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[Archived] Current Immunization Practices and Their Effects on Young Children's (Birth to Five Years) Social and Emotional Development

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Introduction

Although it has been over 200 years since the first successful immunization against smallpox was made by Edward Jenner, only during the last century have vaccines had their greatest impact. Indeed, immunization has been identified as one of the greatest public-health achievements of the 20th century.[1] Through immunization, smallpox and polio have been eradicated from the western hemisphere and global eradication may be achieved within the next five years. Cases of measles have been reduced by over 99% in the western hemisphere, and tetanus (lockjaw), diphtheria (a serious infection of the throat that can be fatal), pertussis (whooping cough), invasive disease

caused by *Haemophilus influenzae* type b, congenital rubella syndrome (infection of the fetus if the mother gets rubella [German Measles] during pregnancy, which leads to severe birth defects including mental retardation, cataracts, heart defects and deafness) and mumps have been reduced by over 90% in jurisdictions using universal immunization. Vaccination is also one of the most cost-effective medical interventions; in contrast to most other medical interventions, most immunization programs for young children are cost-saving.[2]

Subject

In Canada, the National Advisory Committee on Immunization (NACI)[3] recommends that all children be immunized at two, four, six and 18 months of age against diphtheria, tetanus, polio, pertussis and *H. influenzae* type b (meningitis, epiglottitis [infection of the throat], cellulites [infection just below the skin], septic arthritis [infection of the joints] and pneumonia [infection of the lung]). In all provinces and territories, this is accomplished by a single combination vaccine (diphtheria-tetanus-acellular pertussis-inactivated polio-*H. influenzae* b [DTaP-IPV-Hib]). A fifth dose of DTaP-IPV (without the *H. influenzae* b) is given at four to six years of age, at the time of school entry. Two doses of a combined measles, mumps (orchitis [infection of the testicles], parotitis [infection of the salivary gland], meningitis), rubella vaccine (MMR) are given; the first at 12 months of age and the second either at 18 months of age or at the preschool visit. Hepatitis B vaccine is given to all Canadian children either as a three-dose infant series (variably at birth, one and six months; two, four and 18 months; birth, two and 12 months) or a pre-adolescent two- or three-dose series sometime between nine and 12 years of age. New vaccines recently recommended by NACI include varicella (chickenpox) vaccine at 12 months of age,[4] pneumococcal (meningitis, pneumonia, otitis media) conjugate vaccine at two, four, six and 12 to 15 months of age,[5] meningococcal C (meningitis, sepsis) conjugate vaccine at two, four and six months of age,[6] and a mid-adolescent dose of an adult formulation of diphtheria-tetanus-acellular pertussis vaccine (Tdap).[7] These last four vaccines have been variably implemented by the provinces and territories; by autumn 2004, most have implemented the Tdap vaccine, but only half have implemented the varicella vaccine and fewer still have implemented the meningococcal or pneumococcal conjugate vaccines.[8] The most recent vaccine recommendation from NACI is for the universal annual influenza immunization of infants between six months and two years of age for the 2004-2005 flu season.[9]

Problems

As new vaccines providing protection against additional infectious diseases become available, NACI will make recommendations on how they should be used.[3] However, implementation of vaccine programs falls under provincial/territorial jurisdiction, which can lead to regional variability in immunization schedules and inequities in access to publicly funded vaccine programs. Conversely, despite these enormous accomplishments, immunization programs are the victims of their own success. As the diseases against which the vaccines protect become more uncommon, they also become less feared by the population. Vaccine-associated adverse events that are uncommon become relatively more frequent as the diseases and their manifestations become more rare. Vaccines that are being used in healthy children become more feared by parents than diseases that they have never seen. This makes vaccines easy targets for allegations that suggest they cause a host of conditions for which there are no other proven explanations. This further erodes public confidence in vaccination programs, with the risk that vaccine uptake will drop and the diseases they prevent will return.[10]

Research Context

Before licensure, vaccines are studied in healthy adults and children to determine their safety, immunogenicity (ability to elicit protective antibodies or cellular immune responses) and efficacy (their ability to protect against the target diseases under clinical trial conditions). Post-licensure, vaccines are evaluated for safety and effectiveness (how they protect against the target diseases under conditions of normal use). Allegations of rare adverse events caused by vaccines are investigated through epidemiological and case control studies. The public is most attuned to these post-licensure studies and programmatic monitoring that demonstrates ongoing vaccine safety.

