



ORIGINAL ARTICLE

## Antibiotic prescribing patterns in out-of-hours primary care: A population-based descriptive study

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### Abstract

**Objective.** To describe the frequency and characteristics of antibiotic prescribing for different types of contacts with the Danish out-of-hours (OOH) primary care service. **Design.** Population-based observational registry study using routine registry data from the OOH registration system on patient contacts and ATC-coded prescriptions. **Setting.** The OOH primary care service in the Central Denmark Region. **Subjects.** All contacts with OOH primary care during a 12-month period (June 2010–May 2011). **Main outcome measures.** Descriptive analyses of antibiotic prescription proportions stratified for type of antibiotic, patient age and gender, contact type, and weekdays or weekend. **Results.** Of the 644 777 contacts registered during the study period, 15.0% received an antibiotic prescription: 26.1% resulted from clinic consultations, 10.7% from telephone consultations, and 10.9% from home visits. The prescription proportion was higher for weekends (17.6%) than for weekdays (10.6%). The most frequently prescribed antibiotic drugs were beta-lactamase sensitive penicillins (34.9%), antibiotic eye drops (21.2%), and broad-spectrum penicillins (21.0%). Most antibiotic eye drops (73%) were prescribed in a telephone consultation. Most antibiotics were prescribed at 4–6 p.m. on weekdays. Young infants received most antibacterial eye drops (41.3%), patients aged 5–17 years and 18–60 years received most beta-lactamase sensitive penicillins (44.6% and 38.9%, respectively), while patients aged 60+ years received most broad-spectrum penicillins (32.9% of all antibiotic prescriptions). **Conclusion.** Antibiotics were most often prescribed in clinic consultations, but, in absolute terms, many were also prescribed by telephone. The high prescription proportion, particularly antibacterial eye drops for young infants, suggests room for improvement in rational antibiotic use.

**Key Words:** *After hours, anti-bacterial agents, Denmark, drug prescriptions, general practice, infection, primary care*

### Introduction

Increased prescription of antibiotics is a topic of concern and debate in many countries. Antibiotic resistance is a growing problem, which may delay or reduce effective treatment, and high exposure to antibiotics is considered a major cause of antibiotic resistance [1]. Denmark has traditionally had a low use of antibiotics, but its use has increased in the last decade, as in many other European countries [2,3]. Several factors could be related to this change, including changes in medical needs (e.g. population ageing with altered needs), in guideline recommendations (e.g. amoxicillin-clavulanic acid for exacerbations of COPD), introduction of new antibiotics, and in prescribing behaviour of general practitioners (GPs) [3,4]. Furthermore, it has been debated that the

prescription rate is particularly high in Danish out-of-hours (OOH) primary care, especially in telephone consultations without subsequent face-to-face contact. This type of antibiotic prescription might be considered irrational as no good evidence supports antibiotic treatment for infectious conditions without prior medical examination [5,6].

The prescription of antibiotics in telephone consultations has also been supported, as this may be related to the organization of the Danish OOH primary care services, where GPs are placed in the front line and answer all patient calls directly [7,8]. GPs can prescribe medication by telephone consultation. Patients contacting the OOH primary care services are more likely to present with serious and acute illness, in particular infections with fever [9], and

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(Received 22 May 2014; accepted 24 September 2014)

ISSN 0281-3432 print/ISSN 1502-7724 online © 2014 The Author(s)  
DOI: 10.3109/02813432.2014.972067

- Denmark has seen increasing antibiotic prescribing in the last decade; out-of-hours primary care services have been suspected of discharging particularly numerous prescriptions.
- Antibiotics prescription proportions were highest for clinic consultations in out-of-hours primary care.
- In absolute terms, a large proportion of antibiotics were prescribed in telephone consultations.
- There was a high prescription proportion for antibacterial eye drops in telephone consultations, particularly for infants.

antibiotics may form part of effective and efficient treatment of patients. Furthermore, having GPs answering the telephone may also limit follow-up consultations with the patient's own GP, the OOH primary care services, or other health-care providers.

