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Efficiency at the bedside: positive news on how physicians ration resources

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ABSTRACT

Different physicians apply different criteria to ration resources. As such, the final allocation of resources and, therefore, individual patient well-being depends upon a reflected criteria usage. This paper describes an experiment in which eight different criteria for allocating resources were investigated. We found that physicians mostly use health-related criteria when making decisions and that this is supplemented with individual perceptions of well-being. However, discriminating information is not taken into consideration in resource allocation decisions.

KEYWORDS: medical decision making, efficiency, rationing, health, and physician

INTRODUCTION

The need for efficiency dominates many facets of contemporary life. The health care sector is no exception. Within this context, many people have attempted to define fair rules that govern the allocation of the available resources, be it money, time, or access to treatment. On a macro level, the QALY approach (Weinstein & Stason, 1977; Weinstein et al, 2009) is one of the leading concepts that is employed to determine how much money should be allocated to which patient groups or whether certain therapies are worth refunding (Claxton et al, Rawlins & Culyer, 2004). Although QALY facilitates allocation decisions and supports transparency, the lack of a solid process by which equitable allocation of resources can be ensured remains an area of much debate (Dolan et al, 2005; Schosser et al, 2016).

The same problem exists on a micro level. Here, the caregivers are the central actors. They are responsible for providing the necessary treatment to patients and, ideally, they operate with the wider goal of delivering the best service possible. At the same time, physicians and nurses are frequently required to save resources, be it time slots for patients, materials or facilities (Hurst et al, 2014). These targets are often in direct contention with one another, and caregivers must solve this dilemma from case to case on a daily basis (Marckmann, 2009).

The consequences of scarce resources have already blazed a trail into the daily routines of many practitioners, especially physicians. On a macro level, several official studies and political discussions have focused on which services can be refunded, which additional opportunities must be excluded and, of course, the methods by which this can be achieved (Klein, 1993). Here, we talk about rationing (Ubel, 2001). On a micro level, however, it is physicians who must solve the dilemma described above and, consequently, it is them who ration individual treatments (van Delden, 2004). This includes, for example, ruling out more expensive therapies and, thus, refraining from informing the patient about additional treatment options or neglecting to perform certain surgeries for patients who are considered to be aging (Hurst et al, 2014). Such practices should be unacceptable. The question we must ask here is whether we have

already exhausted all opportunities to increase the efficiency of patient-centered care (Emanuel & Fuchs, 2008; Good Stewardship Working Group, 2011; Korenstein et al. 2012). On a micro level, we must also consider the competencies of the physician in complex decision-making situations (Hurst et al, 2006). Is he able to process relevant information appropriately, to neglect irrelevant aspects and, thus, to distribute the resources that are available in the most effective and equitable manner?

Within the context of this paper, when we talk about efficiency, we refer to the relationship between a specific product (output) of the health care system and the resources (inputs) used to create the product (Chisholm & Evans, 2010; Haas et al, 2005). However, this is not enough. Moreover, when focusing on an efficient resource allocation, we must turn our attention to the individuals in need by asking who needs help first and how can we account for, and justify, providing care to one patient at the expense of another. Deducing individual priorities is challenging because it involves deciding what factors should be taken into account to make a fair decision. While objective criteria can be used that relates to aspects such as the diagnostic process of the disease, such as duration until recovery without treatment, or the individual parameters of the patient and comorbidities, subjective criteria is also of relevance when prioritizing how resources are distributed among patients. Pain and discomfort is a personal experience and only the patient him- or herself truly knows the extent of the suffering. Hospitals often employ rating scales to assess the strength of the pain an individual is suffering after surgery and utilize the patient's perception of their pain to make decisions as to when to administer treatment. This is just one example of the direct relationship between subjective perception and medical response. Assessing one's current pain level using a ten-point rating scale is relatively simple. However, decisions are not always quite so straightforward. More difficult scenarios involve deciding whether a patient should undergo an expensive surgery that is associated with serious risks as opposed to accepting life within his or her current limitations and, thereby, never fully recovering. Once again, the patient is the only one who is truly in a position to choose between a life of ongoing pain or a potentially healing treatment that carries serious risks. It's highly likely that, when making such as decision, the patient will not be concerned about budgetary restraints. Physicians frequently encounter cases such as this and, within their role of final decision maker, are faced with the dichotomy of supplying adequate treatment to all patients while also saving resources whenever possible. This is a complex problem that is not easy to solve.

