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Predicting the place of out-of-hours care—A market simulation based on discrete choice analysis

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ABSTRACT

Background: Increasing cost pressure and changing patients' needs in the healthcare sector have led to new delivery models for primary care. Researchers and practitioners need to establish innovative methods to obtain insights into patients' preferences and effectiveness of healthcare services.

Aim: This study reveals the crucial decision criteria of patients in choosing out-of-hours services and provides a projection of a future market share of the newly established central out-of-hours service, called General Practitioner Cooperative.

Design: A computer-aided discrete choice experiment.

Method: Respondents were 350 patients in a European city who decided for a service when confronted with a medical emergency in an out-of-hours case; two scenarios called 'adult' and 'child', describing the persons requiring medical assistance, were used to increase generalizability.

Results: The two most important attributes were 'explanation by the doctor' and 'waiting time' while the others – 'availability of technical equipment', 'ease of access', 'type of consultation' and 'payment method' – were of less importance. The market share projections predict that the new General Practitioner Cooperative will capture about one third of the market ('adult': 39.1%, 'child': 31.3%), ahead of the emergency department, the second most preferred service ('adult': 32.7%, 'child': 30.7%).

Conclusions: This study quantifies the adoption of a new medical service. As a result, it extends current research approaches on eliciting and matching patient's needs and assists policy makers in establishing adequate service capacities.

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1. Introduction

The aging society, increasingly demanding patients and cost pressures have steered most recent health care reforms in developed countries [1]. The objective of improving health system efficiency through cost reduction while at the same time increasing patient satisfaction is

the focus of the transformations. To ensure better decision making during these reforms, policy makers need to obtain a better understanding of patients' preferences and the effectiveness of existing and new healthcare services [2,3].

With regard to primary care in out-of-hours situations, there is a trend to use hospital emergency rooms (ER) for standard and less urgent problems [4] resulting in poorer service for actual emergency cases. At the same time, the decreasing number of general practitioners and their concerns about out-of-hours workload and 24 h availability have led to an increasing workload and dissatisfaction

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among the remaining general practitioners. Policy makers have attempted to address these trends by organizing out-of-hours care in a more structured and feasible way [5,6]. Ultimately, this led to a stronger centralization of primary care centers in various European countries. As the development of the centralized general practitioner (GP) services has been induced by supply rather than demand conditions, little is known on how well new healthcare services meet existing health care needs [7]. Yet, particularly in countries with a free choice option on various medical healthcare services such as England, Sweden, Belgium, Germany and France, it is important to assess the alternatives' relative effectiveness as it determines their adoption. An alternative way to ensure adoption, i.e., through restricting access to some services has been unpopular with patients, professionals and policy makers as this reduced accessibility and quality of primary care in many European countries [8].

Several studies on the use of and satisfaction with GP centers have been conducted [6,7,9,10]. The majority of these studies are based on the assumption that greater satisfaction and loyalty will be reached if patients give high assessments of all individual service elements such as treatment quality, waiting time and accessibility. However, this approach is lacking in estimation of trade-offs between the service elements which would describe patients' behavior in a more realistic way [4,11]. Furthermore, context dependent questions, such as 'why do people prefer one service over another' or 'what is the impact of the new service on the competition' are not answered. Nevertheless, they are important from a scientific as well as practitioners' point of view and warrant further research [3,12].

General research on new services reports a 40% failure rate indicating the intricacy in their development and launch [13]. Crucial factors hereby are a lack of unique customer benefit compared with existing services and the setting of unrealistic market potential and adoption goals [14]. An accurate market assessment is suggested to support better predictions of the demand and service-customer fit [15].

Therefore, this study investigates critical decision criteria in choosing out of hours care and the effectiveness of a new out-of-hours service through a market share prediction. Firstly, the critical characteristics of an out-of-hours healthcare service are identified and the relative importance of the attributes in the decision process estimated. Secondly, a market simulation predicts how well the newly established GP center (General Practitioner Cooperative: GPC) matches these needs and hence, how it will be adopted in comparison to the alternatives of the emergency department (ER), a house visit by a general practitioner (HV) or a pediatric consultation (PD). The findings give policy makers valuable information on the effectiveness of a new medical service to adjust its design and capacity before the final roll-out when changes are more costly [16,17].

