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Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Epidemiology and impact of norovirus outbreaks in Norwegian healthcare institutions, 2005–2018

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ARTICLE INFO

Article history:

Received 11 September 2018

Accepted 18 June 2019

Available online 22 June 2019

Keywords:

Norovirus

Public health surveillance

Disease outbreaks

Health facilities



SUMMARY

Aim: The aim of this study was, for the first time, to describe in detail the epidemiology and impact of norovirus outbreaks in healthcare institutions (HCIs) in Norway to identify areas which may improve outbreak response.

Methods: An analysis of all reported norovirus outbreaks in hospitals and long-term-care facilities (LTCFs) was carried out from week 34, 2005 to week 33, 2018. Seasonality, symptoms and number of cases among personnel and patients were described.

Findings: A total of 20,544 cases, including 7044 healthcare personnel were reported in 965 outbreaks; 740 from LTCFs and 225 from hospitals. Median number of cases per outbreak was 15, interquartile range (IQR) 8–25 in LTCF; and 17, IQR 10–28 in hospitals. All regions reported outbreaks, with one-third of the municipalities having at least one outbreak in LTCFs during the study period. The start of the outbreak season happened almost four weeks earlier in hospitals than in LTCFs. The estimated average number of working days lost for healthcare personnel per year ranged from 1590 to 1944.

Conclusions: Norovirus outbreaks in Norwegian HCIs appears to have a substantial impact on both hospital and LTCFs all over Norway, especially during the winter months. That up to half of all cases were healthcare professionals emphasizes a need for further focus on infection control. Our results suggest that hospitals, affected first, could alert LTCFs in the area in order to prevent further outbreaks.

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Introduction

Outbreaks in healthcare settings affect vulnerable populations, disrupt normal routines and may spread to other healthcare institutions (HCIs). Outbreaks can be limited in

extent by good routines for detection, management of cases and other infection-control measures [1]. Norovirus infection is most often seen in the winter months and is a common cause of outbreaks in HCIs [2] as it has a low infectious dose, short incubation period, and symptoms such as diarrhoea and vomiting which facilitate spread. Symptoms normally lasts around one to three days, but can be longer in hospital patients [3]; and in this type of setting, infection can lead to slower recovery from other illness and even death [4]. Norovirus can

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be divided into several genogroups and genotypes [5]. Genogroup II genotype 4 is the most prevalent genotype globally [6] as well as in the Nordic countries [6]. There is no vaccine and immunity is not well understood; at best it is strain-specific but probably only partial and shortlived as the virus readily undergoes mutation [7,8]. Humans are the only reservoir of the virus and spread of the infection in outbreaks is particularly difficult to control because of the low infectious dose, its stability in the environment and efficient transmission by person-to-person contact and exposure through contaminated surfaces [9]. Norway has national recommendations on norovirus infection in long-term-care facilities (LTCFs) in which the most important measure is isolation or cohort nursing of sick residents. Exclusion of sick staff until 48 h after they are symptom free is also recommended [10]. In a hospital setting, the infection-prevention-control unit will have local procedures. There are around 60 hospitals and 950 LTCFs in Norway [11]. The responsibility for management of local outbreaks lies within the hospital or with the community medical officer (one in each of the 422 municipalities) for outbreaks in LTCFs. All suspected outbreaks in Norwegian HCIs, regardless of the causative pathogen, should be alerted by law to relevant actors, including the Norwegian Institute of Public Health (NIPH), to facilitate communication and response [12,13]. The aim of this study was to describe, for the first time, the epidemiology and impact of these outbreaks in order to identify areas which may improve outbreak response.

Methods

Study design

An analytical study was conducted of all norovirus outbreaks in HCIs reported in Norway.

Data source

Upon suspicion of an outbreak in an HCI, the hospital or the municipal doctor are responsible for alerting the County Governor and the NIPH, as well as the Regional Centre for Infection Control (if in a hospital). Alerting is carried out online and standard reports are stored in a database administered by NIPH. The outbreak report form covers general information about the outbreak: place, date of onset of first and last case, main symptoms, suspected causative agent, laboratory testing, number of persons exposed, number of cases hospitalized or dead, whether the outbreak is over. Specifically, for outbreaks in healthcare institutions, information about number of cases amongst staff is collected. The web-based outbreak alert system is described in detail elsewhere [14]. To ensure that the information about the outbreak is updated, a reminder is generated after three weeks. For this study, data were extracted from week 34 in 2005 to week 33 in 2018 from the Norwegian web-based outbreak alert system.

