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Outbreaks of acute gastroenteritis are frequently caused by caliciviruses. Electron microscopy was used to search for these viruses in fecal samples from patients with acute gastroenteritis. Of 5800 samples collected and analyzed from November 1994 to June 1998, 3700 were associated with outbreaks. A total of 676 outbreaks were analyzed, and viruses were found in 67%. Caliciviruses, usually Norwalk-like viruses (NLVs), were found in 407 (89%) of 455 outbreaks, while Sapporo-like viruses were identified in nine outbreaks, including six that were suspected to include foodborne transmission. Sixty percent of the 1041 patients with calicivirus infections were between 70 and 90 years of age. Food- and waterborne infections were associated with 66 calicivirus outbreaks. Virus-positive outbreaks were documented mainly during winter and spring. The longitudinal survey showed that caliciviruses, and especially the NLVs, cause most nosocomial and community-associated outbreaks in Sweden.

Caliciviruses are recognized as the single most important cause of acute nonbacterial gastroenteritis in sporadic community cases as well as in outbreaks in different settings [1–5]. A significant number of these infections are transmitted via contaminated food [6] and person-to-person contacts [7]. Contaminated surfaces, such as door handles, telephone handsets, and water taps, have been shown to carry calicivirus in detectable amounts, thereby forming an important mechanism for virus transmission [8]. A surveillance system for outbreaks of gastrointestinal illness similar to the one used in both England and Wales [4] is absent in Sweden; therefore, the epidemiologic information concerning calicivirus infections is limited [9] and usually anecdotal in nature. The general opinion in Sweden is that outbreaks of viral gastroenteritis have increased during the last 10 years, particularly in institutional settings, hospitals, and nursing homes.

The aim of the present study was to investigate the role of caliciviruses in acute gastroenteritis in Sweden.

Materials and Methods

Infectious disease units, local medical facilities, and hospitals throughout Sweden were encouraged to collect at least 5 samples from each outbreak of acute gastroenteritis and submit them to the Swedish Institute for Infectious Disease Control (SMI) for analysis. Samples were analyzed by electron microscopy (EM), using standard techniques. In brief, a 10% fecal suspension was prepared in PBS, and a drop of the suspension was incubated for 1 min on a Formvar-carbon coated grid (Agar Scientific, Stansted, United Kingdom) and then stained by 2% tungstophosphoric acid (Merck, Darmstadt, Germany), pH 6 (“drop-on-grid” technique). To increase the sensitivity, a second step was performed (“centrifugation-on-grid”), in which the fecal suspension was clarified at 20,000 g for 30 min, and the supernatant was pelleted directly on the grid at 150,000 g for 10 min in a Beckman (Palo Alto, CA) Airfuge, using an A-100/30 fixed-angle rotor. Specimens were examined under a microscope (Philips CM 100; Eindhoven, The Netherlands) at ×46,000 magnification or via a television monitor at ×920,000 magnification, using a CCD camera (Gatan; Pleasanton, CA). Viruses were identified as Norwalk-like virus (NLV) or Sapporo-like virus (SLV), the latter possessing clearly defined cup-shaped depressions (calyces) on their surface. Particles with clearly seen sharp or club-shaped spikes or with an ill-defined periphery were classified as NLVs.

Results

The study period was from November 1994 to June 1998, thus covering four calicivirus “seasons.” In total, 5800 samples from all parts of Sweden were analyzed, including 3700 associated with 676 outbreaks. Samples were received from all parts of Sweden, with a clear dominance of the southern part of the country, where most of the population resides. However, comparatively few outbreaks involving children were included, as samples from this age group are traditionally analyzed by local laboratories that screen for rotavirus and adenovirus. The data herein include all outbreaks in which at least 1 fecal sample was sent for analysis. Viruses were found in 455 of the outbreaks (67%) investigated.