2. Methodology

Discrete choice experiments (DCEs) are a popular instrument in healthcare economics [e.g., 2,3,18] to determine how individuals make trade-offs in choosing competing services. It is based on the premise that patients

Table 1
Service attributes and levels.

Attributes	Levels
Type of consultation	Hospital emergency department – ER General practitioner Cooperative – GPC Home visit by the general practitioner on duty – HV Pediatrician – PD (in 'child' scenario)
Waiting time between first contact or call and consultation	Less than 30 min Between 30 and 90 min More than 90 min
Information about health problem and therapy	Doctor does not give enough information Doctor gives enough information
Accessibility of the service	Location and phone number are not known Location and phone number are known
Availability of technical equipment	Available Not available
Method of payment	Immediate payment Deferred payment (sent by invoice)

assess the value of a service by combining the separate amounts of values assigned to each service attribute. Moreover, it assumes that the value is not directly observable but only the overall choice. Patients can best provide judgment on objects formed by a combination of attributes rather than on each separate attribute [11]. It is more realistic because respondents are confronted with decisions similar to the ones they face in their daily lives [12]. Evaluating bundles of attributes increases not only the realism but also the complexity for respondents. Earlier studies emphasized restricting the number of attributes and choice tasks depending on the applied method [18].

DCEs allow understanding of the relative importance of one attribute with respect to the overall utility and to what extent a desirable attribute level can compensate for a less acceptable level of another attribute [11]. The availability of tools such as market simulators to measure economic outcomes is another reason for the popularity of DCE [19]. A market simulator allows forecasts of how patients might react when a new service is introduced into an existing market. The market simulation based on DCEs comprises four steps: establishing the attributes and levels; choosing alternative scenarios to present; establishing and estimating preferences; and simulating market behavior [16].

2.1. Attributes and levels

We identified a pool of different attributes and their levels based on a review of medical and services literature [3–5,7,19–21]. Afterwards, we conducted semi-structured interviews with key informants, i.e., GPs, academic researchers and patients to verify, prioritize and refine the service characteristics as well as to assure the relevance for the health care systems' context. Several iteration rounds led to our final, limited set of attributes and levels that were realistic, tradable and comprehensible (Table 1 [18]).

2.2. Scenarios

The next step concerns the context for the patients. To increase the generalizability and robustness of our findings,

we used two scenarios called ‘adult’ and ‘child’ to describe the situations and persons requiring medical assistance during the weekend (see Appendix A for the complete scenario descriptions). Data was collected by means of full-profile choice questions. Hereby, every respondent was confronted with two randomly created profiles – composed of combinations of all 6 attributes – for one scenario and had to choose one of the two profiles. All attributes were clearly worded and explained to the respondents before participation, avoiding misunderstandings about and between the different levels of the attributes.

2.3. Preferences

DCE assumes that individuals strive for utility maximization: when confronted with a set of choices, each being a combination of several alternatives, consumers will choose the alternative giving the maximum value. A homogenous preference structure over the entire population is assumed, which allows aggregating the data obtained. A multinomial logit model using maximum likelihood estimation is applied for the estimation of the part-worths [22]. The estimated part-worths represent the fractional utilities of the different attributes and levels [18].

The multinomial logit model assumes that the probability of choosing an option is proportional to the relative utilities of the options:

$$P_{k,c} = \frac{e^{V_{k,c}}}{\sum_k e^{V_{k,c}}}$$

The utility V can be expressed as:

$$\begin{aligned} V_{k,c} &= \sum_{i=1}^6 \beta^i D_{k,c}^i \\ &= \beta^{Cons} D_{k,c}^{Cons} + \beta^{Wait} D_{k,c}^{Wait} + \beta^{Techn} D_{k,c}^{Techn} + \beta^{Expl} D_{k,c}^{Expl} \\ &\quad + \beta^{Acce} D_{k,c}^{Acce} + \beta^{Paym} D_{k,c}^{Paym} \end{aligned}$$

Following symbols are used: k , specific profile of a medical service; c , choice set consisting of several alternatives (=profiles); $P_{k,c}$, choice probability of profile k in choice set c ; $V_{k,c}$, systematic component of utility of profile k in choice set c ; i , attributes (‘type of consultation’, ‘waiting time’, ‘technical equipment’, ‘explanation’, ‘access’, ‘payment’); β^i , part-worth of attribute i ; $D_{k,c}^i$, Dummy for attribute level of the profile k .

