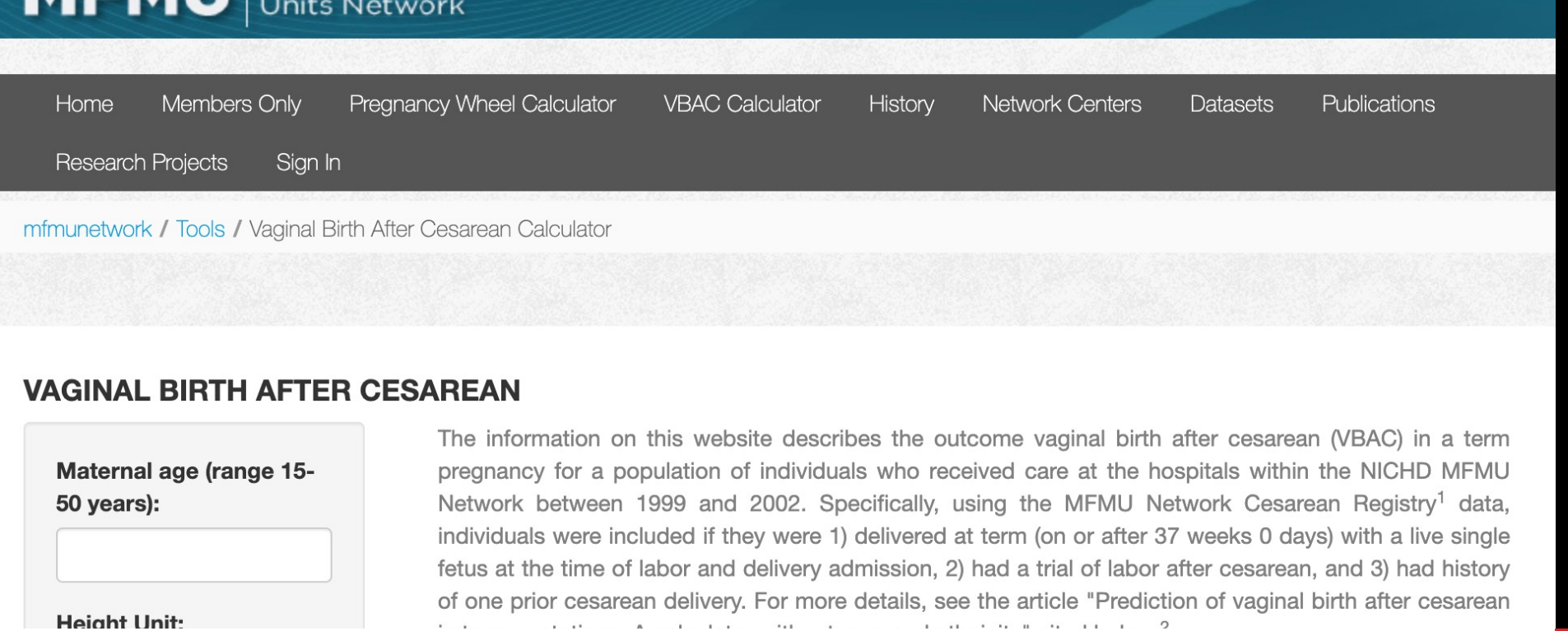
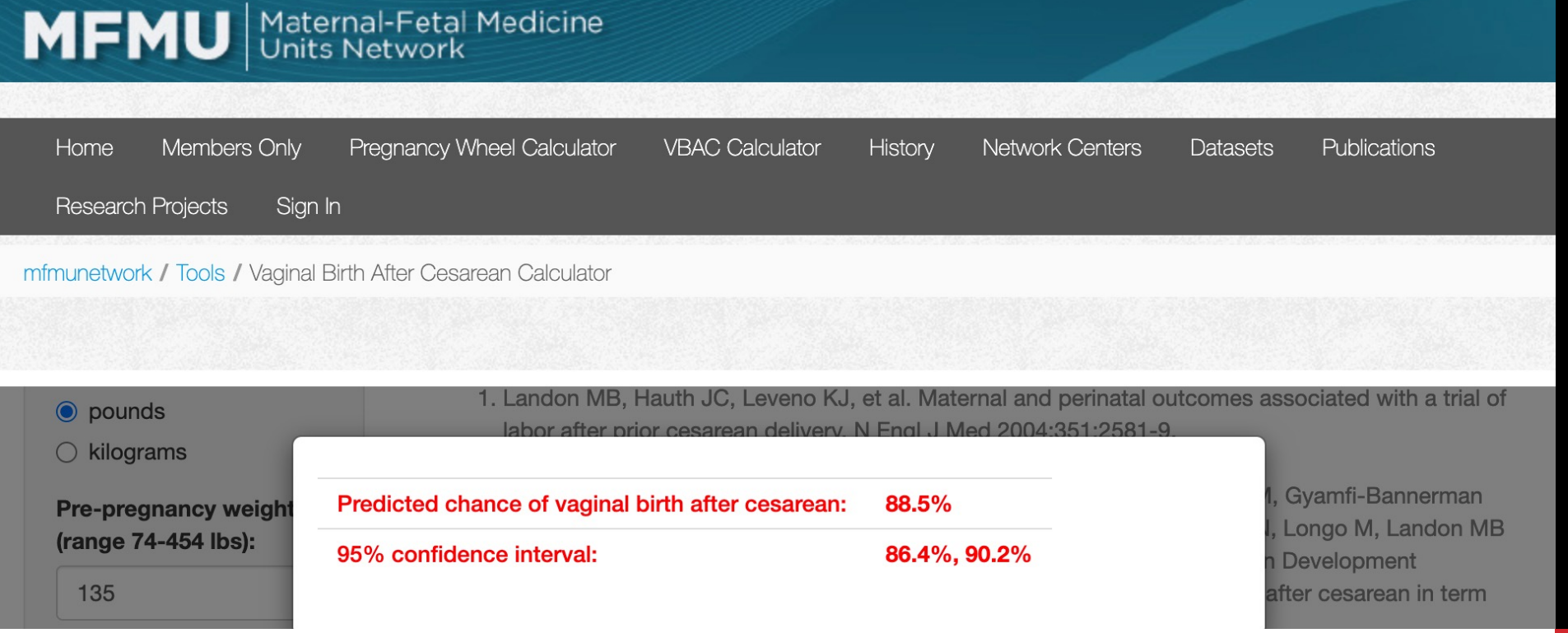
PROBABILITY, PERSONALIZATION, AND RISK IN MEDICAL AI

