

Supplementary I The formula for relative rate at different percentiles calculation

The relative ratio (RR) was calculated with formula

$$\frac{e^{(\text{linear predictor} + \phi^{-1}(0.95)\sigma)}}{e^{(\text{linear predictor} + \phi^{-1}(0.05)\sigma)}} = e^{(\phi^{-1}(0.95)\sigma - \phi^{-1}(0.05)\sigma)}$$
, where $\phi^{-1}(p)$ represents corresponding Z-value from standard normal distribution as described by Abel et al.[1]

Supplementary tables

Supplementary Table 1 shows the characteristics of patients consulting each clinician (case mix). It was based on the following characteristics: age, sex, Charlson co-morbidity index (which is a composite score based on chronic conditions [2]), flu vaccination in the one year before, the number of consultations in the one year before, referral in the year before, smoking history, number of non-AB prescription in the three years before and mean duration of consultations (as recorded by the EHR system). Supplementary Table 2 shows the distribution of the numbers of observations per clinician for the AB measures. The number of AB prescribed ranged by clinician from 86 (5th percentile) to 4304 (95th percentile). Supplementary Table 3 presents the values for Spearman correlations between various measures of AB prescribing, coding of common infections and consultation rates for common infections. Supplementary Table 4 presents the frequencies that clinicians exceeded prescribing percentile thresholds for six AB measures. If the median prescribing across all clinicians was used as threshold, 4.2% of the clinicians prescribed below the medians for all of the six AB measures. On the other hand, 4.8% of the clinicians prescribed above the medians for all these AB measures. The majority of clinicians (95.8%) prescribed at least one AB measure that was above the medians of their peers. When using a more permissive threshold (75th percentiles of AB measures), 76.1% of the clinicians prescribed above this 75th percentile for at least one AB measure.

Supplementary Table 1: Case mix of patients consulting a clinician in general practice and extent of variability in case mix between clinicians

	Mean / % (standard deviation)	5 th percentile	median	95 th percentile
Children 0-14 years (%)	10 (5.2)	4.0	9.1	18.4
Adults 15-74 years (%)	75.8 (6.7)	64.9	76.1	85.6
Older Adults 75+ years (%)	14.2 (7.2)	4.0	13.4	27.0
Women (%)	59.9 (8.3)	47.0	59.6	73.5
Charlson co-morbidity (%):	71.6 (7.9)	58.6	72.0	83.7
No (score 0)				
Low (1-2)	22.8 (5.6)	13.6	22.7	31.8
Moderate (3-4)	4.5 (2.8)	0.0	4.1	9.4
High (5-6)	0.8 (0.9)	0.0	0.6	2.6
Very high (7+)	0.3 (0.5)	0.0	0.0	1.1
Patients with co-morbidity standardised by age and sex (%)	25.8 (5.7)	16.9	25.6	35.0
Flu vaccination in one year before (%)	33.0 (9.7)	18.0	32.7	49.1
Number of consultations in one year before (mean)	9.0 (3.4)	5.0	8.3	15.9
Smoking history:	50.6 (9.9)	35.4	50.1	67.7
Non-smoker (%)				
Current smoker (%)	23.7 (9.6)	11.6	22.3	41.5
Past smoker (%)	25.7 (7.7)	12.0	26.0	37.5
Number of non-AB prescriptions in three years before (mean)	92.0 (38.3)	39.5	87.6	156.6
Duration of consultation (mean)	10.8 (3.9)	5.0	10.7	17.4

Supplementary Table 2: Distribution of the numbers of observations per clinician for the main AB measures

