LUPINE PUBLISHERS

Lupine Online Journal of Pharmacology & Clinical Research

DOI: 10.32474/LOJPCR.2021.03.000151

ISSN: 2644-1373

Research Article

New Development for Cost Sharing Influence in Healthcare

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Received: December 02, 2021 **Published:** December 16, 2021

Abstract

This paper continues the development of a multi-cues system to analyze the influence of economics on medical decision-making; previous research mainly aimed to identify cognitive cost cues to understand the role of implicit financial information, in addition to billing and cost-of-care information on choices [1-3]. This research domain mainly comes from behavioral economics; it has been used in policy for nudges in various fields [4-6]. Cost-sharing research led, for instance, to the emergence of behavioral insight teams in public and private payers in health policies. This paper continues research on economics and clinical judgment studies to discuss the role of recent advances of economic axiomatization of inconsistency (especially the new axioms on homogeneity of alternatives in triads [7] they are potentially relevant to discrete choice experiments (inc. conjoint designs) on healthcare providers and patients, which help to control heterogeneity of demand-for-care in statistical choice models [8,9].

In addition, designs of the random utility models, with inclusion of patients' preferences, as well as physicians and payers are under development. This paper also incorporates a conceptual framework, partly based on strand 1 and 2 research on behavioral economics [9-13]. This "Strand II" of behavioral economics enlarges the research domain from psychology to sociology and anthropology, and from the "quasi-rational" decision-maker to the "enculturated actor". This step will mainly use previous research on the transcripts from qualitative focus groups on physicians in the EU, USA and Canada. It will also use previous studies on narrative networks [14], and applications of this "Strand II" of behavioral economics to medical judgment (e.g. World Bank reports, using this approach to modify the cultural contexts, http://econworldbank.org/research). This research combines sociological and cognitive knowledge to a healthcare economic model; it can also help to better capture the diversity of individual or group level analysis for healthcare decision makers, in different sociological/cultural/religious contexts.

Keywords: Cost-Sharing Research; Conjoint Analysis; Economic Axiomatization; Inconsistency; Value Assessment; Choice Models

Introduction

The current presentation continues research lines on economics and clinical judgement studies, using past development of a multi-cues system (from psychological decision model); it aims to discuss the roles of recent advances on axiomatization of inconsistency [5-7] for potential relevance in using discrete choice experiments to analyze cost sharing influence on providers and patients. Several methodological approaches are currently in progress in a comparative way: the reversed conjoint model, presented at Orahs Oslo [8] discussed consistency issues associated with the type of conjoint models used to analyze the effects of cognitive cost cues on physicians' decision shifts. Since the 2017 invitation by Professor J Hausman of the Economic Department at MIT, choice models have been developed, using random variables for prices of medical services; this leads to select choice sets of alternatives (or consideration choice-sets), using three alternatives per choice set, so as to compare how pricing of alternative treatments impact physician choices at an individual level [8,9,10].

This paper is also a useful milestone in the current stage of development of the economic model with Prof J Hausman and ales, for ways to control heterogeneity of demand for care in choice models, with a specification test applied at individual level to control for Independence of Irrelevant Alternatives (IAA). The current move towards precision medicine, and the increased uncertainty about drugs and vaccine safety and toxicity at individual level will require more and more constant adjustments of ways to control for potential

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heterogeneous responses on outcomes and benefits/risks (Appendix 1). The inclusion of choice models, in combination with conjoint analysis and multicriteria methodologies help to forecast healthcare expenditures, it allows the inclusion of different types of preference assessment to adjust thresholds in existing models such as the Qaly model. These models are used by national technology assessment agencies for listing or pricing decisions of medical services. Integration of more levels to represent subgroups and minorities in national populations will allow to adjust and calibrate the national simulations, used by parliaments for budgeting and all decision-makers for resource allocation.

History

The first relationship with the MCDA Euro Group started at the Vienna meeting [11] where a paper was presented on the demand for care and on proposed algorithms to link individual level data, subgroups of providers of care data and groups levels to guide medical policies. It may also be of use for combinations of stated and revealed preference studies and possible calibration of econometric forecasting of healthcare expenditures (Random Utility modeling). The use of random utility models with physicians, patients and payers was discussed, where previous qualitative research on 6 health system in Europe helped to identify the different critical decision points for interactions between the players (for instance physicians in Germany versus pharmacists in France). The use of psychological models (especially the Lens model) to identify relevant criteria or cues on clinical and economic information lead to include the analysis of the cognitive systems to understand especially the influence of various cost-sharing mechanisms on choices of providers of care under various budget constraints. The interest to use multi-criteria methods, and especially conjoint analysis, is to provide a metrics to approximate the utility or preferences of individual providers of care, patients and payers, and to propose ways to aggregate the individual level data to subgroups and macro level. Introducing the cognitive system also means addressing the role of intelligence in a system. The development stages of a decision tool at the frontier of political and business intelligence systems, possibly for negotiating with multiple stakeholders not limited to traditional economic players such as industry; but also in a larger framework of stakeholders, in the move towards more fairness and equality in access to affordable care. So far, the research steps were mainly inside medical systems and even in one part of the medical system: physicians' practices. So, the congruence of tasks was limited to the physical space of the physician's office and the individual interaction of the physician-patient (Appendix 2).

