Private health centres prescribe more and broader antibiotics

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Abstract

Antimicrobial resistance (AR) – is one of the major public-health problems in the world. Growing rates of AR are associated with continuant overuse of antibiotics. Antibiotics tend to be overconsumed despite increasing knowledge of the causes and consequences of the evolution of AR bacteria. In most countries, the decision to prescribe antibiotics is made by a medical practitioner (MP). Ideally, this choice is based on well-defined criteria, aimed to ensure that the marginal benefit of drug use (improvement in health status) is higher or equal to the marginal cost (increased AR, drug costs, and side effects). However, in a real life setting, physicians do not always adhere to such criteria. To understand and possibly limit the over-use of antibiotics, an analysis of driving mechanisms behind MPs' prescription behaviour is important. In this paper, we focus on economic incentives behind antibiotic prescriptions. More specifically, we analyse how the ownership type (private or public) of primary health care centres affects general practitioners prescription behaviour, using four million prescriptions from Västerbotten, Sweden. Our results suggest that private primary care clinics prescribe more antibiotics than public ones, holding other factors (such as total number of all prescriptions, patients' age and gender and month of prescription) constant. Private providers are also more likely to prescribe broad-spectrum antibiotic than narrow-spectrum comparing to public centres. Our findings could guide policy-makers in developing policies to improve antibiotic use in primary health care.

Keywords: Antibiotic resistance, economic incentives, clinic ownership structure, salary, fee-for-service, capitation.

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1. Introduction

When introduced into specific environment, antibiotic puts a selective pressure on bacterial population inhabiting this environment. This gives advantage to antibiotic resistant bacteria, which survive, reproduce and can spread further. Antibiotic resistance (AR) grows rapidly due to the intensive use of antibiotics, making these drugs to be less and less effective in treating infectious diseases. AR poses a significant threat to current and future generations (Goossens et al., 2005). Therefore, introduction of new policies aimed to rationalize antibiotic use is highly important.

The problem of unnecessary antibiotic prescription is especially relevant in primary care, due to frequent respiratory tract infections (RTIs) among patients. Usually, such infections constitute the major part of all antibiotic prescriptions. At the same time, the common cause of RTI are viruses, which are therefore not treatable by antibiotics. According to a study by Fleming-Dutra et al. (2016) almost half of antibiotics prescriptions for RTIs in US were judged to be inappropriate. There are many possible reasons for why antibiotics are prescribed even when this treatment is ineffective. For example, impatience and limited knowledge among patients may increase their willingness to receive antibiotic treatment. They may consider doctor's willingness to prescribe antibiotic as a characteristic of quality and care (Avorn and Solomon, 2000, Ashworth et al., 2016); this is especially relevant for the countries with restricted over-the-counter sales of pharmaceuticals. If uninformed patients demand antibiotics for non-bacterial infections, and if the profitability of a health care centre depends on the number of patient visits, competition among these centres may create incentives to over-prescribe antibiotics (Butler et al., 1998, Hamm et al., 1996, Zgierska et al., 2014).

Previous research show that above-mentioned economic incentives may play an important role in physicians' medical decision-making (Masiero et al., 2010, Anell et al., 2015). However, there are not many previous studies about the effect of economic incentives on the use of antibiotics. Notable exceptions are Hutchinson and Foley (2001), Fogelberg (2014), and Ellegård et al. (2017). Hutchinson and Foley (2001) find that physicians working under fee-for-service in Newfoundland, Canada, prescribed significantly more antibiotics than salaried physicians did. Using aggregated Swedish data Fogelberg (2014) find that stronger competition between health care providers significantly increases the number of antibiotic prescriptions as long as the provider is not required to pay for the prescribed drugs. Lastly, based on yearly data on pharmaceutical consumption of Swedish children, Ellegård et al.

(2017) find that reimbursement schemes based on antibiotic related Pay-for-Performance indicators, stimulate more appropriate antibiotic prescriptions.

In this paper, we focus on the effect of ownership type of health care centres on antibiotic prescriptions. Silverman et al. (1999) and Devereaux et al. (2002) find a positive and significant correlation between the share of profit driven hospitals and health expenditures. Kessler and McClellan (2001) analyse cost instead of expenditure and find that private hospitals with profit incentives have significantly lower costs than non-profit hospitals for treating heart stroke, controlling for treatment quality. In a more recent study, Granlund (2009) find that private doctors are more likely to veto against generic substitution. To our knowledge, there are no studies about the effect of ownership type of health care centres on prescription of antibiotics.

