

A B S T R A C T

Objectives: To determine if a heightened, passive surveillance system increases the number of physicians reporting two notifiable diseases during a six-month period.

Methods: We conducted a randomized trial among 145 community-based primary care physicians in two counties in Eastern Ontario. Intervention group physicians received a three-part intervention aimed at improving their communication with the health unit to whom all physicians are mandated to report notifiable diseases. The control group physicians remained part of the usual disease reporting system. The outcome was assessed by a relative risk comparing the number of physicians reporting among the intervention group to that in the control group.

Results: Seventy physicians received the intervention and 75 physicians were in the control group. The relative risk for the number of physicians reporting at least one case was 5.9 (95% CI 2.6-13.2).

Conclusions: The intervention had an impact on reporting of notifiable diseases by physicians.

A B R É G É

Objectifs : Déterminer si un système de surveillance passive plus rigoureux augmente le nombre de médecins qui déclarent deux maladies à déclaration obligatoire au cours d'une période de six mois.

Méthodes : Nous avons procédé à une étude randomisée auprès de 145 médecins communautaires de première ligne dans deux comtés de l'est de l'Ontario. Les médecins du groupe d'intervention ont reçu une intervention en trois volets qui visait à améliorer leurs communications avec le service de santé auquel tous les médecins doivent signaler les maladies à déclaration obligatoire. Les médecins du groupe témoin sont demeurés dans le système habituel de déclaration obligatoire des maladies. On a évalué le résultat en fonction d'un risque relatif en comparant le nombre de médecins du groupe d'intervention qui ont produit un rapport à celui des médecins du groupe témoin qui l'ont fait.

Résultats : Soixante-dix médecins ont reçu l'intervention et le groupe témoin en comptait 75. Le risque relatif quant au nombre de médecins signalant au moins un cas s'est établi à 5,9 (IC à 95 %, 2,6 à 13,2).

Conclusions : L'intervention a eu un effet considérable en encourageant les médecins à signaler les maladies à déclaration obligatoire.

Improved Disease Reporting: A Randomized Trial of Physicians

Susan G. Squires, MSc,^{1,2} Kristan J. Aronson, PhD,^{1,2}
Robert S. Remis, MD, MPH,³ John R. Hoey, MD, MSc^{1,2}

Under-reporting of notifiable diseases by physicians is substantial,¹⁻⁹ creating many problems for public health officials in terms of both accurate surveillance and implementation of strategies aimed at preventing and controlling disease. In Ontario, 55 diseases are legally required to be reported to public health officials upon diagnosis.¹⁰

Principal barriers to physician reporting are lack of knowledge as to what diseases are notifiable¹⁰⁻¹⁴ and how to report these to the proper authority,^{6,13,15} and physicians' concerns such as their time involvement and patient confidentiality.^{6,12} Studies aimed at improving surveillance of communicable diseases have compared active (collector-initiated) and passive (provider-initiated) surveillance.^{6,12} Although active surveillance methods have improved the number of diseases reported by physicians, they are expensive to maintain and do not necessarily improve the timeliness of reports,^{1,4} which is important in detecting and controlling communicable disease epidemics.^{16,17}

We decided instead to attempt to improve the less expensive passive surveillance system, with the primary objective of increasing the number of physicians reporting two notifiable diseases. We also looked at which physician characteristics (specialty, gender, number of years in prac-

tice, type of practice and location of practice) might be associated with reporting. Two nationally notifiable, clinically diagnosed diseases, varicella and pertussis, were chosen to evaluate the intervention.

METHODS

All community-based primary-care physicians (family physicians, general practitioners and general practice pediatricians) in the Kingston, Frontenac and Lennox & Addington (KFL&A) region were included in the trial, using a sampling frame from a physician address database provided by the local public health unit. In an effort to minimize within-group practice settings contamination between the study groups,¹⁸ cluster randomization was used with the unit of randomization being the physician's office address. Physicians who had participated in an earlier focus group discussing barriers to reporting or who were employed by the health unit as of January 1, 1995 or whose primary place of practice was in an institution were excluded from this study.

