

# **OPEN SCIENCE & HEALTH ECONOMIC EVALUATIONS**

# WHY INTRODUCING OPEN SCIENCE IN THIS COURSE?

- Comenius Teaching Fellow grant
- Discrepancy between how researchers (and practitioners) should produce scientific knowledge and teaching these skills
  - Creating awareness concerning Open Science
  - Providing some tools to become an 'open practitioner'
- More details on the project:
  - Presentation: <https://doi.org/10.5281/zenodo.7372278>
  - Grant application: <https://doi.org/10.3897/rio.8.e97853>

# LEARNING OBJECTIVES

After this lecture, you should be able to:

- Define what Open Science entails and its importance
- Explain how Open Science principles and practices can be applied to health economic models

# OUTLINE

- Why open science?
- What is open science?
- Open Science in HTA
- Why should I care?

# 1. WHY OPEN SCIENCE?

# PUBLISH OR PERISH

*“The prevailing pragmatism forced upon the academic group is that one must write something and get it into print. Situational imperatives dictate a ‘publish or perish’ credo within the ranks”*

(Source: Wilson, Logan. The academic man: A study in the sociology of a profession. Transaction Publishers, 1964.)

Academic achievement = #publications, citations, H-index, ...

- Measurable

Pressure to publish

# SYSTEM CAN LEAD TO FRAUD

**Diederik Stapel: 'Wat ik heb gedaan is volledig fout. Maar zo begon het niet'**

 Veerle Vroon - 20 februari 2020



Source: <https://cmweb.nl/2020/02/diederik-stapel-wat-ik-heb-gedaan-is-volledig-fout-maar-zo-begon-het-niet/>

*“... I think it is important to emphasize that I **never informed my colleagues** of my inappropriate behavior. I offer my colleagues, my PhD students, and the complete academic community my sincere apologies. I am aware of the suffering and sorrow that I caused to them. I **did not withstand the pressure to score, to publish**, the pressure to get better in time. I wanted too much, too fast. **In a system where there are few checks and balances**, where people work alone, I took the wrong turn. I want to emphasize that the mistakes that I made were not born out of selfish ends.”*

Source: Brabants Dagblad. 31 October 2011.  
Translated from Dutch

# IT'S NOT ONLY ABOUT PSYCHOLOGY...

Los Angeles Times

## Key Breast Cancer Study Was a Fraud

BY THOMAS H. MAUGH II AND ROSIE MESTEL

APRIL 27, 2001 12 AM PT

TIMES MEDICAL WRITERS

A key study pointing to the effectiveness of high-dose chemotherapy and bone marrow transplants in treating metastatic breast cancer was based on faked data, cancer experts said Thursday.

The American Society of Clinical Oncology announced that an unscrupulous South African researcher, Dr. Werner Bezwoda, has led thousands of women with breast cancer to undergo expensive, debilitating and often fatal bone marrow transplants. His data were fraudulent, suggesting the controversial procedure was more effective than it actually is, the society concluded.

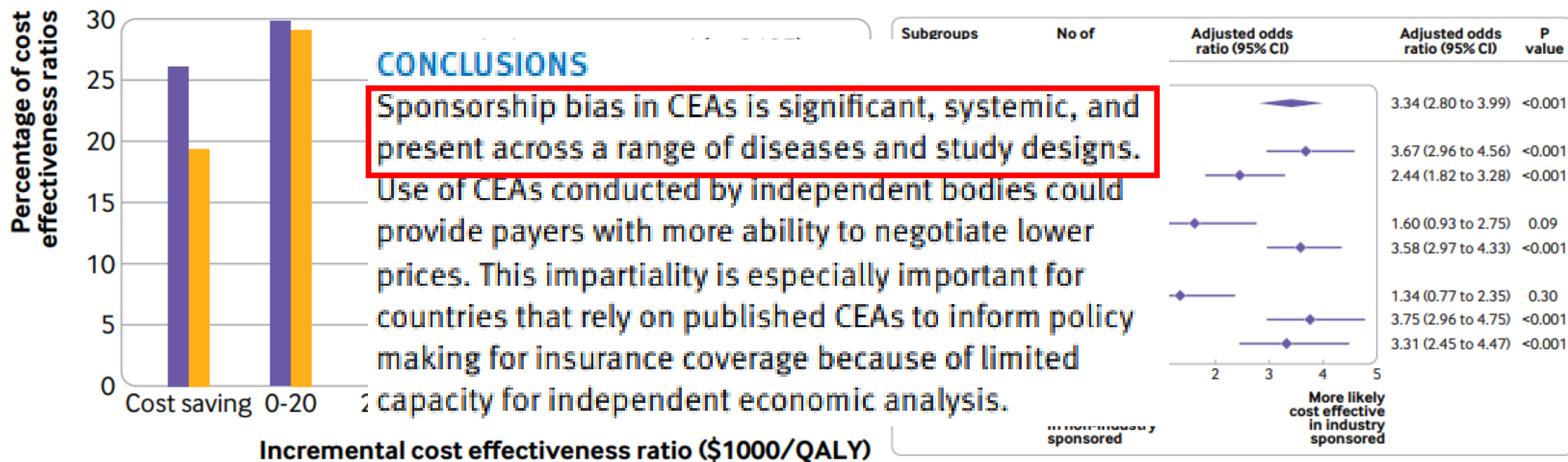
- Dr. Werner Bezwoda
- Faked data
- Potential population harm!
  - Intervention administered without actual proof of effectiveness

Source: <https://www.latimes.com/archives/la-xpm-2001-apr-27-mn-56336-story.html>.

Consulted on 12-04-2023



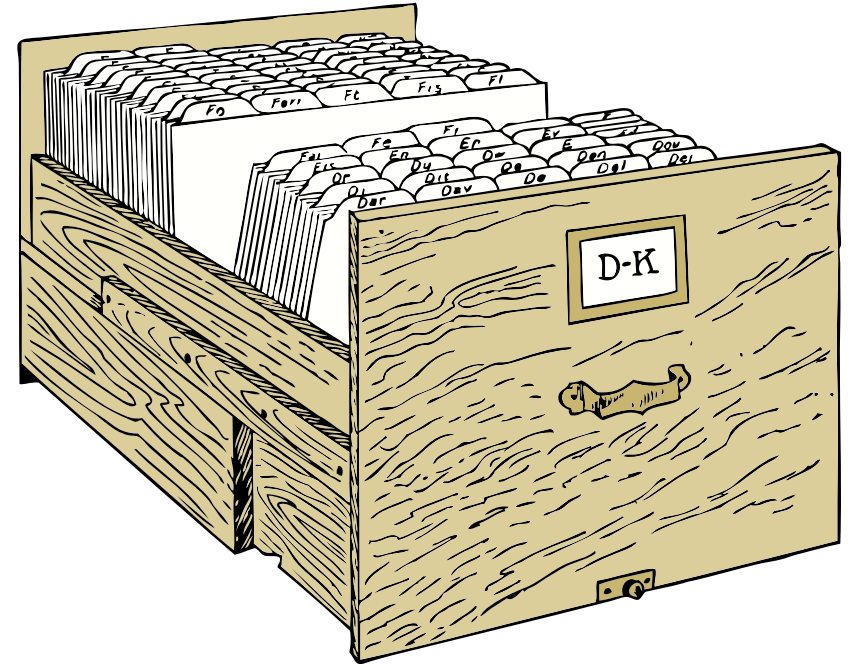
# HEALTH ECONOMIC EVALUATIONS CAN ALSO BE BIASED



Source: Xie & Zhou. BMJ 2022;377:e069573  
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# THE FILE DRAWER EFFECT

- The file drawer effect
  - Negative results are not submitted
  - Selective/ distorted reporting
- But negative results are as important as positive results!
  - Unnecessary duplication of work
    - Decrease efficiency of research



Source: <https://pixabay.com/vectors/file-cabinet-office-equipment-file-146152/?download>

# A REPRODUCIBILITY CRISIS?



Matt Anticole Is there a reproducibility crisis in science?

