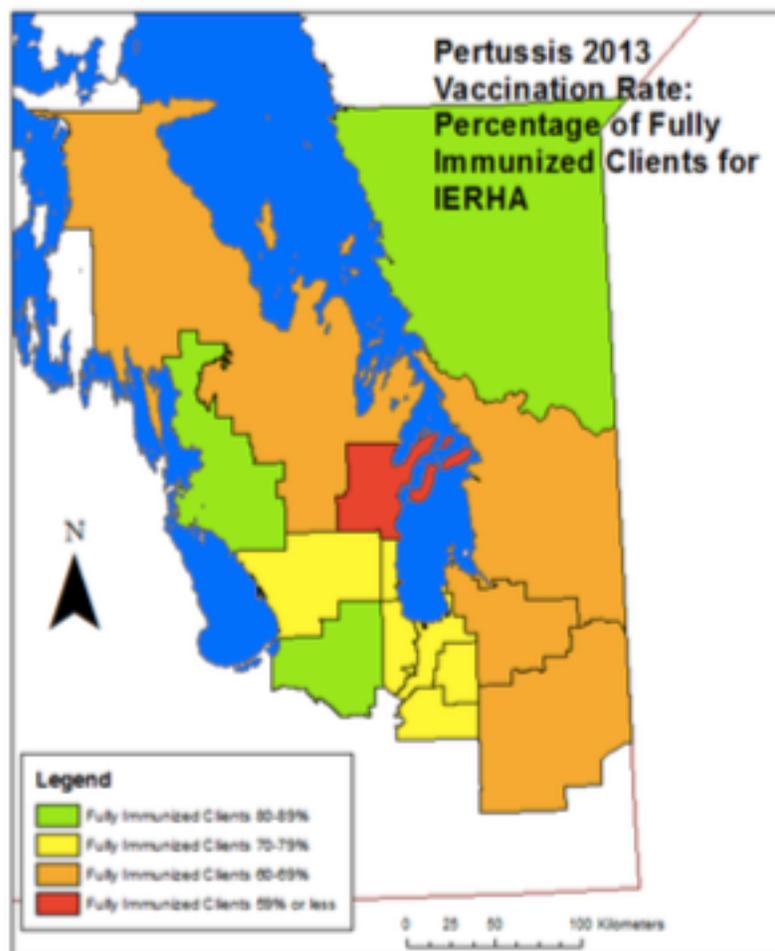


Summary and Analysis of IRHA Immunization Mapping Project

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Abstract

Pertussis, commonly referred to as “whooping cough”, is a highly transmissible upper respiratory infection. Before the introduction of the pertussis vaccine, whooping cough was one of the most common childhood diseases, infecting more than 200,000 children annually, and was a major cause of childhood mortality. Thanks to the Manitoba immunization schedule, pertussis infection is uncommon, and outbreaks are rare. When outbreaks do occur, however, they are attributed to vaccine non-compliance. This points to a short coming in the health care system, and raises the question as to why vaccination series are not being completed, or sometimes not started at all. A recent study by Dr. Tim Hildeman and his team investigated this question, and collected data regarding the vaccination rates in different areas of the Interlake Eastern region. In this paper, I will summarize the data collected by Dr. Hildeman’s study, and analyze the differences seen in immunization rates across the Interlake Eastern region.

Introduction

What is “Whooping Cough”?

Pertussis, commonly referred to as “whooping cough”, is a highly transmissible upper respiratory infection. Although caused by the bacterial species *Bordetella Pertussis*, whooping cough mimics cold viruses in its symptoms. Victims present with runny nose, congestion, red watery eyes, and fever. The hallmark of this infection is a cough with severe wheezing, which can persist for weeks and be so forceful as to break ribs. Other complications are life-threatening, and include pneumonia, apnea, seizures, and brain damage. All ages can be affected by the disease, but the most severe complications are amongst young infants. 80% of life-threatening cases of whooping cough occur in babies under the age of 3 months.¹

First isolated in 1906, *Bordetella pertussis* causes disease by attaching to cilia of the respiratory tract and producing a toxin which paralyzes the cilia. It then creates an inflammatory reaction, and interferes with the clearing of pulmonary secretions. Its antigens appear to evade the host defences, and this combined with its highly communicable nature make it a perfect candidate for outbreaks.²

History of the Pertussis Vaccine

Pertussis outbreaks were first described in the 16th century, and quickly became one of the most common childhood diseases. In the early 1900’s, more than 200,000 cases of pertussis were reported annually, and it was a major cause of childhood mortality. In the 1940s however, the first pertussis vaccines were introduced and were hugely successful in dropping the incidence of the disease.³ It was coupled to the Diphtheria vaccine in 1959, and the DPT-P was introduced as a primary vaccination series in Canada in 1997.⁴ Although it was very effective at creating immunity, this original vaccine was a whole-cell vaccine. It commonly caused side effects such as redness, swelling, and pain at the site of injection. Safety concerns led to the switch to an acellular version of the vaccine, which Canada officially adopted in 1997, and the reports of side-effects dramatically decreased. One problem with the newer vaccine however, is that its effectiveness decreases over time. Because of this, the vaccination program to protect from whooping cough has developed into a series of regular shots and booster shots.¹

