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Physician Decisions as a Source of Variation in Chronic Disease Outcomes

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ABSTRACT

In this paper we describe an investigation into the dynamic relationships between physician practice behavior, patient information, and chronic disease outcomes. Using data from a study of 1000 patients with adult type 2 diabetes we develop a dynamic computer simulation model of archetypical diabetic patients. Simulated patients are specified as sets of standard and fuzzy logic rules that represent physiological and psychosocial disease parameters. The model captures the time-dependency of treatment dose-response as well as the dynamic psychosocial effects of physician treatment moves as reported in the medical literature and as expressed by experts in the treatment of type 2 diabetes. Using the simulation model we study the behavior of physicians who attempt to manage a variety of archetypical patients across multiple encounters, with feedback and time delays spanning multiple years of patient experience. Using both time-series and process data, we partition variation in physician behavior into a macrostructure of treatment outcomes and practice goals, and a microstructure of physician treatment moves in response to patient data. For each simulated patient, we determine conditions under which practice goals are pursued by means of a (feedforward) strategy in which physicians make decisions and choose clinical moves based on predictions of the future patient states, versus a (feedback) strategy in which physicians make decisions and choose treatment moves based on information about the patient's current state and context of care. For each patient archetype and physician reasoning strategy, we identify the effect (including time-lagged effects) of variation in patient information on physician behavior and disease outcome.

The Primary focus of health-care policy in the United States is the improvement of care through increased quality, controlled cost, and expanded access. To accomplish these goals, efforts are aimed at various levels of the health-care system, from changes in the overall structure to changes in patient self-care behavior. Perhaps the most common target in this spectrum is the change in physician behavior. Strategies for changing physician behavior are commonly directed at decreasing practice variability and improving mean outcomes in patient populations. The existence of practice variability and resulting variability in outcomes and costs is well established in the literature (Greenwald et al. 1984; Greenfield et al. 1992; Welch et al. 1994).

Practice variation as a target for intervention follows from the excess cost and unrealized improvement in quality resulting from the less than optimal resource utilization and patient-care decisions. Because resource utilization and patient outcomes are directly related to physician actions, changing physician behavior is at the heart of decreasing practice variation. Achieving this goal requires understanding physician decision-making in the dynamic environment of the physician-patient interaction.

In the project described here, we conduct research that determines how physician and patient characteristics affect decisions made by physicians in the management of type 2 diabetes mellitus. Although it has been argued that improved quality and reduced costs are based on reducing variation in a product or service, the health care system has the important characteristic that services must often be individually tailored to a specific patient's condition. To respond to variation in individual patient needs, variation in services is not only desirable, it may be necessary for maintaining quality of care. We investigate how specific patient information is used by physicians to generate heuristic patient classifications (called patient archetypes) and how this classification is used to further filter patient information and direct physician practice decisions over the course of multiple encounters between a physician and patient.

To study physician decision-making in this context, we need a setting in which we can manipulate patient variables. To do this, we have constructed a series of simulated patients using data from an empirical study of adults with type II diabetes. These simulated patients are comprised of standard and fuzzy logic rules presented in an Automated Medical Record (AMR) environment. Synthetic as well as retrospective clinical data are employed to create the individual patients. Simulated patients are capable of responding plausibly to a large range of physician behaviors. Each simulated patient comprises a dynamic practice environment in which physicians are called upon to made practice treatment decisions. Each physician treats a series of simulated patients. Following each set of treatment decisions, patients update their physiological and psychosocial data for presentation in follow-up encounters. The cycle of physician-patient encounters is continued until sufficient data is recorded.

