

Game Theory in the Healthcare Literature: A Systematic Review Focusing on Negotiations

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Objectives

At 8.8%, health expenditure accounts for a significant share of the gross domestic product[1]. These expenditures are always subject to complex multiparty strategic interactions, e.g. negotiations. Game theoretical models are a standard tool in economics to model them. The aim of this research is to investigate to what extent these models occur in the health literature and whether they are applied and used in real scenarios, especially for negotiations and pharmaceutical pricing.

P	I. Articles with real world data & scenarios
	II. Articles with application of game theory in real world scenarios
I	I. Use of negotiation strategies
	II. Application of game theory in negotiations
C	I. Application of Game theory
	II. Application of Game theory in price negotiations
O	I. Ratio of literature & area utilization
	II. Ratio of literature & financial utilization
S	I + II: All scenarios with real world data in the healthcare sector

Figure 1: PICOS – Schemes for Evaluation

Methods

In order to generate the data reproducibly, a systematic review was carried out. Methodology was based on the Cochrane collaboration handbook[2]. Derivative research questions were transcribed into a PICOS scheme, shown in Figure 1. The inclusion and exclusion criteria were also elaborated (see Figure 2). PubMed[Medline] and LIVIVO were used as databases, as well as further citation tracking. Data was evaluated on the basis of the inclusion and exclusion criteria. The data obtained were randomized into blocks of which 50% were randomly submitted for review as control group. The results were categorized by general terms as shown below. The data thus obtained were evaluated and contrasted in the final analysis.

- Administration
- Biochemistry
- Caregiver
- Disease management
- Drugs & Medical Devices
- E-Health
- Gamification
- Hospital
- Patients
- Professionals
- Resource Allocation
- Study
- Vaccination

Inclusion	Exclusion
Published between 01.01.2004 – 31.03.2019	Textbook Literature
Language: English	Theoretical models without application reference
Literature Type: all	Evolutionary Game Theory
Strategical Interaction	Abstract only
Health-related scenarios	
Application or applicability	
Available as full text	

Figure 2: Inclusion & Exclusion Criteria

Results

A total of 1168 documents were retrieved. 796 full texts (excluding 372 duplicates) were screened. Of these, 126 included application of game theory (GT), research on negotiations was carried out in 109 cases, the intersection covered 5 cases (see Figure 3).

