The underreporting of gastroenteritis outbreaks in nursing homes

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Abstract

Background: Outbreaks of infectious gastroenteritis (GE) are common in nursing homes and cause a great public health burden, since elderly are more susceptible to severe outcome of this disease. For this reason, the Public Health law in the Netherlands obliges health care institutions with vulnerable residents to report clusters of gastroenteritis cases to the municipal health service (GGD), but this is prone to underreporting. To gain more insight into the occurrence of infectious diseases, including outbreaks of gastroenteritis in nursing homes, the Center for Infectious Disease Control (CIb) of the National Institute Public Health and Environment (RIVM) established the Surveillance Network for Infectious diseases in Nursing homes (SNIV). Given these two coexisting reporting systems, we examined whether outbreaks of gastroenteritis reported to SNIV are also reported to the GGD by the SNIV nursing homes, and which factors influence this reporting behavior.

Methods: Seventeen nursing homes from the SNIV network were selected and gave their permission for participation. These nursing homes matched to 12 corresponding GGD's of 5 provinces. Data of the GGDs was collected in a short interview, held by phone. The reported GE outbreaks of the GGDs were matched in time to the reported GE outbreaks of SNIV based on onset or reporting date. The main outcome measure was GE outbreak 'not reported to the GGD'. Adjusted analysis with logistic regression and mixed effects logistic regression was used to determine predictors for reporting and not reporting GE outbreaks to the GGD. Mixed effects logistic regression was used as a sub-analysis to account for clustering within the data. All covariates were included in a backward selection model for multivariate analysis to create a prediction model. Due to the small sample in this study, a p value <0.10 was considered statistically significant, and $0.10<$p value<0.15 was considered borderline significant.

Results: Out of 68 GE outbreaks 66.2% outbreaks were not reported to the GGD. Logistic regression identified 5 covariates predictive of not reporting GE outbreaks to the GGD: higher number of GE cases per week, higher number of beds, personnel working at 1 department instead of multiple departments, higher proportion of residents with own room and higher proportion of residents with own toilets.

Conclusion: Of all GE outbreaks in SNIV nursing homes, only 33.8% were reported to the GGD, which is a public health concern. Factors found to influence the reporting behavior were higher number GE cases per week, personnel working at multiple, higher proportion of the residents having their own room, higher proportion of the residents having their own toilet/bathroom and higher number of beds. Further qualitative research is necessary to examine possible associations of various predictors and reporting behavior of nursing homes.

Introduction

The human population is aging at an impressive rate (1, 2). In January 2013, the Dutch geriatric population consisted of 2.9 million people(3). According to the Central Bureau for Statistics (CBS) this group will approximately increase up to 4.7 million in 2041(3). This trend will correspond with an increase in the prevalence of chronic diseases and a decline in functional status, leading to an increased need for institutional care(4). Presently, 150.000 elderly of the geriatric population receive institutional care in long-term care facilities or nursing homes in the Netherlands. This number is likely to increase in the near future, as a consequence of the ageing population (5-7).

With the increase in age, the ineffective defense of the host may compromise the ability to ward off infectious agents.(1) Immunosenescence changes in nonadaptive immunity, chronic diseases, medications including polypharmaca, malnutrition, decreased cognitive function, the use of invasive devices and functional impairments increase risk of infections in elderly(1, 8-12). Thereby, elderly people may be more susceptible to gastroenteritis and food-borne infections (8, 9). Moreover, susceptible elderly may live close to each other in closed settings like homes for the elderly and nursing homes, increasing the risk of infections with agents that are introduced via food and/or easily spread from person to person. Recent studies have shown that especially infectious outbreaks of gastroenteritis (GE) are common in nursing homes, causing a great public health burden(2, 7). The spectrum of agents responsible for sporadic epidemic infections ranges from enterotoxins such as *S.aureus*, *Clostridium perfringens*, and *Bacillus cereus* to invasive pathogens, including *Salmonella spp*. and *Shigella*. (7, 13-16) Many outbreaks have been attributed to viral agents wherein norovirus are the most common cause of GE outbreaks(17-19).

