Research Needed for Efficient Development and Evaluation of Methods for Transferring Diagnostic Practices to the Clinic

White Paper for NSF SBE 2020: Future Research in the Social, Behavioral & Economic Sciences.

October 15, 2010.

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Acknowledgements. This document has received helpful input from several readers[1], and has been informally endorsed by the program committee of the annual Diagnostic Errors in Medicine conference[2], the executive committee of the board of trustees of the Society for Medical Decision Making along with some individual members[3], members of the Society for Judgment and Decision Making[4], and a former member of the research committee of the American Academy for Family Physicians[5]. Almost every paragraph refers to uncited research, as readers will recognize.

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[2] Eta Berner, Pat Croskerry, Jonathan Edlow, Mark Graber, Omar Hasan, Olga Kostopoulou, Mark Quirk, Gordon Schiff, Kaveh Shojania, Hardeep Singh.

[3] Kathryn McDonald (president), Alan Schwartz (vice president-elect), Angie Fagerlin (trustee), Steven Pauker (historian), Jef Van Den Ende, Laura Zwaan.

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Abstract.

In many fields professional decision makers must assess the present, uncertain situation and categorize it, with different actions depending on those categories. Often it is well understood how to use the information optimally to diagnose the situation, but the individuals in the distributed operational contexts do not diagnose in this way. Often it is well understood how to support people's diagnostic reasoning with information or with diagnostic aids, but those aids are not adopted into the work patterns in the various work sites. Resistance to adoption of optimal diagnostic processes may be attributed to system complexity, individuals' habits of diagnosis, and the stability and inertia due to mutually reinforcing relationships among different actors, procedures, and information systems within a situation. The dissemination of more accurate diagnosis practices to all diagnosers in all situations must overcome these and other sources of resistance. Research methods for producing and testing implementation plans are coarse and expensive, and thus slow and inadequate. The scientific challenge is to improve the methodologies for discovering, selecting, and evaluating effective ways to disseminate the best diagnostic practices to all operational contexts.

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Society depends on individuals to accurately perceive particular situations, as a basis for acting according to their specialized roles (e.g., managers, physicians, teachers, police, securities analysts). In security, that means to recognize a threat. In medicine, that means to diagnose the identity of a patient's disease. In other fields the vocabulary, the particular content, and some of the basic characteristics are different, but the essential problems are the same.

In these applied fields we already know a lot about how to diagnose appropriately, and new developments that improve our capabilities come along regularly. However, the practitioners who must perform the assessments often do not practice in accord with the established principles. A particular type of pattern can be seen in many fields. Research and technology develops a detection or diagnosis procedure. With great capital expense and institutional reorganization effort it becomes integrated into the practices of the system; in practice it is not so accurate (though often it is cumbersome). Relying on it, the people who play a role in the system – the eyes, ears, and brains - come to forget how to make the judgments themselves, and those who depend on the system end up poorer, more inconvenienced, and not much better off. Examples are the rituals of airport security, and in medicine the increasingly common exclusive reliance on specialized diagnostic procedures even when judgment based on the clinical evidence would be sufficient.

There is a need to figure out how to discover and implement better approaches for implementing improved diagnostic practices. Although constructing elaborate programs and forcing them to be adopted all or none might be easier to think about, at a distance, they do not make the best use of available knowledge. We should be able to devise better strategies than "build a whole intervention; test it as a whole in a single large, long, expensive trial". Though we understand elements of it, we lack a coherent science supporting the translation of optimal diagnostic practices based on research on the particular entity that must be assessed (analytical, laboratory) or based on research into the ways the diagnosers think about information, ways of getting information to them, or ways of supporting their diagnostic thinking, into widely distributed case assessment practices. The same need is found in other domains.

The grand challenge here applies when it has already been understood how a system may be arranged to optimally support practitioners' diagnostic reasoning, and how practitioners can reason in order to function effectively within that system. Given that systems are complex, that practitioners' reasoning is habitual, and that the elements of systems are mutually reinforcing and have stability and inertia, the challenge is how to disseminate the more accurate diagnostic practices to all diagnosers. The scientific challenge is to improve the scientific basis for the research methodologies of discovering, selecting, and evaluating ways to disseminate the best diagnostic practices to all operational contexts.

Let us consider the problem as it is manifest in medical diagnosis. In medicine the problem has been termed "translating research into practice." The source science needs to be translated into the target application domain. The target domain is the physician in the context of patient and clinic. Source fields for optimal diagnosis procedures are the clinical sciences -- the laboratory, imaging, physiological, and anatomical sciences -- that develop diagnostic tests, and the analytic and decision theoretic disciplines that develop ways to describe the relations between findings and disease entities. Source disciplines that can be applied for understanding diagnosis as done in the clinic are the psychological sciences, with their descriptions of how physicians do diagnostic reasoning; the educational sciences; the information sciences which study ways of providing doctors access to knowledge (about diagnosis, and about the patient in particular) in the clinic; and the system sciences which have ways of describing how all the parts of the clinic work together. Jointly this second group of source disciplines provides a description of what may need to be changed in the target domain, the clinic, when new diagnostic knowledge is developed. The translation problem, then, is how knowledge about how to diagnose optimally, developed by the source disciplines, can be translated for the clinic, to be embodied in physician cognition, clinical system functioning, and information systems, so that ideally all the physicians in all the clinics diagnose all the patients optimally.

