

**Readability and Coherence of Canadian Provincial Department/Ministry of Health HPV  
Information Intended for the Lay Population**

by

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## AUTHOR'S DECLARATION

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## STATEMENT OF CONTRIBUTIONS

Dr. Arocha and I were responsible for the original study design and methods. Dr. Lee and I were responsible for adjusting the design and methods as issues arose. Dr. Lee and Dr. Arocha guided the use of the tools in the methods, although I was responsible for using the tools in the study. I contributed the majority with the literature search, data collection, data interpretation, writing, figures, tables, and results. Dr. Lee and I executed the data analysis, with advice from a statistician. All authors contributed equally with the editing of the paper/manuscript.

## ABSTRACT

**Background:** Human Papilloma Virus (HPV) is a prime factor in the development of many cancers and genital warts in Canada. A majority of sexually active Canadians are likely to have a HPV infection during their lifetime. Information provided online by each specific provincial department/ministry of health in regards to HPV and vaccination may not be at an ideal standard for the lay population to understand and should be evaluated.

**Purpose:** To assess the readability and coherence of provincial department/ministry of health HPV information to determine if it is adequate for the Canadian lay population to understand.

**Methods and Results:** Seven of 10 Canadian provincial department/ministry of health's HPV information websites were evaluated for readability and coherence. The readability tools Gunning-fog index and SMOG (Simple Measure of Gobbledygook) both found that approximately 60% of the population for each of the provinces evaluated may be able to understand the information. The coherence measures of latent semantic analysis (LSA) and computerized propositional idea density rater (CPIDR) both concluded that relative to the benchmark that represents the lay population, the coherence level is not appropriate (LSA,  $p < 0.001$  and CPIDR,  $p < 0.001$ ).

**Interpretation:** HPV information provided by the Canadian Provincial department/ministry of health websites may not be adequate for the lay population to understand. Readability and coherence are important factors that should be considered to improve the quality and adequacy of the information provided so the message reaches the Canadian population.

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## INTRODUCTION

The Canadian Expert Panel on Health Literacy (Rootman & Gordon-El-Bihbety, 2008) defines health literacy as “one’s ability to access, understand, evaluate and communicate information as a way to promote, maintain and improve health in a variety of settings across the life-course” (p.11). According to this definition, in order for individuals to adopt desired behaviours that affect their physical, mental and social well-being, they must first be able to understand the health information. Studies of Canadian adults with limited literacy (King & Taylor, 2010; Hoffman-Goetz, Donelle, & Ahmed, 2014) have shown that participants were having difficulties maintaining their own health, as well as, the health of others and thus felt helpless. Sixty percent of adults in Canada do not possess the level of health literacy required to manage their own health and health care needs (Hoffman-Goetz et al., 2014). According to the International Adult Literacy Survey of Canadians conducted in 1994, 1 in 5 Canadians 16 years or older had difficulty reading and understanding simple texts. Low health literacy is especially present amongst vulnerable populations, such as Aboriginals, seniors, immigrants and those with limited income or education (Hoffman-Goetz et al., 2014). Since it is difficult to increase the reading ability of the entire population, an approach to reduce disparities would be to ensure that health information is written with clear, plain and coherent language.

Health information about the HPV vaccination in regards to, type of vaccine recommended, which individuals are covered and when individuals should receive the vaccine

has been changing frequently over the years. Considering that many Canadians are accessing health information online, which can help them keep up to date on these HPV vaccination changes, makes it necessary that this information is understandable to the lay population. Across provinces, household Internet access is between 70 – 84%, and 64% of individuals 16 years old and over use the Internet to search for health information (Hoffman-Goetz et al., 2014). Of that 64%, it is likely that a majority of the lay population that would access this material would be young adults or parents, which is the intended audience of the HPV vaccination information. One can expect that the number of individuals, across all socioeconomic statuses, accessing health information from online sources would only increase in the future, which brings into focus the quality and comprehensibility of such information.

It is important that provincial HPV information that is difficult for the lay population to understand be identified and corrected. Tools of content and discourse analysis are available for diagnosing and improving the quality of health information, such as readability formulas and latent semantic analysis. These tools would be invaluable in evaluating provincial HPV information (Gunning, 1952 & McLaughlin 1969). Providing quality health information through the Internet to reach large populations means that important HPV information can be accessed, understood and more likely accepted by more people. Having information that is easy to understand will, hopefully, encourage the intended behaviour of increasing vaccination rates for the target population and help bring each province to the required vaccination rate to achieve herd immunity. Increasing vaccination rates is important considering that current HPV vaccination programs in Canada require women to have approximately 90% uptake rate of the vaccine to achieve herd immunity, while vaccine uptake rates vary across the country, ranging

from roughly 60% in Alberta and Manitoba to approximately 85% in Newfoundland, Nova Scotia and Quebec (Canadian Immunization Committee, 2014).

# CHAPTER 1: LITERATURE REVIEW

This chapter will examine (i) how Human Papilloma Virus (HPV) affects men and women differently and the magnitude of infection in the general population; (ii) what vaccines are available and their effectiveness; and (iii) the methods of assessing the readability and coherence of the HPV health text information presented online on official health websites maintained by the provincial Departments/Ministries of Health.

## 1.1 HPV and Women

HPV is one of the most commonly sexually transmitted infections (STI) among sexually active women. The primary concern of the HPV is that it is a risk factor for the pathogenesis of cervical cancer (Walboomers et al., 1999). Although there are a number of variants of HPV (approximately 40), there are two serotypes (16 and 18) that are responsible for 70% of all cervical cancer cases (Castellsagué et al., 2014). Cervical cancer is currently the second most common type of cancer among women, with approximately 527,000 new cervical cancer cases and 265,700 deaths worldwide in 2012 (Torre, 2015). The prevalence is not as prominent in developed countries, as on average there are 9.0 cases per 100,000 women in developed countries vs. 17.8 cases per 100,000 women in developing countries (Frumovitz, 2014). This is due to the fact that developed countries are able to invest much more in screening programs, like the Pap test than developing countries (Carter et al., 2011; Shastri et al., 2014). However, the incidence has increased in Canada over the last 5 years (Canadian Cancer Society, 2014). According to the Canadian Cancer Society (Canadian Cancer Society, 2014), estimates of the incidence of cervical cancer from 2009 to 2014 have increased from 1300 to 1450 new cases.

Crude mortality rate estimates have remained the same over the past 5 years with an incidence of 380 deaths, which amounts to 1 in 478 cases among Canadian women. To put this in perspective, the incidence of cervical cancer in Canada is much lower than the global incidence rate. Cervical cancer is the 13<sup>th</sup> most frequent cancer among Canadian women, however, within the 15 to 45 years age group, cervical cancer ranks as the 3<sup>rd</sup> most frequent cancer in Canada (ICO Information Centre, 2014).

Apart from cervical cancer, HPV subtypes 16 and 18 are known to cause the development of other types of cancers. These include cancers of the anogenital region (vulva, vagina, and anal canal), the head and the neck. Epidemiological studies by Gaudet et al. (2014) have found that women with a diagnosis of high-grade Cervical Intraepithelial Neoplasia (CIN) have an increased incidence of these cancers. The troubling finding in this study was that even though the prevalence of cervical cancer among Canadian women was declining, the incidences of CIN and HPV infections were rising (Gaudet et al., 2014). To confirm these statistics, Gaudet et al. (2014) analyzed their own longitudinal data of approximately 55,000 British Colombian women and found that women with a past diagnosis of high-grade CIN (grade 2 or higher) had a higher risk of vulvar and vaginal cancer. There was also a significantly higher incidence of anal cancer 5-9 years after diagnosis of CIN 2 or higher. The study also found that head and neck cancer had a significantly increased incidence 0.5-4 years after a CIN grade 2 or higher diagnosis. In support of these findings, Forte (2012) found that there was an increase in HPV-associated throat cancers for age-standardized incidence among Canadian women.

In addition to cancer, HPV is well known to be a leading cause of genital warts. HPV strains 6 and 11 account for 90% of all cases of HPV-induced genital warts (Centres for Disease Control and Prevention, 2012). Although genital warts are relatively harmless, an increased incidence of genital warts could be an indication that the incidence of HPV infection is increasing amongst Canadians. The increase in incidence of CIN and HPV infections leading to genital warts and cancers among Canadian women should be of concern to health authorities and advocates.

Thus, to prevent these adverse outcomes from the more persistent strains of HPV, and preventable burden to the healthcare system, two vaccines called Gardasil and Cervarix, have been advertised to be the answer.

## **1.2 Offered Vaccines:**

Gardasil has been developed to protect females and males from contracting the most common strains of HPV, by Merck Canada. Gardasil can be effectively administered to women at a much larger age spectrum relative to males, 9-45 and 9-26 years of age respectively (Canadian Cancer Society, 2014; Markowitz, 2014). It protects against 4 strains of HPV: strains 16 and 18 which can potentially lead to various cancers and strains 6 and 11 which are precursors to genital warts (Centres for Disease Control and Prevention, 2012). This vaccine is usually administered in a series of three doses over the course of 6 months. Using this method has proven to be 90% to 100% effective in reducing infection from these four strains of HPV (Markowitz, 2014). The vaccine is not effective against any existing infections so it is

recommended that the vaccine is given to females between the ages of 9-13, to protect them before they are sexually active (Markowitz, 2014).

Cervarix is a bivalent HPV vaccine, produced by GlaxoSmithKline, which protects specifically against the high risk 16 and 18 strains. (Monie et al. 2008; Markowitz, 2014; Canadian Cancer Society, 2014). Unlike Gardasil, this vaccine has only been approved for females in Canada (Canadian Cancer Society, 2014). Cervarix is recommended for a much lower age range of 9-26 years of age, relative to Gardasil. Along with being cheaper than Gardasil, studies have shown that Cervarix is more immunogenic and protects women for a significantly longer period of time (Monie et al. 2008; Markowitz, 2014).

### **1.3 HPV and Men**

Recommendation for the use of Gardasil in females was first approved by the National Advisory Committee on Immunization (NACI) in February 2007 (PHAC, 2011). Three years later, in February 2010, Gardasil was authorized to include males 9 to 26 years of age (CCDR, 2012). Considering that HPV was one of the most common and easily transferable STIs, it was an important step towards preventing the potentially deleterious effects HPV could have on men. According to the Canada Communicable Disease Report (2012), it was estimated that 80-90% of anal cancers, 40-50% of penile cancers, 35% of oropharyngeal (throat) cancers and 25% of oral cavity cancers were associated with HPV infections. It was estimated that the high-risk HPV types 16 and 18 contributed to 92% of anal cancers, 63% of penile cancers and 89% of oral cavity and oropharyngeal cancers (CCDR, 2012). In addition to this, the incidence of anogenital

warts and these cancers were increasing according to a consensus of Canadian, Australian and US data. For example, the overall incidence of anal cancer increased in males over the last several decades (roughly 160%) (CCDR, 2012; Van der Loeff et al., 2014). Along with the incidence of anogenital warts increasing for men, the CCDR data confirmed that the male to female incidence rate ratio had increased over time from 0.76 in 1985 to 1.25 in 2004 (CCDR, 2012)

Considering that these cases were preventable, it is promising to see that PEI, Alberta, and Nova Scotia has been providing the Gardasil vaccine for free to boys as well. PEI started in 2013 to vaccinate grade 6 boys, Alberta started in 2014 to vaccinate grade 5 boys, and Nova Scotia started in 2015 to vaccinate grade 7 boys. Currently, the other provinces in this study, do not offer the vaccine free to males but as more evidence support the utility in males, the other provinces could eventually commit.

#### **1.4 Readability and Coherence of Health Information**

To evaluate and analyze the comprehensibility of the provincial health information on HPV, some of the different elements of text characteristics that research has shown to improve the comprehensibility of information will be examined. These include readability, coherence, framing, layout, and associated images/ media. Two are of particular relevance for my study: readability and coherence. Studies have shown that if text readability is low and text coherence is high, a typical reader will be able to understand the material to improve their knowledge and

more likely carry out the intended health behaviours (Kintsch et al 1992; Glanz, Rimer & Viswanath, 2008).

#### **1.4.1 Readability:**

Readability is defined as “the ease with which a person can read and understand written materials” (Pace et al., 2012). Thus, having a material that is easy to understand by the layperson is important to health professionals and educators since health information is increasingly provided through text via the Internet.

In order to assess text difficulty, educators in the 1920s developed formulas to measure the difficulty of text by assessing variables, such as vocabulary, average word and sentence length in a passage. Since then, there have been over 200 readability formulas developed and over a thousand studies published supporting their strong theoretical and statistical validity (Pace et al. 2012). Popular examples of these readability formulas used in research are Flesch Reading Ease and Flesch–Kincaid Grade Level test, which have been used to assess children’s texts (Flesch, 1948). Also, Simple Measure of Gobbledygook (SMOG) analyzes have been popular in evaluating cancer information for adults (McLaughlin, 1969; Friedman et al., 2004). Each of these formulas uses sentence length, word difficulty or word syllable length to predict the educational level needed to read a piece of text. Thus, if sentences tend to be too long and the words tend to have too many syllables, the text would be considered much more difficult, and would be intended for individuals with a higher reading grade level.

Certain readability tools have specific purposes. A majority were produced to score children's text while a few were produced to evaluate more technical texts (Reddish, 2000). The two tools chosen to be used in this study were SMOG and Gunning Fog. As mentioned before studies have used SMOG in the past to evaluate cancer information, which is ideal for HPV information. Using multiple tools was important to increase the reliability of the readability scores. Gunning Fog was chosen because a study by Wang et al. (2013), proved that SMOG and Gunning Fog had the most consistent results compared to other readability measures the study evaluated ( $r=0.98$ )

Even though readability formulas are useful, and can give some insight into how understandable text is, a mathematical formula cannot provide an exhaustive measure of understanding. For instance, the current readability formulas do not take into account the word order of a text, which means rearranging the words in a sentence would have no effect on readability scores (Redish, 1981; Kintsch & van Dijk, 1983). In regards to word length, Friedman et al. (2004) pointed out that formulas like the SMOG analysis tend to rate tougher and shorter words as having a higher readability than easier polysyllabic words. This leads to false readability predictions, which means the difficulty and cohesion of the text are not properly measured (Friedman et al., 2004). Redish (2000) indicates that readability scores should be primarily used as an indication if the text is difficult for the average person. A serious mistake is made when a text is altered to get a better score on a readability tool. Sentence length and word length should not outweigh other factors to text comprehension like content, organization, word order, format or imagery (Reddish, 2000; Klare, 1976).

