

Supplementary Online Content

Sikkens JJ, van Agtmael MA, Peters EJG, et al. Behavioral approach to appropriate antimicrobial prescribing in hospitals: the Dutch Unique Method for Antimicrobial Stewardship (DUMAS) participatory intervention study. *JAMA Intern Med.* Published online May 1, 2017. doi:10.1001/jamainternmed.2017.0946

eFigure 1. Enrollment in the DUMAS Study

eFigure 2. Antimicrobial Appropriateness per Department

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eTable 1. Root Cause Analysis Interview Topic List

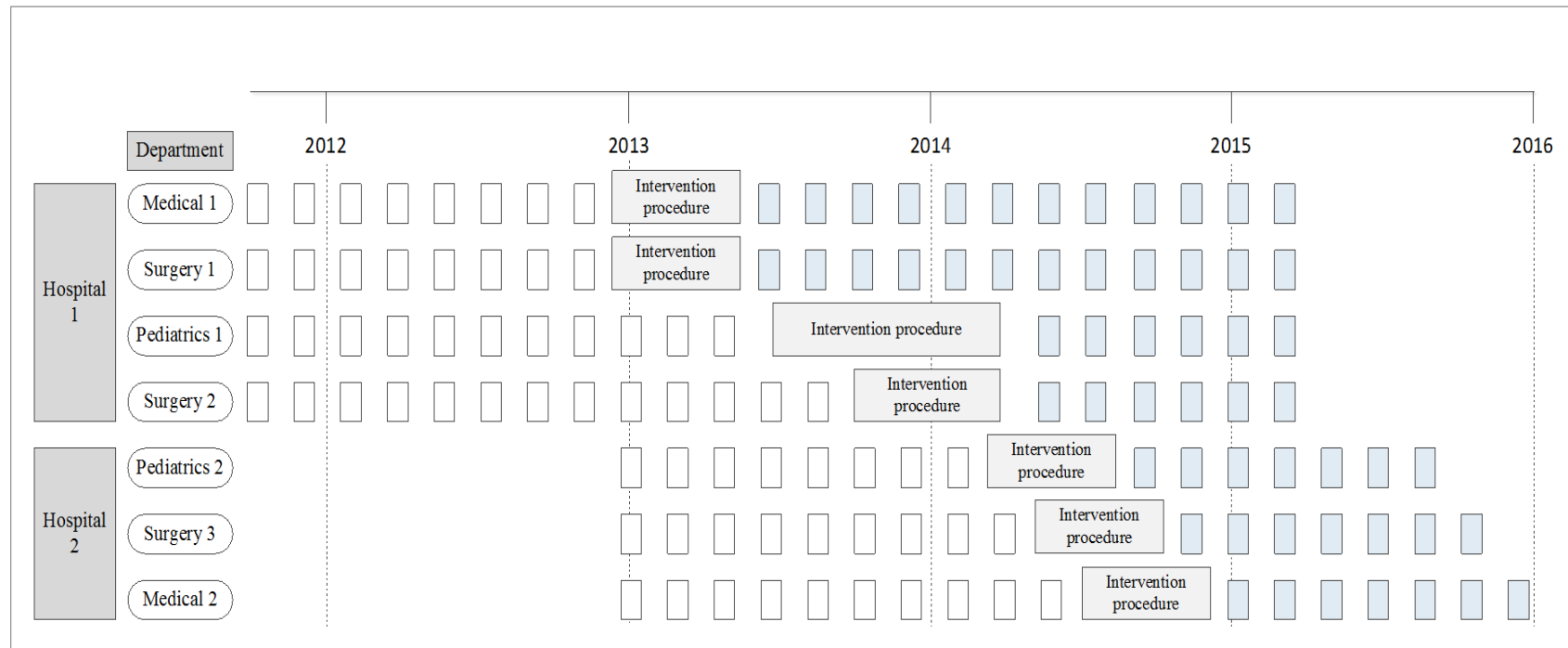
eTable 2. Results of the Root Cause Analysis and Chosen Interventions

eTable 3. Antimicrobial Appropriateness and Consumption per Department

This supplementary material has been provided by the authors to give readers additional information about their work.