The main aim of our study is to find whether there is a significant difference between private (publicly funded) and public primary health care centres in terms of antibiotic prescription. To answer this question, we analyse prescriptions made at public and private primary health care centres in Västerbotten, Sweden in two ways. First, we check if the probability of the prescribed drug being an antibiotic varies systematically within the ownership type. Second, we test if there is a systematic variation in the prescription of broad- and narrow-spectrum antibiotics among private and public centres. The motivation for our second approach is the following. The impetuous growth of AR forced physicians to turn to more frequent prescriptions of broad-spectrum antibiotics. These antibiotics target larger proportion of various bacteria species and hence contribute even more to the development of AR (Kaier and Moog, 2012). Thus, it is important to decrease inappropriate use of broad-spectrum antibiotics. However, patients may also perceive prescription of a broad-spectrum antibiotic as a signal of health care quality, since probability of patient being treated after the first prescription is higher in this case. Doctors' willingness to please patients based on economic incentives together with other possible factors (e.g. diagnostic uncertainty) may turn them to prescribe more of broad-spectrum antibiotics.

The results show that physicians working at private health care centres, compared to county employed physicians, are significantly more likely to prescribe antibiotics and are more likely to choose broad-spectrum antibiotics when prescribing antibiotics. Both these results support the hypothesis that antibiotic prescription behaviour of private physicians is more affected by their willingness to please patients.

2. Institutional background and incentives

All Swedish residents are covered by a mandatory and uniform health insurance, including a pharmaceutical insurance in which reference prices are set equal to the price of the cheapest substitute product. Patients pay a share of the reference price, which is decreasing in the patient's accumulated expenditure within the benefit scheme during a 12-month period, plus the entire price difference if they choose a more expensive product.

Sweden is divided into 21 counties that are responsible for primary health care. They operate most of the primary care centres, but there is also a share (about 40%) of private providers contracted and financed by the counties (Mossialos et al., 2016). Primary care centres have no formal gatekeeping function and are usually organised as team-based practices with general practitioners (GPs), nurses, midwives, gynaecologists, physiotherapists, psychologists, social workers, behavioural therapists and physiotherapists (Anell et al., 2012a). On average, there are four GPs in each primary care centre (Mossialos et al., 2016).

In 2010, Sweden implemented the System of Choice reform. This reform aimed to increase competition in primary health care by making entry to the market free for primary care providers fulfilling the minimum requirements set by the county councils (Anell, 2011). The System of Choice reform attracted new private providers to the market and allowed patients to choose freely with which private or public provider to register. Registration is done with a primary care centre rather than specific general practitioner (GP). Registration is obligatory for all residents except those from the Stockholm County. If a patient does not make an active choice of provider, then he/she is listed in a public or private primary centre suggested by the county council. The most common suggestion is the centre closest to the patient's residence (Konkurrensverkets, 2014). Primary care centres should accept all new applicants and can only pose temporary restrictions on the number of patients. Patients, registered at one centre can still visit GPs in other clinics (Redman and Köping Höggärd, 2007). Although everyone is free to choose primary health care provider in Sweden, only 30 per cent choose a different clinic than the one suggested by the county. According to survey by Konkurrensverkets (2014), the share of individuals who switch clinic in Västerbotten is only around 20%. Both public and private centres receive a mixture of capitation payment for registered patients (about 80%), fee-for-service (17%-18%) and performance-based compensation (2%-3%) for achieving different quality targets (Mossialos et al., 2016).

Västerbotten County, located in the North of Sweden, is in terms of area the second largest county in Sweden, and consists of 15 municipalities. There are about 260,000 inhabitants in the county, of which nearly 80% live in coastal municipalities. There are six private (out of 39) primary care clinics in Västerbotten. This share is much lower than on the national level, which could partly be explained by that the requirements that primary care providers have to fulfil in order to enter the market are higher than in most other counties. Each primary care centre must offer their patients a broad range of medical services, including e.g. maternity care, children's care, and rehabilitation (Anell et al., 2012b, Lundvall et al.). Moreover, the organization of the listing system in Västerbotten has been criticized (Uhlin, 2011): after the System of Choice reform was introduced in 2010, patients who did not make an active choice of their provider stayed on the lists of their previous health care centre. This principle created difficulties for new private providers, as these had to start their practice with no patients on the list, while the capitation payments for registered patients constitute the major part of clinic reimbursement (87% in Västerbotten). Thus, we hypothesise that private primary care centres have more incentives to attract new patients by pleasing them and will test if our data supports this hypothesis.

