EVALUATION OF THE DESIGNATED CLINIC ALLOCATION MODEL USED DURING THE 2001 MLHU MENINGOCOCCAL OUTBREAK

MIDDLESEX-LONDON HEALTH UNIT

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Executive Summary

Introduction

The evaluation of the Middlesex-London Health Unit (MLHU) clinic allocation model provides data on the distribution of students immunized at designated clinics during the 2001 emergency meningococcal outbreak. Findings from MLHU clinic allocation model may be valuable for planning of future mass immunization campaigns. Similar clinic allocation models should be considered for expedient and efficient immunization resource distribution during mass community immunization programs. A lack of established literature discussing clinic allocation methods suggests that an implementation of a clinic allocation model to manage an outbreak immunization campaign was novel practice within Canada.

Background

In the spring of 2001, MLHU conducted an emergency meningococcal vaccination campaign for approximately 106,000 children aged 2 months to 24 years. During Phase II of the campaign, elementary students in the MLHU catchment area were designated a preferred clinic location and day to receive the meningococcal vaccination based on the school that they attended. Clinics were set up at 15 different locations over a two-week period resulting in a total of 69 clinics. It was anticipated that designating elementary school students to a preferred clinic would ensure that no clinic was excessively busy with long waits to be vaccinated and that it would also ensure efficient allocation and management of clinic resources.

Study Objective

The primary aim of this study was to evaluate the adherence of the elementary school population to the preferred clinic assignment during the meningococcal immunization campaign. The secondary goal was to explore the influence of clinic and school characteristics on student adherence.

Methods

Information characterizing the immunization clinic that each elementary school student attended was recorded following the student's vaccination using the Immunization Record Information System (IRIS) administrative database. Descriptive analysis quantified student compliance to the clinic allocation model. Univariate analysis of the variables thought to explain the variation in student compliance was explored. Variables found to be significantly related to student adherence using univariate analyses were then included in a logistic regression equation to predict adherence to the clinic allocation model.

Findings & Discussion

Overall 65.4% of the elementary school population adhered to the MLHU clinic allocation model. Logistic regression analysis indicated that "Region", "Clinic day of the week", "Victoria Day holiday", "Reported meningococcal case", "School size" and "Clinic size" were significant predictors of student adherence to the clinic allocation model. The results of this study were particular to the circumstances surrounding MLHU's campaign. Other immunization campaigns implementing a similar clinic allocation model during different circumstances may report alternate patterns of adherence. Higher numbers of reported meningococcal cases, reported deaths, and other qualifying factors may influence how a population responds to a clinic allocation model and therefore impact on the variables found in this study to be significantly related to student adherence. However, by understanding the adherence results of the MLHU clinic allocation model, more efficient management of immunization clinic resources in future emergency mass vaccination campaigns under similar circumstances may be possible. Of specific importance to the results of the MLHU campaign was the impact of clinic weekday, size of the student's school, and the presence of a holiday weekend.

Introduction

Outbreak and pandemic planning requires the vaccination of a large number of people expeditiously and efficiently. In addition, current health infrastructure may not be adequate to handle mass prophylaxis. Balancing client needs and effectively managing resources are of key importance when planning mass immunization campaigns. With a finite amount of healthcare resources health planners are now required to be more accountable for resources allocated. It has been recently stated that health infrastructures may not be adequate to handle mass prophylaxis[1]. Under these circumstances it is imperative that health planners consider the benefits of an allocation model and establish methods of managing emergency campaigns such that resources may be controlled and patient needs be adequately addressed. While published research in the area of meningococcal outbreak management provides recommendations based on campaign experiences, nowhere in the literature are clinic allocation methods discussed. Three recent Canadian meningococcocal campaigns, Ottawa –1992, Waterloo –1997 and Alberta -2000, did not report the use a clinic allocation method to assign the target population to different clinics[2 3 4]. Target populations for these campaigns selected their attended clinic from a list of possible clinics. Internationally, the use of a clinic allocation method during a meningococcal outbreak has not been reported. Minnesota, USA, set up one immunization clinic for the entire target population during a meningococcal outbreak; while in Southampton, UK, the set-up used to co-ordinate the allocation of a target population to various immunization sites was not clearly reported[5 6]. Thus, a lack of published literature discussing clinic allocation methods suggests that the use of clinic allocation assignments may be a novel approach to planning mass immunization clinics.

In the spring of 2001, the Middlesex-London Health Unit (MLHU) conducted an emergency meningococcal vaccination campaign for those aged 2 months to 24 years in response to four reported cases of meningococcal disease, serogroup C. The campaign consisted of two phases. The first phase of the campaign was conducted within the northern section of the City of London and focused on those between the ages of 15 and 24. A second phase was implemented when a further case of meningococcal disease was reported in the southern part of the City of London; the second phase addressed all those under 24 years of age for the entire health unit catchment area (including North London, South London and Middlesex County). During the two phases of the campaign, over 106,000 people were vaccinated at clinics run by the MLHU. It was during Phase II that the MLHU implemented the clinic allocation model to manage the immunization of elementary school students in the MLHU catchment area. High school students were vaccinated in their home schools, however, it was not possible to offer this to elementary schools due to the large number of schools in the MLHU catchment area.

One additional meningococcal case occurred during the immunization campaign in a student who was not yet immunized bringing the total number of cases to six. No deaths occurred among any of the six affected people. No other cases of meningococcal disease occurred for at least one and a half years following the conclusion of the campaign.

