Taking Care of High-Need Patients in Capitation-Based Payment Schemes - An experimental investigation into the importance of market conditions

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Abstract
Many health care systems use provider payment as an instrument to ensure an efficient and equitable delivery of care. Capitation-based payment schemes are popular because they contain costs. However, they are known to lead to underprovision of care, especially to high-need patients. Using a laboratory experiment, we test whether the availability of resources affects providers’ response to a capitation-based scheme. We find that the relative underprovision of care to high-need patients exists both when providers are resource abundant and constrained. Next, we introduce two different versions of the scheme and test whether they incentivise providers to take better care of high-need patients. One scheme ring-fences part of the capitation payment to a fixed physician salary, whilst the other scheme differentiates payments based on patients’ expected need of care. We find that high-need patients gain the most from a fixed provider salary under resource abundance, but find no difference in gains between patient types under resource constraint. Our results also show that differentiation of capitation makes providers take relatively better care of patients linked to an above average payment compared to a below average payment, regardless of resource constraints. Our findings suggest that both the design of the scheme and the market condition affect providers’ patient prioritisation under capitation.

KEYWORDS
Physician payment system; Equity; Capitation-based payments; Laboratory experiment

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1. Introduction

Most health care systems aim to deliver health care efficiently and equitably within fixed budgets. In an effort to contain costs, many third-party payers (governments or insurers) introduce capitation-based payments. For example in the UK, the US, and the Scandinavian countries general practitioners are paid per capita. Capitation is an ex-ante lump-sum payment per patient registered with a physician (Iversen and Luraas 2000; Scott 2000). As the payment is ex-ante the physicians carry the full treatment costs and thereby secure the payers’ budgets.

The drawback of capitation-based payment schemes is that it forces physicians to make a trade-off between own income and patient benefits thereby incentivising them to provide less than the patient-optimal amount of care (Barham and Milliken 2015; Brosig-Koch et al. 2015; Ellis 1998; Ellis and McGuire 1986; Hennig-Schmidt, Selten, and Wiesen 2011). The literature has shown that it is the high-need patients who suffer the greatest loss of care from this trade-off (Barham and Milliken 2015; Brosig-Koch et al. 2015; Ellis 1998; Hennig-Schmidt, Selten, and Wiesen 2011), implying that capitation potentially leads to an inequitable distribution of health care.

Third-party payers can alter the payment scheme in different ways to improve high-need patients’ access to care. The literature has mainly focused on mixing capitation with fee-for-service payments (Barham and Milliken 2015; Brosig-Koch et al. 2015; Ellis 1998; Ellis and McGuire 1986; Hennig-Schmidt, Selten, and Wiesen 2011). Missing in the literature is an investigation of alternative designs of the capitation-based models. We test two models of capitation-based remuneration: 1) ring-fencing part of the capitation payment to a fixed physician salary, and 2) making the per capita payment higher for patients expected to be of high-need of care than for patients expected to be of low-need of care. Following the standard principal-agent theory (Eisenhardt 1989; McGuire and Pauly 1991), the underlying idea behind these two models is to incentivise physicians to act as better agents for the high-need patients. The first model reduces physicians’ competing interests (i.e. profit maximisation) by eliminating the supply-side cost-sharing. In the second model, the payer sends a signal to the physician about the importance of taking care of high-need patients.

We use an experimental laboratory setting with medical students to test the impact of the remuneration schemes on the care of patients with different needs. This approach is inspired by the growing field of experimental economics in health care (Cox, Green, and Hennig-Schmidt 2016; Galizzi and Wiesen 2017), in which laboratory experiments have been found to confirm findings from natural experiments. In recent years laboratory experiments have been successfully applied to elicit physicians’ preferences for allocation of health care under resource constraints (Ahlert, Felder, and Vogt 2012; Ahlert, Funke, and Schwettmann 2013), for investigating the importance of professional norms for physicians’ decision-making (Kesternich, Schumacher, and Winter 2015), and for addressing the underlying mechanisms of payment schemes in health care (Brosig-Koch et al. 2016, 2015, 2013; Godager and Wiesen 2013; Godager, Hennig-Schmidt, and Iversen 2016; Hennig-Schmidt, Selten, and Wiesen 2011; Hennig-Schmidt and Wiesen 2014). The latter studies use choice scenarios in which respondents choose between increasing own income and treating a single patient. Yet physicians often face resource constraints (such as limited access to machinery, working hours, and specialised personnel) forcing them to trade-off care between multiple patients, i.e. allocating more health care to one patient at the expense of other patients. As this market condition may affect physicians’ allocation of care, we also introduce scenarios in which there are opportunity costs in terms of less provision of care to other patients.
(we henceforth refer to this as "patient opportunity costs").

