EVALUATION OF THE IMPACT OF THE SOURCE (PATIENT VERSUS STAFF) ON NOSOCOMIAL NOROVIRUS OUTBREAK SEVERITY

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ABSTRACT

OBJECTIVE: To study the dependence of infection risk and outbreak size on the type of index case (ie, patient or staff).

METHODS: Nosocomial outbreaks were reviewed and categorized into those started by patients and those started by staff. Infection risks and outbreak sizes were evaluated taking into account the index case category.

RESULTS: Of the 30 nosocomial outbreaks of norovirus with person-to-person transmission, 20 (67%) involved patients as the index cases. Patient-indexed outbreaks affected significantly more patients than did staff-indexed outbreaks (difference in means, 16.25; 95% confidence interval [CI_{95}], 5.1 to 27.0). For the numbers of affected staff, no dependence on the index case category was detectable (difference in means, -1.05; CI_{95}, -9.0 to 6.9). For patients exposed during patient-indexed outbreaks, the risk of acquiring a norovirus infection was approximately 4.8 times as high as the corresponding risk for patients exposed during staff-indexed outbreaks (odds ratio [OR], 4.79; CI_{95}, 1.82 to 8.28). The infection risk for exposed staff during patient-indexed outbreaks was approximately 1.5 times as high as the corresponding risk during staff-indexed outbreaks (OR, 1.51; CI_{95}, 0.92 to 2.49).

CONCLUSIONS: Patient-indexed norovirus outbreaks generally affect more patients than do staff-indexed outbreaks. Staff appear to be similarly affected by both outbreak index category groups. This study demonstrates the importance of obtaining complete outbreak data, including the index case classification as staff or patient, during norovirus outbreak investigations. Such information may be useful for further targeting prevention measures (*Infect Control Hosp Epidemiol* 2005;26:268-272).

During the winter of 2002–2003, more norovirus outbreaks were observed than ever before in Germany and elsewhere.[1,2] In hospitals and long-term–care facilities, many staff members were affected and staff shortage complicated patient care.[3] Wards had to be closed either completely or to new admissions; if many staff were affected, reliable patient care became impossible. Patients had to be transferred to other wards in other departments with staff who were not knowledgeable about the relevant specific diagnostics and therapies.

Thus, implementing appropriate prevention measures is essential, especially because the infectivity and potential spread is great for the currently circulating genetic variants of norovirus. Currently, we lack an understanding of norovirus outbreak dynamics that could enable us to recommend prevention measures adaptable to specific situations. The primary mode of transmission is from person to person in 85% of nosocomial norovirus outbreaks.[4] The influence on outbreak occurrence or severity of the index source (ie, patient or staff) is unknown.

Our study investigated the possible differences between outbreaks in wards depending on the index case category. Furthermore, outbreaks affecting more than one ward in the same hospital were analyzed.

METHODS

All published nosocomial norovirus outbreaks with proven or suspected person-to-person transmission were included (ie, Medline search of studies published from 1962 to 2004 using the terms "norovirus," "Norwalk virus," "small-round structured virus," and "outbreak"), as were data obtained from Outbreak Worldwide Database,[5] German data published in *Epidemiologisches Bulletin*, data from personal communication with another German teaching hospital, and our own data.[6]

Inclusion criteria for statistical analyses were outbreaks with epidemic curves for each ward and outbreaks for which the index case could be identified. For infection risk analyses, outbreaks were included if attack rates were available separately for each ward. Authors of studies of outbreaks published since 1994 were contacted but could not supply further data meeting our inclusion criteria.