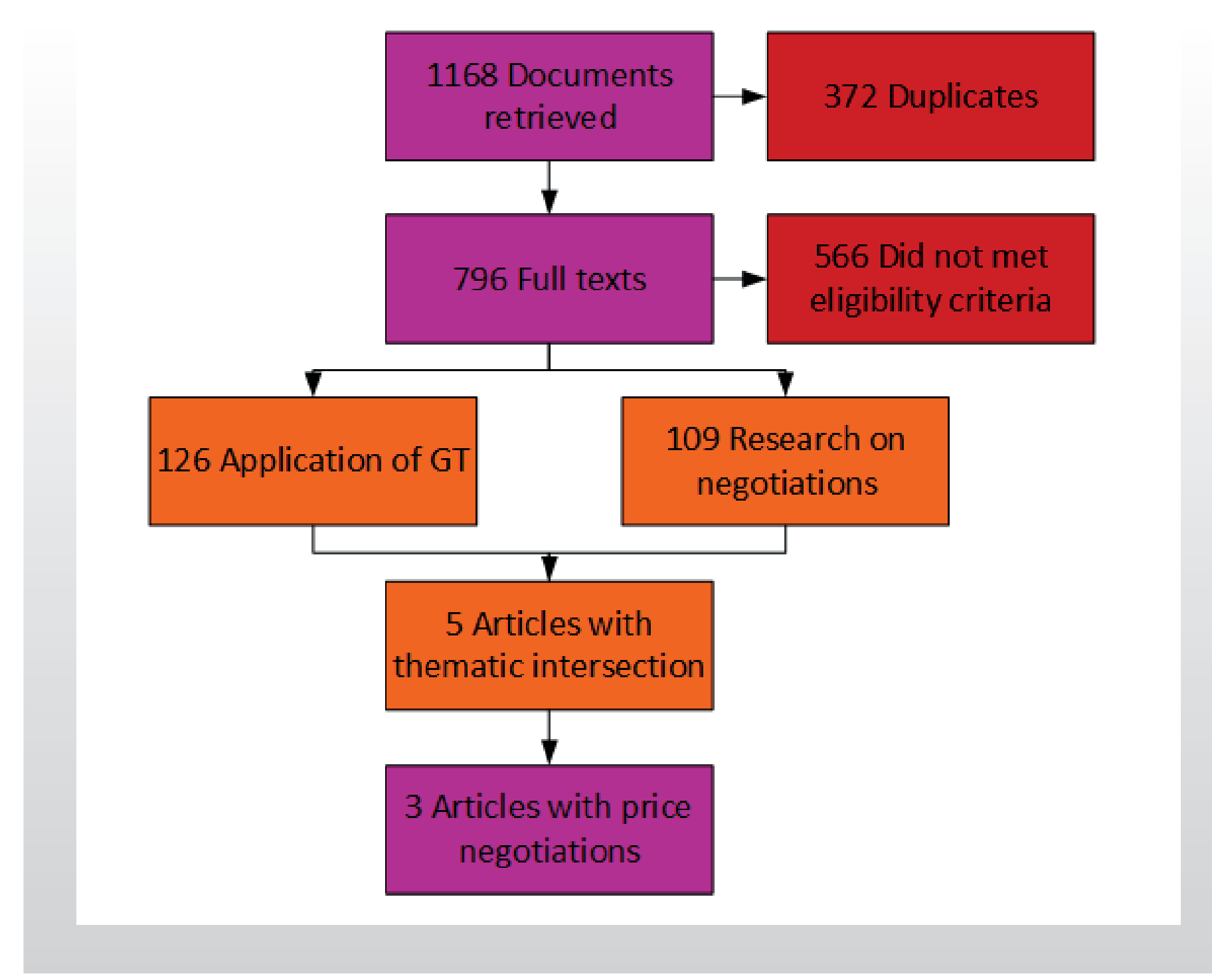


Figure 3: Flowchart on search and screening results.

In these remaining 5 cases a model was presented explaining the process dependencies of negotiations. The remaining cases referring to price negotiations (3) are described in detail below.

I. In the first case, in retrospective, the value-based funding of drugs in Australia corresponded to the game theoretical models used for this purpose. There was a correlation between the recommendation and the outcome of the negotiations, between the government and the sellers. Delay costs also lead to a higher value for money by the seller.[3]

II. In the second case the Australian pharmaceutical market was also

presented as a multi-stage game between regulators and pharmaceutical companies. The relationships between the surplus of consumers and the profit of the companies in relation to product quality were presented, regulated against unregulated. If all the benefits of a drug were realized in the case of a new appearance, existing agreements had to be renegotiated.[4]

III. The third case concerned the influence of compulsory licences on drug negotiations. The study was based on developing countries that were dependent on foreign companies for supplies. It was shown that such licences did not appear under complete information, but under incomplete information. Furthermore, the effects and consequences of such licenses on negotiations were shown in this case. [5]

Apart from negotiations, game theory in the health care literature was mainly applied in three areas: Vaccination-based cases (13); scenarios with resource allocation & provider-based cases (20) and approaches to administrative problems (10) (see Figure 4 and the explaining tables below). In addition, empirical studies based on statistically evaluable data were obtained in 282 cases, but were not further explored in the context of this research.

