

Heterogeneity of rotavirus testing and admitting practices for gastroenteritis among 12 tertiary care pediatric hospitals: Implications for surveillance

Julie A Bettinger PhD MPH¹, Kathryn Wills BSc¹, Nicole Le Saux MD², David W Scheifele MD¹, Scott A Halperin MD³, Wendy Vaudry MD⁴; Members of the Canadian Immunization Monitoring Program, ACTive (IMPACT)

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BACKGROUND: The Canadian Immunization Monitoring Program, ACTive (IMPACT) surveillance for rotavirus relies on monitoring hospital admissions. Because a diagnosis of rotavirus is not necessary for treatment purposes, and rotavirus is not a reportable disease, wide variation may exist in the admitting and testing practices for this disease. From 2005 to 2007, the number of rotavirus admissions differed significantly among IMPACT centres, and this variation could not be explained by population differences alone. Understanding this variation is important when interpreting surveillance data and estimating the cost-effectiveness of rotavirus vaccination programs.

METHODS: Key informant interviews were conducted with pediatric infectious disease physicians and IMPACT nurse monitors involved with rotavirus surveillance to obtain in-depth information about rotavirus testing and admitting practices at each of the 12 IMPACT centres.

RESULTS: A total of 18 of 24 interviews were completed, with at least one interview conducted with physicians and/or nurses at each centre. Four major differences were identified among the centres: case-identification methods, admission definitions, admission criteria and testing criteria. The criteria for admitting and testing patients as well as which patients were defined as admissions had the greatest influence on case totals.

DISCUSSION: The present study found that differences in admitting and testing practices may contribute to significant differences in rotavirus admission totals. Given these differences, caution should be used when using local case estimates for cost-effectiveness analyses and immunization program decisions. The present study illustrates that understanding the factors that influence the identification of a disease is important when interpreting and applying surveillance data.

Key Words: Case identification; Disease burden; Rotavirus; Surveillance

Rotavirus infections are a major medical and public health issue worldwide. More than 95% of children are infected with rotavirus before five years of age (1), making it the leading cause of severe, dehydrating gastroenteritis (2) and the most frequent pediatric vaccine-preventable gastroenteric disease (3). Although rotavirus infections cause approximately 600,000 deaths every year in developing countries (4), they are not a significant source of mortality in North America (5,6). Despite this, rotavirus remains a major public health burden in North America, judging by the high incidence of gastroenteritis morbidity and health care use (5,7). However, accurately measuring the burden

L'hétérogénéité des tests de dépistage du rotavirus et des pratiques d'admission en cas de gastroentérite dans 12 hôpitaux pédiatriques de soins tertiaires : les conséquences pour la surveillance

HISTORIQUE : La surveillance du rotavirus par le Programme canadien de surveillance active de l'immunisation (IMPACT) dépend du suivi des admissions hospitalières. Puisqu'il n'est pas nécessaire de diagnostiquer le rotavirus aux fins de traitement et que le rotavirus n'est pas une maladie à déclaration obligatoire, les pratiques d'admission et de dépistage de cette maladie peuvent comporter d'importantes variations. De 2005 à 2007, le nombre d'admissions imputables au rotavirus a varié considérablement au sein des centres d'IMPACT, et cette variation ne pouvait s'expliquer par de simples différences de population. Il est important de comprendre cette variation pour interpréter les données de surveillance et évaluer le rapport coût-efficacité des programmes de vaccination contre le rotavirus.

MÉTHODOLOGIE : Les chercheurs ont organisé des entrevues avec des témoins privilégiés, soit des médecins en infectiologie pédiatrique et des infirmières-contrôleuses d'IMPACT qui participaient à la surveillance du rotavirus, afin d'obtenir de l'information détaillée sur les tests de dépistage du rotavirus et les pratiques d'admission dans chacun des 12 centres d'IMPACT.

RÉSULTATS : Au total, 18 des 24 entrevues possible ont été réalisées, et au moins une entrevue a eu lieu auprès de médecins ou d'infirmières de chacun des centres. Les chercheurs ont constaté quatre grandes différences entre les centres : les méthodes d'identification des cas, les définitions d'admission, les critères d'admission et les critères pour effectuer des tests. Les critères pour admettre les patients et effectuer les tests de dépistage et la sélection des patients définis comme admis avaient la plus grande influence sur le total des cas.

EXPOSÉ : D'après la présente étude, les différences dans les pratiques d'admission et de test de dépistage peuvent contribuer aux importantes différences dans le total des admissions attribuables au rotavirus. Pour cette raison, il faut faire preuve de prudence lorsqu'on utilise les évaluations d'analyse coût-efficacité et de décisions relatives aux programmes de vaccination. La présente étude démontre l'importance de comprendre les facteurs qui influent sur le dépistage d'une maladie lorsqu'on interprète et qu'on applique les données de surveillance.

of disease from rotavirus remains a challenge because only patients with the most severe infections present to health care professionals, and effective treatment does not require identification of the pathogen; thus, outpatient testing is not routinely performed.