One standard method that can be employed within the context of health benefits is to elicit patient's willingness to pay (wtp) (Olsen & Smith, 2001). Individual willingness to pay for a treatment can also act as a valuable information source that can help physicians decide how to allocate their budget (Brach et al, 2005). This approach can be particularly useful in situations in which a certain number of individuals are awaiting treatment, none of whom are in a life-threatening situation. In such cases, information about each patient's wtp can be used as subjective data to support the decision-making process (Cookson, 2003; Tuominen, 2008). However, this approach is flawed because a patient's wtp may be directly related to his or her personal earnings and, as such, variations in the wtp amounts does not necessarily reflect sufferance and need for help (Donaldson & Shackley, 2003; Brach et al, 2005). Furthermore, it is not clear whether physicians are willing to include subjective information of this nature as this also means that they partly relinquish decision-making responsibilities to the patient.

What is problematic concerning the implementation of wtp assessments in many research studies concerns the fact that the money is hypothetical. Several studies have demonstrated that the amounts of money subjects indicated they were willing to pay significantly deviated from the amounts they really paid in scenarios that involved a real buying situation (Pesheva et al, 2011; Blumenschein et al, 2001). Accordingly, there is a distinct need for studies that are conducted in a context in which the wtp sums are not hypothetical but real.

We conducted an experiment in a laboratory setting in which physicians treated individuals who were really in need. The resources that the physicians had access to for the treatment of the patients were restricted such that it was not possible to treat all individuals. Failing to treat individuals had direct consequences for their well-being.

The focus of this research was twofold. First, we wanted to ascertain if decision makers who had a limited budget available to treat individuals in need were willing to use subjective information when making a decision. To this end, we presented both objective and subjective information, including wtp amounts, to evaluate whether physicians took this information into consideration when making a decision. To apply the decision-making situation to real scenarios, we also added further information that was not directly required for the decision to be made. Second, we evaluated the efficiency of the rationing decisions physicians made by comparing them to those made by individuals in a cohort of non-medical deciders. Therefore, we related the money deciders spent to theoretical revenues from wtp.

We found that physicians are willing to take subjective information into consideration when making rationing decisions. Moreover, some factors are significantly more efficient and comprehensive in complex budget allocation situations than other deciders.

EXPERIMENTAL DESIGN

Our experiment consisted of three components:

- a. the cold pressor test to reduce well-being for the untreated patients
- b. willingness to pay and its further implementation
- c. the extent to which wtp- and other information was taken into account for medical decisions.

Henceforth, we refer to the participants in the study as the *deciders* (the subject who allocated the budget) and the *individuals* (the subjects who awaited a budget allocation to avoid reduced well-being).

- a. Manipulation of well-being: the cold pressor test

The inclusion of real consequences following an allocation decision was central to our experimental design. As such, it was necessary to reduce the well-being of those individuals who were not prioritized. Prioritization and rationing in the health care sector often affects patients who suffer from a disease over a longer period of time and who are not directly confronted with life-threatening conditions. Chronic diseases mostly include a constant or repeatedly upcoming pain perception; for example, back pain. We simulated a reduced well-being that was analogous to the chronic pain that is associated with many different diseases. The so-called cold pressor test (Hines & Brown, 1936) was identified as one option of achieving this as the pain it generates is comparable to chronic pain (Mitchell et al, 2004). The cold pressor test involves subjects immersing their hand in a bowl of cold water. After a few seconds, they start to experience a constant deep pain, and this pain remains relatively stable over some time. The level of suffering varies according to the water temperature and the amount of time the hand is immersed.

In our experiment, we randomly allocated a water temperature and an immersion duration to each participant. These parameters determined whether the pain experienced due to the hypothetical illness was either strong or mild. To precisely simulate the different levels of

reduced well-being, we worked with professional cooling equipment [Julabo F12-ED Refrigerated/Heating Circulator]. Different coolers were provided for different temperatures.

b. Willingness to pay: request and implementation

As reported in the last section, we randomly allocated a water temperature and an immersion duration to each individual. At the beginning of the experiment, everyone saw this information on the screen. After a short trial period involving cold water, we asked the participants how much they were willing to pay to avoid the complete pain induction with the cold water. Here, we implemented the following questioning format, which was based on that suggested by Holt and Laury (Holt & Laury, 2002) (Table 1).