The MLHU set up a system that recommended elementary school students attend specific clinic locations on specific days. While the target population could attend any clinic, they were encouraged to attend the designated clinic on the designated day. The allocation model was used to anticipate the numbers of students that would be at each clinic on a particular day, should they adhere to the clinic recommendation. Other meningococcal campaigns have also reported having a number of different clinic sites. However, in these cases the target populations were instructed to attend the most convenient clinic from a list of possible clinics. Other meningococcal campaigns limited the number of clinic sites, often offering only one clinic site on different days. Campaigns often report long waiting lines the use of only one clinic location increased public panic[7]. It has been recommended that fewer campaign sites be used as more campaign sites often result in stretching available resources[8]. The aim of the MLHU campaign was to operate many clinics such that waiting times and public concern were lessened. The implementation of an allocation model was intended to control campaign resources by anticipating the numbers of people who would attend each clinic.

The evaluation of this clinic allocation model provides data on the distribution of student immunizations at clinics during the 2001 MLHU outbreak. Identifying an optimal clinic allocation method will enable future campaigns to maximize the use of available resources. Understanding how a target population can be instructed to receive necessary care expeditiously and efficiently by way of a clinic allocation model is valuable in today's health care environment.

Clinic Allocation Model

As part of the planning for Phase II of the meningococcal immunization campaign, elementary schools (n =152) in the MLHU catchment area were each designated a preferred clinic location and day to receive the meningococcal vaccination. Elementary schools from the City of London and from the surrounding Middlesex County were involved in the clinic allocation model. Clinics were set up at 15 different locations over a two-week period resulting in a total of 69 clinics. These clinics provided polysaccharide meningococcal vaccine for those 2 to 24 years of age. Separate clinics were set up for children less than 2 years of age who were given conjugate c meningococcal vaccine. Locations were selected based on their proximity to elementary schools, accessibility within the facility and available parking. All elementary school students attending a particular school were assigned to the same clinic location on a specific day. The clinic location chosen for each elementary school was the one that was closest to the elementary school. While elementary school students were encouraged to attend the designated clinic on the specified day, they could attend an alternate clinic or day if they so chose. Clinic designation information for each elementary school was conveyed to the public through newspaper advertisements and information sent home from school with each student. The Health Unit telephone information line and web site also provided clinic designation information.

A method was developed to allocate the students of each elementary school to a specific clinic at a designated location and time outside of school hours. A large map was used to determine which elementary schools would be vaccinated at which clinic locations. The total number of elementary school students assigned to one clinic location was then calculated. The MLHU jurisdiction was divided up into 3 areas: North, South and Middlesex County. A multiplying factor was calculated based on the ratio of the estimated number of 2-24 year olds to the number enrolled elementary school students for the area involved. This factor was used to determine by how much of the total number of elementary school students had to be increased to account for everyone who needed to be vaccinated at each clinic location (i.e., to include the 2-4 year olds and those 15-24 year olds not in school). Depending on the location of the clinic, the appropriate multiplying factor was also multiplied by the total number of elementary school students assigned to one clinic location. This yielded the total number of people anticipated for vaccination at that clinic location over all the days the clinic remained at that location. High school students were not included in the allocation campaign as they were vaccinated at their home school.

The staffing level of each clinic was designed to accommodate vaccinating 1000 people at each clinic location on each day. The total number of days the clinic would operate at each location was calculated by dividing the total number of people anticipated for vaccination at that clinic location by 1000. The total number of elementary school students to be vaccinated on any given day at that clinic location was then determined by dividing the total number of elementary school students assigned to that clinic location by the total number of days that clinic would remain in that location. Depending on the size of the elementary schools, anywhere from one to four schools were assigned to a clinic location on a given clinic day.

Objectives

The overall goal of the study was to evaluate the adherence of the elementary school population to the recommended clinic assignment during a meningococcal immunization campaign. This study has defined adherence to include only those students that received the meningococcal vaccine at the designated clinic location and day. The secondary goal was to explore factors that predicted student adherence based on the results of the MLHU allocation model.

The first objective of this study was to estimate and quantify the amount and type of overall compliance to the allocation model. By showing the proportions of students who attended the designated clinic (adherers), attended an alternate clinic (non-adherers), and those who did not attend any clinic (non-vaccinated). The study evaluated all those vaccinated (adherers + non-adherers) and non-vaccinated.

The second objective of this study was to use univariate and logistic regression analysis to explore campaign factors (student, school and clinic characteristics) that may have influenced adherence. Univariate analysis was used to determine whether school or clinic characteristics (such as school size and clinic weekday, region, location) influenced student adherence to the clinic allocation model. Variables found to be significantly related to student adherence using univariate analyses were then included in further multivariate logistic regression analysis.

Methods

Following approval from both the University of Western Ontario (UWO) Ethics Board and the MLHU Research Advisory Committee (RAC) the study accessed existing administrative data collected during the MLHU vaccination campaign. The Immunization Record Information System (IRIS) is a provincially designed system that was used to record immunization information on school children from the City of London and from Middlesex County during the campaign. Information characterizing the vaccination received, vaccination date, and the immunization clinic attended for each vaccinated elementary school student was recorded using the IRIS database.

An original study database was created using the IRIS database. Inclusion criteria were set up to include only those elementary students who were listed in the IRIS database as attending one of the 152 designated elementary schools in the 2000/01 school year. Criteria were established to exclude students who attended schools not included in the MLHU clinic allocation model because these schools were very small. These students were considered part of the community group that were instructed to attend the most convenient clinic to receive the recommended immunization. A total of 55,345 students recorded in the IRIS database matched to one of the 152 elementary schools.