A central objective of this paper is to investigate whether saliency of patient opportunity costs alleviates or accentuates the underprovision of care to high-need patients. We test this under three different payment schemes: capitation, salary and differentiated capitation.

Our results confirm that high-need patients suffer the greatest loss of care in capitation-based payment schemes. In fact we find that the relative underprovision of care to high-need patients is even more pronounced when physicians face patient opportunity costs. We find that ring-fencing part of the capitation payment to a fixed physician salary is an effective remedy to make physicians take relatively better care of high-need patients when physicians are resource abundant. However, if physicians are resource constrained, fixed salaries will not change their distribution of care between patients. Thus, physicians’ resource constraints may be an important driver of potential inequitable access to care.

We also find that differentiating capitation makes physicians take relatively better care of patients linked to an above average payment compared to patients linked to a below average payment. This result is present under both resource abundance and constraint. In addition we find that when differentiated payments are non-aligned with physicians’ information on the patients’ need of care, they lead to statistically significant changes in resource allocation compared to pure capitation. This result shows that differentiated capitation can influence physicians’ behaviour even when it is not aligned with their prior information about patients’ needs.

The remainder of the paper is organised as follows. Section 2 introduces our research questions. Section 3 presents the experimental design and setting, and Section 4 present our empirical results. Section 5 concludes the paper.

2. Research questions

Our first research question addresses how physicians prioritise patients in a capitation-based system. According to the literature, high-need patients suffer the greatest loss of care under this payment scheme (Barham and Milliken 2015; Brosig-Koch et al. 2015; Ellis 1998; Hennig-Schmidt, Selten, and Wiesen 2011). Nonetheless, it has not yet been studied thoroughly how resource constraints affect care provision of high-need patients under capitation.

Research question 1 Do high-need patients suffer the greatest loss of care under a capitation-based payment scheme? Does the presence of patient opportunity costs affect the result?

Our second research question asks whether ring-fencing part of the capitation payment to a fixed physician salary (consequently allowing physicians to treat patients without incurring any treatment-specific cost) may serve as an instrument to make physicians take relatively better care of high-need patients under a capitation-based payment system. We consider both cases with and without resource constraints for physicians.

Research question 2 Do high-need patients gain the most from ring-fencing part of the capitation payment to a fixed physician salary under a capitation-based payment scheme? Does the presence of patient opportunity costs affect the result?
Our third research question asks whether differentiating capitation based on patients’ expected need of care makes physicians take better care of patients linked to an above average payment on their patient list. Existing literature focuses on the effect on physicians’ selection of patients (Barros 2003; Newhouse 1996), while we investigate whether differentiating capitation affects how patients already on the physicians’ patient list are treated. We also wish to investigate whether the effect of differentiating capitation depends on whether it is aligned with the physicians’ prior information about patients’ need of care, i.e. an above average payment is given for patients in higher need and a below average payment for patients in lower need. We consider both cases with and without resource constraints for physicians.

Research question 3 Do above(below) average payment patients gain(suffer) from a differentiated capitation payment system based on patients’ expected need of care? Does the presence of patient opportunity costs affect the result?

3. Experimental Design and Protocol

3.1. Decision situation

Participants are 55 medical students (36% males, average age 23 years) about to complete their bachelor’s degree in medicine. We focus on medical students, because it is known that their behaviour is the closest to that of specialists working in the health sector (Ahlert, Felder, and Vogt 2012; Ahlert, Funke, and Schwettmann 2013; Hennig-Schmidt and Wiesen 2014).

Each participant is asked to take on the role of a physician. We ask the participants to decide on the quantity of health care services they want to provide to a patient, whose health gain will be influenced by this choice. We do not focus on the baseline severity of illness, but on the marginal benefit as a measure of need.

In each round, physicians are informed about the total health gain produced by each amount of health care service provided, that each unit of health service provided has a fixed cost, and that there is a limit of 12 units of health care service to be given, regardless of the number of patients consulted.

As we wish to investigate whether trade-offs between patients’ care play a role in the physicians’ decision-making, we introduce scenarios in which physicians can satisfy the need of their patients and scenarios in which they cannot (trade-offs). Participants will encounter scenarios with either one or two patients. In the scenarios with one patient, physicians are always able to provide the number of services needed to maximise patient’s health gain; however, in most scenarios with two patients, physicians are unable to provide the exhausting amount and are therefore forced to allocate the services among the patients.

Patients are assumed to be passive and fully insured, accepting each amount of health care service provided by the physician.