Alternative 1	Alternative 2	Alternative 1	Alternative 2
X minutes immersion in y° cold water	Payment of 0,00 EUR		
X minutes immersion in y° cold water	Payment of 0,50 EUR		
X minutes immersion in y° cold water	Payment of 1,00 EUR		
X minutes immersion in y° cold water	Payment of 1,50 EUR		
X minutes immersion in y° cold water	Payment of 2,00 EUR		
X minutes immersion in y° cold water	Payment of 2,50 EUR		
X minutes immersion in y° cold water	Payment of 3,00 EUR		
X minutes immersion in y° cold water	Payment of 3,50 EUR		
X minutes immersion in y° cold water	Payment of 4,00 EUR		
X minutes immersion in y° cold water	Payment of 4,50 EUR		
X minutes immersion in y° cold water	Payment of 5,00 EUR		

Table 1 Questionnaire on willingness to pay to avoid pain

Individuals were asked eleven times to decide if they either preferred to put their hand into water of the allocated temperatures for the immersion duration (Alternative 1) or if they preferred to pay money to avoid the task (Alternative 2). The amount of money participants were offered as options increased in steps of 50 cents from 0 Euro to 5 Euros. Individuals had to mark one alternative in every row.

Real willingness to pay

Wtp information was elicited for every individual. This information was presented to the deciders in the following steps of the experiment. We did not inform the individuals that the deciders would receive their wtp amount during the decision-making process. However, we wanted to make sure that the individuals indicated their real wtp and did not cheat for strategic reasons. Therefore, we implemented a control mechanism. The individuals were informed that one of them would be selected randomly at the end of the experiment and that their wtp matrix would be employed to determine their treatment outcome; i.e., depending on the chosen alternative, the individual either had to immerse his or her hand in the cold water or his or her remuneration for participating in the experiment was reduced according to the defined wtp.

Individuals were not required to pay anything related to their indicated willingness to pay in the context of budget allocation of the decider. Here, the wtp information only served as addition information that may help the decider to rationalize his or her decision.

c. The use of wtp information in decision-making

To generate a scenario that bore a resemblance to real-life medical decision situations, we provided our deciders with a variety of both objective and subjective (even irrelevant) information about the five individuals in need. Some criteria were randomly allocated, others were requested (see Table 2).

Criteria		Description	Levels	Evaluation of criteria
1	Water temperature	Randomly allocated to every individual at the beginning of the experiment, coupled with immersion duration	4° Celsius for 3 minutes	Objective criteria essential to come to a well-grounded rationing decision
			7° Celsius for 2 minutes	
2	Immersion duration in cold water		4° Celsius for 1 minute	
			9° Celsius for 2,5 minutes	
			12° Celsius for 3 minutes	
3	Costs not to go through cold pressor pain	Differing amounts in each session were randomly allocated to each individual, independent from water temperature and immersion duration	Amounts varying between 0,80 EUR and 4,50 EUR	
4	Willingness to pay not to go through cold pressor pain	Elicited via the described procedure for every individual	Amounts varying between 0,00 EUR and 5,00 EUR	Subjective criterion helpful to differentiate individual need
5	Sex	Requested information	M / F	Irrelevant criteria without direct relevance for a fair resource allocation
6	Smoking habits	Requested information	Smoking / non-smoking	
7	Birth place	Requested information	City / country	
8	Parents academics	Requested information	At least one parent with a university degree yes / no	

Table 2 Overview of criteria

As soon as the decider had made his allocation decision, we asked him to rank each of the eight criteria using a rating scale that ranged from 0 (no influence at all) to 10 (essential influence on decision making) to indicate how much this information had influenced the decision.

A central focus of our study was on physicians' competency to efficiently ration resources and, in this context, on the information used to identify a fair solution. To evaluate the decision-making behavior of physicians in comparison to subjects who did not have comparable experience, we employed two additional groups of deciders: Prospective physicians with at least six months of work experience in a hospital and non-medical students from various fields of study.