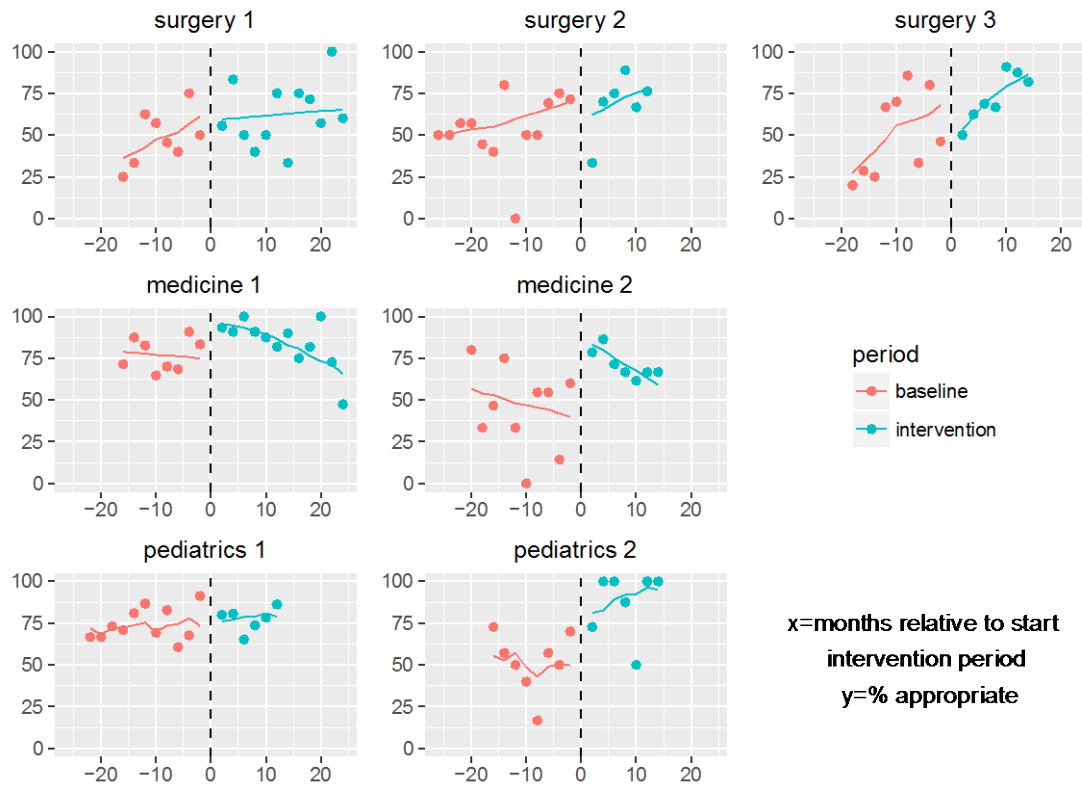
eFigure 1. Enrollment in the DUMAS Study

Schematic overview of DUMAS-study department-enrollment order and timing. Grey boxes represent the period starting with the first plenary session and ending with the installment of the local antibiotic ambassadors