We use archetypes to represent a principled means of setting patient parameters (i.e., the functions that govern patient responses to treatment moves) based on assumptions about the form of patient adaptation to the condition of chronic disease. The archetypes used in the simulation are based on studies of patient adaptation to the conditions of Type 2 diabetes. Each patient archetype is based on the archive of patient cases from which simulated patients are developed. Mean attribute values ($HgbA_1c$, weight, etc.) for the patients in each archetype category are used to specify the characteristic initial and baseline values. Patient instances in each archetype are generated by either sampling patients in the archetype category in the archive, or by introducing variation in the values of an abstract archetype specification.

Archetypes affect patient data through initialization of patient state and response to treatment moves. The archetype designates rates of change for physiological and psychosocial variables. These values include the physiological, psychosocial attributes and initial narrative that includes the patient history and presenting problem.

Physician subjects in the research reported here are recruited at a variety of levels of specialty practice (i.e. family practice, internal medicine, endocrinologist). Each physician receives a series of cases during a two-hour session. We hypothesize that the patient archetypes guide physician response in managing variation in patient care.

Our analysis focuses on three levels of physician practice-behavior: macrostructure, microstructure and mental models. For the first level of organization we investigate the intention and outcomes of actions undertaken by physicians to achieve specific practice goals (e.g., treat a patient with specific symptoms of adult onset diabetes). We refer to this level as the macrostructure of practice behavior (Manoel & Connolly, 1995). We expect the macrostructure of practice to be organized in terms of a means-ends method of processing (Anderson, 1993) in which sub-goals are addressed by activities whose specific form comprises the elements of physician practice behavior.

Analysis of physician behavior reveals patterns of means-ends activity that are invariant with respect to input variables such as patient type, case-mix and categories of patient data. We hypothesize two types of macrostructure for the behavior of physicians in the current study. We refer to these macrostructures as practice strategies. The first practice strategy is one in which physicians make decisions and choose clinical moves based on predictions of the future patient states. We term this a feedforward practice strategy.

A feedforward practice strategy depends on a mental model that includes dynamic (time dependent) information regarding: (1) the patient's disease process, (2) the consequences of past and present courses of action, including patient compliance, and (3) knowledge of the way the patient moves through the clinical care system (Freyd, 1987). A feedforward strategy is supported by clinics in which physicians follow individual patients over time and by clinics in which patients are tracked and monitored so that information about patient state (including past compliance) is available (Brehmer, 1990, 1992).

The second type of practice strategy is based on the concept of a feedback (as opposed to feedforward) process. In this strategy, physicians make decisions and choose clinical moves using information about the patient's current state as he/she appears in the immediate context of care. A feedback practice strategy would be expected in a system in which patients are not followed by specific physicians, but receive care based on whichever provider is available when the need for care arises.

A feedback practice strategy presumes a mental model that is simpler and makes fewer cognitive and organizational resource demands than a feedforward strategy (Brehmer&Allard,1991). It is also more likely to result in misperceptions of patient state when there are delays or missing information in the patient-care system (Sterman, 1989).

We refer to the second level of organization of physician behavior as the microstructure of practice. We describe this structure by means of clinical moves made in response to specific combinations of patient data and circumstances of clinical care. We expect moves comprising the microstructure of practice to be organized as a method of information processing (Simon, 1975; Anderson, 1993). In the context of medical practice such methods will include features such as information seeking, evaluation of patient state and the current context of care, selection of modality and intensity of treatment, and the decision to escalate or consult on treatment with another provider (Hassebrock & Johnson, 1983).

We hypothesize that for experienced physicians there will be stability (invariance) in the macrostructure of practice behavior and variability in the microstructure of this same behavior. Such a combination of stability and variability is, in fact, essential to successful adaption in complex and changing environments (Hacking, 1992; Manoel & Connolly, 1995). Accordingly, best practice (successful) physicians will be those who are able to achieve consistent outcomes based on tailoring their clinical moves to a variety of patient conditions and circumstances.

The third level of organization is the mental models used by physicians to support the feedforward and feedback strategies of practice behavior (as described above). Mental models in this sense are mechanisms whereby physicians generate descriptions of patient conditions, form explanations of current patient functioning and observed patient data, and generate expectations of future patient states (Rouse & Norris, 1986; Kuipers & Kassirer, 1984; Newell, 1990).