Physicians were unaware of this study during the study period and consent was not sought. This was done to minimize the potential of attributing any changes in reporting behaviours to the Hawthorne effect. This was justified as physicians are legally obligated to report all cases of selected diseases and part of the mandate of the health unit is to ensure accurate surveillance of these diseases. This study was approved by Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board.

A randomized trial was conducted for six months between January and July 1995.

1. Department of Community Health and Epidemiology, Queen's University, Kingston, Ontario
 2. Kingston, Frontenac and Lennox & Addington Health Unit, Kingston, Ontario
 3. STD/AIDS Prevention Program, Montreal Regional Health Department, Montreal, Quebec
- Correspondence and reprint requests: Dr. Kristan J. Aronson, Department of Community Health and Epidemiology, Queen's University, Kingston, ON, K7L 3N6, Tel: 613-545-6000 ext. 4953, Fax: 613-545-6686, E-mail: aronson@post.queensu.ca

The intervention group received the following intervention: 1) at the beginning of the study period, a letter explaining the changes to the reporting method, a colour poster with case definitions¹⁹ of the study diseases and the telephone number to call to report these diseases; 2) an invitation to report diseases via a 24-hour direct telephone line with an answering machine (the 'hotline'); and 3) *CD Direct*, a new monthly postcard-sized publication aimed at disseminating communicable disease information and encouraging physicians to report notifiable diseases. The control group physicians remained part of the usual passive surveillance system and were expected to report all cases to the health unit using the usual health unit telephone number (available only during office hours). Reporting by controls was assumed to represent the usual level of (under) reporting. A follow-up telephone survey was conducted to evaluate physician acceptance of the hotline and *CD Directs* between July and October 1995.

Varicella and pertussis were chosen as study diseases since both are primarily clinically diagnosed and physicians would not be able to rely on reporting by laboratories. The combined incidence of varicella and pertussis is sufficiently high to provide the statistical power to detect an increased reporting relative risk of 2.0 associated with the intervention, which was labelled as being relevant to public health practice and statistically significant.

We defined reporting rate as the number of cases (varicella and pertussis) reported per physician per study arm during the six-month study period.

Physician characteristic information was collected from the Canadian Medical Directory.²⁰ Gender was assigned based on the physician's first name. Number of years in practice was calculated as 1995 minus year of graduation. Urban or rural location of practice was defined using the health unit's geographical definitions.²¹ Group or solo practice was defined by the physician's address: if more than one physician shared an address, the physician was determined to be in group practice. In the case of missing or ambiguous information, the physician's office was contacted to obtain the correct information.

Physician Characteristic (n=145)	Intervention (%) (n=70)	Control (%) (n=75)	P-Value*
Specialty			
Family physician/General practitioner	62 (88.6)	74 (98.7)	
Pediatrician	8 (11.4)	1 (1.3)	0.01
Gender			
Male	47 (67.1)	44 (58.7)	
Female	23 (32.9)	31 (41.3)	0.29
Group Practice†			
No	12 (17.1)	12 (16.0)	
Yes	58 (82.9)	63 (84.0)	0.85
Group Practice‡			
No	13 (29.5)	14 (24.6)	
Yes	31 (70.5)	43 (75.4)	0.57
Location of Practice			
Urban	60 (85.7)	53 (70.7)	
Rural	10 (14.3)	22 (29.3)	0.03
Mean number of years in practice ± standard deviation [range]	19.3 ± 10.5 [3-43]	19.5 ± 12.3 [3-58]	0.77¶
Average number of children under 7 years of age per physician practice ± standard deviation [range]‡	461 ± 402 [0-1934]	291 ± 255 [0-1000]	0.01¶¶

* from χ^2 statistic except where noted
† randomization definition
‡ self report from telephone survey (n=101)
¶ Wilcoxon rank sum Z test statistic