3. Data

In order to test our hypotheses we use prescription data provided by the Västerbotten county council. The dataset contains all drug prescriptions written by primary care providers in Västerbotten county from January 2011 and dispensed by Swedish pharmacies until April 2016. The dataset consists of approximately 12 million observations and includes a large number of variables, for example the patient's age (variable *Age* shows patient's age at the moment of drug prescription), gender, and area of residence, as well as patient ID, such that patients are traceable over time. The information about each specific prescription contains the date of prescription (we will further use variables *Year* and *Month*), the workplace of the prescriber and his/her profession (physician, dentist, nurse, etc.) and identification number of the prescribed drug. The variable *Municipality* shows the municipality where the clinic is located. The dataset also includes information on the date the drug was dispensed and by which pharmacy chain, identification number of the dispensed drug, the patient's co-payment and the total cost for the prescription. Information about drugs contain ATC-code, number of defined daily doses per package, strength, form, etc.

After excluding prescriptions done by others than physicians (e.g. nurses) and prescriptions with missing information on, e.g., gender or ATC code, we are left with about 11 million observations. A large share of drugs has been prescribed with an option for multiple purchases. Since, we are interested in analysis of physicians' prescription decisions, we have removed all the repeated purchases of drugs and got a dataset of 4,238,190 observation. Based on workplace information, we create the dummy variable $Private$, which shows whether primary centre is private or public. The main variable of interest is $Antibiotic$ – a dummy variable equal to one when the drug belongs to 'J01 – Antibacterial drugs' group, according to ATC classification with Methenamine ('J01XX05') excluded. Methenamine is considered to be not an antibiotic, but an antiseptic substance, and to have no influence on AR (Sundvall et al., 2015).

4. Methods

Model 1

To identify the effect of ownership structure on the frequency of antibiotic prescriptions, we would ideally use information on tests and diagnoses in combination with the information on antibiotic prescriptions. However, this information is not available in our data. At the same time, primary care centres may significantly differ in the number of patient visits and in the age and gender composition of patients. To account for this, we include all prescriptions and estimate the effect of ownership type on the probability of a prescribed drug being an antibiotic. This approach allows us to hold constant for the age and gender of the individual patient. Controlling for the patient's age is important since, e.g., prescription of non-antibiotic drugs to children is much lower than for adults. We also control for in which municipality the health centre is located and for time effects. Specification 1 is written

$$Pr(Antibiotic_i = 1) = F\left(\alpha + \beta_1 Private_i + \beta_2 Age_i + \beta_3 Age_i^2 + \beta_4 Women_i + \sum_{c=1}^{15} \delta_c Municipality_{ci} + \sum_{a=2}^{72} \gamma_a Year\_Month_{ai} + \varepsilon_i\right).$$

The outcome of the first model is the probability of antibiotic being prescribed among all prescription (which is used as a proxy for visits). However, since some clinics may systematically prescribe more drugs (not necessarily antibiotics) per visit than others, we control for this in specification 2 using the variable *Prescriptions_per_visit*. The variable is defined for each clinic each year as the total number of prescriptions divided by the number of patients' visits. Like the prescription data, the information on patient visits was provided by Västerbotten county council. Controlling for *Prescriptions_per_visit* prevents the estimate for *Private* to be affected by private providers being more or less likely to prescribe non-antibiotic drugs.

Model 2

With the second model, we will go deeper to the analysis of specific types of antibiotics and evaluate if there is a systematic variation in the prescription of broad- and narrow-spectrum antibiotics among private and public primary care centres. In order to do so, we have extracted all prescriptions of antibiotics from the dataset and added a new dummy variable - $Broad$, which shows whether antibiotic is broad-spectrum or narrow-spectrum. The way we define narrow- and broad-spectrum antibiotics is presented in Table A1 in the online Appendix. Our selection of specific types of antibiotics is depicted from (Fogelberg, 2014) and recommended by medical expertise at the Swedish Institute for Communicable Disease Control. Some of antibiotic prescriptions (about 20%) from the original dataset neither belong to narrow- and broad-spectrum groups (in the way we define them) and therefore have been excluded. Finally, we got 150,579 observations and will apply the following specification

$$Pr(Broad_i = 1) = F\left(\alpha + \beta_1 Private_i + \beta_2 Age_i + \beta_3 Age_i^2 + \beta_4 Women_i + \sum_{c=1}^{15} \delta_c Municipality_{ci} + \sum_{a=2}^{72} \gamma_a Year\_Month_{ai} + \varepsilon_i\right).$$

Descriptive statistics of the variables of both models is presented in Table A2 and Table A3 in the online Appendix. In all estimations presented in the paper, a maximum-likelihood logit estimator was used. To examine the robustness of the results, a number of other estimations were performed. We also applied probit models, controlled for age by using indicators for age-groups instead of the continuous variables, and performed the estimations on subsamples. The results from these estimations are available from the author upon request and show that the presented results are robust.