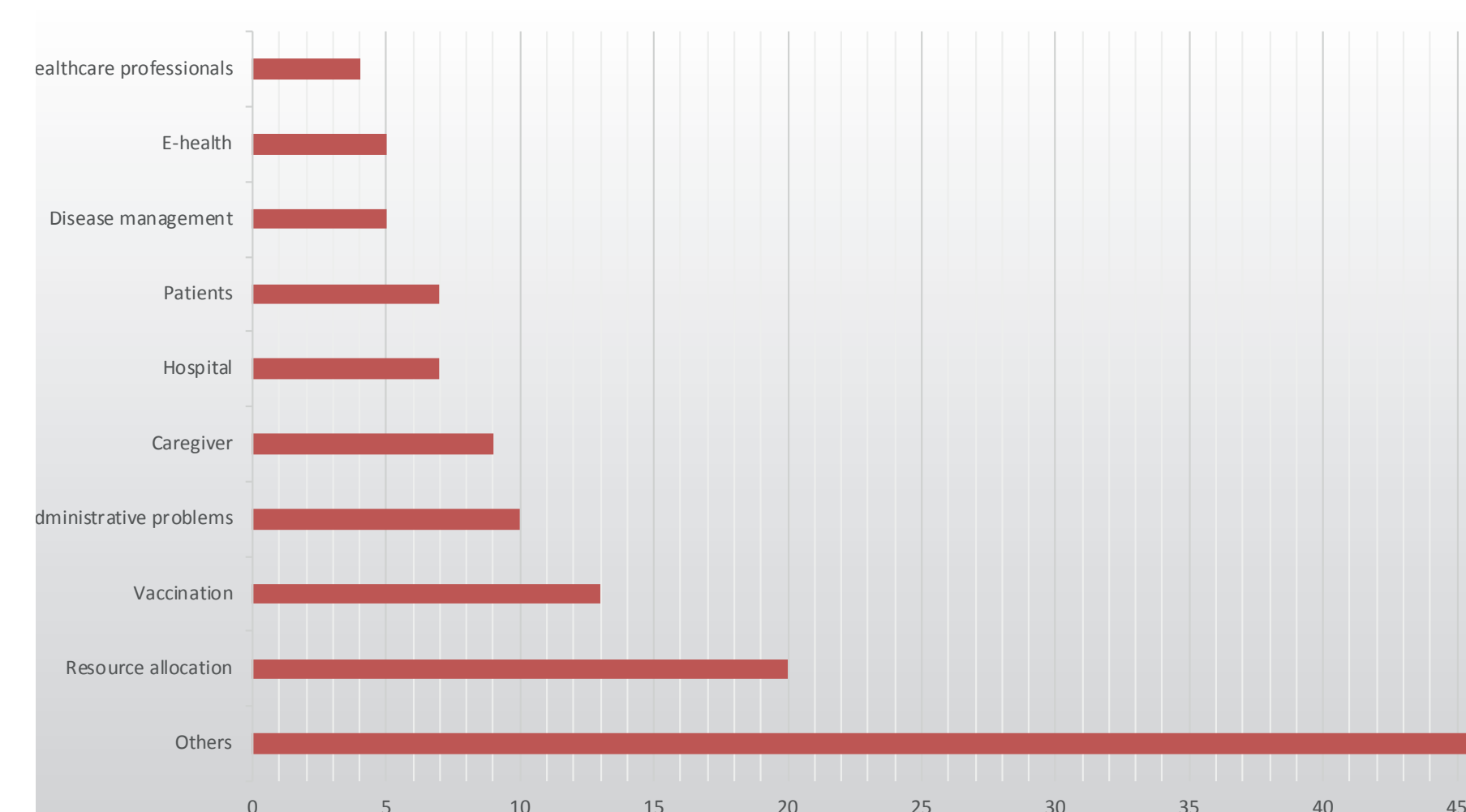


Figure 4: Classification action according to generic terms in game theory based scenarios N=126

Conclusions

In relation to the relevance of various negotiations in healthcare, game theory approaches are rarely used to obtain a better understanding of the underlying incentive structures. This is also clearly illustrated by the relationship in numbers between data-driven research versus model-driven research in this study. Given the fact, that reliable data on health care issues, especially pharmaceutical pricing, are notoriously difficult to get, the question arises whether the few process focused studies are due to particularities of the science or whether there is simply a gap in potentially valuable research to be filled.

Resource allocation

This broad area includes the allocation of resources on an individual as well as on an administrative level.

- E.g.:
- Development of the extensive form of a sequential game whether high or low risk organs should be transplanted^[6]
 - A game-theoretical approach, which predicts a decline in drug quality, should a citizen insurance be introduced, thus respectively the private health insurance sector be reduced^[7]

Vaccination

Almost the entire literature found, dealt with models for acceptance of vaccinations and coverage of vaccinations. If one excludes the development of vaccine sera.

- E.g.:
- Due to herd immunity, a strategic interaction between individuals also arises from the nature of their decision^[8]
 - The interests of the public are weighted against the interests of the individual, with the discrepancy increasing as the cost of vaccination increases^[9]

Administrative & general problems

This area covers the administrative and general problems, as well as legal peculiarities in the administration of the health sector.

- E.g.:
- The representation of mergers and acquisitions as simple prisoner dilemmas. The emerging problems at the level of work culture are represented here by basic models of Game Theory. However, game theory only serves as an abstract model for simplification^[10]

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