Giardiasis in Auckland Water Distribution Zones

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Introduction

In May 1997 Auckland Healthcare Public Health Protection purchased and installed a Geographical Information System (GIS) for use in the surveillance control of a measles epidemic in Auckland. Part of the implementation of the GIS was to design a process that would geocode the street address of disease cases to an x and y co-ordinate from a streets database. Once the measles epidemic had passed other uses of GIS in the service were explored and in particular, ways of examining the relationship between disease incidence and environmental exposure. The limitations of our desktop GIS set-up required the information needed to be readily available in a format that could be entered into ArcView with minimal reconfiguration.

Giardiasis has the second highest annual notification rate of all legally notifiable diseases. Giardiasis was added to the schedule of diseases required to be notified to the Medical Officer of Health under the Health Act 1956 from 6 June 1996. Some notifications were received for first half of 1996 as doctors in New Zealand became aware of its impending change in notification status.

A geographical unit was required to calculate rates of disease. Census area units and meshblocks are conveniently available but a geographical unit was required that could be related to environmental exposure. In Auckland water from different sources and undergoing different treatment is distributed to identifiable zones within a local authority area. These water distribution zones provide a population to determine rates and could allow identification of areas with higher than expected rates of giardiasis and be used for targeting subsequent investigation and analysis.

Aim

To explore the limitations of matching routinely collected data on cases of Giardiasis reported by medical practitioners in Auckland with water distribution zones using a geographical information system.

Method

Letters were sent to the seven local authorities in Auckland requesting water distribution zone boundaries in digital format that could be loaded directly into an ArcView GIS.

Cases of giardiasis notified by medical practitioners in Auckland are stored in a computerised database. The period selected for analysis was 1 July 1996 to 30 June 1998. Where there were insufficient numbers of cases (e.g. in the zone analysis) the entire time period was used, otherwise the data was analysed in two twelve month time periods. The giardiasis case records were geocoded (i.e. given an x and y New Zealand Map Grid co-ordinate by matching the address of the case to a streets database) and the number of cases of giardiasis were counted in each water distribution zone.

The population used to calculate disease rates for each zone was estimated by aggregating meshblock census data based on the proportion of the meshblock falling inside the zone boundary.

Results

Of the seven local authorities only one was able to respond immediately to our request and supply digital water distribution zone boundaries. The rest either did not have a GIS (4 local authorities), the information on distribution zones was not in their GIS (1 authority) or the information was not accurate enough for immediate transfer to our system (1 authority).

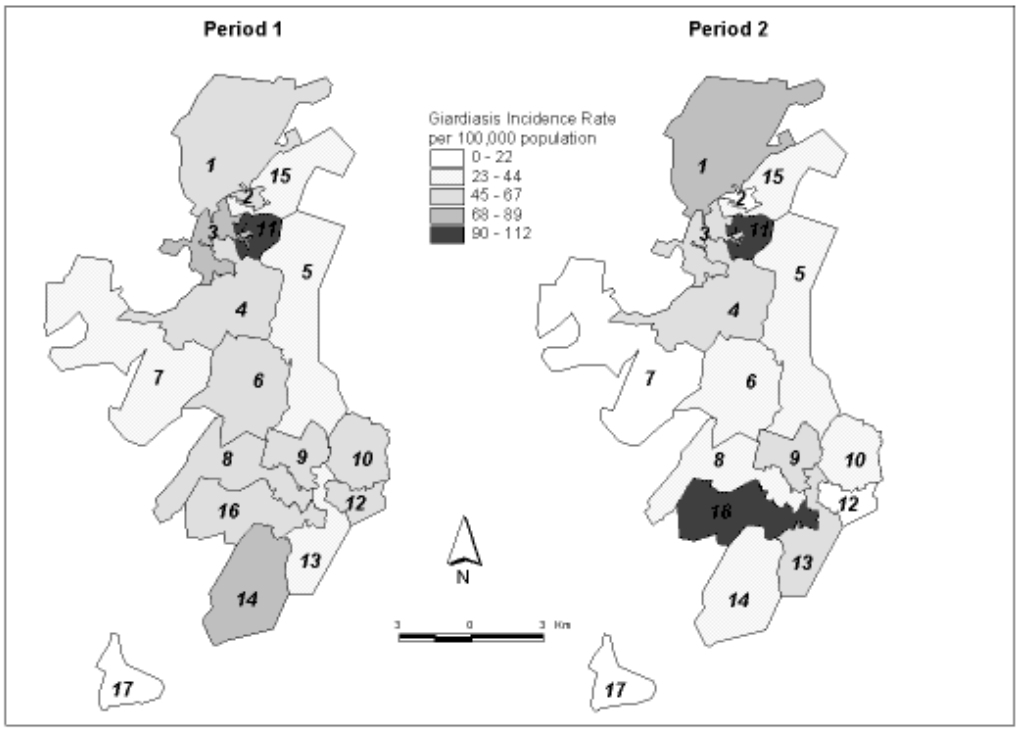

Figure 1 : Giardiasis Incidence in water distribution zones in an Auckland local authority area

