Theoretical Foundations for Evidence-Based Health Informatics: Why? How?

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Abstract. A scientific approach to health informatics requires sound theoretical foundations. Health informatics implementation would be more effective if evidence-based and guided by theories about what is likely to work in what circumstances. We report on a Medinfo 2015 workshop on this topic jointly organized by the EFMI Working Group on Assessment of Health Information Systems and the IMIA Working Group on Technology Assessment and Quality Development. We discuss the findings of the workshop and propose an approach to consolidate empirical knowledge into testable middle-range theories.

Keywords. theory, evidence, health informatics, policy, evaluation

1. Introduction

As part of the evidence-based health informatics (EBHI) movement [1], the EFMI Working Group on Assessment of Health Information Systems and the IMIA Working Group on Technology Assessment and Quality Development held a workshop at Medinfo 2015 to explore how theory in health informatics (HI) is perceived and what can be done to advance theoretical work in the field. In this paper, we report on the workshop discussions and suggest an agenda for theory-based health informatics.

2. Why we need theory in health informatics

For the purposes of our workshop, we adopted the following dictionary definition of theory: "A scheme or system of ideas or statements held as an explanation or account of a group of facts or phenomena; a hypothesis that has been confirmed or established by observation or experiment, and is propounded or accepted as accounting for the known

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facts; a statement of what are held to be the general laws, principles, or causes of something known or observed." [2].

Thus, theory can be explanatory or predictive and encompass a broad continuum of knowledge claims. Gregor [3] proposed five categories of theory in information systems: (1) descriptive, (2) explanatory, (3) predictive, (4) explanatory and predictive, (5) methodological ('how to'). We have elsewhere discussed practitioner demand for theory in HI [4], the need to understand theoretical principles in evaluation studies [5] and how theory can aid the conceptualization of a problem domain [6].

The essential argument for theory is that general principles can be tested, then qualified or falsified and ultimately applied in real world practice if not rejected when empirically investigated. In Lewin's famous aphorism, 'there is nothing more practical than a good theory' [7]. Substantial investments are made in HI, often with unrealistic expectations of unalloyed benefit [8], and major safety and efficiency implications if things go wrong. Therefore, HI policy would benefit from evidence-based theoretical frameworks that explain or predict what is likely to work in what circumstances. 'Facts do not speak for themselves' [9] – they need interpretation and synthesis.

Even with Gregor's most fundamental type, *descriptive* theory, we are forced to think more precisely by classifying our knowledge with defined concepts and relational propositions. Descriptive theory thus gives a common language to articulate hypotheses and models of good practice and perform robust meta-analysis. HI textbooks, standards development groups [10] and proposed educational curricula [11] have provided at least a basic set of concept definitions [12]. Individual studies typically present context and background as an implicit 'map' of the field, but this is seldom articulated as descriptive theory. At the discipline level, there is no overall schema of knowledge in HI. In summary, we have some good building-blocks but no architecture.

3. Medinfo 2015 workshop

The aims of the workshop were to:
- Raise awareness of the need for EBHI to have strong theoretical foundations
- Explore perspectives on what theory can add and what forms it can take
- Identify priority areas for further theoretical work.

3.1. Introductory presentations

The first presenter discussed the definition of theory and illustrated some explicit and implicit theories and theoretical frameworks in HI. The second speaker highlighted the practical need for theory, highlighting that "we still have insufficient understanding of who, why, and under what conditions, [HI] interventions might work" [13]. The presentation argued for the value of realist evaluations that study the context-mechanism-outcome interrelationship. The final presenter illustrated the application of theory in a HI study, using the example of control theory employed in a study of audit and feedback mechanisms [14]. Participants were then split into two groups. The questions to get the discussion started were: What theoretical foundations does HI have? Which areas of HI policy and evaluation have greatest need of theoretical foundations? What kinds of theory are likely to be useful in these priority areas?

3.2. Group discussion

Participants highlighted the relative value of descriptive/prescriptive or explicit/implicit theory. "Implicit theory is useless… it's not science", in the words of one contributor. There was a recurring theme that testability, or falsifiability, was important for a theory to be really useful: "otherwise we are in the realm of belief or conjecture". A theory is a mental map and the goal of a theory is to predict an outcome. There should be a balance between generalizability and specificity of the theory to be useful and valuable.