Definitions

A norovirus outbreak was defined as an alert with either (a) norovirus as suspected causative agent or (b) diarrhoea and/or vomiting as main symptoms with an unknown suspected agent.

The epidemiological year was defined to be from Monday in week 34 to Sunday in week 33 the following year and the start of an outbreak as the indicated date of symptom start of the first case. The start of the season for each epidemiological year was defined as the date 25% of all outbreaks had occurred in hospitals and LTCFs, respectively. The peak of the epidemiological year was defined as the week with the highest five-week moving average number of outbreaks. If more weeks in an epidemiological year had the same maximum value, the first was chosen.

Data analysis

Key variables were described, including date of onset and main symptoms, number of cases among personnel and patients, number of deaths, and laboratory testing. The median number of cases was compared in hospitals, LTCFs, and by symptom using quantile regression (qreg). To test for trends over time in the number of reported outbreaks each epidemiological year and cases affected in each outbreak a negative binomial regression (nbreg) was used. Pearson's correlation coefficient was used to measure whether there was a linear correlation between number of cases in an outbreak and length of the outbreak.

Workdays lost

To calculate number of workdays lost due to norovirus outbreaks in HCI, one day of illness and two days home in 'quarantine' before returning to work was assumed. In order to take into account that the patient or resident:healthcare-staff ratio of the cases was not specified in all outbreaks, the patient or resident:healthcare-staff ratio was applied in hospitals and LTCFs, respectively, from outbreaks where it was specified and a $\pm 10\%$ interval was added. In alerts where the number of staff was not specified, but the number of patients or residents was specified, it was assumed that no staff had become ill.

Timing

To look at timing of the seasons in hospitals and LTCFs, the time in days was calculated from Monday in week 34 in a given epidemiological year to the date of onset for the first case of each outbreak, and the 25th percentile of all outbreaks for each epidemiological year was calculated – as a proxy for the start of the season – and type of institution. To evaluate whether the outbreak seasons happen simultaneously in hospitals and LTCFs, the number of days to the start of the season (25th percentile) and the Monday in the peak week according to the five-week moving average of each season using was calculated Wilcoxon rank-sum test.

Human subject protection

Alerts describe the outbreak and contain aggregated information.

Results

From week 34 in 2005 to week 33 in 2018, 965 outbreaks were reported, 740 (77%) from LTCFs and 225 from hospitals.

