ORIGINAL ARTICLE

Antibiotic prescribing in primary care: first choice and restrictive prescribing are two different traits

M S van Roosmalen, J C C Braspenning, P A G M De Smet, R P T M Grol

Qual Saf Health Care 2007;**16**:105–109. doi: 10.1136/qshc.2006.018580

See end of article for authors' affiliations

Correspondence to: Dr M S van Roosmalen, Centre for Quality of Care Research (WOK) 117, Radboud University Nijmegen Medical Centre, PO Box 9101, 6500 HB Nijmegen, The Netherlands; m.vanroosmalen@kwazo.umcn.nl

Accepted 18 December 2006

Objective: To investigate the quality of antibiotic prescribing in primary care using quality indicators and the relatedness of these indicators. To determine the influence of general practice and practice population characteristics on the indicator scores.

Methods: Data on performance were collected during the Second National Survey of General Practice over 1 year between May 2000 and April 2002 in The Netherlands. The study was carried out in 104 computerised general practices, comprising 195 general practitioners and about 400 000 patients. From a preliminary set of quality indicators on antibiotic prescribing (n = 15), eight were selected covering various medical conditions. Indicator scores were derived. A factor analysis was performed to examine the relatedness of these indicators. Composite scores were calculated for the indicators loading on the same factor. The influence of general practice and practice population characteristics on the quality of antibiotic prescribing was investigated.

Results: Considerable variation was found between indicator scores (32.8–94.2%) and between practices. The factor analysis discovered two interpretable factors—namely, ''first choice prescribing'' and ''restrictive prescribing''. The composite scores were 64% and 68%, respectively. No significant correlation was found between the two composite scores. Practice and population characteristics explained only a small proportion of the variance between practices.

Conclusions: Although different quality indicators on antibiotic prescribing are grouped together over several medical conditions, there is large variation between those indicators. General practices performing well on first choice prescribing do not automatically perform well on restrictive prescribing. There is room for improvement on both aspects of prescribing. The variation between practices is clearly present and should be further investigated.

Antibiotics have been described to fight a wide variety of bacterial infections. At the present time, there is an increasing number of infections caused by bacteria that have become resistant to certain antibiotics. The factors responsible for the emergence and spread of antibiotic resistance have been clearly identified.[1 2] Among them, overuse and misuse of antibiotics constitute the most vital factor. Antibiotics are being prescribed for a range of infections for which they may not be required because they are viral. Inappropriate prescribing also means the use of broad-spectrum antibiotics when narrower spectrum antibiotics would be more appropriate.

The highest rates of antibiotic prescriptions for systemic use are in general practice. About 80% of human antibiotic prescribing takes place in Dutch general practice.[3] General practitioners could play a major role in preventing overuse and misuse of antibiotics and thus contribute to a solution of the growing problem of antibiotic resistance. Although the Dutch antibiotic prescription rates are the lowest in the European Union,[4 5] there is still room for improvement.[6 7] The international trend of a decrease in older (ie, narrower spectrum) antibiotics and an increase in newer (ie, broader spectrum) antibiotics is also present in The Netherlands.[8–10]

Collection of information on the quality of antibiotic prescribing can inform local or national prescribing policies. In order to identify problems in antibiotic prescribing and to implement strategies to improve antibiotic prescribing, quality indicators are needed. Quality indicators are specific and measurable elements of practice that can be used to assess the quality of care. The prime objective of this study was to investigate the quality of antibiotic prescribing in general practice using quality indicators. A conceptually valid set of 15 Dutch quality indicators was available. This set has been developed in a systematic way, on the basis of evidence-based clinical practice guidelines developed by the Dutch College of General Practitioners.[11] This set was operationalised and tested empirically.

Individual quality indicators on antibiotic prescribing are useful tools for general practitioners to use within their own practices; they give them insight in their prescribing behaviour. Improvement programmes can be based on the quality scores—for example, own scores can be compared with reference figures or benchmarks. However, if external judgements for policy matters are to be made about the relative quality of antibiotic prescribing, then individual indicators are much less useful and composite scores may need to be used. The relationship between the individual indicators was tested to determine whether some or all indicators relate to some common trait and whether there is justification in combining indicators in composite scores.