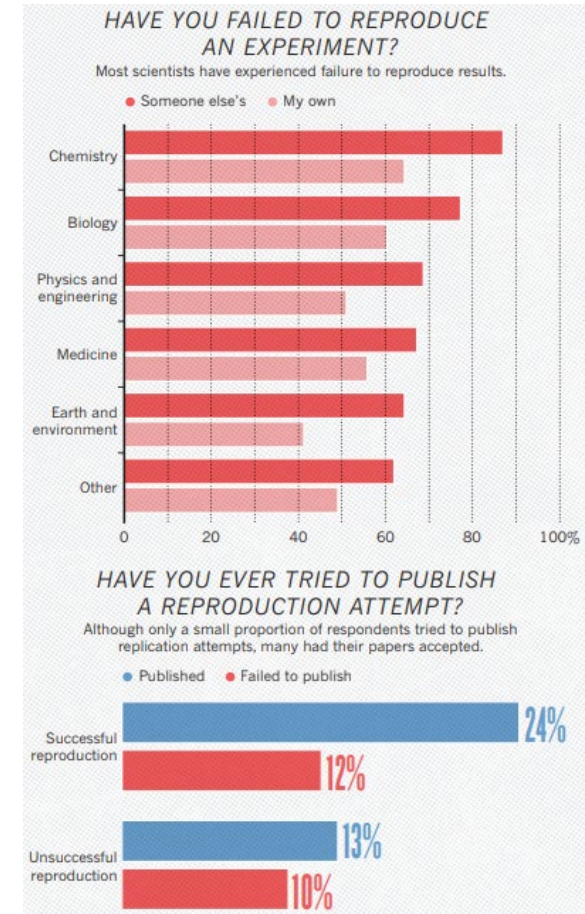
Link: <https://www.youtube.com/watch?v=FpCrY7x5nEE>

License: [CC BY-NC-ND](https://creativecommons.org/licenses/by-nc-nd/4.0/)

# A REPRODUCIBILITY CRISIS?

*“More than 70% of researchers have tried and failed to reproduce another scientist's experiments, and more than half have failed to reproduce their own experiments.”*

Source: Baker, *Nature* 533, 452–454 (2016)  
<https://doi.org/10.1038/533452a>



# WHAT ABOUT HEALTH ECONOMIC MODELS? THE MODEL REPLICATION

- Uncommon
- Aim:
  - Important for research integrity & transparency
  - New & update model conceptualisation ('bypass' *de novo* development)
- Berjemo et al. 2017
  - 5 health economic models using publicly available information
  - 1 replication stopped, 2 replicated, 2 not replicated
- McMannus et al. 2019
  - 5 health economic models using publicly available information
  - Comparison with original outcomes: -4.54% to 108.00% for costs; -3.81% to 0.40% for outcomes

# THE MODEL REPLICATION BARRIERS AND FACILITATORS

## Barriers

- Incomplete inputs reporting
- Use of ambiguous language (e.g. concerning assumptions)
- Confidentiality of model inputs
- Errors
- Conflicting information concerning model structure and inputs
- No clarification from original author (clear annotations are important!)

## Facilitators

- Clear model structure
- Provide example calculations
- Clear reporting of (inputs) tables and assumptions
- Journal data sharing policies, word limits, and the use of supplementary materials

Source: McMannus et al. 2019

# OTHER THREATS TO THE CREDIBILITY OF SCIENCE?

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are you a threat to the credibility of Science?

As an AI language model, I do not have the ability to pose a threat to the credibility of science. However, it is important to use any tool, including AI, responsibly and ensure that any outputs or conclusions drawn from it are rigorously tested and validated using scientific methods. It is also important to recognize the limitations of AI and the potential for bias in its outputs. Ultimately, the credibility of science depends on the rigor and transparency of the scientific method and the community's commitment to upholding those standards.

## **2. WHAT IS OPEN SCIENCE?**



# GIVE YOUR OPINION

- Based on the information you've just heard: what is open science to your opinion or what does it entail?
  - Write it on a piece of paper (1 minute)
- Discuss with your neighbour (2 minutes)
- Share! (2 minutes)

# OPEN SCIENCE

*“[O]pen science is defined as an inclusive construct that combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community. It comprises all scientific disciplines and aspects of scholarly practices, including basic and applied sciences, natural and social sciences and the humanities, and it builds on the following key pillars: open scientific knowledge, open science infrastructures, science communication, open engagement of societal actors and open dialogue with other knowledge systems.”*

UNESCO Recommendations on Open Science:

<https://unesdoc.unesco.org/ark:/48223/pf0000379949.locale=en> accessed on 12-04-2023

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# WHAT IS OPEN SCIENCE?

- Doing science right
- Opening the research process
- Inclusive
- Transparent and accountable
- Reproducible and allowing verification
- Science that is (more) relevant to society

Source: B. Kramer & J. Bosman, Utrecht University Library. Utrecht University Summer School (August 26-30, 2019)

Link: [https://docs.google.com/presentation/d/1V5iJarksQlzJNBM0T8FrrbgGrEhthScY585JEfx7eCk/edit#slide=id.g3d88e11ed5\\_3\\_67](https://docs.google.com/presentation/d/1V5iJarksQlzJNBM0T8FrrbgGrEhthScY585JEfx7eCk/edit#slide=id.g3d88e11ed5_3_67)



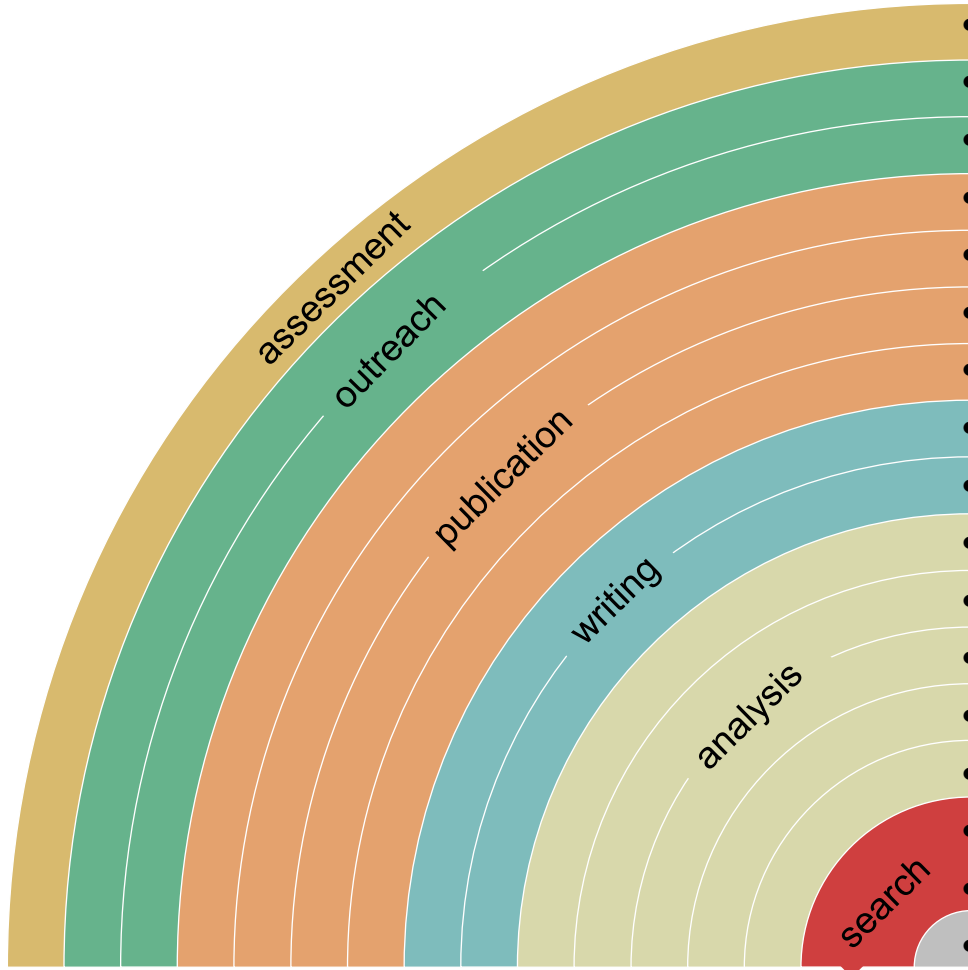
# OPEN SCIENCE AFFECTS THE ENTIRE RESEARCH CYCLE



