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Ontology Driven Immuno-Paediatric Monitoring System

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Abstract: ***Immunization has become a vital part of public health. Children diseases are now being prevented and eradicated through Vaccines. Despite this remarkable success, multiple resurgences have occurred. The abundance of vaccines in paediatric health is overwhelming; hence most parents/wards still lack knowledge about childhood vaccinations. A major source of information in this advent of technology is the web, which is currently syntactic, posed with several human readable web pages as exists in Immunization domain information searches, with a lot time spent jogging on diffusing web contents for most relevant information. This has restricted the web technological potential in this aspect and wards mostly resolves to non-challant attitude to paediatric immunization or incomplete vaccination series, thereby reinforcing resurgences in paediatric health. This work optimizes the benefits of the ongoing web evolution of adding semantics to Web resources and the available tools, implemented with the use of ontology, enabling a semantic search.***

Keywords: Immuno-Paediatric Monitoring, Immunization domain, Vaccines, Semantic Search; Ontology

1. Introduction

Immunization to prevent infectious diseases is a core strategy to improve childhood health as well as survival. Nevertheless, in Africa and all over the world, it is both notable and sobering that over 2, 000, 000 newborns and infants under 6 months of age worldwide die each year due to infections. Substantial mortality among neonates and infants is related to vaccine preventable infectious diseases [6].

Vaccines are effective in preventing disease and mortality [17]. However, most parents are overwhelmed at the number of vaccines that are recommended for their babies starting just after birth, as it may seem too much to give an infant three or four shots at a time every couple of months during the first year of his/her life as they are not well communicated by the physician must clearly communicate to parents and office medical staff that vaccines must be given on time and according to published guidelines. Nevertheless, that first year is when babies are most vulnerable to these diseases, and the ignorance of the parents concerning immunization may be fatal for the child. If a young child gets a disease such as whooping cough, Hepatitis B, or meningitis, the chance that it will claim his/her life is high [1].

One of the greatest challenges facing humanity is ignorance, the lack of reliable information about and knowledge of the natural world we live in. Besides other logistic barriers, lack of knowledge and its dissemination on the part of the involved stakeholders, including parents, physicians, healthcare providers and clinicians has been a major barrier to proper pediatrics immunization. This often reveals in confusing vaccine schedules [17] clinicians not adequately educated about vaccines), health care provider lacks of knowledge about indications for and contraindications to immunizations, absence of a reminder system for missed vaccinations, whereas Practices with reminder systems in place can improve immunization rates.

Moreover, in this whooping information age, most parents still lacks knowledge about childhood vaccinations and not be aware of the threat of vaccine-preventable illness or that safe and effective vaccines are available against these diseases [10].

Despite the many barriers described, research has shown that some interventions can improve vaccinations rates [4], [19]. Stakeholders can obtain immediate information from official immunization web sites, through web browsers which address vaccine safety [4], provide physicians with accurate information about the benefits and risks associated with immunization, misconceptions about vaccines and validity of vaccine information.

Currently, the keyword based search imposed by the current web 2.0 search engines is characterized with cumbersome and ambiguous search result contents, only readable by humans. Such challenge is eminent in Paediatrics Immunization domain related information searches, posed with several human readable web pages, of which a lot time is spent joggling on the diffused web contents for most relevant information. This whole process violates time economic rule of information retrieval and access, which may deter stakeholders' ambition.

This work is however a plunge into the ongoing webs evolution of adding semantics to web resources (semantic web) and the available tools. A major building block of semantic web is the ontology. With ontology, computers can sometimes act as if they "understand" the information they are carrying and this is where the "semantic" comes in [2]. Also, Ontology based search engine systems often derive more useful information than traditional search engine systems because users can find not only particular concepts [18] obtained by a given query but also other related concepts. As a major feature of this work, Paediatric Immunisation. Monitoring Ontology, Immumo-Paedriatic Monitoring Ontology as the semantic backbone of the developed web application.

In practical use, application should be developed to present comprehensive result from ontology query to user, since it is extremely difficult for typical end user to derive results from ontology query as a level of skill in a query language and certain ontology realization is required. This produces problem for common user [18] who may then avoid using the system. This work however provide a semantic search based system that does not require any form of computer skill, by developing a web based application with user interfaces.