Noroviruses are non-enveloped, single-stranded RNA viruses, belonging to a genus within the *Caliciviridae* family(8, 20). Infection is characterized by diarrhea, vomiting, abdominal pain, malaise and low-grade fever(8, 21, 22). Noroviruses are known for their high attack rate especially in closed settings like hospitals, cruise ships and nursing homes(6, 23-26). In addition, the virus needs a very low infectious dose to cause infection and is highly persistent in the environment(25, 27) . These characteristics contribute to a high number of outbreaks. In addition, noroviruses are highly transmissible, highly resistant to disinfectants, have multiple modes of transmission and affect all age groups, making them a threat for nursing homes and hospitals, not only among residents but also personnel. (8, 20, 28-30)

The environment of nursing homes provides the requisite ingredients for outbreaks of GE. First, the residents of nursing homes have multiple chronic diseases and functional impairments that predispose them to infection. Second, residents share sources of air, food, water, medical care, living rooms and bathrooms, increasing chance of transmission of certain infectious agents among these vulnerable residents. Third, the working procedures within nursing homes, like taking care of personal hygiene of the elderly, may limit the possibility to contain an outbreak of infections(1, 5, 7).

In the Netherlands, the law of Public Health was established to prevent, protect against and control transmission of infectious diseases. According to article 26 of this law, health care institutions with vulnerable residents and numerous person to person contact in closed settings, are obligated to report unusual numbers of sick patients to the municipal health service (GGD). By reporting these affected patients at an early stage to the GGD, these authorities are able to investigate which infectious agent is the causative agent of the infection and assess the severity of the situation. To limit the impact of infections, the GGD takes measures in the field of hygiene, source tracing or by offering vaccinations.

In addition to this notification system, to further improve infection prevention, the Center for Infectious Disease Control (CIb) of the National Institute Public Health and Environment (RIVM), established a surveillance network for nursing homes. This Surveillance Network Infectious Disease Nursing Homes (SNIV) gains insight in occurrence of infectious diseases in nursing homes(31). SNIV, established in 2009, was designed as a sentinel active surveillance network involving elderly care physicians and/or nurse practitioners who weekly report infectious diseases in their nursing home in OSIRIS, a web based-application. These nursing homes serve as sentinels for a nationwide surveillance of infectious diseases in nursing homes. SNIV provides insight into gastroenteritis, influenza like disease, probable pneumonia, urine tract infections and mortality.

It is essential to know to what extend the SNIV nursing homes are able to report GE outbreaks to GGD, and which factors influence these reports. The co-existence of two reporting systems may be considered as a heavy workload by the nursing home personnel. If one system would suffice for the registration of GE outbreaks, one might consider to limit the registration to one reporting system.

Therefore, the aim of this study is to examine how many SNIV GE outbreaks are reported to the GGD, and to create a prediction model to study which factors influence this reporting behavior.

Methods

Design and study population

SNIV started in 2009 with 25 nursing homes as a pilot, and increased to a network of 29 participating nursing homes in 2014. At the start of SNIV, a sample size calculation was performed, indicating that a total of 29 nursing homes would be required to obtain a sufficiently accurate estimate of the national incidence rate of an infectious disease in the Dutch population of nursing home residents. The currently, in 2014, 29 participating nursing homes are considered a cohort reporting outbreaks of GE. For each nursing home the following corresponding GGD was invited for participation in our study:

GGD	**Number of Nursing Homes**
1. West Brabant	5
2. Hollands Noorden	3
3. Hollands Midden	3
4. Zuid Holland Zuid	1
5. Gooi en Vechtstreek	1
6. Zuid Limburg	2
7. Rotterdam - Rijnmond	2
8. Drenthe	3
9. Twente	1
10. Utrecht	1
11. Hart voor Brabant	1
12. Kennemerland	2

A retrospective cohort was performed to examine the correspondence between the outbreaks of GE in SNIV reports and those in the GGD reports. The data was examined at outbreak level.

Data collection

Data from the SNIV was recorded by the nursing homes in OSIRIS. Each year general characteristics are gathered at institutional level; age distribution of residents, resident mix (e.g. somatic, psychogeriatric), size of the facility, size of the wards, availability of private bathroom and/or toilet facilities, interchange of personnel between wards, influenza vaccination uptake among residents and personnel, and availability of infection control protocols. As from 2010, these data are collected online for all nursing homes. To minimize the weekly workload for the participants, a maximum of five infections can be registered in the surveillance. This study focused only on GE outbreaks. Nursing homes were informed about our study and gave permission to use the institution name when approaching the GGD.