The seventeen water supply zones in the study area delivered treated and filtered water to approximately 150,000 people (14 % of the population in the Auckland region). The zones had populations varying between 114 and 30,167.

For the water distribution area studied there were 80 notified cases of giardiasis in the first twelve months and 64 cases notified in the second twelve months.

For the total Auckland region in the same periods there were 644 cases and 623 notified cases respectively.

Figure 1 shows the geographical spread of disease incidence in the water distribution zones over each of the twelve month periods. A comparison of the disease incidence rates in each of the zones for each twelve month period is shown in Figure 2.

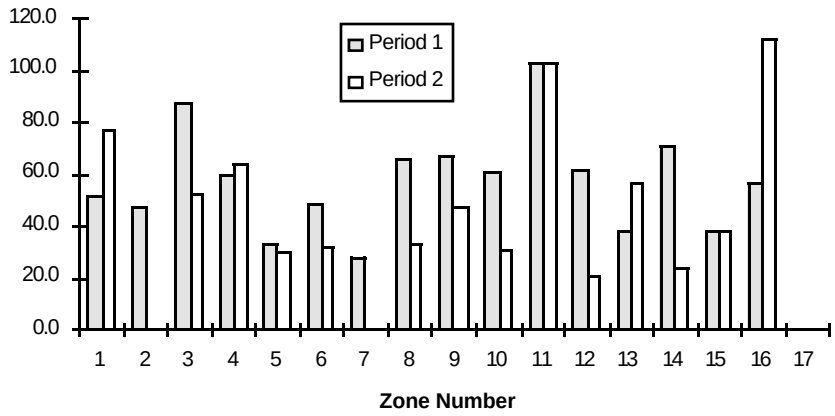

Figure 2 : Incidence rates of giardiasis for water distribution zones in an Auckland local authority area

Zone	Period 1			Period 2		
	No of cases	Disease Incidence Rate*	Age Standardised Rate*	No of cases	Disease Incidence Rate*	Age Standardised Rate*
1	2	51.3	45.2	3	76.9	69.0
2	1	47.2	42.3	0	0.0	0.0
3	5	87.1	78.3	3	52.2	54.1
4	13	59.5	51.3	14	64.1	62.6
5	10	33.1	32.7	9	29.8	29.6
6	9	48.1	49.1	6	32.1	31.5
7	1	27.6	28.1	0	0.0	0.0
8	6	66.4	60.1	3	33.2	30.2
9	7	66.9	61.2	5	47.8	97.9
10	8	60.9	57.9	4	30.4	31.0
11	5	102.2	104.1	5	102.2	115.5
12	3	61.4	63.8	1	20.5	15.9
13	2	38.2	31.2	3	57.2	45.6
14	3	70.6	57.4	1	23.5	18.9
15	3	38.7	34.6	3	38.7	42.6
16	2	56.0	60.3	4	112.1	119.8
17	0	0.0	0.0	0	0.0	0.0
Total	80			64		

* Rate per 100 000 population

Table 1 - Numbers of giardiasis cases and rates for water distribution zones in an Auckland local authority area

The disease rate in Zone 11 is consistently higher than all other rates in both time periods as shown in figure 2. A relative risk of 1.71 (Relative risk [RR] 1.71, 95% confidence interval [CI] 0.84 -3.49, p value [p] 0.21) was calculated for the zone comparing its rate of disease over the two year period with the rest of the zones combined.

The number of cases in each time period, the annual disease incidence rate and age standardised incidence rate (using the Auckland region population from the 1996 census) for each zone is shown in Table 1. With the exception of Zone 9 there was little difference between the age standardised and unadjusted disease rates. Most of the variation between the unadjusted and standardised rate in Zone 9 was due to one case in the 85-89 year age group occurring in a population of 26.