EXPERIMENTAL PROCEDURE

The experiment took place at the medical unit of the Otto-von-Guericke University in Magdeburg, Germany. We conducted 32 sessions in total, 16 with medical deciders and 16 with non-medical deciders. Individuals and deciders were situated in different buildings. One experimenter conducted the experiment in each room. We randomly assigned students either the role of the decider or the individual in need. Physicians only took part in the experiment in the role of deciders.

Individuals

As soon as the subjects arrived, they drew a numbered ball out of an urn. The number was subsequently used to allocate the water temperature, immersion duration for pain induction, and the costs of treatment, i.e. the amount of money deciders had to spend to avoid imminent pain induction, to each subject. We set the costs such that the budget was high enough to treat a maximum of three or four individuals, but never all of them.

The subjects read the experimental instructions that described the whole experiment and were given an opportunity to ask questions. Throughout the experiment, we excluded any health- or medicine-related wording and employed neutral language. The coolers holding water at the pre-set temperatures were placed in front of the participants. We instructed the subjects that the cold water pain would be delivered via these coolers. Subjects signed a consent form through which they agreed to participate in an experiment that potentially included pain induction with cold water.

We acknowledged that there was a risk the subjects would underestimate the intensity of the pain they would experience upon immersing their hand in the cold water. To avoid that, each subject was asked to immerse their hand in a cooler that contained water at a temperature of 7° Celsius for 20 seconds (as allocated water temperatures ranged from 4° Celsius to 9° Celsius, the midpoint of 7° Celsius was deemed to be appropriate).

In the next step, we collected the wtp information from each subject using a computer-based approach. Subjects indicated their wtp in the described manner. They were aware that the amount of money they were willing to pay could reduce their final remuneration.

Decider

The decider was also provided with a set of instructions that were neutrally worded. A cooler holding water at a temperature of 7° Celsius was presented to the decider, and the decider was asked to immerse his or hand in the water for a period of 20 seconds. The purpose of this exercise was to provide the decider with an opportunity to experience the pain that would be administered to the participants.

The decider then waited until all individuals had entered the information requested. As soon as they had finished, the decider was presented with a screen that contained all the criteria for the five individuals (5 times 8 fields). Based upon this matrix, he was now asked to make a decision as to who would receive care and who would not.

Using rating scales, each decider was then asked to rank each criterion according to how much it had influenced his or her rationing decision.

Individuals

Once the decider had allocated his budget, individuals were informed who was permitted to leave and who had to go through the cold pressor pain. The individuals concerned were seated in front of the respective coolers, and a video link between the room in which the individuals were placed and that of the decider was initiated so that the decider could see the individuals awaiting pain induction. The decider was, therefore, able to observe the consequences of his decisions (the decider had been clearly informed at the beginning of the experiment that there would be a video stream during the pain induction process). The experimenter then started a stopwatch and the individuals simultaneously immersed their hands in the water. Depending on the allocated immersion durations, the experimenter informed one individual after the other as soon as their time was over and they were able to remove their hands from the water.

Decider

The decider watched the pain induction procedure, was paid 15 Euros for participating in the experiment, and left the campus.

Individuals

The last step in the research process for the individuals was the realization of the real wtp mechanism. Therefore, one participant was chosen randomly. We opened her wtp-decisions (see Table 1), randomly defined one of the eleven decisions, and realized it: She either received reduced payment or went through a (potentially second) pain induction procedure.

Finally, all subjects were paid 15 Euros for their participation (if payment had not been reduced for the one individual randomly defined) and left the campus.

RESULTS

In this experiment, the deciders were required to allocate their budget based on eight different criteria (Table 2) that consisted of a range of objective, subjective and irrelevant criteria. In the first step, we aimed to understand how our deciders used the available criteria with a focus on wtp. Therefore, after making the rationing decision, the deciders were asked to rate the extent to which each of the criteria had been taken into consideration in their decision through the use of a rating scale.

The results indicated that both the students and the physicians ranked the criteria according to the same priority (see Figure 1).