In 2006 and 2007, two new vaccines were licensed in Canada to protect children against rotavirus gastroenteritis; however, limited information was available on the disease burden in Canada, thereby precluding accurate estimation of the cost-effectiveness of routine vaccination. To date, only Prince Edward Island has implemented routine rotavirus vaccination. Thus, to better understand the burden of disease and to

¹Vaccine Evaluation Centre, BC Children's Hospital and the University of British Columbia, Vancouver, British Columbia; ²Children's Hospital of Eastern Ontario, Ottawa, Ontario; ³Canadian Centre for Vaccinology, IWK Health Centre and Dalhousie University, Halifax, Nova Scotia; ⁴Stollery Children's Hospital and University of Alberta, Edmonton, Alberta

Correspondence: Dr Julie A Bettinger, Vaccine Evaluation Centre, BC Children's Hospital, A5-178-950 West 28th Avenue, Vancouver, British Columbia V5Z 4H4. Telephone 604-875-2422, fax 604-875-2635, e-mail jbettinger@cfri.ca

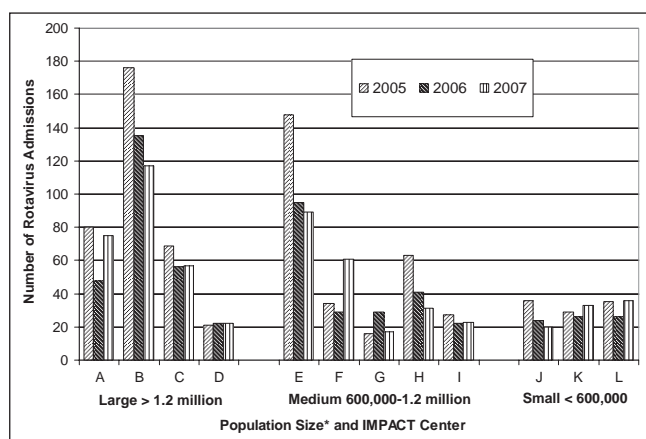


Figure 1) Rotavirus admissions at 12 Canadian Immunization Monitoring Program, ACTive (IMPACT) centres grouped according to city population from 2005 to 2007. *Population figures from Statistics Canada 2006 Census Metropolitan Areas

monitor the epidemiology of rotavirus, the Canadian Immunization Monitoring Program, ACTive (IMPACT) initiated active surveillance of laboratory-confirmed rotavirus admissions at 12 tertiary care pediatric hospitals across Canada in 2005.

Over a three-year period from 2005 to 2007, the number of rotavirus admissions differed significantly among centres and this variation could not be explained by population differences alone. The number of rotavirus admissions according to year, centre and population are shown in Figure 1. We hypothesized that the differences among centres represented selection bias caused by variation in testing and admitting practices, rather than true differences in disease burden, and that this accounted for the remarkable differences observed in IMPACT rotavirus surveillance.

METHODS

IMPACT is a national active surveillance network that captures pediatric vaccine-preventable diseases and adverse events following immunization. IMPACT centres are located across Canada in Newfoundland and Labrador, Nova Scotia, Quebec (three centres), Ontario (two centres), Manitoba, Saskatchewan, Alberta (two centres) and British Columbia. These 12 centres admit more than 75,000 children annually, account for nearly 90% of the nation's tertiary care pediatric beds, receive referrals from all provinces and territories, and serve a population base of approximately 50% of Canada's children (8). All centres have ethics approval for the surveillance. Each centre has a designated nurse monitor who is hired to search for and identify cases and to complete the case report form, and a volunteer investigator who oversees the surveillance. All centres used the same case definition, user's manual and standardized report form to abstract information from patient charts. The case definition included all laboratory-confirmed rotavirus cases admitted to an inpatient ward or equivalent, including cases that required more than 24 h in an observation/short-stay unit, if identifiable. Children who were treated in the emergency department (ED) and released without inpatient admission were excluded from the surveillance. The following *International Classification of Diseases 10th Revision* (ICD-10) codes were used to search for cases: A08 (rotaviral enteritis) and A09 (diarrhea and gastroenteritis of infectious origin). Other search strategies are described below. Hospital-acquired infections were included for patients who had been hospitalized for 72 h or longer before the onset of laboratory-confirmed rotavirus for a reason unrelated to rotavirus, or patients who were readmitted with laboratory-confirmed rotavirus gastroenteritis less than 72 h after hospital discharge for an unrelated event. Each nurse monitor received training on rotavirus case-searching strategies, case identification and case report form completion. Annual nurse monitor meetings were held to ensure data standardization