With the fast digitalization of medical practices and the role of social media to influence especially patients (e.g. with patient associations), it is more important to understand how and when the context of such medical decision-making processing may be influenced and shared not only with the individual patients but also dependent from other influencers. In addition, the role of organizations of care in health systems and linkages between medical systems and economic and social systems are changing and contextualization of cues are affected. Moreover, the move towards more patient-centered health care systems challenges the decision-making process for professions and leads to more and more shared decision with the integration of patient preferences at earlier stages, including the prioritization of alternatives for treatments. The link with the economic system also leads to integrate the public choice in different ways than current normative collective choice and moves it to also include levels where more scarce resources may need to be less unfairly distributed.

In this paper, we discuss a number of issues related to a system of cues that proved to be very efficient in the context of medical practices. It may need to be expanded and adapted to variations in physician-patient interactions, in dynamic ways in more and more individualized decision points in disease progression, but also within different social contexts. It challenges normative critical decision points, usually identified for average populations diagnosed with similar diseases and comorbidities (with consensus of clinical guidelines).The scope of system intelligence has been, so far, limited to the medical or health system; the processes described in the Hamalainen, Jones and Saarinen's book [12] brings interesting additional contributions to this research in the next milestones with fast digitalization of healthcare, since it explains processes in the whole system such as "dispossession" (e.g. possibly with big tech influence such as google and Facebook) or "ambient intelligence" Hamalainen RP was the discussant of Prof Huttin's paper, he is a specialist of system intelligence in Finland. In the current stage of development, the tool is closer to "ambient intelligence" with control of software such as Microsoft, for interactions with computer interface. The decision tools that may include modules of cost cues will also be embedded in human-machine interactions of medical informatics, but also more and more social and medical devices.

Axiomatic Systems for Consistency of Conjoint Estimations and DCE Models

Before discussing the relevance of additional axiomatization for the special application of conjoint studies for cost sharing research, the following section summarizes a brief history of axiom discussion, which is useful for healthcare reform. Healthcare choices have been studied mainly with application of insurance economics (e.g., impact of moral hazard or adverse selection) and use of specific concepts such as induced supply [5] or more recently demand induced supply [19]. Conflicts and issues for relevance of axiomatic systems is not new; in early 1950's, already Arrow especially used mathematical models in social sciences and discussed axiom properties. Recently, he led a multi stakeholders task force for recommendations for health care reforms for a 21st century healthcare system in Annals of Internal Medicine, and highlighted current conflicts of values (affordability, equity, quality, etc.) leading to re-discuss the axiomatization of decision analytics in health care [2], especially in the health service research communities involved in operational research methods.

Methodological discussions and best practices around the use of micro- conjoint data or DCE data, to increase representativity of both physicians and patients' preferences, are timely especially in their benefits/risk's assessments. In previous papers [8,15], consistency issues associated with a special use of micro conjoint data in a "reversed conjoint design" of physicians' cost studies, using both

clinical and economic cues (cost cognitive cues) have been discussed. MCDA methods are still very used in financial management areas, (See Merck CEO's comment on financial models for pharma). Contrary to clinical cues, cost cues are embedded in each medical or health system, so it requires understanding the influence of economics (both implicit and explicit) on decision makers' cognitive systems in the health system, in different organizational arrangements (e.g., solo practices, different sized of medical practices and integrated care, with provisions of health and financial services). In addition, medical professions establish professional norms that also affect cost-sharing mechanisms. Therefore, revisions of budget rules (e.g., with mechanism design approach [9]) need to integrate complex interactions inside healthcare organizations, as well as transactions or interactions at the individual level.