2. Related Works

Immunization is the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine [19]. Vaccination is the process of getting a vaccine into the body or "The act of introducing a vaccine into the body to produce immunity to a specific disease. " A vaccine is what initiates the immunization process; they are usually administered through needle injections but can also be administered by mouth or sprayed into the nose. It is the most effective method of preventing infectious diseases. Vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease [13] [14].

Vaccines are available in different forms. They can be achieved in an active or passive manner. Vaccination is an active form of immunization [4]. Active immunization can occur naturally when a person comes in contact with, for example a microbe. The immune system will eventually create antibodies and other defenses against the microbe. Artificial active immunization is where the microbe or parts of it are injected into the person before they are able to take it in naturally, if whole microbes are used, they are treated. Their effectiveness depends on the immune system's ability to replicate and elicit a response similar to natural infection and it is usually effective with a single dose [3].

Live attenuated vaccines have decreased pathogenicity (the ability to cause disease). Examples of live attenuated vaccines include measles, yellow fever, rotavirus, mumps and influenza. Passive immunization is where pre-synthesized elements of the immune system are transferred to a person so that the body does not need to produce these elements itself. Currently, antibodies can be used for passive immunization, this method of immunization begins to work very quickly but is short lasting [3]. Vaccines are given at different times in a person's life. Those that are administered to infants and children to prevent the development of infectious diseases. are called paediatric vaccines or immunization.

The aim of paedratic immunization to reduce infant and child rate of deaths, control the spread of infectious disease, promote healthy lifestyles for a long disease-free life and help ease the problems of children and adolescents with chronic conditions. [13] [14] Monitoring is the carrying out surveillance on an environment or people in order to detect signals, movement or change of state of quality [11]. The term "Ontology" can be defined as an "explicit specification of conceptualization". Explicit specification of conceptualization means that the ontology is a description (like formal specification of a program) of the concept and relationships that can exist for an agent or a community of agents [7]. The "semantic web" is an evolution and extensions of the existing web that allows computers to manipulate data and information [7]. Semantic search denotes search with meaning, as distinguished from lexical search where search engine look for literal matches of the query [2]. It seeks to improve search accuracy by understanding the searcher's intent and the contextual meaning of terms as they appear on the searchable data space, whether on the Web or within a closed system, to generate more relevant results [15]. Some authors regard semantic search as a set of techniques for retrieving knowledge from richly structured data sources like ontologies and XML as found on the Semantic web [8].

3. Design Architecture

As shown in Figure 1, our architectural design includes three' major components including web application/Pycharm Django, OWL RDF/API, and Immuno – Paedriatic Monitoring Ontology. Each of the architectural components is being discussed in the subsequent sections.