\footnote{The sample size is aligned with other laboratory experiments testing medical decision-making (Godager and Wiesen 2013; Godager, Hennig-Schmidt, and Iversen 2016)}
3.2. Improvement of patients’ health

We assume that patients’ benefit functions are non-decreasing for all number of health care services. We do, however, assume that patients’ benefit from health care services may be exhausted. This functional form is chosen because under a capitation-based payment scheme there is no incentive to overprovide treatment to patients. Furthermore, many health care services do not lead to decreasing health benefits.

We define four types of patients: A, B, C, and D, whose gains from health care are illustrated in table 1. The patient types are defined by 1) the patient’s maximum level of health gain (10 units of health gain versus 20 units of health gain) and 2) the number of services required to exhaust patient’s capacity to gain health (5 units of service versus 10 units of service). We use the latter characteristic to define low- and high-need patients (Culyer and Wagstaff 1993). Thus, patient types A and C are considered high-need patients, whereas patient types B and D are considered low-need patients. The experimental design thereby enables us to test physicians’ responses to a change in the remuneration scheme, across patient types (needs).

From these four types of patients, we build 10 scenarios: Four in which physicians see only one patient (A, B, C, D) and six in which they see two patients at a time (AB, AC, AD, BC, BD, CD). Physicians see the above-mentioned scenarios four times, with different remuneration schemes (within subject design), as we will clarify later on. The experiment lasts 40 rounds (scenarios) in which the physicians will consult 64 patients in total.

[Table 1 about here.]

3.3. Physicians’ income

Each round, the physician receives an initial endowment of 16 experimental dollars. Each unit of health care service provided costs $1 that is deducted from the round’s endowment. The maximum amount of health care services that can be provided is 12; therefore, the physician is ensured a minimum amount of $4 per round. In this way, a physician is guaranteed a daily minimum wage, which would be an inherent characteristic of a real world remuneration system.

At the end of the experiment, two rounds are randomly chosen and the participant is paid, privately, according to her earnings from the selected scenarios (with an exchange rate of $1 = DKK 5)\(^3\) plus a show-up fee of DKK 40. Following the standard protocol of University of Southern Denmark’s experimental lab, participants were paid in canteen vouchers rather than in cash. Participants were aware of this and the average earning was DKK 108, which corresponds to three to four meals.

To incentivise participants to take into account patients’ well being, we randomly select three rounds where the health gain of patients is transformed into DKK with a rate of 1:1 (1 unit of health gain = 1 DKK). The money collected is donated to the Danish Cancer Association and the Danish Heart Association. Physicians are not informed about the identity of the charities (only that they are health-related) until the end of the experiment. This procedure is to avoid behavioural biases due to a preference/aversion towards a specific charity.

\(^2\)To ensure existence of a trade-off between patients in the two-patient scenarios in our analysis, we only include rounds with one high-need patient and one low-need patient, i.e. AB, AD, BC, and CD.

\(^3\)DKK 1 = EURO 0.13
3.4. Remuneration schemes

We wish to investigate whether physicians' choices change when faced with different remuneration schemes (characterised by degree of supply-side cost sharing and differentiated capitation). We use a within-subject design, testing three remuneration schemes in three separate experimental stages: pure capitation (CAP), differentiated capitation (DIFF), and ring-fencing part of the capitation payment to a fixed salary (SAL). The schemes are presented in different orders, see section 3.5. Both CAP and SAL last 10 rounds, in which physicians experience the 10 scenarios presented in section 3.2. The DIFF stage lasts 20 rounds, and physicians experience each scenario twice: once where differentiation is aligned with patients' need of care, and once where differentiation is non-aligned. The rounds were randomised, see section 3.5. The differentiation is merely a communication that the physician receives at the beginning of each round, which indicates whether a specific patient is considered a "below average payment" or an "above average payment" one. Below (above) average payment indicates that the physician receives a payment below (above) average for treating this specific patient.

In the CAP stage, physicians receive an equal amount of experimental dollars per patient. This leads to a daily endowment of 16 experimental dollars and they can provide any amount of care from 0 to 12. Each unit of care provided will reduce the endowment for the round by $1. The daily endowment is $16 independently from the number of patients seen. Physicians receive a fixed amount per patient per "year" (where year is considered the whole stage). This amount is then divided by the number of "days" (rounds) and produces a daily amount of $16. This escamotage is necessary to study how physicians allocate scarce resources between two patients. If the physician had received a daily amount linked to the number of patients visited, there would have been no difference between rounds with one or two patients. Moreover, this design is more realistic, because in a capitation scheme physicians are paid a fixed amount linked to the number of patients registered in their care, but independent from the number of patients consulted.