TABLE 1
Definitions of 'admitted to hospital' in patients with rotavirus gastroenteritis

Counted in surveillance	Centres, n/n	Centres
Patients in the inpatient unit/ward	12/12	–
Patients in the ED for less than 24 h	0/12	–
Patients in the ED for more than 24 h	2/12	D, F
Patients in observation or holding rooms in ED	2/12	E, J
Patients in short-stay rooms in ED	2/12	A, E

ED Emergency department

across the 12 centres and to provide additional training. The IMPACT coordinator visited each centre annually to review processes and provide feedback to the nurse monitor and investigator.

To obtain information about testing and admitting practices at each of the 12 tertiary care pediatric centres, key informant interviews were conducted by telephone with the pediatric infectious disease physician and/or nurse monitor overseeing IMPACT surveillance at each centre between June 15 and August 13, 2009. All investigators and nurse monitors verified the typed interview notes and provided additional comments and clarification.

RESULTS

In total, 18 of 24 potential interviews were completed, with at least one informant (either nurse monitor or investigator) interviewed from each of the 12 centres. Four major differences among centres were identified: case-identification methods, the definition of an admission, the criteria for admission and the criteria for testing.

Case-identification methods

A variety of case-identification methods were used among centres. All centres but one (centre E) used notifications of rotavirus-positive cases directly from the laboratory, either as their sole method of case searching or as one of several methods. Five of 12 centres (centres F, H, K, J and L) searched hospital daily admissions lists to identify patients with symptoms of acute gastroenteritis. The nurse monitor subsequently reviewed those patients' charts to determine whether they had been tested for rotavirus. Additionally, four of 12 centres (D, I, F and H) searched outpatient data sources for cases of acute gastroenteritis, and then followed up for admission and positive rotavirus results. Finally, four of 12 centres periodically searched rotavirus ICD-10 codes to identify any patients missed by other search methods. Centre E used ICD-10 discharge codes as its sole method of case searching.

Definitions of 'admitted to hospital' in patients with rotavirus gastroenteritis

Hospital-specific patient classifications affected which patients were defined as admissions (Table 1). At all 12 centres, patients admitted to the ward or inpatient unit were defined as admissions, while patients in the ED for less than 24 h were not. Five centres treated patients in a variety of short-stay/observation/holding units; and whether patients seen in these areas were defined as an admission varied according to hospital (Table 1). The median length of stay for community-acquired cases was three days (range two to 2.3 days) and the mean was 3.4 days (range 2.3 to 4.0 days). Although centres E and J that included patients in the ED observation or holding rooms in the surveillance had the shortest median and mean duration of stay for community-acquired cases (mean 2.3 and 2.5 days, respectively), this relationship was not consistent for all centres with shorter stay cases counted in the surveillance nor for centre B with the highest number of cases. Centres A, B, D and F had a mean duration of stay of 3.9, 3.5, 3.5, 3.7 days, respectively.

Admitting criteria for acute gastroenteritis

Dehydration status determined admission at nine of 12 hospitals. Factors influencing admission for dehydration included failure of oral

TABLE 2
Criteria for rotavirus testing in the emergency department

Criteria for testing	Centres,	
	n/n	Centres
Patients admitted to the ward with diarrhea	6/12	A, F, G, H, K, L
Patients with severe gastrointestinal symptoms	3/12	B, J, L
Patients are rarely tested	4/12	C, D, E, I
Patients are never tested	0/12	–

rehydration therapy, severe vomiting, electrolyte imbalance and administration of intravenous (IV) rehydration fluids. Patient age and/or underlying health disorders were considered in admissions at three centres (A, D and H). At one centre (D), low risk and less severely ill patients were referred to peripheral hospitals and patients had to have failed IV rehydration in the ED to be admitted. One centre (C) had no defined criteria for admitting gastroenteritis patients from the ED.

Testing criteria for acute gastroenteritis

Table 2 summarizes the criteria for outpatient rotavirus testing in the various EDs. The number of patients tested for rotavirus each year was not available for the remaining centres. Table 3 details testing criteria for inpatients who developed acute gastroenteritis after admission (ie, hospital-acquired cases). Inpatient testing occurred for the purpose of infection control, to record a diagnosis and/or to segregate patients with the same diagnosis in the same isolation room. Across the 12 centres, 27% of cases were hospital acquired (median 19.5%; range 13% [centre E] to 43% [centre B]).

Laboratory tests

Different laboratory tests are used to detect rotavirus in stool samples. Four centres (C, E, G and I) used electron microscopy. The remaining eight centres used immunoassays that, when compared with electron microscopy, ranged in sensitivity from 93% to 100%, and in specificity from 92% to 100%.