Analysis of the age distribution of the cases in the first time period compared to the second is shown in the Table 2. There was a decrease in the number of

Age Group (years)	Period 1				Period 2			
	Male	Female	Total (%)		Male	Female	Total (%)	
0 to 4	11	16	27	(33.8)	2	8	10	(15.6)
5 to 9	4	6	10	(12.5)	2	1	3	(4.7)
10 to 14	0	1	1	(1.3)	1	0	1	(1.6)
15 to 19	0	0	0	(0.0)	0	1	1	(1.6)
20 to 24	2	2	4	(5.0)	1	3	4	(6.3)
25 to 29	3	9	12	(15.0)	2	1	3	(4.7)
30 to 34	1	6	7	(8.8)	4	13	17	(26.6)
35 to 39	2	4	6	(7.5)	5	4	9	(14.1)
40 to 44	0	5	5	(6.3)	1	1	2	(3.1)
45 to 49	0	1	1	(1.3)	2	2	4	(6.3)
50 to 54	0	2	2	(2.5)	3	0	3	(4.7)
55 to 59	2	0	2	(2.5)	1	1	2	(3.1)
60+	0	3	3	(3.8)	0	5	5	(7.8)
Total	25	55	80		24	40	64	

Table 2 - Age and gender breakdown of notified giardiasis cases for each time period

cases reported in under 5 year olds from 27 to 10, 5 to 9 year olds from 10 cases to 3 cases and 25 to 29 years old from 12 cases to 3 cases. An increase in reported cases from 7 to 17 occurred in the 30 to 34 year age group.

The highest disease rate occurred in the 0 to 5 year age group followed by the 30 to 34 year olds, 35 to 39, 25 to 29, and 5 to 9 year age groups. Females represented 69% of the cases (31% males) notified in the first time period and 61% (38% males) in the second twelve months.

Statistical analysis of the change in the rates of disease between the two time periods showed a higher relative risk in the first time period for under 5 years olds (RR 2.70, CI 1.31-5.58, p 0.005), for 25 to 29 year olds (RR 4.0, CI 1.13-14.17, p 0.02) and a higher relative risk in the latter time period for 30 to 34 year olds (RR 2.43, CI 1.01-5.85, p 0.04).

The database used to record cases of giardiasis reported by medical practitioners can record whether the case attends a childcare centre or has travelled overseas. In the two year study period 3 (8%) cases were recorded as attending childcare, 4 (10%) did not attend childcare and for 31 (82%) attendance was unknown. The database can also record whether overseas travel was undertaken. In the three months prior to their notification 6 (4%) cases had overseas travel recorded, 26 (24%) did not undertake overseas travel and for 104 (72%) this was unknown. The high percentage of those "unknown" makes drawing any conclusions impossible.

Discussion

The major mechanisms of acquiring a *Giardia* infection have been reported as faecal-oral transmission (e.g. in day care centres) and the drinking of inadequately filtered water. [1] Giardiasis is a laboratory diagnosis in most cases. Notification of cases of giardiasis will be less than the true incidence of giardiasis when cases do not visit a medical practitioner for financial or other reasons or where a faecal sample is not submitted for laboratory testing. Cases may be notified at higher rates in some locations when a medical practitioner has a special interest in identifying cases of giardiasis or is particularly conscientious in reporting every case of giardiasis.

Notified cases of disease are assigned to a local authority area and this has been used for producing reports of giardiasis incidence rates in local authority areas. Allocation to a local authority often depends on the geographical knowledge of those persons reporting and recording the case. A recent audit of giardiasis notifications against the location provided by the geocoding process showed that up to 25 % of the allocation of cases to local council areas were inaccurate in the Auckland Region. Geocoding provides a more flexible option that not only records the accurate location of cases but allows aggregation of case numbers by different boundaries.

The use of maps and graphs of giardiasis for reporting disease incidence to local authorities responsible for water treatment, and distribution gives more information than using territorial local authority or ward boundaries and is more useful than census area units or meshblocks as water distribution zones are a potential exposure source. There is the potential to identify possible failures in water treatment and areas where infiltration and contamination may be occurring.

In Auckland due to the large numbers of notified diseases, investigation is prioritised. If a case is assessed as at high risk for spreading the disease (e.g. attends a childcare centre or is employed as a food handler) an investigation is performed. In all other cases a letter is sent to the case giving them information on the illness and asking them to contact the public health authorities if they are a high risk. Therefore, in a large number of cases no direct contact is made with the case or caregiver to obtain information on exposure to potential sources of giardiasis and the information recorded in the database is received via a medical practitioner or practice nurse. If information on exposure to all major risk factors was routinely recorded in the database a model could be developed that dealt with these factors.