eFigure 2. Antimicrobial Appropriateness per Department

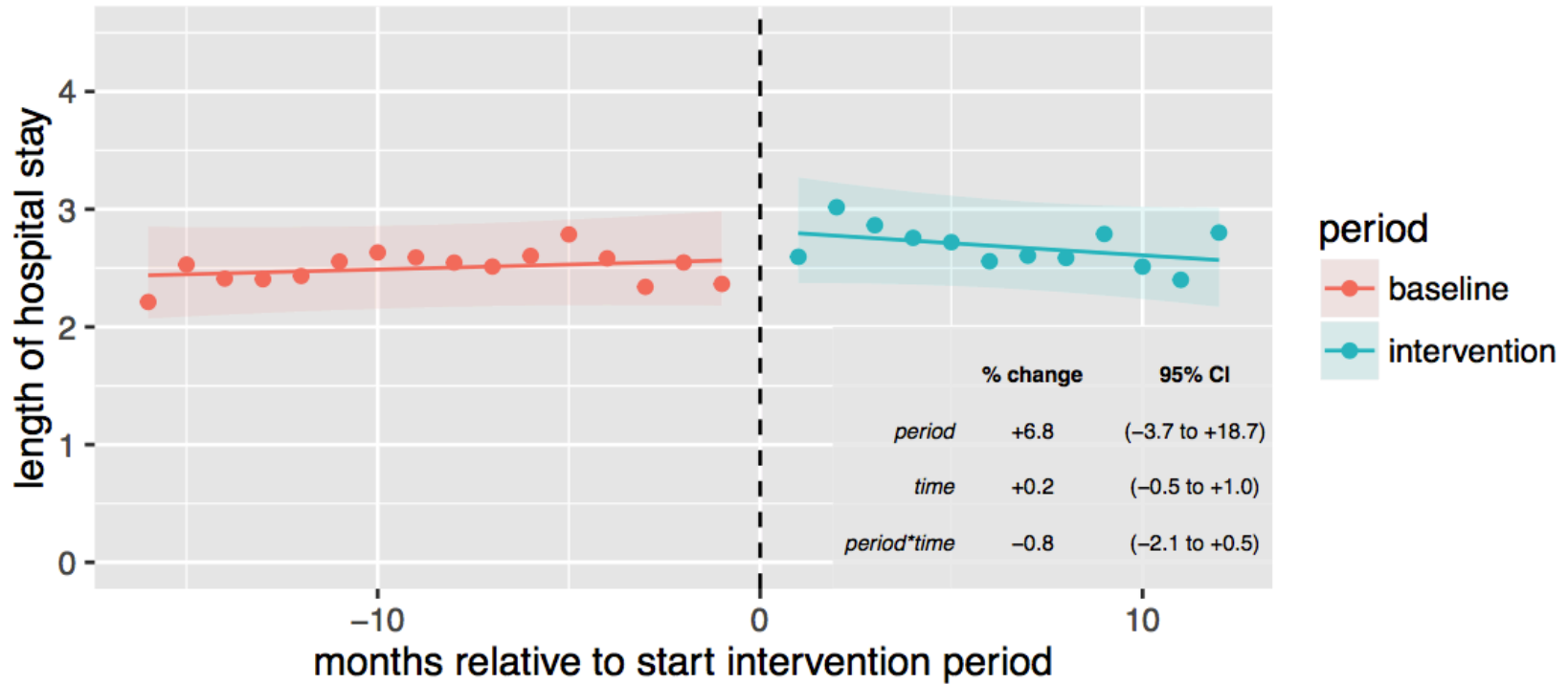
Antimicrobial appropriateness relative to start of the intervention phase per department with all available data.



Points represent results from the point-prevalence surveys, and lines represent predicted means from the regression analysis.

eFigure 3. Length of Hospital Stay

Length of hospital stay in days of therapy relative to start of the intervention phase per department and linear mixed regression analysis.



Points represent uncorrected data, and lines represent predicted means from the regression analysis.