AB measure	Characteristic	5 th percentile	median	95 th percentile
Crude AB prescribing rate [§]	Numerator: number of AB prescribed	86	666	4304
	Denominator: number of consultations	632	4288	23372
Level of incidental AB prescribing (%)	Numerator: number of AB prescribed without prior AB in 12 months before	15	189	1092
	Denominator: number of AB with one year prior follow-up	39	498	3300
Level of repeat AB courses: other AB in prior 30 days in patient prescribed AB (%)	Numerator: number AB with prior AB	12	134	1100
	Denominator: number of AB prescribed	86	666	4304
Number of prior ABs in three years before in patients prescribed an AB (mean)	Mean number of AB with three years prior follow-up	10	295	1810
Use of broad spectrum AB types (%)	Numerator: number broad spectrum AB	31	259	1694
	Denominator: number of AB prescribed	86	666	4304
Patient risk of hospital admission / NNT	Mean NNT in incidental AB users	48	354	1996
Consultation rate for common infections [§]	Numerator: number of infections	62	412	2324
	Denominator: number of consultations	632	4288	23372

[§]per 1000 consultations

Supplementary Table 3: Spearman correlations between various measures of AB prescribing, coding of common infections and consultation rates for common infections

	Standardised rate AB prescribing	Incidental AB prescribing	Repeat AB courses within 30 days	Number of prior ABs in three years before in patients prescribed an AB	Use of broad spectrum AB	Patient risk for hospital admission	Consultation rate for common infections	GP coding of common infections
Standardised rate AB prescribing	1.00	-	-	-	-	-	-	-
Incidental AB prescribing	0.45	1.00	-	-	-	-	-	-
Repeat AB courses within 30 days	0.16	0.04	1.00	-	-	-	-	-
Number of prior ABs in three years before in patients prescribed an AB	0.12	0.07	0.53	1.00	-	-	-	-
Use of broad spectrum AB	0.12	0.30	-0.25	-0.11	1.00	-	-	-
Patient risk for hospital admission	-0.03	-0.07	0.06	-0.01	0.01	1.00	-	-
Consultation rate for common infections	0.54	0.10	-0.13	=0.04	0.12	0	1.00	-
GP coding of common infections	-0.01	0.06	-0.26	-0.12	0.14	-0.02	0.54	1.00

Supplementary Table 4: Frequencies that clinicians exceeded prescribing percentile thresholds for six AB measures[#] (percentiles based on the distribution of AB prescribing of all clinicians in study population)

Percentile thresholds of AB prescribing across all clinicians (from low to high)					
Number of percentile thresholds exceeded	5 th percentile N (%)	25 th percentile N (%)	median N (%)	75 th percentile N (%)	95 th percentile N (%)
0	0 (0)	14 (0.4)	166 (4.2)	942 (23.9)	2992 (75.9)
1	1 (0)	75 (1.9)	519 (13.2)	1193 (30.3)	753 (19.1)
2	6 (0.2)	202 (5.1)	818 (20.8)	1012 (25.7)	170 (4.3)
3	35 (0.9)	572 (14.5)	960 (24.4)	534 (13.5)	24 (0.6)
4	189 (4.8)	894 (22.7)	792 (20.1)	218 (5.5)	3 (0.1)
5	678 (17.2)	1145 (29)	499 (12.7)	41 (1.0)	0 (0)
6	3033 (76.9)	1040 (26.4)	188 (4.8)	2 (0.1)	0 (0)

[#]Clinician prescribing relative to the following six AB measures was assessed (for those with data on all measures):

-Standardised rate of AB prescribing by clinician

-Incidental AB prescribing for selected common infection by clinician (%)

-Patients who receive a repeat AB course within 30 days (%)

-Mean number of prior ABs in three years before in patients prescribed an AB

-Median NNT to prevent one infection-related hospital admission in patients prescribed an AB

-Broad spectrum types of all AB prescribed by clinician (%)

References Supplement

- [1] G. Abel and M. N. Elliott, "Identifying and quantifying variation between healthcare organisations and geographical regions: using mixed-effects models," *BMJ Qual Saf*, vol. 0, pp. 1–7, 2019, doi: 10.1136/bmjqs-2018-009165.
- [2] M. Charlson, M. T. Wells, R. Ullman, F. King, and C. Shmukler, "The Charlson comorbidity index can be used prospectively to identify patients who will incur high future costs.," *PLoS One*, vol. 9, no. 12, p. e112479, 2014, doi: 10.1371/journal.pone.0112479.