A New Epidemiologic and Laboratory Classification System for Paralytic Poliomyelitis Cases

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Abstract: An epidemiologic classification of paralytic poliomyelitis cases (ECPPC) has been in use in the United States since 1976. In 1985, this classification system was reviewed because of recent changes in the epidemiology of paralytic poliomyelitis and improved laboratory capability to definitively characterize poliovirus strains. An alternative classification system was devised, the epidemiologic and laboratory classification of paralytic polio cases (ELCPPC), that incorporated virus isolation and strain characterization with epidemiologic information. Reported paralytic poliomyelitis cases for 1980–86 were classified by both the ECPPC and the ELCPPC classification systems. The new ELCPPC system classified 91 per cent of the reported cases as vaccine-associated, while the ECPPC system classified only 71 per cent of the reported cases as vaccine-associated. The proposed classification system provides more specific and useful information particularly concerning vaccine-associated paralytic poliomyelitis. (*Am J Public Health* 1989; 79:495–498).

Introduction

Poliomyelitis control efforts have been very successful in the United States. Paralytic poliomyelitis cases declined from approximately 16,000 per year in the early 1950s, the immediate pre-vaccine era, to an annual average of less than 10 cases during 1980–86.[1,2]

A system for classification of paralytic poliomyelitis cases known as "epidemiologic classification of paralytic poliomyelitis cases" (ECPPC) has been in use since 1976.[3] Both the last epidemic of poliomyelitis and the last known case of endemic paralytic poliomyelitis due to wild poliovirus in the United States occurred in 1979.[4] Approximately one case of imported paralytic poliomyelitis is reported annually. Oral polio vaccine (OPV), in wide use since 1960, has been associated with a small number of cases of paralytic poliomyelitis annually among vaccine recipients and their susceptible contacts.[5,6] The overall risk of vaccine-associated paralytic poliomyelitis for the period 1973–84 was estimated as one case of paralytic poliomyelitis per 2.6 million doses of OPV distributed.[6] With the elimination of epidemic and endemic cases of paralytic poliomyelitis and only one imported case per year, vaccine-associated paralytic poliomyelitis has become more important. Poliovirus isolates were first reliably identified at the Centers for Disease Control (CDC) by their antigenic properties, using specific polyclonal antibodies,[7] an approach further refined by the use of cross-adsorbed antisera described by van Wezel.[8] While the specificity of antigenic characterization has improved with the development of panels of neutralizing monoclonal antibodies,[9–12] polioviruses are most definitively identified by molecular methods such as oligonucleotide fingerprinting or partial genomic sequencing,[13,14] which measure the extent of genetic sequence relationship among isolates. Molecular characterizations, used at CDC since 1980, have generally (> 90 per cent) confirmed identifications made on the basis of antigenic properties. Confirmation of suspected paralytic poliomyelitis cases depends on medical, epidemiological, and laboratory data. The isolation of polioviruses in stool specimens of patients with suspected poliomyelitis contributes to the decision-making process but does not constitute proof of a causal association of such viruses with paralytic poliomyelitis.

We describe a new classification system for reported paralytic poliomyelitis cases which integrates epidemiologic criteria, virus isolation, and strain characterization results, and then compare it with the existing classification system by applying both systems to reported paralytic poliomyelitis cases in the United States for the period 1980–86.

ECPPC Classification System

The ECPPC classification system distributes all cases into one of four categories: epidemic, endemic, imported, or immune deficient (Table 1). The system classifies cases based on epidemiologic information alone. When it was established, laboratory tests were not available for definitively differentiating between strains of vaccine-like and wild polioviruses.