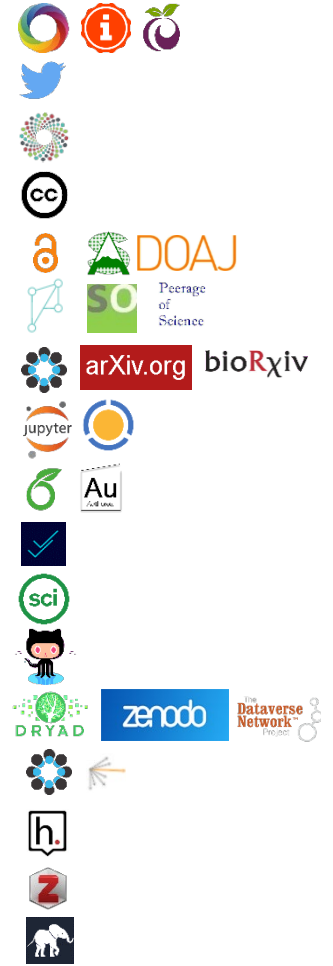
Adapted from: B. Kramer & J. Bosman, Utrecht University Library. Utrecht University Summer School (August 26-30, 2019)

Link: [https://docs.google.com/presentation/d/1V5iJarksQlzJNBM0T8FrrbgGrEhthScY585JEfx7eCk/edit#slide=id.g3d88e11ed5\\_3\\_67](https://docs.google.com/presentation/d/1V5iJarksQlzJNBM0T8FrrbgGrEhthScY585JEfx7eCk/edit#slide=id.g3d88e11ed5_3_67)

# OPEN SCIENCE IS NOT ONLY ABOUT OPEN ACCESS PUBLISHING!



- adding alternative evaluation, e.g. with altmetrics
- communicating through social media, e.g. Twitter
- sharing posters & presentations, e.g. at FigShare
- using open licenses, e.g. CC0 or CC-BY
- publishing open access, 'green' or 'gold'
- using open peer review, e.g. at journals or PubPeer
- sharing preprints, e.g. at OSF, arXiv or bioRxiv
- using actionable formats, e.g. with Jupyter or CoCalc
- open XML-drafting, e.g. at Overleaf or Authorea
- sharing protocols & workfl., e.g. at Protocols.io
- sharing notebooks, e.g. at OpenNotebookScience
- sharing code, e.g. at GitHub with GNU/MIT license
- sharing data, e.g. at Dryad, Zenodo or Dataverse
- pre-registering, e.g. at OSF or AsPredicted
- commenting openly, e.g. with Hypothes.is
- using shared reference libraries, e.g. with Zotero
- sharing (grant) proposals, e.g. at RIO



# TOOLS FOR OPEN SCHOLARLY COMMUNICATION

101 Innovative tools and sites in 6 research workflow phases  
(< 2000 - 2015)



- 400+ tools for open scholarly communication!

Source: Kramer, Bianca; Bosman, Jeroen (2015): 101 Innovations in Scholarly Communication - the Changing Research Workflow. figshare. Poster.  
<https://doi.org/10.6084/m9.figshare.1286826.v1>

# PROMISES OF OPEN SCIENCE

- Improve quality of research
  - More transparent and reproducible
- Efficiency of research
  - Secondary data use
  - Reduce costs of research
  - New hypotheses generation
- Knowledge exchange and impact
  - Increased visibility
  - Credits for the entire work you performed (e.g. software code)

# BARRIERS TO OPEN SCIENCE

- Paywalls to consult AND share scientific knowledge
- Time requirement
- Lack of awareness
- Lack of institutional motivation
- Funding
- Lack of incentives



# RISKS OF OPEN SCIENCE

- Data misuse and misinterpretation
- Loss of privacy
- Ethical concerns:
  - Different legislations address data sharing and confidentiality differently
  - Ethically controversial studies may lead to decreased willingness to participate in research

Source: Lakomý et al. 2019

# OPEN SCIENCE IS ABOUT SCIENCE & SOCIETY

- Performing relevant research for and with society
- Public outreach and engagement
- Mitigate misinformation
- Citizen science
  - Citizen as contributors and collaborators in research project
  - Citizens' active participation in different stage of the research cycle
  - ECSA 10 Principles of Citizen Science
    - <https://www.ecsa.ngo/ecsa-guidelines-and-policies/>

# OPEN SCIENCE INITIATIVES

- Open repositories
  - Open Science Framework
  - ZENODO
  - DANS-EASY
  - ...
- Fostering the practical implementation of Open Science (FOSTER)
- Framework for Open and Reproducible Research Training (FORRT)
- Open Science Communities
  - Student Initiative on Open Science
- FAIR data
- European Citizen Science Association
- And many more...

# FAIR PRINCIPLES

- Findability
  - Meta-data
  - Easy for both human and machines
  - Unique persistent identifier (e.g. doi)
- Accessibility
  - Clear on how to access the data (authorization?)
- Interoperability
  - With other applications and workflows
- Reusability
  - Ultimate goal of FAIR
  - (meta)data should be clearly described
  - Allow replication and combination with other data

Source: GO FAIR <https://www.go-fair.org/fair-principles/> accessed on 12-04-2023



# RECOGNITION AND REWARDS ASSESSMENT

- Goal:
  - Broader recognition of academic staff's work (e.g. education, research, impact, leadership and patient care)
  - More diversity in academic career paths
  - Focus on quality, creativity and content instead of quantity of research results
  - Stimulating Open Science
  - Stimulating academic leadership
- It will take some time!
- In NL: <https://recognitionrewards.nl/>
- @UT: <https://www.utwente.nl/en/service-portal/topics/recognise-reward-talent/#recognition-and-rewards-room-for-everybody-s-talent>

# OPEN SCIENCE @UT

- UT Shaping 2030:
  - Embrace Open Science
  - By 2023: Open Access and FAIR data as the new norm
- Open Science Community Twente
  - Events & Newsletter
- Digital Competence Centre, supports
  - Improving open, reproducible, and transparent research
  - Open Access publication
  - Adhering to FAIR principles
- 4TU FAIR data Fund
- BMS Open Access Fund
- Recognition & Rewards: Shaping Expert Group Individuals and Teams

# **3. OPEN SCIENCE IN HTA**

# TO YOUR OPINION

1. Why is Open Science relevant in the context of HTA / HE modelling?
2. How does the Open Science principles and practices affect HTA/ HE modelling?