CS109

KATIE CREEL

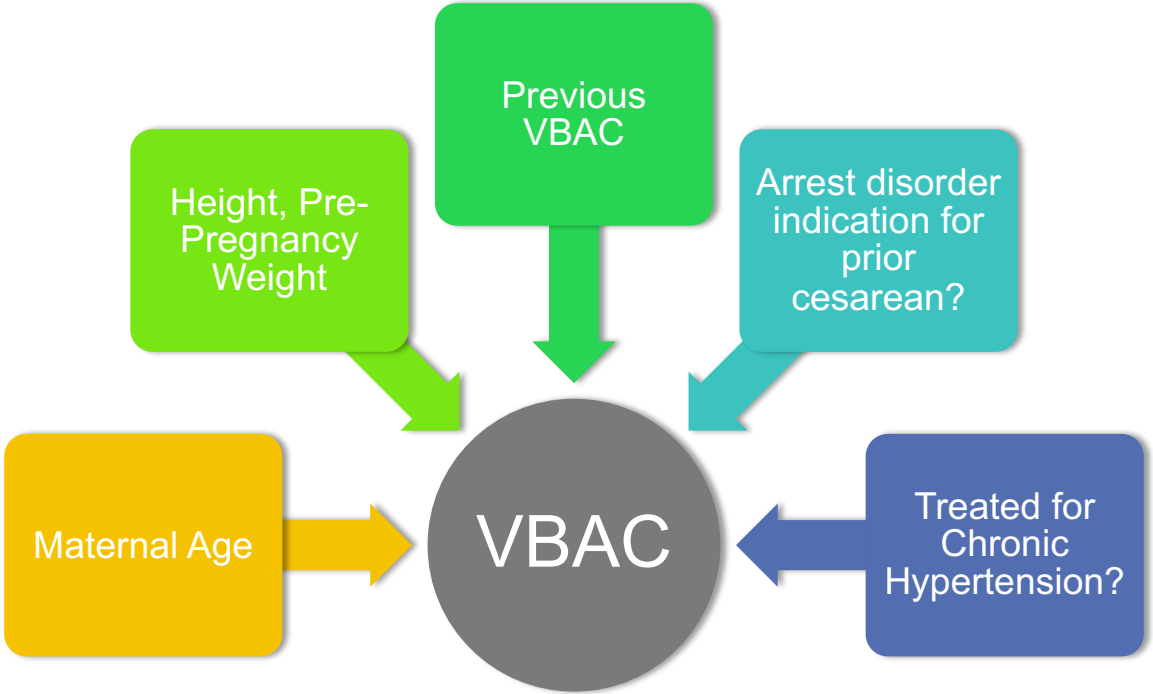


MEDICAL DECISION SUPPORT CALCULATORS – ALGORITHMS WITHOUT AI



CALCULATORS WITHOUT MACHINE LEARNING FUNCTION AS A BLACK BOX … WITH KNOWN INPUTS

VBAC INCLUSIONS



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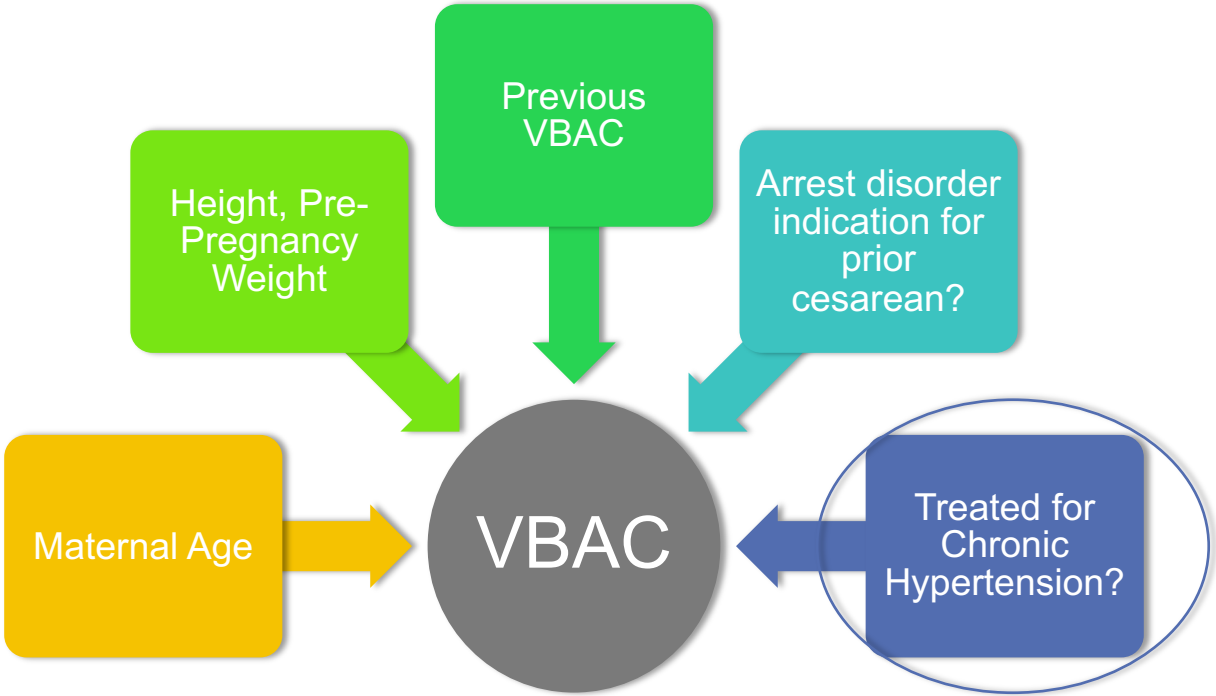