Variable	Total (n=145)		Intervention (n=70)		Control (n=75)	
	# reports	# MD	# reports	# MD	# reports	# MD
Total Standard Reports	62	25	48	19	14	6
Varicella	36	19	29	16	7	3
Pertussis	26	36	19	4	7	5
Total Hotline Reports	142*	23	142	23	0	0
Varicella	134	23	134	23	0	0
Pertussis	8	4	8	4	0	0
Total Reports	204†	39	190	33	14	6
Varicella	170*	33	163	30	7	3
Pertussis	34‡	12	27	7	7	5

* a total of 172 varicella reports were received: 144 varicella reports were received by the hotline but two were excluded because one was reported by a parent; for the other, the physician's name was not given.
† 208 reports were received between January 15-July 15, 1995. See *
‡ 36 pertussis reports were received but 2 were excluded as 1 physician reported the same case using both methods.

After all data for the primary objectives were collected, a telephone survey of the study participants was conducted using a structured interview format to obtain information on other potentially confounding variables such as number of children in a practice and to assess the acceptability of the intervention to those physicians to whom it was available.

Data analysis and statistical testing

The number of physicians who reported at least one case of varicella or pertussis, the method of reporting and the number of reports were counted. Rates and relative risks (RR) with 95% confidence intervals (CI) were calculated using the recommended intra-cluster correlation coefficient of 0.05.²² The mean number of reports per

TABLE III
Associations Between Physician Characteristics and Reporting as Measured by Relative Risks from a Univariate Analysis

Variable	Reporting Rate	RR	95% CI	P-value*
Specialty Pediatricians	0.33	1.26	0.48-3.31	0.70†
Gender Female	0.28	1.05	0.61-1.83	0.85
Practice Type Group practice‡¶ (n=145)	0.31	3.67	0.95-14.2	0.03
Practice Location Urban	0.29	1.62	0.74-3.53	0.20
Number of Years in Practice < 19 years (versus ≥ 19 years)	0.34	1.83	1.01-3.32	0.04

* testing the null hypothesis that RR=1 using a X2 test with df=1, except where noted
† Fisher's Exact Test
‡ cluster randomization definition
¶ self report from telephone survey (n=101)

physician was calculated for each study group and the groups were compared using the Wilcoxon Rank Sum Test.²³ A Poisson regression was performed to assess physician characteristics associated with reporting while controlling for any potential confounding variables.²⁴

RESULTS

From the sampling frame, 172 physicians were identified for potential inclusion into this study. Thirteen were ineligible because they had participated in the focus group, employed by the health unit, or had practices in institutions. A total of 159 physicians, in 53 clusters ranging in size from 1 to 18 physicians (mean cluster size of 2.6 physicians), were randomized: 74 physicians to the intervention arm and 85 physicians to the control arm. An additional 12 physicians were ineligible and were excluded after randomization: 8 were non-primary-care specialists, 3 had moved out of the region, and 1 was employed by the health unit. The study included 145 physicians, 70 in the intervention and 75 in the control groups.

Table I compares the characteristics of physicians in the intervention and control groups. A higher proportion of pediatricians, with more children as patients, and more urban practices were observed in the intervention group.

Table II shows 39 physicians reported 204 cases during the six-month intervention period with varicella reports accounting for 83%. In the intervention group, 33 (47%) physicians reported at least one case compared to only six (8%) in the control group. The relative risk for reporting associated with the intervention was 5.9 (95% CI 2.6-13.6); that is, physicians in the intervention group were almost six times more likely to report at least one case compared to physicians in the control group. For varicella alone, the proportions of physicians reporting were 42% for the intervention and 4% for the control group with a relative risk for reporting of 10.7 (95% CI 3.1-36.7) associated with the intervention. For pertussis, the proportion of physicians reporting were 10% for the intervention group and 7% for the control group, with a relative risk for reporting of 1.5 (95% CI 0.50-4.5). No control physician used the hotline method for reporting, indicating no contamination between the groups.

The mean number of reports per physician in the six-month period was 2.7 for the intervention group and 0.2 for the control group, a statistically significant difference ($p < 0.01$). For varicella, the means were 2.3 for the intervention group and 0.09 for the control group ($p < 0.001$). For pertussis, the respective reporting means were 0.4 and 0.09 ($p = 0.46$).