The computer-based questionnaire was set up with Sawtooth Software SSI WEB Internet System 3.0.1. It contained sections about respondents’ familiarity with the services and the socio-demographics. Afterwards, every respondent answered on 10 DCE questions which is below the threshold causing difficulties in completing DCE surveys [12]. A pilot study tested the questionnaire and led to a minor revision of the attribute and level formulations.

2.4. Market simulation

In DCE, as applied here, part-worths are estimated by means of multinomial logit model, of which the Independence of Irrelevant Alternatives (IIA) is assumed. This

assumption is often criticized as being unrealistic. The Sawtooth SMRT 4.20 Market simulator estimates choice shares by means of the Randomized First Choice method. This method is reported to be robust for IIA problems [19]. The parsimony and predictive validity, illustrated in earlier medical studies makes the Randomized First Choice especially suited for research with policy implications [23]. Additionally, we checked for IIA by comparing our results with market shares obtained with the results of two methods (pairwise comparison; share of preference [19]) that are both subject to IIA. The two last methods give highly similar results, while Randomized First Choice leads to marked differences, illustrating better resistance to IIA.

The market simulator requires firstly the input of the estimated part-worths representing the patients’ preferences. Secondly, we need to identify the actual market performance of the services. For the discrete attributes ‘type of consultation’ and ‘payment’ there are objective level values (i.e., ‘ER’, ‘GPC’, ‘HV’, and ‘PD’; ‘immediate’ and ‘deferred’) available. For the other attributes, the expert opinion of eight doctors who are familiar with all services supplied us with the actual service performance. Since such performance is typically in between the two extreme levels, we assume linearity of the part-worths and interpolate them. In order to increase the validity we choose doctors with different main occupations (4 doctors from GPC and ER respectively) and the author team verifies the face validity of the results. Finally, we predict the market shares under the assumption of full market information and equal awareness for all services. A subsequent sensitivity analysis estimates market share changes resulting from a change of one attribute for one service at a time. This analysis is useful for decision makers in health policy because the results demonstrate the impact of adjustments in service designs [24].

3. Results

3.1. General statistics

Data was collected from people waiting at three free health care centers for new born and children in a Western European city. The wide coverage of this service, namely 97% of all new born in the region, minimizes a potential selection bias of the respondents [25]. We used computer-assisted surveys with support permanently available which resulted in 350 fill-out questionnaires. Such sample – especially in combination with on-site assistance – is viewed as sufficiently large to provide reliable DCE results [18] and matches sizes used in earlier DCE studies [e.g., 3]. Non-participation of all approached people (482) was mainly due to language problems (18.8%), lack of interest to participate (13.8%) or no time (5.0%). 4 out of 5 respondents filled out the questionnaire without assistance. In both scenarios, almost all respondents have heard of the out-of-hours services (‘adult’: ER: 98.9%; HV: 95.7%; GPC: 80.4%; ‘child’: ER: 98.2%; HV: 94.0%; GPC: 83.1%; PD: 98.2%) indicating a high degree of familiarity. While the number of respondents of foreign origin (44.3%) does not fully match the share in the entire city (26.8%), it corresponds

Table 2
Socio-demographic statistics.

	Adult scenario	Child scenario
Questionnaire language		
Dutch	165	159
English	16	6
Arab	3	1
Sum	184	166
Mean age (years)	31	31
Gender		
Male	19.6%	23.5%
Female	80.4%	76.5%
Marital status		
Married or living together with one child	42.9%	51.8%
Married or living together with two or more children	45.1%	34.3%
Single with one child	6.5%	5.4%
Single with two or more children	2.2%	2.4%
Other	3.3%	6.0%
Mean number of family members	3.60	3.52
Mean number of kids	1.67	1.65
Foreign origin	44.0%	44.6%
Total sample	350	

with the neighborhood of the new GPCs. Table 2 contains more details on the socio-demographics.

