Overdiagnosis and Radiologists

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Disclosures

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Objectives

• Explain why radiologists overdiagnose

• Give examples of overdiagnosis

• Offer (partial) solutions
Rabbit hole of Precision

Ms. Patel, 32, presented to ED with syncope

CT to “rule out” pulmonary embolism
We just can’t say “normal”

Impression:

1. No PE. Please note isolated sub segmental embolus not entirely excluded

2. Main pulmonary artery enlarged at 3.2 cm. This can be seen with pulmonary hypertension. No definite left-right shunt is seen. Please note, this is not a gated CT
Doubt, Science and Closure

Measured pulmonary artery

2.9 cm MPA is threshold for pulmonary hypertension

Introduced doubt

Introduced diagnoses that weren’t “excluded”
Pulmonary Hypertension or not

Echo: tricuspid regurgitation

Cardiac MRI: left-right shunt

Right heart catheterization

"Off hand, I'd say you're suffering from an arrow through your head, but just to play it safe, I'm ordering a bunch of tests."
Victim of Medical Imaging Technology (VOMIT)

Too much information

Added information more likely to confuse than clarify

Difficult to “unknow”
Ms. Patel worse off because of my interpretation
A line has to be drawn somewhere
Cyril Radcliffe. 1947
Thresholds

Thresholds are exact but the science is not

Decision making dichotomous

Variables continuous

Line must be drawn somewhere
Border disputes in the Gray Zone

UNIMODAL DISTRIBUTION

If cut-off point is set at level of C, test will be highly sensitive, but will yield many False Positives. If cut-off is set at D, it will increase specificity if the test
How are Thresholds Derived?

Cases: severe

Control: healthy volunteers

Consensus (fallacy of golden mean)

Statistical biases (Cook, Academic Radiology, 2015)
Effect of Thresholds

False sense of insecurity

Thresholds bind radiologists

“I measure therefore I am”

Pseudoprecision

Indication Drift
What’s provenance of 2.9 cm?
Study which lit the fire

Retrospective

36 patients with pulmonary hypertension (MPAP > 19 mm Hg)

9 controls (MPAP < 20 mm Hg)

Phtn. Mean diameter 35 +/- 6 mm

Controls. Mean diameter 27 +/- 2 mm
Test characteristics

If cut-off for MPA diameter is 29 mm:

Sensitivity – 87%
Specificity – 89%
PPV – 0.95
Likelihood ratio – 3.36

Study cited 249 times!
“However, it is important to emphasize that a diameter of less than 29 mm does not necessarily exclude pulmonary hypertension. In patients with mild pulmonary hypertension”
A Greek Tragedy

18 YO M, football player faints, has echo which questions non compaction cardiomyopathy, sent for cardiac MRI to rule out
Incorporation Bias: The Case of Non Compaction Cardiomyopathy

• Non compacted: compacted myocardium > 2.3 in diastole = Non Compaction (0.3 % - prevalence)
• 7 patients (Peterson, JACC, 2005). Specificity – 99 %
• 25 % of heart failure patients and 8 % of healthy volunteers fulfill threshold (Kohli, EHJ, 2008)
• 40 % healthy, MESA, meet criterion (Kawel, Circ Card Imaging, 2012)

Adherence to Thresholds (Kini, Academic Radiology, 2015)
How do we know who has disease?

- Pathology
- Imaging
- Numbers/Thresholds
- Expert panel
Imaging defines disease
Epistemology of Overdiagnosis

1. Biological spectrum
2. Disease Reservoir
3. Information Problem
Why Spectrum Matters?

Biological systems non linear.

Asymmetric error

Asymmetric benefits
Spectrum Bias

Just because test distinguishes between “obviously” diseased & “obviously” normal doesn’t mean it distinguishes between “mildly” diseased & broader coastline of normal
Radiologist’s Paradox

No one asks for our help for obvious

We’re asked to adjudicate gray zone

We’re most useless when most needed
Technology and Disease Reservoir

Black and Welch, NEJM 1993

“as a general principle, the prevalence of any disease increases with observer’s ability to detect the abnormalities associated with the disease”
How to Increase Prevalence of AAA

201 high risk patients

Palpation: 5/201 – 2 %

US: 18/201 - 9 %

60 % of additional aneurysms: 3.6 cm – 4 cm

(Lederle. Arch Int Med. 1988)
65 M. Healthy. Informed consumer

Calcium scan: “6 mm ground glass opacity in the right lower lobe”

6 mm, 8 mm, 8 mm, 9 mm

Lobectomy: Adenocarcinoma-in-situ

Dies, 75 from MI
Counterfactual of Peter: Pierre

65 M. Healthy

Lives in France

Dies, 75 from MI
Peter spent week in hospital with lines, chest tubes, portion of his lung missing, for a disease which was not bothering him, to prevent an outcome he was destined not to have
Story of Paul

72, weight loss and hemoptysis. Met adenocarcinoma lung.

Calcium scan 7 years earlier

“6 mm ground glass nodule, likely inflammatory.”

Dies 6 months later

Paul’s counterfactual lives to 90
Overdiagnosis vs. Underdiagnosis

Peter overdiagnosed/ overtreated

Paul underdiagnosed/ undertreated

Both harmed

At $T = 0$, fates indistinguishable
The Information Problem

1. Some benefit (Paul)

2. Many don’t (Peter)

3. We don’t know who will and who won’t
Choose an Error

Information Problem

a) Trade-offs
b) Choice

- Over call or under call?
- Over treat or under treat?
Blackstone Ratio

Better ten guilty go free than an innocent be sent to the gallows

William Blackstone
Burden of Proof

Easier to show clinical significance than prove absence

What’s our Blackstone Ratio (numbers willing to harm)?
The Overdiagnosed are Grateful

Peter thinks he is Paul

A doctor who hurts Peter to save Paul knows he has the support of both Peter and Paul
Overdiagnosis is not False Positive

False positive: limitation of a test

Overdiagnosis: exuberance of a test
MDC T and Subsegmental Pulmonary Embolus

Incidence of PE: 62 to 112 per 100,000

Cause-specific mortality: 12.3 to 11.9 per 100,000

Rise linked to MDCT (1998 to 2006)

Rising use of prophylaxis for VTE

(Wiener, BMJ, 201)
Lack of Independent Verifier

How do we know a subsegmental PE is real?
Subsegmental PE and Narcissism of Small Differences

High interobserver variability

Disagreement - 30 % (Miller, Ann of ATS, 2015)
The Road to Overdiagnosis

Why V/Q scan was replaced by CT?

- Intolerance of uncertainty

- Want dichotomous answers
Overdiagnosis Karmic Cycle

Higher quality hospitals, higher adherence to prophylaxis, more VTE, more imaging

(Bilmoria JAMA IM, 2013)
What’s our Blackstone Ratio for Subsegmental PE?

93 patients with isolated SSPE

71 treated/ 22 untreated

8 bleeds/ 5 major bleeds

No deaths

(Donato, Thromb Res, 2010)
Why Radiologists Overdiagnose?

Imaging defines disease

Thresholds and Gaussian trap

Spectrum mixing: Gray zone

Imperative to measure

Difficult to unknow

Information problem
The old quacks peddled fake cures to treat real diseases. The new quacks peddle fake diseases to justify new cures

(Thomas Szasz. The Medicalization of Everyday life)