For the infection risk analyses, Epi-Info software

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TABLE 1
STUDIES ON NOSOCOMIAL OUTBREAKS: INDIVIDUAL WARDS

Study	Month and Year of Outbreak	Country	Department	No. of Outbreak Wards	No. of Infected Individuals	Index Case	Included in Statistical Analyses	Included in Attack Rate Analyses
Kaplan et al.[7]	December 1980	US	Nursing home	2	72	P, P	-	-
Gustafson et al.[8]	April 1981	US	Chronic care	1	53	U	-	-
Riordan and Wills[9]	September to October 1983	UK	Elderly care unit	4	97	S, S, S, U	-	-
Leers et al.[10]	April 1983	Canada	Internal medicine	6	126	P, S, U, U, U, U	-	-
Spender et al.[11]	January to February 1985	UK	Pediatrics	4	48	U, U, U, S	-	-
Gellert et al.[12]	December to January 1988–1989	US	Elderly care unit	3	181	S, U, U	-	-
Pegues and Woernle[13]	July 1991	US	Nursing home, two wings	1	91	P	P	P
Chadwick and McCann[14]	November 1992	UK	Elderly care unit	2	126	U, U	-	-
Cunney et al.[15]	February 1993	Ireland	Elderly care unit, internal medicine	2	95	U, U	-	-
Green et al.[16]	January 1994	UK	Internal medicine	1	50	P	P	P
			Elderly care unit	4	81	P, U, U, U	-	-
Green et al.[17]	May 1994	UK	Psychiatry	1	29	U	-	-
Russo et al.[18]	October 1995	Australia	Elderly care unit, internal medicine	2	98	P, S	P, S	-
Caceres et al.[19]	January 1996	US	Not described	1	37	S	S	S
Marx et al.[20]	February 1996	US	Elderly care unit	1	86	P	P	-
O'Neill et al.[21]	June 1999	UK	Elderly care unit	1	16	P	P	-
	April 1999	UK	Internal medicine	1	30	P	P	-
Khanna et al.[3]	February to March 2001	Switzer-land	Dermatology, inter-nal medicine, BMT	3	63	P, S, S	P, S, S	-
Sinn[22]	January to February 2001	Germany	Internal medicine, elderly care unit	2	68	P, S	P, S	-
McCall and Smithson[23]	January 2001	UK	Acute elderly care unit	1	58	P	-*	-
Mattner et al.[6]	November to January 2002–2003	Germany	Psychiatry, two in internal medicine, pediatrics, internal medicine, trauma	6	165	P, P, P, S, S, U	P, P, P S, S	P, P, P, S
Borck†	November to January 2002–2003	Germany	Four in internal medicine, neur-ology, obstetrics, surgery, two in the elderly care unit, neurology, internal medicine, surgery, elderly care unit	13	366	P, P, P, P, P, P P, P, P, S, S, S, U	P, P, P P, P, P P, P, P, S, S, S	-
Total				62	2,036	P = 25; S = 16; U = 21	30	7

P = patient; S = staff; U = unknown; US = United States; UK = United Kingdom; BMT = bone marrow transplant unit.
*Study was excluded because the staff group comprised a subgroup not belonging to the ward.
†H. U. Borck, MD, personal communication, 2003.

TABLE 2
NOSOCOMIAL NOROVIRUS OUTBREAK SIZES DIFFERENTIATED BY THE INDEX CASE: PATIENT OR STAFF*

	Mean No. of Affected Patients	Mean No. of Affected Staff	Mean No. of All Affected Individuals
Observed means for patient-indexed outbreaks	27.75	11.75	39.5
Observed means for staff-indexed outbreaks	11.5	12.8	24.3
95% confidence interval for difference in mean†	5.1 to 27.0	-9.0 to 6.9	1.1 to 29.0
P†	.006	.78	.036

*Thirty wards included.
†Using Welch's approximate *t* test (two sided).

TABLE 3
INFECTION RISK OF PATIENTS DEPENDING ON THE INDEX CASE: PATIENT OR STAFF*

Index Case	No. of Patients Infected	No. of Patients Not Infected	Total	OR	CI_{95}	*P*
Patient (5 wards)	154	202	356	4.79	1.82 to 8.28	< .0005
Staff (2 wards)	21	132	153			
Total	175	334	509			

OR = odds ratio; CI_{95} = 95% confidence interval.
*Denominator population was available from only 7 wards.

TABLE 4
INFECTION RISK OF STAFF DEPENDING ON THE INDEX CASE: PATIENT OR STAFF*

Index Case	No. of Staff Infected	No. of Staff Not Infected	Total	OR	CI_{95}	*P*
Patient (5 wards)	79	145	224	1.51	0.92 to 2.49	.08
Staff (2 wards)	36	100	136			
Total	115	245	360			

OR = odds ratio; CI_{95} = 95% confidence interval.
*Denominator population was available from only 7 wards.

(version 6; Centers for Disease Control and Prevention, Atlanta, GA) was used. Further statistical analysis (Welch's approximate *t* test) was performed using Mathematica software (version 4.2; Wolfram Research, Inc., Champaign, IL).

RESULTS

From 19 publications and 1 personal communication, 62 outbreak wards including 2,036 individuals were included for analyses (Table 1).[3,6-23] In 25 (40%) of the outbreaks, patients were the index; in 16 (26%), staff were the index. The index could not be identified in 21 (34%) of the outbreaks. The quality of data has improved during the past 20 years. The first outbreak included in our statistical analyses occurred in 1991.[13] Thirty of these outbreaks (between 1991 and 2003) were included in our study. A total of 1,033 individuals (670 patients and 363 staff members) were involved as cases. The number of affected wards in a given hospital ranged from 1 to 13 (mean, 15 individuals per outbreak ward). Twenty (67%) of the outbreaks were started by patients, whereas 10 (33%) of the outbreaks were started by staff. On internal medicine wards (with the neurology and pediatrics departments included), 11 of 18 outbreaks were patient indexed. In contrast, in elderly care units and psychiatry units, 7 of 8 outbreaks were patient indexed.