3.2. Part-worths

Tables 3 and 4 present the estimation of the part-worths of the levels and their statistical significances. The Chi-Squares of both models are well above the critical value for a 0.01 significance level. It indicates that respondents' choices are significantly affected by the various attributes and levels. A comparison of the levels of both scenarios shows similarities in the significances. The levels of the dimensions 'technical equipment available', 'explanation',

'waiting time' and 'easy access' are all highly significant ($p < 0.01$), except for the waiting time level '30–90 min'. The attribute 'payment' is only significant ($p < 0.05$) in the 'adult' scenario. The levels of 'type of consultation' show statistically significant results for GPC ($p < 0.05$) and for 'PD' ($p < 0.01$). The latter is only available in the 'child' scenario.

The fractional utilities of both scenarios show a high degree of similarity leading to a greater generalizability and confidence in the robustness of analysis. The size of the part-worths indicates the intensity and the sign shows the direction in which a change of the attribute changes the overall utility. The attributes' relative importance as indicated in Tables 3 and 4 allows for an easier interpretation of the results.

Patients considered the 'explanation' about the problem and the treatment as the most important factor in the choice of service ('adult': 35.8%; 'child': 38.5%), followed by the waiting time for consultation ('waiting time': 'adult': 25.7%; 'child': 23.8%). These two characteristics secured approximately two thirds of the variability in utilities observed. The third important attribute is the availability of technical equipment ('adult': 14.9%; 'child': 12.5%). The accessibility of the services ('adult': 12.2%; 'child': 11.2%) is the fourth most important dimension in the adult context but only ranked fifth if a child was involved. The type of consultation is on the fifth ('adult': 6.6%) and fourth position respectively ('child': 11.9%). The least important service characteristic is the method of payment contributing only 4.7% ('adult') and 2.1% ('child') to the judgment.

To check the robustness of the results, we also tested for the impact of socio-demographics and familiarity with the services. While the study includes a broad range of nationalities and cultures representing a valid sample of a large city population, it appears that such patient characteristics and service familiarity do not substantially alter the part-worths, i.e., neither their directions nor their significances.

Table 3
Part-worths 'adult' scenario.

Attribute	Level	Part-worth ^a	Standard error	Significance	Attribute importance
Type of consultation	ER	−0.007	0.078		6.6%
	GPC	−0.113	0.053	*	
	HV	0.120	0.079		
Technical equipment available	Yes	0.263	0.053	**	14.9%
	No	−0.263	0.053	**	
Explanation	Enough	0.631	0.041	**	35.8%
	Not enough	−0.631	0.041	**	
Waiting time	<30 min	0.447	0.056	**	25.7%
	30–90 min	0.013	0.053		
	>90 min	−0.459	0.055	**	
Easy access	Yes	0.214	0.038	**	12.2%
	No	−0.214	0.038	**	
Payment	Immediately	−0.083	0.038	*	4.7%
	Later	0.083	0.038	*	
Log-likelihood for this model	−1050.4				
Degrees of freedom	8				
Model chi-square	450.0**				

^a Part-worths are zero centered, as opposed to selecting one arbitrary part-worth to be zero.

* $p < 0.05$.

** $p < 0.01$.

Table 4

Part-worths 'child' scenario.

Attribute	Level	Part-worth	Standard error	Significance	Attribute importance
Type of consultation	ER	0.079	0.095		11.9%
	GPC	−0.155	0.064	*	
	HV	−0.187	0.097		
	PD	0.263	0.067	**	
Technical equipment available	Yes	0.236	0.048	**	12.5%
	No	−0.236	0.048	**	
Explanation	Enough	0.728	0.045	**	38.5%
	Not enough	−0.728	0.045	**	
Waiting time	<30 min	0.443	0.058	**	23.8%
	30–90 min	0.014	0.055		
	>90 min	−0.457	0.060	**	
Easy access	Yes	0.212	0.041	**	11.2%
	No	−0.212	0.041	**	
Payment	Immediately	−0.039	0.041		2.1%
	Later	0.039	0.041		
Log-likelihood for this model	−908.0				
Degrees of freedom	9				
Model chi-square	454.3**				

* $p < 0.05$.** $p < 0.01$.