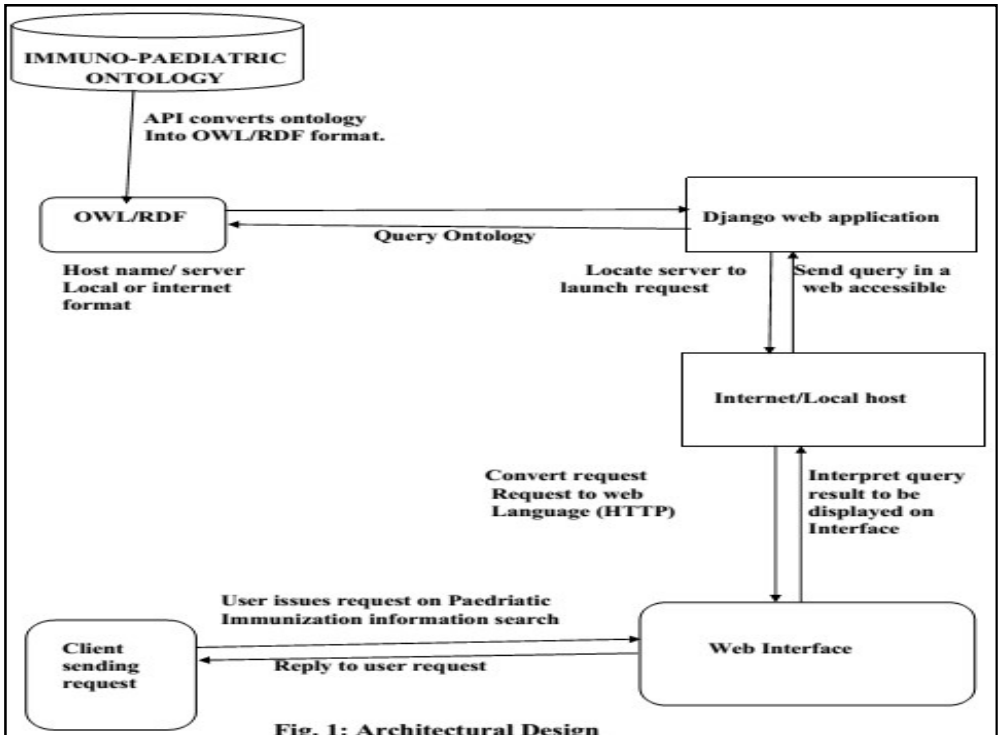

Fig. 1: Architectural Design

3.1 Immuno-. paediatric Ontology

The architecture is basically driven by the ontology, which provides the semantic basis that enables or generates precise information result on request. As there are no previously related ontologies on Paediatricimmunisations available from third party for re-use in this work, the ontology for Paediatricimmunisation was developed from scratch. All Information about the various types of Diseases (symptoms, mode of transfer and complications) and Vaccines (age of administration, disease it fights against and type of administration) and so on are established as concepts/classes, properties/relations and individuals/ instances in the system ontology. The ontology is coded in web ontology Language using protégéontology editor [11]. Figure 2 and 3 depict some portion of the Immuno-. paediatric Ontology.

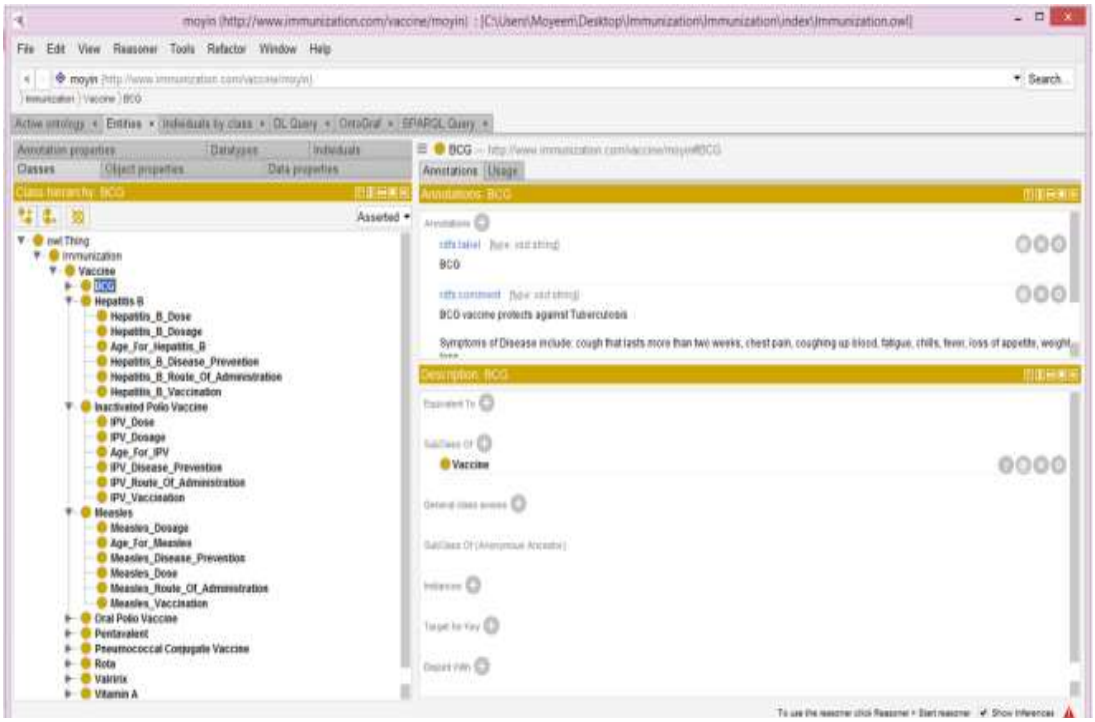

Figure 2: Hierarchy Representation of TheImmuno-Paediatric Classes on Protégé editor

Also, based on the concepts and *"Immunizations"* as the domain, *many object-type properties are derived with owl "top Object Property"* including *"has Age", "has Disease", "has Dose", has RDA", "has Vaccination type,* As shown in Figure 3, the properties are created in order to form interclass relations and to interpret OWL individuals/instances