Several studies have investigated the determinants of antibiotic prescribing in primary care.[12–14] However, these studies were restricted to a certain medical condition. In our study, the quality indicators covered a wider range of medical conditions. From our study, we could identify whether there are consistent effects across indicators and medical conditions.

METHODS

Development of a set of quality indicators on antibiotic prescribing

The quality indicators on antibiotic prescribing were based on the evidence-based clinical practice guidelines developed by the

Dutch College of General Practitioners. After an iterated consensus rating procedure, 15 disease-oriented quality indicators were selected on the basis of the criteria contribution to health gain and/or efficiency gain. These indicators covered nine medical conditions (table 1). The selection procedure is described in detail elsewhere.[15 16] At the end of this procedure, the indicators were found to be conceptually valid measures of quality combining scientific evidence and expert opinion. The next step in devising the set of indicators consisted of operationalising them by defining numerators and denominators and testing them empirically in practice.

The indicators described the percentage of patients with drug regimens according to the evidence-based guideline. They were formulated in a way that a higher percentage represents greater adherence to the guidelines. However, the wording of the guidelines does not generally indicate that a certain procedure must be 100% adhered to; they acknowledge that in some patients, due to clinical characteristics, one has to deviate from the recommendations.

Data collection

During the Second National Survey of General Practice in the Netherlands (NS2), data were collected to determine the quality of antibiotic prescribing. Data collection took place between May 2000 and April 2002. The NS2 has been described in detail elsewhere.[17] In the NS2, 104 computerised general practices comprising 195 general practitioners and about 400 000 patients participated. During 12 months, the general practitioners registered all health problems presented within a consultation and diagnoses were coded using the International Classification of Primary Care (ICPC; V.2, 1998). Different consultations concerning the same health problem were linked to one episode. Additionally, data were registered on drug prescribing and were classified according to the Anatomical Therapeutic Chemical codes (version of 11 November 1998). By linking ICPC with Anatomical Therapeutic Chemical codes at an episode level, it could be examined whether and which antibiotics were prescribed for a specified health problem. General practice (urbanisation level, setting, size of practice, number of patients per full-time general practitioner, number of general practitioners and pharmacy attached) and practice population characteristics (% women, % aged >65 years, % social health insurance, % non-western allochtonous) have also been collected during the Second National Survey of General Practice.

Analyses

Data were analysed with SPSS V.12. Practices were included if they could provide data for each indicator.

Descriptive statistics

Quality scores on the individual indicators were calculated for each general practice. These scores were summarised and averaged by the number of general practices providing data. The mean, standard deviation and range are presented per indicator (table 2).

Relationship between indicators

The relationship between the indicators was tested. The objective was to determine whether there was evidence of consistency to support the hypothesis that some or all indicators are related to a common trait and that there was justification for combining individual indicators. Firstly, a principal component analysis was performed to group together collinear indicators to form a composite score. Factors with eigenvalues >1 were retained. Missing values were handled using listwise deletion. Secondly, Varimax was used as the method of rotation. Thirdly, reliability coefficients (Crohnbach's α) were computed, including the indicators loading on the same factor. A Crohnbach's $\alpha > 0.60$ is perceived as satisfactory for the internal validity.[18] Composite quality scores were calculated per practice as an average of the individual indicators loading on the same factor. The correlation between the composite quality scores was examined using Pearson's correlation.

Association with general practice and practice population characteristics

The associations between the dependent variables (the individual quality indicators and the composite quality scores) and the independent variables (general practice and practice population characteristics) were investigated. Firstly, simple linear regression analyses were performed. Secondly, multiple linear regression analyses were performed, including the variables that were significant at the univariate level. Because of the explorative character, we used the method entry that simultaneously included the selected variables at once to assess independent predictors. p Values <0.05 were considered to be significant.