Data from the GGD was not directly available. The GGD uses Orion Osiris or HP zone for the registration of infectious diseases outbreaks. In order to get a review of GE reports, the GGD were approached by phone. A short interview was held per GGD, containing the following questions:

1. Are there GE outbreaks reported for (name of nursing home)?
2. What was the causative agent of the outbreak?
3. In case of registered GE report, when was the beginning and the end of the outbreak? If not available, what was the reporting date?

The reported GE outbreaks of the GGD were matched to the reported GE outbreaks of the SNIV based on onset date or reporting date. Matches of both reporting systems were labeled as "GE outbreak reported to GGD" or "GE outbreak not reported to GGD". This new variable was added to the existing dataset of the SNIV.

Measures

The outcome measure was dichotomized, based on whether or not GE outbreaks were reported to the GGD. The variable "GE outbreak" was already generated in the SNIV dataset. GE was defined as one of the following definitions:

1. Loose stool, 3 or more times per day, deviating from normal stool for this person
2. Loose stool combined with one of the following symptoms: fever, vomiting, nausea, abdominal pain, abdominal cramps, blood or mucus in stool.
3. Vomiting combined with two of the following symptoms: fever, nausea, abdominal pain, abdominal cramps, blood or mucus in stool.
4. Vomiting three times within 24 hours (without additional symptoms and if vomiting is not associated with drug use.

GE outbreaks were registered on week number level per nursing home. Since nursing homes did not register the end of an outbreak, an outbreak free week was considered as the end of an outbreak.

The following covariates were considered: total number of beds, total number of residents, total number of communal areas, number of care units, exchange of staff, individual room, private toilet, private bathroom, individual GE cases, season of outbreak. (Appendix 1)

Statistical Analysis

We performed univariate and multivariate logistic regression using SPSS software 19.0, to determine the predictors for "GE outbreak not reported to the GGD". All covariates were included in a univariate model as well as a backward selection model for multivariate analysis to create a prediction model. Since GE outbreaks within the same nursing home were likely to be more similar to each other than they were to GE outbreaks in other nursing homes, we additionally performed a sub-analysis with mixed effects logistic regression to check for clustering effect. Due to the small sample size of this

study, a p value <0.10 was considered statistically significant, and 0.10<p value<0.15 was considered borderline significant.

Results

Of 29 participating nursing homes, a total of 17 reported outbreaks of GE, and were included in this study. We examined to which extend these 17 SNIV nursing homes report GE outbreaks to a total of 12 corresponding GGD's.

Baseline characteristics for each nursing home and characteristics of GE outbreaks are shown in Table 1. Out of the 68 SNIV registered GE outbreaks, 45 (66.2%) outbreaks were not reported to the GGD . The average duration of a GE outbreak for all nursing homes was 1.69 weeks (median:1, minimum:1, maximum:8, range:7).

Univariate logistic regression resulted in significant ($p<0.10$) covariates predictive of not reporting outbreaks to the GGD: higher number GE cases per week (OR=1.10; 95% CI: 0.98-1.23; p=0.09), personnel working at multiple departments (OR=0.14; 95% CI: 0.04-0.53; p=0.00) and higher proportion of the residents having their own room (OR=0.59; 95% CI: 0.36-0.96; p=0.03). Of borderline significance was higher number of shared areas, with an OR of 0.92 (95% CI: 0.83-1.02; p=0.11) (Table 2).

All covariates, including those not statistically significant in univariate analysis, were included in a backward selection model for multivariate analysis. This model identified 5 covariates predictive of *not* reporting GE outbreaks to the GGD: higher number of beds (OR=1.02; 95% CI: 0.99-1.04; p=0.07), personnel working at multiple departments (OR=0.11; 95% CI: 0.02-0.53; p=0,00), higher proportion of the residents having their own room (OR=0.40; 95% CI: 0.20-0.83; p=0.01) and higher proportion of the residents having their own toilet/bathroom (OR=2.80; 95% CI: 1.22-6.40; p=0.02). Of borderline significance was higher number GE cases per week with an OR of 1.09 (95% CI: 0.98-1.22; p=0.11) (Table 2).