To evaluate the existing system and suggest possible future interventions, we need to obtain systematically collected information concerning anti-biotic prescribing at OOH primary care services. We aimed to describe the frequency and characteristics of antibiotic prescribing (type of antibiotics, patient age and gender, contact type, and time of contact) in one of the Danish OOH primary care services.

## Material and methods

### *Design and setting*

We conducted a population-based retrospective observational study of all patient contacts with the OOH primary care service from June 2010 to May 2011. The study was performed in the Central Denmark Region (1.2 million citizens). In four of the five Danish regions, GPs provide regional OOH primary care on a rotating basis. The regional OOH primary care service consists of two call centres and 13 consultation centres located throughout the region. Opening hours are from 4 p.m. to 8 a.m. on weekdays, during the entire weekend, and at holiday times. Patients in need of acute care outside office hours must call the OOH primary care service, where GPs answer calls and perform telephone triage to decide type and level of health care needed. GPs can decide to end the contact on the telephone (i.e. telephone consultation), plan a face-to-face contact with a GP (i.e. clinic consultation or home visit), or refer the patient to the emergency department (ED) or ambulance care.

In general, 59% of all contacts are telephone consultations, 28% are clinic consultations, and 13% are home visits [10]. The OOH registration system is fully computerized, and each contact is registered in the patient's medical record through the unique civil registration (CPR) number assigned to every Danish citizen. An electronic copy of the record is subsequently sent to the patient's own GP, and data are transmitted to the regional administration for remuneration purposes as the GPs are paid a fee for service.

### *Data and variables*

The electronic OOH registration system provided data on patient age and gender, date and time of contact, type of contact, and detailed prescription information on type, dose, and duration through Anatomic Therapeutic Chemical (ATC) coding [11]. Contact and prescription information was delivered in two separate datasets.

Age was categorized into the following groups: 0–4, 5–17, 18–60, and 60 + years of age. Time period was categorized on the basis of contact peaks directly after opening hours: 0–8 a.m., 8 a.m.–4 p.m., 4–6 p.m., 6–8 p.m., and 8 p.m.–0 a.m. Weekend was defined as Friday from 4 p.m. to Monday to 8 a.m. as well as bank holidays, and weekdays as Monday 4 p.m. to Friday 8 a.m.

### *Procedure for coding contacts with antibiotic prescription*

We selected all antibiotics prescriptions on the basis of the registered ATC codes for antibiotic drugs. We made a list of all prescriptions by using the ATC level-5 codes, and two physician researchers independently defined and selected the antibiotic drugs on the basis of the WHO website coding system [11] and discussed the final list to achieve consensus (see Box 1) on classification of antibiotics.

### *Data analysis*

Descriptive analyses of antibiotic prescription frequencies were performed, including percentage, 95% confidence intervals (CI), and proportion. The prescription proportion (PP) was calculated by dividing number of antibiotic prescriptions by number of contacts. First, we presented the proportions of contact type, gender, age group, weekdays or weekend, and type of antibiotic. Second, we stratified for type of contact, patient age group, weekdays or weekend, and type of antibiotic. STATA was used to perform the statistical analyses.

Box 1. List of ATC level-5 codes for recoding into antibiotic drugs.

