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Original Study

A Process Evaluation of an Antibiotic Stewardship Intervention for Urinary Tract Infections in Nursing Homes

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A B S T R A C T

Objectives: To assess the internal and external validity of a cluster randomized controlled trial (cRCT) evaluating a decision tool with supportive interventions for the empirical treatment of urinary tract infections (UTIs) in nursing homes (NHs), and to identify facilitators and barriers in implementing this antibiotic stewardship intervention.
Design: Mixed-methods process evaluation study.
Setting and Participants: Physicians, nursing staff, client council members, and residents of Dutch NHs.
Methods: We used cRCT data of the ANNA study (Antibiotic Prescribing and Non-prescribing in Nursing Home Residents With Signs and Symptoms Ascribed to Urinary Tract Infection). In addition, we sent out an online evaluation questionnaire, conducted semistructured interviews with physicians and nursing staff, and consulted client council members.
Results: Internal validity was lowered: control group physicians participated in several non–study-related activities regarding UTI. External validity was good: almost all intervention components had a high fidelity (52%-74%) and were perceived as relevant (physicians: 7.2-8.6 of 10, nursing staff: 6.5-8.5 of 10) and feasible (physicians: 7.5 of 10, nursing staff 6.4 of 10), with feasibility for residents with dementia and urine incontinence needing attention. The most common reason for deviating from the advice generated by the decision tool was an unclear illness presentation. Identified facilitators to implementation were confidence in the intervention, repeated intervention encounter, and having "champions" in the NH. Barriers were limited involvement of nursing staff, unstable nursing teams, residents' and representatives' belief that antibiotics should be prescribed, and a low antibiotic prescribing threshold within the NH culture.
Conclusions and Implications: Lowered internal validity may have reduced the study effect. Attention should be paid to the feasibility of the intervention in residents with dementia and urinary incontinence. Improvement opportunities for implementation were higher nursing staff involvement and repeated intervention offering.

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Nursing home (NH) residents are frequently prescribed antibiotics for urinary tract infections (UTIs).[1] A substantial proportion of these prescriptions is considered to be inappropriate,[2-6] for various reasons. First, antibiotics are often prescribed for nonspecific signs and symptoms that are incorrectly attributed to UTI, such as changes in mental status. Second, antibiotics are regularly prescribed merely in response to a positive urine dipstick test, that is, the presence of leucocytes and/or bacteria in the urine, but this does not establish, especially in frail older adults, a UTI diagnosis. Lastly, physicians may prescribe antibiotics in case of pressure from nursing staff, residents, and their representatives.[7-9]

Antibiotic overprescribing contributes to the development of antimicrobial resistance[1] and should be avoided. Therefore, we developed a multicomponent intervention to improve antibiotic prescribing for UTIs in NHs. This intervention consisted of an electronic health record (EHR)-integrated decision tool for the empirical treatment of suspected UTI in frail older adults, in combination with several supportive interventions for physicians and nursing staff. We performed a cluster randomized controlled trial (cRCT) into this intervention's effects [the ANNA study (Antibiotic Prescribing and Nonprescribing in Nursing Home Residents With Signs and Symptoms Ascribed to Urinary Tract Infection)],[10] with a process evaluation attached.

Process evaluations are needed for interpreting study results and are therefore an essential part of establishing the effectiveness of complex interventions.[11,12] They can provide insight into which intervention components were successful and contribute to an optimized and sustainable further development and implementation of interventions.[13] In a process evaluation, the sample and intervention quality are studied for assessing internal and external validity of the trial.[14] Internal validity indicates to what extent the established effect size actually is a consequence of the intervention. Internal validity is determined by assessing whether the study has been designed, conducted, and analyzed adequately, and to what extent the intervention was implemented. External validity indicates to what extent the results can be generalized.[15] To determine external validity, it is investigated whether the study population is representative and whether the intervention is relevant and feasible.[14]

The aim of this process evaluation was to establish the (1) internal validity and (2) external validity of the ANNA study. In addition, it aimed to (3) identify factors that influence the implementation process of the intervention positively (facilitators) and negatively (barriers).

Methods

Study Design

The ANNA study evaluated the effect of a multicomponent antibiotic stewardship intervention on appropriate antibiotic prescribing (for a description of intervention components, see Table 1). This study was performed between March 2019 and March 2020 in 16 NH organizations in the Netherlands (10 intervention group, 6 control group), on somatic and psychogeriatric care wards. Medical care in Dutch NHs is mainly provided by specialized "elderly care physicians."[18] Shortly before study onset, the Dutch Association of Elderly Care Physicians (Verenso) published a revised guideline on UTI, including the UTI treatment decision tool on which the study intervention components are based, and so allowing physicians of the control group access to a paper version of the decision tool. More information about the study design and trial results of the ANNA study can be found elsewhere.[10,19]

There are multiple frameworks to perform a process evaluation. The current process evaluation followed the framework of Leontjevas and colleagues,[14] in which a distinction is made between "first order" and "second order" process data evaluation. First-order process data address sampling quality and intervention quality. Second-order process data include the identification of facilitators and barriers in the process of intervention implementation.

Sample quality provides information on both internal validity and external validity, and the same is true for intervention quality. For example, sample data can be used to evaluate whether randomization was performed adequately (ie, internal validity), and to evaluate whether the study population was representative (ie, external validity). Regarding intervention quality, for example, if a certain intervention element was not adequately performed, the study results cannot be attributed to the whole intervention (ie, internal validity), and the generalizability of the intervention can be questioned if acceptability of one of its elements was low (ie, external validity).

Data Sources and Collection

We used several sources for data collection (Table 2): cRCT data, online evaluation questionnaires among physicians and nursing staff members (Supplementary Material 1), semistructured interviews with physicians and nursing staff members (Supplementary Material 2), and short questionnaires among client council members (Supplementary Material 3).

Table 1
Description of the Antibiotic Stewardship Intervention of the ANNA Study

Stakeholder	Interventions
Physicians*	For physicians, we developed an EHR-integrated decision tool for the treatment of suspected UTI in frail older adults. The decision tool generates an advice to either start antibiotics or not to start antibiotics, the latter accompanied by the advice to actively monitor the patient. The decision tool is based on an international Delphi study–developed algorithm integrated in the UTI guideline of the Dutch Association of Elderly Care Physicians (Verenso).[16,17] We distributed pocket cards (the decision tool in paper form) to physicians for situations without access to the EHR. Additionally, we provided them with a training consisting of an interactive presentation and role-play on the rationale behind the decision tool, on how to train nursing staff on this content (training on the job) and on how to deal with pressure to prescribe antibiotics expressed by nursing staff, residents, and their family. Lastly, we developed an information leaflet for residents who are not prescribed antibiotics, that can be used as a supportive tool by physicians and nursing staff in their communication with residents and their family.
Nursing staff	We provided all nursing staff a video of 6 minutes about dealing with suspected UTI in NH residents. In addition, we invited several members of the nursing staff (at least 1 per participating department) to become a "UTI expert" by completing an e-learning. This e-learning contains a more detailed version of the topics addressed in the video, and pays attention to how to deal with pressure from residents and their family who insist on performing a urine dipstick test or asking physicians for an antibiotic prescription. We handed over a pocket card with a summary of the e-learning to these experts and asked them to train all nursing staff (training on the job). On request, we provided nursing staff teams an additional interactive presentation on dealing with suspected UTI in NH residents.

*Physicians and advanced practice registered nurses.