3.3. Market shares

The part-worths provide us with the input for the market share simulator. As mentioned above, we used experts to estimate real market performance of the different services as the second input for the market simulation. Table 5 presents the experts' evaluation of all attributes per service collected on a 7-item scale. We use the Randomized First Choice method to calculate the market shares.

In the simulated service choice GPC (39.1%) is preferable to ER (32.7%) and HV (28.2%) in the 'adult' scenario. When the patient was a child, the GPC (31.3%) and ER (30.7%) were the most chosen services, followed by PD (24.6%) and HV (13.5%). Our sensitivity analysis showed that a 10% improvement in the performance assessed by the experts would lead to higher increases in market share for 'explanation' ('adult': 4.6%; 'child': 4.8%) followed by 'waiting time' (3.4%; 3.8%). The impact of improvement in access (1.4%; 1.5%) and availability of technical equipment (0.6%; 0.5%) are less pronounced. As the attribute 'payment' is binary coded, a relative change is not applicable. Instead,

we estimate the impact of switching from an immediate to a deferred payment model. The market share of a new GPC service would increase by 4.8% and 2.9% respectively.

4. Discussion

The purpose of this study is to quantify how a new service, namely the GPC service, matches patient needs and thus contributes to the literature on configuration and planning of new medical services. In the following paragraphs we discuss various issues regarding (1) the methodology and study design, (2) the part-worths' estimation and attribute importance and (3) the market simulation and identify future research opportunities.

4.1. Methodology and study design

In previous research DCE proved to be a reliable and useful tool for eliciting patients' preferences in healthcare [4], as it simulates patients' decisions based on specific scenarios. In our study, we split our sample in two contexts

Table 5Real market performance of the services expert opinion^{a,b}.

Type of consultation	Waiting time	Technical equipment	Access	Explanation	Payment ^c
<i>Adult</i>					
ER	3.1	5.8	6.6	4.6	7.00
GPC	6.1	3.4	6.4	6.1	1.00
HV	4.0	3.5	5.9	5.9	1.00
<i>Child</i>					
ER	3.3	5.9	6.8	5.3	7.00
GPC	6.3	3.2	6.4	6.1	1.00
HV	4.1	3.7	6.0	6.1	1.00
PD	3.4	4.8	3.0	6.1	1.00

^a Scale with the extremes: 7 (positive) to 1 (negative).^b ME total: mean of all 8 doctors.^c For the attribute 'payment' we choose actual levels as they are available.

(‘adult’ and ‘child’) in order to increase the generalizability of the study’s findings. The DCE methodology appears particularly suited for reproducing decision making in tensed situations (i.e., need for out-of-hours care) where patients need to simultaneously consider multiple alternatives and their performance levels.

4.2. Part-worth estimation and attribute importances

This research builds on earlier studies and intends to represent a more complete range of attribute bundles. The satisfactory explanation about the treatment by the doctors proved to be the most important attribute, followed by ‘waiting time’, ‘availability of technical equipment’ and ‘accessibility’ of the service. The least important and only insignificant attribute is the payment terms, suggesting that an immediate payment, which is required at GPC, PD and HV, is not perceived as especially negative. It is not entirely unexpected, since in the local out-of-hours health care system only the payment terms differ, but the amount to be paid remains equal for all services.

The quality of the doctors’ advice accounts for more than one third (‘adult’: 35.8%; ‘child’: 38.5%) of the decision. The high importance of the attribute ‘explanation’ is in line with results from healthcare industry as well as the services marketing field: competence, listening, communication and understanding of the individuals by the doctor/frontline personnel have been identified as highly important for the quality of the service [10,20]. Researchers have often used questionnaires that directly ask patients about attributes’ importance and satisfaction with models of primary care ([5]; see [12] for a review of various methods). In spite of an overall consistency with our findings, the lack of traditionally functioning markets favors indirect methods to elicit preferences such as choice-questions in DCE [18]. The approach allows estimating shares of yet less known services which is particularly advantageous in our study.