Table 1 Selection of quality indicators on antibiotic prescribing

Diagnosis	Recommendations*	Status	Reason for exclusion
Uncomplicated urinary tract infections (≥12 years)	First choice: trimethoprim or nitrofurantoin	Included	
	Duration of therapy 3 days	Excluded	Lack of standardisation in coding duration
Acute otitis media (<6 months)	Prescribe antibiotics	Excluded	Too few cases
Acute otitis media (>24 months)	Restrictive prescribing	Included	
Acute sore throat	Restrictive prescribing	Included	
Acute sore throat; acute tonsillitis	First choice: feniticillin, phenoxymethylpenicillin	Included	
Asthma in children (<12 years)	Restrictive prescribing	Included	
Children with fever (<6 years)	Restrictive prescribing	Excluded	Too broad an indicator
Sinusitis	Restrictive prescribing	Included	
	First choice: amoxicillin, doxycyclin, cotrimoxazole	Included	
Pelvic inflammatory disease	First choice: doxycyclin	Excluded	Too few cases
Urethritis in men	First choice: ciprofloxacin, doxycyclin	Excluded	Too few cases
Bacterial skin infections; erythema migrans in adults	First choice: doxycyclin	Excluded	No specific ICPC code
Bacterial skin infections; erysipelas	First choice: feniticillin, phenoxymethylpenicillin	Included	
Bacterial skin infections due to bite wounds	First choice antibiotics	Excluded	No specific ICPC code

ICPC, International Classification of Primary Care.
*Based on the evidence-based guidelines from the Dutch College of General Practitioners as available in 2000.

Table 2 Descriptive statistics (%) for quality indicators on antibiotic prescribing ordered by their quality scores (n = 94)

		Mean (SD)	Min	Max
Bacterial skin infections; erysipelas	1st choice	32.8 (26.1)	0	100
Sinusitis	Restrictive	33 (17.0)	0	80.6
Acute otitis media (>24 months)	Restrictive	56 (15.9)	20	86.1
Acute sore throat; acute tonsillitis	1st choice	70.2 (24.4)	0	100
Uncomplicated urinary tract infections (≥12 years)	1st choice	73.8 (13.0)	9.8	94.6
Sinusitis	1st choice	79.3 (17.5)	15	100
Acute sore throat	Restrictive	88.1 (11.3)	39.5	100
Asthma in children (<12 years)	Restrictive	94.2 (8.7)	50	100

RESULTS

Assessment of applicability of quality indicators on antibiotic prescribing

From the preliminary set of 15 quality indicators on antibiotic prescribing, seven were excluded. For two medical conditions, no specific ICPC code could be identified. One indicator on duration of treatment was excluded, because duration was not coded in a standardised way. One indicator was judged to be too broad to give useful information. For three indicators, the number of cases per practice was too small to be meaningful. Table 1 summarises the indicators and the reasons for exclusion.

Quality of antibiotic prescribing

Out of the 104 participating practices, three failed to come up with diagnostic codes (learning period too short), and five practices had technical problems in extracting the data during the collection period. Of the remaining practices, 94 practices could provide data for each indicator (97%). Table 2 presents the individual indicators ordered by their quality scores. The quality scores varied considerably per indicator. The recommendation on first choice antibiotic prescribing for bacterial skin infections (erysipelas) was least adhered to (32.8%). The recommendation on restrictive antibiotic prescribing in children <12 years of age with asthma was best adhered to (94.2%). Furthermore, considerable variation in the quality scores was found between general practices: for some recommendations the adherence rate varied between 0% and 100%. In general, the variation between general practices was greater when the guideline recommended a first choice antibiotic than when it recommended restrictive antibiotic prescribing.

Relationship between indicators

In all, 94 practices were included in the factor analysis. Two factors were obtained. These could theoretically be explained by the contents of the indicators. The four indicators on first choice antibiotic prescribing loaded on one factor explaining 27% of the variance, and the four indicators on restrictive antibiotic prescribing loaded on another factor explaining 21.6% of the variance. Table 3 reports the factor loadings after rotation. The reliability coefficient was 0.66 for the four indicators loading on the factor ''first choice prescribing'', and 0.56 for the four indicators loading on the factor ''restrictive prescribing''. When the indicator with the factor loading <0.50 was omitted from the reliability analysis, the reliability coefficient increased to 0.61. The composite score for indicators loading on the factor ''first choice prescribing'' was 64.1% (SD = 14.7). The composite score for indicators loading on the factor ''restrictive prescribing'' was 67.8% (SD = 8.9). The correlation between the two composite scores was low ($r = 0.06$; $p = 0.59$).

Associations with general practice and practice population characteristics

Table 4 shows the results of the multiple linear regression analyses for the individual quality indicators with more than one variable significantly associated at the univariate level (see table 4 footnote). Although various general practice and practice population characteristics were found to be significantly associated with various quality indicators, no consistent effects were found across all of the measures.