### 1.4.2 Text Coherence

According to Reinhart (1980), text coherence is comprised of the semantic and grammatical connectedness between discourse and context. He simplified the definition by expressing that coherence can be broken down to connectedness, consistency, and relevance. *Connectedness* is displayed if units of texts (for example, propositions or sentences) are interconnected to each other with semantics and grammar. *Consistency* refers to the absence of contradictions in the entire text. *Relevance* is associated with whether a unit of text is in context to the general topic of the text (Reinhart 1980). Appropriate analyzes should be used to assess if health information texts follow Reinhart's definition of coherence, propositional and latent semantic.

#### *Text Connectedness*

For a unit of text to be considered minimally connected, Reinhardt (1980) explained that each unit of text must be connected to the adjacent sentence (adjacent pair) or a non-adjacent preceding unit of text within the same segment (e.g., within a paragraph). Furthermore, for a unit of text to be coherently connected it must be either referentially linked or linked by a semantic sentence connector. If a text meets at least one of these criteria, it is deemed to be coherently connected (Reinhardt, 1980).

A referential link means that a unit of text is connected to the same referent. A referent can be considered a noun, verb or any of their variants (Reinhardt, 1980).

For example,

“Once upon a time a man had happened to begin walking. He lived in Alabama and walking made it seem awfully far away. *While he was walking all of a sudden he saw a tree and on that tree was a bird and the bird had its mouth open.* The bird said *Ida*, anyway, it sounded like *Ida*...

Frederick went into the army, became an officer and came to Washington. *There he fell in love with a woman, was she older was she younger or was she the same age.* She was not older perhaps she was younger, very likely she was not the same age as his age...” (Reinhardt, 1980. p. 171-172).

In each of these two sections, the sentences are referentially linked together. For example, in the third and fourth sentences of the first section the referent is the bird. Between the two sections, the italicized sentences are referentially linked by the pronoun ‘he’. Thus, sentences or units of text can be referentially coherent whether or not they share the same topic (Reinhardt, 1980).

According to Reinhardt (1980), if a text appears not to be referentially linked it can be linked by semantic connectors, and remain coherent. Semantic connectors can be identified as markers for semantic relations, such as comparison (similarity), contrast, exemplification and cause, and effect. An example of a temporal relation is the following: “The first man landed on the moon. At the very same moment, a young boy died in Alabama of untreated pneumonia” (Reinhardt, 1980, p.176)

### *Text Consistency*

For a text to be consistent, it must be absent of contradictions, and this is evaluated by making sure each sentence is followed from the previous sentence (Reinhardt, 1980). This is

important because a text can be coherently connected but fail the consistency test. For example, in this transcript excerpt from a schizophrenia patient:

“I was living at home. But my father is dead now... That's why you can say he's probably decided to smoke a pipe.” (Freeman et al., 1966. p.47)

In this example, the second and the third sentences are shown to be referentially linked, which should indicate that it is referentially coherent. But based on common sense these two sentences cannot be true together. Thus, based on the consistency criteria this text is not coherent (Reinhardt, 1980).

#### *Text Relevance:*

According to Reinhardt (1980), out of the three criteria for coherence, relevance is the least understood. Most of the situations where relevance is considered to be violated are when questions are followed by responses that are irrelevant to the question (Reinhardt, 1980). Thus, this criterion is much less useful in determining coherence for the purpose of evaluation of online health information. However, the text relevance criterion may be more useful in the evaluation of a subject's response to a question, but this is not one of the objectives of this study.

#### *Local and Global Coherence:*

Connectedness and consistency fit into broader categories of coherence which are local and global coherence. Using LSA in the study, the objective is to evaluate local global coherence as part of my coherence assessment. Local coherence is a measure of the semantic connectedness between sentences of discourse. van Dijk & Kintsch (1983) explained that for there to be local

coherence the reader expects the explanation provided by the following or second sentence to be connected and consistent with the first (pg.103). This definition satisfies van Dijk & Kintsch's criteria for text processing as it implies that semantic coherence is grounded on the relations of 'cause', 'consequence' and 'temporality'. These relations are important aspects of discourse because giving clear and logical progress from beginning to end ensures that the reader will not be confused about the relationships of the idea or referents (Beaugrande & Dressler 1981). Intuitively local coherence can be defined and guided by the overall global coherence of a text or discourse. Van Dijk & Kintsch (1983) explained that global coherence characterizes text as whole or larger fragments of the text. Global coherence, "organizes and orders predicates, referents and properties around the central ones and imposes unity and sequence" (van Dijk & Kintsch, 1983). In layman terms, global coherence ensures that propositions, sentences or ideas are related around a topic or central theme. An example of this would be a piece of health information with a general theme of HPV vaccination. The information in the text would most likely cater or fall in line with that theme. If the idea is far removed from the overall theme it would not fall in line with connectedness and consistency, and thus, lower the overall global coherence of the text.

#### **1.4.2.1 Propositional Density:**

Propositional density, known as P-density, is defined as a measure that determines the effectiveness of processing and storage of linguistic information or semantic content by the reader and is calculated as the number of propositions divided by the total number of words in a

text (Kintsch & Van Dijk, 1983; Brown, Snodgrass, Kemper, Herman, & Covington, 2008). Propositions are the smallest idea units underlying the surface representation of the text, which have true value (Arocha et al., 2005; Johnson et al., 2003). A proposition includes first a predicate and then the associated arguments. Predicates are verbs, adjectives, adverbs and sentence connectives. Arguments refer to individuals, such as things or persons (Kintsch & Van Dijk, 1983). For example, “Take the vaccine” is a proposition, where the vaccine is the argument and take are the predicate.

In terms of its application to reader understanding, a study by Kintsch & Keenan (1973) found that the more propositions a piece of text had, the longer it took to read, even if the text was the same length as another comparable text. The longer reading time was due to that fact that increasing propositional density increases processing difficulty and reduces memory performance of the reader (Kintsch & Keenan, 1973).

#### **1.4.2.2 Latent Semantic Analysis:**

One method of determining coherence in the text is through latent semantic analysis (LSA) (Landauer, Foltz & Laham, 1998). LSA is a statistical method for mining and representing the meaning of words in a text in context to each other. In layman terms, the meaning of a text or discourse is primarily portrayed by the words it is composed of. Rather than only words order to derive meaning, LSA derives meaning by solving many sets of simultaneous equations to capture the more important, contextual usage of words (Landauer et al., 2011).

LSA has proven to achieve more than propositional analysis since it analyzes the semantic relatedness between texts, more than the simple term-term overlap measures used in the propositional analysis. Just like propositional analysis, it draws from the theory that a text has high coherence if the reader is able to create a connected mental representation from the information provided from a piece of literature (Kintsch & Van Dijk, 1983). However, it can be more comprehensive than just a propositional analysis because the meaning that LSA derives from units of text derives its strength from computing and analyzing a large number of text examples (Foltz, 1998). LSA uses the analysis of these text examples to create a semantic space. This is what LSA uses to find semantic similarities and distinctions between terms across a text. Terms or larger units like sentences are represented by vectors in this space. The vectors are a weighted average of semantically related terms and accounts for the importance of each unit of text. The semantic similarity between two units of text can be compared by calculating the cosine of the angle between the vectors. These values help determine coherence. If the vectors are semantically related they will have a higher cosine value and thus a higher coherence. The opposite is true if the vectors are not semantically related.

LSA differs from the propositional analysis in a few important ways that can be both strengths and limitations. As mentioned before LSA analyzes semantics between vectors across the entire text. This is good because LSA is able to analyze indirect semantic overlap that propositional analysis could miss. Propositional analysis tends to analyze semantics using the summed contiguous pairwise co-occurrences of words, which is much more local than across the entire text. LSA does not analyze text using this method. Thus, it does not account for word order. Hence, syntactic relations, logic, and morphology are not there to inform the analysis.

LSA seems to compensate well without these aides according to Landauer et al. (1998) but can account for some incompleteness in the analysis. An example of this is in the study by Flotz et al. (1998) comparing the semantic analysis between propositional analysis and LSA. They evaluated the propositional analysis done on a student encyclopedia article by conducting LSA on the same text. They found that LSA was able to detect additional meaning similarities in the absence of literal word repetition. This finding is important because it ties into the point that “coherence does not just mean that the terms are repeated or are used in semantically related ways” but also involves the relation of those terms to the overall text (Flotz et al. 1998, p. 14). This is how LSA is able to measure global coherence. Flotz et al. advocated that this measure of global coherence can be captured by taking the average of the sentence to sentence cosines of a text. This was confirmed through a study Foltz et al. conducted using data from Britton & Guloz (1991) reading comprehension study. The purpose of the reading comprehension study by Britton & Guloz (1991) was to see if comprehension of a textbook would increase by making readability revision, principled provision, and heuristic revision. The readers were assessed based off of the number of propositions able to be recalled. They found that the principled and heuristic provisions of the textbook produced significantly better comprehension by the reader than the original or readability revisions. Flotz et al. used the three revisions and the original textbook and analyzed them using LSA. The average sentence-to-sentence cosine was taken of each text and produced the same results as Britton & Guloz (1991).

A very powerful feature of LSA, that separates it from other coherence measures, is its ability to generalize prior knowledge of the intended reader when analyzing the text for coherence. Landauer et al. (2011) indicate that “LSA can perform many meaning-based

cognitive tasks as well as humans” (p. 4). LSA was the first model “to match literate humans on tasks that if done by people would be assumed to imply an understanding of the meaning of words and passages” (Landauer et al., 2011, p. 5). The way LSA accomplishes this is by choosing a semantic space that is representative of the individuals that are intended to read the text. For example, LSA provides semantic spaces that are representative of individuals with varying reading grade levels. McNamara et al. (1996) conducted a study to examine how readers’ previous knowledge interacted with the coherence of the text. They had the individuals read for different tasks each with varying degrees of coherence. They found that the individuals with the least amount of prior knowledge were able to understand the most coherent text. Next, they tested LSA using a semantic space that was generally relatable to a reader with the least amount of prior knowledge. The calculation with LSA predicted the exact same text difficulty as the previous study, where the greatest sentence-to-sentence cosine was found for the most coherent out of the four texts evaluated. Thus, LSA is able to go beyond the basic sentence-to-sentence overlap and generally take into account the reader’s knowledge when evaluating a text for coherence (local and global) (Landauer et al. 1998).

Another strength of LSA is that it is easy to analyze large bodies of text, unlike propositional analysis, which is very time-consuming. Thus, the amount of effort demanded by propositional analysis limits the size of text that can be analyzed. Because LSA has been computerized, it does not have this limitation and can analyze a piece of text for coherence, regardless of its size (Foltz et al., 1998). This is important because LSA can be used to automatically compute sentence-to-sentence coherence and then mark the ones that have a lower coherence than average. This would be an asset to writers of health information because it can

help them quickly fix a low coherence text that would be difficult for low-grade level and low-knowledge readers to understand (Foltz et al., 1998).

Collectively, all of these methods for analyzing readability and coherence, such as the SMOG test, propositional analysis, and LSA, can compensate for their individual limitations and provide a strong assessment of the comprehensibility of a piece of text.

### **1.4.3 Prior Knowledge**

When an individual is trying to interpret a text, prior knowledge of the overall themes and topics of the text or discourse will help the reader understand new information. Hirsch (2003) indicates that prior knowledge about a theme or topic tends to increase basic comprehension, which allows the working memory to have less demand, and allows it to make connections between the new material and individual's knowledge to draw conclusions. According to Hirsch, background knowledge is usually integrated with the semantics of the text to construct a coherent mental model of the situation. An expert makes this model very quickly by making multiple connections with their background knowledge. A novice would have a much more difficult time since they would have much less knowledge of the particular theme and would take much more time to create a model let alone be adequate. For example, a professor who studied HPV or similar viruses would have a much easier time constructing that model in their mind to interpret new information about HPV. Hirsch explains that other than subject knowledge (domain knowledge) or similar background knowledge, vocabulary knowledge correlates with the reading comprehension. Experts agree that for an individual to adequately comprehend a

particular text, they should know between 90-95% of the words in that text (Hirsch, 2003). This would allow the reader to better interpret the meaning of the text and also learn words or infer the definition of words that they have not learned before, without sacrificing comprehension (Hirsch, 2003).

Adequacy of this prior knowledge is usually assessed in using concept maps. Studies usually instruct participants to construct a concept map before and after a lesson or reading material on a particular topic (intervention). Participants construct a concept map based on their background knowledge (domain and vocabulary knowledge) by arranging concepts as hierarchies, and linking relevant concepts in a web (Rebich & Gautier, 2005; Rice, Ryan & Samson, 1998). The more relevant concepts the individuals have written down, with accurate explainable links, the better their background knowledge (Rebich & Gautier, 2005; Rice et al, 1998).

Therefore, a text with high coherence would not include additional themes or topics that would be exceptionally above the background knowledge of the intended reader. This would allow the intended reader to use the background knowledge they have to better understand the text they must interpret. Making it easier for the reader to draw linkages between ideas in the text by allowing them to incorporate their prior knowledge will increase their coherence. Similarly, a text with a low reading grade score that caters to the intended reader will include as much as possible only words that are for the specified reader's vocabulary. Difficult technical words that would not typically be in the intended reader's vocabulary should not be included in the text if the writer's goal is to achieve high readability (Hirsch, 2003 & Hoffman-Goetz, 2014 pg. 22).

## CHAPTER 2: RESEARCH QUESTIONS & RATIONALE

The overarching research goal was to determine the readability and coherence of provincial HPV information intended for the lay population. To achieve this, a series of pertinent questions were asked.

### **Question 1:**

Will the readability levels of the provincial HPV information be congruent with the Programme for the International Assessment of Adult Competencies (PIACC) level of education obtained by Canadian adults aged 16 to 65 for each province?

### **Hypothesis 1:**

The reading levels of the provincial HPV information will be at a higher level than the educational level obtained by Canadian adults aged 16 to 65 for each province.

### **Rationale:**

Based on the studies of readability and cancer information, web-based information tends to be written at reading levels meant for high school students or higher (Friedman et al., 2004; Friedman & Hoffman-Goetz, 2006). This contrasts the reading level of the general Canadian population. According to the International Adult Literacy Survey (IALS), the average reading level of the Canadian population is around grade 8 or 9 level, or some secondary school education (Friedman et al. 2006; Hayes et al. 2013). Thus, it will be important to investigate if the HPV information offered in 2014 by each province can target the sector of the population with a reading level below high school.

**Question 2:**

Will the provincial HPV information have a coherence level adequate for the lay population?

**Hypothesis 2:**

The HPV information will generally have a lower coherence that will be required for the lay population.