In the DIFF stage, physicians receive a different amount of experimental dollars for patients with different expected needs. Following the definition by Culyer and Wagstaff (1993) we measure patients' need of care as the expected minimum amount of resources required to exhaust capacity to benefit. Patients are divided into two groups: "below average payment" and "above average payment", where physicians receive for "above average payment" patients twice as high a payment than for "below average payment" patients.4 Physicians are informed whether a patient belongs to the above- or below average payment group. As before, the daily endowment is 16 experimental dollars and physicians can provide any amount of care from 0 to 12. We thereby guarantee that any difference we observe is caused by the categorisation of subjects (and not income effects). Each unit of care provided will reduce the endowment for the round by $1.

To test the impact of the categorisation of subjects we expose the physicians to scenarios in which the differentiation is aligned with patients' actual need of care and scenarios in which it is non-aligned. In the aligned scenarios, patient types A and C are labelled as "above average payment" patients, because they require 10 units of health care services to exhaust their capacity to benefit from care, while patient types B and D are labelled as "below average payment" patients. In the non-aligned scenarios, patient

4The chosen difference in payment is aligned with the difference in the patients' need of care in the experiment (5 units versus 10 units).
types A and C are labelled as "below average payment", while patient types B and D are labelled as "above average payment". Consequently, this stage consists of twice as many rounds as the CAP and SAL stages: 10 aligned rounds and 10 non-aligned ones, with a total of 20 rounds and 32 patients.

In the SAL stage part of the capitation is ring-fenced to a fixed physician salary. Physicians are informed that the choices made in this stage do not influence their income, implying that money not spent on health care services cannot be converted into earnings. However, physicians are aware that one of the rounds will be randomly chosen and that the health gains in this round will be transformed into DKK and donated to charity. The stage is thereby a benchmark for the physician's supply of health care in the absence of any financial incentive. This benchmark enables us to calculate the effect of the different payment schemes on the treatment of each patient type.

3.5. **Experimental protocol**

The experiment was conducted at the Experimental Laboratory at University of Southern Denmark. The experiment did not need approval by the Regional Ethics Committee. The experiment was computerised (programmed with z-Tree) and conducted in Danish. We ran three sessions with a total of 55 medical students (36% male, average age 23) in May, October and November 2015. Sessions had 30, 18, and 7 participants. Depending on their number, participants were allocated to one, two, or three computer rooms. Therefore, in each room, there were roughly 7 to 12 participants independently from the sessions. The students were recruited (voluntarily) from the faculty of medicine and signed an informed consent before participating in the study. Students were informed that the experiment was about physicians’ decision-making and that they would be remunerated for their participation.

Upon arrival, participants were randomly allocated to cubicles where they made their decisions in full anonymity. At the beginning of the experiment the general instructions were read aloud (see online resource A). Participants were given plenty of time for clarifying questions, which were posed and answered in private. To check for participants’ understanding of the decision task, they had to answer a pre-experimental questionnaire (see online resource B). The experiment did not start until all participants had answered the questionnaire correctly.

Instructions for each stage were read aloud right before each stage began (see online resources A and C). Subjects were randomly assigned to one of two orders of the stages. 30 subjects were presented with the order CAP, DIFF, and SAL, and 25 subjects were presented with the order SAL, DIFF, and CAP. We chose to keep the DIFF stage in between the other two stages because we wanted subjects to get some experience with the task, before introducing the signals from the differentiation. Within each of all three stages rounds were randomised. Randomisation of the rounds and stages allows us to neutralise potential ordering effects.\(^5\)

After the experiment, participants were paid in private according to their choices. After all participants had been paid, an online transfer of money was made to the Danish Cancer Association and the Danish Heart Association, which participants could witness.

The experiment lasted for approximately one hour. Participants earned, including

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\(^5\)We tested whether the average number of services provided differ under SAL and CAP across ordering. For both stages, we find no statistically significant differences at the 5% level across ordering.
their participation fee, on average DKK 108. In total, DKK 1,462 was transferred to the Danish Cancer Association and DKK 1,477 to the Danish Heart Association.

In many health care systems, payers monitor physicians’ activity - and encourage physicians to benchmark themselves against each other. This type of environment is expected to increase physicians’ agency towards both payer and patients (Eijkenaar et al. 2013). To increase the realism of our setting, we inform physicians that at the end of the experiment they will be communicated privately the average number of health care services provided by the other physicians (as a group) so to compare their work with that of others.