The study data was anonymized by removing identifying student information from the original database. The first and last names, date of birth and Ontario Health Card Number (OHCN) were removed from each record and replaced with a MLHU student code. The MLHU student code was a unique numeric code that was created for all individual cases studied.

The following variables were included in the study database. Age was derived from the date of birth and was used to verify that cases met the appropriate age range for elementary school students. Student level grade data was used to verify that students were within the required elementary grade range. A MLHU "school code" was used to identify each of the 152 elementary schools included in the MLHU clinic allocation model. For anonymity purposes this variable was re-coded from the facility code taken from the original IRIS database. "Clinic code" was used to uniquely identify each of the 69 clinics. "Clinic number" was used to identify each of the 15 different clinic locations. Similarly clinic day was used to identify each of the 13 clinic days. Finally, MLHU "student code" identified all student cases (n = 55,345).

Variables not initially included in the working study database but necessary for analysis purposes were created and added to the study database. New variables were derived to assess whether the attended clinic was the same as the designated clinic. Variables were created to indicate whether the designated clinic location was the same or different from the attended clinic location and whether the designated clinic day was the same or different when compared to the attended clinic day. Indicator variables were created to identify the designated clinic's:

- Region - City of London or Middlesex County
- Victoria Day Holiday – held on Saturday or Monday of the Victoria Holiday
- Reported Meningococcal Case - held on the same day as the reported meningococcal case or not.
- Clinic day of the week – the day of the week on which the designated clinic day fell (no clinics were held on a Sunday).

A distance variable was created using mapping software (MapInfo) that captured the distance between student residence location and the designated clinic location. It was anticipated that the distance variable may be related to whether the designated clinic or an alternate clinic location was selected. Missing cases for the residence to clinic distances (missing = 14,850 of 55,345) were given the average distance of students assigned to the same clinic location.

Analysis

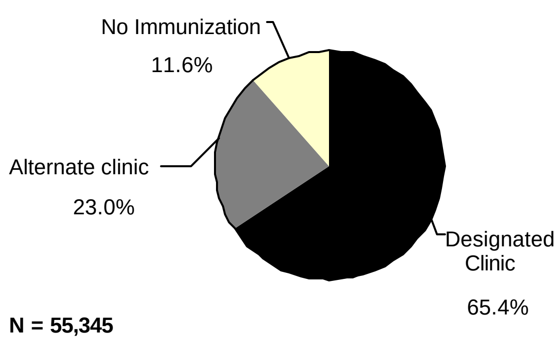
The first objective of this study was to evaluate the overall compliance of the student population involved in the MLHU clinic allocation model. Descriptive statistics using SPSS© software and MS Access© were used to characterize student compliance to the clinic allocation model by quantifying the amount and type of overall student compliance. This was accomplished by showing the proportions of students who attended the designated clinic, attended an alternate clinic, and those who did not attend any clinic (i.e. who did not receive the emergency meningococcal vaccine). Graphs and charts were created using Microsoft Excel. Confidence intervals that present the distribution within which 95% of all the scores occur were calculated and plotted.

Univariate analysis was undertaken to evaluate the relationship between proposed influential variables (Region, Victoria Day Holiday, Reported Meningococcal Case, Clinic Weekday, Distance) with student adherence. Variables related to student adherence at the 5 percent nominal level of significance on univariate screening were then examined with multivariate logistic regression (backward elimination; alpha entry set to 0.25 and alpha removal set to 0.1). The approach to the nomination of influential variables was liberal and did not adjust for the repeated application of statistical tests.

Results

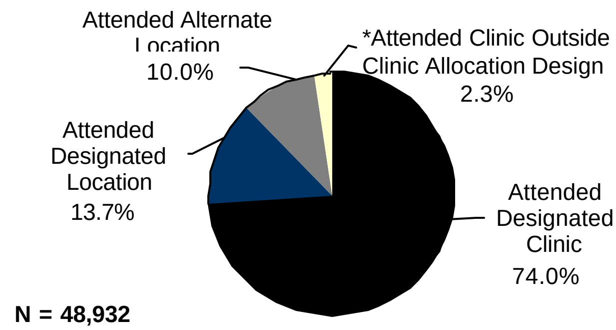
The overall results showed 65.4% of the 55 345 students received a meningococcal shot at their designated clinic (Figure 1). Just under one quarter of students (23.0%) attended either an alternate clinic location or day to receive the vaccine, and 11.6% did not receive the meningococcal vaccination.

Figure 1: Overall Elementary Student Compliance:
Middlesex-London Health Unit Area, 2001



When considering only those students immunized (48,932) close to three-quarters (74%) attended the designated clinic location and day (Figure 2). Of the remaining students (those choosing to attend an alternate clinic) 13.7% attended the designated clinic location but on an alternate day. There were 1,113 students (2.3%) that received the meningococcal vaccine at clinics not included in the clinic allocation model. Of these students, over 50% (644 of 1,113) received the emergency vaccination at one of the two catch-up clinics held the weekend following the close of Phase II of the meningococcal campaign. The remaining 469 students received the meningococcal vaccine at various clinics held during the proceeding months of June through August 2001.

Figure 2: Vaccinated Elementary Student Compliance
Middlesex-London Health Unit Area, 2001



Decreased adherence was observed for the youngest (59.7%) and oldest (63.0%) students assigned to a designated clinic to receive the meningococcal vaccine compared to those students aged between 8 and 11 years (68.4% and 66.2% respectively) (Figure 3). However, the differences were not marked, with all age groups showing between 60-70% adherence to the designated clinic.