Table 2
Data Sources Used for the Process Evaluation of the ANNA Study

Source	Study Population	Data	Intervention Group	Control Group	Period
cRCT data	Residents with suspected UTI	Compliance with the treatment advice generated by the EHR-integrated decision tool; reasons for noncompliance	X		March 2019–March 2020 (during data collection of the cRCT)
Online evaluation questionnaire (Supplementary Material 1)	Prescribers* and nursing staff	Sampling quality Intervention quality of all intervention components	X X	X	February 2020 (shortly before the completion of the cRCT data collection)
Semistructured interviews (Supplementary Material 2)	Prescribers* and nursing staff	Sampling quality Intervention quality of all intervention components Facilitators and barriers in the implementation process	X X X	X	February-March 2020 (shortly before until shortly after the end of the cRCT data collection)
Short questionnaire (Supplementary Material 3)	Client council members†	Intervention quality of the information leaflet for residents who are not prescribed antibiotics	X		February 2020 (shortly before the completion of the cRCT data collection)

*Physicians and advanced practice registered nurses.
†An NH-affiliated advisory group that represents the interests of residents and their representatives.

For the interviews, purposive sampling was used, whereby variation in levels of commitment to the study was sought. A topic list was developed based on the 5 domains described in the consolidated Framework for Implementation Research: intervention characteristics, inner setting (organization features), outer setting (organization context), characteristics of individuals, and process.[20] The audio-recorded interviews were conducted by 2 researchers (J.R. and J.E.) and were, because of the COVID-19 pandemic, mostly performed interviews by telephone. We interviewed until data saturation was achieved.

Measures

For assessment of sampling quality, we (1) described recruitment and assessed reach (by describing the number of NHs, NH staff members, and residents involved in the study); (2) assessed the quality of randomization by describing the randomization procedure and comparing characteristics of the intervention group with characteristics of the control group; and (3) assessed completeness of data.

For assessment of intervention quality, we assessed (1) relevance, (2) feasibility, and (3) the extent to which the intervention was performed as planned ("fidelity"). In the evaluation questionnaire, we investigated relevance and feasibility by asking physicians, nursing staff members, and client council members to rate several questions on a scale between 1 and 10 (where 1 meant "not at all" and 10 meant "very much"). We investigated fidelity by asking physicians and nursing staff members if they had used the different intervention components in the intended situations, and reasons for not using these. Relevance, feasibility, and fidelity were also addressed in the interviews.

With regard to the process of intervention implementation, both questionnaires and interviews were analyzed for barriers and facilitators (see next section). An overview of the data sources used for each process evaluation element is provided in Table 3.

Table 3
Overview of Data Sources Used per Process Evaluation Element

Process Evaluation Element	Data Sources
Sample Quality	
Recruitment	Participation data, interviews
Reach	Participation data
Randomization and comparisons intervention and control group	cRCT data, questionnaires, interviews
Completeness of data	Questionnaires, interviews
Intervention quality	
Relevance	Questionnaires, interviews, short questionnaire client council
Feasibility	cRCT data, questionnaires, interviews, short questionnaire client council
Fidelity	Questionnaires
Process of intervention implementation	
Facilitators and barriers	Questionnaires, interviews

Data Analysis

We analyzed cRCT data and questionnaires descriptively using SPSS version 20.0 (IBM Corp, Armonk, NY, USA). We performed a deductive thematic analysis of the interviews. Two researchers (J.R. and J.E.) individually coded the verbatim transcripts using the final version of the topic list and discussed all coded transcripts for consensus. When consensus could not be entirely reached, a third researcher (D.G.) was involved. Subsequently, the 2 researchers identified barriers and facilitators and discussed these with 2 other researchers (M.S. and D.G.).

Ethics

The Medical Research Ethics Committee of Amsterdam University Medical Centers, location VU University Medical Center, approved our study protocol on December 27, 2018. We obtained written informed consent from all residents or their representatives and from all NH professionals.

Results

Characteristics of the physicians and nursing staff who participated in the questionnaires and interviews are described in Tables 4 and 5.

Internal and External Validity

Sampling quality

Recruitment and reach. We invited 27 NHs for study participation. Reasons for not participating were as follows: study topic not considered a priority (n = 3), organizational issues (n = 6), participating in other studies (n = 1), and not interested (n = 1). In total, 16 NHs decided to participate (59%) and all participating NHs completed the full study period.

During the trial's data collection, approximately 140 physicians and 2500 nursing staff members were employed at the participating NH units. Intervention group physicians and nursing staff members

Table 4
Characteristics of Physician Respondents (n = 59)

Characteristic	Questionnaire		Interview	
	Intervention Group (n = 31)	Control Group (n = 21)	Intervention Group (n = 5)	Control Group (n = 2)
Gender, female	23 (74%)	13 (62%)	2 (40%)	2 (100%)
Age, y				
<30 y	6 (19%)	3 (14%)	0 (0%)	0 (0%)
30-40 y	7 (23%)	8 (38%)	1 (20%)	1 (50%)
40-50 y	12 (39%)	1 (5%)	3 (60%)	0 (0%)
50-60 y	6 (19%)	5 (24%)	1 (20%)	1 (50%)
60-70 y	0 (0%)	4 (19%)	0 (0%)	0 (0%)
Medical specialization				
Elderly care physician	17 (55%)	14 (67%)	2 (40%)	2 (100%)
Elderly care physician in training	2 (7%)	0 (0%)	0 (0%)	0 (0%)
Nonspecialized physician	6 (19%)	5 (24%)	1 (20%)	0 (0%)
Advanced practice registered nurse	6 (19%)	2 (10%)	2 (40%)	0 (0%)
Years of experience			Unknown	Unknown
<5	11 (36%)	8 (38%)		
5-10	8 (26%)	4 (19%)		
10-20	6 (19%)	1 (5%)		
20-30	6 (19%)	6 (29%)		
>30	0 (0%)	2 (10%)		
Work setting				
Psychogeriatric care ward	7 (23%)	7 (33%)	1 (20%)	0 (0%)
Somatic care ward	3 (10%)	1 (5%)	2 (40%)	1 (50%)
Psychogeriatric and somatic care ward	18 (58%)	11 (52%)	2 (40%)	1 (50%)
Other care ward	2 (7%)	2 (10%)	0 (0%)	0 (0%)
Missing	1 (3%)	0 (0%)	0 (0%)	0 (0%)

received all intervention components before study onset. Newly employed NH staff also received the interventions within a month of starting work, except for the training (they received digital hand-outs instead). One physician transferred from a control NH to an intervention NH.

Around 3600 residents, or their representatives, received study information, of which around 1200 gave informed consent, around 300 indicated that they did not want to participate, and around 2100 did not respond. The most common reason for not participating, reported voluntarily on the informed consent form and registered anonymously by medical secretaries, was the expected burden of the study. During the interviews, physicians indicated that the study's information folder, which was developed according to a mandatory format, was too long and complicated to understand and that it deterred residents from participating. Additionally, they indicated not having had enough time to allay residents' fears.

> R1, physician of the intervention group: "Also, people who call to ask, ahm ahm, if extra blood will be drawn then? And that I think: 'What makes you think that?' Very weird."