4. Results

4.1. Underprovision of health care to high-need patients under capitation

Our first research question addresses whether high-need patients suffer the greatest loss of care under CAP both in scenarios with and without patient opportunity costs. Table 2 shows the average supply of care under CAP in cases where physicians face a single patient and cases where they face two patients. We measure care by the average number of health care services provided and these services’ share of the patient-optimal level, which enables a comparison between different patient types. Similar to previous studies (Barham and Milliken 2015; Brosig-Koch et al. 2015; Ellis 1998; Hennig-Schmidt, Selten, and Wiesen 2011), we find that high-need patients on average receive a lower share of their patient-optimal benefit level than low-need patients under CAP. This result applies to both one-patient and two-patient scenarios. In fact, the relative underprovision of care to high-need patients is more pronounced when physicians face two patients (mean=-19.00-(-11.27)=-7.73 percentage points, p=0.006), implying that high-need patients suffer more when physicians are resource constrained.

Result 1 High-need patients suffer the greatest loss of care under a capitation-based payment scheme. This relative underprovision of care is even more pronounced in the presence of patient opportunity costs.

[Table 2 about here.]

4.2. Taking care of high-need patients by ring-fencing part of the capitation payment to a fixed physician salary

Our second research question asks whether ring-fencing part of the capitation payment to a fixed physician salary make physicians take better care especially of high-need patients. Table 2 shows the physicians’ average supply of health care under SAL and CAP. Care is increased for both high- and low-need patients when physicians’ salaries are fixed. We find that when physicians are resource abundant, high-need patients

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6By definition the share of the patient-optimal benefit level cannot exceed 1 (100%).

7To ensure existence of a trade-off between patients in the two-patient scenarios, these analyses use data from scenarios including one high-need and one low-need patient, i.e. AB, AD, BC, and CD.

8Unless noted otherwise, all statistical tests presented in Section 4 are two-sided t-test performed using standard errors obtained by bootstrapping with resampling clustered by physician (10,000 replications).
gain the most from the imposed fixed physician salary (mean=5.91 percentage points, p=0.014). This result relies on a comparison of the share of patient-optimal benefits given to high- and low-need patients. By restricting the sample to high- and low-need patient with the same marginal benefit from care (patient types A and D), we can also compare the average number of services. This comparison also shows a larger gain for high-need patients when moving from the CAP regime to the SAL regime (mean=1.16 services; p=0.001).

However, ring-fencing physicians' salary does not have the same impact on physician behaviour, when resources are constrained. Under these market conditions high-need patients still suffer a greater loss of care compared to when there is resource abundance (mean=-20.82-(-5.36)=-15.45 percentage points; p<0.001). A comparison of two-patient scenarios under SAL and CAP shows that both high- and low-need patients gain from physicians' salaries being fixed, but SAL does not change the relative distribution of services across high- and low-need patients relative to CAP (mean=-1.82 percentage points; p=0.304). Comparing the average number of services provided to patients (with equal marginal gain from care), we reach the same conclusion (mean=0.19 services; p=0.300).

**Result 2** High-need patients gain the most from ring-fencing part of the capitation payment to a fixed physician salary when resources are abundant. However, in the presence of patient opportunity costs, fixed salary is not a remedy for ensuring that high-need patients receive a greater proportion of care.

### 4.3. Taking care of high-need patients by differentiating capitation

Our third research question asks whether differentiated capitation based on patients' expected need of care affects physicians' supply of care to enlisted patients. We consider scenarios in which the payment differentiation is aligned with patients' need of care and scenarios in which the payment differentiation is non-aligned. Table 3 shows physicians' average supply of care in scenarios with alignment and non-alignment of the payment differentiation.

We compare scenarios where the payment differentiation is aligned with patients' needs to scenarios where the payment differentiation is non-aligned. The results show that being labelled as an "above average payment" patient compared to being labelled as a "below average payment" patient increases the patients' share of the optimal benefit level by around 2-4 percentage points (cf. column 3). This result is statistically significant and robust across both patients' need of care and also the presence of patient opportunity costs. Thus, the differentiation of payments affects physicians' supply of care to enlisted patients, independently from the actual needs of patients and from providers' resource conditions.

Next, we investigate whether high (low)-payment patients gain (suffer) from differentiated capitation payments compared to under a pure capitation-based scheme (CAP). The results show that when the payment differentiation is aligned with patients' actual need of care, care increases to high-need (above average payment) patients and decreases to low-need (below average payment) patients compared to the supply of care under CAP. The observed changes are, however, statistically insignificant both with and without the presence of patient opportunity costs. This result also holds when we compare the average number of services provided to patients with the same marginal benefit from care, who differ only in their need of care (patient types A.
and D). (Patient A versus patient D - one patient case: mean=0.25 services, p=0.253. Patient A versus patient D - two patient case: mean=0.11 services, p=0.575).