Psychological models such as the Brusnwik model have been used in clinical judgement analysis; It helps to identify attributes or economic cues, but is not the only way to find economic or socio economic, cultural or technical criteria to assess their impacts on providers and patients' choices. Clinical judgement studies, using this type of psychological models proved to be very efficient and accurate. The usual mathematical formula started with Hursch, Hammond et ales, then it has been known as the Tucker formulae (1964 version and its revision). It is used to calculate the consistency of judgment tasks for each physician and within groups of physicians. The index is called the Rs consistency index; in the Tucker statistical formulae composed of two components: a modeled component and an unmodeled one; it is part of the first component. The main performance measure is provided with the Global Achievement measure, which calculates the match between tasks and the ecological environment. For clinical settings, especially in medical practice offices, the environment is controlled, and the accuracy obtained with such formulae is usually very high: in medical sciences, Rs up to 0.8 or 0.9 (see the two metareviews on the topics).

However, economic studies on clinical choices are very rare and Rs never really quantified; moreover, economics of such cognitive environment is under-researched. It includes patient economics, but also physician and practice economics, in addition to product economics. Moreover, the type of information processing in a digital environment led to impact the financials of both providers and patients and their behaviors. So, it remains useful to see whether other ways to assess consistency could be especially useful if the cues or criteria are not limited to psychological cues. They may include, as in the new strand of behavioral economics, cultural and social cues to represent variations in social and cultural contexts of the studies. So, advances in axiomatization by mathematical economists may provide useful approach to complement the Rs from judgement studies.

Footnote: For interested readers, in the same MCDA2016 event, a presentation on pharmaceutical industry players, also uses a multi criteria approach to represent the financial management of their portfolio (using electre Tri) Add :

The development of axioms from mathematical economists, such as the Trento team (Brunelli et ales) was explained at the EWG-MCDA Vienna meeting in 2016. The system of six properties of the axiomatic system could ensure consistency of preferences; moreover, under some specific conditions, both consistency and also transitivity of pair wise comparison on sets of criteria may be achievable. Conjoint models and axiom systems for such algorithms are usually reviewed in the ordinal theory or the Van Neumann- Morgenstern utility theory (Morgenstern and Von Neumann, Friedman and Savage Marshak Herstein and Miller Jensen) [16]. In the case of a reversed conjoint model, to understand the influence of cost cues on physicians' choices in different pharmaceutical systems, three main axioms have been discussed as to other conjoint models. They are three axioms linked to the ordinal theory: stability, continuity and transitivity. A main issue remains to be understood from the series of cost studies on physicians using the reversed conjoint approach: the inter-country comparability of results from one group of physicians to the other, between medical systems.

Empirical studies using conjoint models are often used for pricing of products, in a competition analysis, or for elicitation of preferences on different sets of product attributes. Softwares are now available to provide consistency tests on the survey instruments, mainly to check stability of responses (e.g. on the diabetic medical market, for two types of long-acting insulin during a trial, study [17]). Tests of consistency may be used to validate a measurement of welfare values, with incorporation of patients' preferences between different products in trial designs, but not especially incorporating unmet needs in the comparison of products. The use of such methods for cost-sharing research helps with the inclusion of similar types of information, which is processed by individual or groups, in the cognitive space, to help understand the nature of implicit restraints and for instance, to anticipate lack of adherence and compliance. The reversed conjoint model discusses multi-criteria design, where both criteria on products or new technologies are compared, but also patients' characteristics are combined in a design, not automatically at the same time [5,8,11].

Recent discussion on inconsistency to propose some conditions that may allow both consistency and transitivity may be relevant for the special application of reversed conjoint for physicians' choices: In the current axiomatic system proposed, when 5 properties for consistency are satisfied, then the transitivity property cannot be satisfied. So, there is no real function that can represent a statistical estimation, which is both consistent and transitive. Or, a function capturing both consistency and transitivity depends on the system of axioms. If there is an exclusion of one of the 5 properties, then such a function may exist. When the researcher can estimate whether the exclusion of an assumption of continuity makes sense, the axiom on continuity may be excluded from the system of axioms, for instance, for small variations in preferences, there is not automatically a modification of the consistency index. The idea that conditions of small variations may allow to remove that property from the axiomatic system, may provide interesting venues for clinical choices in several types of diseases or stages of disease progression, especially with the use of biologics or evolving epigenetics [8,21].