Research Questions

Although there are many vaccine-related research questions, the questions of most importance to parents and vaccinators concern vaccine safety. These can be divided into three basic questions: 1) Is there any truth to the allegations that vaccines cause rare unrelated diseases (such as multiple sclerosis, autism or Crohn’s disease)? 2) Is there ongoing evidence that current immunization programs are safe? and 3) How do parents make immunization decisions for their children?

Recent Research Results

1. Investigating allegations

There is clear evidence that vaccines can be associated with rare adverse events. For example, live attenuated polio vaccine causes paralytic disease (vaccine associated paralytic polio) after the first dose in one out of 750,000 doses administered,[11] measles vaccine may cause encephalopathy after one in a million doses,[12] and Guillain-Barré Syndrome has been associated with influenza vaccines containing certain strains (swine flu, for example).[13] However, it has been alleged, and subsequent research has refuted, that vaccines cause a wide range of problems for which no other pathogenic explanation is currently known, including pertussis vaccine and sudden infant death syndrome (SIDS)[14] and permanent brain damage;[15] measles vaccine and inflammatory bowel disease;[16] hepatitis B vaccine and multiple sclerosis;[17] and thimerosal as a vaccine preservative and autism.[18] The most recent vaccine allegation is that the apparent increase in cases of autism observed over the past two decades is a result of the combined MMR vaccine, which overwhelms the immune system with three simultaneous viral infections causing increased gut permeability to neurotoxins, thereby causing irreversible brain damage leading to autism.[19] As a result of these unproven allegations, uptake rates of MMR vaccine have declined, particularly in the United Kingdom, with a resultant increase in reported cases of measles.[20] Well designed epidemiological studies have demonstrated that there is no association between the apparent increase in reported cases of autism and the use of MMR vaccine. In a retrospective cohort study of all births in Denmark between 1991 and 1998, representing over 530,000 people and 2.1 million person-years of observation, there was no increased risk of autism associated with receipt of MMR vaccine.[21] In two related studies from the UK, Taylor and colleagues were unable to detect a correlation between autism and receipt of MMR.[22,23] A retrospective study in Finland examined MMR vaccination records with hospital discharge data in over 500,000 children and found no clustering of hospitalization for autism within three months of vaccination.[24] In the United States, a case-control study of children with autism in Atlanta showed similar rates of MMR immunization in cases and controls, suggesting there was no temporal link between autism and MMR immunization.[25] A study in California demonstrated increasing rates of autism between 1980 and 1994 with steady immunization rates, suggesting no link between MMR immunization and autism.[26] Indeed, the increase in cases of autism may be the result of changes in the case definition and more complete reporting.[27] While there does not appear to be evidence that these allegations have affected immunization rates in Canada, firm data may be lacking.[28]

2. Ongoing programmatic monitoring of vaccine safety

In Canada, vaccine-associated adverse event (VAAE) surveillance is the responsibility of the Immunization and Respiratory Disease Division of the Centre for Infectious Diseases Prevention and Control of the Population and Public Health Branch of Health Canada, which uses both active and passive surveillance methodology to monitor vaccine safety. In the passive system, VAAEs are reported by health-care providers through provincial public-health authorities to a national database. Severe VAAEs are reviewed by an expert advisory committee (Advisory Committee on Causality Assessment) to determine the relationship of the event to immunization. Health Canada's active surveillance system for VAAEs, which is called IMPACT (Immunization Monitoring Program, Active), is based in 12 pediatric hospitals across Canada that account for over 90% of the tertiary-care pediatric beds in Canada and serve as the local hospital for 45% of Canada's pediatric population.[29] IMPACT is a partnership between Health Canada and the Canadian Paediatric Society. Pediatric infectious disease specialists at each IMPACT site supervise a nurse monitor who each day surveys all hospital admissions for selected adverse events – potentially related to preceding immunization – as well as hospital admissions and complications of vaccine-preventable diseases. Recent studies from the IMPACT network have provided some reassuring information about the safety of vaccines. In one study, IMPACT showed that the number of febrile seizures (fits associated with high fevers) requiring hospitalization decreased by 79% and the number of hypotonic-hyporesponsive (rag-doll like) episodes decreased by 60 to 67% after Canada switched from using the whole-cell pertussis vaccine to the use of acellular pertussis vaccine in 1997-1998.[30] In a second report, IMPACT showed the lack of encephalopathy or encephalitis (dysfunction or inflammation of the brain) caused by pertussis containing vaccines during an 11-year period.[31] In a third study, IMPACT described the Canadian experience with the rare association of thrombocytopenia (decrease in the number of platelets, blood cells that help stop the blood vessels from leaking) and measles containing vaccines and showed that, in general, there is usually a good outcome after this complication.[32] On the vaccine-preventable disease surveillance front, IMPACT has recently described the continued severity of pertussis in infants too young to have completed their three-dose primary immunization series[33] and the near elimination[34] and continued control[35] of invasive disease caused by *H. influenzae* type b after the implementation of universal infant immunization.