# WHY OPEN-SOURCE MODELLING?

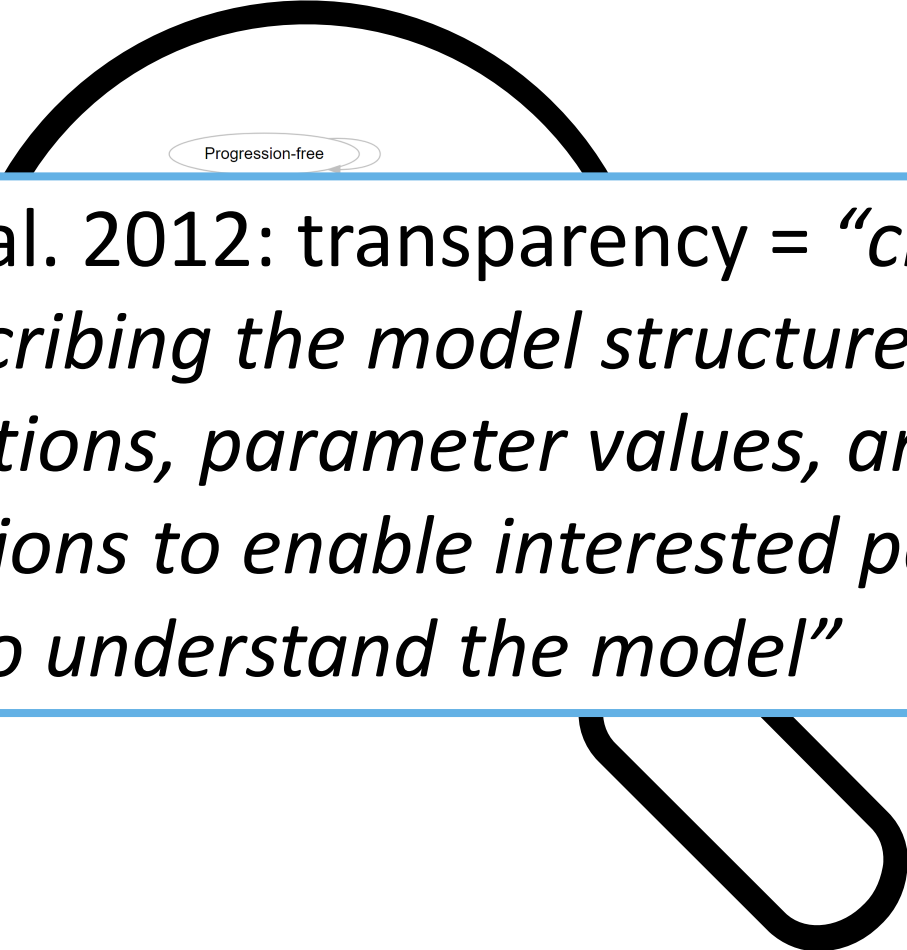
- HE models inform public health decisions
  - HE models are generally not publicly available
    - Lack of transparency
    - Difficult to get insights in how HE models work
  - Lack of systematic (reporting of) model validation
    - Risk of errors → harmful decisions
- ‘Black box’ feeling

*“an article about computational result is advertising, not scholarship. The actual scholarship is the full software environment, code and data, that produced the result.”*

Source: Donoho DL. An invitation to reproducible computational research. *Biostatistics*. 2010;11(3):385–8. pmid:20538873

# HEALTH ECONOMIC MODEL TRANSPARENCY

What is (health economic) model transparency?



Progression-free

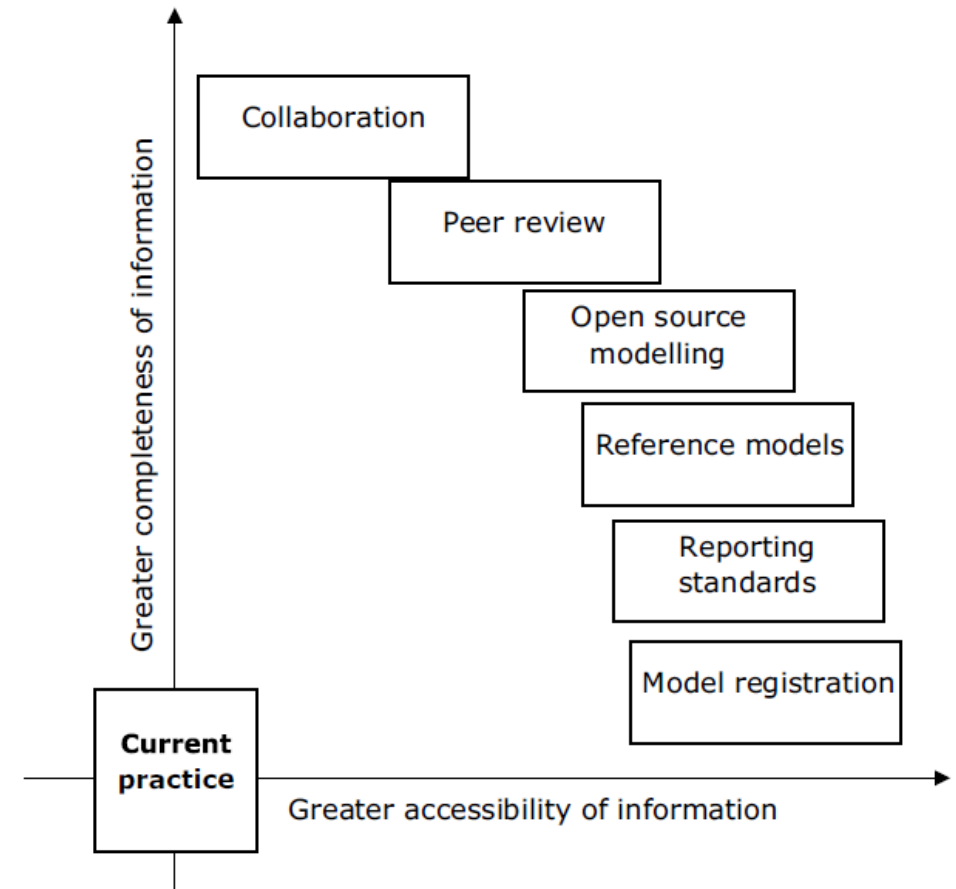
Eddy et al. 2012: transparency = *“clearly describing the model structure, equations, parameter values, and assumptions to enable interested parties to understand the model”*

Figure:  
Own material & logo's are used with  
permission from Microsoft

# TRANSPARENCY IS NOT ONLY ABOUT PROGRAMMING

```
1 C   A weird program for calculating Pi written in Fortran.
2 C   From: Fink, D.G., Computers and the Human Mind, Anchor Books, 1966.
3
4   PROGRAM PI
5   DIMENSION TERM(100)
6   N=1
7   3 TERM(N)=((-1)**(N+1))*(4./(2.*N-1.))
8   N=N+1
9   IF (N-101) 3,6,6
10  6 N=1
11  7 SUM98 = SUM98+TERM(N)
12  WRITE(*,28) N, TERM(N)
13  N=N+1
14  IF (N-99) 7, 11, 11
15  11 SUM99=SUM98+TERM(N)
16  SUM100=SUM99+TERM(N+1)
17  IF (SUM98-3.141592) 14,23,23
18  14 IF (SUM99-3.141592) 23,23,15
19  15 IF (SUM100-3.141592) 16,23,23
20  16 AV89=(SUM98+SUM99)/2.
21  AV90=(SUM99+SUM100)/2.
22  COMANS=(AV89+AV90)/2.
23  IF (COMANS-3.1415920) 21,19,19
24  19 IF (COMANS-3.1415930) 20,21,21
25  20 WRITE(*,26)
26  GO TO 22
27  21 WRITE(*,27) COMANS
28  STOP
29  23 WRITE(*,25)
30  GO TO 22
31  25 FORMAT('ERROR IN MAGNITUDE OF SUM')
32  26 FORMAT('PROBLEM SOLVED')
33  27 FORMAT('PROBLEM UNSOLVED', F14.6)
34  28 FORMAT(I3, F14.6)
35  END
36
```

Source: <https://www.quora.com/What-do-you-mean-for-IT-spaghetti-code>



Source: Sampson et al. 2019

# MODEL TRANSPARENCY – EDDY ET AL. 2012

- ‘What does the model do and how?’
- Purpose:
  - Allow review of the model’s structure, equations, parameter values and assumptions
  - In order to understand model accuracy, limitations and potential applications
- Documentation is crucial:
  - Non-technical: for any interested reader, to understand the model results
  - Technical: for reviewers and modellers, to be able to review/replicate the model