Categories of antibiotic drugs	ATC level-5 codes		
Antibiotics for topical use, including corticosteroids with antibiotics (= dermatologicals with antibiotics*)	D06BA01	D06BX01	D07CC01
	D06AX01	D06AA03	J01XC01
	D06AX09	D07BC01	
	D06AX13	D07CA01	
Gynaecological anti-infectives (= gynaecologic antibacterial drugs*) Tetracyclines	G01AF01	G01AA10	
	J01AA02	J01AA06	
	J01AA04	J01AA07	
Broad-spectrum penicillins	J01CA01	J01CA04	J01CA11
	J01CA02	J01CA08	
Beta-lactamase sensitive penicillins	J01CE01	J01CE02	
Beta-lactamase resistant penicillins	J01CF01	J01CF05	
Penicillins combined with beta-lactamase inhibitor (i.e. bioclavid)	J01CR02		
Sulphonamides, trimethoprim, nitrofurantoin	J01EA01	J01EB02	J01XE01
Macrolides and lincosamides (= macrolides*)	J01FA01	J01FA09	J01FF01
	J01FA06	J01FA10	
Fluoroquinolones	J01MA01	J01MA02	J01MA14
Antibiotic ophthalmologicals, including combinations of antibiotics and corticosteroids (= antibacterial eye drops*)	S01AB01	S01AA01	S02CA02
	S01AX06	S01AA12	S02CA03
	S01AX11	S01AA13	S03CA01
	S01AX13	S01AA30	S03CA04
	S01AX19	S02AA15	
	S01AX22	S01CA01	
Other antibiotics	J01DB01	J01DH03	J01GB01
	J01DC02		

Note: \*Name of the antibiotic group as used in this article.

## Results

### Frequency of antibiotic prescriptions

During the study period, 644 777 contacts with OOH primary care were identified. Of these, 96 916 resulted in antibiotic prescription, corresponding to a prescription proportion of 15.0%, 95% confidence

interval (CI) 14.9–15.1 (Table I). In 1388 (1.4%) of these contacts, more than one type of antibiotic was prescribed. Antibiotics were more often prescribed in clinic consultations (26.1%, 95% CI 25.9–26.3) than in telephone consultations (10.7%, 95% CI 10.6–10.8) or home visits (10.9%, 95% CI 10.7–11.1). The prescription proportion was highest for patients

Table I. Number of antibiotic prescriptions per contact type, gender, and age (n, %, proportion, and 95% CI).

	All contacts		Number of antibiotic prescriptions		Prescription proportion <sup>1</sup>	
	n (%)	95% CI	n (%)	95% CI	%	95% CI
Contact type:						
Telephone consultations	382 748 (59.4)	59.2–59.5	40 908 (42.2)	41.9–42.5	10.7	10.6–10.8
Clinic consultations	180 032 (27.9)	27.8–28.0	47 058 (48.6)	48.2–48.9	26.1	25.9–26.3
Home visits	81 997 (12.7)	12.6–12.8	8 950 (9.2)	9.1–9.4	10.9	10.7–11.1
Gender:						
Male	291 209 (45.2)	45.0–45.3	41 558 (42.9)	42.6–43.2	14.3	14.1–14.4
Female	353 568 (54.8)	54.7–55.0	55 358 (57.1)	56.8–57.4	15.7	15.5–15.8
Age:						
0–4 years	126 113 (19.6)	19.5–19.7	20 955 (21.6)	21.4–21.9	16.6	16.4–16.8
5–17 years	89 760 (13.9)	13.8–14.0	13 695 (14.1)	13.9–14.4	15.3	15.0–15.5
18–60 years	310 827 (48.2)	48.1–48.3	47 604 (49.1)	48.8–49.4	15.3	15.2–15.4
> 60 years	118 077 (18.3)	18.2–18.4	14 662 (15.1)	14.9–15.4	12.4	12.2–12.6
Week(end): <sup>2</sup>						
Weekdays	240 512 (37.3)	37.2–37.4	25 587 (26.4)	26.1–26.7	10.6	10.5–10.8
Weekend	404 265 (62.7)	62.6–62.8	71 329 (73.6)	73.3–73.9	17.6	17.5–17.8
Total	644 777 (100.0)		96 916 (100.0)		15.0	14.9–15.1

Notes: <sup>1</sup>Prescription proportion: percentage of antibiotic prescriptions of all contacts. <sup>2</sup>Weekdays: Monday to Thursday from 4 p.m. to 8 a.m.; weekend: from Friday 4 p.m. to Monday 8 a.m., and including bank holidays.

aged 0–4 years (16.6%, 95% CI 16.4–16.8) and lowest for contacts with patients aged 60 + years (12.4%, 95% CI 12.2–12.6). The prescription proportion was higher for weekends (17.6%, 95% CI 17.5–17.8) than for weekdays (10.6%, 95% CI 10.5–10.8). Of all antibiotics prescriptions, nearly half were prescribed in clinic consultations, while more than 40% were prescribed in telephone consultations.