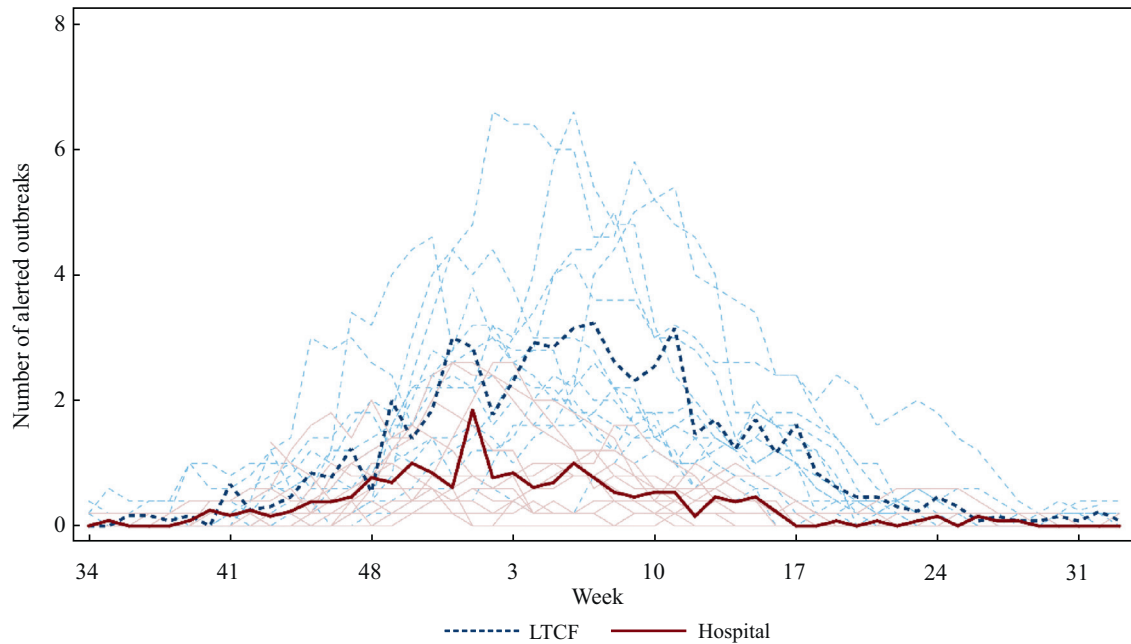


Figure 1. Average weekly number of reported outbreaks 2005/2006 to 2017/2018 (bold lines) and five-week moving average number of reported outbreaks by epidemiological year (faded lines) in Norway, by healthcare institution. LTCF, long-term-care facility.

The number of reported outbreaks peaks during the winter months (Figure 1). The number of outbreaks per epidemiological year in hospitals and LTCFs fluctuated during the period (Figure 2). Of the 965 alerted outbreaks, norovirus was the suspected agent in 96%, the remaining 4% were alerted as viral or unknown suspected agent with diarrhoea and/or vomiting as main symptoms. In 67% of outbreaks a faecal sample had been sent for laboratory verification, 80% of these were confirmed as norovirus when the outbreak was alerted or updated.

Extent

During the 13 epidemiological years study period, 20,544 cases, including 7044 healthcare personnel were reported to be affected by norovirus outbreaks. The estimated yearly number of workdays lost amongst healthcare personnel, assuming a minimum of one day sick and two days home in quarantine before returning to work with a $\pm 10\%$ interval, varied from 1590 to 1944.

In 67% of the outbreaks, symptoms lasted one to three days. Diarrhoea and/or vomiting were the main symptoms in 99% of

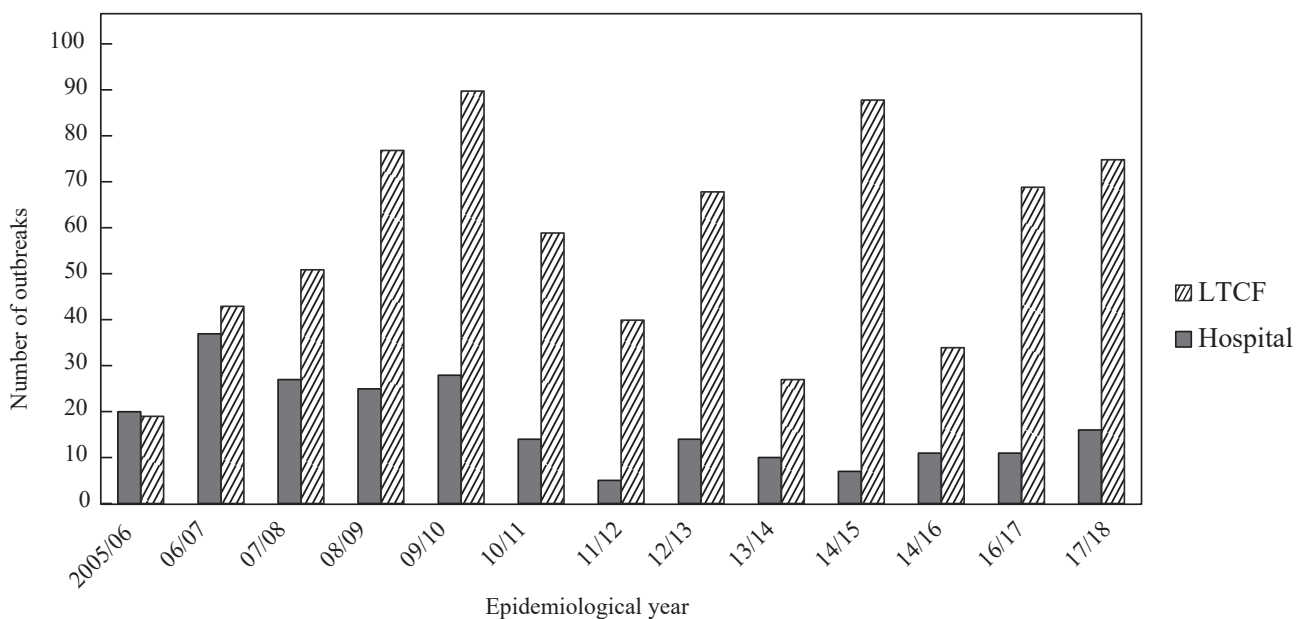


Figure 2. Number of norovirus outbreaks reported per epidemiological year, 2005/2006 to 2017/2018, by type of healthcare institution (hospitals and long-term-care facilities (LTCFs)).