Simple and multiple linear regression analyses were also performed for the composite scores. In the simple linear regression analyses for the composite score ''first choice prescribing'', practice size (intercept (SE) = 57.7 (3.1); $\beta = 0.24$ ($p = 0.02$)) and the number of general practitioners per practice (intercept (SE) = 57.7 (2.8); $\beta = 0.27$ ($p = 0.01$)) were found to have a significant positive relationship. In the simple linear regression analyses for the composite score ''restrictive prescribing'', the percentage of patients aged >65 years (intercept (SE) = 73.5 (2.5); $\beta = -0.24$ ($p = 0.02$)) was found to have a significant negative relationship and the percentage of patients with a higher education (intercept (SE) = 62.2 (1.9); $\beta = 0.33$ ($p = 0.001$)) was found to have a significant positive relationship. No significant relationships were found in the multiple linear regression analyses, neither for the composite score ''first choice prescribing'' nor for ''restrictive prescribing''.

DISCUSSION

From a set of 15 systematically developed quality indicators on antibiotic prescribing,[11] eight could be applied in practice. Considerable variation was found in the scores on the individual quality indicators. The indicators were formulated such that a higher percentage represents closer adherence to the guidelines. However, the wording of the guidelines does not generally indicate that a certain procedure must be 100% adhered to. In general, guidelines on first choice prescribing contain more stringent recommendations than guidelines on restrictive prescribing, which give more room for ruling out certain patients. In the case of indicators on first choice prescribing a compliance rate of 100% is almost attainable, whereas for indicators on restrictive prescribing the adherence rate might be expected to be lower. The maximum score for the first choice prescribing indicators was 79.3% (sinusitis), showing that there is considerable room for improvement. In the case of restrictive antibiotic prescribing, it is more difficult to set a standard. Overprescribing might lead to antibiotic resistance, unnecessary costs and side effects. On the other hand, too restrictive prescribing—that is, underprescribing—might put patients at risk for preventable complications.[19 20]

Individual quality indicators are useful tools for general practitioners to identify problem areas within their practices. For policy matters, reviewing all the individual indicators is not

Table 3 Results of the principal component analysis; factor loadings from the rotated component matrix (Varimax rotation, n = 94)

		F1	F2
Acute sore throat; acute tonsillitis	1st choice	0.77	0.07
Bacterial skin infections; erysipelas	1st choice	0.77	0.09
Uncomplicated urinary tract infections (≥12 years)	1st choice	0.72	–0.07
Sinusitis	1st choice	0.55	–0.19
Acute otitis media (>24 months)	Restrictive	0.06	0.79
Acute sore throat	Restrictive	–0.07	0.77
Sinusitis	Restrictive	0.22	0.65
Asthma in children (<12 years)	Restrictive	–0.25	0.33
% Variance explained		27%	22%
Crohnbach's α		0.66	0.56

n = 94.

an easy task. Clearly, it would help to divide them into more general areas. This would make the task of determining the quality of performance easier. For that reason, we studied the possibility of categorising groups of indicators. If some indicators can be put together because they more or less cover the same area, could we do with fewer indicators in the future? The quality of antibiotic prescribing as a whole may be a generic trait within a particular general practice, regardless of the medical condition being managed. Performing well or worse on a set of related indicators over various medical conditions is more compelling evidence of a true underlying difference in quality, as it is more unlikely that such a pattern could arise from random events. Our indicators could be grouped together by aspect of prescription—that is, first choice and restrictive antibiotic prescribing. Although the Cronbach's α's are not very high, the two scales are supported by the factor analysis and the content of the indicators. The low loading of the asthma indicator for children can be attributed to a ceiling effect, as the indicator score was 94.2% and SD was low.