The mental models we investigate support stability in the macrostructure on physician practice. They also enable variability in clinical moves that comprise the microstructure of physician responses to the variation present in clinical care environments (Gentner & Stevens, 1983; Johnson-Laird, 1983).

The work we report informs research as well as health care policy in three ways. First, it provides an empirical foundation for understanding the relationship between variation in physician decisions, individual patient characteristics and variation in the outcome of clinical care. Second, we provide means for extending applications of the Automated Medical Record from the delivery of care to clinical training and decision support. Finally, the work we describe provides resources that may inform the development of clinical guidelines and other improved care practices.

References

Anderson, J.R. (1993). Problem solving and learning. *American Psychologist*, 48 (1), 35-44.

Brehmer, B. (1992). Dynamic decision making: Human control of complex systems. *Acta Psychologica*, 81, 211-241.

Brehmer, B. (1990). Strategies in real-time, dynamic decision making. In Robin M. Hogarth (ed.), *Insights in Decision Making*, University of Chicago Press Chicago, pp. 262-279.

Brehmer, B. & Allard, R. (1991). Dynamic decision making: The effects of task complexity and feedback delay. In J. Rasmussen, B. Brehmer and J. Leplat (eds.), *Distributed Decision Making: Cognitive Models for Cooperative Work*, John Wiley & Sons, pp. 319-334.

Freyd, Jennifer J. (1987). Dynamic mental representations. *Psychological Review*, 94(4), 427-438.

Gentner, D. & Stevens, A.L. (1983). *Mental Models*. Hillsdale, NJ: LEA.

Greenfield, S., Nelson, E. C., Zubkoff, M., Manning, W., Rogers, W., Kravitz, R.L., Keller, A., Tarlov, A.R., Ware, J.E. Jr. (1992). Variation in resource utilization among medical specialties and systems of care: results from the Medical Outcomes Study. *JAMA* 267, 1624-1630.

Greenwald, H. P., Peterson, M. C., Garrison, L.P., Hart, L.G., Moscovice, I.S., Hall, T.L., Perrin, E.B. (1984). Interspecialty variation in office-based care. *Medical Care* 22,14-29.

Hacking, Ian (1992). The Self-Vindication of the Laboratory Sciences. In Andrew Pickering (ed.), *Science as Practice and Culture*. Chicago, IL: University of Chicago Press, pp. 29-64.

Johnson, P.E., & Hassebrock, F. (1982). Validating computer simulation models of expert reasoning. In R. Trappl (ed.), *Cybernetics and systems research*. North Holland Publishing Company.

Johnson-Laird, P.N. (1983). *Mental Models*. Cambridge, MA: Harvard University Press.

Kuipers, B. & Kassirer, J.P. (1984). Causal reasoning medicine: Analysis of a protocol. *Cognitive Science*, 8(4), 363-385.

Manoel, E. & Connolly, K.J. (1995). Variability and the development of skilled actions. *International Journal of Psychophysiology*, 19, 129-147.

Newell, A. (1990). *Unified Theories of Cognition*. Harvard University Press, Cambridge, pp. 42-110.

Rouse, W.B. & Morris, N.M. (1986). On looking into the black box: Prospectus and limits in the search for mental models. *Psychological Bulletin*, 100(3), 349-363.

Simon, H.A. (1975). The Functional Equivalence of Problem Solving Skills. *Cognitive Science*, 7, 268-288.

Sterman, John D. (1989). Misperceptions of feedback in dynamic decision making. *Organizational Behavior and Human Decision Processes*, 43, 301-335.

Welch, H. G., Miller, M. E., Welch, W.P. (1994). "Physician profiling: An analysis of inpatient practice patterns in Florida and Oregon. *New England Journal of Medicine* 330, 607-612.