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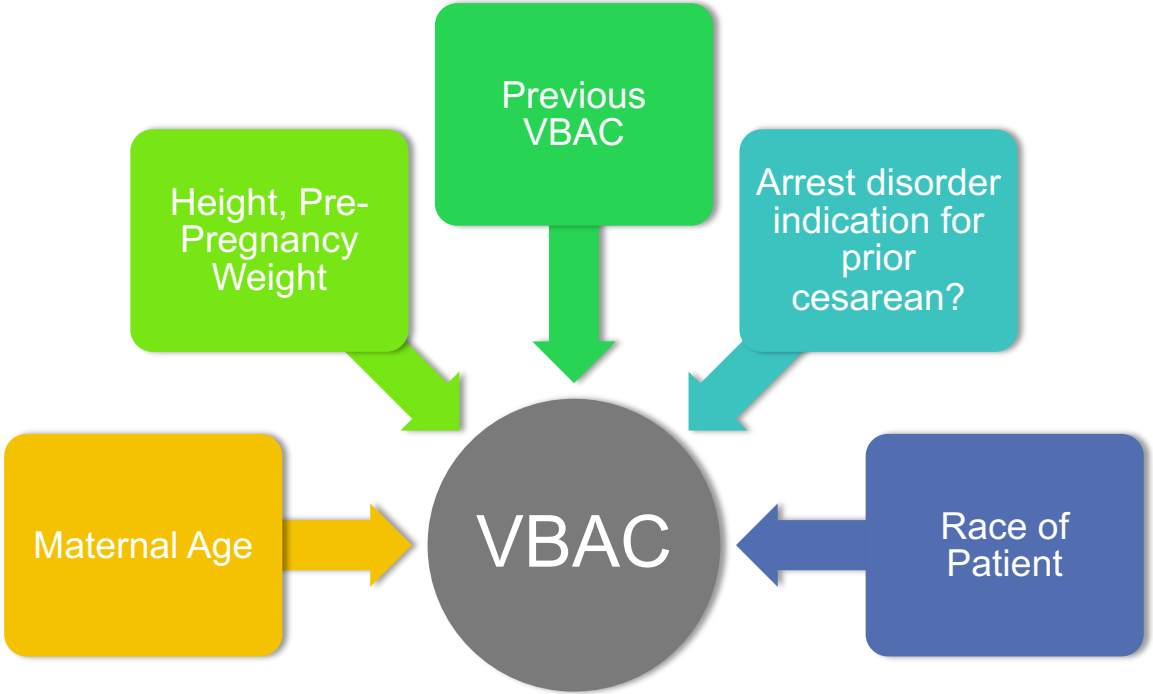


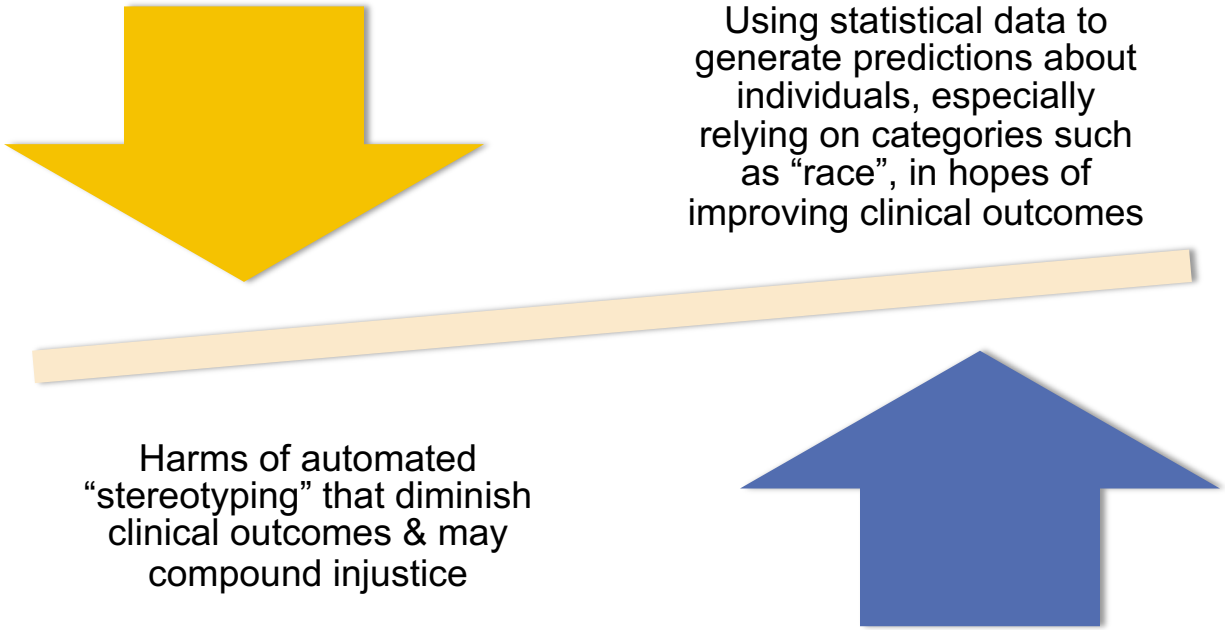
RACE & VAGINAL BIRTH AFTER C-SECTION (VBAC) CALCULATOR

VBAC Calculator assigns lower likelihood of success with VBAC to African-American and Hispanic women

2017 - Vyas et. al. challenge the use of race in VBAC calculator, arguing that it exacerbates disparities by discouraging vaginal birth

2021 – calculator updated to remove race, substitute prior treatment for chronic hypertension

RACE-BASED STATISTICAL GENERALIZATIONS & STEREOTYPING: A MIS-FRAMED TRADEOFF?

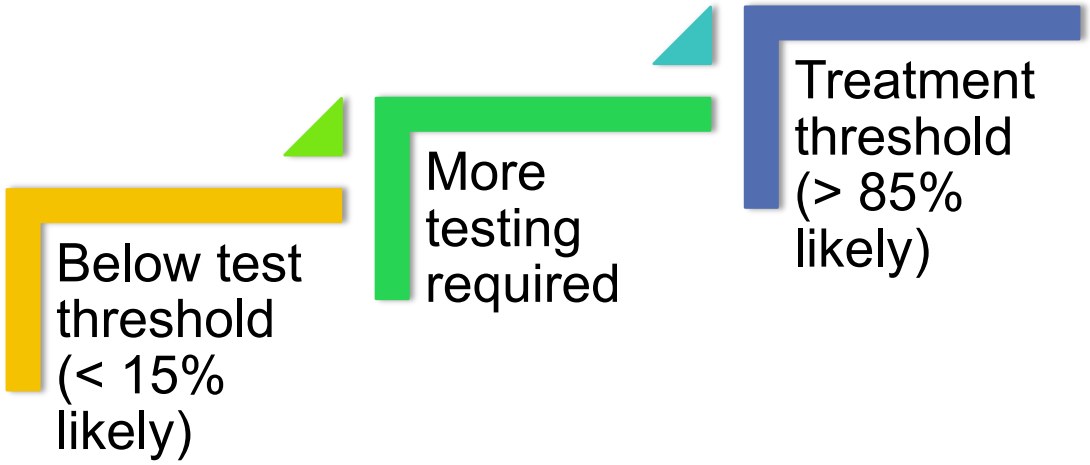


STEREOTYPES, RISK, AND PERSONAL VALUES

PROBABILISTIC CLASSIFIERS

THRESHOLD APPROACH

- **Probabilistic Classifier produces a probability for each possibility**
- **(e.g. 51% likely to be cancerous, 25% likely to be benign tumor ...)**
- **Diagnostic AI then applies thresholds in order to deliver recommendation**



HOW & WHEN SHOULD AUTOMATED THRESHOLDS BE SET?