When the payment differentiation is non-aligned with patients’ actual need of care we find a stronger behavioural response, demonstrating that the signal has an effect even when it goes against the physicians’ prior information about patients’ needs. The change in relative resource allocation across high- and low-need patients is most pronounced in the two patient cases, where patient opportunity costs are salient. Here, the below average payment (high-need) patients are relatively worse off compared to above average payment (low-need) patients following the differentiation (mean=-4.18 percentage points, p=0.037). Comparing the average number of services provided to patients with equal marginal benefit from care (patient types A and D), we see a similar change, which is statistically significant at a 10 percentage level (mean=-0.32 services, p=0.105).

The fact that we only find statistically significant changes when the differentiation is non-aligned with patients’ actual need of care may be explained by our laboratory setting. In our setting physicians have perfect information about patient benefits. Therefore, a payment differentiation perfectly aligned with patients’ benefits does not provide any new information about the patients’ need of care. The non-aligned payment differentiation, on the other hand, provides contrasting information about patient prioritisation, suggesting to physicians that their information may not be complete or correct. The non-aligned setting is therefore more appropriate for testing whether physicians react to new information that stands in opposition to prior beliefs.

Result 3 Above average payment patients receive more care than below average payment patients under a differentiated capitation-based payment scheme. Physicians respond to the payment differentiation, in particular when it stands in contrast to prior information on patients’ actual need of care. These responses are unaffected by the presence of opportunity costs.

5. Discussion and concluding remarks

Previous studies have shown that patients in high-need of care suffer the greatest loss of care under a capitation-based payment scheme (Barham and Milliken 2015; Brosig-Koch et al. 2015; Ellis 1998; Hennig-Schmidt, Selten, and Wiesen 2011), potentially leading to an inequitable access to care. We confirm the relative underprovision of care to high-need patients - and find that this underprovision is even more pronounced when physicians are resource constrained. As resource constraints are a common market condition in health care, we suggest that previous studies may thus have underestimated the relative underprovision of care to high-need patients under capitation-based payment schemes.

We investigate ways to incentivise physicians to take better care of high-need patients when remunerated by capitation. First, we test the effect of ring-fencing physicians’ salaries on their supply of care. We find that all patient types gain from the fixed physician salary. In scenarios with resource abundance, the provision of care to high-need patients’ increases the most; whereas equity in access to services for high-need patients is not improved when physicians are resource constrained. From this
finding we conclude that patient opportunity costs can be an important driver of an inequitable access to health care.

Second, we test whether differentiation of capitation affects physicians’ supply of care to their enlisted patients. Despite keeping physicians’ total capitation payment fixed, we find that physicians respond to differentiated capitation by providing more care to above average payment patients than to below average payment patients. This result is unaffected by the presence of patient opportunity costs. Thus, information about patient prioritisation provided by the payment differentiation affects physicians’ treatment pattern.

We test whether the effect of differentiated capitation make above(below) average payment patients gain (suffer) compared to scenarios where physicians are paid by pure capitation. We find statistically significant changes in treatment patterns when the differentiation is non-aligned with patients’ actual need of care. This finding stresses the importance of the differentiation correctly reflecting patients’ need of care. Failing to do so, the differentiation of capitation may potentially exacerbate an adverse distribution of care (Roland and Olesen 2016). At the same time our results demonstrate that differentiated capitation is a potentially strong tool for influencing physicians’ behaviour, as the signal from this type of payment scheme can override prior beliefs on patients’ benefit from care.

In this paper, we show that differentiation of capitation affects physicians’ decision-making in a controlled laboratory setting. The question remains whether it also affects physicians’ behaviour in a real world setting. We expect that if an actual payer were to determine the differentiation, it would be of greater impact to the physicians than is the case in a laboratory setting. However, as patients do not wear ”price tags” in consultations, the information provided by the payment differentiation might not be sufficiently salient to affect physicians’ decision-making. The development of technological infrastructure in many health care systems, however, creates possibilities for information sharing between payers and physicians such that patients’ payment profiles potentially can be made salient to the physicians during consultations.

While physicians may also (to some degree) be able to select their patient population, opting for above average payment patients, their patient population will still consist of both above- and below average payment patients. Our findings are therefore applicable also in a framework of patient selection.

Disclosure statement
No potential conflict of interest was reported by the authors.