One might expect that general practices perform either well or worse on antibiotic prescribing taken as a whole, and thus on both aspects of prescription. However, in general practices where there was a high rate of adherence with the recommendations on restrictive antibiotic prescribing, it did not always follow that the recommendations on first-choice antibiotics were well adhered to. Therefore, local and national policy makers should give attention to both aspects of prescription in the formulation of strategies to improve clinical practice to combat antibiotic resistance. Although dose and duration are important aspects of the quality of antibiotic prescribing as

Table 4 Regression coefficients (multiple linear regression) for the individual quality indicators

	Bacterial skin infections; erysipelas (1st choice)	Uncomplicated urinary tract infections (≥12 years; 1st choice)
General practice characteristics		
Urbanisation (reference = rural)		
Urban	–0.19	
Suburban	–0.28*	
Setting (reference = group)		
Solo		
Duo		
Size of practice	0.10	–0.02
Number of patients/full-time GP		
Number of GPs	0.10	0.27
Pharmacy (1 = yes, 0 = no)		
Practice population characteristics		
% Women	–0.14	
% Aged >65 years		
% Higher educated		
% Social health insurance		
% Non-western allochtonous		
Intercept (SE)	132.5 (74.9)	67.7 (3)
Proportion explained variation (R^2)	0.16	0.07

GP, general practitioner.
*p<0.05.
Significant results for the simple linear regression analyses:
(1) Acute sore throat; acute tonsillitis—1st choice (no significant relations).
(2) Bacterial skin infections; erysipelas—1st choice (suburban: intercept (SE) = 35.2 (2.9); β = –0.20 (p = 0.05)) (size of practice: intercept (SE) = 21.8 (5.5); β = 0.23 (p = 0.03)) (number of GPs: intercept (SE) = 22.3 (4.8); β = 0.25 (p = 0.02)) (% women: intercept (SE) = 189.4 (75.6); β = –0.21 (p = 0.04)).
(3) Uncomplicated urinary tract infections (≥12 years)—1st choice (size of practice: intercept (SE) = 67.3 (3.0); β = 0.23 (p = 0.03)) (number of GPs: intercept (SE) = 67.6 (2.7); β = 0.25 (p = 0.01)).
(4) Sinusitis—1st choice (% non-western allochtonous: intercept (SE) = 80.8 (2.2); β = –0.26 (p = 0.01)).
(5) Acute otitis media (>24 months)—restrictive (% higher educated: intercept (SE) = 48.6 (3.4); β = 0.24 (p = 0.02)).
(6) Acute sore throat—restrictive (% aged >65 years: intercept (SE) = 94.8 (3.1); β = –0.23 (p = 0.03)).
(7) Sinusitis—restrictive (% higher educated: intercept (SE) = 22.8 (3.6); β = 0.30 (p = 0.003)).
(8) Asthma in children (<12 years)—restrictive (% social health insurance: intercept (SE) = 106.6 (6.2); β = –0.20 (p = 0.05).

well, only one indicator on these aspects was chosen by our expert panel.[15] No information was gathered on this item, because standardisation in coding duration was lacking.

Because we were able to collect data from a large general practice computer database, we could provide information on drugs linked to the medical condition. When such a comprehensive data collection system does not exist, simpler, drug-specific indicators on overuse or misuse—for example, the quantity of antibiotics dispensed and the proportion of small-spectrum antibiotics—could be used as an alternative. For this case, one could also use a pharmacy database. Our results of consistency between indicators over various medical conditions support the use of such a database for signalling possible general problem areas for policy matters. The disadvantage is that one still needs to have detailed information when one wants to address the specific problems underlying these overall scores.

Adherence to the quality indicators on antibiotic prescribing varied widely between practices. This variation could probably be explained by observable characteristics of general practices and the populations served. However, only a small proportion of the variation could be explained by the potential determinants that were investigated. Although various quality indicators were related to each other, there were no consistent effects across indicators loading on the same factor. But it seems that the quality of first choice prescribing was more related to practice characteristics and the quality of restrictive prescribing more to practice population characteristics. Based on the investigated characteristics, we could not divide the general practices performing well or worse on antibiotic prescribing. We investigated only general characteristics; more specific characteristics related to prescribing behaviour might explain the variance between the practices.

This study established a set of valid and applicable quality indicators on antibiotic prescribing. The set showed large variation between indicators and between practices indicating much room for improvement. The indicators did group together by aspect of prescription. For policy matters on quality improvement efforts, more global indicators could be used.

Authors' affiliations
M S van Roosmalen, J C C Braspenning, R P T M Grol, Centre for Quality of Care Research (WOK) 117, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands
P A G M De Smet, Department of Clinical Pharmacy, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands

Competing interests: None.