Table 5
Characteristics of Nursing Staff Respondents (n = 162)

Characteristic	Questionnaire		Interview	
	Intervention Group, n (%) (n = 98)	Control Group, n (%) (n = 55)	Intervention Group, n (%) (n = 6)	Control Group, n (%) (n = 3)
Gender, female	94 (96)	53 (96)	6 (100)	2 (67)
Age				
<30 y	13 (13)	13 (24)	2 (33)	1 (33)
30-40 y	24 (25)	13 (24)	1 (17)	1 (33)
40-50 y	29 (30)	12 (22)	1 (17)	1 (33)
50-60 y	27 (28)	10 (18)	1 (17)	0 (0)
60-70 y	5 (5)	7 (13)	1 (17)	0 (0)
Type of nurse				
Certified nurse assistant	6 (6)	4 (7)	0 (0)	0 (0)
Licensed practical/vocational nurse	58 (59)	29 (53)	2 (33)	2 (67)
Registered nurse	32 (33)	18 (33)	4 (67)	1 (33)
Licensed practical/vocational nurse in training	1 (1)	0 (0)	0 (0)	0 (0)
Registered nurse in training	1 (1)	4 (7)	1 (17)	1 (33)
Years of experience			Unknown	Unknown
<5	13 (13)	12 (22)		
5-10	17 (17)	9 (16)		
10-20	32 (33)	17 (31)		
20-30	19 (19)	11 (20)		
>30	17 (17)	6 (11)		
Work setting				
Psychogeriatric care ward	50 (51)	32 (58)	3 (50)	1 (33)
Somatic care ward	32 (33)	16 (29)	1 (17)	1 (33)
Psychogeriatric and somatic care ward	12 (12)	4 (7)	3 (50)	1 (33)
Other	4 (4)	3 (6)	0 (0)	0 (0)

Randomization and comparisons intervention and control group. We outsourced the cluster randomization to an independent statistician who used randomization software. The proportion of settings that were dedicated to psychogeriatric care was similar in the intervention and control group (71% vs. 73%), as well as the mean total number of beds per NH (161 vs. 173). Questionnaire results showed that 19% of intervention physicians and 52% of control group physicians participated in non–study-related activities regarding UTI.

In the interviews, NH staff of not only the intervention group but also the control group indicated that they had become more aware of and self-reflective about the importance of appropriate antibiotic prescribing because of participation in the data collection for the ANNA study.

> R13, physician of control group: "Because you get those reminders every time, it gives you the idea that you really have to consider it each time, like 'hey, what did I do, and did it have an effect?' And yes, why did you actually prescribe it, so it does feel like an intervention. At the same time, I know that we are the control NH, and that of course we have not received all kinds of other tools from you. But still, this already makes you aware of what you are doing."

Among the residents who provided informed consent for study participation, 212 developed at least 1 UTI during the study period. In total, 295 cases of UTI were included. Most cases were in female residents (79%) with a mean age of 86 years. Several resident characteristics differed between the intervention and control group. In the intervention group were fewer residents with dementia (38% vs. 58%), fewer residents with a catheter (13% vs. 26%), more women (85% vs. 70%) and more residents with risk factors for UTI (ie, having recurrent UTI, renal or urinary tract abnormalities, diabetes mellitus, or compromised immunity) (57% vs. 46%).[10]

Completeness of data. In the evaluation questionnaire, 6 of 31 (19%) of the intervention group physicians and 1 of 21 (5%) of the control group physicians reported that they did not collect data for all eligible suspected UTIs. Reasons for not collecting data were lack of time or not being familiar with the case report form. One physician in the intervention group indicated to not have collected data if he wanted to deviate from the treatment advice.

> Evaluation questionnaire, Physician of intervention group: "I very clearly had different ideas about the policy to be taken, than the direction I knew the decision aid was going to send me to. A time limitation would also sometimes play a role in this. Incidentally, this has happened a few times."

In response to this report, we asked several physicians in the interviews whether they had received signals from their participating colleagues that not collecting data in case of treatment advice deviation occurred more often, but this was not the case.

Intervention quality

Relevance. Physicians scored the relevance of the different intervention components 7.2 to 8.6 (of 10), and nursing staff 6.5 to 8.5 (Table 6). Interviews showed that the intervention resulted in more awareness regarding antibiotic prescribing for UTI, more attention for urinary tract–related signs and symptoms, more appropriate use of urinalysis, and continued attention for the national UTI guideline.[17] Members of the client council scored the relevance of the information leaflet as 8.4.

Feasibility. cRCT data showed that intervention group physicians deviated from the treatment advice in 54 of the 189 cases (29%). The decision to prescribe antibiotics was more frequently contrary to the treatment advice than the decision not to prescribe antibiotics (38% vs. 15%). The most common reason for nonetheless prescribing antibiotics was an unclear illness presentation. Other common reasons were degree of illness, severity of signs and symptoms, "better safe than sorry," recurrent UTIs in history, and a request of others (especially representatives and colleagues). The most common reason for not prescribing antibiotics was that results of additional tests (eg, urinalysis) were not yet known at the moment of data collection.

Physicians rated feasibility of the decision tool 7.5, and nurses 6.4 (out of 10; Table 6). Physicians and nursing staff members considered it less feasible in residents with dementia or behavioral problems because of their difficulties in expressing the symptoms that need to be assessed. Feasibility is also considered limited in residents with urinary incontinence, as symptoms such as frequency and increase in urine incontinence are difficult to assess in these residents. In residents with recurrent UTIs, it was mentioned to be more difficult to withhold antibiotics because of pressure from representatives.

Members of the client council made several recommendations with regard to the layout of and the language used in the information leaflet for residents who are not prescribed antibiotics.

Fidelity. Questionnaire results showed that, with the exception of the information leaflet, all intervention components were used by the majority of the physicians and nurses (52-74%) (Table 6).

Process of intervention implementation

Identified facilitators regarding the implementation of the study intervention, for physicians, include confidence in the intervention (intervention characteristics), repeated intervention encounter (intervention characteristics), attention for antimicrobial resistance in social media (outer setting), and guideline publication (outer setting). A physician-related barrier is the habit of prescribing antibiotics for nonspecific signs and symptoms, and confirming a UTI with urinary analysis (inner setting). Specific to nursing staff, several barriers were identified. These include a lack of familiarity with the rationale behind the intervention (intervention characteristics); limited intervention offering (intervention characteristics); insufficient study involvement (inner setting); an unstable team of nursing staff (inner setting); and nursing staff with limited flexibility, motivation for education, and difficulties with learning (characteristics of individuals). An open attitude of nursing staff toward change in antibiotic use for UTI was identified as a facilitator (characteristics of individuals).

Another identified facilitator is having an ambassador for the intervention, also called a "champion" (process), which was considered a "requirement" by several interview respondents. Other identified barriers are the belief of residents and representatives that antibiotics are needed (inner setting) and a lack of facilitation of implementation activities by the NH organization (inner setting). Table 7 describes more detailed information on each of the abovementioned facilitators and barriers.

