Residents had an Increasing Risk of Norovirus Gastroenteritis Infection Than Health Care Workers During an Outbreak in a Nursing Home

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Objectives: To study norovirus gastroenteritis infection among residents and health care workers (HCWs) during an outbreak in a nursing home by investigating the attack rate and positive diagnostic rate for norovirus by reverse transcription–polymerase chain reaction (RT-PCR).

Methods: All members in a Chang Gung Memorial Hospital–affiliated nursing home from November 17, 2006, to November 25, 2006, including 236 residents and 125 HCWs, whose available medical records were available were consecutively included in the retrospective analysis. Fecal specimens of symptomatic residents and HCWs were tested for norovirus by RT-PCR. In addition, routine stool analysis and a stool culture study were conducted to identify the bacterial and parasitic agents. The fecal specimens of asymptomatic residents and HCWs were tested only for norovirus by RT-PCR.

Results: The outbreak was controlled within 9 days during the outbreak period. There were 51 symptomatic cases, 41 residents and 10 HCWs, during the norovirus outbreak. The odds ratio (OR) of the attack rate in the residents was approximately 2.4 times higher than that in the HCWs (OR: 2.4; 95% confidence interval [CI]: 1.2–5.0; \( P = .015 \)). Norovirus was detected in 59 (30.6%) of 193 residents and in 11 (10.5%) of 105 HCWs who provided stool specimens for the study by RT-PCR. The OR of the positive diagnostic rate for norovirus by RT-PCR in the residents was approximately 3.8 times higher than that in the HCWs (OR: 3.8; 95% CI: 1.9–7.5; \( P < .001 \)).

Conclusions: During an outbreak of norovirus gastroenteritis in a nursing home, the infection can be easily transmitted from person to person and affects both residents and HCWs. In addition, residents had a higher risk of norovirus gastroenteritis infection than HCWs. (J Am Med Dir Assoc 2010; 11: 592–597)

Keywords: Norovirus; outbreak; nursing home
Norovirus-induced acute gastroenteritis is usually self-limited; however, it may be life-threatening owing to frailty and age. Hence, the management of a norovirus outbreak in a nursing home with senile and frail residents presents many challenges. Residents in nursing homes are thought to be more easily infected with norovirus and become diseased more easily than health care workers (HCWs); however, supporting data are limited. Norovirus gastroenteritis infection is defined as the presence of norovirus in stool samples and/or the presence of clinical symptoms of norovirus gastroenteritis. In this outbreak, nearly all residents and HCWs provided stool specimens for the investigation of norovirus by reverse transcription–polymerase chain reaction (RT-PCR).

Our data indicated a higher attack rate and positive diagnostic rate for norovirus by RT-PCR in a Chang Gung Memorial Hospital (CGMH)-affiliated nursing home during an outbreak of norovirus gastroenteritis.

METHODS

Setting

The site of the outbreak was a 300-bed nursing home for the elderly and chronically ill affiliated with a medical center, CGMH. On average, regular residents occupied 78% of the 300-bed facility and the actual number of residents on November 17, 2006, was 236. Nearly 83% of all residents had disabilities in activities of daily living (ADLs) and those residents requiring 1 or more tube feedings, Foley insertion, or chronic tracheotomy comprised 63%.

Outbreak Definition

Diagnosis of infectious gastroenteritis was based on criteria established by the Centers for Disease Control (CDC) in Taiwan. Norovirus gastroenteritis infection was defined as the presence of norovirus in stool samples and/or the presence of clinical symptoms during a specific time period attributable to norovirus gastroenteritis. We identified norovirus as the only causative agent of the gastroenteritis outbreak. The causative contagious pathogen norovirus was identified by RT-PCR assay. The laboratory test results were negative for other possible causative agents.

Patients and Microbiologic Investigation

All residents and HCWs, whether symptomatic or asymptomatic, including 236 residents and 125 HCWs in the CGMH-affiliated nursing home were consecutively included in the analysis. A total of 193 (81.8%) of 236 residents and 105 (84.0%) of 125 HCWs provided stool specimens for this study. Fecal specimens of asymptomatic residents and HCWs, were tested only for norovirus by RT-PCR.

Microbiologic Methods

RNA extraction

About 0.1 g of stool sample was mixed evenly with 500 μL of transport medium (2% MEM), and centrifuged at 3000 rpm for 5 minutes. RNA isolation by using the auto-extraction system (Magna pure auto-extraction machine, MAGNA Pure, Roche Diagnostics, GmbH, Mannheim, Germany) from the 200-μL supernatant of the centrifuged mixture yielded a total of 50 μL of RNA solution.