Caliciviruses were the dominant virus found in all settings studied (figure 1) and were detected in 407 (60%) of the 676 outbreaks. Different hospital settings and nursing homes accounted for 50% and 26%, respectively, of all outbreaks in which caliciviruses were found. Schools and day care centers accounted for 4.5% of the outbreaks. Contaminated food or water was suspected in 15% of all outbreaks. Caliciviruses had the highest detection rate in foodborne outbreaks (72%), followed by outbreaks in nursing homes (61%). The viruses were...
found in 57% of gastroenteritis outbreaks in hospitals and in 55% of the outbreaks in schools and day care centers.

SLVs (caliciviruses with "classic" morphology) were identified in nine well-defined outbreaks: Three were in day care centers, and six involved outbreaks with suspected foodborne transmissions. No specific age group dominated among the affected individuals (median age, 40 years; range, 1–66).

The age of the calicivirus-affected patients in nursing homes and geriatric wards was high (median age, 84 years; figure 2). Samples were obtained from only a few of the sick staff members; however, they appeared to be affected to the same extent as the patients. This finding is contrary to those in outbreaks caused by rotavirus in similar settings, where usually only patients became ill. Also in general hospital settings, caliciviruses were most frequently identified in the elderly (median age, 78 years; figure 2), and although samples were frequently obtained from younger patients and staff, we were seldom able to find viruses in their stools. In foodborne outbreaks, caliciviruses were usually found in the young and middle-aged (median age, 42 years; figure 2) individuals.

**Figure 1.** Number of gastroenteritis outbreaks in different settings where calicivirus or other viruses were identified—Sweden, November 1994 to June 1998.

**Figure 2.** Age of patients with documented calicivirus infections in different settings—Sweden, November 1994 to June 1998.
In a fair number of outbreaks, only rotavirus could be identified (figure 3 and figure 4). This was especially true in nursing homes and geriatric wards, where rotavirus dominated the viral findings, at least periodically. In what seemed to be a single outbreak, both calicivirus and rotavirus could be identified among several patients, suggesting that outbreaks with ≥2 pathogens can occur concomitantly.

The number of calicivirus cases and the number of nosocomial outbreaks in which caliciviruses could be identified show a very predictable seasonal pattern in Sweden (figure 4). A low level of cases and outbreaks of gastroenteritis are reported to SMI in the summer (June to August); however, the number of reports increase beginning in October. This increase continues through November and December and reaches maximum levels in January through March. April and May usually show decreasing numbers, and the lowest levels of gastroenteritis occur in midsummer. Compared with the seasonal pattern of rotavirus, the calicivirus season seems to start and peak earlier (figure 4). Suspected foodborne outbreaks of calicivirus seem to have a more even distribution through the year (figure 5); however, a small peak was found in December as a result of several outbreaks connected to the traditional Swedish Christmas buffet.

Foodborne transmission was suspected in 92 outbreaks, and calicivirus could be identified in 66 of these outbreaks (72%). A specific food item was identified in 14 cases, which included bakery products (6), oysters (4), water (3), and frozen raspberries (1). In the remaining cases, different types of salads, sandwiches, and cold buffets were suspected. Infected food handlers (sometimes with sick children at home) were identified in a few cases, and in other cases, persons who became sick during meals were suspected of virus transmission. The six cases of foodborne outbreaks involving SLVs included consumption of oysters, cakes, different cold buffets, and salads.

Discussion

In Sweden, viruses were found in two-thirds of all outbreaks of gastroenteritis studied from 1994 to 1998, and calicivirus was the most commonly identified virus (found in 60% of these outbreaks). The dominance of calicivirus was especially evident in nursing homes and in cases of suspected foodborne infections. Similar results have been reported from England and Wales [4] and from Australia in the survey of Wright et al. [10]. In a study from the United States, Fankhauser et al. [5] also reported that calicivirus outbreaks were most frequent in hos-
The quality of sampling varied; in some outbreaks it occurred too late in the disease process to enable virus detection, and in other cases, only 1 or 2 samples were obtained from a given outbreak. In addition, the comparatively low sensitivity of the detection method used (EM) probably meant that some calicivirus cases were undetected and that some outbreaks were left without any suspected pathogen. Despite these drawbacks, viruses were found in most (67%) outbreaks studied.