*Types of antibiotic prescriptions*

The most frequently prescribed antibiotics were beta-lactamase sensitive penicillins (prescription proportion: 5.2%), antibacterial eye drops (3.2%), and broad-spectrum penicillins (3.2%) (Table II). The type of prescribed antibiotic drug varied slightly with contact type. Antibacterial eye drops were prescribed most often in telephone consultations, followed by penicillins (beta-lactamase sensitive and broad-spectrum types of penicillin). In clinic consultations and home visits, beta-lactamase sensitive and broad-spectrum types of penicillins were most frequently prescribed.

In total, 82.6% of all prescriptions for sulphonamides, trimethoprim, and nitrofurantoin and 73.0% of all antibacterial eye drops were prescribed in telephone consultations, whereas 66.5% of all beta-lactamase sensitive penicillins were prescribed in clinic consultations.

*Types of antibiotics per age group*

The most frequently prescribed types of antibiotics varied between age groups: antibacterial eye drops for infants aged 0–4 years (41.3%) and beta-lactamase sensitive penicillins for children aged 5–17 years (44.6%) and adults aged 18–60 years (38.9%) (Table III). Above 60 years, patients most frequently received broad-spectrum penicillins (32.9%).

*Types of antibiotics for weekdays and weekends*

Broad-spectrum penicillins were more frequently prescribed during weekdays than at weekends, for all contact types (Table IV). For beta-lactamase sensitive penicillins the prescription proportion was higher during weekends than during weekdays. Antibacterial eye drops had a similar rate during weekdays and weekends.

At weekends antibiotics were more frequently prescribed on Saturdays than on Sundays, most often during the daytime. Most antibiotics were prescribed during weekdays (Monday to Friday) at 4–6 p.m., just after the opening hours of the OOH primary care service and at 6–8 p.m. (not in Table).

Table II. Distributions of type of antibiotic prescriptions in OOH primary care per contact type (n, %, and proportion).\*

Type of antibiotic prescription	Total (n = 644 777)		Telephone consultation (n = 382 748)		Clinic consultation (n = 180 032)		Home visit (n = 81 997)	
	Prescriptions n (%) <sup>1</sup>	Prescription proportion % <sup>2</sup>	Prescriptions n (%) <sup>1</sup>	Prescription proportion % <sup>2</sup>	Prescriptions n (%) <sup>1</sup>	Prescription proportion % <sup>2</sup>	Prescriptions n (%) <sup>1</sup>	Prescription proportion % <sup>2</sup>
Beta-lactamase sensitive penicillins	33 835 (34.9)	5.2	7915 (19.3)	2.1	22 506 (47.8)	12.5	3414 (38.1)	4.2
Antibacterial eye drops	20 503 (21.2)	3.2	14 959 (36.6)	3.9	5226 (11.1)	2.9	318 (3.6)	0.4
Broad-spectrum penicillins	20 353 (21.0)	3.2	8970 (21.9)	2.3	8910 (18.9)	4.9	2473 (27.6)	3.0
Macrolides	6309 (6.5)	1.0	1634 (4.0)	0.4	3657 (7.8)	2.0	1018 (11.4)	1.2
Beta-lactamase resistant penicillins	4741 (4.9)	0.7	1075 (2.6)	0.3	3232 (6.9)	1.8	434 (4.8)	0.5
Sulphonamide, trimethoprim, nitrofurantoin	4487 (4.6)	0.7	3705 (9.1)	1.0	648 (1.4)	0.4	134 (1.5)	0.2
Dermatologicals with antibiotics	3323 (3.4)	0.5	1656 (4.0)	0.4	1587 (3.4)	0.9	80 (0.9)	0.1
Penicillins combined with beta-lactamase inhibitor	1732 (1.8)	0.3	258 (0.6)	0.1	682 (1.4)	0.4	792 (8.8)	1.0
Fluoroquinolones	1362 (1.4)	0.2	631 (1.5)	0.2	458 (1.0)	0.3	273 (3.1)	0.3
Tetracyclines	234 (0.2)	0.0	80 (0.2)	0.0	140 (0.3)	0.1	14 (0.2)	0.0
Gynaecologic antibacterial drugs	30 (0.0)	0.0	20 (0.0)	0.0	10 (0.0)	0.0	0 (0.0)	0.0
Other antibiotics	7 (0.0)	0.0	5 (0.0)	0.0	2 (0.0)	0.0	0 (0.0)	0.0
Total	96 916 (100.0)	15.0	40 908 (100.0)	10.7	47 058 (100.0)	26.1	8950 (100.0)	10.9