Table 1

Median number of total cases and healthcare personnel in norovirus outbreaks by type of healthcare institution

	Total number of cases			Number of personnel	
	Median	IQR	Maximum	Median	IQR
LTCF	15	8–25	126	5	2–11
Hospital	17	10–28	290	8	5–15

IQR, interquartile range; LTCF, long-term-care facility.

outbreaks. The median number of people reported ill was 15 in LTCF and 17 in hospitals (Table 1). The median number of people reported ill was lower in outbreaks without vomiting ($N = 87$) as one of the main symptoms (nine cases) compared with outbreaks with vomiting ($N = 875$) amongst the main symptoms (16 cases), $P < 0.001$.

Information about date of onset for the last case was available for 79% of outbreaks which had been reported to be over ($N = 482$ outbreaks). The median number of days from first to last case was eight days (interquartile range (IQR) 5–16) for LTCFs and 10 (IQR 5–20) in hospitals. The number of cases in an outbreak and the length of the outbreak was positively correlated (Pearson's correlation coefficient = 0.62). Food was the suspected source of transmission in 25 outbreaks (2.7%).

For outbreaks in LTCFs, 72 cases (0.91%) were reported to have been admitted to hospital; another 53 (0.67%) were reported to have died because of their norovirus infection. Ten (0.40%) cases in the hospital outbreaks died as a result of their norovirus infection.

The start of the season (25th percentile of outbreaks) happened earlier in hospitals than LTCFs in nine of 13 epidemiological years. Over the 13 epidemiological years, the median start of the season at the national level was 27 days earlier in hospitals than in LTCFs, $P = 0.03$. The peak of reported outbreaks happened earlier in hospitals compared with LTCFs in 10 epidemiological years, and the median over the 13 epidemiological years was seven weeks earlier, $P = 0.006$.

The 740 norovirus outbreaks reported from LTCFs were reported from 159 of the 422 municipalities in Norway (Figure 3). When looking at all reported outbreaks of any type in an LTCF, 24 additional municipalities (total 183) had reported at least one outbreak during the period.

Discussion

This study shows that norovirus outbreaks pose an important burden for HCIs all over Norway, especially in the winter months. In addition to affecting an already vulnerable population, this study shows that these outbreaks indeed also impact on the internal workflow and resources, with a conservative estimate of around 1800 days of absenteeism per year due to these outbreaks, during which staff would have to be covered for by other internal or external healthcare staff.

Surveillance of norovirus outbreaks exists in Germany and Scotland. In Germany, reporting of norovirus outbreaks in HCIs has been mandatory since 2001. In contrast to what is seen in Norway, outbreaks were smaller (median nine cases vs 15 in this study) and around 80% of norovirus outbreaks were reported from hospitals (vs 23% in this study) during the first 12

months after introduction of the system [15]. Varying ways of counting interdepartmental outbreaks, better collaboration with the local level or under-reporting from hospitals may explain this. In Scotland, surveillance of ward closures due to norovirus infection has been in place since October 2017. From then until week 26, 2018, 219 wards or bays have been closed due to confirmed or suspected norovirus [16]. This is markedly more than the 16 reported outbreaks in hospitals in Norway 2017/18, in a population of similar size. The occurrence of norovirus outbreaks has also been studied prospectively; Curran *et al.* [17] aimed to identify the index cases of norovirus outbreaks in the UK and Ireland in 54 acute and non-acute healthcare centres; only five out of the 54 included centres did not experience any outbreak during one winter. Also, Lopman *et al.* found that 171 inpatient units, had on average 1.3 gastroenteritis outbreaks in the 1-year follow-up period. Of these, 63% were caused by norovirus [2].