Manitoba Immunization Schedule

Manitoba's universal childhood immunization program provides protection against a wide variety of common pathogens and illnesses, including diphtheria, tetanus, *Haemophilus influenzae* type b, *streptococcus pneumoniae*, *Neisseria meningitidis*, measles, mumps, rubella, polio, varicella, hepatitis B, human papilloma virus, influenza, and of course pertussis. Vaccines in Manitoba are given by physicians, nurse practitioners, or public health nurses, and can be given in private or public health offices.⁴ The program begins with what is known as the primary series. In this primary series, a variety of shots are given at four different times; 2, 4, 6, and 18 months of age, and protects against polio, tetanus, diphtheria, meningitis, whooping cough, and pneumonia. At 12 months, after the commencement of the primary series, vaccination against measles, mumps, rubella, and chicken pox is administered. Next, preschool boosters of the primary series are given at age 4-6. By age 17 children should have received a tetanus or diphtheria booster. Receiving all the recommended shots at each age renders a child's immunization status complete-for-age.⁵

The pertussis antigen, one of the six antigens given in the primary series, is given alongside the diphtheria, tetanus, polio, and *Haemophilus influenzae* type B antigen, hence the name of the vaccine which is DTaP-IPV-HiB. The booster includes tetanus, diphtheria, pertussis and polio, and is thus named Tdap-IPV. Children to receive the DTaP-IPV-HiB vaccine at the four times described above, and are given a pre-school Tdap-IPV booster between the ages of 4-6 years. Thus, five doses of the pertussis antigen are given to children before the age of 7. All five shots are required for the vaccination series against pertussis to be considered complete.³ A second booster is recommended for adolescents aged 14-16 years, and adults should have an additional booster at least once in their lifetime.¹ The immunization program is extremely effective when completed, and yields great success in protecting against pertussis infection.

Purpose of the study

Non-compliance is a common issue in all fields of medicine, and its consequences are of particular importance when it relates to vaccines and public health. With so many vaccination shots and boosters required, it is a challenge to ensure completion of any vaccination series. Such challenges are important to recognize because pertussis outbreaks, though uncommon in comparison to the early 1900s, still do occur. In November 2015, southern Manitoba suffered from 50 cases of whooping cough. To put this number in perspective, prior to the outbreak only 10-15 cases were seen in total from 2000 to 2014. Thus, the 50 cases in one month in 2015 was a public health disaster. Another 42 cases were seen in 2016, with 10 of which occurring in the Steinbach area. The majority of those who acquired the infection were babies who had not been vaccinated.⁶ This points to a short coming in the health care system, and raises the question as to why vaccination series are not being completed.

In order to properly answer this question and make the changes necessary to effectively protect Manitoban communities, it must be known what areas of the province are reporting low vaccination rates. A recent study by Dr. Tim Hildeman and his team investigated this question, and collected data regarding the vaccination rates in different areas of the Interlake Eastern region. In this paper, I will report the data collected by Dr. Hildeman's study, and analyze the differences seen in immunization rates across the Interlake Eastern region.

Methodology

Dr. Hildeman's study focuses on the Interlake Eastern region. It includes rural municipalities, colonies, villages, towns, cities, FN territories, unconsolidated territories, and provincial and federal parks. An artificial geographical grouping system was used, in which districts were created and represented geographical clusters of around 10,000 people. This was done to not only increase data specificity, but also offer greater anonymity. The region divided into 15 districts, and each was abbreviated by a code.³

The data was pulled from these districts using Panorama, a new provincial public health electronic database yielding immunization and vaccine information. Next, the software tool ArcGIS was utilized to display and analyze the data geographically. Using 6 digit postal codes, data relating to valid pertussis containing vaccines was collected for all children born in 2013 and 2014.³

Individuals were stratified into 1 of 3 immunization status categories. Fully immunized refers to those who have completed the series for their age and received four doses of pertussis antigen. Partially immunized refers to children who received only 3 doses, and completely unimmunized means no valid doses were received. There is no category for those who were partially immunized with only 1 or 2 doses, and this is because only 6% of children fell into this category. Thus, this cohort is not analyzed in this study.