# TRANSPARENCY OF INTENDED METHODS

## Methodology

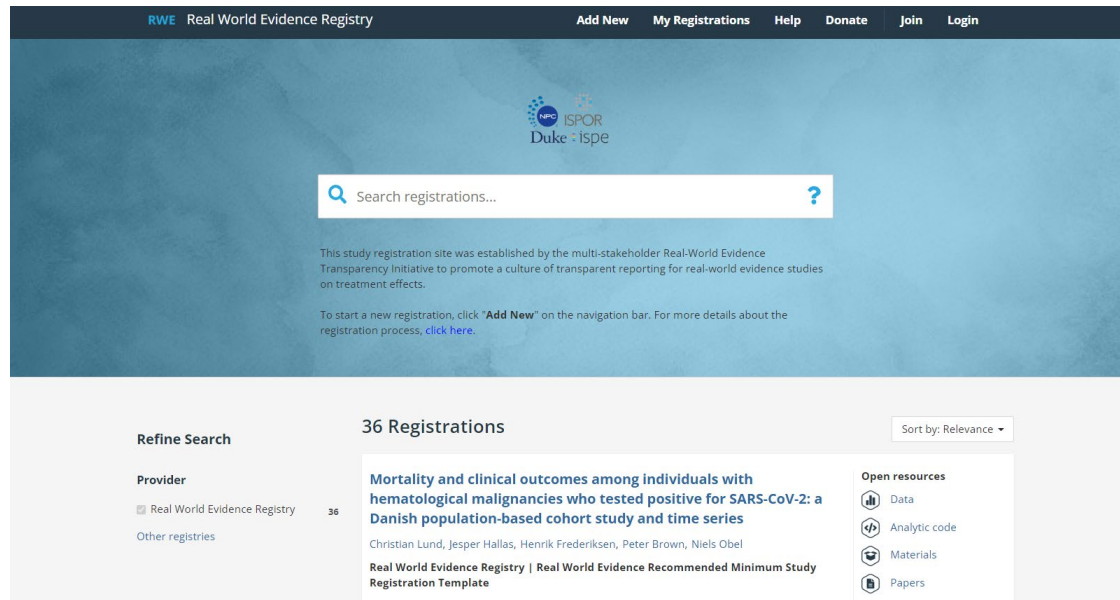
### **Content of Health Economics Analysis Plans (HEAPs) for Trial-Based Economic Evaluations: Expert Delphi Consensus Survey**



Joanna C. Thorn, PhD,\* Charlotte F. Davies, PhD,\* Sara T. Brookes, PhD, Sian M. Noble, PhD, Melina Dritsaki, PhD, Ewan Gray, PhD, Dyfrig A. Hughes, PhD, Borislava Mihaylova, DPhil, Stavros Petrou, PhD, Colin Ridyard, PhD, Tracey Sach, PhD, Edward C.F. Wilson, PhD, Sarah Wordsworth, PhD, William Hollingworth, PhD

- Why? Lack of consistency!
- 58 items divided in 8 sections (administrative data, method of data collection & analysis, reporting, ...)
- You can still deviate from the plan → justify why

# TRANSPARENCY THROUGH REGISTRATION



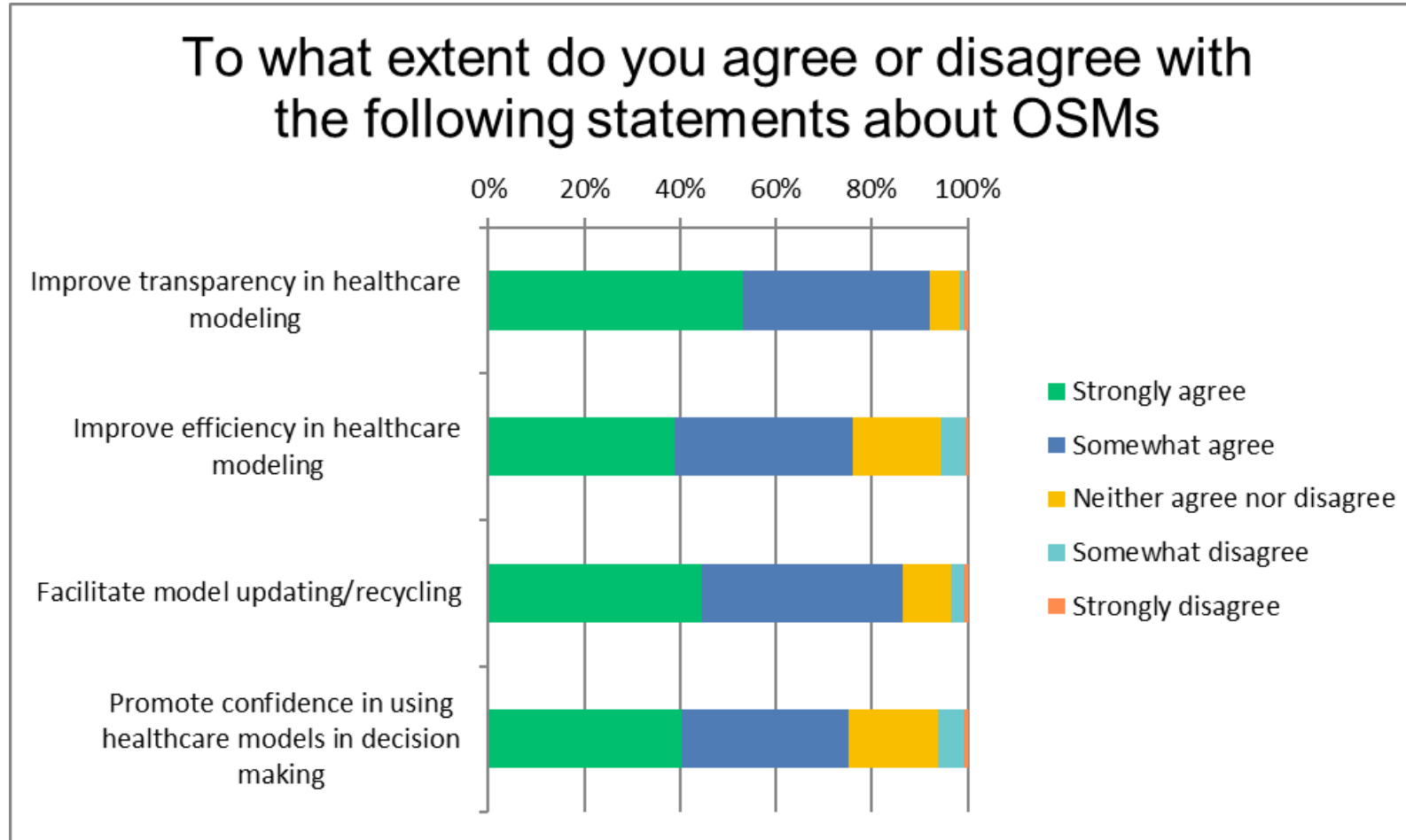
- Real world evidence registry
  - Improve transparency of reporting of studies using real-world evidence
- 36 registrations since 2021...

Source: <https://osf.io/registries/rwe/discover>  
accessed on 12-04-2023

# TRANSPARENCY THROUGH OPEN-SOURCE MODELS (OSM)

- OSM Clearinghouse (<https://cevr.shinyapps.io/Clearinghouse/>)
  - Repository of OSM
- PeerModels Network (<https://www.peermodelsnetwork.com/>)
  - Improve model accessibility
  - Stakeholders' involvement
- Innovation and Value Initiative (<https://thevalueinitiative.org/>)
  - OSM development
  - Stakeholders' involvement and iterative model development
- ISPOR Open Source Models Special Interest Group

# WHY OPEN-SOURCE MODELS?



Source: Pouwels et al. 2022



# IMPROVING PRACTICE THROUGH OSM

PharmacoEconomics (2019) 37:1329–1339  
<https://doi.org/10.1007/s40273-019-00837-x>

PRACTICAL APPLICATION



**A Need for Change! A Coding Framework for Improving Transparency in Decision Modeling**

Fernando Alarid-Escudero<sup>1</sup> · Eline M. Krijkamp<sup>2</sup> · Petros Pechlivanoglou<sup>3</sup> · Hawre Jalal<sup>4</sup> · Szu-Yu Zoe Kao<sup>5</sup> · Alan Yang<sup>6</sup> · Eva A. Enns<sup>5</sup>

- Framework using open source software R
- Coding recommendations
  - Map structure
  - Variable names
- Why?  
→ Not all health economists are not software engineers!