ELCPPC Classification System

In 1985, expert consultants were asked by CDC to review the applicability of the ECPPC system because of

TABLE 1—Epidemiologic Classification of Paralytic Poliomyelitis Cases (ECPPC): United States, 1980 through 1986

Categories	Number of Cases
I. EPIDEMIC	
A. Oral Polio Vaccine (OPV) not received from 4–30 days before onset of illness	0
B. OPV received from 4–30 days before onset of illness	0
II. ENDEMIC	
A. No history of receiving OPV or of contact with an OPV recipient as defined in B and C below	6
B. OPV received from 4–30 days before onset of illness	23
C. Onset of illness 4–60 days after OPV was fed to a recipient in contact with the patient *and* contact occurred within 30 days before onset of illness	
1. Household contact—vaccinee and patient regularly share the same home for sleeping	14
2. Community contact or non-household contact	10
III. IMPORTED—Disease develops in United States resident who has traveled outside the United States in areas with known endemic or epidemic poliomyelitis	5
IV. IMMUNE DEFICIENT	8
TOTAL	66

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TABLE 2—Epidemiologic and Laboratory Classification of Paralytic Poliomyelitis Cases (ELCPPC): United States, 1980 through 1986

Categories	Number of Cases
I. SPORADIC	
A case of paralytic poliomyelitis not linked epidemiologically to another case of paralytic poliomyelitis	
A. Wild virus poliomyelitis: Virus characterized as wild virus	0
B. Vaccine-associated poliomyelitis	
1. Recipient—OPV was received 4 to 30 days before onset of illness	
a. Virus characterized as vaccine-related	16
b. Virus not isolated or not characterized	7
2. Contact—Illness onset was 4 to 75 days after OPV was fed to a recipient in contact with patient and contact occurred within 30 days before onset of illness	
a. Household—vaccinee and patient regularly share the same household for sleeping	
i. Virus characterized as vaccine-related	11
ii. Virus not isolated or not characterized	5
b. Non-household	
i. Virus characterized as vaccine-related	6
ii. Virus not isolated or not characterized	3
3. Community—No history of receiving OPV or of contact with an OPV recipient, as defined in 1 and 2, and virus isolated and characterized as vaccine-related	4
C. Poliomyelitis with no history of receiving OPV or of contact with an OPV recipient, as defined in B1 and B2, and virus not isolated or not characterized	1
II. EPIDEMIC	
A case of paralytic poliomyelitis linked epidemiologically to another case of paralytic poliomyelitis.	
A. Not a recipient of OPV	
1. Virus characterized as wild virus	0
2. Virus characterized as vaccine-related	0
3. Virus not isolated or not characterized	0
B. OPV recipient—OPV received 4 to 30 days before onset of illness	
1. Virus characterized as wild virus	0
2. Virus characterized as vaccine-related	0
3. Virus not isolated or not characterized	0
III. IMMUNOLOGICALLY ABNORMAL	
Proven or presumed	
A. Wild virus poliomyelitis—Virus characterized as wild virus	0
B. Vaccine-associated poliomyelitis	
1. Recipient—OPV was received 4 to 30 days before onset of illness	
a. Virus characterized as vaccine-related	5
b. Virus not isolated or not characterized	0
2. Contact—Illness onset was 4 to 75 days after OPV was fed to a recipient in contact with patient and contact occurred within 30 days before onset of illness	
a. Household—vaccinee and patient regularly share the same household for sleeping	
i. Virus characterized as vaccine-related	1
ii. Virus not isolated or not characterized	0
b. Non-household	
i. Virus characterized as vaccine-related	1
ii. Virus not isolated or not characterized	0
3. Community—No history of receiving OPV or of contact with an OPV recipient, as defined in 1 and 2, and virus isolated and characterized as vaccine-related	1
C. Poliomyelitis with no history of receiving OPV or of contact with an OPV recipient, as defined in B1 and B2, and virus not isolated or not characterized	0
IV. IMPORTED	
Poliomyelitis in a person (US resident or other) who has entered the United States	
A. Virus characterized as wild virus	
1. Onset of illness within 30 days before entry	2
2. Onset of illness within 30 days after entry	1
B. Virus characterized as vaccine-related	
1. Onset of illness within 30 days before entry	0
2. Onset of illness within 30 days after entry	0
C. Indeterminate—Virus not isolated or characterized	
1. Onset of illness within 30 days before entry	1
2. Onset of illness within 30 days after entry	1
TOTAL	66

recent changes in the epidemiology of paralytic poliomyelitis in the United States and the improved laboratory capability since 1980 to definitively characterize poliovirus strains. The consultants were requested to:

- provide revisions of the system or an alternative if in their view the current classification system was no longer adequate;
- apply any revised or new system to cases of poliomyelitis with onset of illness from 1980–84 that met the CDC Paralytic Poliomyelitis case definition*;
- classify the same cases of poliomyelitis by the older ECPPC system.