Role of Recent Technologies for Studies on Reimbursement Design, Using Multi Cost Cues

The original application on reversed conjoint for economic topics relating to physicians' choices was initiated to incorporate the implicit economic information that restrains or shifts clinical decisions. A system of 4 cost cues was then identified and compared between 6 health systems, to assess the role of such economic information on medical decision-making: Patient affordability (Cue 1), Patient demand for cheaper treatment (Cue 2), Patient co-medication for co-morbidity (Cue 3), Patient disease severity (Cue 4) [11,12,23]. The objective function of the physician should be to optimize/minimize the global level of co-pay for his patient. However, it is not always the case that he may minimize the global co-pay (e.g., discussion between levels of cue 2 and cue 3). Such a system of cognitive cues can help to minimize the global co-pay for the patient and the health system. However, a comprehensive number of studies are necessary for external validity (inside a health system and possibly across systems) to also control issues such as lack of knowledge or partially computerized information. Moreover; reimbursement criteria differ in each system and some systems of cues may include a dominant criterium, especially age or clinical criteria. A major limitation to develop a decision tool with conjoint designs is the potential cost involved for such studies, especially when they capture unstructured data, for instance from conversation of care at the point of visit (in order to create an alert system, when financial restraints create a major interference with clinical choices and patient adherence). This is the reason to discuss the role of recent technologies in this paper. They not only enable new economical ways to generate data, but also solve some consistency issues. Conventional research methods used for such applications on conjoint models have been online internet survey and pen and paper with qualitative research such as focus groups, to identify cues /attributes and levels. As an example of a more recent technology described in this paper is a method to generate User Generated Content (UGC) as presented by Timoshenko and Hauser at the Sawtooth conference in 2019:[21] "This method changes the process of collecting the data" and the authors describe the following steps:

Use of Pre Trained Word Embeddings,

Creation of numerical sentences representation to capture the semantic meaning of UGC sentences, Clustering sentences representations and Sampling sentences from different clusters (to ensure diversity of content). The User Generated Content (UGC) is a method to identify attributes and generate attribute levels; such technological development not only reduce the cost of such studies but also modify the range and types of unstructured data that can be collected: twitter posts; customer blogs, complaint data; it allows therefore to identify not only the demand for care or medical services but possible unmet and met patient needs , partly covered by existing supply and the financing of health systems. In the move towards Universal Health Coverage, methods to adjust needs, supply and demand for health and their main input (health care), make studies with multi criteria attributes again quite useful, to extract what is to be prioritized in health systems, facing complex forms of inequalities, whatever the level of Country GNP.

Conjoint design can benefit of such technologies, especially in the type of application used to identify cost cues that may interfere with clinical cues in a medical decision- making process. As in the original conjoint design for physicians' cost sensitivity studies, this UGC technology is text based. The conversation of care, as well as other forms of unstructured data such as pictorial content, or sources of data such as complaints or other sources of information such as open notes of providers of care could complete the original transcripts. The understanding of the content of such extraction of unstructured data may be beyond human process and the use of machine learning methods, such as UGC for instance, may provide workable solutions. In the current stage of the prototypes, only text has been used for conversation of care, however, the research cost of lexical analysis, with or without the help of a software is too high, for scaling up such methodologies to be used in various decision points. Moreover, the expansion to various kinds of unstructured data may help with more comprehensive understanding of unmet patient needs in various delivery modes, but machine learning tools may become necessary to help with classification of content (such as relevant or not relevant content) or authors mentioned "informative versus non informative content". A combined "machine human" approach has been investigated for instance with the company QSR but remains at this point at a pilot stage; it will certainly address the limitations to the development of such decision tools, due to time, cost, attention or multiply judges [22,23].

Conclusion

This paper shows that the complexity of decisions in Health care multi-stakeholders and move towards precision medicine boost methods combining Human machine approaches and automatization [1]; it also leads to revise the current stage of discussion in the axiomatization of decisions. These new methods can deal with some problems of consistency: a reduction of time of administration lead to reduce consistency problems such as stability of responses according to number of clinical vignettes and overlapping cues; some semanticist issues such as using corpus of language, definitions and existing tools of translations. A next research agenda with experiments using Conjoint/DCE instruments on patients and physicians 'preferences, could include consistency checks with automated online self-reported information. An example of combined clinical and economic cues in a reversed conjoint model could be with inclusion of social and economic cues in Physicians' conjoint designs with hypothetical construct of clinical vignettes, for cases of patients, unemployed or precarious (e.g., short term employed workers over 50, diagnosed with cardiac diseases and different threats of cardiac arrest and fatal events, with and without covid 19 (as user cases of comorbidities with long covid effects, more or less severe).

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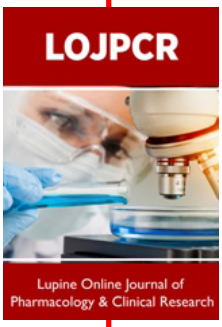
DOI: 10.32474/LOJPCR.2021.03.000151



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