4.3. Market simulation

Previously, researchers identified the need for predicting the demand for new services as it is highly relevant for capacity planning, maximization of adoption rates and cost assessment of the alternatives [7,17,26]. The prediction of demand demonstrated a high choice share for the GPC service (‘adult’: 39.1%; ‘child’: 31.3%) making it the preferred service offer. The ER is the second most chosen option, followed by the PD in the ‘child’ scenario and the HV as the least chosen. The shift in services’ use suggests better use of resources as ER is regarded as the least efficient option in delivering primary care [27]. The higher than expected market share of the GPC might partly be explained by an overestimation of the GPC service by the experts. It similarly occurs in new product development in other industry sectors; we limited this effect by using experts with different medical professions. The sensitivity analysis reveals that the adoption of the new GPC service would particularly benefit from improvements in GP’s explanation and accessibility. This is an interesting finding because the

initial shift toward the GPC is less promising than expected [28] but may be accelerated through such improvements.

At present, there is strong dominance of the ER and the PD in the healthcare industry [7,9]. Our research illustrates that in the future the new GPC service might be preferred to ER and PD. It is in line with the suggestion that stronger experience in a medical service is positively related to its usage [6]. Consequently, we can predict a major shift toward the GPC once the service is actually known and used. In order to enhance ‘user’ adoption, strategies are required to increase awareness and to communicate advantages, intended use and accessibility of the GPC service.

4.4. Limitations and future research

In our sample, three quarters of the respondents were women, waiting at the Free New born and Child health care services. Although the share is similar to earlier studies in healthcare [10], future investigations might examine the effect of gender on this particular service. As indicated above, patients’ characteristics such as service familiarity, age, gender and foreign origin do not substantially affect the utilities. However, a future research approach may investigate the relationship between patients’ characteristics and preference heterogeneity more in detail which was not the focus of our study.

Moreover, we carefully selected and validated the service attributes. However, DCE only allows integrating a limited set of attributes to keep the judgment manageable for respondents. Additional service attributes or psychological cues may also play a role in service choice and might be subject to future studies.

4.5. Managerial implications

From a managerial perspective, our findings are important because they offer the possibility to prioritize and quantify the decision criteria in a health care system. They demonstrate how a negative performance in one characteristic might be substituted by another which is useful for future services’ reconfiguration. Another value of this study lies in the prediction of the choice of alternatives for health systems with a free choice option. A market simulation and the related sensitivity analysis enable healthcare providers, who are increasingly made accountable for the expenditures, to conduct a more accurate and reliable service capacity planning. Future research could combine DCE results with the cost of different attribute bundles in order to find optimal cost-effectiveness [3,21], which was beyond the scope of this study.

5. Conclusions

In conclusion, this paper demonstrates a rigorous way to estimate patients’ preference pattern and to predict their service adoption behavior. It provides a more powerful approach than the pure analysis of single decision criteria in order to design complex new medical services. Evidently, the design of the newly established GPC matches patients’ preferences for healthcare services, and the GPC can be a

well-perceived alternative to ER, PD or HV in an out-of-hours situation when focusing on the crucial elements.

Ethical approval

We received ethical approval of this study by the Ethical Committee of the University of Antwerp in September 2005 (record no. A 05 45).

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Conflict of interest

The authors have no link with either GPDS or ED departments.

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The first author had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis

Appendix A. Scenarios

A.1. "Adult" scenario

You have a visit on a Saturday night from a friend or relative who will stay the night at your home. During the night, the visitor wakes up and feels unwell. So you decide to look for medical assistance.

A.2. "Child" scenario

It is Sunday morning. Your three-year-old child has a fever. You gave him already a medicine to lower the fever. It helped but the fever is coming back. So you decide to look for medical assistance.

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