To assess whether physician characteristics influenced reporting behaviour, the intervention and control arms were combined and a comparison was made between those physicians who reported at least one case during the study period and those who did not report any case. Table III indicates that the physician characteristics studied had no influence on reporting, which was confirmed in a multivariate regression analysis.

The intervention was judged acceptable since 75% of the reports received from the intervention group physicians were communicated through the hotline. For the intervention arm only, 134 varicella (82%) reports and 8 (30%) pertussis reports were reported to the hotline. This disease-specific difference in reporting was statistically significant ($p < 10^{-6}$). Further, results from the telephone survey indicated a high level of acceptance (73%) of the intervention among those who responded (response rate 63%), with no statistically significant difference in physician characteristics and reporting behaviour between respondents and non-respondents. Of physicians who liked the hotline, 79% cited the reason that they could call it at any time to report. Almost all (95%) intervention physicians stated that they received and read at least one *CD Direct*.

DISCUSSION

This randomized trial, designed to evaluate a method of improving passive reporting, showed a six-fold increase in reporting by physicians receiving the intervention. Further, the mean number of reports per physician per study arm (reporting mean) was about 14 times higher for the intervention group than for the control group. When stratified by disease, the intervention group reported 26 times more varicella reports and 4 times the number of pertussis reports than the control group. We are aware of no other study that evaluated similar methods of improved passive surveillance. In randomized trials comparing active and passive surveillance systems, a two- to five-fold increase in reporting has been noted.^{1,4}

The intervention appears to have been responsible for the increase in reporting;

however, the fact that only a short-term (in this case, a six-month) commitment was required from physicians may have contributed to its success.

Although the intervention increased reporting for varicella, this study did not show a statistically significant effect for pertussis. At least three reasons may account for this. First, because a pertussis outbreak had been ongoing in the KFL&A region since August 1993 and all primary-care physicians had been sent a letter from the health unit informing them of the outbreak, pertussis reporting may already have been improved. Second, pertussis generally has a low incidence rate relative to varicella. To detect a true statistically significant difference in reporting of pertussis, we would have required either more cases, a larger sample size of physicians or a longer time frame. A third possible explanation is that this intervention is disease-specific and does not increase the number of pertussis reports but does increase the number of varicella reports. There is some evidence that reporting patterns may be disease-specific.^{1,4,8,9}

The imbalance in the study groups in terms of more children per practice, a higher proportion of pediatricians and a higher proportion of urban practices was addressed by excluding the pediatricians and re-running the analyses. When this was done, there were no longer statistically significant differences between the characteristics of the intervention and control groups. After excluding pediatricians, the relative risk for reporting remained essentially identical (6.0; 95% CI 2.7-13.4), as was the varicella-specific reporting relative risk (11.5; 95% CI 3.7-36.1). The mean number of reports was slightly lower at 2.5 for intervention group physicians. For varicella, the reporting mean was virtually identical (2.4). Thus, the exclusion of pediatricians to redress the imbalance in physician characteristics which occurred by chance in randomization had little effect in altering the results and interpretation of this trial.

The methodology of this study did not permit us to attribute the increases in reporting to any particular part of the intervention. Further, it is impossible to determine the extent of under-reporting

since the true incidence of these diseases is not known. Our experience indicates that physicians will cooperate with the health unit in an improved passive surveillance program. This is important since public health surveillance depends on physician cooperation. In assessing the acceptability of the intervention using the data from the telephone survey, given the low response, it is probable that the survey results may be biased towards a favourable assessment.

The generalizability of this study is limited in at least two respects. Our intervention may be disease-specific. Only two diseases were studied and, as previously noted, this study was unable to detect a statistically significant difference in number of pertussis reports received by study physicians. Further, it may not be possible to generalize these results to regions with considerably different demographic characteristics. For ethical reasons, this hotline would only be appropriate for non-urgent diseases (with respect to any public health action or follow-up that may be required). Also, diseases which are laboratory-confirmed or for which confidentiality is a concern (such as sexually transmitted diseases) may be inappropriate or unacceptable.

