes
Medicare Part C & Part D Insurers
Annual Fee
Subsidies: Out-of-Pocket Expenses
Health Insurance Policy Holder
Health Savings Accounts
Cadillac Plans' Tax
Misuse of HSA Funds
3.8% Investment Income Tax
Premium Tax Credit Subsidies
"Excessive Profits"
Individual Mandate: Buy Health Insurance
Individuals
Mandatory Worker Auto-Enrollment
Employer Mandate: Provide Health Insurance
Employers
Large Employers
Large Business Employees
Small Employers
Small Business Employees
Self-Insured Health Plans
MEWA Health Plans
W2 Health Insurance Disclosure
Small Business Health Insurance Tax Credit
10% Tax On Indoor Tanning Services
CMS
CMS Actuary
Federal Coordinated Health Care Office
Center for Medicare & Medicaid Innovation
Community-Based Care Transitions Program
Non-Hospital Value-Based Purchasing Program
ITS Accountable Care Organizations Program
Medicaid/ CHIP
Medicaid Health Home Program
Medicaid Expansion: +16 million
State Medicaid Agencies
State-Specific Adult Health Quality Measures
Medicaid Quality Measurement Program
Medicare
Medicare Cuts: $528.8bn
Medicare Advantage Cuts: $206.9bn
Subsidy: Medicare Part D Drug Program
Hospital Value-Based Purchasing Program
Medicare Administrative Contractors
Hospitals
Health Industry
Mandates, Regulations, Taxes, & Payment Cuts
Medical Device Manufacturers
Pharmaceutical Companies
Medical Device Excise Tax
Annual Fee
Home Health Agencies
Ambulatory Surgical Centers
Skilled Nursing Facilities
Hospice Programs
Inpatient Rehabilitation Facilities
Long-Term Care Hospitals
PPS-Exempt Cancer Hospitals
Physicians
Physician Quality Reporting System
Physician Value-Based
Other New Regulatory Programs
4
Other New Bureaucracies
22
Other New Reporting Requirements
59
Other New Taxes
19
Other New Boards, Councils, & Pilot Programs
26

Overtreatment, undertreatment, overdiagnosis, underdiagnosis, uncontrolled costs and budgets, medical treatment errors and **wrongly placed incentives** .....

OUR BODIES

OUR

MINDS

OUR FRIENDS & FAMILIES

OUR EMPLOYERS & ECONOMIES

OUR
WORLD

HOW ARE WE GOING TO FIX THIS?

MOVE TO VALUE?

MOVE TO CALIFORNIA!

3

CRUCIAL

INGREDIENTS

+1

SECRET

INGREDIENT

creativity

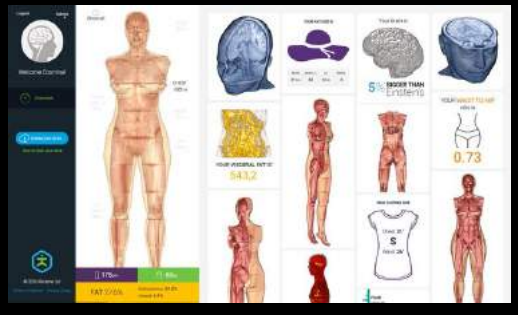
POWERED BY THE
SCIENCE MUSEUM

HAVAS

TEDxLondon
TED

WIRED
Health

Delivers Analytic
Guidance for
Follow-up
Procedure Value



EXPONENTIA
MEDICINE

BARTS
MEDICINE

HAVAS

0 1 58
CLEAR
M
S
START
STOP

THE DARK SIDE?