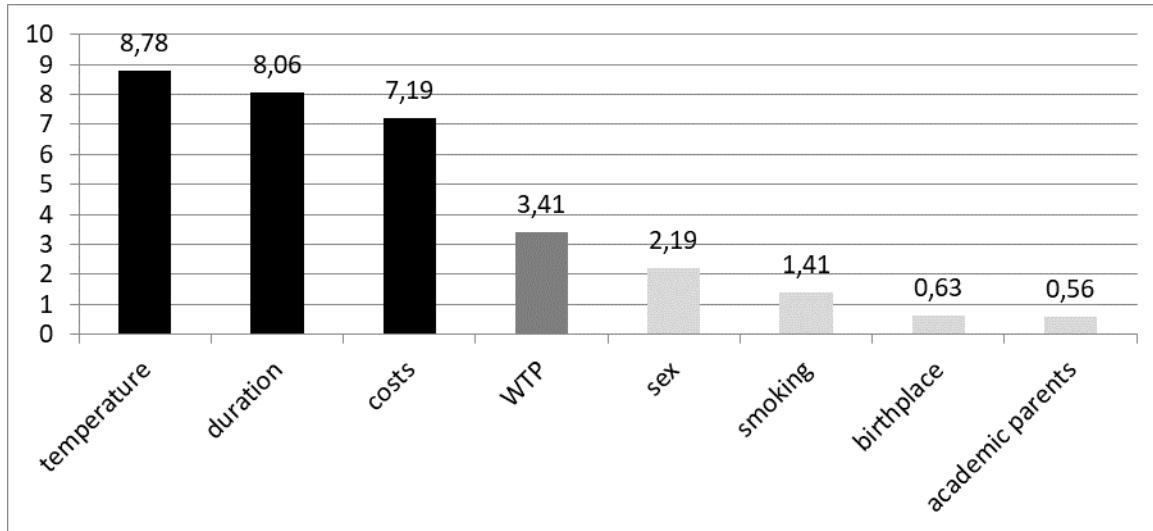


Figure 1 Ranking of criteria for the two decider groups

The visible distribution of ratings in the figure confirms that there were significant differences between the three categories of criteria (Wilcoxon, 1%-level and 5%-level). Specifically, the deciders indicated that:

- Objective criteria had the highest priority within the allocation process
- the subjective criterion *willingness to pay* was its own, subordinated category and
- the four remaining criteria were of minor or no relevance to our deciders.

Our research question was designed to determine whether the physicians were willing to include the subjective criterion *WTP* when making a treatment decision. We found that there was a significant difference between the two decider-groups: physicians indicated that, for them, *WTP* was an important criterion when making a comprehensive rationing decision (Mann-Whitney-U-Test, 5%-level, 1-sided).

To summarize, the objective criteria took precedence for both sets of decision makers; i.e., the factors of *how strong is the pain*, *how long the pain lasts*, and *how much do I have to spend to gain relief from pain*. After recognizing these criteria, they were then interested in the individually perceived sufferance, which was manifest by *WTP*.

In this context, another finding is of interest. We designed the different pain doses with water temperature and immersion duration such that it was difficult to intuitively define a ranking of sufferance for the individuals (Who suffers more? The individual who has his or her hand immersed 7° Celsius cold water for two minutes or the one who has his or her hand immersed in 4° Celsius cold water for one minute?). Only one pain dose could be identified as strongest: 4° Celsius (coldest temperature included) for 3 minutes (longest immersion duration included). If decision makers first considered pain intensity and then pain duration, one should assume that all individuals awaiting the strongest pain dose would have been treated as a priority. This

assumption is true for the physicians: 94% used their budget to prioritize the individual with the strongest pain dose, whereas only 75% of the non-medical deciders did so.

Now let's analyze this result from a wtp-perspective: What was the effect of wtp on the individuals awaiting the strongest pain dose of 4° Celsius for 3 minutes? In only 31% of the sessions, these individuals indicated that they were wtp the highest amount in comparison to the co-participants. This means that, although individuals indicated intermediate urgency in their session group, physicians ultimately prioritized them based on the objective criteria, not their wtp.

In the next step, we focused on the second research question concerning the efficiency of allocation decisions. Our analysis was based on the theoretical assumption that, in the experiment, the indication of wtp was not directly coupled with a payment. However, based on the control mechanism, small revenues were possible. We supposed that all amounts subjects were willing to pay were real possible revenues. Based on this assumption, we aimed to find out how the deciders balanced both the money they spent to avoid pain induction and potential revenues from the individuals they prioritized. Depending on this ratio, we evaluated decisions for financial efficiency.