Notes: <sup>1</sup>Percentage of antibiotic prescriptions per contact type. <sup>2</sup>Prescription proportion: percentage of antibiotic prescriptions of all contacts within contact type. \*95% CI for the prescription proportions are not presented in the table as the interval does not expand more than 0.1% for all prescription proportions.



Table III. Distribution of antibiotic prescriptions for patient age groups per contact type and type of antibiotics (proportion with 95% CI).

Contact type	Age Years	Contacts n	Antibiotic prescriptions n	Beta-lactamase sensitive			Broad-spectrum penicillins			Antibacterial eye drops			Macrolides			Beta-lactamase resistant penicillins		
				Prescription proportion % <sup>1</sup> (95% CI)	penicillins % <sup>2</sup> (95% CI)	% <sup>2</sup> (95% CI)	penicillins % <sup>2</sup> (95% CI)	Antibacterial eye drops % <sup>2</sup> (95% CI)	Macrolides % <sup>2</sup> (95% CI)	penicillins % <sup>2</sup> (95% CI)								
Telephone consultation	0-4	79 415	9883	12.4 (12.2-12.7)	6.4 (5.9-6.9)	8.3 (7.7-8.8)	77.8 (76.9-78.6)	1.3 (1.1-1.6)	0.2 (0.1-0.3)									
	5-17	51 037	4227	8.3 (8.0-8.5)	19.6 (18.4-20.8)	13.0 (12.0-14.1)	41.5 (40.1-43.0)	3.3 (2.8-3.9)	3.6 (3.1-4.2)									
	18-60	192 760	21 235	11.0 (10.9-11.2)	26.4 (25.8-27.0)	23.7 (23.2-24.3)	23.2 (22.6-23.8)	5.2 (4.9-5.5)	3.2 (2.9-3.4)									
Clinic consultation	> 60	59 536	5563	9.3 (9.1-9.6)	15.1 (14.2-16.1)	46.1 (44.7-47.4)	10.7 (9.9-11.5)	4.5 (4.0-5.1)	4.1 (3.6-4.7)									
	All	382 748	40 908	10.7 (10.6-10.8)	19.3 (19.0-19.7)	21.9 (21.5-22.3)	36.6 (36.1-37.0)	4.0 (3.8-4.2)	2.6 (2.5-2.8)									
	0-4	41 504	10 448	25.2 (24.8-25.6)	39.9 (38.9-40.8)	40.0 (39.1-40.9)	8.9 (8.3-9.4)	3.7 (3.4-4.1)	0.9 (0.7-1.1)									
Home visit	5-17	34 309	8952	26.1 (25.6-26.6)	56.0 (55.0-57.0)	15.8 (15.0-16.6)	10.8 (10.1-11.4)	4.7 (4.2-5.1)	5.4 (5.0-5.9)									
	18-60	88 793	23 792	26.8 (26.5-27.1)	49.4 (48.8-50.0)	11.1 (10.7-11.5)	12.6 (12.2-13.0)	10.2 (9.8-10.5)	9.6 (9.2-10.0)									
	> 60	15 426	3866	25.1 (24.4-25.8)	40.8 (39.2-42.3)	17.4 (16.2-18.6)	8.7 (7.8-9.6)	11.3 (10.3-12.3)	9.5 (8.6-10.5)									
All	0-4	180 032	47 058	26.1 (25.9-26.3)	47.8 (47.4-48.3)	18.9 (18.6-19.3)	11.1 (10.8-11.4)	7.8 (7.5-8.0)	6.9 (6.6-7.1)									
	5-17	5194	624	12.0 (11.1-12.9)	38.6 (34.8-42.6)	47.3 (43.3-51.3)	7.1 (5.2-9.4)	3.5 (2.2-5.3)	0.5 (0.1-1.4)									
	1-60	29 274	2577	8.8 (8.5-9.1)	44.5 (42.5-46.4)	18.4 (16.9-19.9)	6.8 (5.8-7.8)	7.8 (5.6-10.4)	6.0 (4.1-8.4)									
All	> 60	43 115	5233	12.1 (11.8-12.4)	33.6 (32.3-34.9)	30.5 (29.2-31.7)	1.1 (0.8-1.4)	13.0 (11.8-14.4)	6.9 (6.0-8.0)									
	All	81 997	8950	10.9 (10.7-11.1)	38.1 (37.1-39.2)	27.6 (26.7-28.6)	3.6 (3.2-4.0)	11.8 (11.0-12.8)	4.2 (3.7-4.8)									
	All	81 997	8950	10.9 (10.7-11.1)	38.1 (37.1-39.2)	27.6 (26.7-28.6)	3.6 (3.2-4.0)	11.4 (10.7-12.1)	4.8 (4.4-5.3)									