5. Results

Estimation results are presented in Table 1. The results suggest that private clinics have higher probability of antibiotic being prescribed according to both specifications (with and without correction for the number of total prescriptions per visit). Depending on the specification, private primary care centres have 1.062-1.068 higher odds of antibiotic prescription than public ones, holding all other factors constant, showing that private centres in relative terms are 6%-7% more likely to prescribe antibiotics. This result can also be interpreted in absolute terms. In about 4.41% of cases, public physicians prescribed antibiotic, such that odds is approximately equal to 0.046. Then, in case of private clinic the odds increases to about 0.049, which means that the probability of antibiotic being prescribed (versus non-antibiotic drug) is approximately equal to 4.67%, which is 0.26 percentage points higher than the assumed probability for public clinics.

We also find significant effect of socio-demographic variables such as age and gender. According to the point estimates from logistic regression of specification 1, the probability of antibiotic prescription decreases with age up to an age of 87.5. This may be explained by older patients having higher variation in types of drugs prescribed, while the antibiotic use among very old patients increases due to higher frequency of infectious diseases. According to our results, women have higher probability of antibiotic prescriptions than men do. This could be partly explained by the fact, that women have higher frequency of urinary tract infections – common reason for antibiotic use, including unnecessary use.

According to the estimation results of *Model 2*, private primary care centres have 1.132 higher odds of prescribing broad-spectrum antibiotic (versus narrow-spectrum) than public ones, showing that physicians in private centres compared to county employed physicians are 13% more likely to choose a broad antibiotic when prescribing any antibiotic. In about 32% of cases, public physicians prescribed broad-spectrum antibiotic, such that odds is approximately equal to 0.471. Model predicts the odds for private clinics to be about 0.533, which means that the probability of broad-spectrum antibiotic prescribed is approximately equal to 35%, which is 3 percentage points higher than the assumed probability for public clinics. Results of Model 2 also shows that the probability of prescribing broad-spectrum antibiotics increases with age up to an age of 57.5, then decreases with age for older people and is lower for women.

Table 1

Estimation results, odds-ratio.

	Dependent variable		
	The prescribed drug is an Antibiotic		*The prescribed antibiotic is of broad-spectrum*
	Model 1 (1)	*Model 1* (2)	*Model 2*
Private	1.068***	1.062***	1.133***
	(0.008)	(0.008)	(0.020)
Age	0.933***	0.933***	1.047***
	(0.000)	(0.000)	(0.001)
Age²	1.0004***	1.0004***	0.9996***
	(0.0000)	(0.0000)	(0.0000)
Women	1.311***	1.310***	0.339***
	(0.006)	(0.007)	(0.004)
log(Prescriptions_per_visit)		0.934***	
		(0.011)	
Municipality	Yes	Yes	Yes
*Year*Month*	Yes	Yes	Yes
Observations	4,238,190	4,238,190	150,579
Log Likelihood	-716,055.000	-716,039.400	-88,254.110
Akaike Inf. Crit.	1,432,266.000	1,432,237.000	176,664.200

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors are shown in parentheses. Estimation results for combination of prescription year and month and municipality fixed effects are omitted in order to save space and are available upon request

6. Discussion

Growing rates of AR pose a threat to current and future generations, such that antibiotic drugs are becoming less effective in treating infectious diseases. Therefore, it is extremely important to detect factors causing antibiotic misuse. Our results support the hypothesis about presence of moral-hazard problem in private primary health care centres caused by economic incentives to please patients, which may result in higher proportion of unnecessary antibiotic prescriptions. It was found that private physicians were 6-7% more likely to prescribe antibiotics rather than non-antibiotic comparing to the county employed physicians working in non-profit primary care centres. We controlled for patient characteristics, seasonality, municipality specific effects, as well as for the yearly number of prescription per visit. However, our analysis does not allow ruling out if private centres, have higher share of patients with infectious diseases. This may be the case if patients possess some information or just believe they have higher chance to get antibiotic prescription in private centre or believe that the quality of care for non-infectious diseases are better in public centre.

Result from the second model shows that private physicians, in addition to being more likely to prescribe antibiotics, were 13% more likely than county employed physicians to choose broad-spectrum antibiotics when prescribing antibiotics. Even though systematic variation in diagnoses between different clinics may also affect the result, we believe the second model is much less vulnerable to these potential differences. Thus, the result from the second model strengthens our hypothesis that antibiotic prescription at private centres are affected by their stronger incentives to please their patient.