Only seven wards could be included in the infection risk analyses because only these studies included the denominator population.

A detailed analysis yielded the following results: (1) outbreaks started by patients affected more patients and individuals than did outbreaks started by staff (Table 2); (2) outbreaks started by staff affected as many staff as did outbreaks started by patients (Table 2); (3) the risk of a patient being affected was more than twice as high in an outbreak started by a patient compared with an outbreak started by staff (Table 3); and (4) the risk of staff members being affected was independent of the index source category group (Table 4).

Analysis of all available nosocomial outbreaks revealed that 14 (23%) of 62 ward outbreaks were proved or suspected to have been started by staff from the same hospital but from another affected ward.

DISCUSSION

Norovirus outbreaks emerged during the past few years in Central Europe. In Germany during the winter of 2002–2003, up to 150 outbreaks per week were reported to the nationwide surveillance system. The majority (85%) of these outbreaks were nosocomial.[1,2] In Europe, hospital outbreaks, compared with outbreaks in other settings such as schools and hotels, were reported more often to surveillance systems and seemed to involve fewer individuals.[4] In contrast, outbreaks in Japan reported to its national surveillance systems demonstrated that hospital outbreaks involved more than 20 to 50 individuals, respectively.[24] Norovirus spread is facilitated by its transmission mode (contact transmission and possibly by aerosols when handling patient emesis), complicating the termination of outbreaks.[25] Until now, little was known about the severity of such outbreaks based on the source or index case as a patient or staff member. Some data support transmission through food, water, and contact,[4,24,26,27] but to our knowledge, no investigation had been conducted to assess the impact of index case category on the severity of nosocomial outbreaks.

Our study demonstrates that outbreak patterns depend on the index case category. Patient-indexed outbreaks involve more individuals and more patients than do staff-indexed outbreaks. On the other hand, staff affection was independent of the index case category. These observations provide evidence for a faster and more effective spread of noroviruses within the patient group in patient-indexed outbreaks. There are several probable reasons for this. Patients may have poorer hygiene than do staff. It is possible that patient-source illness is not recognized as quickly as staff illness, so the virus has more time to spread before control measures are instituted. Furthermore, patients may have a weaker immune response to the virus, and therefore excrete much larger numbers of virus than do younger staff.

The observation that patient-indexed outbreaks are more severe contradicts the common assumption that mostly staff are responsible for the person-to-person transmission of norovirus in the hospital. Additionally, when patients transmitting the virus to other patients (by either aerosol or physical contact) is taken into account, more aggressive measures are required to prevent nosocomial transmission, such as those recommended by the Centers for Disease Control and Prevention, the National Disease Surveillance Center in Ireland, or the Robert-Koch-Institut in Germany.[28-30] Isolation procedures, immediate environmental decontamination of soiled areas, frequent handwashing[28,29] or hand antisepsis with a virus-active alcoholic disinfectant,[30] or staff and patients wearing masks when contact with feces or vomitus is expected should be effective in stopping further spread between patients in patient-indexed outbreaks.

Although it may be difficult to identify the index case while an outbreak is ongoing, one should try to do so as early as possible. Indeed, Table 1 illustrates that in approximately two-thirds of all published nosocomial norovirus outbreaks, the index cases were determined.

In contrast, although staff were affected to approximately the same extent in both patient- and staff-indexed outbreaks, it may be prudent to apply similar prevention measures for staff and patients, such as minimizing contacts among staff and applying appropriate hand antisepsis procedures not only after patient contact but also after contact with other staff members.

The statistical analysis of attack rates of patient-indexed outbreaks supports the closing of a ward to new admissions as a prevention measure.

For staff-indexed outbreaks, the corresponding prevention measure would consist of reducing contact with infected staff by sending staff home until at least 48 hours after their symptoms resolve.[31]

On the other hand, when the less severe course of staff-indexed outbreaks is considered, it is possible that under certain circumstances (eg, high compliance with hand hygiene and prevention measures and a low attack rate), closing the ward to new admissions might be avoided.

Unfortunately, little is known about the dynamics of norovirus outbreaks. It is important to analyze the dynamics of an outbreak to devise more specific prevention measures. To this end, it is necessary to collect complete outbreak data, such as ward-specific epidemic curves regarding all involved groups of individuals, and to perform surveillance of individuals at risk (attack-rate calculation) as recommended by Beck-Sague et al. (from the Centers for Disease Control and Prevention).[32]

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