Table 3 shows the sub analyses of univariate and multivariate logistic mixed regression accounting for clustering effects in the data, which may exist due to the fact that outbreak reporting may differ between nursing homes for reasons not measured in this study. The multivariate logistic mixed regression model provided the same covariates, except for GE cases per week, this covariate did not remain statistically significant . The likelihood – ratio test of this latter model provided a p-value of 0.44., indicating no significant difference between the logistic regression model and the mixed effects logistic regression model, and thereby no significant clustering effect.

Tabel 1. Characteristics of nursing homes and GE outbreaks not reported to GGD.

Province	VPH code[1]	Beds	Rooms[2]	Care units	Room[3] (%)	Toilet[3] (%)	Bathroom[3] (%)	GE outbreaks			GE cases	Length of outbreak (Mean)[6]
								Not reported to GGD	Total GE outbreaks	Not reported to GGD (%)		
Drenthe	*VPH2402*	176	3	9	>75	<25	<25	2	4	50	67	2
	VPH9474	100	16	6	25-50	<25	<25	3	5	60	57	2.2
	VPH5637	179	1	7	>75	<25	<25	4	4	100	35	2.5
Noord-	*VPH9847*	74	14	13	>75	>75	>75	2	2	100	7	1
Holland	*VPH8940*	106	5	4	>75	<25	<25	6	6	100	56	2
	VPH9079	195	3	6	50-70	<25	<25	9	11	82	149	1.7
Noord-	*VPH5272*	199	20	3	>75	<25	<25	4	4	100	30	1
Brabant	*VPH2500*	152	10	5	>75	>75	>75	0	2	0	16	1
	VPH0056	58	3	2	>75	50-75	50-75	1	2	50	2	1
	VPH0851	113	3	3	>75	25-50	25-50	1	9	11	127	1.9
Overijssel	*VPH1980*	203	5	17	>75	<25	<25	0	1	0	5	1
Zuid-	*VPH8716*	32	6	4	>75	<25	<25	1	1	100	10	2
Holland	*VPH6688*	132	5	2	<25	<25	<25	2	2	100	4	1
	VPH7470	60	4	2	<25	<25	<25	2	3	67	42	1
	VPH1418	91	1	2	>75	50-75	50-75	0	1	0	15	2
	VPH0301	130	9	3	>75	50-75	50-75	8	10	80	110	1.5
	VPH2680	179	1	5	50-75	50-75	50-75	0	1	0	20	2
Total								**45** (66.2%)	**68**			1.6

([1]code of nursing homes, [2]shared rooms, [3]percentage of residents with own room, toilet or bathroom, [4]mean length of GE outbreaks in weeks)

Tabel 2. Odds ratio (OR), 95% confidence intervals (95% CI) and p-value for independent associations between different variables and the reporting behavior of nursing homes, as found in a multivariate logistic regression model.

				Univariate analysis			Multivariate analysis		
		N	%	**OR**	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**
Covariates									
Season	*High Season*	13	19.1	1					
	Low Season	55	80.9	1.19	0.32-4.37	0.80			
GE_cases_week		448	-	1.10	0.98-1.23	0.09*	1.09	0.98-1.22	0.11*
Number of beds		10.032		1.001	0.99-1.02	0.39	1.02	0.99-1.04	0.07*
Size nursing home (number of residents)	*Small <164*	33	48.5	1					
	Big >=164	35	51.5	1.78	0.64-4.94	0.27			
Total of personnel		11.136	-	1.00	0.99-1.00	0.30			
Rooms		443	-	0.92	0.83-1.02	0.11*			
Number of care units		347	-	1.14	0.94-1.38	0.19			
Personnel working at 1 department	*Yes*	25	36.8	1					
	No	38	55.9	0.14	0.04-0.53	0.00*	0.11	0.02-0.53	0.00*
Own Room		-	-	0.59	0.36-0.96	0.03*	0.40	0.20-0.83	0.01*
Own toilet/bathroom		-	-	1.30	0.78-2.16	0.31	2.80	1.22-6.40	0.02*
Uniform	*Yes*	23	33.8	1					
	No	18	26.5	0.44	0.21-1.57	0.2			

***statistically significant (p<0.10), p value of 0.11 was considered borderline significant.**

Tabel 3 Odds ratio (OR), 95% confidence intervals (95% CI) and p-value for independent associations between different variables and the reporting behavior of nursing homes, as found in a multivariate mixed effects logistic regression model.