Designing of RT-PCR primers

Of the primers, SR33 (5′TGTCAGATCTCATCATCA CC3′), SR46 (5′TGGAATTCCATCGCCCACTGG3′), SR48 (5′GTGAACAGCATAAATCACTGG3′), SR50 (5′GTGAACAGTATAAACACCTGG3′), and SR52 (5′GTGAAACAGTATAAACACCTGGG3′) are designed for RT-PCR and to detect norovirus of differential genotypes (GI and GII); thus, SR33 was used as a forward primer; SR48, SR50, and SR52 as reverse primers of GI; and SR46 as

![Fig. 1](image-url). Onset of 51 symptomatic cases clinically diagnosed as infectious gastroenteritis in a CGMH-affiliated nursing home from November 17, 2006, to November 25, 2006.

![Fig. 2](image-url). Gel electrophoresis of PCR products from real-time PCR run for detection of Norovirus group II. Lane M is the 100 bp of marker; Lane ENC is the negative control; Lane G1 P is the positive control of GI type of norovirus; Lane G2 P is the positive control of GII type of norovirus; the specimens of Lane 2 and Lane 6 are the positive clinical samples of GII type of norovirus.
a reverse primer of GII for reaction separately with GI or GII to gain a product of 123 base pairs (bp).

**Norovirus analysis**

An amount of 25 μL of 1-step RT-PCR reagent mixture (Qiagen, GmbH, Hilden, Germany) containing 5 μL of the virus RNA was for reactions with the GI primers set (SR33, SR48, SR50, and SR52) and GII primers (SR33, SR46). The final concentration of the primers was 0.4 μM for RT-PCR at 50°C for 30 minutes, placed at 95°C for 15 minutes, and then PCR for 40 cycles: at 94°C for 30 seconds, at 52°C for 30 seconds, at 72°C for 1 minute, and at 72°C for 7 minutes. Then 10 μL of final PCR products of 123 bp in length were analyzed by 2% agarose gel electrophoresis.

**Statistical Analysis**

The chi-square test was used to examine whether there were any significant differences. To quantify the extent of risk, we also computed the odds ratio (OR), together with their 95% confidence intervals (CI). All tests were conducted at the conventional 5% level of significance.

**Table 1.** Demographic Characteristics of 51 Symptomatic Cases, 41 Residents and 10 HCWs, Clinically Diagnosed as Infected with Norovirus during This Outbreak

| 51 Cases |  
|----------|----------|
| Residents: 41 | HCWs: 10 |
| Age, mean years ± SD | 77.2 ± 11.2 | 27.6 ± 6.1 |
| Female | 25 (61.0%) | 10 (100.0%) |
| Male | 16 (39.0%) | 0 (0%) |

HCWs, health care workers.

**RESULTS**

**The Outbreak**

From November 17, 2006, to November 25, 2006, there were 51 symptomatic cases at the CGMH-affiliated nursing home that met the definition of infectious gastroenteritis from CDC that affected 41 residents and 10 HCWs (Figure 1). One resident and 2 HCWs who developed symptoms of vomiting and diarrhea on November 17, 2006, were treated as cases of common acute gastroenteritis. An outbreak of infectious gastroenteritis was suspected when another 9 residents and 2 HCWs became ill on November 18, 2006. An epidemiological inspection revealed that 1 symptomatic HCW was regarded as the index case. Thirteen very sick residents with hypovolemic status were hospitalized. Less serious cases were isolated in the nursing home. Enteric isolation of the affected patients was requested, such as their vomitus, residual food, and stools. Meals were no longer served in the kitchen of the nursing home, and all residents received meals in their rooms. No visitors or new residents were permitted into the nursing home.

**Table 2.** Demographic Characteristics in 361 Subjects (including 236 Residents and 125 HCWs) Were Consecutively Included in the Analysis during This Outbreak

| 361 Subjects |  
|-------------|----------|
| Residents: 236 | HCWs: 125 |
| Age, mean years ± SD | 76.0 ± 12.1 | 31.8 ± 8.3 |
| Female | 117 (49.6%) | 107 (85.6%) |
| Male | 119 (50.4%) | 18 (14.4%) |

HCWs, health care workers.
use of running water was encouraged as essential for hand hygiene. Residents and HCWs were also instructed to wash their hands with ethanol-based products such as 75.0% ethyl alcohol and 7.5% iodophors rather than regular soap. All parts of the nursing home building, including residents’ rooms, toilets, bathrooms, floors, nursing stations, and elevators were thoroughly disinfected with sodium hypochlorite 3 times a day. The use of gowns, masks, and gloves was required for HCWs who came into close proximity with residents during the norovirus-associated gastroenteritis outbreak. HCWs suspected of having norovirus gastroenteritis were asked to stop working immediately. The Emergency Department and Infection Control Committee of CGMH was informed of the possibility of contagious gastroenteritis when affected patients were transferred from the nursing home to the CGMH. No new cases were reported after November 26, 2006. The outbreak in the CGMH-affiliated nursing home was completely controlled within only 9 days. A nurse at the CGMH, who was caring for the sick residents who were transferred from the nursing home, was infected with norovirus-associated gastroenteritis, as confirmed by RT-PCR; however, no norovirus gastroenteritis outbreak occurred at the CGMH.