**Rationale:**

Coherence is needed to make text easier to understand. According to Ta-Min, Arocha & Hoffman-Goetz (2007), after evaluating a series of cancer information pages on the Internet, they found that the texts generally had a low level of coherence. The authors compared the semantic network of the text to the mental model produced by participants and discovered that the majority of the web-based cancer information has a lower level of coherence. Knowing the level of coherence of a text is important because it allows a health educator or a health professional to know whether the average individual will understand the text and be able to realize the required behaviour.

**Question 3:**

Will the assessments of readability and coherence have a mutual association in the case of the provincial HPV information?

**Hypothesis 3:**

There will not be a mutual association between these two types of tests.

**Rationale:**

The two readability tools Gunning-Fog and SMOG are each affected by manipulating the word and sentence lengths. If word and sentence lengths are shortened, this would lower the readability scores, but could make the text harder to understand. If the shorter word is more difficult and the sentence is short and choppy, this would lower the coherence (Friedman et al, 2004). Coherence measures evaluate text beyond the surface level such as local and global coherence (Landauer et al. 1998). The tools use two different measures to accomplish two contrasting goals. Therefore, because of these differences, they may not be mutually associated.

Evidence of this was proven through the comparison was drawn between coherence and readability tools in the study by Ta-min et al. (2007). They found that comparing coherence scores from propositional analysis to those from the three readability tests, a low readability level was generally not related to a high degree of coherence and vice versa (Ta-Min et al., 2007). Thus, using propositional density analysis and LSA, we can derive the coherence of the text and determine if there is a relation to readability, using Pearson correlation.

## CHAPTER 3: METHODS

### 3.1 Data Collection:

HPV vaccination information was obtained from the websites of departments/ministries of health in seven Canadian provinces. The provinces were British Columbia, Saskatchewan, Manitoba, Ontario, New Brunswick, Prince Edward Island and Newfoundland. Not all Canadian provinces were included because during the time of data extraction only the seven provinces listed above had province-specific HPV vaccination information. In addition, only English websites were included as the coherence measures used are made for English text. More specifically the grade 9 semantic space offered by LSA needed has only been constructed for English text (Landauer et al. 1998). The dates of data extraction were the 28th and 29th of March, 2015.

The reason why the websites of the departments/ministries of health for each of the seven Canadian provinces were included, over national HPV vaccination information, or other sources were two-fold. The first reason was that coverage in Canada varies across provinces since the 1982 Constitution Act of Canada gives provinces jurisdiction over health care. Therefore, vaccination information and regulations would differ for each province, and the layperson must make decisions based on their respective province's information. The second reason is that provincial departments/ministries of health should present reputable health information relative to unregulated/ less credible sources.

The only information that was meant for the lay public was analyzed. Any information meant for health professionals was not considered in the analysis.

### **3.1.1 Readability Analysis:**

The vaccination information of each of the seven provincial websites was evaluated using two commonly used readability tools: the Gunning-Fog index<sup>and</sup> the SMOG readability formula (Simple Measure of Gobbledygook) (Gunning, 1952 & McLaughlin 1969). These tools give the rough education level needed to understand particular documents (See Appendix A for documents). More than one readability tool was used in order to increase the strength and reliability of the results. In addition, although these two readability tools measure reading grade level differently, studies have shown that Gunning-Fog and SMOG have been consistent during evaluation of a variety of health information materials (Wang et al. 2013; Janan & Wray, 2014).

For the SMOG readability formula, the websites of departments/ministries of health for each of the seven Canadian provinces had to contain a minimum of 30 lines of continuous text. To calculate the reading grade level using the SMOG formula, these standard guidelines were followed:

- Select 10 sentences in a row near the beginning, 10 in the middle, and 10 in the end for a total of 30 sentences.
  
- Count every word with three or more syllables in each group of sentences. Repeated words are also included in the total.

- Calculate the square root of the number arrived at in Step 3 and round it off to nearest 10.
- Add 3 to the figure arrived at in Step 4 to yield the SMOG Grade.

The SMOG grade level calculated determines the level of education needed for an individual to fully understand the text (McLaughlin, 1969; Hoffman-Goetz et al. 2014).

Gunning-Fog was calculated using the standard guidelines. But considering some of the documents that needed to be analyzed were very long, sampling one section of the text would lead to an inaccurate fog index score. So instead, a sample was taken near the top of the text, another near the middle of the text, and another near the end of the text. A fog index score was calculated individually for each of the sections. Then the average was taken to calculate the overall Gunning fog index score for that particular document.

The procedure taken to calculate the Fog index score for each of the documents was as follows and a sample of the calculation can be found in Appendix B:

- Each of the samples taken from the beginning, middle and end of the document had approximately 200 words each. In each sample, the number of exact words and sentences was calculated.
- The average sentence length (ASL) was calculated by dividing the total number of words in the sample by the number of sentences.

- The number of words with three or more syllables that were not i) proper nouns, ii) combinations of easy words or hyphenated words, or iii) two syllable verbs made into three with –es and –ed endings.
- This number (the number of polysyllabic words) was divided by the number of words in the sample passage. For example, 40 long words divided by 100 words gives you 40 Percent Hard Words (PHW).
- The average sentence length (ASL) and the percent hard words (PHW) were added.
- The sum was multiplied by 0.4.

To improve the reliability of the results, two raters were employed to assess the readability of each provincial document. This is necessary because for each readability tool the parts of the text chosen by the rater are subject to a slight variation. For example, when extracting text to be evaluated from the middle of a document, two raters may select slightly different sections of the text, and this variance can lead to a difference in the final scores. The inter-rater reliability was calculated using the concordance correlation coefficient. This method of calculation was chosen because grade levels are not ordinal, in the traditional sense but are continuous values. For example, using the readability tools to evaluate a text, the score produced will not be rounded to the nearest grade level but will be keeping whatever decimal value tool produces (ie. 10.78). Thus, ordinal values of the grades are not being used but any value between the grades are also included to provide more accurate information about the readability of the material.

Once the agreement between the raters proved to be adequate ( $\rho_c \geq 0.9$ ), the readability scores for the provincial HPV information compared to the Programme for the International

Assessment of Adult Competencies (PIACC) data (Table 1). The PIACC has data on the level of education obtained by Canadian adults aged 16 to 65 in each province. PIACC has highest educational attainment broken down into four categories which are ‘less than high school diploma’, ‘high school diploma’, ‘postsecondary education – below bachelor’s degree’ and ‘postsecondary education – bachelor’s degree or higher’. ‘Less than high school diploma’ is defined as individuals who have had no formal education or highest attainment of education includes elementary school or middle school. ‘High school diploma’, is defined as individuals whose high level of educational attainment includes senior high school, adult secondary school, or upgrading programs or courses. ‘Postsecondary education – below bachelor’s degree’, is defined as individuals whose highest level of educational attainment includes non-university certificate or diploma from a college, school of nursing, technical Institute, trade certificates, apprenticeship certificates, university transfer programs, or university certificate or diploma programs below bachelor’s degree. ‘Postsecondary education – bachelor’s degree or higher is defined as individuals whose highest level of educational attainment includes bachelor’s degree, university certificate above bachelor level, professional degree, Master’s, Ph.D. The PIACC data, and the four defined categories for educational attainment were used to determine the highest level of completed education by the population for each of the provinces. Once the highest level of completed education was determined, it was compared to the Gunning-Fog and SMOG grades obtained for the provincial HPV information. Thus, the proportion of the population that would be able to understand this information was determined.

**Table 1:** Proportion of the population aged 16 to 65, by highest level of completed education

	Highest level of completed education	%	s.e.	Literacy		Numeracy	
				Aver.	s.e.	Aver.	s.e.
Saskatchewan	Less than high school	18.4	(0.2)	235	(4.4)	221	(4.2)
	High school diploma	27.5	(0.1)	265	(3.4)	256	(3.9)
	Postsecondary education - below bachelor's degree	33.5	(0.1)	279	(3.0)	272	(2.9)
	Postsecondary education - bachelor's degree or higher	20.7	(0.1)	301	(3.8)	294	(3.6)
Alberta	Less than high school	15.7	(0.3)	244	(4.8)	232	(5.2)
	High school diploma	25.3	(0.1)	272	(3.5)	261	(4.2)
	Postsecondary education - below bachelor's degree	34.1	(0.2)	280	(2.8)	272	(3.4)
	Postsecondary education - bachelor's degree or higher	24.9	(0.1)	301	(3.5)	296	(3.9)
British Columbia	Less than high school	12.6	(0.1)	234	(5.8)	224	(6.3)
	High school diploma	27.0	(0.1)	267	(3.5)	257	(4.0)
	Postsecondary education - below bachelor's degree	33.8	(0.1)	280	(2.7)	270	(2.9)
	Postsecondary education - bachelor's degree or higher	26.7	(0.1)	296	(3.5)	291	(3.7)
Yukon	Less than high school	17.7	(0.1)	238	(19.5)	227	(20.1)
	High school diploma	23.0	(0.2)	264	(13.8)	246	(15.0)
	Postsecondary education - below bachelor's degree	36.0	(0.1)	285	(12.5)	272	(9.9)
	Postsecondary education - bachelor's degree or higher	23.2	(0.1)	309	(10.4)	294	(9.6)
Northwest Territories	Less than high school	30.8	(0.1)	216	(9.1)	197	(11.0)
	High school diploma	21.0	(0.0)	250	(7.5)	236	(7.9)
	Postsecondary education - below bachelor's degree	30.9	(0.0)	265	(6.0)	255	(6.4)
	Postsecondary education - bachelor's degree or higher	17.3	(0.0)	302	(4.8)	293	(5.5)
Nunavut	Less than high school	56.0	(0.2)	191	(4.6)	169	(5.4)
	High school diploma	13.2	(0.1)	243	(6.3)	226	(6.6)
	Postsecondary education - below bachelor's degree	23.2	(0.3)	249	(5.2)	232	(5.4)
	Postsecondary education - bachelor's degree or higher	7.7	(0.2)	299	(5.0)	292	(5.7)

Source: Statistics Canada, *Skills in Canada – First Results from the Programme for the International Assessment of Adult Competencies (PIAAC) ANNEX D, 2012*, Reproduced and distributed on an "as is" basis with the permission of Statistics Canada.

**Table 1: Continued**

	Highest level of completed education	%	s.e.	Literacy		Numeracy	
				Aver.	s.e.	Aver.	s.e.
<b>OECD average</b>	Less than high school	24.2	(0.1)	246	(0.4)	237	(0.4)
	High school diploma	40.3	(0.1)	271	(0.3)	267	(0.3)
	Postsecondary education - below bachelor's degree	14.7	(0.1)	284	(0.4)	281	(0.5)
	Postsecondary education - bachelor's degree or higher	20.7	(0.1)	302	(0.3)	302	(0.3)
<b>Canada</b>	Less than high school	14.8	(0.1)	234	(1.6)	222	(2.0)
	High school diploma	24.9	(0.0)	267	(1.2)	257	(1.4)
	Postsecondary education - below bachelor's degree	34.7	(0.0)	276	(0.9)	268	(1.1)
	Postsecondary education - bachelor's degree or higher	25.6	(0.0)	300	(1.0)	295	(1.0)
<b>Newfoundland and Labrador</b>	Less than high school	22.9	(0.1)	230	(3.1)	210	(3.9)
	High school diploma	22.1	(0.0)	261	(2.6)	248	(3.0)
	Postsecondary education - below bachelor's degree	38.0	(0.1)	269	(1.8)	256	(2.3)
	Postsecondary education - bachelor's degree or higher	17.0	(0.0)	311	(2.9)	304	(3.7)
<b>Prince Edward Island</b>	Less than high school	17.3	(0.2)	237	(6.3)	223	(6.5)
	High school diploma	26.3	(0.1)	270	(5.3)	256	(5.7)
	Postsecondary education - below bachelor's degree	35.7	(0.1)	283	(3.8)	271	(5.3)
	Postsecondary education - bachelor's degree or higher	20.8	(0.1)	310	(4.1)	302	(4.7)
<b>Nova Scotia</b>	Less than high school	17.6	(0.1)	236	(4.1)	221	(4.3)
	High school diploma	22.9	(0.1)	266	(2.9)	254	(3.4)
	Postsecondary education - below bachelor's degree	36.7	(0.1)	274	(2.4)	263	(2.6)
	Postsecondary education - bachelor's degree or higher	22.8	(0.0)	310	(2.6)	304	(2.7)
<b>New Brunswick</b>	Less than high school	18.7	(0.1)	225	(3.2)	209	(3.7)
	High school diploma	27.2	(0.1)	263	(2.6)	248	(3.2)
	Postsecondary education - below bachelor's degree	34.9	(0.1)	275	(2.2)	263	(2.4)
	Postsecondary education - bachelor's degree or higher	19.1	(0.1)	307	(2.8)	298	(2.7)
<b>Quebec</b>	Less than high school	16.2	(0.1)	225	(2.2)	218	(2.6)
	High school diploma	20.9	(0.0)	264	(1.6)	259	(1.7)
	Postsecondary education - below bachelor's degree	39.2	(0.0)	271	(1.2)	269	(1.2)
	Postsecondary education - bachelor's degree or higher	23.7	(0.0)	299	(1.4)	295	(1.3)
<b>Ontario</b>	Less than high school	13.1	(0.1)	238	(3.2)	224	(3.7)
	High school diploma	26.2	(0.1)	267	(1.8)	255	(2.1)
	Postsecondary education - below bachelor's degree	32.5	(0.1)	277	(2.0)	268	(2.3)
	Postsecondary education - bachelor's degree or higher	28.2	(0.1)	299	(1.8)	295	(1.8)
<b>Manitoba</b>	Less than high school	18.9	(0.2)	234	(5.1)	221	(5.9)
	High school diploma	26.9	(0.1)	272	(3.4)	261	(3.8)
	Postsecondary education - below bachelor's degree	31.5	(0.1)	279	(3.2)	271	(3.9)
	Postsecondary education - bachelor's degree or higher	22.6	(0.1)	303	(3.2)	295	(4.2)

*Source: Statistics Canada, Skills in Canada – First Results from the Programme for the International Assessment of Adult Competencies (PIAAC) ANNEX D, 2012, Reproduced and distributed on an "as is" basis with the permission of Statistics Canada.*

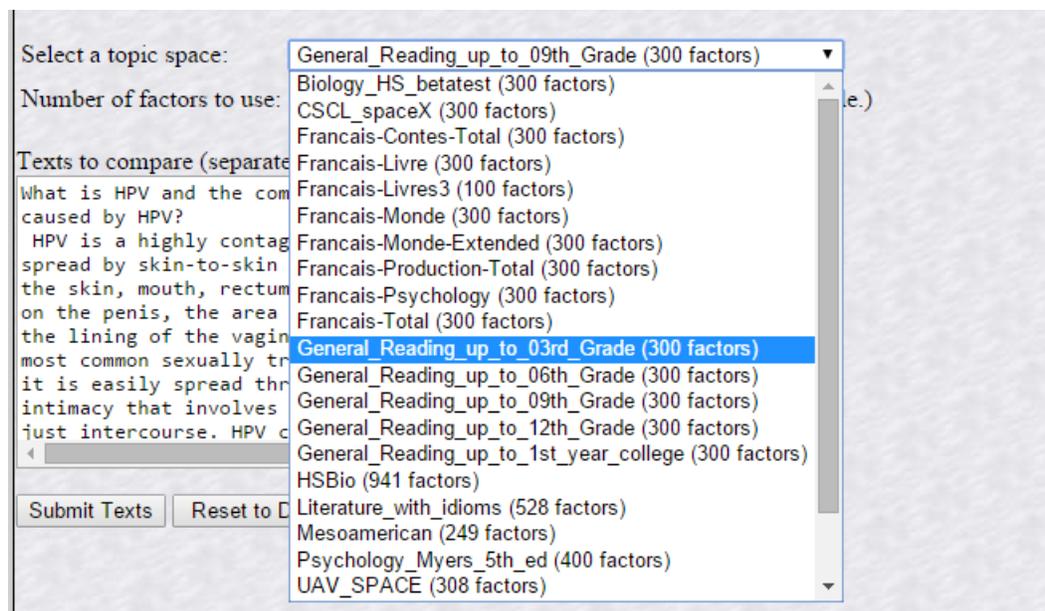
### **3.1.2 Coherence Analysis**

To determine if the coherence level of the texts is adequate for the lay population, two methods were used on the provincial HPV information: latent semantic analysis (LSA) and propositional density via use of the computerized propositional idea density rater software (CPIDR) (Landauer et al, 1998; Kinstch & Keenan, 1973; Covington, 2007).