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Compliance with Ethical Standards

This study solely used data from a questionnaire. All participants signed an informed consent regarding their participation in the survey. In Denmark, research on data from questionnaires does not require approval from the Committee on Health Research Ethics. The secretariat at the Regional Committees on Health Research Ethics in Denmark provided a written statement confirming this exemption.
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Table 1. Patient’s health gain for a given number of health care services

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<td>8</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>18</td>
<td>20</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>20</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>20</td>
<td>20</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
<td>20</td>
<td>10</td>
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</tbody>
</table>
Table 2. Physicians’ average supply of care to high- and low-need patients under CAP and SAL, presented as number of services and percentage of patient-optimal care

<table>
<thead>
<tr>
<th>Patient need</th>
<th>CAP</th>
<th>SAL</th>
<th>SAL versus CAP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) Services</td>
<td>(2) Services</td>
<td>(3) Services</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>One patient scenarios</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-need</td>
<td>7.84</td>
<td>9.37</td>
<td>1.54***</td>
</tr>
<tr>
<td></td>
<td>(3.41)</td>
<td>(2.20)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Low-need</td>
<td>5.03</td>
<td>5.50</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>(2.48)</td>
<td>(1.66)</td>
<td>p=0.003</td>
</tr>
<tr>
<td>High versus low</td>
<td>2.81</td>
<td>-11.27***</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p=0.014</td>
</tr>
<tr>
<td>Two patient scenarios</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-need</td>
<td>5.88</td>
<td>6.72</td>
<td>0.84***</td>
</tr>
<tr>
<td></td>
<td>(2.49)</td>
<td>(1.66)</td>
<td>p=0.001</td>
</tr>
<tr>
<td>Low-need</td>
<td>3.91</td>
<td>4.45</td>
<td>0.54***</td>
</tr>
<tr>
<td></td>
<td>(1.37)</td>
<td>(1.03)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>High versus low</td>
<td>1.97</td>
<td>-19.00***</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p=0.304</td>
</tr>
</tbody>
</table>

aThe table presents the average number of health care services (left column) and average percentage of patient-optimal benefit (right column) given to low- and high-need patients in the schemes SAL and CAP. We consider scenarios in which physicians face one patient and two patients with a trade-off between a high- and a low-need patient. In parentheses are standard deviations. Two-sided t-tests are performed using standard errors obtained by bootstrapping (resampling clustered by physician, 10,000 replications) to test the difference in the provided care. Number of observations for one patient cases per stage per patient need n=110. Number of observations for two patient cases per stage per patient need n=220. *** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.
Table 3. Physicians’ average supply of care for high- and low-need patients under CAP and DIFF (aligned/non-aligned), presented as number of services and percentage of patient-optimal care