				Univariate analysis			Multivariate analysis		
		N	%	**OR**	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**
Covariates									
Season	*High Season*	13	19.1	1					
	Low Season	55	80.9	1.01	0.17-5.47	0.99			
GE_cases_week		448	-	1.10	0.98-1.25	0.09*			
Number of beds		10.032		1.01	0.98-1.03	0.60	1.02	1.00-1.04	0.07*
Size nursing home (number of residents)	*Small <164*	33	48.5	1					
	Big >=164	35	51.5	1.64	0.17-15.64	0.67			
Total of personnel		11.136	-	1.00	0.99-1.01	0.50			
Rooms		443	-	0.91	0.77-1.1	0.30			
Number of care units		347	-	1.12	0.82-1.53	0.48			
Personnel working at 1 department	*Yes*	25	36.8	1					
	No	38	55.9	0.13	0.02-0.74	0.02*	0.12	0.02-0.57	0.01*
Own Room		-	-	0.89	0.54-1.49	0.67	0.34	0.18-0.83	0.02*
Own toilet/bathroom		-	-	1.03	0.68-1.56	0.87	2.69	1.12-3.25	0.02*
Uniform	*Yes*	23	33.8	1					
	No	18	26.5	0.79	0.61-1.01	0.06*			

***statistically significant (p<0.10)**

Discussion

This study revealed that over half of the GE outbreaks in SNIV nursing homes were not reported to the GGD. These findings underscore the need of more support and guidance for nursing homes in reporting GE outbreaks to the GGD, especially since nursing homes are obliged to report GE outbreaks according to the Dutch Public Health law. It must be noted that the end of a GE outbreak was self-defined in this study as an outbreak-free week. However, nursing homes might consider an outbreak starting after an outbreak-free week as the same outbreak. This may be explained by the short mean duration of an outbreak (1.6 weeks).

The following predictors of not reporting GE outbreaks to the GGD were identified: i) higher number of GE cases per week; ii) higher number of beds; iii) personnel working at multiple departments; iv) proportion of the residents having their own room; and v) proportion of the residents having their own toilet/bathroom. With respect to the higher number of GE cases per week, the odds of not reporting a GE outbreak to the GGD was 1.09 greater for each extra GE case per outbreak week. Each nursing home differs in the way when they define GE cases as an outbreak. Nursing homes might not consider all GE cases as an outbreak and therefore not reported to the GGD.

With respect to the higher number of beds, the odds of not reporting a GE outbreak to the GGD was 1.02 times higher for each extra bed. Nursing homes with a higher number of beds have more residents which increases the potential risk of transmission of GE. In order to control the spreading of infectious diseases, these nursing homes may handle stricter measures to prevent outbreaks. In addition, large nursing homes often have more specialized staff with more knowledge of prevention of infectious diseases. It could be the case that these nursing homes do not see the need of also reporting GE outbreaks to the GGD since they are most likely to get outbreaks under control by themselves, making them more prone to not reporting GE outbreaks to the GGD.

The odds of not reporting a GE outbreak to the GGD was 0.11 times lower if personnel worked at multiple departments, compared to those where personnel worked at only one department. It is possible that personnel with a more dynamic work environment exchange more information between each other, which could also relate to sharing knowledge about the importance of reporting GE outbreaks to the GGD.

The odds of not reporting a GE outbreak to the GGD was 0.40 times lower for each extra 25% of the residents having their own room. This may be explained by the fact that having an own room decreases the chance of contact with infected residents, thereby reducing the risk of transmission of GE. It is also possible that these nursing homes are more modern and may handle stricter measures and may be more aware of regulations concerning the importance of reporting GE outbreaks to the GGD.

Finally, for each extra 25% of the residents having their own toilet/bathroom, the odds of not reporting GE outbreaks to the GGD was 2.80 times greater than reporting a GE outbreak to the GGD.

Residents with a personal toilet/bathroom in their room are probably less likely to contaminate other residents with GE, resulting in less uncontrollable situations. Considering this fact, such nursing homes may consider themselves capable of managing outbreaks with their own protocols and not entail the necessity of reporting these GE outbreaks to the GGD.