eTable 1. Root Cause Analysis Interview Topic List

Interview guide (translated from the original Dutch version)
Introduction:
The goal of this interview is to perform a root cause analysis and to discuss ideas for interventions to improve antimicrobial use. This interview is voluntary and everything discussed will be used while preserving your anonymity. It is possible that we use fragments of this interview in the future plenary discussion, or in scientific publications, but this will be done without using your name or in any way that the statements can be redirected to you. This interview will be audiorecorded. Do you consent to participate according to these conditions?
[if the interviewee mentions a reason/cause for suboptimal antimicrobial use, keep on questioning (5x why) for underlying causes until the interviewee cannot continue naming another underlying cause]
General questions:
1. What is your opinion on the clinical antimicrobial use within your department? What goes well, what can be improved? if suboptimal situations are mentioned-> are these systematic or incidental? Can you relate these to technical (i.e. electronic prescription system down-time), organizational (i.e. local rules, guidelines, training of new staff, management priorities, culture, etc), human (knowledge, competence), or patient related factors? Are there any differences to other departments, for instance department (name other surgery/medicine department)
2. How do physicians on your department usually choose the right antimicrobial drug? What is your experience of working with external consultants (ID physicians, clinical microbiologists)? What is their influence? Do you notice any difference between the advices of these specialties? Do you undergo training in antimicrobial prescribing?
3. Is there any situation or antimicrobial drug indication that you find especially difficult?
4. How important is the prevention of development of antimicrobial resistance for you when considering antimicrobial prescribing?
5. What is your opinion of the hospital antimicrobial guideline-system? Which version do you use, on paper or the digital version? How can the system and the guidelines be improved?
Results of your department
The baseline measurement of the DUMAS study shows that your department's antimicrobial appropriateness is xx%. Most inappropriate prescriptions were for indication X/ deviated from appropriate use because they were too long/ too much IV / no streamlining etc. (include department-specific information). For instance: (name at least 5 examples of frequent inappropriate prescriptions).

What is your first reaction to these findings?
What is your explanation? (discuss each type of frequent inappropriate prescription and use 5xWhy)
Improvement?
1. What is in your opinion the best way to improve antimicrobial prescribing in this hospital? And for your department? What is your personal role in this? Is your department different from other departments? Which interventions to improve antimicrobial use would you like for your department?
2. On a scale of 1 (not confident at all) to 10 (totally confident), how confident are usually you of prescribing an appropriate antimicrobial prescription?
3. Any remaining questions, topics for discussion or advice?

eTable 2. Results of the Root Cause Analysis and Chosen Interventions

Department	Baseline appropriateness	Intervention period appropriateness	Main problems	Identified causes	Interventions
Surgery 1	48%	60%	<p>Unnecessary and/or prolonged treatment and prophylaxis with amoxicillin-clavulanate for soft tissue infections.</p> <p>No/late IV-oral switch.</p>	<p>Fear for post-surgical complications. Physicians seldom encounter clinical problems caused by antimicrobial resistance, therefore low priority for prudent antimicrobial use.</p> <p>Residents consider clinical ward work less important. Automatic prescribing habits make work easier (one-size-fits-</p>	<p>Physician-led revision of guidelines followed by presentation of new guideline.</p> <p>Weekly stand-up sessions (nurses & physicians) to discuss resident-generated iv-oral switch reports (for four months).</p>

				all)	
Surgery 2	60%	73%	Prolonged IV treatment with broad-spectrum antibiotics for complicated soft tissue infections. Antibiotic choice deviated from guidelines.	Inexperienced residents facing complicated infections with relatively low availability of supervisory support. Supervisors do not know or support use of hospital guideline.	Infectious disease specialist presence during weekly grand ward round (continuous). Improvement of digital guideline availability.

Surgery 3	53%	70%	Inappropriate antibiotic choice & duration for various indications. No/late IV-oral switch and streamlining.	Guidelines unknown and hard to find. Consulting microbiologists set wrong example by deviating from guidelines.	Creation of top 10 of antimicrobial prescription indications, followed by place links to the corresponding guidelines on the department homepage. Education session on antibiotic use by microbiologist.
Medicine 1	77%	91%	Inappropriate antibiotic choice for respiratory and soft tissue infections. Prolonged treatment for various infections. Late	Guidelines not user-friendly and hard to find. Infectious disease specialists set wrong example by deviating from guidelines. Nurses and physicians not familiar with advantages and prerequisites of early	Guideline revisions. Infectious disease specialists promise to give correct example and to comment on prescribing of colleagues. Daily stand-up sessions (nurses & physicians) to discuss resident-generated iv-oral switch reports (for three

			IV-oral switch.	IV-oral switch.	months). Monthly education sessions on resident-generated antibiotic subjects (continuous).
Medicine 2	49%	75%	Unnecessary and/or prolonged broadspectrum treatment of respiratory infections. Late IV-oral switch and inappropriate dosing.	Automatic prescribing habits make work easier. Guideline unclear. Inexperienced residents with relatively low availability of supervisory support due to high work load. Prefer no interference from other specialties.	Guideline revision. Supervisors promise to improve prescribing, increase focus on antibiotics during ward rounds, and adhere to guideline. Improvement of digital guideline availability.