INVENTION

↓

REGULATION

↓

COMMUNICATION

BARRIERS

DOCTORS

PATIENTS

BIOPHARMA

TRIALS

PUBLISHERS

REGULATORS

POLY

PHARMACY

PAYERS

SHORT TERM BENEFIT

M
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CLEAR
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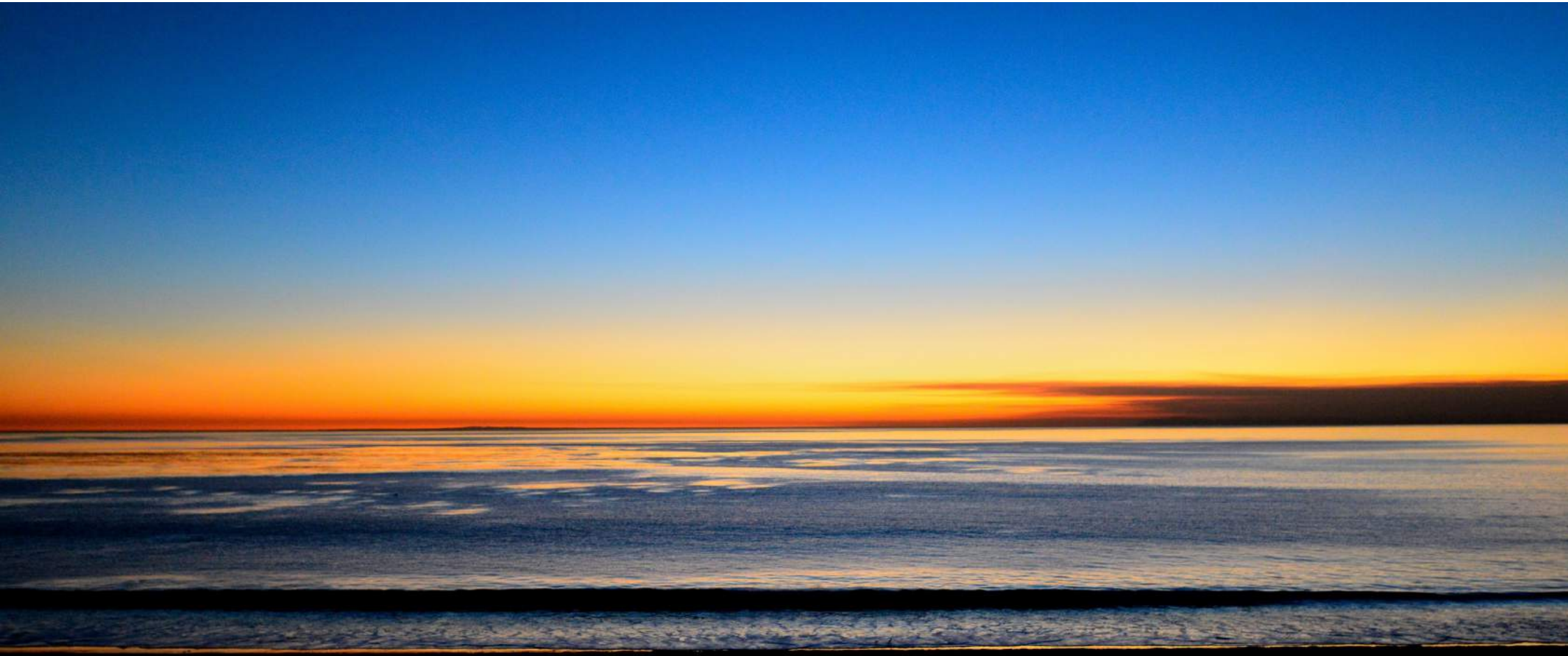
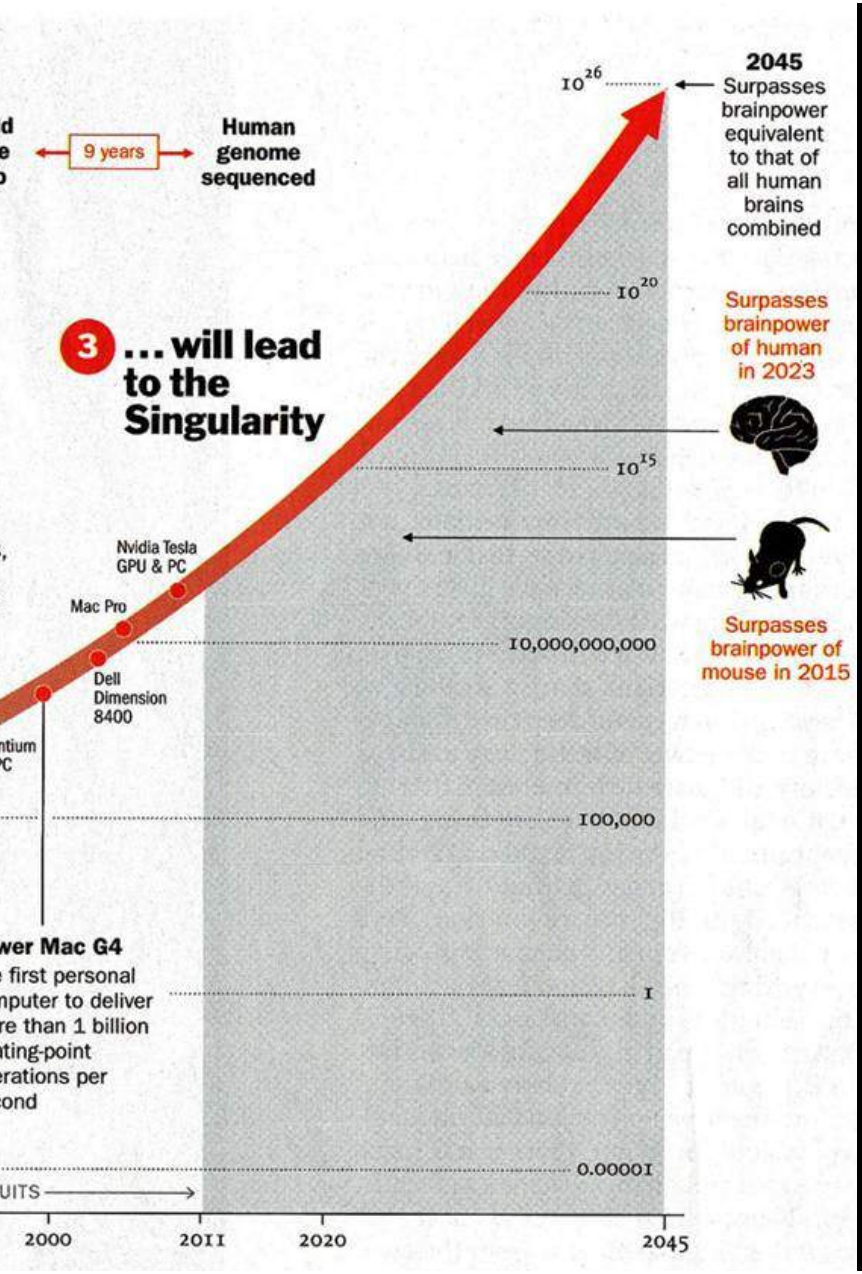
START
STOP



et lux in tenebris lucet

TECHNOLOGY
CREATIVITY
CARE



"Do not underestimate the power of Exponentials."

"Do not underestimate the power of Exponentials."

"Do not underestimate the power of Yourselves."

"Do not underestimate the power of Exponentials."

"Do not underestimate the power of Yourselves."

"Do not underestimate the power of the Dark Side."

SENTRIAN
Remote Patient Intelligence

HAVAS

CHHP

drjack@chhp.com @drjackUK