Discussion

In this process evaluation study, we investigated internal and external validity of the antibiotic stewardship intervention evaluated in the ANNA study, and aimed to identify improvement opportunities for intervention implementation. The internal validity was reduced by control group physicians participating in several non–study-related activities regarding UTI. The external validity was good, although attention should be paid to feasibility of the intervention in residents with dementia and urine incontinence. Important facilitators for

Table 6
Results of Questionnaires (10-Point Scale Scores) and Interviews With Regard to Intervention Quality

Intervention Quality Component	Questionnaires		Interviews	
	Physicians	Nursing Staff	Findings	Illustrating Quotes
Relevance	Extent to which total intervention set helped to prescribe according to UTI guidelines*,†: 7.7	Extent to which the total intervention helped to deal with possible UTI†: 6.5	More awareness of antibiotic prescribing for UTI	R18, physician: "I think that has made people more aware of the fact that we should not prescribe antibiotics just like that, that we must have solid substantiation to do that. And I think particularly about that flow chart."
	Extent to which each tool helped to prescribe according to UTI guidelines*,†: EHR-integrated decision tool: 8.1 Pocket card: 7.9 Training: 7.2 Information leaflet: 7.3	Extent to which each tool helped to deal with suspected UTI†: E-learning: 8.5 Pocket card: 6.7 Video: 6.5 Information leaflet: 6.9	More attention for urinary tract –related signs and symptoms	R7, physician: "And I do think that's a very strong part of such a guideline or of such a decision aid, that you start asking targeted questions. So that's actually quite good, to have such a list, of peeing in small amounts, fever…"
	Extent to which respondent would recommend each tool to colleagues†: EHR-integrated decision tool: 8.6 Pocket card: 8.2 Training: 7.5 Information leaflet: 7.3	Extent to which respondent would recommend tool to colleagues†: Pocket card: 7.6 Video: 7.1 Information leaflet: 7.2	More appropriate use of urinalysis	R5, physician: "You only use the dipstick tests for urinary tract –related complaints."
			Continued attention for the guideline	R1, physician: "Because I was confronted with it all the time. So then… it keeps coming back." R7, physician: "…As you read the guideline, ahm, you then resolve to act accordingly, you know. But then at some point that resolution fades out again. And because of the ANNA survey, that didn't actually happen this time. Well, by having to take those steps, you're just more aware of it, of assessing whether someone has a UTI or not."
	Client council members Would recommend that nursing homes distribute the leaflet "extra observation and control (active monitoring)" to residents and their representatives: 8.4			
	Questionnaires		Interviews	
	Physicians	Nursing staff	Findings	Illustrating quotes
Feasibility	Decision tool/pocket card for physicians and its advice is usable for all patients†: 7.5	The pocket card and its advice is usable for all patients†: 6.4		
	Decision tool/pocket card is less feasible in:			
	residents with dementia and behavioral problems "People with severe dementia who can no longer indicate if they have abdominal pain, or pain when urinating. In those cases, some of the symptoms cannot be investigated. They may be present, but we don't find out about them, which makes diagnosing and treating a UTI more difficult."	residents with dementia and behavioral problems "I find that bladder infections manifest differently in dementia patients than in people without dementia, the pocket reference card has never caused me to detect a bladder infection."	residents with dementia and behavioral problems	R5, physician: "Well, sometimes it's not possible to examine someone at all. Ahm, because their behaviour makes it impossible, or because they simply don't indicate it… So in itself this is a very nice list, but for my target group it does not work that way… especially with people who are quite far along in their dementia. Really in those last stages. That's where it gets really difficult."

(*continued on next page*)

Table 6 (*continued*)

	Questionnaires		Interviews	
	Physicians	Nursing staff	Findings	Illustrating quotes
	residents with recurrent UTIs or urologic abnormalities	residents with recurrent UTIs or urologic abnormalities	residents with recurrent UTIs	R1, physician: "In particular the clients with recurrent UTIs, and often you get comments from their relatives, like 'you know, when we see these symptoms then we know for sure that she has a UTI.'"
			residents with urinary incontinence	R1, physician: "Or when people are really incontinent. Ahm. A lot of questions are already not applicable then"
				R5, physician: "The frequency of miction is difficult to ascertain in someone with incontinence."
			residents involving a urologist	R18, physician: "And yes, then I don't follow up on it, because the urologist gave another advice."
	situations in which representatives insisted to prescribe antibiotics	situations in which residents want to have antibiotics	situations in which representatives insisted to prescribe antibiotics	R5, physician: "I do notice the latter, and I don't know if that's because of the ANNA survey or not, but that relatives are just more empowered, and want something to be done quickly. And to wait and see, that's not appealing. Sure, you can still say: 'Yes, we'll keep an eye on it.' But well, after that… people just want a pill and be better soon."
	Other points of attention:			
			Differentiating between 'not being yourself' and a delirium is difficult	R7, physician: "What is different from normal, and what is delirium, that is a gray area… If someone is a little different, then you often think it is delirium, you know. So that's good to be aware of."
			Bothersomeness of signs and symptoms is sensitive to interpretation	R18, physician: "Like, does the patient have one or more of the above symptoms… or very bothersome symptoms. And then, it is always a bit open to interpretation, I thought."
			Not directly clear how to use urinary dipstick test	R5, physician: "And then indeed ahm, yes, the decision tree almost always sends you to 'No antibiotics.' So initially I found it remarkable that you don't even have to use the urine stick then. But later, ahm, I thought yes, indeed, the thought behind it is that you basically use the stick only in cases of… urinary tract–related complaints."

	Questionnaires	Interviews
	Physicians	Nursing staff
Fidelity	Did you use/have followed the […]? EHR-integrated decision tool: 68% Pocket card: 74% Training: 61% Information leaflet: 10%	Did you use/have seen the […]? Pocket card: 60% Video: 52% Information leaflet: 13%

*Verenso guideline: the guideline "Urinary Tract Infections in Frail Older Adults."[17]

†On a scale between 1 and 10 (where 1 means "not at all" and 10 means "very much").

Table 7
Facilitators and Barriers in Implementation of the Antibiotic Stewardship Intervention of the ANNA Study Identified in the Interviews

Domain	Subthemes	Facilitators	Barriers
Intervention characteristics	Confidence in the intervention	There was much confidence among physicians in the intervention because it is based on the national UTI guideline. In addition, positive experiences with the intervention enhanced confidence.	Confidence of nursing staff in the intervention was limited in case of unfamiliarity with the rationale behind the intervention.
	Repeated confrontation with the intervention	Attention for appropriate antibiotic prescribing was reinforced by being offered the intervention at multiple occasions.	Since nursing staff received the intervention just once, attention for appropriate antibiotic prescribing decreased over time.
Outer setting (organizational context)	Attention in social media	Much attention for antibiotic resistance in social media stimulated that physicians are positive about the intervention and remained focused on the intervention.	—
	Publication of revised guideline	Physicians were aware that they have to pay attention to the subject of UTI, given the recently revised guideline of the Dutch Association of Elderly Care Physicians on this topic.	—
Inner setting (organization features)	Antibiotic prescribing culture	—	Physicians had the habit of prescribing antibiotics for nonspecific signs and symptoms and confirming a UTI with urinary analysis.
	Involvement of nursing staff	—	Nursing staff was barely involved in the decision to participate in the study, and in the implementation of the intervention, and was therefore less informed and less committed.
	Team characteristics	—	An unstable team of nursing staff (due to high nursing staff turnover and temporary workers) complicated implementation of the intervention.
	NH organization facilitation	—	Physicians and nursing staff often did not receive time for intervention implementation.
	Belief of residents and representatives that antibiotics are needed	—	When residents and their representatives believe that antibiotics are needed, they may feel anxious, irritated, or disadvantaged if they are not prescribed antibiotics.
Characteristics of individuals	Changing behavior of individuals	An open attitude of nursing staff toward changes in the use of antibiotics for UTI was beneficial for intervention implementation.	Nursing staff with limited flexibility, limited motivation for education, and difficulties with learning (low educational level) were described as barriers to the implementation process.
Process	Ambassador	It facilitated the implementation if at least 1 person who works in the place where implementation occurs supports and propagates the intervention (champion).	—

implementation were repeated encounter of the intervention and having champions in the NHs; important barriers were limited involvement of nursing staff, an unstable nursing staff team, residents' and representatives' belief that antibiotics should be prescribed, and a culture of low-threshold antibiotic prescribing.