# OSM IN PRACTICE

Pharmacoeconomics (2019) 37:1313–1320  
<https://doi.org/10.1007/s40273-019-00827-z>

PRACTICAL APPLICATION

## Developing Open-Source Models for the US Health System: Practical Experiences and Challenges to Date with the Open-Source Value Project

Jeroen P. Jansen<sup>1,2</sup> · Devin Incerti<sup>1</sup> · Mark T. Linthicum<sup>1</sup>

Pharmacoeconomics (2019) 37:829–843  
<https://doi.org/10.1007/s40273-018-00765-2>

ORIGINAL RESEARCH ARTICLE

## A Flexible Open-Source Decision Model for Value Assessment of Biologic Treatment for Rheumatoid Arthritis

Devin Incerti<sup>1</sup> · Jeffrey R. Curtis<sup>2</sup> · Jason Shafrin<sup>1</sup> · Darius N. Lakdawalla<sup>3</sup> · Jeroen P. Jansen<sup>1,4</sup>

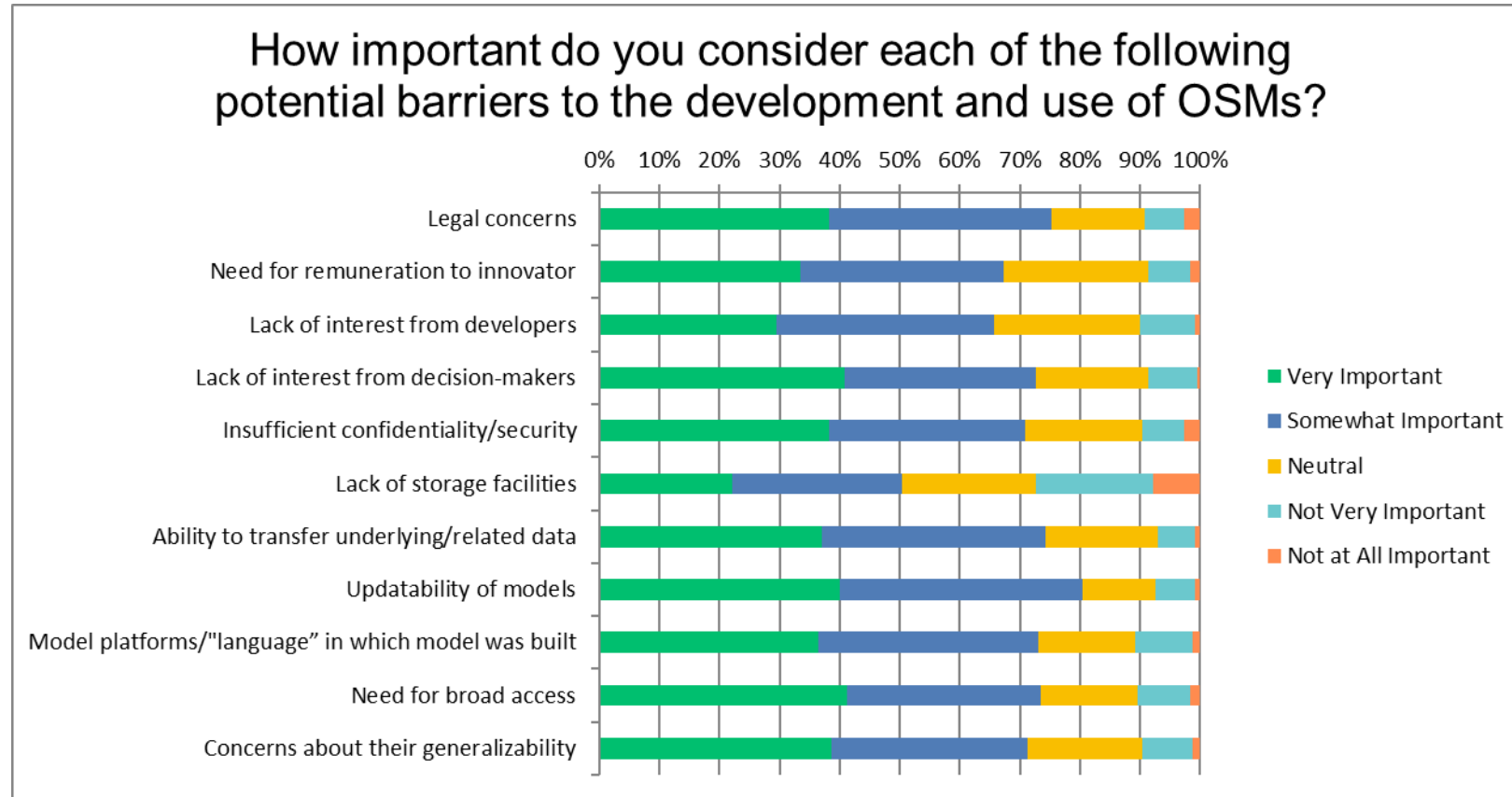


- Accessibility
  - Different stakeholders require different (level of) information (e.g. web-interface)
  - Requires more resource than traditional HE models
- Iterative development based on stakeholders' feedback
  - Challenging to include clinical expert feedback

# OPEN-SOURCE HE MODELS

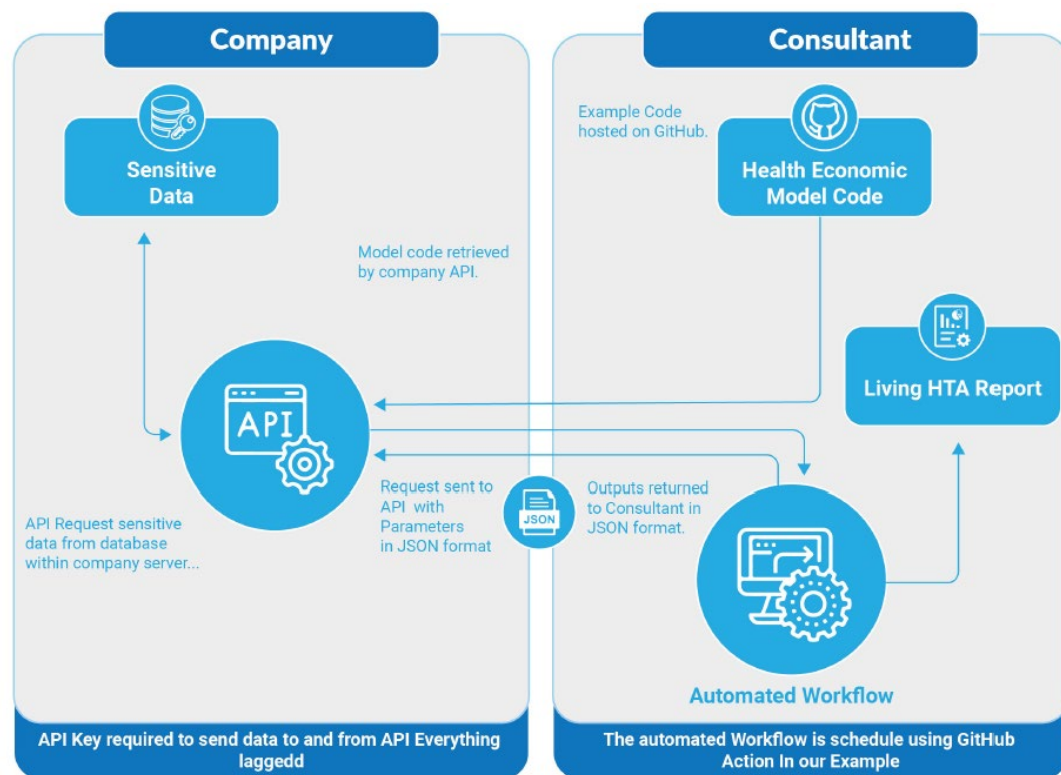
- Any idea why health economic models are not routinely publicly accessible?