We believe our study design was robust in terms of avoiding biases or reducing their effects. Statistically significant results were demonstrated even with a relatively small sample size and when accounting for the effects of cluster randomization. This intervention was a simple, pragmatic and inexpensive tool that could easily be tested with other diseases or conditions (such as injury surveillance) and in other populations. Our results suggest that primary-care physicians will cooperate in time-limited public health strategies to improve disease-reporting practices.

ACKNOWLEDGEMENTS

The authors thank the staff in the Communicable Disease Department of the Kingston, Frontenac and Lennox & Addington Health Unit in assisting with this study and all the primary care physicians who participated. Dr. Aronson was supported in part through a Research Scholar Award (Health Canada).

REFERENCES

- Vogt R, LaRue D, Klaucke D, Jillson D. Comparison of an active and passive surveillance system of primary care providers for hepatitis, measles, rubella, and salmonellosis in Vermont. *Am J Public Health* 1983;73:795-97.
- Weiss B, Strassburg M, Fannin S. Improving disease reporting in Los Angeles county: Trial and results. *Public Health Rep* 1988;103:415-21.
- Valleron AJ, Bouvet E, Garnerin P, et al. A computer network for the surveillance of communicable diseases: The French experiment. *Am J Public Health* 1986;76:1289-92.
- Thacker S, Redmond S, Rothenberg R, et al. A controlled trial of disease surveillance. *Am J Prev Med* 1986;2:345-50.
- Goodman R, Berkelman R. Physicians, vital statistics, and disease reporting. *JAMA* 1987;258:379-81.
- Konowitz P, Petrossian G, Rose D. The under-reporting of disease and physicians' knowledge of reporting requirements. *Public Health Rep* 1984;99:31-35.
- Haward R. Scale of undernotification of infectious diseases by general practitioners. *Lancet* 1973;808:873-74.
- Kimball A, Thacker S, Levy M. Shigella surveillance in a large metropolitan area: Assessment of a passive surveillance system. *Am J Public Health* 1980;70:164-66.
- Marier R. The reporting of communicable diseases. *Am J Epidemiol* 1977;105:587-90.
- Government of Ontario. *Health Promotion and Protection Act, 1983. Amendments 1988*. Ministry of the Attorney General. Toronto: Queen's Printer for Ontario, September 1988.
- Voss S. How much do doctors know about the notification of infectious diseases? *BMJ* 1992;304:755.
- Schramm M, Vogt R, Momolen M. The surveillance of communicable diseases in Vermont: Who reports? *Public Health Rep* 1991;106:95-97.
- Harvey I. Infectious disease notification - a neglected legal tool. *Health Trends* 1991;23:73-74.
- Tizes R, Pravda D. Proposed toll-free telephone reporting of notifiable diseases. *Health Serv Rep* 1972;87:633-37.
- Benenson AS (Ed.) *Control of Communicable Diseases in Man* 15th ed. Washington, DC: American Public Health Association, 1990;83-86, 318-22.
- Cutts F, Waldman R, Zoffman H. Surveillance for the expanded programme on immunization. *WHO Bulletin OMS* 1993;71:633-39.
- Centers for Disease Control. Guidelines for evaluating surveillance systems. *MMWR* 1988;37S5:1-18.
- Hauck W, Gillis C, Donner A, Gortner S. Randomization by cluster. *Nurs Res* 1991;40:356-58.
- Health and Welfare Canada. Canadian communicable disease surveillance system: Disease-specific case definitions and surveillance methods. *Can Dis Wkly Rep* 1991;17S3:13-14, 26.
- Canadian Medical Directory 1994. Toronto: Secombe House, 1994.
- Carr P, Mowat D. Community Health Status Report. Kingston: KFL&A Health Unit, 1994.
- Donner A. An empirical study of cluster randomization. *Int J Epidemiol* 1982;11:283-86.
- Altman D. *Practical Statistics for Medical Research*. London: Chapman & Hall, 1991;194-97.
- Selvin S. *Practical Biostatistical Methods*. Belmont, CA: Wadsworth Publishing Company, 1995;342.

Received: June 10, 1997

Accepted: July 28, 1997