#### **3.1.2.1 Latent Semantic Analysis**

According to Landauer et al. (1998), one of the most important features of coherent discourse is the quality of overlap and transitions of meaning as it flows across the text. LSA has the capability to model this quality of coherence and quantify it by measuring the semantic similarity of one section of the text to the next. The University of Colorado online LSA software ([lsa.colorado.edu](http://lsa.colorado.edu)) was used for the analysis.

The first priority was to choose an appropriate semantic space provided by the website. The semantic space would need to embody mutual constraints that would be representative of the lay population because we want to know if the information that is coherent enough for their typical reading grade level and general background knowledge. According to the International Adult Literacy Survey (IALS), the average reading level of the Canadian population is around grade 8 or 9 level, or some secondary school education (Friedman & Hoffman-Goetz, 2006; Hayes, 2013). Thus, the semantic space that was chosen was “general reading up to the ninth grade” (Figure 1).



**Figure 1:** Semantic Space options on the LSA website

Once the semantic space was chosen and the text to compare was inputted, the sentence to sentence comparison was initiated. LSA is able to calculate and analyze the transition from sentence to sentence, within a paragraph or within the whole text. LSA will compute the cosine of the angle between two vectors (each vector represents a sentence in this case). According to Landauer et al. (1998), LSA discourse coherence can be thought of as movements in a high dimensional space. The size and direction of these movements can signal the pace the discourse transitions to a new topic. Thus, highly coherent discourse should have small movement, represented by greater cosine values, while less coherent discourse will have larger movements and smaller cosine values in a high dimensional space (Landauer et al., 1998). In other words, the closer the score is to 1 the more coherent the text is, and the closer to 0 the less coherent it is.

0.17	12: About 400 women in Canada die each year from HPV related cancer and an average of seven women are diagnosed with cervical cancer on PEI yearly.
0.09	13: What is HPV Vaccine and what does it contain?
0.26	14: The HPV vaccine used in PEI is an inactive dead vaccine that helps protect against the diseases caused by HPV types 6, 11, 16 and 18.
0.00	15: It works best when given before the person becomes sexually active.
0.20	16: When given at this young age, the immunity level achieved is known to be very strong.
0.01	17: A series of three doses is recommended at intervals of 0, 2, and 6 months.
0.10	18: It is not yet known how long protection will last after immunization but at present no boosters are necessary.
0.02	19: The vaccine contains highly purified inactive proteins from HPV types 6, 11, 16, and 18.
0.23	20: When administered it causes the body to make antibodies against these HPV types.
0.49	21: The vaccine also contains traces of amorphous aluminum hydroxyphosphate sulphate to improve the body's ability to form antibodies, sodium chloride and water for injection.
0.05	22: There is no mercury in the vaccine.
0.15	23: This vaccine provides protection against 70 percent of HPV that cause cervical cancer and 90 percent of HPV related anal cancers and genital warts.
0.28	24: The vaccine does not treat these diseases once a person contracts them.
0.28	25: What are the possible reactions from the vaccine?
0.46	26: The most serious but rare side effect is a severe allergic reaction anaphylaxis which can be life threatening and usually occurs within 15 - 20 minutes of receiving the vaccine.
0.15	27: Procedures are in place for the nurse to quickly respond to anaphylaxis.
0.15	28: Those who receive the vaccine are asked to remain in the waiting area for 15 minutes after immunization.
0.07	29: The most common side effect is soreness around the injection site.
0.59	30: Minor side effects may include localized swelling, redness and itching at the injection site.
0.89	31: Other side effects may include headache, fever, dizziness and/or nausea.
0.26	32: It is not necessary to give acetaminophen for example, Tylenol or Tempra with every immunization.
0.28	33: However, if your child is experiencing discomfort or fever, acetaminophen can relieve these symptoms.
0.63	34: See a doctor or seek medical attention if your child has any serious side effects.
0.28	35: Report serious reactions to the public health nurse whenever they occur.
0.03	36: When should the vaccine not be given?
0.54	37: 1 Those who are allergic to any contents of the vaccine should not receive this vaccine.
0.64	38: 2 Those who had an anaphylactic reaction after getting a previous dose of the vaccine.
0.43	39: 3 Those who are ill and have a fever above 38.5 degrees Celsius or 101.3 degrees Fahrenheit should return for their immunization at a later date.
0.26	40: What are the risks if the vaccine is not received?
0.33	41: HPV infection is very common, and while most HPV infections go away by themselves, those that persist are more likely to develop into cancer.
0.17	42: Some types of HPV create a risk for cervical cancer in women and for anal cancer in both men and women.
0.08	43: At least one in 10 Canadians will develop genital warts in their lifetime, and though warts caused by the virus can be treated, they are difficult to remove and often come back after treatment.
0.36	44: Genital warts spread to two-thirds of people who come into contact with them and have significant psychosocial impact in those who are affected.
0.13	45: Should those who receive HPV vaccine continue to have regular screening done?
0.21	46: Yes, those who have received the HPV vaccine should have regular screening and testing done as recommended by their health care provider.
0.83	47: For example, males and females who have been advised to have anal cancer screening are recommended to follow the advice of their health care provider to continue that screening.
0.12	48: Women should have Pap smears at the appropriate intervals.
0.13	49: This is because the vaccine provides protection against 70 percent of those human papillomaviruses that cause cervical cancer, and a woman can become infected with one or more of the other 30 percent of these viruses that do cause cervical cancer.

Mean of the Sentence to Sentence Coherence is: 0.27

Standard deviation of the Sentence to Sentence is: 0.22

Figure 2: Example LSA output

An example of the output that LSA provides is shown in Figure 2. Each sentence is numbered by the program. After each sentence is given a value based off of the matrix calculation performed by LSA, in the specified semantic space, the cosine of the angle between the two sentences is calculated and placed on the far left side. The program also calculates the mean of the sentence to sentence coherence which is displayed near the bottom of the output. According to the Landauer et al. (1998) taking the mean cosine of the substance to sentence comparison would be an accurate predictor of reader comprehension. But to determine if these coherent scores were adequate for the lay population a benchmark had to be established.

Reinforcing the fact that the average reading level of the Canadian population is around grade 8 or 9, which is the equivalent of some secondary school education, literature that was representative of the lay population was chosen. Samples were taken from three grade 9 science textbooks that are approved on the Trillium's list (Ellis & Sandner, 2009; Davies, 2011; Blake, Tigist, Steve & Frank, 2009). The textbooks on the Ontario Ministry of Education's "Trillium's list", were put under rigorous evaluation in conjunction with the standards in the ministries policy document, "*guidelines for approval of textbooks*". These textbooks are approved by many other provinces in Canada including Alberta and British Columbia. Science textbooks were chosen because the textual structure was similar to the way provincial HPV information was presented. Ten samples were taken from each of the three textbooks, giving a total of 30 samples. Coherence scores were calculated for each of the 30 samples using the LSA program. Each of the 30 samples was chosen randomly by using the online random number generator

(<https://www.random.org/>) to determine which section to analyze. If the same section was chosen twice, a new section was chosen using the online random number generator.

In order to determine the provincial HPV, information has coherence level adequate for the lay population, two t-tests were performed for the LSA coherence analysis using R. First, each province's HPV information coherence score was compared to the textbook coherence scores that were representative of the lay population. Second, all provincial scores were compared to the textbook coherence scores. Hence, hypothesis tests with the following null hypotheses were performed:

- 1) The null hypothesis: the coherence value of HPV information for each province is equal to coherence value of the grade 9 provincial literature.

The alternative hypothesis: the coherence value of the HPV information for each province is less than the coherence value of the grade 9 provincial literature.

- 2) The null hypothesis: the mean coherence value of HPV information for each province is equal to the mean coherence value of the grade 9 provincial literature.

The alternative hypothesis: the mean coherence value of HPV information for each province is less than the mean coherence value of the grade 9 provincial literature.

All t-tests were one-tailed, and for all P values, a significance level of 0.05 was used.

### 3.1.2.2 CPIDR

CPIDR was used to calculate the propositional density (Covington, 2007). The HPV information was submitted to the “Analyze Text” field of the program. The program does this by finding all of the part-of-speech tags, such as verbs, adjectives, adverbs, prepositions, and conjunctions. Using the tags, the software is able to compute the total amount of propositions that the text has. The count is also adjusted using the integrated rules the program has to improve the accuracy of the calculation. For example, it combines auxiliary verbs with the main verb (Covington, 2007; Brown et al., 2008). Before the program computes the propositional density, it provides a ‘details window’, which shows you how the text was analyzed, so you can account and adjust for mistakes, see Figure 3 (Covington, 2007).

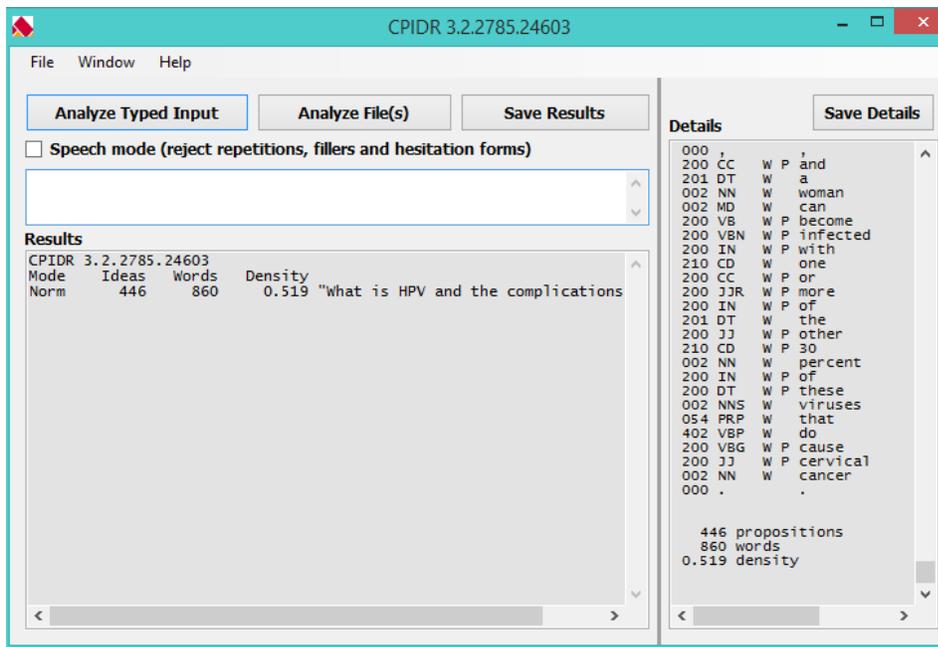


Figure 3: Output and Details window for CPIDR

CPIDR was used for each of the seven provincial HPV department/ministries of health information. Just like with LSA, in order to determine if these propositional density scores were adequate for the lay population, a benchmark was needed to draw a comparison. Thus, the 30 samples of grade 9 textbooks provided by the Trillium's list were also analyzed.

In order to determine whether the provincial HPV information has a coherence level adequate for the lay population, two t-tests were performed for the propositional density coherence analysis using R. Just like with LSA, each province's HPV information coherence score was compared to the textbook coherence scores that were representative of the lay population. Second, all provincial scores were compared to the textbook coherence scores. The t-tests were performed with the following hypotheses:

- 1) The null hypothesis: the propositional density value of HPV information for each province is equal to the propositional density value of the grade 9 provincial literature.

The alternative hypothesis: the propositional density value of HPV information for each province is greater than the propositional density value of the grade 9 provincial literature.

- 2) The null hypothesis: the mean propositional density value of the HPV information for all seven provinces is equal to the mean propositional density value of the grade 9 provincial literature.

The alternative hypothesis: the mean propositional density value of the HPV information for all seven provinces is greater than the mean propositional density value of the grade 9 provincial literature.

### **3.3 Pearson Correlation**

In order to see if the assessments of readability and coherence have a mutual association, the Pearson product moment correlation was calculated. The Pearson product moment correlation was chosen because the data being analyzed from both the coherence and readability measures are both continuous data. Four calculations were performed in order to draw a conclusion. The readability tools of SMOG and Gunning-Fog were compared to the coherence tools of LSA and propositional density using the Pearson product moment correlation. All calculations were performed in R. R is a programming language used for statistical computing. According to Burns (2007) it compares well with other commercial statistic software such as SAS, SPSS, and SATA.

For all P values, a significance level of 0.05 was used.

## CHAPTER 4: RESULTS

The work presented in the remainder of this chapter is currently under review in a scholarly peer-reviewed journal as:

Tulsieram, K.L., Arocha, J.F., & Lee J. Readability and Coherence of Canadian Provincial Department/Ministry of Health HPV Information Intended for the Lay Population.