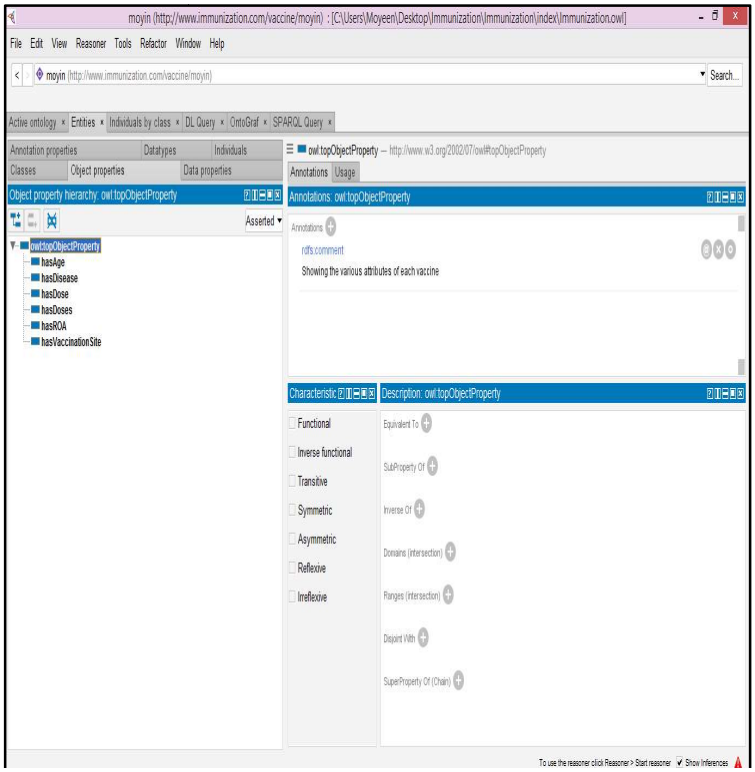

Figure 3: Object Property of Immuno-Paediatric Ontology

Moreover, based on these concepts, some data-type properties are generated via *owl: top Data Property* such as *"age", "disease Prevention", "dose", "doses", "route Of Administration", "vaccination Site"* as shown in Fig 4.

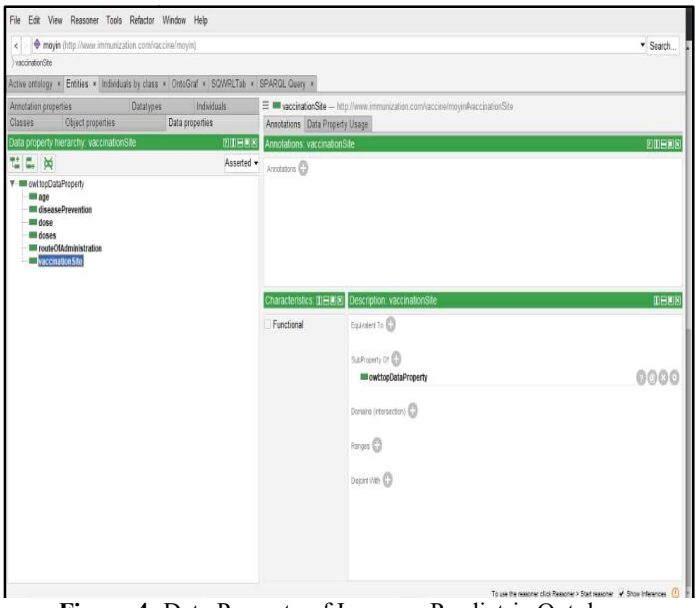

Figure 4: Data Property of Immuno-Paediatric Ontology

An additional semantically structured relation belonging to the classes is *"OWL individual"* declarations, which includes all instances of the classes that are related to individual classes. The Instances can be manually typed or retrieved from another source like database. As shown in Figure 5, the Class *"vaccine"* includes several OWL individual like Chiken Pox, Diarhoria Disease, Diphtheria, Haemophilus Influenza type b, Hetititis Intradermal,

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Intramuscular and so on. Figure 6 shows the ontograph display of graphical relationship between concepts in the ontology.