It was seen that a small proportion of residents at LTCFs were admitted to hospital during norovirus outbreaks. This may be necessary in severe cases despite the risk of spread from one institution to the next. Our results suggest that hospitals are affected by norovirus outbreaks earlier in the epidemiological year than LTCFs. Potentially because there is a greater influx of patients from the community, where norovirus circulates, to and from hospital than between the community and LTCFs as also suggested by Sadique *et al.* [18]. This finding, however, could only be evaluated on the national level, as the number of reported outbreaks is low. That the start of the outbreak season seemed to start earlier in hospitals than in LTCFs, at least at the national level, suggests an opportunity that with improved communication, hospitals could alert LTCFs within the same area in order to prepare for the outbreak season and limit the extent of further outbreaks.

Slightly more cases were seen amongst healthcare staff in hospitals compared to LTCFs, though no information about the number of healthcare staff at risk during the outbreaks is available. The patient or resident:healthcare-staff ratio varies with the level of care needed and type of department and will most often be higher in hospitals. Whether this explains the slightly higher proportion of staff affected in hospital outbreaks is unknown. Nevertheless, healthcare staff do represent a big proportion of cases in the reported outbreaks, indicating a need for improved compliance with infection prevention and control measures. Outbreaks are an economic burden for HCIs, both as infected staff need to be covered for during illness and 'quarantine' and cohort nursing may require extra staff.

The relatively high number of people infected during an outbreak underscores the infectiousness of norovirus and norovirus can serve as a worst-case scenario for introduction of other, more virulent, person-to-person transmitted pathogens into HCIs. With the current information captured in the alert system, it was not possible to assess the extent to which national recommendations were followed and/or which infection prevention control procedures are in place locally. But the high number of people infected do suggest a potential for limiting spread, for example by having systems and routines in place before outbreaks happen, as advised in the national recommendations.

Even though NIPH routinely promotes the web-based outbreak alert system and teaches outbreak management, both at the regional and national level, in order to strengthen local capacity and encourage the use of the alert system, under-