### INTRODUCTION:

Human Papilloma Virus (HPV) is estimated to be one of the most commonly sexually transmitted infections (STI) in Canada. More than 70% of sexually active Canadians are likely to have an HPV infection at some point in their lives (Butler-Jones, 2013). When an HPV infection progresses, it can develop into cervical, penile and various other types of cancers (Torre et al., 2012; Markowitz & Unger, 2012). It is the primary cause of cervical cancer in women (Castellsagué et al. 2014). Some HPV strains also contribute significantly to the prevalence of genital warts (Markowitz & Unger, 2012). A vaccine, such as Gardasil 9, is able to protect against 90% of the HPV strains that lead to cervical cancer, and provide some protection from other cancers and genital warts (CDC, 2012). Thus, vaccines to prevent contraction of some of the HPV strains are valuable to Canadians.

Considering that many Canadians access health information online, including information on HPV vaccination, it is important that this information is clear to the lay population. This would allow the lay population to understand the risk the virus poses and the benefits of the

vaccine. Across provinces, household Internet access is between 70% – 84% and 64% of individuals 16 years and older use the Internet to search for health information (Hoffman-Goetz, Donelle, & Ahmed, 2014). One can expect that the number of individuals, across all socioeconomic statuses, accessing health information from online sources would only increase in the future, which brings into focus the comprehensibility of such information. Research has shown that much of the health information is difficult to understand (Friedman et al. 2006; Friedman et al. 2004; McInnes & Haglund, 2011). If this is true, does this also apply to official websites, such as those of ministries and departments of health?

To evaluate and analyze some of the important aspects of comprehensibility of the provincial health information on HPV, the different elements of text characteristics that research has shown to improve the comprehensibility of information, will be examined. Two are of particular relevance for our study: readability and coherence. Studies have shown that if text readability level is low and text coherence is high, a typical reader will be able to understand the material to improve their knowledge and help carry out the intended health behaviours (Kintsch et al 1992; Glanz, Rimer & Viswanath, 2008).

The main objective of the present study was to evaluate whether the readability and coherence of the HPV information from the official provincial websites in Canada are sufficiently adequate for the general population to understand.

## METHODS:

HPV vaccination information was obtained from the websites of departments/ministries of health for each of seven Canadian provinces. The provinces were British Columbia, Saskatchewan, Manitoba, Ontario, New Brunswick, Prince Edward Island and Newfoundland. Not all Canadian provinces were included because during the time of data extraction only the seven provinces listed above had province-specific HPV vaccination information. The dates of data extraction were the 28th and 29th of March, 2015.

The documents were analyzed to assess (1) text readability and (2) text coherence. The first was assessed by means of two commonly used readability tools: the Gunning-fog index and the SMOG readability formula (Simple Measure of Gobbledygook) (Gunning, 1952 & McLaughlin 1969). These were the tools chosen as they have a high concordance when determining readability scores (Wang et al. 2013; Janan & Wray, 2014). These tools give the rough education level needed to understand documents. Two raters assessed the readability of each provincial document. This is necessary because for each readability tool the parts of the text chosen by the rater are subject to a slight variation. For example, when extracting text to be evaluated from the middle of a document, two raters may select slightly different sections of the text, and this variance can lead to a difference in the final scores. The inter-rater reliability for each test was calculated using the concordance correlation coefficient,  $\rho_c$  (NIWA, 2005).

The percentage of Canadians able to read the documents for each province was found by obtaining the Programme for the International Assessment of Adult Competencies (PIACC) data<sup>17</sup>. The PIACC has data on the level of education obtained by Canadian adults aged 16 to 65

in each province. Using the PIACC data to determine the highest level of completed education by the population for each of the provinces and comparing it to the Gunning-Fog and SMOG grades obtained for the provincial HPV information, the proportion of the population that would be able to understand this information was determined.

To determine if the coherence level of the texts is adequate for the lay population, two methods were used on the provincial HPV information: latent semantic analysis (LSA) and propositional density via use of the computerized propositional idea density rater software (CPIDR) (Landauer et al, 1998; Kinstch & Keenan, 1973; Covington, 2007).

LSA is a methodological approach to discourse analysis based on the hypothesis that a text has a high degree of coherence if the reader is able to create a connected mental representation from the information provided from a piece of literature (Kintsch & van Dijk, 1983). Similarly Landauer states, “LSA theory addresses the problem of exactly how word and passage meaning can be constructed from experience with the language, that is, by what mechanisms instinctive, learned, or both this can be accomplished” (Landauer, McNamara, Dennis, & Kintsch, 2011, p.3). This alludes to two important premises for using LSA to represent a population and evaluate HPV information. The first being, “LSA can perform many meaning-based cognitive tasks as well as humans” (Landauer et al., 2011, p.4). Moreover, LSA is able to determine the quality of overlap and transitions of meaning as it flows across the text and gives it a cosine value to indicate the level of coherence. Transitions in meaning are regarded as one of the most important features of coherent discourse (Landauer, Flotz & Laham, 1998).

Propositional density, known as P-density, is defined as a measure that determines the effectiveness of processing and storage of linguistic information/ semantic content by the reader and is calculated as the number of propositions divided by the total number of words (Brown et al. 2008). The CPIDR software is able to calculate the propositional density of a text automatically. It is important to note that both LSA and propositional density can be used to measure the coherence of a text, with one key difference. For LSA the closer the score is to 1 the more coherent the text is and the closer to 0 the less coherent it is while with propositional density it is the exact opposite. Both of these coherence analyzes were performed on each of the seven provincial HPV documents.

According to the International Adult Literacy Survey (IALS), the average reading level of the Canadian population is around grade 8 or 9 level, or some secondary school education (Friedman et al. 2006; Hayes et al. 2013). In order to get a coherence score that was representative of the lay population, samples were taken from three grade 9 science textbooks that are approved on the Trillium's list. The textbooks on the Ontario Ministry of Education's, "Trillium's list", were put under rigorous evaluation in conjunction with the standards in the ministries policy document, "*guidelines for approval of textbooks*" (Ellis & Sandner, 2009;

Davies, 2011; Blake, Tigist, Steve & Frank, 2009). These textbooks are approved by many other provinces in Canada including Alberta and British Columbia. Science textbooks were chosen because the textual structure was similar to the way provincial HPV information was presented. Ten samples were taken from each of the three textbooks, giving a total of 30 samples. Coherence scores were calculated for each of the 30 samples using both types of analysis. Each of the 30 samples was chosen randomly by using the online random number

generator (<https://www.random.org/>) to determine which section to analyze. If the same section was chosen twice, a new section was chosen using the online random number generator.

To determine if the provincial HPV information has a coherence level adequate for the lay population, t-tests were performed for both methods of coherence analysis. The tests were performed in two ways. First, each province's HPV information coherence score was compared to the textbook coherence scores that were representative of the lay population. Second, all provincial scores were compared to the textbook coherence scores. All t-tests were one-tailed, with the hypothesis that the coherence of the provincial HPV information would be less than that of the textbook samples.

Lastly, Pearson product moment correlation coefficients were calculated to determine if the readability and coherence scores had a mutual association.

For all p-values, a significance level of 0.05 was used.

## RESULTS:

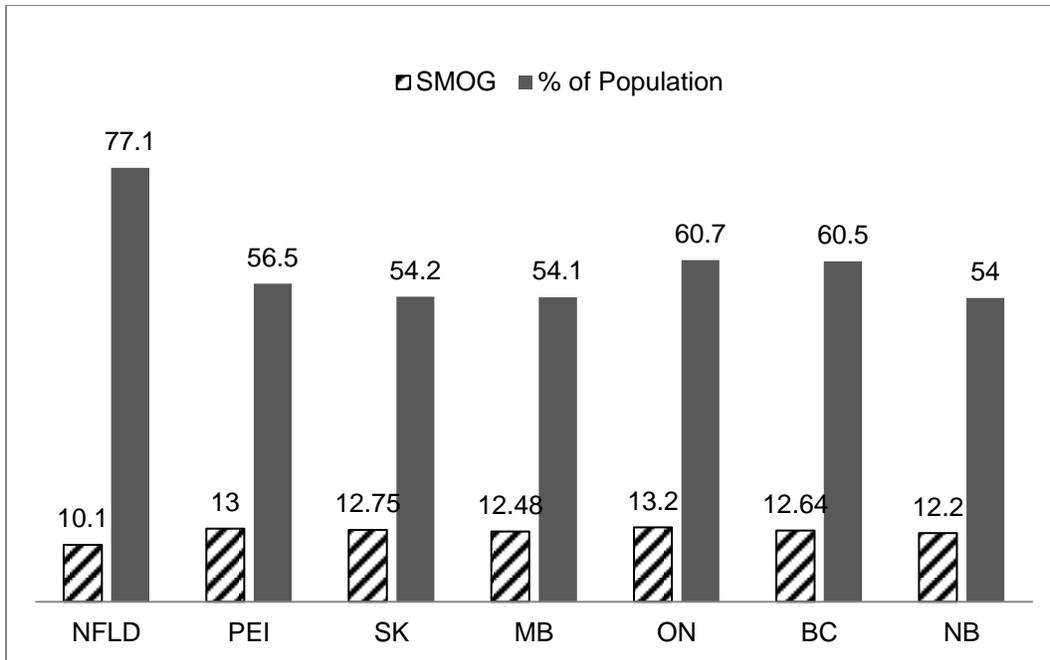
### *Readability Assessment*

The readability scores from both SMOG and Gunning-Fog, together with the percentage of the population that would be able to understand the HPV information for each province, are reported in Figures 4 and 5 respectively. The concordance correlation coefficients between the raters were 0.90 and 0.94 for the SMOG and FOG analyzes, respectively. Using the SMOG scores to evaluate the HPV information from each province, six out of the seven provinces had scores that indicated that an individual would need some postsecondary education to understand

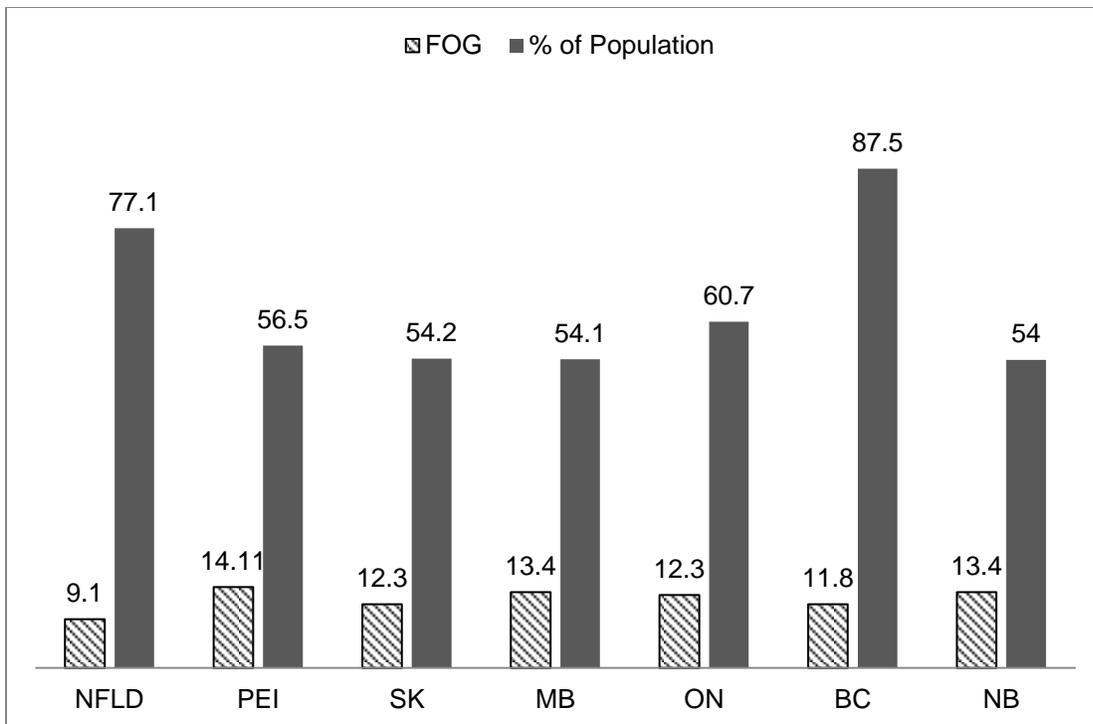
the information (below bachelor's degree or reading grade level greater than 12). The only exception was Newfoundland, which had a score indicating that someone with a high school diploma would be able to understand the HPV information for that province (reading grade level between 9 and 12).

The Gunning-Fog scores produced similar results. Five out of seven provinces had scores indicating that an individual would need some postsecondary education to fully understand the information presented (below bachelor's degree or reading grade level greater than 12). The exceptions were British Columbia and Newfoundland, the latter having a similar score as was found with the SMOG readability analysis (reading grade level between 9 and 12).

As shown in Figure 4, the percentage of the Canadian adults aged 16 to 65 that would be able to understand this HPV information for each of the provinces evaluated is greater than 50%. In general, the provinces that were noted as exceptions above, namely British Columbia (exclusively with the Gunning Fog Index calculation) and Newfoundland, exhibited higher percentages than the other provinces.



**Figure 4:** Percentage of the population in each province that can understand the HPV information according to the SMOG score.



**Figure 5:** Percentage of the population in each province that can understand the HPV information according to the FOG score.

### ***Coherence Assessment***

The results of the t-test performed for each province indicated that the coherence of the HPV information was not adequate for the general lay population to understand. The results of LSA (See Table 2) show that the average coherence value of grade 9 provincial literature, which represents the lay population, was significantly greater than the coherence value of the HPV information for each province. The subsequent t-test found that the mean LSA coherence value,  $0.364 \pm 0.067955$ , for the grade 9 provincial literature was significantly greater than the mean coherence value of the HPV information for all provinces ( $p < 0.001$ ).

Table 2 includes the results of the propositional density analysis. This t-test found the average coherence value of the grade nine provincial literature was significantly less than coherence value of the HPV information for each province. Once again when evaluating the provinces together for propositional density, using the CPIDR software, also showed that the mean coherence value of the grade 9 provincial literature,  $0.470233 \pm 0.018054$ , was significantly less than the mean coherence value of the HPV information for all provinces ( $p < 0.001$ ).

Table 2: Coherence Scores from Each Province and Their Comparisons with the Coherence of Textbook Samples Representative of the Lay Population.