REFERENCES

1 **Guven GS**, Uzun O. Principles of good use of antibiotics in hospitals. *J Hosp Infect* 2003;**53**:91–6.
2 **World Health Organization**. WHO global strategy for containment of the antimicrobial resistance. WHO/CDS/CSR/DRS 2001.2.
3 **Bruinsma N**, Filius PMG, de Smet PAGM, *et al.* Antibiotic usage and resistance in different regions of the Dutch community. *Microb Drug Resist* 2002;**8**:209–14.
4 **Cars O**, Mölstad S, Melander A. Variation in antibiotic use in the European Union. *Lancet* 2001;**357**:1851–3.
5 **Goossens H**, Ferech M, VanderStchele R, *et al.* Outpatient use in Europe and association with resistance: a cross-national database study. *Lancet* 2005;**365**:579–87.
6 **Akkerman AE**, Kuyvenhoven MM, Van der Wouden JC, *et al.* Analysis of under- and overprescribing of antibiotics in acute otitis media in general practice. *J Antimicrob Chemother* 2005;**56**:569–74.
7 **Akkerman AE**, Kuyvenhoven MM, Van der Wouden JC, *et al.* Determinants of antibiotic prescribing in respiratory tract infections in general practice. *J Antimicrob Chemother* 2005;**56**:930–6.
8 **Kuyvenhoven MM**, van Balen FAM, Verheij TJM. Outpatient antibiotic prescriptions from 1992 to 2001 in The Netherlands. *J Antimicrob Chemother* 2003;**52**:675–8.
9 **Kuyvenhoven MM**, Verheij TJM, de Melker RA, *et al.* Antimicrobial agents in lower respiratory tract infections in Dutch general practice. *Br J Gen Pract* 2000;**50**:133–4.
10 **Otters HBM**, van der Wouden JC, Schellevis FG, *et al.* Trends in prescribing antibiotics in Dutch general practice. *J Antimicrob Chemother* 2004;**53**:361–6.
11 **Braspenning JCC**, Drijver R, Schiere AM. Kwaliteits- en doelmatigheidsindicatoren voor het handelen in de huisartsenpraktijk. In: *Handboek kwaliteit van zorg* [in Dutch]. Vol C4. Maarssen: Elsevier, 2003:1–30.
12 **De Sutter AI**, De Meyere MJ, Maeseaneer JM, *et al.* Antibiotic prescribing in acute infections of the sinuses: a matter of personal habit? *Fam Pract* 2000;**18**:209–13.
13 **Mazzaglia G**, Caputi AP, Rossi A, *et al.* Exploring patient- and doctor-related variables associated with antibiotic prescribing for respiratory infections in primary care. *Eur J Clin Pharmacol* 2003;**59**:651–7.
14 **Akkerman AE**, Kuyenhoven MM, van der Wouden JC, *et al.* Prescribing antibiotics for respiratory tract infections by GP's: management and prescriber characteristics. *Br J Gen Pract* 2005;**55**:114–18.
15 **Braspenning J**, Drijver R, Schiere AM. *Quality indicators for general practice (Kwaliteits- en doelmatigheidsindicatoren voor het handelen in de huisartspraktijk* [in Dutch]). Nijmegen/Utrecht: Centre for Quality of Care Research/Dutch College of General Practitioners, 2001.
16 **Campbell SM**, Braspenning J, Hutchinson A, *et al.* Research methods used in developing and applying quality indicators in primary care. *BMJ* 2003;**326**:816–19.
17 **Schellevis FG**, Wetsert GP, De Bakker DH. *Tweede nationale studie naar ziekten en verrichtingen in de huisartspraktijk: vraagstellingen en methoden* [in Dutch]. Utrecht: Nivel, 2004.
18 **Bland JM**, Altman DG. Statistics notes: cronbach's alpha. *BMJ* 1997;**314**:572.
19 **Van Zuijlen DA**, Schilder AG, van Balen FA, *et al.* National differences in incidence of acute mastoiditis: relationship to prescribing patterns of antibiotic for acute otitis media? *Pediatr Infect Dis J* 2001;**20**:140–4.
20 **Price DB**, Honeybourne D, Little P, *et al.* Community-acquired pneumonia mortality: a potential link to antibiotic prescribing trends in general practice. *Respir Med* 2004;**98**:17–24.