The control group did not provide the—intended—usual care but care that was comparable to the intervention group. Participating in the control group created awareness of the importance of appropriate antibiotic prescribing, and the structured data collection facilitated physicians to make a conscious treatment decision. In addition, an external factor that has likely contributed to increased attention for appropriate diagnosis and treatment for UTI was the publication of the revised national UTI guideline.[17] These conditions together have likely led to the non–study-related activities regarding UTI that were undertaken by control group physicians (eg, meetings with a microbiologist or pharmacist to reflect on antibiotic prescribing behavior).

Not achieving the intended number of study cases seems to be related to the informed consent procedure. Although participants of the study were not exposed to a burdensome intervention in the opinion of the research team, the most given reason for not participating was the expected high burden. Because of the length and complexity of the study's information folder, residents and their representatives did not get a clear picture of what the intervention entailed. Although use of plain language in recruitment materials is advised for cognitively impaired older adults,[21] this was only possible to a limited extent in our study because of national legislation regarding requirements for information provision to possible study participants. Not finding a significant intervention effect in the ANNA study may be a consequence of the increased awareness of appropriate antibiotic prescribing for UTI in control group participants in combination with a lower number of study cases than planned.[10]

According to the interviews and questionnaires, physicians perceived the intervention as less feasible in residents with dementia. Contrarily, cRCT data showed larger between-group differences in appropriate antibiotic prescribing for residents with dementia compared to those without dementia.[10] The intervention focuses, among other things, on not attributing nonspecific signs and symptoms to UTI. Such signs and symptoms are especially common in residents with dementia. Intervention group physicians may have attributed nonspecific signs and symptoms to UTI less often, and therefore included fewer residents with dementia. This explains the lower percentage of residents with dementia in the intervention study arm, and support the hypothesis that the intervention is actually feasibly unlike the interview and questionnaire findings. Possibly, physicians and nursing staff just feel less comfortable in adhering to the treatment advice in residents with dementia, in line with previous

work describing dementia as a major contributor to diagnostic uncertainty and difficult treatment decisions regarding infections.[22]

The Consolidated Framework for Implementation Research was previously used to evaluate the implementation of complex interventions in the long-term care setting.[23,24] In line with these studies and a review study, we found that champions, management support, and a culture facilitating change have a positive influence on implementation.[23-25] Specific to the intervention in the current study, additional facilitating factors include repeated offering of the intervention and familiarity with the rationale behind the intervention. These latter factors were present in the intervention elements for physicians, but were missing in the intervention elements for the nursing staff.

Many of the identified barriers in the implementation process were related to the involvement of nursing staff. In this study, nursing staff was not involved in the decision to participate in the study, and at request of management, the burden of the intervention components for nursing staff was limited as much as possible. As a consequence, physician involvement in the study was more prominent compared with nursing staff involvement, whereas nursing staff plays a crucial role in UTI diagnosis in NH residents. The limited involvement of nursing staff resulted in nursing staff being less informed and less committed.

A strength of this process evaluation study is that a variety of data sources was used to gain insight into the different studied elements. A limitation is that only a portion of the participating physicians and nursing staff completed the questionnaire. It is, therefore, conceivable that selection bias plays a role and that the fidelity and the relevance are overestimated. However, the results of the questionnaires on relevance and feasibility were in line with the interviews that were conducted in a very heterogeneous population in terms of commitment to the study.

Conclusion and Implications

Increased awareness of appropriate antibiotic prescribing for UTI, in the control group, limited internal validity of the ANNA study. In combination with issues regarding patient recruitment, this may have reduced the study effect. External study validity was good, yet attention should be paid to feasibility of the intervention in residents with dementia and urinary incontinence. Implementation of the study intervention would be facilitated by repeated intervention offering, allocation of champions, and active involvement of nursing staff.

Disclosure

SG reports participation in an advisory board concerning intravenous administration of temocillin in 2019. The other authors have no competing interests to disclose.

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Supplementary Material 1. Online Evaluation Questionnaire: Physicians

This document includes the questions included in the online evaluation questionnaire for physicians participating in the ANNA study, translated from the original language (Dutch).

General
* = required

Gender*:
- Male
- Female
- I'd rather not say

Age*:
- <30 y
- 30-40 y
- 40-50 y
- 60-70 y
- >70 y

Number of years' experience as physician in a nursing home:
- <5 y
- 5-10 y
- 10-20 y
- 20-30 y
- >30 y

Job function*:
- Elderly care physician
- Elderly care physician in training
- Advance practice registered nurse
- Nonspecialized physician
- General practitioner in training
- Other, namely*…

I am employed at nursing home organization*: …
Location: …
Ward: …

I am employed on a ward for:
- Somatic care
- Psychogeriatric care
- Somatic and psychogeriatric care

Participation in the ANNA Study

1. To what extent did you experience a need for more attention to the topic "appropriate antibiotic use for urinary tract infections," prior to onset of the ANNA study?*

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)

Interventions in the ANNA Study (Intervention Group Physicians Only)

[The explanations below are displayed only when applicable]

1. Decision tool: after entering signs and symptoms on the case report form in YSIS [electronic health record], a treatment advice appears that is in line with the guideline "Urinary Tract Infections" of Verenso. This is called the decision tool.
2. Pocket card physicians: the pocket card has been distributed before study onset. It contains the treatment algorithm of the guideline "Urinary Tract Infections in Frail Older Adults" of Verenso.
3. Pocket card nursing staff: the pocket card has been distributed before study onset. It describes signs and symptoms that have to be observed in case of a urinary tract infection suspicion, when to consult a physician, and what to do in case of an active monitoring policy.
4. Physician training: prior to study onset, a training session was organized by the research team, comprising a PowerPoint presentation, a role-play/exchange of tips and tricks, and a quiz. The training was afterward sent to participants by e-mail.
5. Information leaflet "extra observation and control (active monitoring)": prior to study onset a patient information leaflet was sent per e-mail. This can be distributed to patients and patients representatives for residents who are not prescribed antibiotics.

Decision tool
2A. Did you use the decision tool[1]?*

- Yes
- No *(questions 2B and 2C do not appear)*
  - Why not?
    - I did never encounter the decision tool
    - Other, namely: …

2B. To what extent did the decision tool1 help you in prescribing antibiotics for urinary tract infection in accordance with the Verenso guideline[$]?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

[$] Verenso guideline: the guideline "'Urinary Tract Infections in Frail Older Adults"

2C. To what extent would you recommend the decision tool[1] to your colleague physicians?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Pocket card: physicians
3A. Did you use the pocket card for physicians[2]?*

- Yes
- No *(question 3B and 3C do not appear)*
  - Why not?
    - I was never offered the pocket card
    - Other, namely: …

3B. To what extent did the pocket card for physicians[2] help you in prescribing antibiotics for urinary tract infection in accordance with the Verenso guideline[$]?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

[$] Verenso guideline: the guideline "'Urinary Tract Infections in Frail Older Adults".

3C. To what extent would you recommend the pocket card for physicians[2] to your colleague physicians?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Pocket card: nursing staff
4A. Has the pocket card for nursing staff[3] been part of a deliberation with a nursing staff member about a patient with a urinary tract infection suspicion?*

- Yes
- No *(questions 4B and 4C do not appear)*

Explanation (optional): …

4B. To what extent did the pocket card for nursing staff[3] (indirectly) help you in prescribing antibiotics for urinary tract infection in accordance with the Verenso guideline[$]?*

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

[$] Verenso guideline: the guideline "Urinary Tract Infections in Frail Older Adults"

4C. To what extent would you recommend the pocket card for nursing staff[3] to your colleague physicians?*

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Physician training

5A. Have you been present at the physician training or did you study the presentations afterwards[4]?