<b>Province</b>	<b>LSA Value</b>	<b>p-value</b>	<b>Propositional Density Value</b>	<b>p-value</b>
<b>NL</b>	0.23	< 0.001	0.491	< 0.001
<b>PEI</b>	0.27	< 0.001	0.519	< 0.001
<b>SK</b>	0.25	< 0.001	0.513	< 0.001
<b>MB</b>	0.23	< 0.001	0.490	< 0.001
<b>ON</b>	0.26	< 0.001	0.489	< 0.001
<b>BC</b>	0.25	< 0.001	0.499	< 0.001
<b>NB</b>	0.23	< 0.001	0.489	< 0.001

Table 3 shows the Pearson product moment correlations between the readability and coherence measures used in the present study for the HPV provincial documents. No evidence was found that the tests of readability and coherence were significantly correlated in regards to the analysis of the provincial HPV information, in the particular range that was being evaluated.

Table 3: Mutual Associations between Readability and Coherence Tools

<b>Readability Tool</b>	<b>Coherence Tool</b>	<b>r (cor)</b>	<b>p-value</b>
<b>SMOG</b>	PD	0.3636048	0.4227
<b>SMOG</b>	LSA	-0.6590557	0.1074
<b>FOG</b>	PD	0.3339711	0.4641
<b>FOG</b>	LSA	-0.3635492	0.4228

## DISCUSSION:

Our results show that the readability levels of the HPV information found on the official health ministry website for each of the seven provinces evaluated were too high for the general population to understand. According to the International Adult Literacy Survey (IALS), the average reading level of the Canadian population is around grade 8 or 9 level of some secondary school education (Friedman et al. 2006; Hayes et al. 2013). This concurs with other studies that showed that web-based health information tends to be written above the average comprehension of high school level (Friedman et al. 2006; Friedman et al. 2004; McInnes & Haglund, 2011). Although the results of the present study indicate that a majority of the population in each province can understand the HPV information presented, these are generally segments of the population with a higher level of education attainment. In addition, age is a factor that can skew the percentage of the population that actually read the material. Studies indicate that although intellectual ability does not decrease with age, thinking in abstract terms and the ability to perceive relationships from what we read, can decrease in the elderly (Baker et al. 2000; Kutner et al. 2006). Considering, literacy is affected as we age, and the baby boomers are now in the 50+ category, which represents a large portion of the population. The percentage of the population that can understand the HPV information in Figures 4 and 5 may be significantly lower (Statistics Canada, 2008; Turcotte & Schellenberg, 2007).

It is important, for the less educated proportion of the population to understand this material, as they have the lowest awareness and the greatest risk of infection (Marlow, Waller, & Wardle, 2007).

Newfoundland's HPV information had the lowest reading grade level score according to both readability tools. This could be explained by the fact that of all the provinces Newfoundland has the greatest proportion of the population aged 16 to 65 with less than a high school education at 22.9% (Hayes, 2013). In contrast, Ontario (which according to SMOG its HPV information has the highest reading grade level) has the greatest proportion of the population between ages 16 to 65 with post-secondary education (bachelor's degree or higher) at 28.2% (Hayes, 2013).

Interestingly, according to the Gunning-Fog individuals with a high school diploma and higher should be able to understand the British Columbia's HPV information, while according to SMOG individuals would need some post-secondary education to understand the material. Although a Gunning-Fog of 11.8 indicates that someone with a high school diploma should be able to read the HPV information, the score of 11.8 indicates that the information is on the higher end of the capabilities of a high school graduate, relative to a score of 9.8. Thus, with a score so close to the threshold of needing some post-secondary education to understand the material, and SMOG score indicating some post-secondary education is needed to understand the information, it would not be wise to definitively categorize having a high school diploma as the adequate educational level to understand B.C.'s HPV information.

In general, each province's HPV information had a coherence score that was inadequate for the lay population. This finding corroborates previous (Ta-min, Arocha & Hoffman-Goetz, 2007) where participants had to read web-based cancer information. Analysis of the read transcriptions using propositional analysis agreed with our findings in that the web-based cancer information has a lower level of coherence than what is needed for the participants involved.

Our results show that tests of readability and coherence are not correlated. Other studies have also shown that text readability and text coherence are typically uncorrelated because each measures distinct properties of a text (Friedman et al, 2004; Ta-min et al, 2007). The readability as a measure of a text's comprehensibility is calculated by accounting for word and sentence lengths. However, this is not the only factor in a person's ability to understand the text, as underlying factors of coherence, such as semantic connectedness, cohesion, and consistency are also important measures to take into account (Reinhart, 1980). As Friedman et al. (2004) explained, if word and sentence lengths in a text are shortened, this would lower the readability score, but there is no guarantee that the text would be easier to understand. For example, shorter words (even though it has fewer syllables indicating easier readability) may actually be more difficult while short sentences can sound fragmented (Friedman et al., 2004). The study by Ta-Min et al. (2007) showed that a low readability level was generally not related to a high degree of coherence and vice versa when comparing coherence scores from propositional analysis to those from three readability tests (Ta-min et al., 2007). Therefore, it would be more effective if both readability and coherence are included in the analysis of health information as they are important factors in a population's ability to understand a given text.

In summary, considering that HPV vaccination can have a great impact on the health of men and women, it is important that the Canadian population is able to understand the risks and benefits of HPV vaccination. This study should inform provincial departments/ministries of health that the web-based HPV information they are sharing with the lay population is not clear

to the population that they are targeting, and the factors addressed in this study, namely readability and coherence, must be considered to achieve the intended goal.

There are several limitations with the present study. First, seven out of ten provinces' HPV information websites were evaluated. The other three provinces that were excluded did not have HPV information available at the time of analysis. Thus, information from each provincial website is limited to what was posted at the time of analysis. Second, each of the analyzed websites may be updated in the future, which limits the analysis to the currently posted information and only until the content of the provincial/territorial HPV vaccination information is modified. Third, only English information was analyzed. Readability and coherence levels for French or other languages were not considered because the literature to produce the benchmark for the lay population's coherence scores was restricted to English texts. Fourth, our study did not account for information that can be accessed from less reputable websites and media sources. This is an important factor because generally less reputable web pages may appear on search engine results above the official provincial government's websites. Finally, understanding of health information is not only contingent on readability and coherence. Other factors, such as prior knowledge, impact of illustrations, multimedia, and presentation of the information (layout) can affect an individual's ability to understand health information. Despite these limitations, the results of the study can make the current information provided to the lay population more effective by considering important factors such as readability and coherence.

## CHAPTER 5:

### GENERAL DISCUSSION

As mentioned previously, it is important, for the less educated proportion of the population and individuals who have English as a second language (other than French), who have poor English literacy to understand this material. It would be beneficial if the information was tailored towards these groups as they tend to have the lowest awareness and the greatest risk of infection (Marlow, Waller, & Wardle, 2007). A study by Chen et al. using US Census Bureau data, in regard to HPV-related cancers, for both black and white men, having 12 years or more of education would have less prevalence and lower mortality. Those with less than 12 years of education have greater mortality. Other studies show that parental educational attainment is correlated to contraceptive use by their children. Santelli et al. (2000) found that contraceptive use among female adolescents was higher if their parents were college educated. It is also well-known that lower educational attainment is associated with having a lower socioeconomic status (SES). People with a lower SES tend not to know and have less access to preventative treatment/vaccines, earlier detection, and follow-up. More importantly, individuals of lower educational attainment or lower SES tend to have diseases and cancer diagnosed at many later stages when treatment options are limited (Chen et al., 2007).

Although it was apparent that high education of an individual and parental education leads to a lower risk of acquiring HPV, some studies have found opposing evidence when it comes to vaccinating their children. A Canadian study by Oglive et al. (2010) found that parents

with more education were more likely not to initiate their daughters receiving the vaccine. Similarly in a recent study in Norway, higher maternal education was correlated to their daughters having a lower chance to receive the vaccine (Feiring et al. 2015). The studies suggest that this could be due to the fact that more educated parents tend to play more of an active role in their children's health, and use current information to inform their decisions (Ogilvie et al. 2010 & Feiring et al. 2015). But according to the authors, the source could be a problem as the media tend to send mixed messages about the safety of the HPV vaccine (Ogilvie et al. 2010 & Feiring et al. 2015).

The results show amongst all of the provinces evaluated, Newfoundland's HPV information had the lowest reading grade level score according to both readability tools. This could be credited to the fact that the Department of Health and community services report on a policy framework for chronic disease prevention and management in Newfoundland and Labrador, emphasizes accessibility (Newfoundland and Labrador Department of Health and Community Service, 2011). The report acknowledges that barriers to programs and services that the province provides are attributed to the low literacy; and for the state to increase accessibility, "access to plain language health information are accommodated as much as possible" (Newfoundland and Labrador Department of Health and Community Service, 2011). It is promising that the Department of Health and community services of Newfoundland is aware of lower literacy since they have the greatest proportion of the population aged 16 to 65 with less than a high school education at 22.9% (Hayes, 2013). This can be explained by the fact that during the last 20 years, in Newfoundland 80% of the population that migrates away from Newfoundland tends to be younger people aged 15 to 29 (CLLN, 2012 & Chagnon & Martel

2012). These individuals tend to be highly educated relative to the general population, which can account for the fact that Newfoundland has a greater proportion of the population with less than a high school education. Although Newfoundland is committed to increasing accessibility of health information, in terms of readability, it is still not adequate for the least educated portion of the population.

As stated previously, Ontario (which according to SMOG its HPV information has the highest reading grade level) has the greatest proportion of the population between ages 16 to 65 with post-secondary education (bachelor's degree or higher) at 28.2% (Hayes, 2013). Although this may seem appropriate since the population is much more educated compared to other provinces, there is still a significant proportion of the population that may not be able to read at that level. One important consideration to keep in mind is that in Ontario roughly 25% of the population is a visible minority and a significant percentage of them have English as a second language. Although some may have a very strong English literacy skills there are many that would have a difficult time understanding health information at such a high level (Todd & Hoffman-Goetz, 2010). Many immigrants are well educated but may not be able to understand even the lowest reading levels of health information. It may be more beneficial if health information was written in their native tongue (Todd & Hoffman-Goetz, 2010).

Having the reading grade level at 13.2 for Ontario's HPV information means that it would be very difficult for almost 40% of the population to read the material, according to the PIAAC data. In addition, it would be very naïve to definitively say that based on the results presented in the Fog and SMOG tables that this is the exact percentage of the population that can

read at this level. This is because studies have shown that educational attainment cannot be a direct substitute for literacy but can be an approximate predictor. This is because generally individuals often read several grades lower than the highest grade achieved in school (Chew et al. 2004, Hoffman-Goetz et al. 2014 pg. 29). Therefore, it is likely that the percentage of the population in each province that can understand HPV information according to the Fog and SMOG scores, presented Figures 4 and 5, could be significantly lower.

As indicated earlier, the reason why LSA and CPIDR were used to measure coherence of HPV information was for the purpose of measuring both global and local coherence in the most efficient way possible while ensuring the reliability of my results. Global and local coherence was measured using LSA. This was done by taking the average of the cosines for each sentence within the text evaluated (averaged sentence-to-sentence cosines) (Flotz, 1998; Britton & Gulgoz 1988). In addition, according to McNamara et al. (1996) and Landauer & Dumais, (1997), LSA can capture the reader's ability to incorporate their past experience that influence how they perceive semantic relationships between pieces of textual information, which demonstrates both local and global coherence. To accomplish this, the semantic space chosen was a "General Reading up to 9<sup>th</sup> Grade" using the LSA website. Hence, LSA analyzed the information with the capability and the general past experience of an individual with a reading ability up to grade 9.

Based on evaluating the benchmark of standardized grade 9 textbooks from Ontario's trillium list, it was concluded that each province's HPV information does not meet the levels of coherence measured by LSA. In terms of global coherence, the HPV provincial information is not written in a way where the overall central themes, topics, referents, etc. are organized around

central ones and ensures unity and sequence throughout the entire text. Although, one can argue that if Provincial HPV text were analyzed as a whole, instead of by subsections to separate the different topics or subheadings such as, “vaccination information” vs “What is HPV?”, the global coherence will be much lower because the topics are different. This hypothesis was tested and there was no significant difference between analyzing separate sub-sections and the entire text. The test showed that the average sentence-to-sentence coherence of each subsection of the HPV information were slightly lower but not significantly lower than analyzing the entire text.

According to the results, the coherence levels being inadequate for the intended reader also signifies that they would have difficulty using past experiences or background knowledge to aid in their interpretation of HPV information. This means that the information should be written in a way where the referents used are more likely to link to a reader’s past experience so they can have stronger relationships between pieces of textual information. In other words, the information should be written keeping in mind the general previous knowledge or vocabulary the intended reader would be likely to have. This would be very beneficial and make it easier for the reader to make mental links (semantic relationships) and increase their ability to comprehend information (Hirsch, 2003). An argument can be made that individual readers have their own previous knowledge that would affect their ability to create semantic relationships between the text which affect their local and global coherence of a text. While this is a fair argument, McNamara et al. (1996) and Landauer & Dumais (1997) have proven that LSA is capable of generally representing the past experience of the intended reader by choosing the appropriate semantic space, to evaluate text/information, to determine if it is written with the likely inferences and assumptions the intended reader would make.

Propositional density was calculated using CPIDR. CPIDR evaluated standard grade 9 textbooks from Ontario's Trillium list to form a benchmark to evaluate each province's HPV information. According to a t-test comparing the two propositional density values for coherence, the Provincial HPV information was significantly higher. A number of propositions relative to a number of words in the Provincial HPV information would be too high for the intended reader to comprehend. This means that there are too many idea units per sentence which make it harder for the intended reader to understand. Having higher propositional density than the benchmark would mean that the reading time would be much higher, lower recall and processing efficiency (Kintsch & Keenan, 1973). These factors play a role in whether the individual would even read the material, let alone carry out the intended behaviour.

An important premise behind my research was to determine that the knowledge that the HPV provincial information provided would be understandable to the intended reader (primarily parents). This was crucial as studies have shown that parents have low knowledge of the HPV vaccine (Parez et al. 2015; Olsten et al. 2005). A recent study found that Canadian parents are still unaware that boys could receive the vaccine, due to previous anchoring bias (Parez et al. 2015). Studies by Parez et al. (2015) and Olsten et al. (2005) agreed that informing parents with basic knowledge about the HPV vaccine was an important first step to encourage HPV vaccination of their children. Other studies suggest that basic knowledge such as, what ages to vaccinate boy and girls, may not be enough to convince parents. A study by Dempsey et al. (2006), found that providing parents with a basic HPV information did seem to improve knowledge post-survey, this increased knowledge did not have a strong effect on the

acceptability of the vaccine by parents for their children. These results indicate that the knowledge that should be presented to parents should be targeting their attitudes/beliefs towards vaccination. Examples of tailoring the knowledge to influence the attitudes of parents include addressing perceived risks of the vaccine, noting the benefits of the HPV vaccine and the risks the virus possesses (Olsten et al. 2005; Dempsey et al. 2006; Reiter et al. 2009). Combining messages that promote an attitude level change, along with ensuring that the message would be understandable through measures of comprehensibility discussed in my study, could improve acceptance by the lay population.