FALSE POSITIVES AND FALSE NEGATIVES

	Condition y = 1	Condition y = 0
Event $\hat{y} = 1$	True positive	False positive
Event $\hat{y} = 0$	False Positive	False Negative

This table is sometimes called a "confusion matrix"

FALSE POSITIVES AND FALSE NEGATIVES

	Condition y = 1	Condition y = 0
Event $\hat{y} = 1$	True positive	False positive
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= CAT! (True positive)

FALSE POSITIVES AND FALSE NEGATIVES

	Condition y = 1	Condition y = 0
Event $\hat{y} = 1$	True positive	False positive
Event $\hat{y} = 0$	False Positive	False Negative

= CAT! (False Positive)

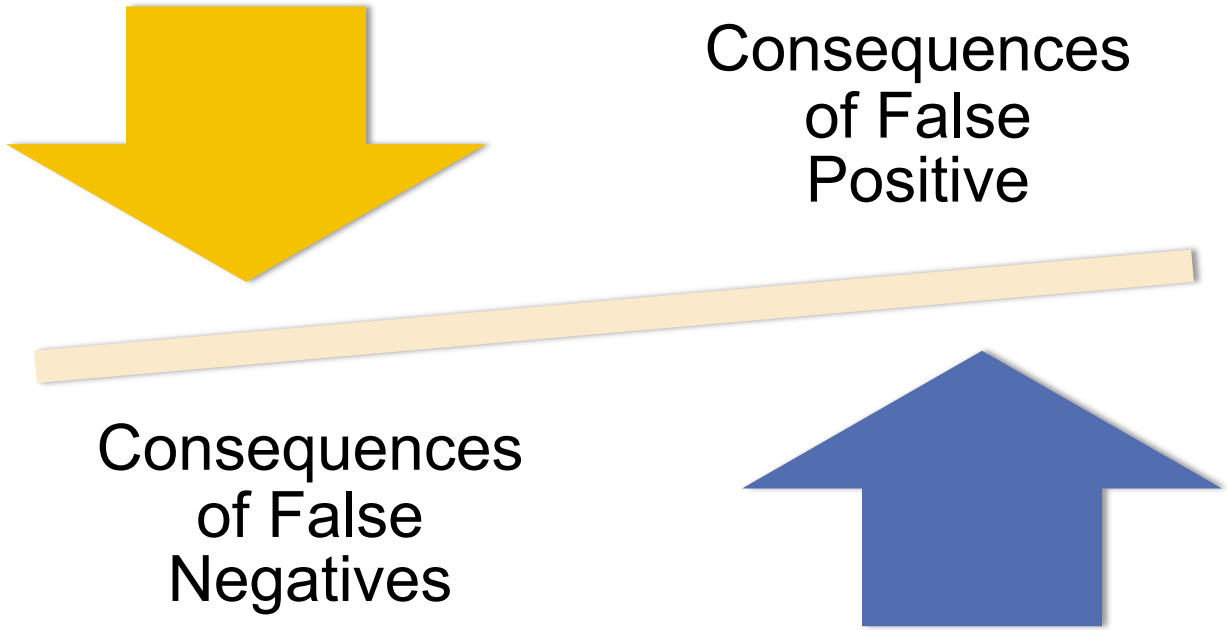
INDUCTIVE RISK

Jeffrey (1956): Scientists are not in the business of accepting or rejecting hypotheses; rather, they should assign probabilities or degrees of belief to them.

Steel (2015): Decisions about whether to accept or reject a scientific hypothesis can have implications for practical action.

When this happens, acceptance decisions should depend in part on non-epistemic value judgments about costs of errors (Johnson 2020).

THRESHOLD SETTING DEPENDS ON VALUES



THRESHOLD SETTING HAS EPISTEMIC COSTS

Setting a decision threshold within a "black-box" medical AI system is sometimes preferred if it is seen as simpler for the clinician or as a shield against lawsuits.

However, automatic threshold-setting:

- **Leaves information on the table, degrading quality of token decision instances**
- **Makes it harder for junior clinicians to develop clinical judgment and practice placing *appropriate* trust in the device**

THRESHOLD SETTING HAS ETHICAL COSTS

Automatic threshold-setting also has ethical costs.

In clinical settings, there can be no “one-size-fits-all” decision threshold.

For patient autonomy, it is appropriate for the decision threshold to take values and attitudes towards risk of a particular patient into account.

BUILDING A PERSONAL RISK-VALUE PROFILE

For a given condition, what is the patient's:

- **Valuing of true positive**
- **Disvalue of false positive**
- **Valuing of true negative**
- **Disvaluing of false negative**

- **Attitude towards overdiagnosis and misdiagnosis**
- **Attitude towards overtreatment *vs.* undertreatment**
- **Expected expected value of additional years of life of varying quality levels.**

RISK-VALUE GAMBLES

Another way to discover the patient's risk-value profile is to ask them to engage in hypothetical "gambles" such as:

"I would rather risk surgical complications to treat a benign tumor than risk missing a cancerous tumor" (Buchak 2013).

MAKING DECISIONS ABOUT THE FUTURE

Simple decision theory says:

P = Probability of an outcome occurring

V = Value/utility of that outcome

P x V = Expected Value

MAKING DECISIONS ABOUT THE FUTURE

Simple decision theory says:

P = Probability of an outcome occurring

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P x V = Expected Value

Likelihood of finding ice cream in my freezer = 0.99

Value of freezer ice cream = 3 ☹

Value of ice cream from truck = 9 ☺

Likelihood of ice cream truck driving by = 0.3

Ice cream truck search = 2.70

Freezer ice cream search = 2.97

Ice Cream Van Search = 2.70

Freezer Ice Cream = 2.97

Alas ....

ADDING RISK

Now let's model risk of outcomes separately from their probability or their value. The combined score is the "risk weighted expected utility."