Notes: <sup>1</sup>Percentage of antibiotic prescriptions of all contacts. <sup>2</sup>Percentage of antibiotic prescriptions for all contacts resulting in an antibiotic prescription.

Table IV. Distribution of antibiotic prescription for weekdays and weekends<sup>1</sup> per contact type and type of antibiotics (proportion with 95% CI).

Contact type	Contacts n	Antibiotic prescriptions n	Beta-lactamase sensitive			Broad-spectrum penicillins			Antibacterial eye drops			Macrolides			Beta-lactamase resistant penicillins		
			Prescription proportion % <sup>2</sup> (95% CI)	penicillins % <sup>3</sup> (95% CI)	% <sup>3</sup> (95% CI)	penicillins % <sup>3</sup> (95% CI)	Antibacterial eye drops % <sup>3</sup> (95% CI)	Macrolides % <sup>3</sup> (95% CI)	penicillins % <sup>3</sup> (95% CI)								
Telephone consultation:	Weekdays	147 336	9720	6.6 (6.5-6.7)	17.8 (17.1-18.6)	23.3 (22.4-24.1)	37.2 (36.2-38.2)	3.8 (3.4-4.2)	2.3 (2.0-2.6)								
	Weekends	235 412	31 188	13.2 (13.1-13.4)	19.8 (19.4-20.3)	21.5 (21.0-22.0)	36.4 (35.8-36.9)	4.1 (3.8-4.3)	2.7 (2.6-2.9)								
	All	382 748	40 908	10.7 (10.6-10.8)	19.3 (19.0-19.7)	21.9 (21.5-22.3)	36.6 (36.1-37.0)	4.0 (3.8-4.2)	2.6 (2.5-2.8)								
Clinic consultation:	Weekdays	60 451	13 045	21.6 (21.3-21.9)	46.4 (45.5-47.2)	20.3 (19.6-21.0)	11.8 (11.2-12.4)	6.8 (6.4-7.2)	7.6 (7.1-8.0)								
	Weekend	119 581	34 013	28.4 (28.2-28.7)	48.4 (47.9-48.9)	18.4 (18.0-18.8)	10.8 (10.5-11.2)	8.1 (7.9-8.4)	6.6 (6.3-6.9)								
	All	180 032	47 058	26.1 (25.9-26.3)	47.8 (47.4-48.3)	18.9 (18.6-19.3)	11.1 (10.8-11.4)	7.8 (7.5-8.0)	6.9 (6.6-7.1)								
Home visit:	Weekdays	32 725	2822	8.6 (8.3-8.9)	37.1 (35.4-38.9)	31.2 (29.5-33.0)	3.3 (2.7-4.0)	11.1 (9.9-12.3)	3.9 (3.2-4.6)								
	Weekend	49 272	6128	12.4 (12.1-12.7)	38.6 (37.4-39.8)	26.0 (24.9-27.1)	3.7 (3.2-4.2)	11.5 (10.7-12.3)	5.3 (4.8-5.9)								
	All	81 997	8950	10.9 (10.7-11.1)	38.1 (37.1-39.2)	27.6 (26.7-28.6)	3.6 (3.2-4.0)	11.4 (10.7-12.1)	4.8 (4.4-5.3)								