Future research of the readability and coherence of HPV information should include the territories. Considering that Northwest Territories and Nunavut have the greatest proportion of their population with less than a high school diploma (Table 1), evaluating their HPV information would have a greater potential public health impact. In addition, northern Canada (the territories) tend to have the highest rates of HPV infection especially in aboriginal women, which further justifies extending my research to the territories (Jiang et al, 2013). The prime factors for not including the territories in my study were time and constraints that the LSA coherence assessment has. Considering a significant proportion of the population speaks English as a second language and have a much lower educational attainment, it would be difficult and time-consuming to build a semantic space that encapsulates the characteristics of the populations of the territories. But with more time, this can be possible.

## CHAPTER 6:

# CONCLUDING REMARKS & IMPLICATIONS FOR PUBLIC HEALTH

Considering that roughly two-thirds of the Canadian population, 16 years or older, use the Internet as a primary source of health information, it is important that they can understand such information in order to practice the appropriate behaviour (Hoffman-Goetz et al., 2014). An important goal of this study is to inform various public health agencies that the health information that they are providing may not be clear to the population that they are targeting, and that the factors addressed in this study, such as readability and coherence must also be considered to achieve the intended goal of making health information understandable by the lay population. The techniques used in this study to evaluate health information could be implemented by public health agencies to help improve their existing and future material, in order to provide more effective communication.

Other factors such as, forming health messages that influence an individual's attitudes and beliefs, would be just as important as making the information understandable. Together they could be more effective in conveying the appropriate message to encourage vaccine uptake. On a higher level, policy changes of making the HPV vaccine mandatory as part of childhood immunization programs in schools would be more effective in increasing vaccination rate.

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**\*Appendix A: Provincial Ministry/ Department of Health HPV Information URL's**

**British Columbia:**

<http://www.healthlinkbc.ca/medications/content.asp?hwid=zb1250>

**Manitoba:**

<http://www.gov.mb.ca/health/publichealth/cdc/vaccineeligibility.html>

**Saskatchewan:**

<http://www.gov.mb.ca/health/publichealth/cdc/vaccineeligibility.html>

**Ontario:**

<http://www.health.gov.on.ca/en/ms/hpv/info.aspx>

**New Brunswick:**

[http://www2.gnb.ca/content/gnb/en/departments/ocmoh/cdc/content/human\\_papillomavirus.html](http://www2.gnb.ca/content/gnb/en/departments/ocmoh/cdc/content/human_papillomavirus.html)

**Prince Edward Island:**

[http://www.gov.pe.ca/photos/original/dhw\\_cpho\\_fs\\_hpv.pdf](http://www.gov.pe.ca/photos/original/dhw_cpho_fs_hpv.pdf)

**Newfoundland:**

[http://www.health.gov.nl.ca/health/publichealth/cdc/Protect\\_against\\_HP.V.pdf](http://www.health.gov.nl.ca/health/publichealth/cdc/Protect_against_HP.V.pdf)

\*Note: some websites and their fact sheets may have been updated and/or no longer exist from date of data collection.

**Appendix B: Sample of HPV information Analyzed**

## British Columbia

### Human Papillomavirus (HPV) Vaccine

#### British Columbia Specific Information.

The HPV vaccines, Cervarix<sup>®</sup> (HPV2) and Gardasil<sup>®</sup> (HPV4), protect against infection from certain types of human papillomaviruses (HPV). Health Canada approves the HPV vaccines Cervarix<sup>®</sup> (HPV2) and Gardasil<sup>®</sup> (HPV4) for use in women up to the age of 45. The vaccine is provided free to girls in grade 6. Girls born in 1994 or later who were eligible for the HPV vaccine but did not receive it may contact their local health unit to get vaccinated at no cost. Women and girls under the age of 45 who are not eligible to receive the vaccine for free can purchase it from a pharmacy or at their doctor's offices. For more information about the HPV vaccine, see [HealthLinkBC File #101b Human Papillomavirus \(HPV\) Vaccine](#).

For more information about HPV see [HealthLinkBC File #101a Human Papillomavirus \(HPV\) Infection and Genital Warts](#). If you are interested in information on other HPV vaccine programs in BC, visit [ImmunizeBC HPV \(Human Papillomavirus\)](#).

#### How It Works.

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These vaccines are given in three shots (injections) over 6 months. In response to these vaccines, which contain an inactive form of [human papillomavirus](#) (HPV), your body makes [antibodies](#) against the virus. This response is known as active [immunity](#).

#### Why It Is Used.

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HPV is the most common [sexually transmitted infection](#) (STI). There are more than 100 known types of HPV, some of which are known to cause cervical cancer or [genital warts](#). Both Gardasil and Cervarix protect against the two most common types of cancer-causing HPV (types 16 and 18), while Gardasil also protects against two viruses that can cause genital warts (types 6 and 11).

The HPV vaccine is recommended for females 9 to 45 years of age and males 9 to 26 years of age. Gardasil is used for males. Females can get either vaccine.

It's important that girls get the vaccine before they begin to have sex. Women up to 45 years of age may benefit from getting an HPV vaccine, even if they are already having sex or have had abnormal Pap test, cervical cancer, genital warts, or HPV infection. These women may not yet have HPV infection or the HPV types that the vaccines block.

HPV vaccine recommendations may be different in your province or territory. Check with your doctor or provincial ministry of health to find the HPV vaccine recommendations in your area. You can keep track of when your child received vaccines using the [National Childhood Immunization Record](#) (What is a [PDF](#) document?) or the [Alberta childhood immunization record](#) (What is a [PDF](#) document?) .

## How Well It Works.

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For people who do not have HPV, the vaccine is nearly 100 per cent effective in preventing infection by the most common types of HPV that can cause cervical cancer in females and genital warts in males and females. But the vaccine does not affect existing cervical changes caused by HPV. And the vaccine does not protect against all types of HPV that can cause cancer and genital warts.

## Side Effects

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Mild reactions to the HPV vaccine are common and include:

- Pain, redness, swelling, or itchiness where the shot was given.
- Fever.

Even though [serious allergic reactions](#) are rare with Gardasil, call your doctor or local health unit right away if you or your child has trouble breathing, a high fever, or anything unusual after having the shot.

A person who has had a severe allergic reaction to a previous dose of the vaccine or to yeast should not get another dose. Tell your doctor or nurse if you or your child has had a severe reaction to any vaccine or has severe allergies.

See Drug Reference for a full list of side effects. (Drug Reference is not available in all systems.)

## What To Think About.

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People with a mild illness, such as a cold, can get the HPV vaccine. But if they are more ill, they should wait until they are better.

Pregnant women should not get the HPV vaccine.

Because the vaccine does not protect against all types of HPV, women who have received the HPV vaccine still need regular Pap tests after they become sexually active to check for changes in the cells of the [cervix](#).

Your provincial or territorial health ministry may not yet cover the cost of the HPV vaccine outside of school-based vaccination programs. You may have to pay for the vaccine yourself.

Complete the [new medication information form \(PDF\)](#) (What is a [PDF](#) document?) to help you understand this medication.

## Human Papillomavirus (HPV) Infection and Genital Warts

### What is HPV Infection?

HPV is one of the most common sexually transmitted infections (STIs). It can infect all of the throat, genital area and surrounding skin. This includes the vagina, cervix, penis, vulva, rectum, and anus.

There are more than 100 types of HPV, and about 40 of these affect the genitals. Two types cause 70 per cent of cancers of the cervix, plus a number of less common cancers of the throat, anus, penis, vagina and vulva.

Two other types of HPV cause most of the cases of genital warts, which are flat or cauliflower-like bumps that occur in the genital area.

It is possible to have more than 1 type of HPV infection at the same time. For an accurate diagnosis, all suspicious bumps and lesions should be checked by a health care professional. Cervical cancer that is caused by HPV is detected using a Pap test, which is a routine part of a female sexual health exam.

### How is HPV spread?

HPV is spread by skin-to-skin contact. This can be during oral, vaginal or anal sex, or during any other activity in which skin-to-skin contact takes place.

### How common is HPV infection?

Three out of 4 sexually active people will get at least one HPV infection at some time in their lives. The more sexual partners you have, the higher the possibility of getting an HPV infection.

### What are the symptoms of HPV?

Genital warts are a symptom of HPV. Genital warts caused by HPV are soft, bumps that are usually painless, may be itchy, and sometimes bleed. They can be found in the groin, genitals, buttocks and inside the vagina or anus.

Since many strains of HPV do not produce visible warts, most people do not show any signs or symptoms of an HPV infection. As a result, they can pass HPV to others without knowing it.

### What are the risks of HPV infection?

Most people who have an HPV infection clear it within 2 years. When it does not clear, cells infected with the cancer-causing type of HPV start to change. As a result, almost 200 women develop cervical cancer every year in BC, and close to 50 women die from the disease.

## How are Genital Warts treated?

Genital warts can be treated using topical medication or freezing. These are usually applied to the area over a 4 to 6 week period. The length of treatment may vary depending upon the severity of the warts. These treatments do not get rid of the HPV infection; a person who has been treated may still pass it on, even if the warts are no longer visible.

**Caution:** Do not use non-prescription wart removal products to treat genital warts. These products are not intended for use in the genital area and may cause serious burning.

## Is there a vaccine for HPV?

There are 2 HPV vaccines available in Canada: Cervarix<sup>®</sup> and Gardasil<sup>®</sup>. Both vaccines protect against infection by HPV types that cause most cases of cervical cancer and several less common cancers. Gardasil<sup>®</sup> also protects against infection by the HPV types that cause most cases of genital warts. The vaccines prevent HPV infection but do not get rid of the infection once it has occurred. For more information on the HPV vaccines, see [HealthLinkBC File #101b Human Papillomavirus \(HPV\) Vaccines](#).

## How can I reduce my chance of getting a sexually transmitted infection (STI)?

### **Practice safe sex by using a condom.**

When used as directed, male and female condoms help prevent the spread of many STIs, including HIV, during vaginal, anal and oral sex. Condoms are less effective at protecting against STIs transmitted by skin-to-skin contact, such as herpes simplex, genital warts (human papillomavirus or HPV), and syphilis.

Important things to remember when using condoms:

- Check the condom package for damage and to ensure the expiry date has not passed.
- Carefully open the package so that the condom does not tear.
- Keep condoms away from sharp objects such as rings, studs, or piercings.
- Store condoms at room temperature.
- A new condom should be used every time you have sex.
- Use only water-based lubricants with male latex condoms. Oil-based lubricants, such as petroleum jelly, lotion, or baby oil can weaken and destroy latex.
- Avoid using spermicides containing nonoxynol-9 (N-9). It irritates sexual tissue and may increase the chance of getting an STI.

### **Get vaccinated.**

Some STIs, such as hepatitis A, B and human papillomavirus (HPV) can be prevented with vaccines. Talk to your health care provider about how to get these vaccinations.

### **Know your sexual health status.**

If you have recently changed sexual partners, or have multiple sex partners, getting regularly tested for STIs will tell you if you have an infection. Finding and treating an STI, (including HIV) reduces the chances of passing the infection on to your partner.

The more partners you have, the more likely you are to be exposed to a sexually transmitted infection.

### **Talk about prevention.**

Talk to your partner about STIs and how you would like to prevent them before having sex. If you are having trouble discussing safer sex with your partner, talk about it with your health care provider or a counselor.

For tips on how to talk to your partner, visit the BC Centre for Disease Control (BCCDC) Smart Sex Resource at <http://smartsexresource.com/sex-talk/talk-aboutit>.

### **Informing Partners.**

If you have a sexually transmitted infection and are sexually active, it is important to tell your sexual partners. This will enable them to make decisions about their health and getting tested.

For more information on how you can reduce your chance of getting an STI, see [HealthLinkBC File #08o Preventing Sexually Transmitted Infections \(STIs\)](#).

## **Human Papillomavirus (HPV) Vaccines**

### **What are the HPV vaccines?**

The HPV vaccines, Cervarix<sup>®</sup> (HPV2) and Gardasil<sup>®</sup> (HPV4), protect against infection from certain types of human papillomaviruses (HPV). Both vaccines protect against infection from HPV types 16 and 18 that cause about 70 per cent of cervical cancers, 80 per cent of anal cancers and other cancers such as cancers of the mouth and throat, penis, vagina, and vulva. The HPV4 vaccine also protects against infection from HPV types 6 and 11 that cause about 90 per cent of cases of genital warts. The vaccines are approved by Health Canada.

### **Who should get the HPV vaccines?**

The HPV4 vaccine is provided free to girls in grade 6 as 2 doses given at least 6 months apart. Girls and young women born in 1994 or later who missed getting the HPV4 vaccine may contact their health care provider to get immunized at no cost.

The HPV4 vaccine is recommended, but not provided free, for the following people:

- adult women up to 45 years of age;
- boys and men 9 to 26 years of age; and
- men 27 years of age and older who have sex with men.

The HPV2 vaccine is recommended for girls and women 9 to 45 years of age. It is not routinely provided for free. The vaccine is not currently approved for use in men.

The HPV vaccines are given as either 2 or 3 doses over a 6 month period. Girls who are 9 to 14 years of age need 2 doses given at least 6 months apart. All others for whom the HPV vaccines are recommended need 3 doses.

Those not eligible for free HPV vaccine can purchase it at most pharmacies and travel clinics.

It is best to get immunized before becoming sexually active and coming in contact with HPV; however, people who are sexually active may still benefit from the vaccines. The vaccines do not treat HPV infections.

What are the benefits of the HPV vaccines?

In men who have never been infected with HPV, the HPV4 vaccine prevents about 85 per cent of cases of anal cancer caused by HPV types 16 and 18. The vaccine also prevents about 90 per cent of cases of genital warts caused by HPV types 6 and 11.

In women who have never been infected with HPV, the HPV2 and HPV4 vaccines both prevent almost 100 per cent of cases of cancer of the cervix caused by HPV types 16 and 18. The HPV4 vaccine also prevents almost 100 per cent of cases of genital warts caused by HPV types 6 and 11.

**It is important for women to get regular Pap tests once they become sexually active because the HPV vaccine protects against most but not all cancers of the cervix.**

What are the possible reactions after the vaccines?