How do you value the risk of:

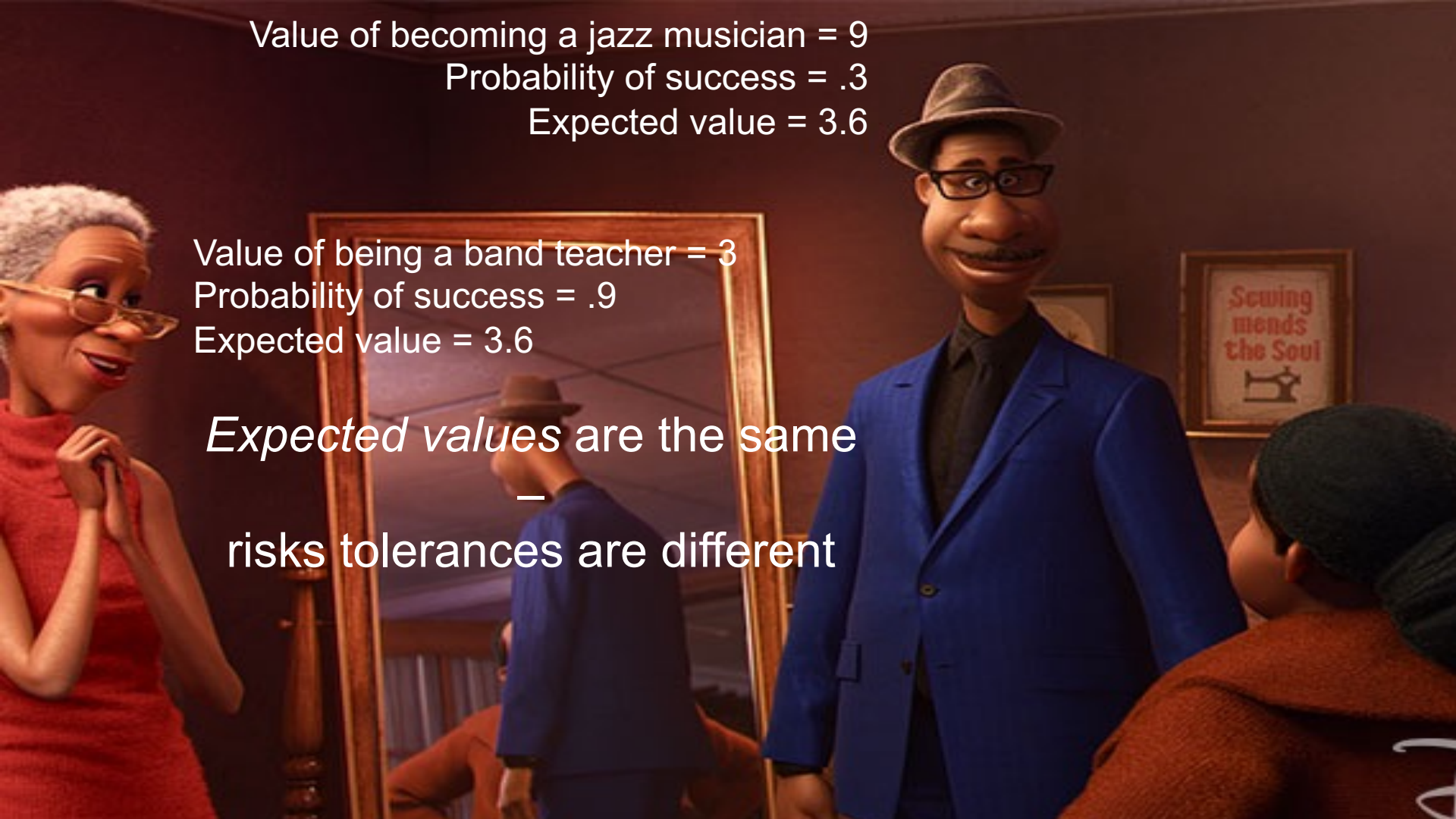
- **High chance of acceptable outcome vs.**
- **Low chance of great outcome vs.**
- **Low chance of devastatingly bad outcome**


Value of becoming a jazz musician = 9
Probability of success = .3
Expected value = 3.6
Sewing mends the Soul

Value of becoming a jazz musician = 9
Probability of success = .3
Expected value = 3.6

Value of being a band teacher = 3
Probability of success = .9
Expected value = 3.6

Expected values are the same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Probability of success = .9
Expected value = 3.6
Expected values are the same
–
risks tolerances are different
Sewing mends the Soul

RISK-WEIGHTED EXPECTED UTILITY

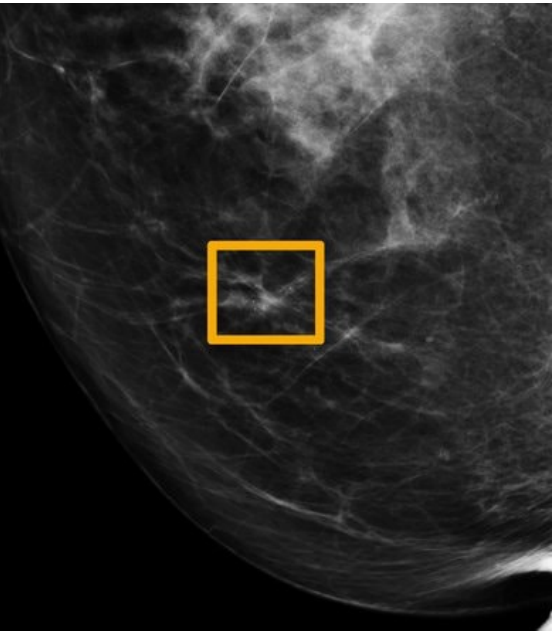
Buchak (2013) argues that it is rational to make decisions based on "risk-weighted expected utility" – to take into account our tolerances for risk in addition to our values and preferences.

r(p) measures the importance of the top p-portion of outcomes

CLINICAL DECISION-MAKERS SHOULD BE PROVIDED EITHER WITH PROBABILISTIC OUTPUTS

OR ELSE WITH A RECOMMENDATION THAT TAKES BOTH THE PROBABILITIES AND THE PATIENT'S VALUES AND TOLERANCE FOR RISK INTO ACCOUNT.