# BARRIERS TO OPEN-SOURCE HE MODELS



Source: Pouwels et al. 2022

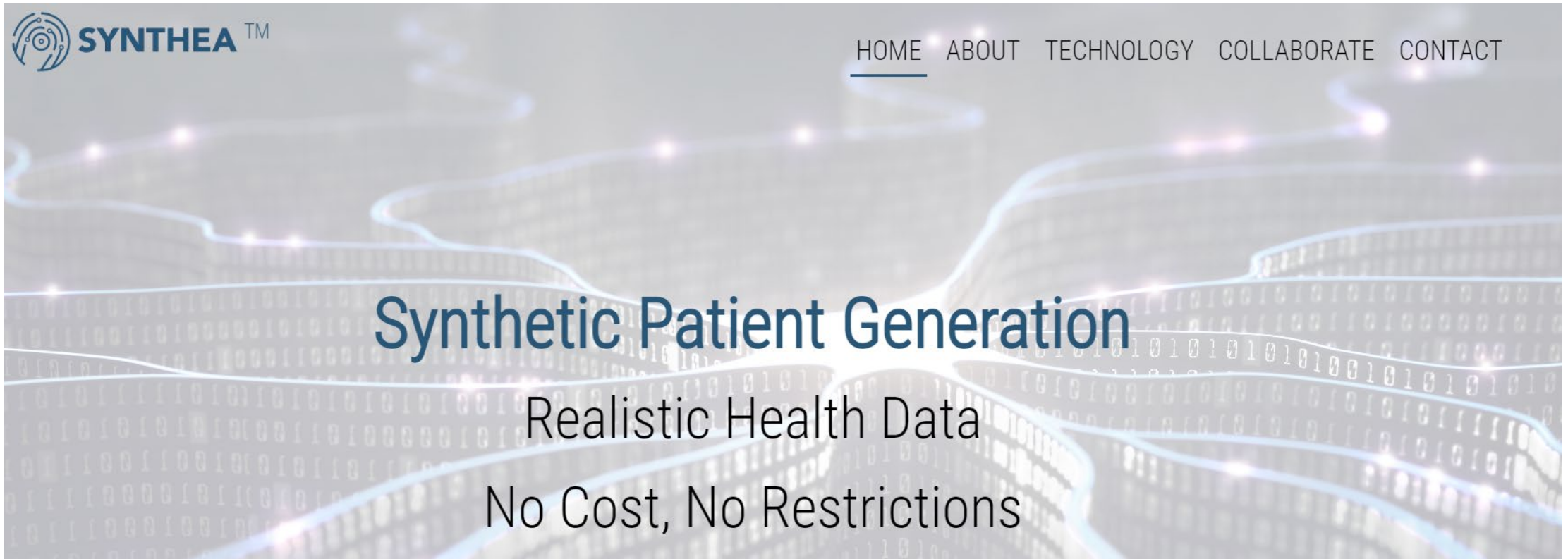
# OVERCOMING BARRIERS – CONFIDENTIALITY LIVING HTA'S



Source: Smith et al. 2020

- Avoid sending / sharing data
- Data separated from model
  - Transparency & validation
- Automatic update of results
  - New data
- BUT
  - Not yet 100% safe
  - Running model remotely is still a 'black box'
  - Still complex to set up
  - Working without the underlying data is challenging

# OVERCOMING BARRIERS – CONFIDENTIALITY SYNTHETIC DATA

A banner for the Synthea website. The background is a light blue-grey gradient with glowing blue lines and binary code (0s and 1s) scattered throughout. In the top left corner is the Synthea logo, which consists of a stylized circular icon with a central dot and the word "SYNTHEA" in blue capital letters followed by a trademark symbol. In the top right corner, there is a navigation menu with the words "HOME", "ABOUT", "TECHNOLOGY", "COLLABORATE", and "CONTACT" in a light blue-grey font, with "HOME" underlined. In the center of the banner, the text "Synthetic Patient Generation" is written in a large, bold, blue font. Below this, the text "Realistic Health Data" and "No Cost, No Restrictions" is written in a smaller, black font.

**SYNTHEA**™

HOME ABOUT TECHNOLOGY COLLABORATE CONTACT

**Synthetic Patient Generation**

Realistic Health Data

No Cost, No Restrictions

Source: <https://synthetichealth.github.io/synthea/#home>  
accessed on 12-04-2023

# BROADENING ACCESS MAKING HE MODELS SHINY

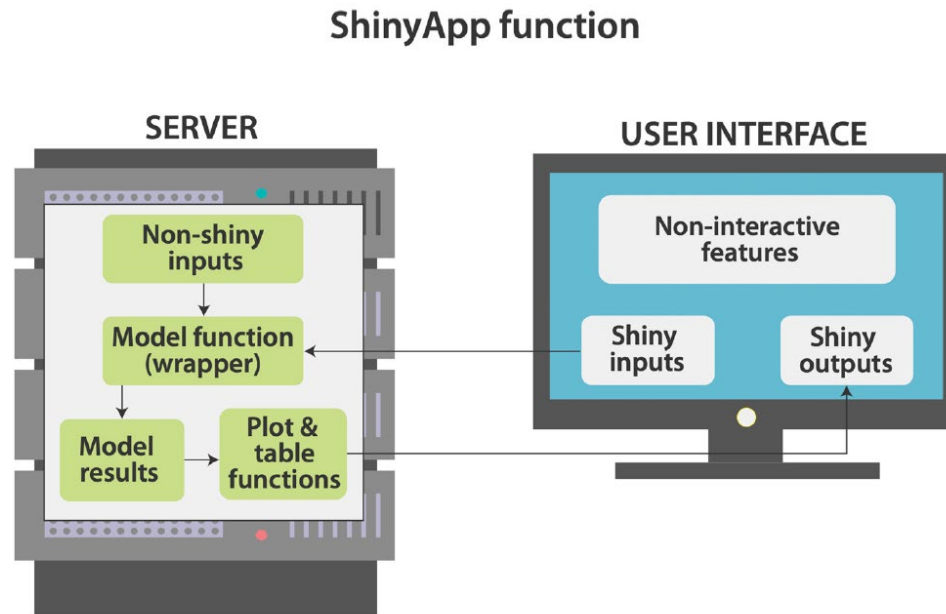


Figure 1. Diagram depicting how the Sick-Sicker app is structured.

Source: Smith & Schneider. 2020

- Allows non-technical users to interact with HE model
  - Useful for communication and validation
- Requires additional skills
- Shortcut:
  - [ShinyQuickStarter](https://cran.r-project.org/web/packages/ShinyQuickStarter/index.html) (<https://cran.r-project.org/web/packages/ShinyQuickStarter/index.html>)

# BENEFITS & RISKS OF TRANSPARENCY

Benefits	Risks
<u>Productivity</u>	
<ul style="list-style-type: none"><li>• Prevent duplication</li><li>• Increase efficiency</li><li>• Avoid delays</li></ul>	<ul style="list-style-type: none"><li>• Greater workload</li><li>• Potential delays</li><li>• Diminishing returns</li></ul>
<u>Scope and rigour</u>	
<ul style="list-style-type: none"><li>• Error reduction</li><li>• Improve quality</li><li>• Facilitate validation</li></ul>	<ul style="list-style-type: none"><li>• Misuse</li></ul>
<u>Accountability</u>	
<ul style="list-style-type: none"><li>• Accountability for reasonableness</li><li>• Maintenance of IP</li><li>• Greater credibility</li></ul>	<ul style="list-style-type: none"><li>• Risk to career</li><li>• Risk to IP</li><li>• Burden of responsibility</li></ul>

Source: Sampson et al. 2019



# THE MODEL VALIDITY (EDDY ET AL. 2012)

Reliability: Are the results reproducible?

*More technical issue*

Validity: Is the model fit-for-purpose?