Results

Table 1: 2013 Cohort Pertussis Vaccination Rate

District	Percent Fully Immunized (%)	Percent Partially Immunized (%)	Percent Completely Unimmunized (%)
Arborg/Riverton	51	16	38
Powerview/Pine Falls	68	14	6
Beausejour	70	19	5
Springfield	72	10	12
St. Laurent	78	8	6
Pinawa/Lac du Bonnet	62	18	13
Selkirk	74	13	4
Stonewall/Teulon	81	6	10
Winnipeg Beach/ St. Andrews	77	11	10
St. Clements	72	18	10
Fisher/Peguis	69	18	6
Whiteshell	65	8	19

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District	Percent Fully Immunized (%)	Percent Partially Immunized (%)	Percent Completely Unimmunized (%)
Gimli	79	8	11
Eriksdale/Ashern	85	9	2
Northern Remote	84	15	0
Interlake Eastern Average	74	12	9

Table 2: 2014 Cohort Pertussis Vaccination Rate

District	Percent Fully Immunized	Percent Partially Immunized	Percent Completely Unimmunized
Arborg/Riverton	50	19	29
Powerview/Pine Falls	64	23	1
Beausejour	62	14	13
Springfield	68	11	14
St. Laurent	63	21	5
Pinawa/Lac du Bonnet	71	19	4
Selkirk	65	19	7
Stonewall/Teulon	73	12	11
Winnipeg Beach/ St. Andrews	77	10	12
St. Clements	70	17	6
Fisher/Peguis	66	16	9
Whiteshell	63	7	19
Gimli	60	21	8
Eriksdale/Ashern	69	20	4
Northern Remote	82	16	0
Interlake Eastern Average	68	15	9

Analysis

As can be seen in the data, from 2013 to 2014 the average rate of completed pertussis immunization series for the entire Interlake Eastern region dropped by 6%, from 74% to 68%. Though this gives the impression that vaccination rates are dropping, two years is not great enough time to establish a trend in vaccination rates. In fact, a larger study conducted by Dr. Hilderman in 2011 looking at vaccination data across all of Manitoba from April 1, 2000 to March 31, 2008 show average rates to be fairly consistent. Pertussis immunization rates have remained just above 70% throughout this period.⁵ The drop below 70% found in 2014 may be the beginning of a trend of dropping average rates, but without further annual data it is too preliminary to conclude.

When analyzing the rates of individual districts, the number of fully immunized children either drops or remains static in all, with the exception of Pinawa/Lac du Bonnet district. In this district, the rate improved by 9% from 2013 to 2014. Though the increase in completed immunizations is encouraging, it must be noted that this district had amongst the lowest prevalence of fully immunized individuals in 2013, sitting at 62%. Thus, even with its improvement, it is still below the Interlake Eastern's regional average. Again, as this only reports two years of data, no true trend can be determined regarding a rise or fall in rates without further study. Additionally, as mentioned above, with the exception of Pinawa/Lac du Bonnet no significant changes were noted within districts from 2013 to 2014. Thus, this analysis will focus on differences between the districts, rather than within them, and the two sets of data from 2013 and 2014 will be used for cross referencing and validation.

Rates of Completely Unimmunized

It is evident from the results that the number of children who receive complete protection from pertussis varies hugely among the different Interlake Eastern regions. In 2013, the rates range from 51% in the Arborg/Riverton district to 85% in the Eriksdale/Ashern district. The large discrepancy between these two areas is also seen in 2014. This indicates that there are significant factors among different areas which are impacting the delivery and completion of the primary immunization series.

Arborg/Riverton is an interesting district for analysis, for in addition to having the lowest rates of fully immunized individuals in both studied years, they also have the highest percentage of completely unimmunized children amongst all Interlake Eastern districts. In 2013, 38% of children in the Arborg/Riverton area received no immunity to pertussis, and in 2014 the rate was still high at 29%. This means that on average, between 2013 and 2014, 1 in 3 children never got a single pertussis containing vaccination. This is very concerning, as such a large cluster of children with no protection puts the area at a very high rate for outbreak.

It must be determined what factors in certain communities are contributing to such low rates of immunization. Obstacles within communities may vary widely. One may be a shortage in health care providers. A community which lacks a family physician for periods of time may not receive care during these critical infant years when primary series vaccines are delivered. Families may or may not travel to an adjacent town or municipality for regular well child visits, but even if they do, such travel distance creates an obstacle to care and lowers compliance. A slightly different scenario which could lead to low immunization rates would be a rural area whose physicians are frequently changing. It can be easy for patient records to be lost or well

child check-up reminders to be forgotten in an office of continual state of transitioning. A lack of continuity with one physician also interrupts the building of rapport with patients, which is of great importance when encouraging parents and patients to complete a vaccination series. Finally, religion can greatly influence the decision to vaccinate. Certain belief systems perceive vaccinations unnatural for immoral, due to the impression that they artificially modify and contaminate the human body. Other groups of religion have issues with the contents of the vaccines themselves, if they are made from human-derived substances or components of certain animals for example. Of critical importance in such patients is the need for proper information sharing. Healthcare providers must communicate the objective of the vaccine, to protect children against diseases which have caused thousands of deaths in the past. Additionally, it is important to be honest in discussing any side effects to the individual post-vaccination. Though an immunization cannot and should not ever be forced upon an individual, it is the hope that with adequate communication and education, patients will acknowledge the utmost importance of such vaccination series and choose to protect their children and the community.