CASE STUDY 1: BREAST CANCER SCREENING



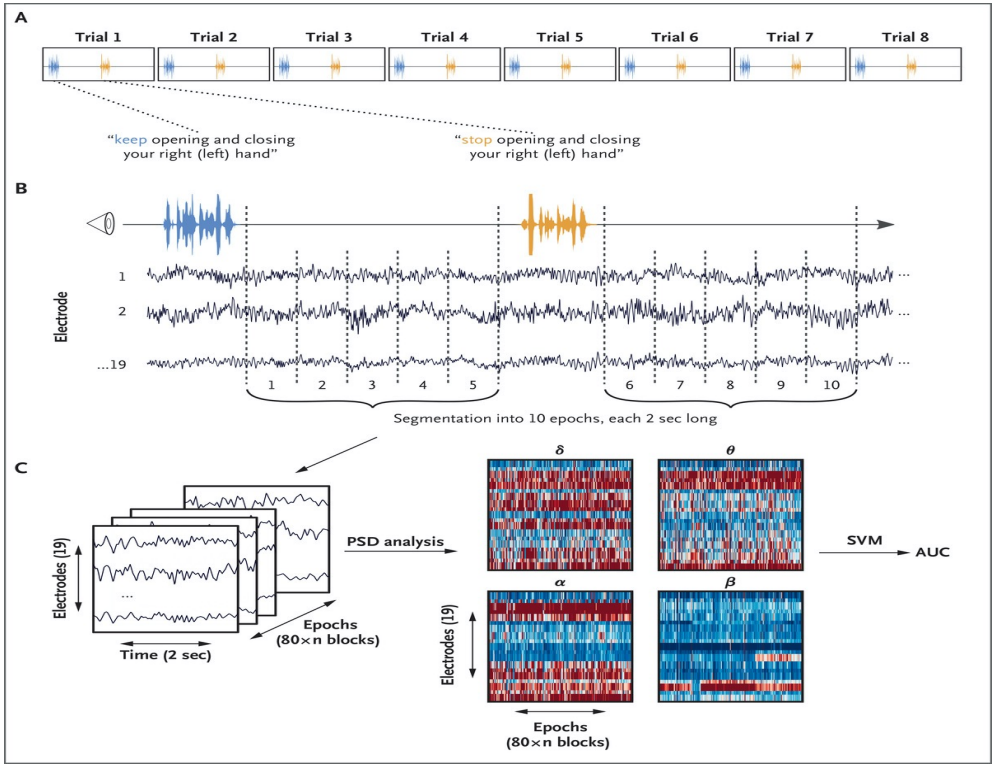
Mammogram → Probabilistic Likelihood → Clinical Decision (Recall?)

CASE STUDY #2: D*IAGNOSING COGNITIVE-MOTOR DISSOCIATION (CMD)*

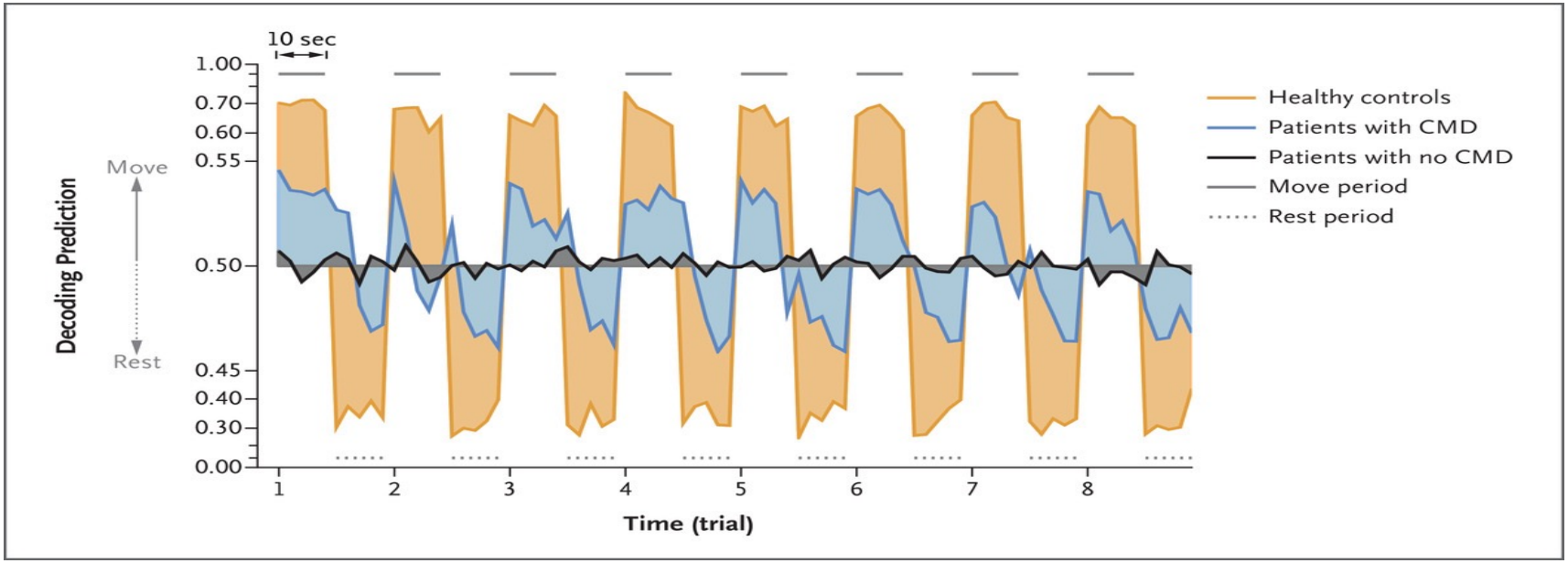
Patients with unresponsive wakefulness syndrome (formerly known as the vegetative state) are in fact able to modulate their brain activity in response to commands (Kondziella et al. 2016; Edlow et al. 2017).

“keep opening and closing your right hand” will sometimes elicit different brain activity from the command “stop opening and closing your right hand”, even though the patient’s right hand does not move. This is called “cognitive-motor dissociation” (CMD) (Schiff 2015).

Motor Command Protocol and Data Processing, from Claassen et al. (2019)



Temporal Pattern in Healthy Volunteers and in Patients with and Patients without Cognitive–Motor Dissociation.



HOW TO INCORPORATE PATIENT VALUES & RISK PROFILES

1. RAW SCORE

Output of the AI or medical device is the raw probability score.

Clinician uses verbal or written summary of patients' values and risk profile to arrive at recommendation.

2. INCORPORATE INTO RECOMMENDATION

In addition to probability, AI or medical device also displays "second opinion" recommendation that incorporates risk-value profile

STEREOTYPING ABOUT VALUES: STATISTICAL GENERALIZATIONS IN CULTURAL ATTITUDES

STATISTICAL GENERALIZATIONS BASED ON CULTURAL PREFERENCES

Cross-Cultural Issues in the Disclosure of Cancer

Jill L. Mitchell MA

First published: 25 December 2001 |
https://doi.org/10.1046/j.1523-5394.1998.006003153.x | Citations: 122

