On Successfully Implementing Medical Guidelines for Breast Cancer Screening: A Role for Agent-Based Simulation Analysis in Mitigating Overdiagnosis

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Abstract: This study presents a methodological strategy for contributing to the successful implementation of breast cancer screening with minimal overdiagnosis based on the development of agent-based simulation models, with a special focus on improving health communication.

Background: Implementation science is a new branch of translational studies that focuses primarily on the development of patient-centered post-studies in the context of health care research, with the use of sophisticated multiple-scenario complex computational models, complementary to observational studies (Madon et al 2007). It focuses on comparatively studying the adoption of a variety of procedures and agents in health care practice ultimately to improve health outcomes, prior to their instantiation, thereby reducing avoidable risk as an ethical imperative (Garbayo & Stahl, 2016).

Despite its ethical relevance and urgency, implementation science post-studies are not yet largely pursued (Solomon, 2010). That lack of implementation data affects the ability of health care providers to have more precise knowledge on how prevent and/or mitigate overdiagnosis in the context of health care application of a non-idealized, real-life implementation medical decision science. In the case of breast cancer screening, post-studies of implementation errors on breast cancer screening regarding patient understanding and decision-making considering the 2009 US Preventive Task Force (USPTF) were scarce. In order to avoid breast cancer overdiagnosis, USPTF recommended starting mammography at age 50, in sharp contrast with previous guidelines proposed by cancer societies. The resulting guideline disagreement generated much public confusion, particularly given the public perception of early screening as providing an established good, such as improved survival due to early screening. We suggested elsewhere (Garbayo & Stahl, 2016) that such types of implementation errors that fail to inform patient shifting of screening behavior, should primarily be conceived as modeling problems for ethically handling psychology of communication and information diffusion issues in the case of guideline disagreement. To mitigate these threats, preventive post-studies can be simulated with a combination of different techniques, such as discrete-based simulation and, most importantly, agent-based simulation (Banks, 1998). We suggest that modeling and simulation analysis of information flow, spread, networks of agents as autonomous decision-makers - with the inclusion of communication failure costs - should be pursued to improve our understanding of the health communication state of affairs as a result of implementing new guidelines in a context of guideline disagreement, in order to ultimately better support a patient-centered shared-decision-making platform, mitigating harms for patients associated to breast cancer screening overdiagnosis.

In order to fulfill this methodological gap, we suggest adapting the D.E.E.P. (Stahl, 2008 - Describe, Evaluate, Explore, Predict, Persuade) framework for designing discrete event simulations in health care to the post-studies of breast cancer screening under medical guideline disagreement. We propose to extend and modify this framework so that it could also be also applicable for agent-based simulations, considering in particular, the need for agent simulating information flow, spread, network and communication costs.

Objectives: This ongoing study aims at methodologically proposing agent-based simulating breast cancer screening medical guideline implementation health communication scenarios in order to ultimately contribute to mitigate overdiagnosis.

Method: Agent-based simulation of health communication is used under a modified D.E.E.P framework for discrete-event simulation (Stahl, 2008) - Agent D.E.E.P. studies may be particularly suited to research uncertainty effects in patients' decision-making strategies regarding breast cancer-screening and breast cancer prevention in clinical setting, extended for agent-based simulation. DEEPP (Stahl, 2008) original propositions, Describe, Evaluate, Explore, Predict, Persuade, are extended appropriately.

Results: Preliminary agent-based simulation methodology research converges into a learning-curve reduction of agent uncertainty regarding the implementation of medical guidelines for breast cancer screening overdiagnosis based on the projected simulation and revision of distributed results in communication models in clinical and public health settings and in the noise reduction of competing guidelines, as well for the modeler.

AGENT D.E.E.P.	PUBLIC HEALTH LEVEL	CLINICAL LEVEL	MODELER LEVEL
DESCRIBE	Agent-based simulation in the context of the aggregate of organization - describe information flow, spread - contagion models, signaling models	Agent-based simulation in the clinical team concerning medical decision-making on breast cancer screening under uncertainty, personalization, shared-decision-making with value clarification modeling	Challenge to design agent communication network under guideline disagreement; calibration challenges
EVALUATE	Agent-based simulations consider criteria of success (scientific, ethical, epistemic) and models ranking models in the context of public health Traffic signaling models test rules with outcomes	Agent-based simulations consider criteria of success (scientific, ethical, epistemic) and models ranking models in clinical context	Ranking criteria simulation research, with ethical, epistemic and scientific considerations in designing evaluative elements of agent-based simulation
EXPLORE	Agent-based simulations to explore alternative scenarios and hypotheses on public health policy	Agent-based simulations to explore alternative scenarios and hypotheses on shared decision-making	Exploration of data-driven and hypotheses driven research, coupled with real-life decision science methodological considerations
PREDICT	Agent-based simulation for predictive analysis at the broader, public health level Traffic signaling model	Agent-based simulation for predictive analysis at the narrower, clinical level Traffic signaling model	Design predictive analyses models and consider observational studies for statistical inference
PERSUADE	Agent-based simulations developed to clarify persistent disagreement and provide basis for strengthening the discussion on implementation strategies at the public health level	Agent-based simulations developed to clarify persistent disagreement and provide basis for strengthening the discussion on screening weighting at the clinical level	Broader consideration on simulation analytics and medical guidelines disagreement, contradiction and representation (logic, semantic) and relevance (ethical, epistemic)

Conclusions: Agent-based simulation research in an AgentDEEP framework may contribute with ethically developed, implementation knowledge for policy-makers and implementers for predicting and reducing confusion in the information flow for patients contemplating the decision of doing a breast cancer screening under guideline uncertainty, while avoiding overdiagnosis, and thereby contribute to reduce harm and strengthen patient autonomy and participation in the medical decision-making process.

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