The groups agreed on the need for theory, especially where much research has been done that could be utilized. The example of computerized physician order entry (CPOE) was cited. One participant had worked for a year in the area of clinical decision support systems (CDSS) but was not aware of explicit theories being used in studies evaluating CDSS (however, see [15]; this raises other questions about continuing professional development and keeping up with the literature). It was suggested that multiple theories are needed in some projects, depending on their complexity. Similarly, the relative immaturity of HI suggested that we will primarily be applying theory from other reference disciplines (such as psychology, when thinking about behaviour change) before developing our own.

Another common thread in the discussion was that a 'learning health system' gives a system, a framework, to integrate evaluation findings back into practice [16]. There was a view that HI is all about clinical decision-making, and that this is under-emphasized. The structure of a learning health system would foster an environment for real world testing of theories about clinical decision support. Standards for the way studies are reported will also affect whether theory is adequately explained – there was a view that STARE-HI [17] must be more explicit in describing the underlying theory.

Limitations were recognized too, including political and industrial constraints on generalization given the variance of commercial arrangements and governmental policies. Discussion included the difficulties of accounting for the multiple co-occurring variables arising from diversity in local customization, environment, configuration and workflow. Realist evaluation was generally seen as an effective way to manage that complexity and integrate qualitative and quantitative data.

A positive proposal was to develop a 'theory toolbox', cataloguing known theories and constructs whether from sociology, psychology, information systems, human factors engineering, implementation science, economics or wherever. The idea was voiced that this would be a good programme for a series of PhD projects, perhaps coordinated in some way. Theory should be an important element of HI education.

4. An agenda for theory development in evidence-based health informatics

We derive the following summary points from the workshop:
- General agreement that we need theory in HI
- Theory must be testable to be useful in real world application
- There are several prime areas in HI where a wealth of research evidence could be consolidated into theory
- Theory needs to be 'realist', considering what is likely to work in what circumstances

- A 'theory toolbox' would be a useful start (building upon previous work about evaluation methods [18] and implementation frameworks [19]).

The call for practical testability echoes Merton's argument for middle-range theory in sociology [20]: "Sociological theory, if it is to advance significantly, must proceed on these interconnected planes: (1) by developing special theories from which to derive hypotheses that can be empirically investigated and (2) by evolving, not suddenly revealing, a progressively more general conceptual scheme that is adequate to consolidate groups of special theories." For HI, that is likely to mean a mixture of domain-based theories and ones applied from other disciplines. They need to be abstract enough to permit generalization, but concrete enough to permit testing. It is the testability that we take to define the scale or level of theory as middle-range.

What topics in HI are candidates for middle-range theory? We suggest that there are grounds for a 'socio-technical theory of CPOE' (based on [21] etc.), covering social and technical aspects of design and implementation, critical success factors and unintended consequences. There could be a 'theory of clinical terminology', covering desiderata [22], usability, redundancy, comprehensibility and reliability. Another possibility is a 'theory of alerting', including severity, alert fatigue and context sensitivity. These are only examples. Some might be 'tested' post facto (cf. [23]) or by natural experiments [24], unless studies can be designed to allow controlled trials at an appropriate scale [25, 26].

A substantial obstacle to this agenda is that it may not be seen by funders as an attractive area of work (an opinion supported by experience of some of the authors). Therefore we suggest that a pragmatic way forward would be to form a collaborative network of PhD students and supervisors to make a start and demonstrate what can be done. An initial 'theory toolbox' should be eminently achievable. Funding sources for research collaboration and exchanges might support this. Our vision is in line with the WHO co-sponsored Bellagio call for an evidence-based approach to eHealth [27].

5. Conclusion

The Medinfo 2015 workshop was a useful opportunity to raise the profile of theory in EBHI and consult on how best to make progress. The authors gratefully acknowledge the experience and insights of the workshop participants. We have proposed an agenda to take forward middle-range theory development as an important component of EBHI and welcome constructive debate and collaboration. The proposal calls for practical testability based on consolidation of existing research findings into special theories that are abstract enough to generalize but concrete enough to test. This agenda offers a solid foundation for the continuing work of the IMIA Working Group on Technology Assessment and Quality Development, the EFMI Working Group on Assessment of Health Information Systems and the AMIA Working Group on Evaluation.

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