As described above, in each session, we allocated different costs to the five pain combinations. Individuals then disclosed their wtp amounts. As such, in addition to the four irrelevant criteria (gender, smoking habits, etc.) the decision makers worked with five times four criteria. To maximize efficiency, you cannot simply select individuals with the highest wtp; you always have to verify the costs they generate to come to a good result. If, for example, an individual was willing to pay 3,00 Euros (which is high in comparison to many other individuals), but his treatment cost 3,50 Euros, this results in a negative financial statement. On the contrary, someone with a lower wtp of 1,50 Euros and costs of 0,80 Euro results in a positive revenue. Incorporating this additional criteria results in high complexity for the decision-making process.

We analyzed the data accordingly. The most striking result was that the physicians maximized revenues significantly better (i.e., in 69% of the sessions) than the non-medical decision makers (i.e., in 25% of the sessions). However, one must question what happened in the remaining sessions. We conducted a detailed analysis of the data, searching for potential strategies besides efficiency and wtp, and searched for allocation patterns as follows:

- prioritizing individuals allocated to the coldest temperatures (intensity)
- prioritizing individuals allocated to the longest immersion durations
- trying to free as many individuals as possible from pain, independent from pain parameters and wtp.

In all five sessions, the physician decision makers who did not optimize revenues all focused on the individuals awaiting the strongest pain intensity; i.e. water temperature was the central criterion.

While one group of the non-medical student decisions makers focused on pain intensity as the main strategy (44%), five sessions could not be explained by any of the supposed strategies. These partly seem to be solved irrationally as, for example, the available budget was not fully

allocated. We interpreted this to be an indication that some of the non-medical deciders had been burdened by the complexity of the task (see Figure 2).



Figure 2 Strategy distribution

CONCLUSION

The study described in this paper was designed to develop insights into the extent to which wtp information as a subjective criterion influenced comprehensive resource allocation decisions. In addition, the aim of the experiment was to ascertain if, in addition to taking objective health-related criteria into consideration, physicians also respect aspects of efficiency and, thus, arrive at more efficient allocation solutions than deciders who have no medical background.

The results revealed that all deciders employed a general hierarchy of criteria when making decisions. This hierarchy confirmed the relevance of objective criteria but also that additional information, such as wtp, can influence a physician's perception of the affected person and, thereby, the ultimate allocation decision.

Wtp is also important for physicians when it comes to the question of allocation efficiency. The findings of this research indicated that the physicians demonstrated a significantly stronger drive to optimize potential revenues relating to costs for the individual with theoretical earnings from wtp. A central criterion besides the monetary variable for both decider groups was pain intensity. Deciders did not seek to maximize revenue but focused on individuals who were threatened with the strongest pain, a valuable and comprehensible strategy. However, it was only in the group of medical decision makers that we could understand the implemented strategies in every session. It seems that the physicians were able to process the information that was available better than the control group. They managed to ignore irrelevant information, define their maxims, and make consistent decisions.

On a micro level, prioritization and rationing cannot be standardized or even controlled. Therefore, there is a need for physicians to review complex situations and set acceptable maxims to allocate resources. At the outset of this research, we questioned whether it was possible to enhance the efficiency of the decisions that are made at the bedside and whether physicians can cope with the complexity they encounter when making such decisions. The

findings of the current study revealed that there is a significant gap between students without medical background and physicians with work experience in terms of how information is used. We do not know whether this originates from the process by which students are selected for medical studies or if students develop such competencies during their training. However, the findings indicate that the people who work as physicians do possess the key competences required to make decisions as to who receives treatment. Moreover, this implies that these competences can be further developed so that, for example, training on ethics and efficiency could help physicians with their daily decision tasks (Langer et al, 2016).

One of the limitations of the current study was that it was not possible to realize a wtp scenario that had real implications for long-term health and well-being. However, the findings do indicate that the elicitation of wtp information may provide decision makers with solid insights into the extent of a patient's suffering and these insights could facilitate decision making. In terms of current relevant topics, such as shared decision making or compliance, approaches like wtp could further strengthen interpersonal competences and have beneficial results for society.

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