Inappropriate antibiotic prescription imposes cost for society in term of growing rates of antimicrobial resistance. Our results are important to consider when designing policies aimed to improve antibiotic use in primary care. However, more research has to be done, preferably based on the data including diagnostic information. Such data would allow to conduct a more detailed analysis of GPs' decision-making process, to some extent judge about appropriateness of antibiotic prescriptions and to better justify our hypothesis.

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Appendix

Table A1

Classification of broad- and narrow-spectrum antibiotics.

Narrow-spectrum antibiotics	*Broad-spectrum antibiotics*
PcV (fenoximetylpenicilin) J01CE02	Amoxicillin J01CA04
Nitrofurantoin J01XE01	Amoxicillin and enzyme inhibitor J01CR02
Pivmecillinam J01CA08	Doxycyklin J01AA02
Trimetoprim J01EA01	Cefalosporins J01DB + J01DC + J01DD + J01DE
	Erytromycin J01FA01
	Kinolones J01MA02 + J01MA06

Table A2

Model 1. Descriptive statistics.

Variable	Sample	Antibiotic=1	Antibiotic=0
Private	16.09	16.67	16.07
Age	62.78±19.87	48.58±26.61	63.44±19.25
Women	58.45	63.49	58.22
Prescriptions_per_visit	3.49±0.95	3.42±0.92	3.49±0.95
Prescription month			
January	8.92	9.19	8.90
February	8.38	8.59	8.37
March	9.00	9.13	9.00
April	8.66	8.11	8.68
May	9.17	7.79	9.23
June	8.18	7.21	8.22
July	6.78	7.95	6.72
August	7.70	8.22	7.67
September	8.44	8.57	8.43
October	9.18	8.94	9.19
November	8.18	8.28	8.17
December	7.43	8.02	7.41
Prescription year			
2011	21.30	23.17	21.21
2012	19.43	21.01	19.36
2013	22.88	19.41	23.04
2014	19.94	18.54	20.01
2015	16.45	17.88	16.39
Municipalities			
Nordmaling	2.89	2.28	2.92
Bjurholm	1.07	0.91	1.07
Vindeln	2.49	2.34	2.50
Robertsfors	2.97	2.49	2.99
Norsjö	2.09	2.17	2.09
Malå	1.96	1.97	1.96
Storuman	3.30	3.17	3.31
Sorsele	1.50	1.82	1.48
Dorotea	1.56	1.28	1.57
Vännäs	3.03	2.75	3.05
Vilhelmina	3.64	3.88	3.63
Åsele	1.70	1.55	1.71
Umeå	40.69	41.93	40.64
Lycksele	6.02	5.98	6.02
Skellefteå	25.08	25.47	25.06
Observations	4,238,190	187,987	4,050,203

Table A3

Model 2. Descriptive statistics.

Variable	Sample	Broad=1	Broad=0
Private	16.89	18.13	16.30
Age	48.93±26.94	52.36±24.63	47.30±27.83
Women	66.57	51.29	73.83
Prescription month			
January	9.38	10.03	9.06
February	8.77	9.06	8.63
March	9.34	9.74	9.14
April	8.21	8.26	8.20
May	7.81	7.68	7.86
June	7.13	6.67	7.34
July	7.78	7.19	8.06
August	7.88	7.70	7.97
September	8.46	8.41	8.48
October	8.84	9.05	8.74
November	8.30	8.40	8.25
December	8.11	7.81	8.25
Prescription year			
2011	23.67	27.67	27.77
2012	21.22	22.53	20.60
2013	19.06	18.12	19.51
2014	18.26	16.63	19.04
2015	17.78	15.05	19.08
Municipalities			
Nordmaling	2.45	1.91	2.70
Bjurholm	0.89	0.90	0.89
Vindeln	2.36	2.41	2.34
Robertsfors	2.49	2.82	2.33
Norsjö	2.27	2.28	2.27
Malå	1.98	1.98	1.98
Storuman	3.09	3.13	3.08
Sorsele	1.86	2.20	1.70
Dorotea	1.20	1.30	1.16
Vännäs	2.69	2.31	2.87
Vilhelmina	3.76	4.51	3.40
Åsele	1.54	1.62	1.51
Umeå	42.10	42.14	42.08
Lycksele	6.07	6.19	6.02
Skellefteå	25.23	24.27	25.69
Observations	150,579	48,518	102,061