Common reactions to the vaccines may include soreness, redness and swelling where the vaccine was given, fatigue, muscle or joint ache or headache.

It is important to stay in the clinic for 15 minutes after getting any vaccine because there is an extremely rare possibility of a life-threatening allergic reaction called anaphylaxis. This may include hives, difficulty breathing, or swelling of the throat, tongue, or lips. If this happens after you leave the clinic, call 9-1-1 or the local emergency number. This reaction can be treated, and occurs in less than 1 in a million people who get the vaccine.

It is important to always report serious or unexpected reactions to your health care provider.

**Acetaminophen or Tylenol can be given for fever or soreness. ASA or Aspirin should NOT be given to anyone under 20 years of age due to the risk of Reye Syndrome.**

For more information on Reye Syndrome, see [HealthLinkBC File #84 Reye Syndrome](#).

Who should not get the HPV vaccines?

Speak with your health care provider if you or your child have had a life threatening reaction to a previous dose of HPV vaccine or to any component of the vaccine, including yeast, or to latex.

Women who are pregnant should not get the HPV vaccine.

There is no need to delay getting immunized because of a cold or other mild illness. However, if you have concerns speak with your health care provider.

What is HPV?

HPV is one of the most common sexually transmitted infections (STIs). Three out of 4 sexually active people will get HPV at some point in their lives. Anyone who has any kind of sexual activity with another person involving oral, genital or anal contact can get HPV. Sexual intercourse is not necessary to get infected. The more sexual partners you have the higher the risk of being infected with HPV. Men who have sex with men are also at higher risk of HPV infection.

What happens when you are infected with HPV?

Most people infected with HPV do not show any signs or symptoms and can pass the virus on to others without even knowing it. Most often an HPV infection will clear on its own. For some people, HPV will not go away and cells infected with the virus can become cancerous over time. Every year in BC approximately:

- 175 women will get cervical cancer and 50 will die from the disease.
- 6,000 women will develop high risk changes to the cervix which are precancerous.
- Over 500,000 women will undergo Pap tests and over 20,000 will need further follow-up which may include additional Pap tests and other procedures to stop cancer of the cervix from developing.
- 110 people will get anal cancer and 20 will die from the disease.
- 5,500 people will develop genital warts.

Mature Minor Consent.

It is recommended that parents or guardians and their children discuss consent for immunization. Efforts are first made to seek parental/guardian or representative consent prior to immunization. However, children under the age of 19, who are able to understand the benefits and possible reactions for each vaccine and the risk of not getting immunized, can legally consent to or refuse immunizations.

For more information, see [HealthLinkBC File #101a Human Papillomavirus \(HPV\) Infection and Genital Warts](#).

For more information on immunizations visit ImmunizeBC at [www.immunizebc.ca](http://www.immunizebc.ca).

## **Prince Edward Island**

What is HPV and the complications of illnesses caused by HPV?

HPV is a highly contagious virus that is spread by skin-to-skin contact. It can infect the skin, mouth, rectum, anus, cervix, the skin on the penis, the area around the vagina and the lining of the vagina. HPV is one of the most common sexually transmitted infections and it is easily spread through any kind of intimacy that involves genital contact - not just intercourse. HPV commonly affects teenagers and young adults. It is estimated that 70 percent of Canadians will have at least one HPV infection over their lifetime. While most HPV infections go away on their own some remain and create a risk for a variety of cancers.

There are over 100 types of HPV and some can lead to health problems such as warts on the hands and feet, genital warts, head and neck cancers, cervical cancer and cancer of the vagina, vulva, anus and penis. Certain types of HPV cause almost all cases of cervical cancer. There are over 2100 HPV related cancers in females and over 560 in males in Canada per year. In addition, there are more than 47,000 cases of other HPV related disease. About 400 women in Canada die each year from HPV related cancer and an average of seven women are diagnosed with cervical cancer on PEI yearly.

What is HPV Vaccine and what does it contain?

The HPV vaccine used in PEI is an inactive (dead) vaccine that helps protect against the diseases caused by HPV types 6, 11, 16 and 18. It works best when given before the person becomes sexually active. When given at this young age, the immunity level achieved is known to be very strong. A series of three doses is recommended at intervals of 0, 2, and 6 months. It is not yet known how long protection will last after immunization but at present no boosters are necessary.

The vaccine contains highly purified inactive proteins from HPV types 6, 11, 16, and 18. When administered it causes the body to make antibodies against these HPV types. The vaccine also contains traces of amorphous aluminum hydroxyphosphate sulphate (to improve the body's ability to form antibodies), sodium chloride and water for injection. There is no mercury in the vaccine. This vaccine provides protection against 70 percent of HPV that cause cervical cancer and 90 percent of HPV related anal cancers and genital warts. The vaccine does not treat these diseases once a person contracts them.

What are the possible reactions from the vaccine?

The most serious but rare side effect is a severe allergic reaction (anaphylaxis) which can be life threatening and usually occurs within 15 - 20 minutes of receiving the vaccine. Procedures are in place for the nurse to quickly respond to anaphylaxis. Those who receive the vaccine are asked to remain in the waiting area for 15 minutes after immunization.

The most common side effect is soreness around the injection site. Minor side effects may include localized swelling, redness and itching at the injection site. Other side effects may include headache, fever, dizziness and/or nausea. It is not necessary to give acetaminophen (for example, Tylenol or Tempra) with every immunization. However, if your child is experiencing discomfort or fever, acetaminophen can relieve these symptoms.

See a doctor or seek medical attention if your child has any serious side effects. Report serious reactions to the public health nurse whenever they occur.

When should the vaccine not be given?

- 1) Those who are allergic to any contents of the vaccine should not receive this vaccine.
- 2) Those who had an anaphylactic reaction after getting a previous dose of the vaccine.
- 3) Those who are ill and have a fever above 38.5 degrees Celsius (or 101.3 degrees Fahrenheit) should return for their immunization at a later date.

What are the risks if the vaccine is not received?

HPV infection is very common, and while most HPV infections go away by themselves, those that persist are more likely to develop into cancer. Some types of HPV create a risk for cervical cancer in women and for anal cancer in both men and women.

At least one in 10 Canadians will develop genital warts in their lifetime, and though warts caused by the virus can be treated, they are difficult to remove and often come back after treatment. Genital warts spread to two-thirds of people who come into contact with them and have significant psychosocial impact in those who are affected.

Should those who receive HPV vaccine continue to have regular screening done ?

Yes, those who have received the HPV vaccine should have regular screening and testing done as recommended by their health care provider. For example, males and females who have been advised to have anal cancer screening are recommended to follow the advice of their health care provider to continue that screening.

Women should have Pap smears at the appropriate intervals. This is because the vaccine provides protection against 70 percent of those human papillomaviruses that cause cervical cancer, and a woman can become infected with one or more of the other 30 percent of these viruses that do cause cervical cancer.

## **Appendix C: Sample Readability Calculations:**

## SMOG Grade Calculation for Prince Edward Island's HPV document

HPV is one of the most common sexually transmitted infections and it is easily spread through any kind of intimacy that involves genital contact - not just intercourse.

HPV commonly affects teenagers and young adults.

It is estimated that 70% of Canadians will have at least one HPV infection over their lifetime.

While most HPV infections go away on their own some remain and create a risk for a variety of cancers.

There are over 100 types of HPV and some can lead to health problems such as warts on the hands and feet, genital warts, head and neck cancers, cervical cancer and cancer of the vagina, vulva, anus and penis.

Certain types of HPV cause almost all cases of cervical cancer.

There are over 2100 HPV related cancers in females and over 560 in males in Canada per year.

In addition, there are more than 47,000 cases of other HPV related disease.

About 400 women in Canada die each year from HPV related cancer and an average of seven women are diagnosed with cervical cancer on PEI yearly.

2. What is HPV Vaccine and what does it contain?

This vaccine provides protection against 70% of HPV that cause cervical cancer and 90% of HPV related anal cancers and genital warts.

The vaccine does not treat these diseases once a person contracts them.

3. What are the possible reactions from the vaccine?

The most serious but rare side effect is a severe allergic reaction (anaphylaxis) which can be life threatening and usually occurs within 15 - 20 minutes of receiving the vaccine.

Procedures are in place for the nurse to quickly respond to anaphylaxis.

Those who receive the vaccine are asked to remain in the waiting area for 15 minutes after immunization.

The most common side effect is soreness around the injection site.

Minor side effects may include localized swelling, redness and itching at the injection site.

Other side effects may include headache, fever, dizziness and/or nausea.

It is not necessary to give acetaminophen (e.g. Tylenol or Tempra) with every immunization.

29

5. What are the risks if the vaccine is not received?

HPV infection is very common, and while most HPV infections go away by themselves, those that persist are more likely to develop into cancer.

Some types of HPV create a risk for cervical cancer in women and for anal cancer in both men and women.

At least one in 10 Canadians will develop genital warts in their lifetime, and though warts caused by the virus can be treated, they are difficult to remove and often come back after treatment.

Genital warts spread to two-thirds of people who come into contact with them and have significant psychosocial impact in those who are affected.

6. Should those who receive HPV vaccine continue to have regular screening done?

Yes, those who have received the HPV vaccine should have regular screening and testing done as recommended by their health care provider.

For example, males and females who have been advised to have anal cancer screening are recommended to follow the advice of their health care provider to continue that screening.

Women should have Pap smears at the appropriate intervals.

This is because the vaccine provides protection against 70% of those human papillomaviruses that cause cervical cancer, and a woman can become infected with one or more of the other 30% of these viruses that do cause cervical cancer.

35

Total Polysyllabic Word Count: 103

Square root of 103 = 10.14889157

Rounded to nearest tenth: 10.1

**SMOG Grade = 3+10.14889157 13.15=13**

### Sample Gunning-Fog Calculation for Prince Edward Island:

There are over 100 types of HPV and some can lead to health problems such as warts on the hands and feet, genital warts, head and neck cancers, cervical cancer and cancer of the vagina, vulva, anus and penis. 39

Certain types of HPV cause almost all cases of cervical cancer. 12

There are over 2100 HPV related cancers in females and over 560 in males in Canada per year. 19

In addition, there are more than 47,000 cases of other HPV related disease. 14

About 400 women in Canada die each year from HPV related cancer and an average of seven women are diagnosed with cervical cancer on PEI yearly. 29

Number of exact words: 113

Number of sentences: 5

Average Sentence Length (ASL):  $113/5 = 22.6$

Number of polysyllabic words considered after exceptions: 13

Percentage of Hard Words (PHW):  $13/113 = 11.61$

Grade Level =  $0.4 (22.6 + 11.61) 13.68=14$

The most serious but rare side effect is a severe allergic reaction (anaphylaxis) which can be life threatening and usually occurs within 15 - 20 minutes of receiving the vaccine. 29

Procedures are in place for the nurse to quickly respond to anaphylaxis. 12

Those who receive the vaccine are asked to remain in the waiting area for 15 minutes after immunization. 18

The most common side effect is soreness around the injection site. 11

Minor side effects may include localized swelling, redness and itching at the injection site. 14

Other side effects may include headache, fever, dizziness and/or nausea. 11

It is not necessary to give acetaminophen (e.g. Tylenol or Tempra) with every immunization. 14

However, if your child is experiencing discomfort or fever, acetaminophen can relieve these symptoms. 14

Number of exact words: 123

Number of sentences: 8

Average Sentence Length (ASL):  $123/8 = 15.4$

Number of polysyllabic words considered after exceptions: 22

Percentage of Hard Words (PHW):  $22/123 = 17.89$

Grade Level =  $0.4(15.4 + 17.89) + 13.32 = 13$

HPV infection is very common, and while most HPV infections go away by themselves, those that persist are more likely to develop into cancer. 26

Some types of HPV create a risk for cervical cancer in women and for anal cancer in both men and women. 22

At least one in 10 Canadians will develop genital warts in their lifetime, and though warts caused by the virus can be treated, they are difficult to remove and often come back after treatment. 34

Genital warts spread to two-thirds of people who come into contact with them and have significant psychosocial impact in those who are affected. 23

Number of exact words: 105

Number of sentences: 4

Average Sentence Length (ASL):  $105/4 = 26.3$

Number of polysyllabic words considered after exceptions: 13

Percentage of Hard Words (PHW):  $13/105 = 12.38$

Grade Level =  $0.4 (26.3 + 12.38) 15.47=15$

**FOG Scores:**

Top: 13.68 14

Middle: 13.32 13

End: 15.47 15

**Average:**

Without rounding: 14.16

With rounding: 14

**Appendix D: Readability Analysis Results Aggregated Table for Rater 1 and 2**

Table 4: SMOG and Gunning Fog Grades for each Province – Rater 1

Province	Smog Grade	Gunning Fog for 3 parts of text			Average
		Top	Middle	End	
SK	12.75=13	13.88=14	10.6=11	12.33=12	12.27*
MB	12.48=12	11.76=12	12.2=12	16.18=16	13.38*
PEI	13.00=13	14.0=14	13.55=14	14.79=15	14.11*
BC	12.64=13	11.49=11	11.66=12	12.33=12	11.83*
NFLD	10.1=10	9.14=9	9.48=10	8.63=9	9.08*
ON	13.20=13	12.13=12	11.35=11	13.36=13	12.28*
NB	12.2=12	12.3=12	15.35=15	12.51=13	13.39*

Table 5: SMOG and Gunning Fog Grades for each Province – Rater 2

Province	Smog Grade	Gunning Fog for 3 parts of text			
		Top	Middle	End	Average
SK	12.70= <b>13</b>	12.70= <b>13</b>	10.69= <b>11</b>	10.15= <b>10</b>	<b>11.18*</b>
MB	12.80= <b>13</b>	10.66= <b>11</b>	14.98= <b>15</b>	14.17= <b>14</b>	<b>13.27*</b>
PEI	13.15= <b>13</b>	13.68= <b>14</b>	13.32= <b>13</b>	15.47= <b>15</b>	<b>14.16*</b>
BC	11.54= <b>12</b>	10.17= <b>10</b>	12.83= <b>13</b>	10.59= <b>11</b>	<b>11.20*</b>
NFLD	9.48= <b>9</b>	8.50= <b>9</b>	7.87= <b>8</b>	9.26= <b>9</b>	<b>8.54*</b>
ON	13.34= <b>13</b>	12.51= <b>13</b>	12.71= <b>13</b>	13.19= <b>13</b>	<b>12.80*</b>
NB	12.37= <b>12</b>	12.37= <b>12</b>	14.90= <b>15</b>	12.64= <b>13</b>	<b>13.30</b>

\*Note: the averages were calculated using the unrounded grade for each section evaluated with gunning fog (using the unrounded numbers produced the same general average)