Pediatrics 1	73%	78%	<p>Prolonged post-surgical IV prophylaxis.</p> <p>Inappropriate dosing.</p> <p>Prophylaxis not discontinued during treatment.</p> <p>No deescalation of carbapenems in the presence of culture results.</p>	<p>Large department with many subspecialties without uniform policies.</p> <p>Fear for complications with immunocompromised patients and post-surgery. Prefer no interference from other specialties. Pediatric policy gets relative scarce attention in hospital antibiotic committee.</p>	<p>Double physician check of all drug prescriptions. Physician-led guideline revision (not yet finished at study end). Deal with pediatric surgeon on reducing post-surgical prophylaxis.</p>
Pediatrics 2	51%	86%	<p>Unnecessary combination therapy for neonatal</p>	<p>Relatively few attention of infectious diseases and antibiotic guideline committee for pediatrics</p>	<p>Physician-led guideline revision. Supervisors promise to adhere to the new</p>

			infections. Inappropriate dosing.	department and vice versa. No uniformity in supervisors opinions.	guideline.
Abbreviation: IV, intravenous.					

eTable 3. Antimicrobial Appropriateness and Consumption per Department

Antimicrobial appropriateness and consumption per department over baseline period (16 months) and intervention periods (per year)

Antimicrobial appropriateness, %	baseline	intervention year 1	difference with baseline	relative risk for appropriateness	95% CI	intervention year 2	difference with baseline	relative risk for appropriateness	95% CI
Surgery 1	48	60	+12	1.20	(0.82 to 1.54)	65	+16	1.28	(0.91 to 1.59)
Surgery 2	64	73	+9	1.13	(0.89 to 1.31)	-	-	-	-
Surgery 3	57	70	+13	1.18	(0.96 to 1.36)	-	-	-	-

Medicine 1	77	91	+14	1.15	(1.05 to 1.23)	75	-2	0.98	(0.80 to 1.10)
Medicine 2	49	75	+25	1.34	(1.14 to 1.53)	-	-	-	-
Pediatrics 1	74	78	+4	1.02	(0.91 to 1.13)	-	-	-	-
Pediatrics 2	51	86	+35	1.43	(1.25 to 1.64)	-	-	-	-
Antimicrobial consumption, days of therapy	baseli ne	interventi on year 1	differen ce with baseline	relative difference, %	95% CI	interventi on year 2	differen ce with baseline	relative difference, %	95% CI

per admission									
Surgery 1	1.7	1.5	-0.2	-11.9	(-33.4 to +16.9)	2.1	+0.3	+19.7	(-9.5 to +57.5)
Surgery 2	4.7	3.6	-1.2	-24.5	(-44.9 to +2.7)	-	-	-	-
Surgery 3	0.9	1.0	+0.1	+13.2	(-1.2 to +29.9)	-	-	-	-
Medicine 1	8.7	8.0	-0.7	-7.6	(-28.9 to +20.7)	8.0	-0.6	-7.5	(-28.8 to +19.9)
Medicine 2	1.0	1.3	+0.3	+22.2	(-3.2 to +53.2)	-	-	-	-

Pediatrics 1	4.6	6.4	+1.7	+36.8	(+16.8 to +59.2)	6.3	+1.6	+34.5	(+15.3 to +56.5)
Pediatrics 2	0.9	0.9	-0.1	-6.3	(-18.2 to +7.5)	-	-	-	-