Notes: <sup>1</sup>Weekdays: Monday to Thursday from 4 p.m. to 8 a.m. Weekend: from Friday 4 p.m. to Monday 8 a.m., and including bank holidays. <sup>2</sup>Percentage of antibiotic prescriptions of all contacts. <sup>3</sup>Percentage of antibiotic prescriptions for all contacts resulting in an antibiotic prescription.

## Discussion

### *Statement of principal findings*

In 15% of all contacts with the OOH primary care service, an antibiotic drug was prescribed; antibiotic drugs were prescribed more than twice as often in clinic consultations than in telephone consultations or on home visits. The most frequently prescribed antibiotic drugs were beta-lactamase sensitive penicillins, antibacterial eye drops, and broad-spectrum penicillins; antibacterial eye drops for children aged below five years, beta-lactamase sensitive penicillins for patients aged 5–60 years, and broad-spectrum penicillins for patients aged above 60 years. Nearly half of all antibiotics were prescribed in clinic consultations, but more than 40% of all antibiotics were prescribed in telephone consultations (in particular antibacterial eye drops, sulphonamides, trimethoprim, and nitrofurantoin). The highest prescription proportion was seen just after opening hours on weekdays (at 4–6 p.m.).

### *Strengths and weaknesses*

Our study included statistically precise data at detailed ATC level on all patient contacts at a regional OOH primary care service during a 12-month period, thus accounting for seasonal variations. We identified all prescriptions made in a catchment area covering about 1.2 million inhabitants, and the GPs were unaware of the ongoing investigation. The automatic electronic data collection ensured complete and valid data with limited risk of information or selection bias.

The organization of the setting was similar to that in other Danish regions. Our results may, therefore, be generalized to other settings. The routinely collected data did not allow us to review the indications for antibiotic prescriptions or measure guideline adherence.

### *Findings in relation to other studies*

Home visits are generally reserved for severely ill patients. However, we did not find a higher proportion of antibiotic prescriptions for home visits, and our data could not identify the reasons behind this finding (such as lower rate of infections, presence of medication at home, subsequent referral to a hospital, or low threshold for offering a home visit).

Patients often contact the OOH primary care services for health problems related to infections, which may increase the need for antibiotic prescriptions [16]. Several studies report that factors other than strictly medical indications influence decisions as to

whether or not to prescribe antibiotics, such as a particular time of day or week, pending weekend, time constraints, and heightened workload [3,4,17,18]. All these factors are more prominent in OOH primary care. We found an increased propensity for prescription of antibiotics during the first opening hours of the OOH primary care service during weekdays. The high workload during these hours could be a possible explanation as a higher medical need for antibiotics is unlikely in this particular period. Yet, also lack of accessibility to one's own GP and convenience for the patient (i.e. direct and immediate access to an OOH GP) may play a role. During weekends antibiotics were more frequently prescribed; the longer time to opening hours of one's own GP could influence the prescription behaviour of the GPs on duty. One study found that GPs prescribed antibiotics in a similar way in and out of office hours, but with significant differences between individual GPs [19]. A Dutch study on guideline adherence at OOH primary care services found that prescription of antibiotics had a lower adherence score (69%) than prescription of pain medication and referral of patients, with over-prescription of antibiotics in 42% of cases and under-prescription in 21% of cases [20].