Mitchell et al[2] in a case control study of giardiasis in Canterbury in 1993 reported the highest rate of disease in preschoolers and young adults. The cases reported in Auckland follow this general pattern especially for preschoolers who have at least twice the rate of disease for any age group except 30-34 year olds. The statistically significant difference in the case incidence between the two time periods for under 5 year olds may have been associated with a child care outbreak.

The inclusion of cases that have known risk factor exposure in the analysis masks the number of cases whose only known risk of exposure was to the water in this zone. This has the effect of changing the apparent risk of giardiasis by water distribution zone. This effect known as confounding, cannot easily be adjusted for, requiring relatively complex statistically analyses and more detailed data on other risk factors for illness.

The number of cases of disease in each water distribution zone is small (between 0 and 13) and markedly affects the precision of the analysis. The poor precision is reflected by the wide confidence limits around point estimates. As a consequence many estimates failed to achieve statistical significance at the <0.05 level. One way of overcoming this problem would be to aggregate data for several years. As giardiasis was added to the schedule of notifiable diseases in June 1996, further years of data were not available to include in the analysis. The small number of cases in some water distribution zones means that unless there was a significant increase in the rate of notification there would be little value in analysing this data at intervals less than one year.

The water supplied to the distribution zones within the area studied is all filtered and has an Aa grading in the Register of Community Drinking Water Supplies in New Zealand, a published register of water quality throughout New Zealand. There are four supply sources used for all of these zones but the percentage of water supplied from each can vary among distribution zones. Water distribution zones could be aggregated if information was readily available to group the zones on common attributes. Other factors such as age or type of pipes were not readily available. This is an area that could be investigated further and as local authorities develop their own geographical and information systems is likely to become more readily available.

It cannot be assumed that the delivery of treated water to a household will mean that this water will be used as the main or only supply of drinking water. Some households may use roof or bore water for financial reasons or for preference of taste or other perceived health benefits. People who live in reticulated areas may be exposed to *Giardia* if they drink water from other geographical areas where the water is not filtered or they come in contact with contaminated recreational water. Water consumption in not limited to where people reside but also occurs at work, school, daycare etc.

This analysis was done for one area of Auckland representing about 15% of Auckland's total population, and will allow a comparison of rates of giardiasis within other areas of Auckland, between treated and untreated water and different water supply sources such as bore and roof water. Once information concerning other water distribution zones is obtained, the number of giardiasis cases can be determined for untreated and unfiltered supplies. This comparison would be useful for determining at what "case rate" action such as investigation of cases and the water supply should be initiated.

Due to the limitations of our desktop GIS set-up, information needed to be readily available in a format that could be entered into our existing system with minimal reconfiguration. However, the fact that only one TLA could provide digital water distribution zone boundaries limited the analysis undertaken. Efforts are continuing to obtain digital water distribution zones boundaries for other areas of Auckland. Another local authority will shortly be able to supply digital zones and consideration is currently being given to digitising the boundaries that are available in paper format as there are other areas of analysis that would use these boundaries.

It may also be useful for public health providers to focus their investigations in areas of high rates by using longitudinal data in surveillance for an individual area e.g. if the monthly rate was greater than 100% of the annualised rate then investigate. Other methods, such as detecting clusters of disease, may be better able to pinpoint areas where *Giardia* may be entering the water supply system after the treatment of the water e.g. through pipe infiltration. This method is likely to require the same exclusion of known factors that cause giardiasis.

Conclusions

Geocoding notified cases of giardiasis and calculating rates in water distributions zones is a relatively simple process. The process of geocoding increases the accuracy of location of cases and this can be used for analysis within the local authority areas.

A major limitation to the usefulness of matching cases of notified disease to water distribution zones to identify problems with sources of water and perhaps failure of water treatment/filtration is the number of factors that could have caused the giardiasis. If these factors were recorded for every notified case in the current database a model could be developed to control for each risk factor. Notified giardiasis cases that were likely to be associated with reticulated water could then be identified and further investigation by public health and water supply authorities would be warranted.

The low numbers of cases in each water distribution zone make analysis of data in the zones in time periods of less than a year impractical. Ways of aggregating zones will be explored further.

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