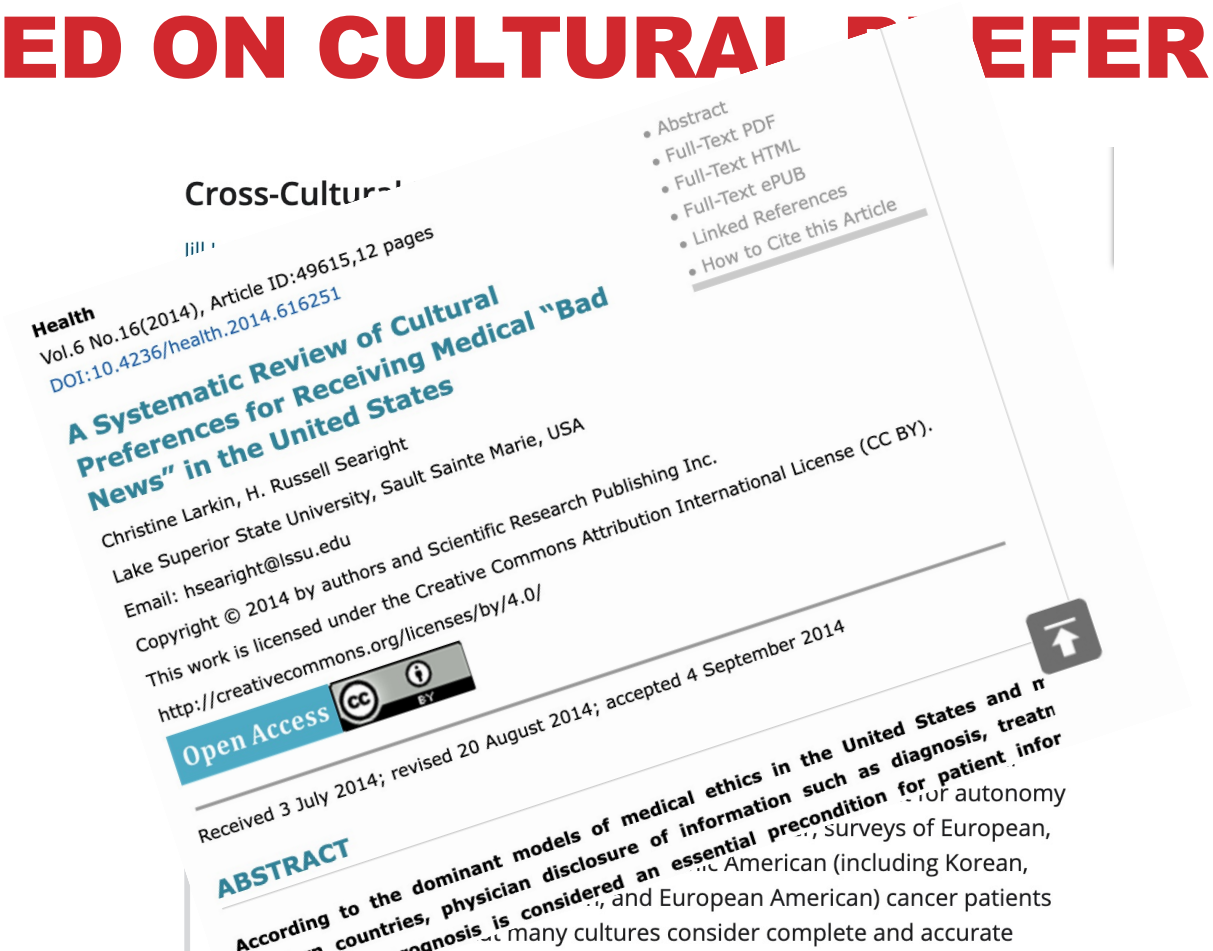
Jill L.Mitchell 108 Mattek Ave., DeKalb, IL 60115.

Abstract

PURPOSE : To increase awareness of cultural differences in the disclosure of a cancer diagnosis or prognosis, the author reviews several surveys of patients and physicians from around the world.

OVERVIEW : The Western medical community is increasingly emphasizing full truthful dislosure of cancer diagnoses or prognoses and respect for autonomy as necessary prerequisites to ethical practice. However, surveys of European, Japanese, Native American, and various ethnic American (including Korean, Chinese, Mexican, Hispanic, African, and European American) cancer patients and physicians reveal that many cultures consider complete and accurate

STATISTICAL GENERALIZATIONS BASED ON CULTURAL [illegible]EFERENCES



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- Abstract
- Full-Text PDF
- Full-Text HTML
- Full-Text ePUB
- Linked References
- How to Cite this Article

Health
Vol.6 No.16(2014), Article ID:49615,12 pages
DOI:10.4236/health.2014.616251

A Systematic Review of Cultural Preferences for Receiving Medical "Bad News" in the United States

Christine Larkin, H. Russell Searight
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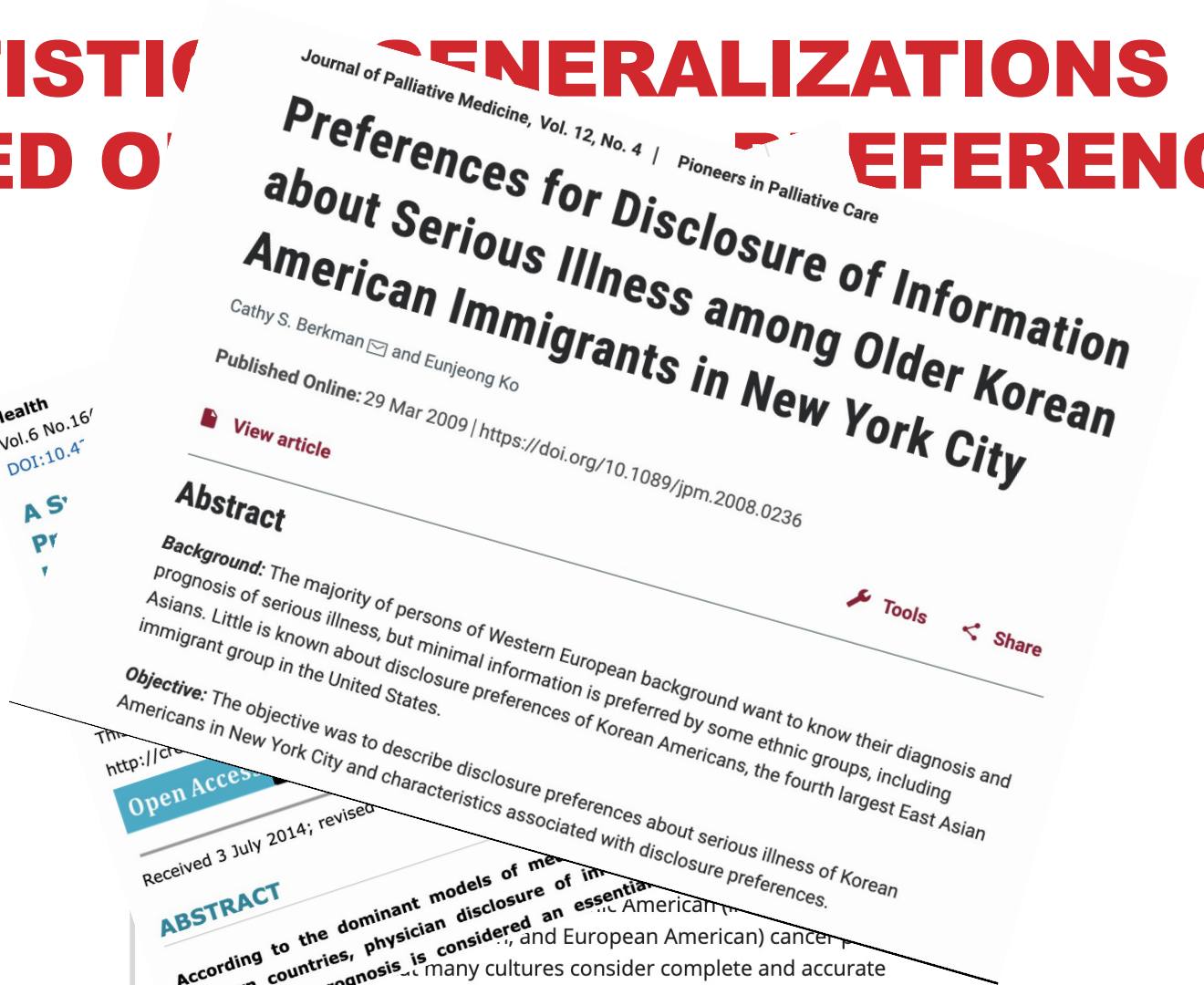
Email: hsearight@lssu.edu