Figure 3: Elementary Student Adherence by Age
Middlesex-London Health Unit Area, 2001

Student adherence was similar across the 15 clinic locations; with the only noted differences being between clinics in City of London vs. clinics in Middlesex County (Figure 4). Student adherence was higher for students designated to clinics held in Middlesex County (71.5%) compared to clinics held in the City of London (64.1%) (Figure 5).

Figure 4: Adherence by Clinic Location
Middlesex-London Health Unit Area, 2001

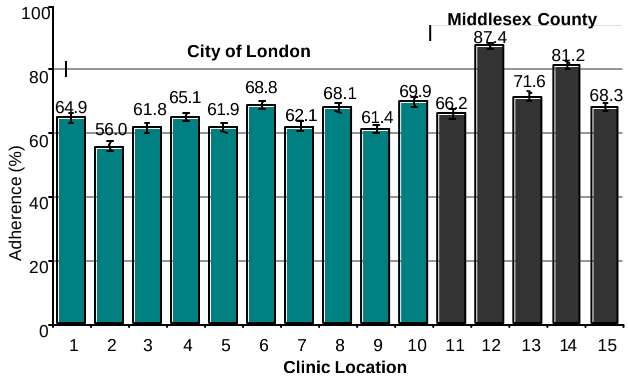


Figure 6: Student Adherence by Clinic Date
Middlesex-London Health Unit Area, 2001

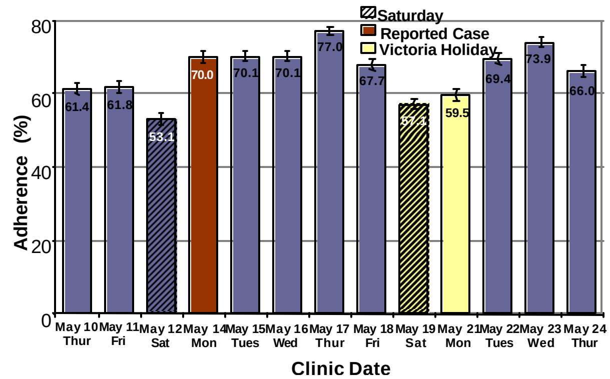


Figure 5: Adherence to Clinics held in the City of London and Middlesex County
Middlesex-London Health Unit Area, 2001

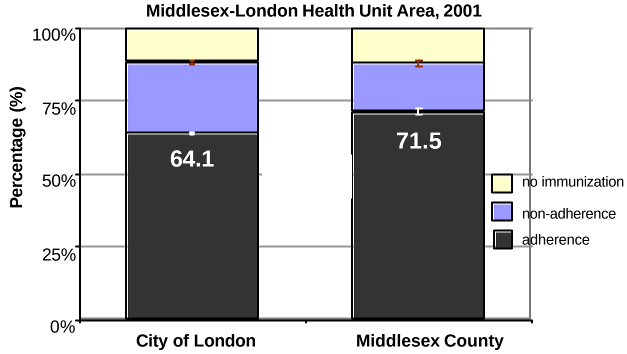


Figure 7: Adherence to Clinics held on a non-holiday vs. those held during the Victoria Holiday
Middlesex-London Health Unit Area, 2001

Variation in the level of student adherence was observed by clinic day (Figure 6). Clinics held during the Victoria Day holiday weekend (Saturday and Monday) (Figure 7) saw lower adherence to designated clinics compared to other days (58.1 ±1.1% vs. 66.7 ± 0.4%). Clinics that fell on the same day as the media report of a meningococcal case in the community saw higher adherence compared to all other clinic days (70.0 ± 1.2% vs. 64.9 ± 0.4%) (Figure 8). Clinics that fell on a Wednesday had the highest weekday adherence (71.5 ± 0.9%) while clinics that fell on a Saturday had the lowest student adherence (54.9 ± 1.0%) (Figure 9). Compared to all days of the week, excluding Sunday as no clinics were held on this day, Saturday clinics had the lowest reported rates of adherence (Figure 10).

Figure 8: Adherence to Clinics held on the day of a Reported Meningococcal Case vs. Al Other Clinics
Middlesex-London Health Unit Area, 2001

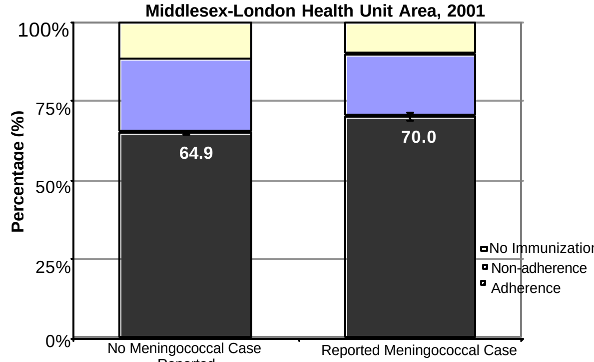


Figure 9: Adherence by Day of the Week
Middlesex-London Health Unit Area, 2001

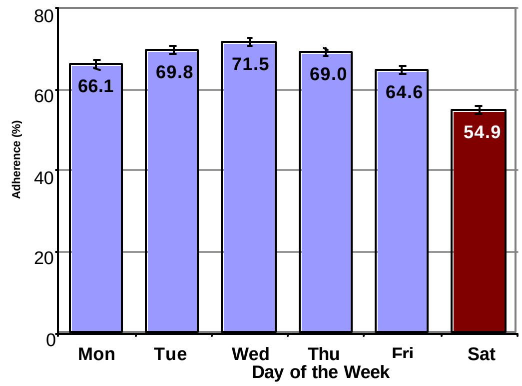


Figure 11: Adherence by Distance between Student Residence and Clinic Location.
Middlesex-London Health Unit Area, 2001