Caliciviruses were recognized as an important cause of gastroenteric outbreaks in community and institutional settings. However, our data do not allow us to determine the absolute magnitude of the problems caused by these viruses. Samples typically were obtained from only a few of the total number of ill people in a given outbreak. We also know that samples were obtained from patients in only a fraction of all hospital outbreaks, and only a small number of the outbreaks were reported. Although investigation of outbreaks was encouraged, about one-third of all samples arrived at the laboratory as single cases without background information linking or not linking them to an outbreak. As most of them came from hospitalized persons, they were probably derived from unreported outbreaks. Outbreaks in the community (e.g., those occurring in families) or in different places of work hardly ever get reported or sampled, an experience that Sweden shares with other countries [4]. An introduction of a national surveillance system is needed to ascertain the total impact of the caliciviruses in Sweden.

As found by Dedman et al. [4] in England and Wales, most cases of calicivirus infection in Sweden, particularly cases of NLV, were among patients ≥70 years old who were being cared for in nursing homes and geriatric wards. This finding clearly demonstrates that caliciviruses affect elderly people. In general, however, younger hospitalized patients and hospital staff get sick to the same extent as the elderly; in fact, in most outbreaks, more staff members than patients they nursed were ill. Despite this finding, few identifications of calicivirus infections are made in staff or patients <60 years old. The reason for this is not understood, but a possible explanation would be that samples from staff members were usually collected when they returned to work, not while they were symptomatic. The low detection rate in young and middle-aged patients presently lacks a reasonable explanation but could be due to a shorter period of viral shedding or to a lower concentration of viral particles in their stools (or both). This may be true in hospital settings, but in cases of foodborne transmission, viruses are predominantly found in young and middle-aged persons.

The international trade of food items is becoming an in-

Figure 4. Number of gastroenteritis outbreaks, by month, in which calicivirus or rotavirus was identified—Sweden, November 1994 to June 1998.
creasingly important factor in the spread of virus. This fact was clearly demonstrated by an outbreak of gastroenteritis that was linked to a dessert based on calicivirus-contaminated frozen raspberries. The berries were the first used of a shipment of several tons of frozen raspberries that had just arrived from Bosnia and were meant to be distributed throughout Sweden. Imported frozen raspberries, other frozen berries, and vegetables have been involved in outbreaks in several countries [11, 12].

So far, SLVs have mainly been found in young children in day care centers and pediatric hospital wards [13–15], and they have less often been found in outbreaks affecting adults. During the 4 years covered by this study, SLVs were seen only as single cases among adults in hospitals or nursing homes and never related to outbreaks in these settings. However, our observations of SLV involvement in six foodborne outbreaks are similar to those of Noel et al. [16] describing the Parkville virus, a new genetic variant of SLV, from a foodborne outbreak among adult staff at a school.

Compared with the information obtained from institutional and foodborne outbreaks, very little is known concerning sporadic community cases of acute gastroenteritis in Sweden. Caliciviruses were a relatively uncommon finding in patients seeking medical care in infectious disease units. This does not necessarily reflect the situation in the community, as patients seeking these services do so after a relatively long period of illness (Svenungsson B, personal communication), when the shedding of virus has fallen below the detection limit for EM.

There is an accepted opinion among medical professionals in Sweden that outbreaks of gastroenteritis in hospital settings have increased during the last 10 years. The reasons behind this opinion are not fully elucidated; however, it is clear that a significant portion of the acute gastroenteritis cases occurring in older children and adults is caused by caliciviruses, particularly NLV. With improved diagnostic methods, such as polymerase chain reaction [2, 5], it is reasonable to assume that the importance of caliciviruses in acute gastroenteritis will become even more evident.

References