Received 3 July 2014; revised 20 August 2014; accepted 4 September 2014

ABSTRACT

According to the dominant models of medical ethics in the United States and n countries, physician disclosure of information such as diagnosis, treatm is considered an essential precondition for patient infor for autonomy surveys of European, ic American (including Korean, , and European American) cancer patients t many cultures consider complete and accurate

STATISTIC ENERALIZATIONS BASED O EFERENCES



Journal of Palliative Medicine, Vol. 12, No. 4 | Pioneers in Palliative Care

Preferences for Disclosure of Information about Serious Illness among Older Korean American Immigrants in New York City

Cathy S. Berkman and Eunjeong Ko

Published Online: 29 Mar 2009 | https://doi.org/10.1089/jpm.2008.0236

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Abstract

Background: The majority of persons of Western European background want to know their diagnosis and prognosis of serious illness, but minimal information is preferred by some ethnic groups, including Asians. Little is known about disclosure preferences of Korean Americans, the fourth largest East Asian immigrant group in the United States.

Objective: The objective was to describe disclosure preferences about serious illness of Korean Americans in New York City and characteristics associated with disclosure preferences.

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Received 3 July 2014; revised

ABSTRACT

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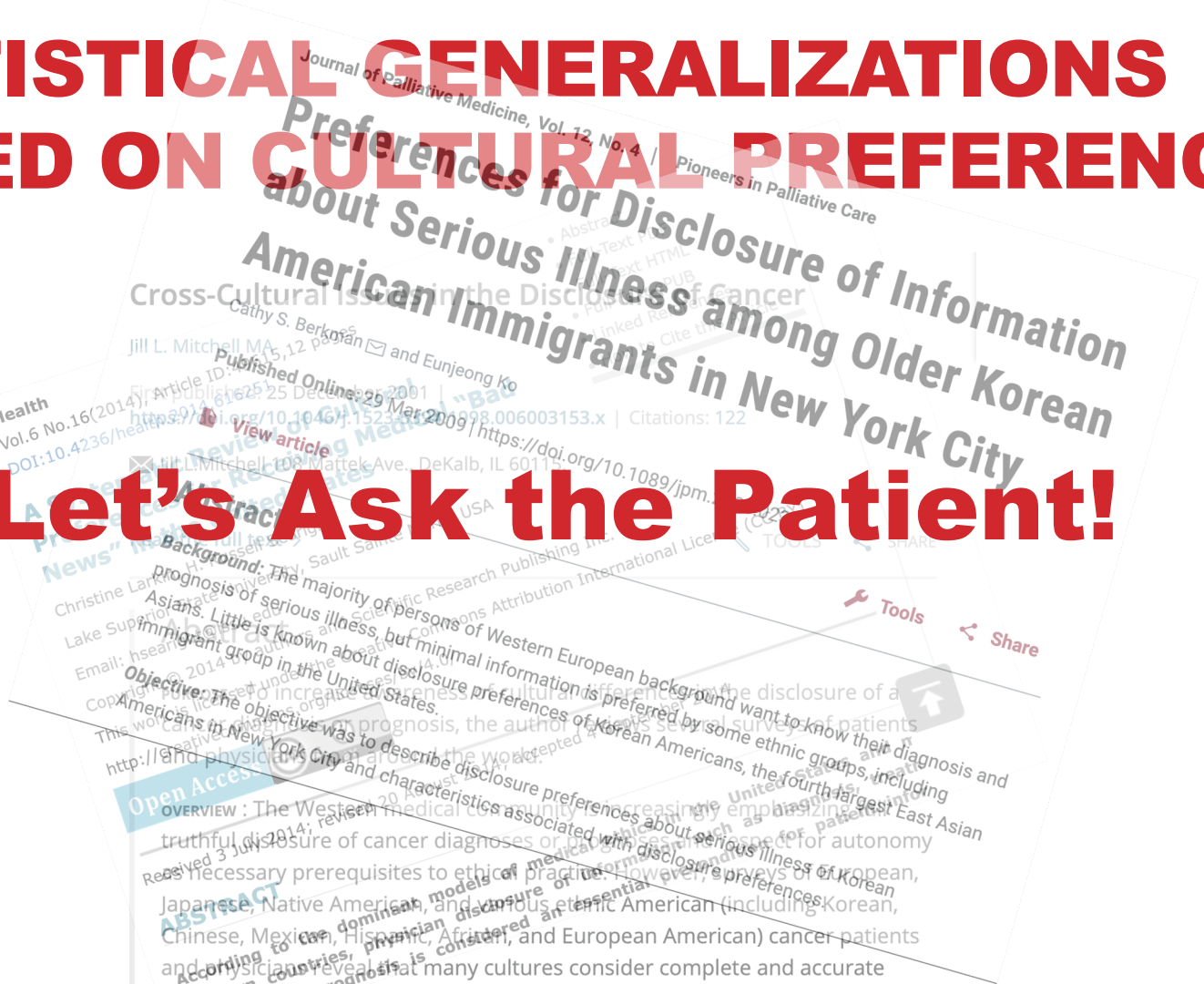

Let's Ask the Patient!

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REFERENCES:

- BUCHAK, WEIGHING THE RISKS OF CLIMATE CHANGE
- BIRCH ET. AL., CLINICAL DECISIONS USING AI MUST RESPECT PATIENT VALUES

THANK YOU!