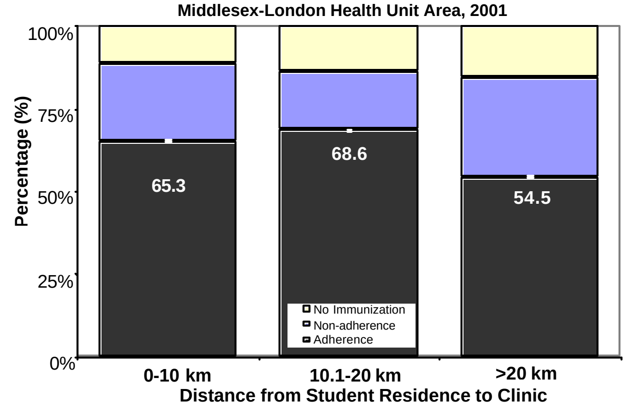
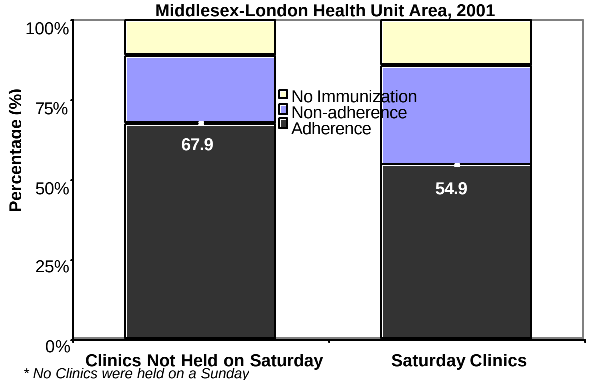


Figure 10: Adherence to Clinics held on a Saturday vs. Clinics held on *ALL other days
Middlesex-London Health Unit Area, 2001

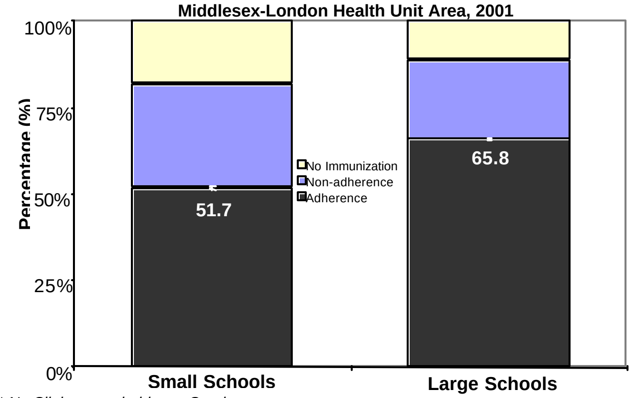


** No Clinics were held on a Sunday*

The distance between student residence and the designated clinic location was also evaluated. Student adherence was highest for those students living between 10 and 20 km from the designated clinic location with 68.6 ± 0.4%, compared to those living within 10 km of the clinic location (65.3 ± 0.4%) and compared to those living further than 20 km from the designated clinic location (54.5 ± 0.4%) (Figure 11).

Student adherence was lower for those students attending a small school (a school with 150 students or fewer) with only 51.7 ± 0.4% adherence compared to students attending larger schools (65.8 ± 0.4%) (Figure 12).

Figure 12: Adherence by Students attending small schools vs. large schools (> 150 students)
Middlesex-London Health Unit Area, 2001



** No Clinics were held on a Sunday*

Student adherence was also significantly associated with clinic size. Large clinics, clinics that administered more than 1000 immunizations, had higher rates of student adherence compared clinics with low clinic counts (Figure 13). Similarly, Figure 14 depicts the overall clinic counts (students + community immunizations), the student counts (adhered students + alternate students), as well as the adhered counts (adhered students). Clinics were ranked from largest to smallest. Clinics with the largest clinic counts also had the highest rates of adherence and the highest levels of alternate student counts, i.e. the largest number of students for whom the clinic was chosen as an alternate clinic.

Figure 13: Adherence to Clinic vs Size of Clinic
Middlesex-London Health Unit Area, 2001

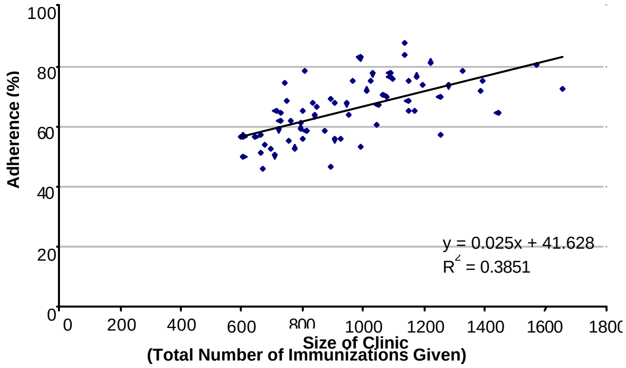
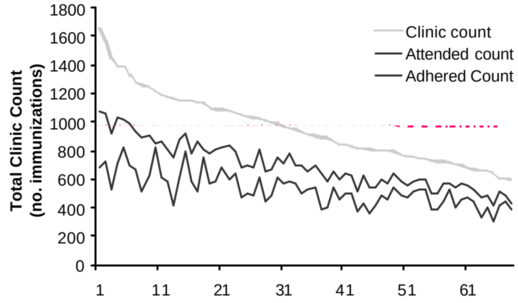


Figure 14: Total Clinic Count, Attended, and Adhered counts
Middlesex-London Health Unit Area, 2001



*Clinics were ranked largest to smallest

Results from the univariate analysis are found in Table 1. Univariate associations between student adherence and influential school and clinic factors are presented in the form of crude (unadjusted) odds ratios. The odds ratios convey the same pattern of adherence presented earlier using bar charts and error bars.