The GPs prescribed nearly half (42%) of all antibiotics on the telephone. Most prescriptions were for antibacterial eye drops and broad-spectrum penicillin, but prescriptions for lower urinary tract infections (LUTIs) were also frequently made by telephone. It is questionable whether all these prescriptions were well indicated from a medical perspective. On the one hand, an uncomplicated case of LUTI can be treated with antibiotics prescribed solely on the basis of history-taking according to national guidelines. On the other hand, conjunctivitis, one of the main indications for prescription of antibacterial eye drops, is mostly of viral origin. Acute conjunctivitis is considered a self-limiting condition, and most patients get better regardless of antibiotic use [14]. Social context seems to play a role as well, because in Denmark child day care institutions often demand ongoing treatment of conjunctivitis for a child to be present. Full-time work participation of Danish women is high, so Danish families have high incitements for getting children to day care. Thus, future studies could focus on interventions aimed at reducing prescriptions for conjunctivitis (e.g. use of delayed or wait-and-see prescriptions) [15].

GP telephone triage may also influence the prescription behaviour. GPs may, more often than nurses, decide to prescribe antibiotics in a telephone consultation rather than plan subsequent face-to-face contact. Many of these patients may also receive an antibiotic prescription in a face-to-face contact.

Such a subsequent contact could increase “state of the art” prescribing, but may also decrease patient satisfaction (e.g. face-to-face contact may be less convenient) and put pressure on the consultation shifts.

Small-spectrum penicillins, such as beta-lactamase sensitive penicillins, were prescribed frequently. Yet a considerable proportion of prescriptions were for broad-spectrum penicillins, as well as for macrolides. We could not find studies presenting comparable figures, but an increase in the use of broad-spectrum antibiotics has been described elsewhere [2,4]. Even though we have no information on the indication for prescribing antibiotics and thus regarding appropriateness, this proportion seems relevant for future studies and interventions. The general recommendation for prescribing antibiotics is to minimize the use of broad-spectrum drugs as much as possible in order to avoid development of resistance.

#### *Meaning of the study: implications*

This study suggests that rational prescription of antibiotics in the OOH primary care services may be promoted in Denmark. An earlier Danish study indicated that an intervention in primary care may limit antibiotic prescribing considerably [21]. Our results suggest that areas for targeted intervention could be telephone prescriptions of antibacterial eye drops and penicillin. For instance, GPs could be recommended to advise self-care for conjunctivitis. The high number of antibiotic prescriptions for LUTIs in telephone consultations may be relevant, but it requires high quality of history-taking and clear indications for prescribing. This routine may cause ineffective treatment and lack of proper investigation for serious symptoms of LUTI.

Future studies should assess the medical appropriateness of antibiotic prescriptions in OOH primary care and should particularly address diagnosis, indications, and specific patient groups. The relation between access to diagnostic tests in OOH primary care services (e.g. C-reactive protein test and rapid strep test) and antibiotic prescription is also an important area for future studies. GPs currently have limited access to diagnostic tests, and this may affect the use of antibiotic drugs, particularly in the OOH service where patients in need of immediate care are unknown to the GPs and tend to be worried.

#### **Conclusions**

Antibiotics were most often prescribed in clinic consultations, but, in absolute terms, many were also

prescribed by telephone. The prescription proportion seemed high, particularly antibacterial eye drops for young infants. Also, the frequent prescription of broad-spectrum penicillins and macrolides suggest room for improvement of rational antibiotic use, both in telephone consultations and in clinic consultations. Further studies on the appropriateness and motives for prescribing antibiotics in out-of-hours primary care are highly relevant to further promote rational prescription.

#### **Ethical approval**

According to Danish national regulations, research based on registry data on non-identifiable persons does not require approval by a research ethics committee.

#### **Funding**

No specific funding.

#### **Declaration of interest**

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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