This problem has also been called implementation science, dissemination science, delivery science, health services research, when it is about a particular practice, such as the use of a treatment (Bonham & Solomon, 2010). Examples are the physician's practice of using a particular effective preventive drug with a patient after a heart attack, or the hospital staff's behavior of washing their hands between touching different patients. With diagnosis, it is not just a particular behavior, but a way of thinking, that should be consistent with the new research

findings or with prescribed optimal practices. The terms "knowledge transfer" or "translation" better express the concept here.

Current state of research.

Need for the research: Diagnosis is not accurate enough in practice. In medicine, diagnostic error due to physician cognition (diagnostic competence and performance) is common. Effective diagnostic methods are available but not used; ways of reasoning about clinical information are taught but not remembered; individuals who know better methods find that the clinic as a system does not support their using those methods.

Previous research on translation: Importing information to the clinic. Progress in information technology has enabled the rapid communication and accessible storage of large amounts of patient information, resulting in multiple redesigns of the clinical work space to integrate the patient consultation with the medical record. Physicians have rapid access to the primary research literature about diagnostic modalities, as well as to collections of summaries of the most clinically relevant information. Yet diagnostic errors and delays remain common.

Previous research on translation: Changing clinic practices. The attempt to change physician behaviors or clinic practice patterns, to conform with proven better practices, has received extensive attention. Studies have evaluated the impact of a) lectures describing the research proof, b) the creation of guidelines describing recommended practices, c) social marketing, d) academic detailing, one-on-one visits with trusted peers or opinion leaders, e) measurement of practice performance, f) comparison of that performance to the performance of peer clinics and exemplar clinics, g) examination of exemplar clinics and teaching others their methods, h) providing temporary staff to facilitate the change in clinic procedures through training and quality improvement techniques, i) providing computer programs which assist with the recommended practice (e.g., preventive services reminder systems), j) providing computers to run those programs, and k) motivating clinic leaders and staff to change through relations with peers, or through ongoing personal relations with regional agents (Nagykaldi & Mold, 2007). Each of these has been shown effective, in some studies. However, using combinations of approaches is more effective.

It requires extraordinary cost, effort, and time to evaluate a translation program using the current translation research methods. There are thousands of plausible combinations of the above elements. Randomization must be by clinic, or at best by practitioner, rather than by

patient. Only a few interventions (bundles of elements) can be tested in a given study. It takes a long time to develop plans, get funding, recruit and train participating clinics, accrue patients, measure pertinent clinic behaviors and patient outcomes, and analyze with the most appropriate statistics. By the time the effect of one or a few combinations of the elements, that seemed a good idea at the start, can be compared, five years have passed. And the analysis can only compare one combination versus another, without providing insight on what particular elements were crucial for the observed effects, because the design confounds the elements that are bundled together. There is not enough research support money, nor enough research manpower, to address the needs with the current research methodology.

Research needing support.

To promote the translation of better practices for using diagnostic information into applied contexts, research is needed on the process of translating results from source to target domains. Again, our medical examples illustrate needs that apply in other areas as well.

Information technology. Information systems potentially have impacts that are difficult to anticipate in detail. Graphic displays of potential and actual changes in disease probability due to diagnostic findings, of uncertainty reduction, or of other pertinent constructs, may make their meaning more intuitively accessible. These could be available in the clinic as calculators, or automatically produced and provided to the clinician. The computer system could also provide information regarding the diagnosticity of particular findings, the costs of tests, the likelihood of morbidity from tests, utility based threshold probabilities for whether to use a diagnostic modality, the costs per anticipated information gain, or other pertinent considerations, in a dynamic manner. But the more sophisticated the concepts, the more barriers to their being adopted.

The relative advantages of push or pull technologies, providing information physicians probably should use, or just what they ask for, are not known with respect to the support of clinical diagnosis. While there is a large secondary research publishing industry, in which the implications of research are restated, summarized, metaanalyzed, and distributed to clinicians, its efficacy compared to Google type searches has not been assessed. Web tools may potentially provide better information about disease prevalence, or changes in disease prevalence, than summaries of publications.

Translation from research into diagnostic practice. Translating new developments in diagnosis into practice offers special challenges, because they require changing the thinking practice of physicians, along with changing the information systems so that they better support diagnosis with information and with cognitive support, and changing the organization of the clinical system so that it better supports accurate diagnosis. This seems more challenging than simply changing physician behavior. Therefore research on the best methods to disseminate more optimal diagnosis methods may require different methods and different measures than used previously. The need for more efficient designs, described above, still applies.

Conclusion.

There is tremendous potential to improve the assessment of particular threats or particular patients' diseases through the utilization of diagnostic and inference principles that have already been developed, and types of relevant information that are already well understood, but it takes work to change people's practices, and there are a variety of sources of resistance. Work enhancing the methodological basis by which programs for disseminating improved diagnostic processes are invented and evaluated could have an impact in multiple fields of application, such as medicine, the military, security, and police work.

Supporting research of this sort would give the NSF the opportunity to provide basic science support for the mission agencies, such as the NIH, charged with promoting the translation of new strategies for making inferences about the state of the world from the laboratory into general usage. The basic science for knowledge transfer needs to be developed so that the best implementation strategies can be identified; the science as currently practiced is very expensive and clumsy.

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Nagykaldi, Z., & Mold, J. W. (2007). The role of health information technology in the translation of research into practice: an Oklahoma Physicians Resource/Research Network (OKPRN) study. J Am Board Fam Med, 20(2), 188-195.