Table 1: Results from a Univariate Analysis of Binary and Categorical Predictors of Student Adherence to the Meningococcal Clinic Allocation Model implemented by the MLHU during an emergency meningococcal campaign.

Variable	*Odds Ratio*	*95% C.I. for Odds Ratio* *Lower*	*Upper*	*P Value*
Region (Rural = 1, City = O)	0.71	0.68	0.75	0.000
Age Group				
4, 5, 6 years	0.90	0.86	0.95	0.000
7, 8, 9, 10, 11 years	1.00			0.000
12, 13, 14 years	0.86	0.82	0.89	0.000
School Size (<150=1, >150=0)	0.56	0.50	0.62	0.000
Clinic Size (>1000=1, <1000=0)	1.77	1.71	1.84	0.000
Week Day				
Saturday	1.00			0.000
Monday	1.60	1.51	1.70	0.000
Tuesday	1.90	1.79	2.02	0.000
Wednesday	2.07	1.94	2.21	0.000
Thursday	1.83	1.73	1.94	0.000
Friday	1.50	1.42	1.59	0.000
Victoria Day holiday (Yes=1 no=0)	0.69	0.66	0.73	0.000
Reported Case (Yes=1 No=0)	1.26	1.18	1.34	0.000
Distance				
0-10 km	1.00			0.000
10.1 - 20 km	1.16	1.07	1.25	0.000
20+ km	0.64	0.53	0.77	0.000

Logistic regression analysis was used to establish a model that was predictive of student adherence using the independent variables that were first found to be related to adherence in the descriptive and univariate analyses. Included in the multiple logistic regression model building (stepwise backward elimination) were the following independent variables: Region (City of London vs. Middlesex County), Clinic Weekday (M, T, W, Th, F, and S), Reported meningococcal case (Y or N), Victoria Day Holiday (Y or N) School size (small < 150 or large ≥150), Clinic size (<1000 immunizations vs. ≥ 1000 immunizations) and Student age group (4-6 years, 7-11 years, 12-14 years). Due to the presence of multicollinearity between the variables Clinic Weekday, Reported Meningococcal case and Victoria Holiday two models were determined; the first included all independent variables with the exception of Clinic Weekday and the second model included all independent variables with the exception of Victoria holiday and Reported Meningococcal case.

In the presence of influential clinic and school variables, the location of the clinic, i.e. whether it was located in Middlesex County vs. the City of London remained a significant predictor of student adherence being higher in Middlesex County (Table 2).

Similarly, in the presence of campaign variables, younger (4-6) and older students (12-14) had a significantly lower odds ratio compared to students ages 7-11 years. Children in the middle age group being more likely to adhere to the clinic allocation model. School size remained a significant predictor of student adherence with students attending small schools (< 150 students) less likely to adhere to a clinic allocation model compared to students attending larger schools. Students assigned to Saturday clinics had a significantly lower odds ratio in the presence of influential clinic and school factors while those students assigned to Wednesday clinics were the most likely to adhere to the clinic allocation model. In the presence of all other campaign factors, those students living within 10 km of the clinic location were the most likely to adhere. In the presence of school and clinic variables student adherence on the day of a reported case remained higher compared to all other days (Table 3).

Table 2: Results from a Multiple Logistic Regression Analysis of Binary and Categorical Predictors of Student Adherence to the Meningococcal Clinic Allocation Model implemented by the MLHU during an emergency meningococcal campaign.

Variable	*Logistic Regression*	*Odds Ratio*	*95% C.I. for Odds Ratio* *Lower*	*Upper*	*P Value*
Constant	0.65	1.91			
Region (Rural = 1, City = O)	-0.44	0.64	0.61	0.68	0.0000
Age Group					
4, 5, 6 years	-0.10	0.90	0.86	0.94	0.0000
7, 8, 9, 10, 11 years		10..			0.0000
12, 13, 14 years	-0.17	0.84	0.81	0.88	0.0000
School Size (<150=1, >150=0)	-0.68	0.51	0.45	0.56	0.0000
Day of the Week					
Saturday		1.00			
Monday	0.55	1.72	1.63	1.83	0.0000
Tuesday	0.68	1.97	1.85	2.10	0.0000
Wednesday	0.75	2.11	1.97	2.25	0.0000
Thursday	0.66	1.94	1.83	2.05	0.0000
Friday	0.42	1.52	1.44	1.61	0.0000
Distance					
0-10 km		1.00			0.0000
10.1 - 20 km	-0.12	0.89	0.81	0.98	0.0127
20+ km	-0.68	0.51	0.42	0.61	0.0000

Table 3:
Results from a Multiple Logistic Regression Analysis of Binary Predictors of Student Adherence to the Meningococcal Clinic Allocation Model implemented by the MLHU during an emergency meningococcal campaign.