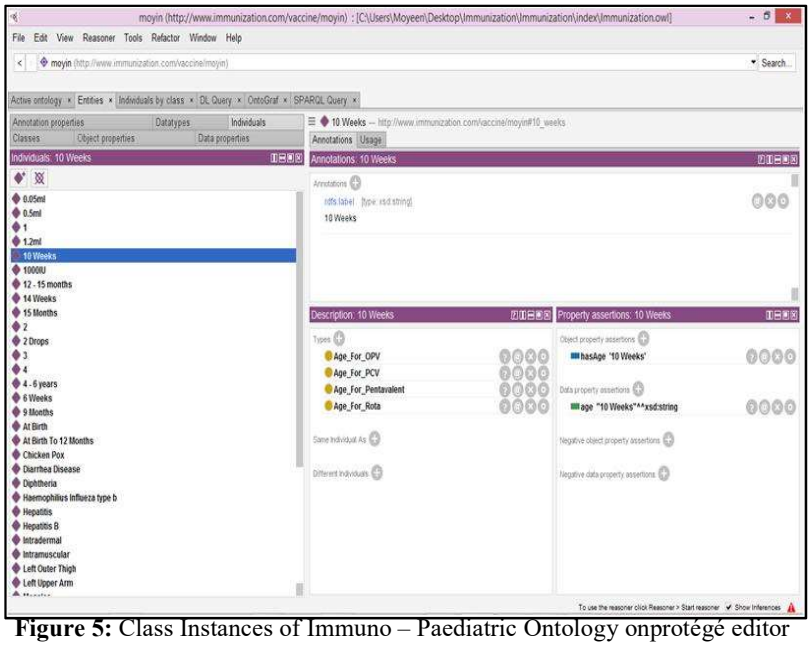

Figure 5: Class Instances of Immuno – Paediatric Ontology onprotégé editor

3.2 OWL RDF/API Resource Description Framework

The OWL RDF/API Resource Description Framework gives a high-level implementation of ontology concepts for integration into web accessible format. The generated OWL RDF is an interpreted format of the ontology created to the Web Interface Program.

3.3 Web interface design

The developed ontology requires an interface, being a web based in this work, to access the knowledge represented in it. Hence a web based application was developed, using Djangoin development environment (IDE). Django isa Python-based free and open-source web framework, which follows the model-template-view (MTV) architectural pattern. The application captures user requests which include asking for vitamins related enquiry. Figure 7 shows the search interface of the web application developed. From the search page, the user can either search for a symptom or browse through the vitamins and their characteristics.

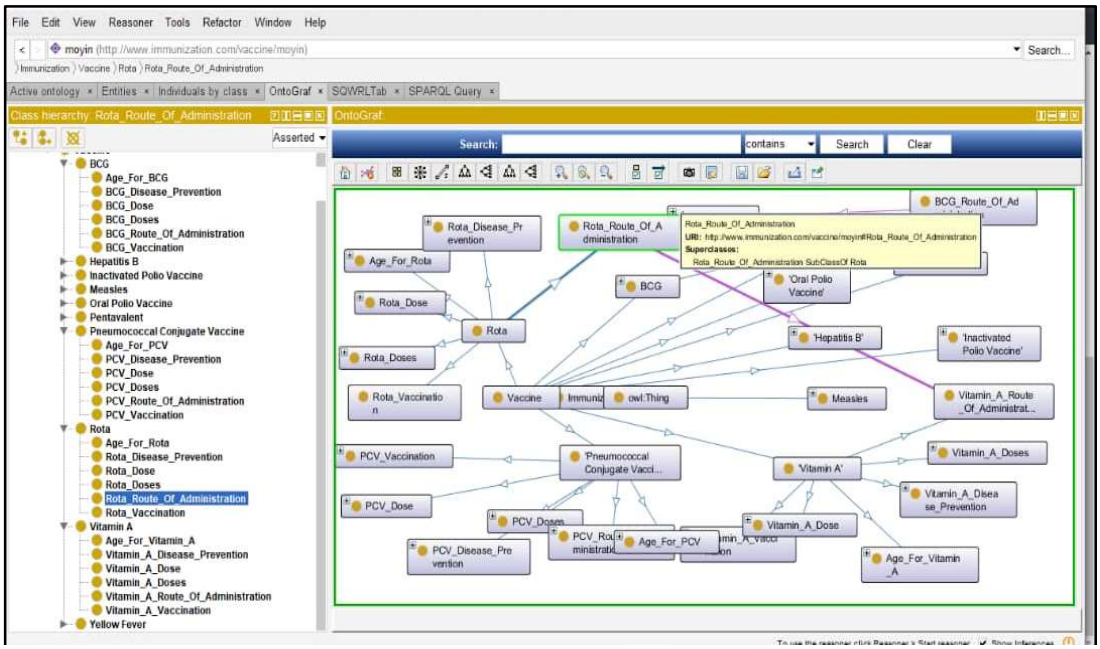

Figure 6: Onto-graphical relationship between concepts of the ontology

Figure 8 shows the result page where the user gets the result of his/her search. The result also includes a search bar,