- Yes
- No *(questions 5B and 5C do not appear)*
  - Why not?
    - I was never offered the training
    - Other, namely: …

5B. To what extent did the physician training / the presentation[4] help you in prescribing antibiotics for urinary tract infection in accordance with the Verenso guideline[$]?*

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

[$] Verenso guideline: the guideline "Urinary Tract Infections in Frail Older Adults"

5C. To what extent would you recommend the physician training[4] to your colleague physicians?*

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Information leaflet: "Extra Observation and Control (Active Monitoring)"

6A. Did you distribute the information leaflet "Extra Information and Control (Active Monitoring)"[5] to patients/representatives?*

- Yes
- No *(questions 6B and 6C do not appear)*
  - Why not?
    - I was never offered the information leaflet
    - Other, namely: …

6B. To what extent did the information leaflet5 (indirectly) help you in prescribing antibiotics for urinary tract infection in accordance with the Verenso guideline[$]?*

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

[$] Verenso guideline: the guideline "Urinary Tract Infections in Frail Older Adults"

6C. To what extent would you recommend the information leaflet[5] to your colleague physicians?*

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

7A. Did you give nursing staff during (telephone) consultations give extra explanations (training on the job) about the new work methods regarding urinary tract infections in frail older adults? (if nursing staff did not have this explanation before)*

- Always
- In more than half of the cases
- In less than half of the cases
- Never

7B. What was/were reason(s) to not (always) do this? *(multiple answers possible) (question does not appear when 7A = "always")*

- I was never asked to do this
- Lack of time physician
- Lack of time nursing staff
- No interest physician
- No interest nursing staff
- Nursing staff was sufficiently informed
- Other, namely …

8. To what extent did the total intervention bundle help you in prescribing antibiotics for urinary tract infection in accordance with the Verenso guideline[$]?* (does not appear if question 2A, 3A, 4A, 5A, or 6A was answered with "no")

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

[$] Verenso guideline: the guideline "Urinary Tract Infections in Frail Older Adults"

Internal and External Influences

9. To what extent did the other activities from the ANNA study (think about the kick-off meetings, contact with the study team, and recruitment materials such as posters, news items and information letters) help you in appropriate antibiotic prescribing for urinary tract infections?*

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

10. In the past year, did you participate in non–ANNA study related activities regarding appropriate antibiotic use for urinary tract infections?*

- Yes, namely *(multiple answers possible)*:
  - Internal training, namely: …
  - Pharmacotherapeutic audit meetings
  - Conference/symposium, namely: …
  - Activities of the Regional Cooperative Networks Antibiotic Resistance (ABR zorgnetwerk), namely: …
  - Activities of the Collaborating Academic Elderly Care Networks (SANO), namely: …
  - Activities of Verenso, namely: …
  - Other, namely: …
- No

11. **To what extent did these non–ANNA study related activities help you in appropriate antibiotic prescribing for urinary tract infections?*** *(appears if question 10 was answered with "yes")*

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

ANNA Study Pop-Up

Pop-up: when you enter a urinary tract infection in the electronic patient file of a participating patient, a pop-up appears: "This patient is eligible for inclusion in the ANNA study." Please note: with "pop-up" we do not refer to the decision tool.[1]

Did you ever encounter a pop-up in YSIS with the text: "This patient is eligible for inclusion in the ANNA study"?

- **Yes**
- **No** *(questions 12A and 12B do not appear)*

To what extent do you agree with the following statements?
12A. The ANNA study pop-up motivates me to appropriately prescribe antibiotics for urinary tract infections.*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)

12B. The decision tool[1] has added value over only the pop-up in promoting antibiotic prescribing in accordance with the Verenso guideline[$]?* (intervention group physicians only)
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)

[$] Verenso guideline: the guideline "Urinary Tract Infections in Frail Older Adults"

Applicability Decision Tool / Pocket Card Physicians (Intervention Group Physicians Only)

To what extent do you agree with the following statement?
13A. The decision tool/pocket card for physicians and the resulting treatment advice from the Verenso guideline[$] is usable for all patients.* (does not appear if question 2A and 3A were answered with "no")
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

[$] Verenso guideline: the guideline "'Urinary Tract Infections in Frail Older Adults".

13B. In my opinion, the decision tool/pocket card is less usable in the following situations/patients:* …
(does not appear if question 2A and 3A were answered with "no" and/or if question 12A was answered with "10")

Degree of Implementation

14. Do you know which physician in your organization is contact person for the ANNA study?

- Yes, namely …
- No

To what extent do you agree with the following statements?
15A. Because of participation in the ANNA study, *physicians* are aware of the newest insights regarding urinary tract infections.
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

15B. Because of participation in the ANNA study, *nursing staff* is aware of the newest insights regarding urinary tract infections.
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

15C. Because of participation in the ANNA study, *residents/representatives* are aware of the newest insights regarding urinary tract infections.
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Implementation

To what extent do you agree with the following statement?
16. It was easy to conduct the ANNA study in my nursing home organization.*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Research Tool

Instruction: with research tool we refer to all forms (registration- and evaluation forms) in YSIS. After completion of the forms by physicians, the research team automatically received the entered data.

17A. How often, do you estimate, did you establish a urinary tract infection suspicion during the study conduction (March 2019–now)?

- 0 times
- 1-3 times
- 4-6 times
- 7-9 times
- 10-15 times
- 15-20 times
- 20-25 times
- More than 25 times

17B. Did you complete research forms in YSIS on possible urinary tract infection suspicions?*

- Yes
  - At which percentage of patients did you complete research forms in YSIS upon a possible urinary tract infection suspicion?*
    - <25%
    - 25%-50%
    - 50%-75%
    - >75%
- No *(question 17D and further ones do not appear)*

17C. Did it occur that you did *not* collect data from a patient of yours that consented to ANNA study participation, and who had a possible urinary tract infection?*

- Yes
  What was the reasons here for?* *(multiple answers possible)*
  - A pop-up to collect data did wrongly not appear
  - The research tool with which data can be collected, did not function
  - I did not have sufficient time to collect data
  - I did not know how to use the research tool with which data can be collected
  - Other, namely: …
- No

17D. From which patients did you collect data?* *(multiple answers possible)*

- Patients with a urinary tract infection
- Patients with a urinary tract infection in the differential diagnosis
- Patients whose urine was dipsticked by nursing staff, regardless of my differential diagnosis
- Other, namely: …

To what extent do you agree with the following statements?
18A. The research tool is easy to use.* (if 17B is "yes")
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

18B. It takes little time to collect data with the research tool.* (if 17B is "yes")
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

18C. I would sooner participate in a study wherein data are collected with an YSIS-integrated research tool compared to a study where data are collected otherwise (for example on paper forms).* (if 17B is "yes")
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

End of the questionnaire
Is there anything more you want to share about the ANNA study and/or working according to the new guideline? …

Online Evaluation Questionnaire: Nursing Staff

This document includes the questions included in the online evaluation questionnaire for nursing staff participating in the ANNA study, translated from the original language (Dutch).

General

* = required.

Gender*:
- Male
- Female
- I'd rather not say

Age*:
- <30 y
- 30-40 y
- 40-50 y
- 60-70 y
- >70 y

Number of years' experience as nurse (aid) in a nursing home:
- <5 y
- 5-10 y
- 10-20 y
- 20-30 y
- >30 y

Job function* *(multiple answers possible)*:
- Nurse aide level 2
- Nurse assistant (former level 3)
- Nurse level 4
- Nurse level 5
- Nurse aide level 2 in training
- Nurse assistant (former level 3) in training
- Nurse level 4 in training
- Nurse level 5 in training
- Other, namely*…

I am employed at nursing home organization*: …
Location: …
Ward: …

I am employed on a ward for:
- Somatic care
- Psychogeriatric care
- Somatic and psychogeriatric care
- Neither

I am evening/night/weekend nurse, head nurse, triage nurse / I take nursing shifts[$,*]:
- Yes
- No

[$] During the day/evening/weekend shift, are you the first responsible nurse for multiple wards. If something is going on with a resident, you are the first to be called prior to consultation of a physician.