			95% C.I. for Odds Ratio		
Variable	*Logistic Regression*	*Odds Ratio*	*Lower*	*Upper*	*P Value*
Constant		3.29			0.000
Region (Rural = 1, City = O)	-0.48	0.62	0.58	0.65	0.000
Age Group					
4, 5, 6 years		0.90	0.86	0.94	0.0000
7, 8, 9, 10, 11 years	-0.11				0.0000
12, 13, 14 years	-0.17	0.84	0.81	0.88	0.0000
School Size (<150=1, >150=0)	-0.61	0.54	0.49	0.61	0.0000
Victoria Day holiday (Yes=1 No=0)	-0.41	0.67	0.63	0.70	0.0000
Reported Case (Yes=1 No=0)	0.26	1.29	1.22	1.38	0.0000
Distance					
0-10 km					0.0000
10.1 - 20 km	-0.12	0.89	0.81	0.97	0.0090
20+ km	-0.64	0.53	0.43	0.64	0.0000

Variables entered into the model: Region, Age, Reported Case, Victoria Holiday, School size, Student Residence to Clinic Distance

Discussion

During Phase II of the campaign, students attending almost all elementary schools in the City of London and surrounding Middlesex County were designated to a clinic location and day to receive the meningococcal vaccination. It was anticipated that recommending elementary school students attend a designated clinic would ensure that no clinic was excessively busy with long waits to be vaccinated and that it would also ensure efficient allocation and management of clinic resources. Clinics were set up to accommodate 1000 immunizations each day. The average overall clinic attendance at the 69 designated clinics was 967 immunizations per clinic. The 2001 MLHU campaign was a success; however the range in clinic attendance (576 to 1656) indicated there were clinics that were over-used (surpassing the 1000 count) and clinics that were under-used (with total immunization counts well under the anticipated 1000). Evaluation of the clinic allocation model highlighted characteristics particular to the target population (elementary school students) and to the designated clinics that appear to have influenced the observed levels of adherence at designated clinics as well as overall clinic counts.

Overall 65.4% of the elementary school population adhered to the clinic allocation design by receiving a meningococcal vaccine at the designated location and day recommended by the MLHU. While the results of the MLHU clinic allocation model are particular to the circumstances surrounding the MLHU campaign, future emergency mass immunization campaigns set up under similar circumstances may anticipate close to two thirds of the target population (65.4%) attend the designated clinic location and day.

Other immunization campaigns implementing a similar clinic allocation model during different circumstances may report alternate patterns of adherence. Higher numbers of reported meningococcal cases, reported deaths, and other qualifying factors may influence how a population responds to a clinic allocation model and therefore impact the variables found in this study to be significantly related to student adherence and overall clinic counts. However, by understanding the adherence results of the MLHU allocation model, more efficient co-ordination of immunization clinic resources in future emergency mass vaccination campaigns set up under similar circumstances may be possible.

The evaluation of the clinic allocation model used during the MLHU emergency meningococcal outbreak was a retrospective cross-sectional study. One limitation of this study was therefore that there was no population to serve as a control to the target population participating in the clinic allocation model. A control group would lend increased strength to the findings of the evaluation of the MLHU clinic allocation model.

There were no deaths during the 2001 MLHU emergency meningococcal campaign; this may have contributed to a lessened state of panic in the elementary student population. The result may have been an increased willingness to comply with recommended clinic allocation assignments, more students may have waited to attend the designated clinic day even if it had been on the last day rather than attending an earlier clinic day, and therefore the results of this study may show a higher observed level of overall adherence than might otherwise occur in the event of a death due to the outbreak.

This study relied on existing data collected for administrative purposes. Due to the retrospective nature of this study, other variables that may have affected a school's level of adherence to the allocation model were not captured and therefore not available for use in this study. One study hypothesis was that families with siblings at different schools and assigned to different designated clinics would have chosen one of the designated clinics to attend to receive the meningococcal immunization for all members of the family. Therefore, those students with siblings that attended different schools may have chosen to attend an alternate clinic; the designated clinic of the sibling. Sibling information was not available for the purposes of this study. Future studies may wish to also evaluate student family variables and the impact of siblings designated to different clinic assignments on adherence.

For the purpose of this study it was assumed that those students that chose not to receive the meningococcal vaccine would have done so regardless of whether or not a clinic allocation model was implemented. It is recognized that the presence of a clinic allocation model may have influenced the 11.0% of students not immunized. The fact that there were no deaths during the campaign may have also had an affect on the choices made by students not immunized. Future studies evaluating the group of students not immunized during an emergency meningococcal outbreak is indicated.

School Characteristics

There were school characteristics that were significantly related to adherence. The size of the school was significantly related to school adherence; students attending smaller schools had lower reported adherence to designated clinics. Smaller schools were thus associated with higher levels of non-adherence and non-participation during the emergency immunization campaign. Future campaigns may want to increase the education effort directed towards small schools regarding participation in emergency immunization campaigns using the clinic allocation model. Students recommended to clinics in Middlesex County had higher adherence compared to students assigned to clinics in the City of London. There were fewer County clinics (13 County vs. 56 City) and therefore less choice for students attending schools in Middlesex County to attend alternate clinics. It was anticipated that schools where a higher proportion of students were bused, would choose to attend clinics located closer to their home rather than closer to their school. However there were no significant differences in adherence between schools with high and low proportion of students that took the bus (results not shown). The possibility exists that those students who regularly travel longer distances, up to 20 km, to get to school also chose to travel the extra distance to attend the designated clinic in the same familiar area as their elementary school. Results found that those students living further than 20 km way from the designated clinic location were less likely to adhere to MLHU's allocation model.