where user can search again for another symptom. The Home Page contains a link of all the types of Vaccines (see Figure 9). The links directs users to the detail page, where users can select the particular attribute of the desired vaccine.

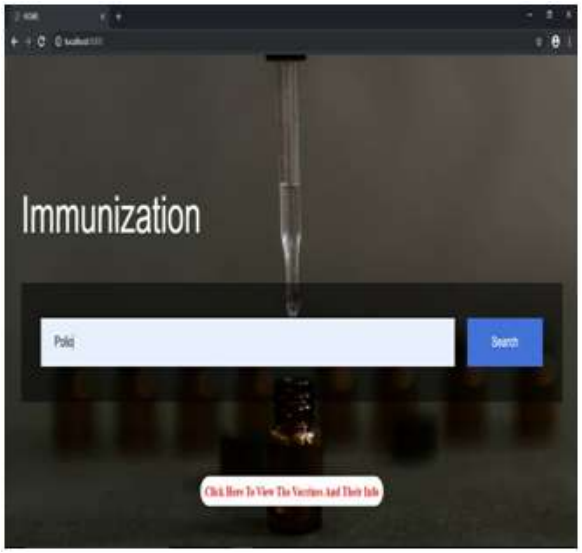

Figure 7: Search Page

Figure 8: Search Result Page

Figure 9: Home Page

The detail page, gives an explicit output of the particular click of choice on the home page (see Figure 10). For example if the user clicks on Oral Polio, the link directs the user to the detail page for Oral Polio Vaccine and displays the various properties of the vaccine.

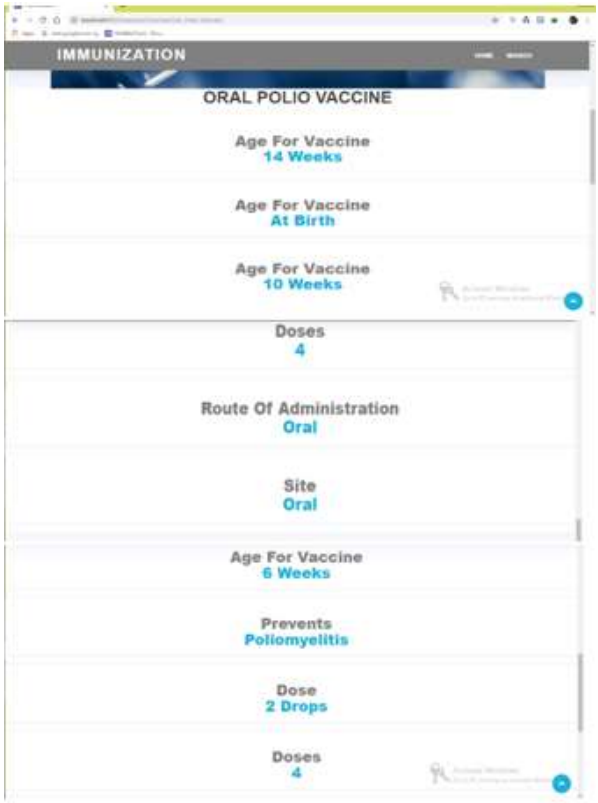

Figure 10: Detail Page

4. Conclusion

This work has spelt out the various paediatric immunizations by integrating related and relevant information on a website. Most parents lacks knowledge about childhood vaccinations neither are they aware of immunization schedules, types of vaccine, disease/diseases the vaccines prevent, how disease is spread, disease symptoms, disease complications, dosage of vaccine, number of doses to be administered, mode of administration, and frequency of vaccination amidst others.

From the representation of the different concepts and inferences used in this research work, awareness has been created to users about the various paediatric vaccinations available, Diseases they fight against, Age of administration, Site of administration, Dose of vaccine and route of administration.

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