I am Quality Nurse*:
- Yes
- No

Participation in the ANNA Study

1. To what extent did you experience a need for more attention to the topic "urinary tract infections," prior to onset of the ANNA study?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)

Interventions in the ANNA Study (Intervention Group Nursing Staff Only)

(The explanations below are displayed only when applicable.)

1. Pocket card nursing staff: the pocket card has been distributed before study onset. It describes signs and symptoms that have to be observed in case of a urinary tract infection suspicion, when to consult a physician, and what to do in case of an active monitoring policy.
2. Educational video: at study onset an introductory e-mail was sent to all nursing staff (employed at wards participating in the ANNA study). This mail contained a link to an educational video, in which it is explained what the new urinary tract infection guideline of Verenso means for the work of nursing staff.
3. Information leaflet "extra observation and control (active monitoring)": prior to study onset a patient information leaflet was (digitally) distributed. This can be distributed to patients and patients' representatives for residents who are not prescribed antibiotics.

Pocket card
2A. Did you use the pocket card for nursing staff1?*

- Yes
- No (question 2B and 2C do not appear)
  - Why not?
    - I was never offered the pocket card
    - Other, namely: …

2B. To what extent did the pocket card for nursing staff[1] help you in dealing with possible urinary tract infections?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

2C. To what extent would you recommend the pocket card for nursing staff1 to your colleague nursing staff?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Educational video
3A. Did you see the educational video[2]?*

- Yes
- No (questions 3B, 3C, 10A, and 10B do not appear)
  - Why not?
    - I was never offered the educational video
    - I could not open the educational video at work
    - I could open the education video at work, but without sound
    - Other, namely: …

3B. To what extent did the educational video[2] help you in dealing with possible urinary tract infections?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

3C. To what extent would you recommend the educational video[2] to your colleague nursing staff?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Information leaflet: "Extra Observation and Control (Active Monitoring)"
4A. Did you ever distribute the information leaflet "extra information and control (active monitoring)"[5] to patients/representatives?*

- Yes
- No (questions 4B and 4C do not appear)
- Why not? …

4B. To what extent did the information leaflet[5] (indirectly) help you in informing patients/representatives about the work methods in case of possible urinary tract infections?*
(not at all) 1 2 3 4 5 6 7 89 10 (very much)
Explanation (optional): …

4C. To what extent would you recommend the information leaflet[5] to your colleague nursing staff?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Training on the job
5. Did you receive extra explanation (training on the job) of a physician, during (telephone) consultations, about the new work methods regarding possible urinary tract infections in frail older adults?

- Yes
- No

6. To what extent did the total bundle of interventions in the ANNA study help you in dealing with possible urinary tract infections?*
(does not appear if 2A, 3A, and 4A are answered with "no")
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Internal and External Influences

7. To what extent did the *other* activities from the ANNA study (think about contact with the study team and recruitment materials such as posters, news items, and information letters) help you in dealing with possible urinary tract infections?*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

8. In the past year, did you participate in non–ANNA study related activities regarding urinary tract infections and antibiotic resistance?*

- Yes, namely (multiple answers possible):
  - Work meeting
- Internal training, namely: …
- Conference/symposium, namely: …
- Activities of Vilans, namely: …
- Activities of the Dutch Professional Nurses Organisation (V&VN), namely: …
- Activities of the Regional Cooperative Networks Antibiotic Resistance (ABR zorgnetwerk), namely: …
- Activities of the Collaborating Academic Elderly Care Networks (SANO), namely: …
- Activities of Verenso, namely: …
- Other, namely: …
- No

9. To what extent did these non-ANNA study related activities help you in dealing with possible urinary tract infections?* (appears if question 8 was answered with "yes")
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

Applicability Pocket Card: Nursing Staff (Intervention Group Nursing Staff Only)

To what extent do you agree with the following statement?
10A. The pocket card and its resulting advice is usable for all patients.* (does not appear if question 2A was answered with "no")
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

10B. In my opinion, the pocket card is less usable in the following situations/patients:* …
(does not appear if question 2A was answered with "no" and 10A was answered with "10")

Degree of Implementation

11. Do you know who in your organization is nursing staff contact person for the ANNA study?

- Yes, namely …
- No

To what extent do you agree with the following statements?
12A. Because of participation in the ANNA study, *nursing staff* is aware of the newest insights regarding urinary tract infections.
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

12B. Because of participation in the ANNA study, *physicians* are aware of the newest insights regarding urinary tract infections.
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

12C. Because of participation in the ANNA study, *residents/representatives* are aware of the newest insights regarding urinary tract infections.
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …
Implementation.

To what extent do you agree with the following statement?
13. It was easy to conduct the ANNA study in my nursing home organization.*
(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …
End of the questionnaire.

Supplementary Material 2

Interview Topic List: Physicians

This document includes topic list for interviews conducted among physicians participating in the ANNA study, translated from the original language (Dutch). The theme "interventions" was only addressed in interviews with physicians participating in the intervention group.

Theme	Subtheme	Example Questions

Changes regarding urinary tract infections (UTIs)
*Did you experience any changes at work regarding UTI? If so, how do you **experience working** with the **new guideline**?*
	The role of physicians	• In the past year, did anything **change** in how physicians **deal** with **UTI suspicions**?
		  • Thinking of UTI
		  • Performing physical examination
		  • Ordering urinalysis
		  • Treatment policy
		  • Informing nursing staff/residents/representatives (leaflet)
		  • Culture regarding antibiotic prescribing
		  • Own role in changes

	The role of nursing staff	• In the past year, did anything **change** in how nursing staff **deals** with **UTI suspicions**?
		  • Thinking of UTI
		  • Performing urinalysis
		  • Requesting antibiotics for UTI
		  • Informing residents/representatives (leaflet)

	The role of residents/ representatives	• In the past year, did anything **change** in the **point of view** of residents/ representatives regarding diagnosis and treatment of **UTI**?

	The role of the ANNA study	• Which **elements of the ANNA study** played a **role** in the earlier mentioned **changes**? Which elements were **essential**?
		  • Intervention group: decision tool, pocket cards (physicians/nursing staff), e-learning, physician training, educational video, information leaflet, recruitment materials (poster/news items/information letters), contact ANNA study team.
		  • Control group: recruitment materials (poster/news items/information letters), contact ANNA study team.
		• Control group: Do you think the **pop-up** in the ANNA study (with the reminder) **influenced appropriate antibiotic prescribing** according to the new guideline?

	External activities	• Are there any **activities** from **outside** the ANNA study that played a **role** in the earlier mentioned **changes**?
Interventions **Decision tool / pocket card** *What do you think of the **decision tool** / **pocket card**?*	Use of the decision tool / pocket card	• Do you **use** the **decision tool / pocket card**? If so, how/when? If not, why not?

	Questions in the decision tool/ pocket card	• To what extent is it **possible** to **answer** the **questions** that result in a treatment advice in the decision tool/pocket card?
		  • Different urinary tract-related signs and symptoms
		  • Different target groups
		• **How** do you collect **information** about the **presence and absence** of signs and symptoms?