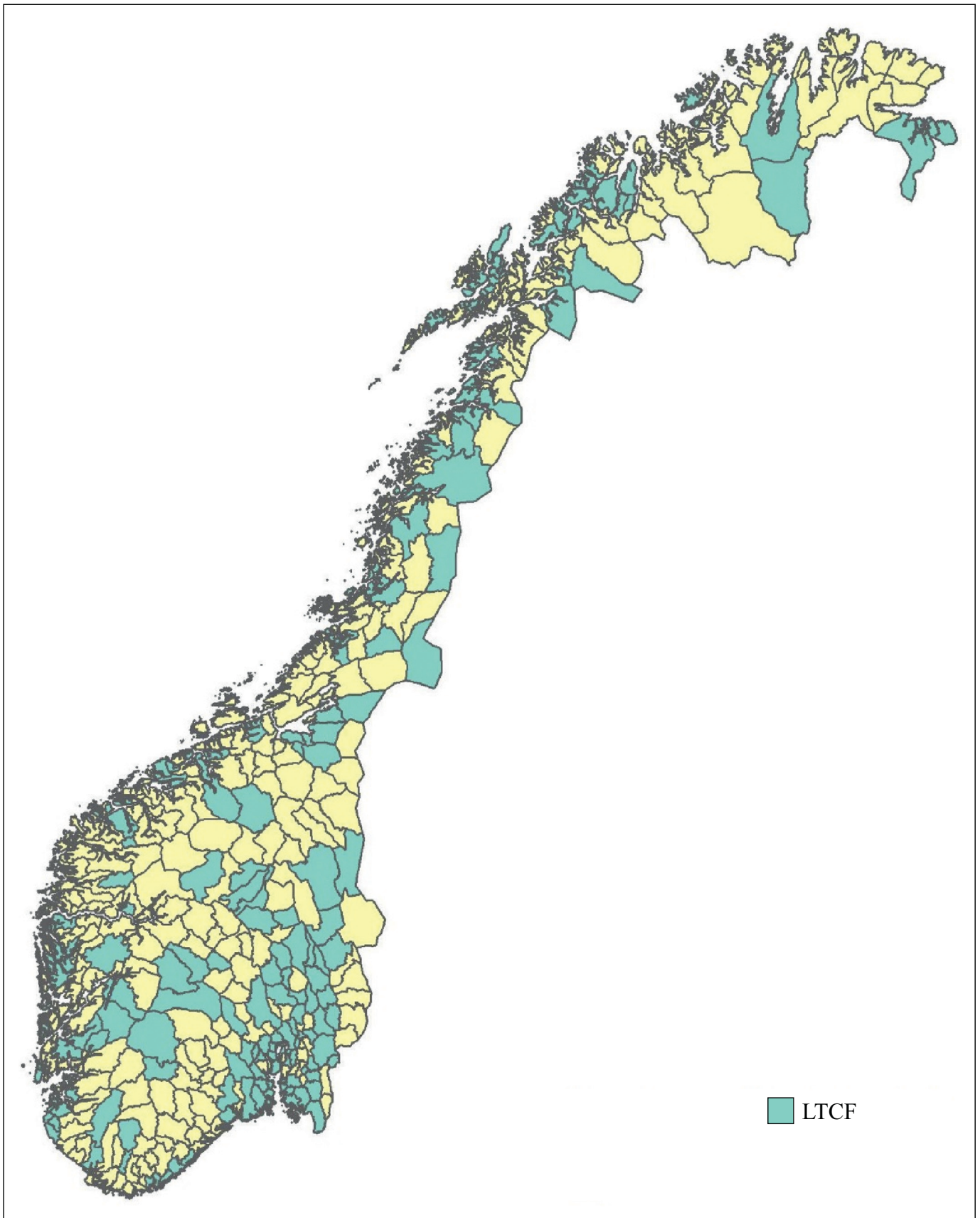


Figure 3. Municipalities with at least one norovirus outbreak reported in a long-term-care facility (blue shading), 2005/2006 to 2017/2018.

reporting is still apparent. If the under-reporting of outbreaks reflects a lack of awareness concerning outbreak management, or a lack of communication between the LTCF and the municipal doctors about ongoing outbreaks, it is worrying. The alert system serves to alert relevant stakeholders so that outbreak support and advice can be given in an early phase. The alert system can also be used for statistical purposes to get a national overview of outbreaks which will facilitate targeted capacity building, guideline development and communication messages in order to increase awareness and investigate whether there are any changes in trends.

Limitations

This study has three main limitations: the sensitivity of the norovirus outbreak definition and under-reporting of number of outbreaks and number of cases in each outbreak. Classification as a norovirus outbreak is dependent on local definitions. The infection prevention measures for diarrhoea and vomiting are the same for all the common pathogens in this setting. Samples were submitted for testing in two thirds of the outbreaks and most were confirmed as norovirus at the time of reporting or updating. Information about the genotypes of the isolated strains from each outbreak or of dominant strain of the season was not available. For this reason, it was not possible to evaluate the effect of the genotype.

Concerning under-reporting, the number of outbreaks notified through the outbreak alert system and reported here, most likely represent only a proportion of all norovirus outbreaks occurring in Norwegian HCIs. Although outbreaks were reported from all parts of Norway, some areas had not reported any outbreaks of any kind during the 13-year study-period.

The alert system is used for the mandatory alerting of suspected outbreaks. Reporting should happen as soon as the outbreak is suspected and before the full extent of the outbreak is known. Even though the system sends a reminder to update the details about the outbreak, including the case numbers, three weeks after the initial alert, some under-reporting of the extent of each outbreak is expected.

This is the first comprehensive description of norovirus outbreaks in HCIs in Norway. Even though the analyses revealed under-reporting that is unlikely to reflect the real epidemiology, this study clearly shows that these outbreaks affect both hospital and LTCFs all over Norway. Norovirus infection may delay medically important procedures and recovery, but also presents a major challenge to the functional ability of an HCI and its resources as up to one-half of cases were healthcare personnel.

It is recommended that NIPH promotes the outbreak alert system to increase reporting and improve the quality of the data and strengthen local capacity for outbreak management and general infection control. It is also recommended to investigate possibilities for improving communication between hospitals and LTCFs regarding when the norovirus season starts and progresses, for hospitals and LTCFs to be prepared and to take early action to prevent and limit further spread.

Conflict of interest statement

None declared.

Funding sources

This work was funded by the Norwegian Institute of Public Health.

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