Rates of Partially Immunized

Another concern is high rates of partially immunized individuals. It must be acknowledged that partially immunizing children is a great improvement from delivering no vaccine doses at all. Some areas have succeeded in efforts to get at least a single dose of the vaccine to their new borns, which is a great change to see. Powerview/Pine Falls, for example, has significantly reduced its number of children receiving no immunity, and as a result the 2013 and 2014 cohort data show a rise in partially immunized individuals from 12% to 23%. So while this is a positive change, there are other regions which have not reduced their numbers of completely unimmunized, and their rates of partially immunized children remain static. In 2013 districts including Beausejour, Pinawa-Lac du Bonnet, St. Clementine, and Fisher Peguis all had rates of partial immunization sitting around 18%. The rates showed little change in 2014, and means that in these 4 areas about 1 in 5 children received 3 doses of the pertussis antigen, and did not come back for their fourth.

It must be questioned why it is that there is such difficulty delivering this final fourth pertussis dose to children for their primary series. As mentioned previously, the number of children who were partially immunized in 2013 and 2014 with only 1 or 2 doses of the antigen is very small, 6%. Yet as high as 23% of children receive 3 doses of the vaccine and miss their fourth shot. Thus, for those who begin the vaccination series yet do not complete it, the drop out tends to occur between the 3rd and 4th dose. There are many potential reasons as to why this may be, but it may partially be attributed to the timing of the 4th primary series shot. As explained above, the first four doses of pertussis antigen in the primary series are delivered at 2 months, 4 months, 6 months, and 18 months. Though the shot at 18 months is considered a booster, it is still required for a child to be considered fully immunized. In Manitoba, however, maternity leave is typically only up to 12 months. By 18 months, parents may be back at work and it may become a greater challenge to bring a child to the clinic. This consideration should be discussed with parents at the visit preceding 18 months, and it may be appropriate for health care providers to warn parents that this can be a challenge. Additionally, aside from the DTaP-IPV-HiB vaccination administration, no other immunization or well child test are scheduled at 18 months. Compliance to complete the immunization series must therefore rely on parents understanding the importance of this fourth vaccination shot. It may also be the case that

parents feel their child has had “enough” after 3 doses, and the fourth is purely optional. Emphasis again needs to be on greater communication between the healthcare team and families. If parents are able and willing to bring their child in for the 2, 4, and 6 month primary series shots, the root cause is likely different from the issues surrounding high rates of completely unimmunized children. Presumably, the issues lies in the understanding of the importance of this fourth shot. As described, being an acellular vaccine, multiple shots are required for complete protection. Though receiving some doses may be slightly better than no immunity, a children are still at risk of contracting whooping cough if the immunization process is not complete. The risk involved in not completing the primary series must be discussed with patients, and it must be understood that if the family’s intention when beginning the immunization program was to protect their child from harmful illnesses, completion is an absolute necessity.

Conclusion

The Manitoba immunization schedule has been designed to protect children from serious infection. Whooping cough is an infection in which the vaccination has shown huge success. Outbreaks are now completely preventable, and those that do occur are the consequence of non-adherence to the immunization schedule. Dr. Hilderman’s study investigated the different areas of the interlake eastern region, and reported the rates of immunization. The results point to significant differences among communities regarding the completion of the primary vaccination series. Areas such as Arborg and Riverton stand out due to their low rates of completely immunized children from the 2013 and 2014 cohort. Other areas, such as the Northern remote region, consistently show high rates of completely immunized children. The next steps in this project must investigate the barriers preventing infants from receiving their primary series vaccinations in various regions of the province, as it is clear that differences exist. Additionally, the study pointed out that in those who start but do not complete their immunization series, the tendency to drop out occurs at the 18 month visit. Greater emphasis must be made by physicians on the importance of the fourth and final dose of the DTaP-IPV-HiB vaccine. The objective of the data gathered in this study is to aid in increasing the rates of completely immunized children in Manitoba. As previous studies have shown, these numbers have been relatively static in Manitoba since 2000. With outbreaks of these preventable diseases still being reported, it is of utmost importance to gather information that will help better protect children and communities. Vaccination is the most effective intervention to protect children from disease, and with better compliance and healthcare delivery, it can be hoped that one day illnesses such as whooping cough can be not only rare, but eradicated from our communities.

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