<table>
<thead>
<tr>
<th>Patient need</th>
<th>DIFFa (1)</th>
<th>Services</th>
<th>%</th>
<th>DIFFna (2)</th>
<th>Services</th>
<th>%</th>
<th>DIFFa vs. DIFFna (3)</th>
<th>p-value</th>
<th>CAP (4)</th>
<th>Services</th>
<th>%</th>
<th>DIFFa vs. CAP (5)</th>
<th>Services</th>
<th>%</th>
<th>DIFFna vs. CAP (6)</th>
<th>Services</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One-patient scenarios</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-need</td>
<td>7.92</td>
<td>78.18</td>
<td>7.62</td>
<td>75.09</td>
<td>0.31**</td>
<td>3.00**</td>
<td>7.84</td>
<td>76.91</td>
<td>0.90</td>
<td>1.27</td>
<td>-0.22</td>
<td>-1.82</td>
<td>p=0.022</td>
<td>p=0.022</td>
<td>p=0.563</td>
<td>p=0.265</td>
<td>p=0.345</td>
</tr>
<tr>
<td></td>
<td>(3.33)</td>
<td>(32.23)</td>
<td>(3.51)</td>
<td>(34.05)</td>
<td>p=0.022</td>
<td>p=0.022</td>
<td>(3.41)</td>
<td>(32.73)</td>
<td>p=0.563</td>
<td>p=0.402</td>
<td>p=0.265</td>
<td>p=0.345</td>
<td>(3.41)</td>
<td>(32.73)</td>
<td>p=0.563</td>
<td>p=0.402</td>
<td>p=0.265</td>
</tr>
<tr>
<td>Low-need</td>
<td>4.78</td>
<td>87.64</td>
<td>4.96</td>
<td>90.36</td>
<td>-0.18***</td>
<td>-2.72***</td>
<td>5.03</td>
<td>88.18</td>
<td>-0.25</td>
<td>-0.55</td>
<td>-0.06</td>
<td>2.18</td>
<td>p=0.004</td>
<td>p=0.004</td>
<td>p=0.143</td>
<td>p=0.705</td>
<td>p=0.105</td>
</tr>
<tr>
<td></td>
<td>(2.21)</td>
<td>(27.09)</td>
<td>(2.15)</td>
<td>(23.89)</td>
<td>p=0.004</td>
<td>p=0.004</td>
<td>(2.48)</td>
<td>(26.45)</td>
<td>p=0.143</td>
<td>p=0.705</td>
<td>p=0.671</td>
<td>p=0.105</td>
<td>(2.49)</td>
<td>(26.45)</td>
<td>p=0.143</td>
<td>p=0.705</td>
<td>p=0.671</td>
</tr>
<tr>
<td>High vs. low</td>
<td>3.14</td>
<td>-9.46***</td>
<td>2.66</td>
<td>-15.27***</td>
<td>0.49</td>
<td>5.82***</td>
<td>2.81</td>
<td>-11.27***</td>
<td>0.34</td>
<td>1.82</td>
<td>-0.15</td>
<td>-4.00</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p=0.119</td>
</tr>
<tr>
<td><strong>Two-patient scenarios</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-need</td>
<td>5.95</td>
<td>59.45</td>
<td>5.75</td>
<td>57.45</td>
<td>0.20**</td>
<td>2.00*</td>
<td>5.88</td>
<td>58.82</td>
<td>0.06</td>
<td>0.63</td>
<td>-0.14</td>
<td>-1.36</td>
<td>p=0.056</td>
<td>p=0.056</td>
<td>p=0.549</td>
<td>p=0.219</td>
<td>p=0.219</td>
</tr>
<tr>
<td></td>
<td>(2.46)</td>
<td>(24.56)</td>
<td>(2.39)</td>
<td>(23.85)</td>
<td>p=0.056</td>
<td>p=0.056</td>
<td>(2.49)</td>
<td>(24.86)</td>
<td>p=0.549</td>
<td>p=0.549</td>
<td>p=0.219</td>
<td>p=0.219</td>
<td>(2.49)</td>
<td>(24.86)</td>
<td>p=0.549</td>
<td>p=0.549</td>
<td>p=0.219</td>
</tr>
<tr>
<td>Low-need</td>
<td>3.88</td>
<td>76.64</td>
<td>4.04</td>
<td>80.64</td>
<td>-0.16***</td>
<td>-4.00***</td>
<td>3.91</td>
<td>77.82</td>
<td>-0.03</td>
<td>-1.18</td>
<td>0.13*</td>
<td>2.82**</td>
<td>p=0.009</td>
<td>p=0.001</td>
<td>p=0.671</td>
<td>p=0.434</td>
<td>p=0.048</td>
</tr>
<tr>
<td></td>
<td>(1.44)</td>
<td>(26.99)</td>
<td>(1.29)</td>
<td>(25.60)</td>
<td>p=0.009</td>
<td>p=0.001</td>
<td>(1.37)</td>
<td>(26.80)</td>
<td>p=0.671</td>
<td>p=0.434</td>
<td>p=0.079</td>
<td>p=0.048</td>
<td>(1.37)</td>
<td>(26.80)</td>
<td>p=0.671</td>
<td>p=0.434</td>
<td>p=0.079</td>
</tr>
<tr>
<td>High vs. low</td>
<td>2.07</td>
<td>-17.18***</td>
<td>1.71</td>
<td>-23.18***</td>
<td>0.36</td>
<td>6.00***</td>
<td>1.97</td>
<td>-19.00***</td>
<td>0.10</td>
<td>1.81</td>
<td>-0.26</td>
<td>-4.18**</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p=0.037</td>
</tr>
</tbody>
</table>

* The table presents the average number of health care services (left column) and percentage of patient-optimal benefit (right column) given to low- and high-need patients in the scheme DIFF (for aligned and non-aligned cases) compared to CAP. DIFFa is where the differentiation is aligned with patients’ need of care, i.e. high(low)-need payments receive an above(below) average payment. DIFFna is where the differentiation is non-aligned with patients’ need of care, i.e. high(low)-need payments receive a below(above) average payment. We consider scenarios in which physicians face one patient and two patients with a trade-off between a high- and a low-need patient. In parenthesis are standard deviations. Two-sided t-tests are performed using standard errors obtained by bootstrapping (resampling clustered by physician, 10,000 replications) to test differences in provided care. Number of observations for one patient cases per stage per patient need n=110. Number of observations for two patient cases per stage per patient need n=220. *** Significant at the 1 percent level, ** Significant at the 5 percent level, *Significant at the 10 percent level.