In 2005, the Dutch Inspection for Health Care (IGZ) indicated that there is hardly any crisis management in nursing homes and residential homes. The IGZ investigated the degree of underreporting by nursing homes and residential homes, and the determinants associated with it, in the GGD Hart voor Brabant. This study showed that there is indeed an underreporting of infectious diseases in nursing homes and residential homes. In addition, lack of work instructions, lack of registration systems and lack of regular meetings of infectious diseases in nursing homes and residential homes were found to cause this underreporting(32).

The GGD Zuid-Holland West performed a similar study, and looked into the practical implementation of the reporting of outbreaks in medical and non-medical institutions. They indicated that residential homes are more prone to underreporting than nursing homes. This underreporting is caused by confusion about who the responsible carrier is for reporting outbreaks to the GGD. The head of a residential home does not receive all medical information of the residents, which increases the chance of unreported outbreaks(33).

Internationally, the underreporting of infectious diseases varies per country. The study of Haagsma et al (2013) reconstructed a surveillance pyramid for seven pathogens in seven European Union member states. The degree of under-diagnosis and underreporting varied by pathogen and country. Underreporting and under-diagnosis were low for Germany, Sweden, Denmark, The Netherlands, UK Italy and Poland. These varying degrees of underreporting and under-diagnosis are explained by differences in healthcare usage and differences in laboratory practice(34). Haagsma et al (2013) underscore the international problem of underreporting and highlights the need of more guidelines and control in reporting infectious diseases.

This study gained insight into the missing part of the “surveillance pyramid”, a model used to illustrate steps that must occur for an episode of illness in the population to be registered in surveillance(35, 36). Our findings can be applied to improve the estimates of the real number of GE outbreaks in nursing home populations, and the disease burden that comes with it. In addition, GGD’s could promote informing nursing homes about the importance of reporting GE outbreaks, in order to help them improve their protocols for controlling GE outbreaks.

For the purpose of the analyses of this study, the results can be considered robust since two separate analyses resulted in similar findings. Since clustering effect of the data was checked and found not necessary to be taken in to account, the predictors found here are more likely to differ between outbreaks rather than between nursing homes. This offers opportunity for intervention, since apparently outbreak characteristics influence reporting behavior.

A potential limitation of this study is the solely focus on reported GE outbreaks in SNIV that were known to the GGD. In order to learn more about the missing part of the surveillance pyramid, one might consider to look at the GE outbreaks reported to the GGD and not registered in the surveillance system of SNIV. Given the lack of time in our study, we were not able to investigate factors that influence the underreporting of GE outbreaks to the GGD. The factors influencing underreporting, that were found by the study of the IGZ (2005), might be applicable to our findings. However, more research is necessary to gain insight in determinants causing underreporting in SNIV nursing homes(32).

Furthermore, the power of this research was low due to the fact that there were only 68 outbreaks registered, combined with the fact that the SNIV data were incomplete. Prior to participation in the SNIV project, each nursing home is asked to fill in an form regarding characteristics of the nursing homes. These forms occasionally contain blank boxes, probably because nursing homes not always have the required knowledge to fill in the form completely. As a result, not all variables of the SNIV data could be included, possibly there are more indicators for not reporting GE outbreaks to the GGD than this study indicates. This shows that these forms may need to be adjusted and that nursing homes may need assistance when filling in a form.

Another finding of this study was that in univariate analyses most of the variables were not statistically significant, both for logistic regression and mixed effects logistic regression. However, this changed when adding these variables together in multivariate analyses, indicating potential correlation or interaction. Moreover, in multivariate analyses with mixed effects logistic regression, the variable GE cases per week was not significant any more.

In conclusion, our analyses revealed underreporting of outbreaks of GE in nursing homes to GGDs. Since the outbreaks were reported to SNIV, they were recognized as such by nursing home personnel, indicating a potential information gap that may be filled by the GGD. With this information the GGD and RIVM may be able to improve their policies regarding the reporting of GE outbreaks. Further research, including qualitative aspects, will be necessary in order to obtain more information about factors that influence the reporting behavior of nursing homes. Since surveillance systems are simple in structure to keep the work load low, such systems are not sufficient in providing this detailed or qualitative information.

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