DISCUSSION

To rationalize the introduction of new vaccination programs, provincial health immunization planners seek cost-effectiveness and disease burden data, and inevitably request these data from their own pediatric hospitals as well as national sources. In fact, according to the Erickson et al (9) analytical framework for immunization programs, disease burden, cost-effectiveness and the ability to evaluate an immunization program are three important considerations for immunization program planners. IMPACT data, both locally and nationally, can provide much needed information for these purposes.

IMPACT undertook surveillance for rotavirus admissions believing the diagnosis, testing and admitting practices to be similar among participating hospitals. Each centre was surveyed before initiation of surveillance to determine whether hospital admissions were tested for rotavirus. A case definition of laboratory-confirmed rotavirus in admitted patients was used to eliminate false positives and improve the precision of the surveillance definition. All cases were actively identified and summarized using standardized procedures. In spite of this, our experience revealed important differences in case totals among the centres that could not be explained by population differences alone, thus prompting further investigation of specific practices.

Centres B and E accounted for a disproportionately large number of cases because of notable differences in the criteria for what was defined as a hospital admission (centre E), more liberal testing for community-acquired cases (both centres) and a higher proportion of hospital-acquired cases (centre B). At centre E, all patients in the short-stay unit and the observation unit were considered admissions by the hospital, whereas other centres with such units (A, B, G, J) did not classify patients cared for in these units as admissions. Thus, in centre E, patients in short-stay units were tested for rotavirus and information was available from the hospital chart, whereas in other centres, patients in short-stay units were

TABLE 3
Rotavirus testing criteria for inpatients (hospital-acquired cases)

Criteria for testing	Centres,	
	n/n	Centres
All symptomatic patients	6/12	A, B, F, G, H, K
Symptomatic patients <4 years of age	2/12	E, L
No specific criteria for testing (physician dependent)	4/12	C, D, I, J

not tested and information was not available for these cases. Among centres that tested all symptomatic inpatients, centre B had the largest proportion of hospital-acquired cases (43%), which accounted for some of the increase in case numbers at this centre. Centre D accounted for a disproportionately smaller number of cases because of aggressive treatment, management and referral in the ED, which shifted the burden of disease to the ED and other outlying community hospitals and, ultimately, limited the number of admissions and the number of cases tested because only admitted cases were tested. Centre D used IV locks, which allowed for more severely ill patients to be treated on an outpatient basis and actively referred less severely ill patients to community hospitals, thus limiting admissions and decreasing the opportunities for hospital-acquired infections.

To accurately represent the burden of disease and epidemiology of rotavirus and to properly assess the effects of the new rotavirus vaccines, it is important to understand and account for the differences in admitting and testing practices across Canada when examining rotavirus surveillance data. Using data from centre D (where the majority of cases are managed on an outpatient basis, are not tested and information is not collected) may lead to a drastic underestimate of the true burden of disease and underestimate the cost-effectiveness of an immunization program. Using data from centre E may more accurately represent the true burden of disease for community-acquired cases, but may overestimate the severity. Data on hospital-acquired infection from either centre E or centre L would underestimate the burden of disease because these centres only tested symptomatic inpatients younger than four years of age. Finally, even with active searching, identification and review for rotavirus cases, important information gaps exist. Because a rotavirus diagnosis is not necessary to manage and treat patients, standardized testing protocols that would identify a similar group of patients at each hospital across Canada do not exist. While all centres tested admitted cases, the lack of standardized testing and admission criteria contributed to the variation seen across the surveillance network. Only a handful of centres were able to provide information on the total number of rotavirus tests ordered each year. This information was not captured at 50% of the centres. More importantly, determining the denominator to make sense of such information is challenging because few centres collect the number of outpatient cases presenting with gastroenteritis. Such information is critical to understand local testing practices and separate secular trends from changes in rotavirus epidemiology. The lack of testing for rotavirus in outpatient cases, in which the majority of disease is experienced, remains another information gap. The majority of centres with short-stay units or observation units in their ED were unable to provide information on these patients, due to lack of testing and/or unavailable, incomplete or inaccessible ED records.

The nonstandardized admitting and testing practices across Canada make determining true baseline epidemiology of rotavirus and the cost-effectiveness of immunization programs difficult and complicates surveillance to monitor the effects of immunization programs. Although imperfect, baseline data on rotavirus is clearly important. Given the more than 90% efficacy of rotavirus vaccines against severe disease (7,10-12), significant decreases to admissions, ED visits and short-stay units should all be measurable when publicly funded programs are implemented. Consideration will need to be given to admitting and testing practices when monitoring these changes.

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