Epidemiological Investigation
An epidemiological inspection revealed that 1 symptomatic HCW was regarded as the index case. The index case had contact with the symptomatic resident and HCW who were sick on November 17, 2006, and her stool tested positive for norovirus by RT-PCR. Other symptomatic cases can be traced to previous contact history with the index case or the index case–associated symptomatic cases. Norovirus is an important causative agent of foodborne outbreaks of gastroenteritis; however, a foodborne outbreak was not the primary route of transmission, as those symptomatic residents and HCWs had not shared food from the same food resource. It was determined that norovirus was transmitted from person to person during this outbreak.

Microbiologic Results
RNA extracted from stool samples was subjected to RT-PCR for detection of norovirus. Identification of the fecal samples from 298 cases was performed using RT-PCR, and 70 cases were detected as positive for GI1 type of norovirus (Figure 2). All stool samples from those symptomatic residents and HCWs were negative for other contagious pathogens, such as Salmonella spp, Shigella spp, Campylobacter spp, and Amoeba spp.

Patients’ Investigation
During the outbreak period, there were 51 symptomatic cases, 41 residents and 10 HCWs, clinically diagnosed as infected with norovirus. The attack rate was 14.1% (51 of 361) in the CGMH-affiliated nursing home, 17.4% (41 of 236) for residents and 8.0% (10 of 125) for HCWs. For the residents in the CGMH-affiliated nursing home, the attack rate was approximately 2.4 times (OR: 2.4; 95% CI: 1.2–5.0; P = .015) higher than for the HCWs during the outbreak of norovirus gastroenteritis (Figure 3; Tables 1 to 3). Norovirus was detected in 59 (30.6%) of 193 residents and in 11 (10.5%) of 105 HCWs who provided stool specimens for the study by RT-PCR. The OR of the overall positive diagnostic rate for norovirus by RT-PCR in the residents was approximately 3.8 times higher than that in the HCWs (OR: 3.8; 95% CI: 1.9–7.5; P < .001) (Figure 3; Tables 4 and 5). Thirteen (31.7%) of 41 symptomatic residents required hospitalization (Table 6). The laboratory test results for other possible causative agents were negative. No HCWs required admission for further treatment during the norovirus outbreak. No patient died or suffered from severe complications, and the outbreak was controlled within 9 days.

Environmental, Water, and Food Investigation
Foodborne norovirus outbreak is not likely as epidemiologic data did not link to food. All environments were regarded as contaminated areas and disinfected. Water supply and residual food, as well as stored frozen food, tested negative for other contagious pathogens such as Escherichia coli and Rotavirus.

DISCUSSION
Most infectious gastroenteritis fulfills definitions to identify a norovirus outbreak: a consistent clinical syndrome and positive diagnosis for norovirus by RT-PCR. Rarely

Table 3. Attack Rate: Residents or HCWs

<table>
<thead>
<tr>
<th>No. of symptomatic</th>
<th>No. of asymptomatic</th>
<th>Total</th>
<th>Attack rate</th>
<th>OR</th>
<th>CI95</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents</td>
<td>41</td>
<td>195</td>
<td>236</td>
<td>17.4%</td>
<td>2.4</td>
<td>1.2–5.0</td>
</tr>
<tr>
<td>HCWs</td>
<td>10</td>
<td>115</td>
<td>125</td>
<td>8.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>310</td>
<td>361</td>
<td>14.1%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HCWs, health care workers; OR, odds ratio; CI95, 95% confidence interval.

Table 4. Demographic Characteristics in 298 Subjects (including 193 Residents and 105 HCWs) Who Provided Stool Specimens Were Consecutively Included in the Analysis during This Outbreak

<table>
<thead>
<tr>
<th>298 Subjects</th>
<th>Residents: 193</th>
<th>HCWs: 105</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean years ± SD</td>
<td>75.3 ± 12.2</td>
<td>29.6 ± 8.1</td>
</tr>
<tr>
<td>Female</td>
<td>98 (50.8%)</td>
<td>100 (95.2%)</td>
</tr>
<tr>
<td>Male</td>
<td>95 (49.2%)</td>
<td>5 (4.8%)</td>
</tr>
</tbody>
</table>

HCWs, health care workers.
are all symptomatic patients with definite positive diagnosis for norovirus tested by RT-PCR. Different definitions have been used in the diagnosis of the norovirus outbreak.\textsuperscript{5–10} There are several limitations in the study of most norovirus outbreaks, eg, the cases may have recovered from the diarrhea episodes or did not provide stool samples. Thus, very few stool samples were collected for further study. During the outbreak period, nearly all members of the CGMH-affiliated nursing home were examined; this included evaluation of their clinical, epidemiological, and laboratory characteristics.