*Non-technical, requires judgement*



Source:

<https://pixabay.com/vectors/tiro-target-butt-shot-gun-bullet-160574/>



# THE MODEL VALIDITY (EDDY ET AL. 2012)

- ‘How well does the model represent reality?’
  - Purpose: judging the accuracy of a model in making suitable/relevant predictions
  - Can we ‘trust’ the model and model outcomes?
- Consider
  - Simplifications
  - Assumptions
  - Different sources
  - Extrapolations

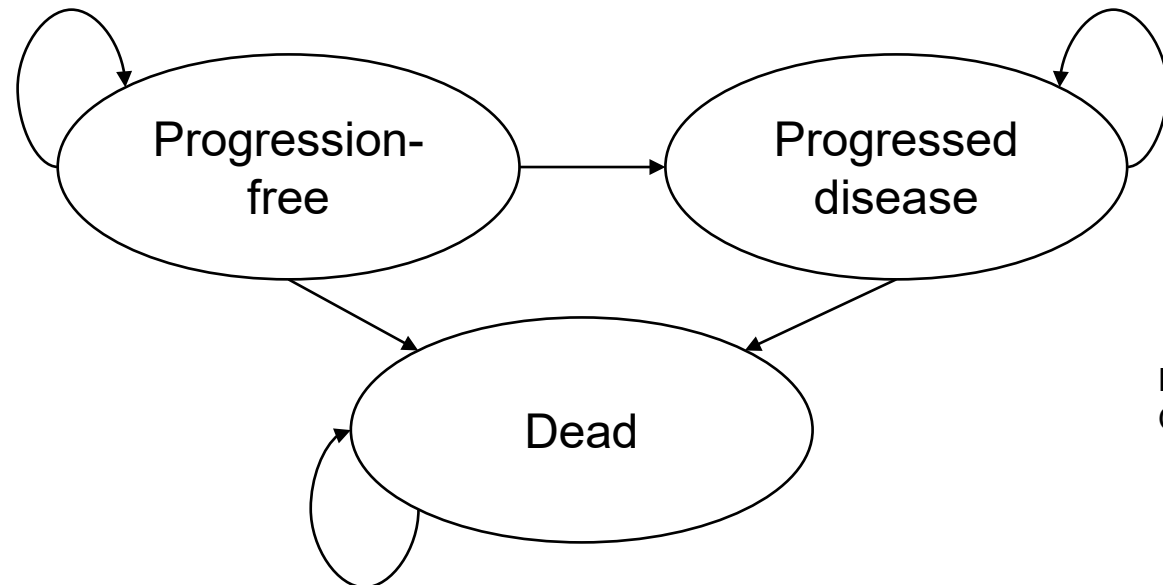


Figure:  
Own material

# TYPES OF VALIDITY (EDDY ET AL. 2012)

- Face validity
  - Corresponding to current science & evidence
- Verification / internal validity
  - Behave as intended / implemented correctly
- Cross validity
  - Comparing the model with others
- External validity
  - Model outcomes compared with real world outcomes
- Predictive validity
  - Model forecasts compared with actual outcomes

# ASSESSING THE VALIDITY OF HE MODELS

- AdviSHE (Vemer et al. 2015): Tool to help **describe** validation efforts :
  - Validation of the conceptual model
  - Input data validation
  - Validation of the computerised model
  - Operational validation
  - Other validation techniques
- TECH-VER checklist (Büyükkaramiki et al. 2019): comprehensive checklist for the **technical verification** of decision analytical models

# 4. WHY SHOULD I CARE?

Adapted from: Student Initiative for Open Science. SIOS LECTURE “Introduction TO open science”  
Retrieved from <https://osf.io/2qsd6> on 30-11-2022

# YOUR OPINION IS NEEDED

- Discuss in pairs (3 minutes)
  - Why do you think Open Science is relevant to you?
  - How do you think Open Science may affect your daily working life?
- Share (2 minutes)

# FIRST

## SOURCE: SIOS 2019

- You are the future **researcher**
  - Perform research relevant for society
  - Moral 'obligation' to perform open, transparent, and reproducible research
  - Adherence to Open Science is gaining attention for academic careers
- You are the future **practitioners**
  - Best practices informed by Open research
- You are (future) **citizens**
  - Be critical, not cynical!
  - Don't believe everything you read

# SECOND

- You may benefit from Open Science endeavours:
  - Find and re-use open data and software
    - Efficiency gain!
  - Facilitate collaboration
  - Enhance quality of your work
  - Enhance visibility of your work



# WRAP UP

- Open Science is a movement promoting research that is more:
  - Transparent
  - Valid
  - Reproducible
  - Reusable
  - Accessible
  - Inclusive
- Within HTA, Open Science is mostly championed through open-source modelling, public outreach, stakeholder involvement during HE model development
- You may benefit from practicing Open Science!

# ANY QUESTION?

## A Rough Guide to SPOTTING BAD SCIENCE

Being able to evaluate the evidence behind a scientific claim is important. Being able to recognise bad science reporting, or faults in scientific studies, is equally important. These 12 points will help you separate the science from the pseudoscience.

- 1. SENSATIONALISED HEADLINES**

**Aa** Article headlines are commonly designed to entice viewers into clicking on and reading the article. At times, they can over-simplify the findings of scientific research. At worst, they sensationalise and misrepresent them.
- 2. MISINTERPRETED RESULTS**

**X** News articles can distort or misinterpret the findings of research for the sake of a good story, whether intentionally or otherwise. If possible, try to read the original research, rather than relying on the article based on it for information.
- 3. CONFLICTS OF INTEREST**

**X** Many companies will employ scientists to carry out and publish research - whilst this doesn't necessarily invalidate the research, it should be analysed with this in mind. Research can also be misrepresented for personal or financial gain.
- 4. CORRELATION & CAUSATION**

**Graph** Be wary of any confusion of correlation and causation. A correlation between variables doesn't always mean one causes the other. Global warming increased since the 1800s, and pirate numbers decreased, but lack of pirates doesn't cause global warming.
- 5. UNSUPPORTED CONCLUSIONS**

**???** Speculation can often help to drive science forward. However, studies should be clear on the facts their study proves, and which conclusions are as yet unsupported ones. A statement framed by speculative language may require further evidence to confirm.
- 6. PROBLEMS WITH SAMPLE SIZE**

**Person** In trials, the smaller a sample size, the lower the confidence in the results from that sample. Conclusions drawn can still be valid, and in some cases small samples are unavoidable, but larger samples often give more representative results.
- 7. UNREPRESENTATIVE SAMPLES USED**

**Magnifying Glass** In human trials, subjects are selected that are representative of a larger population. If the sample is different from the population as a whole, then the conclusions from the trial may be biased towards a particular outcome.
- 8. NO CONTROL GROUP USED**

**Two People** In clinical trials, results from test subjects should be compared to a 'control group' not given the substance being tested. Groups should also be allocated randomly. In general experiments, a control test should be used where all variables are controlled.
- 9. NO BLIND TESTING USED**

**Eye** To try and prevent bias, subjects should not know if they are in the test or the control group. In 'double blind' testing, even researchers don't know which group subjects are in until after testing. Note, blind testing isn't always feasible, or ethical.
- 10. SELECTIVE REPORTING OF DATA**

**Bar Chart** Also known as 'cherry picking', this involves selecting data from results which supports the conclusion of the research, whilst ignoring those that do not. If a research paper draws conclusions from a selection of its results, not all, it may be guilty of this.
- 11. UNREPLICABLE RESULTS**

**Refresh** Results should be replicable by independent research, and tested over a wide range of conditions (where possible) to ensure they are consistent. Extraordinary claims require extraordinary evidence - that is, much more than one independent study!
- 12. NON-PEER REVIEWED MATERIAL**

**Book** Peer review is an important part of the scientific process. Other scientists appraise and critique studies, before publication in a journal. Research that has not gone through this process is not as reputable, and may be flawed.

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Source: Compound of Interest. 2014. A Rough Guide to Spotting Bad Science. <https://www.compoundchem.com/wp-content/uploads/2014/04/A-Rough-Guide-to-Spotting-Bad-Science-20151.pdf> accessed on 12-04-2023

**ANY QUESTION ON THE HTA-RELATED  
LITERATURE?**



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