Adherence was significantly related to school size, region, day of designated clinic and also to whether the clinic fell on a holiday weekend and whether the designated clinic fell on the same day a new case of meningococcal disease was reported. Future campaigns will find larger schools (greater than 150 students), located in Middlesex County, assigned to a clinic day other than Saturday, not on a holiday weekend, and assigned to a clinic day that coincides with a new reported case of meningococcal disease (motivation) to be associated with higher levels of adherence. This information allows campaign planners a greater knowledge of what resources will be required to accommodate the numbers of students to be immunized from each school based on school characteristics and designated clinic characteristics.

Clinic Characteristics

Differences between the fifteen clinic sites were not significant (Figures 4). This may be due in part to the MLHU planning effort to designate students to clinics in appropriate geographical areas. Students were assigned to clinic locations based on their school's proximity to the clinic location. Therefore it may be possible that in the absence of a clinic allocation model for clinic location, students may have chosen to attend the preferred MLHU clinic location. Given the MLHU planning efforts to match students with the most geographically appropriate clinic sites, it may be that the underlying importance of the clinic allocation model was the distribution of students across designated clinic days for each given location and not the distribution of students to the 15 clinic locations. The success of the clinic allocation model in assigning students to appropriate clinic sites can also be measured by the 76% (42,917 of 55,345) of those immunized that attended the designated clinic location. Therefore the system implemented by the MLHU to designated students to clinics close in proximity to their elementary school can therefore be considered a success.

The clinic allocation model was necessary primarily for managing student flow to the immunization clinics on the different days of the campaign. Significant differences were found between the thirteen clinic days (Figure 6). There were factors that appeared to have influenced the levels of adherence observed over the course of the 13 clinic days. The particular day of the week on which the clinic day fell was strongly associated with adherence. Saturday had significantly lower proportions of students adhere to the clinic allocation design (Figures 6, 9 and 10). Saturday clinics also had fewer students choose this clinic day if students were attending an alternate clinic. It is important to note that there were only two of the clinic days were Saturdays, and one of the two was also the Victoria Day long weekend. This may have influenced the low adherence observed on Saturday, however, adherence on the Saturday not also on a holiday weekend was equally as low (Figure 6). However, clinics held on Saturdays still had greater than 55% percent adherence. Therefore, Saturday clinics did serve a proportion of the target population. Future campaigns may plan to continue to offer clinics on Saturdays but may plan to allocate fewer resources on this day in the anticipation that adherence may be lower resulting in smaller overall clinic counts.

Student adherence was also higher for the clinic day held on the same day as a meningococcal case was reported by the media (Figure 8). The student with meningococcal disease reported in the media attended that same school that was assigned to receive the immunization on the same day. It is therefore possible that the higher adherence observed on the same day as the reported case was the result of the increased awareness of the case by those students assigned to attend clinics on that day.

As already discussed, the overall size of the clinic was positively related to student adherence. Larger clinics were associated with larger proportions of students that adhered to the designated clinic. Also associated with large overall clinic counts (Figure 14) were larger numbers of students for whom the clinic was an alternate clinic choice as well as larger numbers of community immunizations. These findings can be interpreted such that clinics that were popular for students, (demonstrated by increased adherence and increased numbers for whom the clinic was chosen as an alternate clinic) were also popular with the community.

Implications

It is the possibility of having under-used clinics and over-used, popular clinics during a campaign that make estimating total clinic counts essential. Resources can be added or redistributed depending on how many more or fewer immunizations are required compared to the planned 1000 immunizations per clinic. Being able to predict which clinics are more likely to be over-used as well as those clinics that will be under-used allows health planners to better allocate campaign resources. One result of better allocating resources is shorter waiting times for those immunized, which in turn results in less public panic for those involved. There are also direct benefits to the Health Unit if campaign planners are better able to anticipate attendance and thereby allocate fewer resources to meet the decreased immunization demand at smaller clinics. This will result in fewer resources wasted at smaller clinics and a more efficient uptake of the emergency vaccine if clinics that have characteristics of large (popular clinics) are staffed and stocked with appropriate resources. Thus there are direct benefits to those participating in an emergency immunization campaign. The greater the proportion of the population adhering to the clinic allocation model the better health planners are able to predict the pattern of demand for the emergency vaccine.

The MLHU clinic allocation model used for the coordination of student immunizations during the 2001 emergency meningococcal outbreak was the first of its kind. Important findings resulted from the evaluation of this clinic allocation model:

- Overall 65.4% of the target student population adhered to the MLHU clinic allocation design.
- Student attendance at designated clinics was found to be higher when located in Middlesex County and for weekday clinics (Monday – Friday), on the same day as reported meningococcal case, clinics not held on the Victoria Day holiday weekend, for students attending schools with enrollment sizes equal to

or larger than 150 students, and for students living within 10 km of the clinic location.

- The MLHU Clinic Allocation Model was most beneficial for distributing an equal number of student immunizations across clinic days. Saturday clinics saw the lowest observed levels of adherence to designated clinics.
- Large overall clinic sizes were popular for both target student population and individuals from the community. Large clinics had high proportions of students adhere to the clinic allocation model, were not held on a Saturday, and were not held on the Victoria holiday weekend.

The evaluation of the MLHU clinic allocation model provides data on the distribution of student immunizations to designated clinics during the 2001 emergency meningococcal outbreak. Findings from MLHU clinic allocation model may be valuable for planning of future mass immunization campaigns. Similar clinic allocation models should be considered for expedient and efficient immunization resource distribution during mass community immunization programs.

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