Norovirus gastroenteritis infection was defined as the presence of norovirus in stool samples and/or the presence of clinical symptoms of norovirus gastroenteritis. The attack rate during an outbreak of norovirus gastroenteritis in a nursing home can be obtained by the number of patients in the nursing home who were exposed to and infected with the norovirus as well as those who became symptomatic. In our study, the positive diagnostic rate for norovirus by RT-PCR in residents and HCWs suggested that the cases, symptomatic or asymptomatic, had positive findings for fecal norovirus excretion. The attack rate and positive diagnostic rate for norovirus by RT-PCR were investigated to evaluate the status of norovirus gastroenteritis infection among residents and HCWs in a nursing home during an outbreak. According to our data, during this outbreak, the residents of the nursing home had a higher attack rate than the HCWs. Therefore, our study provided supporting data that residents have a greater risk of norovirus gastroenteritis infection than HCWs during an outbreak in a nursing home.

Many reports described high infections among residents in nursing homes during an outbreak of norovirus gastroenteritis, as residents were senile and in declined health. Generally, norovirus-associated gastroenteritis is mild and self-limited, so hospitalization is not needed and treatment is just supportive, such as rehydration and antiemetics. Residents in nursing homes are frail and elderly, which may lead to mortality or an increased need for hospital care when exposed to norovirus gastroenteritis.\textsuperscript{11,12} When an outbreak of norovirus gastroenteritis is suspected, an early diagnosis is urgently needed for all people at the nursing home because all patients admitted to the hospital during the outbreak we studied were symptomatic residents. In addition, more attention should be paid to symptomatic residents. This is of special importance because chronically ill nursing home residents easily become volume depleted enough to require hospitalization for fluid rehydration and electrolyte replacement.\textsuperscript{13}

Not all infections with norovirus result in clinical symptoms, as many asymptomatic cases act as reservoirs. Our data also showed many asymptomatic norovirus gastroenteritis carriers identified by RT-PCR assay in residents and HCWs. According to our experiences, asymptomatic carriers, although they can be important reservoirs for norovirus, neither seem to experience increased morbidity nor do they prolong the duration period of an outbreak providing the outbreak is rapidly recognized and infected patients and the environments are correctly managed. However, the role of the asymptomatic carrier in a nursing home during an outbreak of norovirus gastroenteritis still needs to be established.

Norovirus outbreaks can affect both residents and HCWs in the CGMH-affiliated nursing home. All symptomatic HCWs were female. This might be because there were only a few male HCWs and they did not have close contact with the residents and other HCWs. Those male HCWs also spent less time in the facility. The risk factors for norovirus infection are associated with the levels of dependence. HCWs have a high level of contact with residents with ADL disability in nursing homes and are easily and directly infected by ill persons, such as nearby HCWs or residents. In addition, the HCWs with a high level of contact with ADL disability residents in nursing homes are easily infected directly from ill persons, such as nearby HCWs or residents, and are subjected to secondary attacks from those infected persons. This often leads to a rapidly spreading outbreak in a closed setting like a nursing home.\textsuperscript{14} There is a likelihood that transmission to highly dependent inmobile residents probably occurred on the hands, clothing, or equipment carried by staff as they moved from room to room. A quick response to a suspected outbreak of norovirus gastroenteritis and its early diagnosis is urgently needed in a nursing home. Interventions such as enteric isolation of the affected patients, suspension of regular meals, and disinfection of personnel and the environment must be carried out immediately. Such early management

| Table 5. Positive Diagnosis for Norovirus by RT-PCR from Those Who Provided Stool Specimens: Residents or HCWs |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                  | No. of PCR(+)   | No. of PCR(-)   | Total           | Positive Diagnostic Rate | OR   | CI95        | P     |
| Residents        | 59              | 134             | 193             | 30.6%                      | 3.8  | 1.9–7.5    | <.001 |
| HCWs             | 11              | 94              | 105             | 10.5%                      |      |            |       |
| Total            | 70              | 228             | 298             | 23.5%                      |      |            |       |

RT-PCR, reverse transcription–polymerase chain reaction; HCWs, health care workers; OR, odds ratio; CI95, 95% confidence interval.
can reduce the spreading of the virus, shorten the course duration of an outbreak, and decrease mortality and morbidity.15

REFERENCES