3. What parents want to know about immunization and from whom they want to hear it

Recent studies into the knowledge, attitudes, beliefs and behaviours of parents about immunization have been very informative and must be considered as new vaccine programs are

planned. Parents have many misconceptions about vaccines. They want to understand the diseases for which their child is being immunized and receive an explanation of the risks and benefits of each vaccine.[36-40] Given the number of vaccines currently recommended, this task might appear daunting; however, studies have demonstrated that parents want information presented in a concise format that can be accomplished with an increase in contact with the health-care provider of only a few minutes.[41-43] Of utmost importance to parents is the mode of information transfer; while written information is valued, it must be delivered in conjunction with a face-to-face discussion with the health-care provider.[43,44] Multiple studies have demonstrated that the most valued factor and critical component in a parent's decision to immunize is the recommendation of their doctor or nurse.[37,45] Program planners must consider this observation and be aware that some health-care providers may not always be the best advocates for immunization, and they themselves may need to be the target of education programs.[46,47]

Conclusions

Immunization programs in Canada have been successful in decreasing the incidence of their target diseases by over 90%. However, despite these successes, challenges to vaccine programs exist. Because the diseases have become less common as a result of immunization, familiarity with and fear of these diseases has diminished and concern with the vaccines has increased. Vaccines for diseases that are no longer common are easy targets for unproven allegations about their safety, further jeopardizing gains achieved through immunization. This has led to the need for equally effective but safer vaccines and the need to pay more attention to educating and reassuring parents about diseases and vaccines. At the same time as old vaccine programs need attention to maintain their relevance in the minds of the public, new vaccines and new vaccine programs are being introduced. Differences among the provinces and territories in which vaccines are publicly funded cause confusion and create inequities across the country. It is hoped that the recent joint federal and provincial/territorial initiative called the National Immunization Strategy[48] will diminish the variability of programs in Canada.

Implications

As Canada moves its national immunization strategy forward, it must take into account the lessons learned from the past. Immunization programs would benefit from standardization across Canada. New vaccines, including quadravalent meningococcal conjugate vaccine (a vaccine against the four most common types of Neisseria meningitidis, a bacteria that causes meningitis),

nasal influenza vaccines, group A streptococcal vaccine and human papillomavirus vaccine (an infection of the cervix that predisposes a woman to cervical cancer), are not far from being available. Although safety, immunogenicity and efficacy data are essential to license a vaccine, epidemiological and social science research (knowledge, attitudes, beliefs and behaviours) is needed before programs are implemented. Information from research must be made available to parents and vaccinators in an easily accessible format. Many good resources are already available for parents and providers, including books[49,50] and Web sites, some of which contain vaccine information brochures:

- Canadian Paediatric Society www.cps.ca
- Canadian Coalition for Immunization Awareness and Promotion www.immunize.cpha.ca
- Division of Immunization and Respiratory Diseases, Health Canada http://www.hc-sc.gc.ca/pphb-dgspsp/dird-dimr/
- It's Your Health www.hc-sc.gc.ca/english/iyh
- National Immunization Program of the Centers for Disease Control and Prevention (US) www.cdc.gov/nip
- Immunization Action Coalition (US) www.immunize.org; Vaccine information for the public www.vaccineinformation.org
- National Network for Immunization Information (US) www.immunizationinfo.org
- National Partnership for Immunization (US) www.partnersforimmunization.org).

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