	Advice resulting from the decision tool/pocket card	• To what extent do you **follow** the **advice** of the decision tool / pocket card? • Reasons for deviation • **How** do you deal with an **inconclusive treatment advice**? (inconclusive treatment advice: the advice would possibly be different if more had been known about the presence of certain signs and symptoms)
	Applicability	• In which way could the **applicability** of the decision tool / pocket card be **increased** • In your opinion, to what extent has the **treatment advice added value over just being reminded** of the topic "appropriate prescribing" by means of a pop-up? (The intervention group receives a treatment advice after completing the study forms. The control group also completes study forms, but does not receive a treatment advice. Do you think receiving a treatment advice has added value? Or do you think a reminder of the study, for example, because a physician has to complete forms for the ANNA study, to the same extent leads to more appropriate antibiotic prescribing for UTI?)
	Lay-out	• What do you think of the **lay-out** of the decision tool / pocket card?

(*continued on next page*)

(*continued*)

Theme	Subtheme	Example Questions
Physician training *Were you present at the training session/did you see the PowerPoint presentation that was sent afterwards? If so, what do you **remember most** of the training in the ANNA study?*	Teaching method	• What do you think of this teaching method?
Information leaflet "extra observation and control (active monitoring)" **What is your experience with the information leaflet?**	Use Applicability	• Has the information leaflet been distributed? Why/why not? By who? • How did residents/representatives respond to the information leaflet? • How could we improve the information leaflet? (content, language, layout) • How could we facilitate that the information leaflet reaches patients/representatives more often?

Implementation
What are your **experiences with participation** in the ANNA study?
	Implementation in general
	Participation needs of personnel
	Participation needs of residents
	-
	Implementation of the ANNA study
		• How do you experience the **attitude toward change** at the ward/in the organization?
		• What do **you and your colleagues** think of the **decision** to participate in the ANNA study?
		  • Relevance of the topic (appropriate antibiotics for UTI/antibiotic resistance)
		  • Willingness to commit (external) pressure
		• How did **residents/representatives** respond to **participation** in the ANNA study?
		• What were **facilitators** and **barriers** in **implementing** the ANNA study? (*Innovative nature* of the nursing home, *attitude* of the nursing home toward scientific research, *experience* of staff with research, *willingness to change* among staff, a *sense of safety* to introduce changes, *appreciation* for research tasks being conducted, *support* from management/physicians/nursing staff, *sufficient coordination* from the ANNA study team/the nursing home, *sufficient time/communication resources* for research, good *interdisciplinary collaboration*, *motivation* of physicians/nursing staff/patients/representatives, *sufficient/clear information* for physicians/nursing staff/patients/representatives, *education* of nursing staff, *staff turnover*)

Interview Topic List: Nursing Staff

This document includes topic list for interviews conducted among nursing staff participating in the ANNA study, translated from the original language (Dutch). The theme 'interventions' was only addressed in interviews with nursing staff participating in the intervention group.

Theme	Sub-theme	Example Questions

Changes regarding urinary tract infections (UTIs)
*Did you experience any changes at work regarding UTI? If so, how do you **experience** the **new working method** for a UTI suspicion?*
	The role of nursing staff	• In the past year, did anything **change** in how nursing staff deals with **UTI suspicions**?
		  • Thinking of UTI
		  • Performing urinalysis
		  • Requesting antibiotics for UTI
		  • Informing residents/representatives
		  • Own role in changes

	The role of physicians	• In the past year, did anything **change** in how physicians deal with **UTI suspicions**?
		  • Thinking of UTI
		  • Performing physical examination
		  • Ordering urinalysis
		  • Treatment policy
		  • Informing nursing staff/residents/representatives (leaflet)

	The role of residents/ representatives	• In the past year, did anything **change** in the **point of view** of **residents/ representatives** regarding diagnosis and treatment of **UTI**?

	The role of the ANNA study	• Which **elements of the ANNA study** played a **role** in the earlier mentioned **changes**? Which elements were **essential**?
		  • *Intervention group: pocket card, e-learning, educational video, information leaflet, recruitment materials (poster/news items/information letters), contact ANNA study team.*
		  • *Control group: introductory video, recruitment materials (poster/news items/information letters), contact ANNA study team.*

	External activities	• Are there any **activities** from **outside** the ANNA study that played a **role** in the earlier mentioned **changes**?
Interventions	Use of the pocket card	• Do you **use** the **pocket card**? If so, how/when? If not, why not?

Pocket card for nursing staff
*What do you think of the **pocket card for nursing staff**?*
	Questions on the pocket card	• To what extent is it **possible** to **answer** the **questions** that result in a treatment advice on pocket card?
		  • Different urinary tract-related signs and symptoms
		  • Different target groups
		• **How** do you collect **information** about the **presence and absence** of signs and symptoms?

	Advice resulting from the pocket card	• To what extent do you **follow** the **advice** of the pocket card? • Reasons for deviation • Do you think this **decision-making** as nursing staff is **appropriate for your function**? (gatekeeper)

	Conditions for use of the pocket card	• What are the **conditions for use** of the pocket card?
		  • Educational level
		  • Experience
		  • Prior knowledge

	Applicability	• How could we facilitate that the pocket card will be used better / more broad?
		  • Possibilities to better identify signs and symptoms
		  • Possibilities to better be able to adhere to the advice

	Layout	• What do you think of the **layout** of the pocket card? (small, large)
Educational video *Did you see the video? If so, what do you **remember most** of the video?*	Teaching method	• What do you think of this **teaching method**?
E-learning *Did you do the e-learning? If so, what do you **remember most** of the e-learning?*	Teaching method	• What do you think of this **teaching method**?
Information leaflet "extra observation and control (active monitoring)"	Use	• Has the information leaflet been distributed? Why / why not? By who? • How did residents/representatives respond to the information leaflet?
What is your experience with the information leaflet?	Applicability	• How could we improve the information leaflet? (content, language, layout) • How could we facilitate that the information leaflet reaches patients/representatives more often?

(*continued on next page*)

(*continued*)

Theme	Sub-theme	Example Questions

Implementation
What are your **experiences with participation** in the ANNA study?
	Implementation in general	• How do you experience the **attitude towards change** at the ward/in the organization?
		• What do **you and your colleagues** think of the **decision** to **participate** in the ANNA study?
		  • Relevance of the topic (antibiotic resistance)
		  • Willingness to commit
		• How was the involvement of nursing staff in decision making regarding participation in the ANNA study?
		• How did **residents/representatives** respond to **participation** in the ANNA study?
		• What were **facilitators** and **barriers** in **implementing** the ANNA study?
		(*Innovative nature* of the nursing home, *attitude* of the nursing home toward scientific research, *experience* of staff with research, *willingness to change* among staff, a *sense of safety* to introduce changes, *appreciation* for research tasks being conducted, *support* from management/physicians/nursing staff, *sufficient coordination* from the ANNA study team/the nursing home, *sufficient time/communication resources* for research, good *interdisciplinary collaboration*, *motivation* of physicians/nursing staff/patients/representatives, sufficient/unclear information for physicians/nursing staff/patients/representatives, *education* of nursing staff, *staff* turnover)

	Participation needs of personnel	
	Participation needs of residents	
	-	
	Implementation ANNA study	

Supplementary Material 3

Questionnaire: Client Counsel

1. To what extent do you recommend nursing homes to distribute the leaflet "Extra Observation and Control (Active Monitoring)" to residents and their representatives?

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …

2. To what extent is the ANNA study aligned to the needs of the residents and their representatives?

(not at all) 1 2 3 4 5 6 7 8 9 10 (very much)
Explanation (optional): …