For reported cases of paralytic poliomyelitis with onset in 1985 and 1986 and for cases with onset in 1980–84 but reported after the 1985 review, personnel at CDC assigned cases to classification categories in both systems. The consultants recommended that an alternative classification system be adopted that would incorporate virus isolation and strain characterization results and epidemiological information. The system, labeled the Epidemiologic and Laboratory Classification of Paralytic Poliomyelitis Cases (ELCPPC), is presented in Table 2. Some definitions for case classification were changed: 1) a contact case has onset of illness 4–75 days (formerly 4–60 days) after OPV was fed to a recipient in contact with the case; 2) "immunologically abnormal" includes cases in persons with proven or presumed immunological abnormalities regardless of the etiology of their abnormality (primary immunodeficiency, drug-induced suppression, etc.); and 3) "imported" includes cases in persons (US residents or others) with onset within 30 days before or after entry into the United States.

Comparison between ECPPC and ELCPPC Classification Systems

A total of 66 reported cases of paralytic illness with onset during the period 1980–86 met the CDC definition for paralytic poliomyelitis; 45 cases were confirmed by expert consultants in 1985 and the remaining cases by expert reviews since then. Poliovirus isolates were available for analysis for 46 (70 per cent) of the 66 cases, and van Wezel type-specific neutralization, oligonucleotide fingerprinting, and/or genomic sequencing was done. Forty-three viruses (93 per cent) were characterized as vaccine-like and three (7 per cent) as wild. These cases were classified according to the new ELCPPC system (Table 2).

The cases also were classified according to the old system, ECPCC, using only the available epidemiologic information (Table 1). Six cases were classified into the category "endemic, not vaccine-associated." In fact, poliovirus was isolated and characterized as vaccine-like from five of these cases. No specimen was available from the sixth patient. Three of the five cases classified as imported cases had poliovirus isolated and characterized as wild. No specimens were available from the other two patients. Five of the eight immune-deficient cases had received oral polio vaccine (OPV) and two had contact with a recipient; information was insufficient on the remaining case. All eight immune-deficient cases had poliovirus isolates characterized as vaccine-like.

*A patient must have had paralysis clinically and epidemiologically compatible with poliomyelitis and, at 60 days after onset of symptoms, had a residual neurological deficit, had died, or had no information available on neurologic residua (This classification was formerly known as the Best Available Paralytic Poliomyelitis Case Count (BAPPCC) case definition).

For the period 1980–86, 60 of the 66 reported cases of paralytic poliomyelitis in the United States were vaccine-associated either by epidemiologic and/or strain characterization; five (8 per cent) cases were imported and one case that occurred in 1980 could not be classified as vaccine-associated paralytic poliomyelitis because no specimen for isolation was available and epidemiologic information was incomplete. While the ELCPPC classified 91 per cent of the cases by epidemiological and/or laboratory characterization as vaccine-associated, only 71 per cent were classified as vaccine-associated by the ECPPC which relies on epidemiological information (Table 3).

International Application

The World Health Organization (WHO) estimates that more than 250,000 cases of paralytic poliomyelitis occur each year worldwide.[15] Control or elimination of the disease in developed countries using either oral or inactivated polio vaccine has generated interest in the global eradication of poliomyelitis.[16,17] Given the progress by the Expanded Program on Immunization of WHO in achieving immunization with three doses of polio vaccine of more than 50 per cent of children in many developing countries,[15] the World Health Assembly adopted the goal in May 1988 of global eradication of poliomyelitis by the year 2000.[18] The WHO Region of the Americas, through the Pan American Health Organization (PAHO), established a target for elimination of indigenous poliomyelitis by the end of 1990, while the WHO European and Western Pacific Regions have set targets for elimination by 1995. Global eradication of poliomyelitis is feasible by achievement and maintenance of high immunization levels, effective surveillance to detect all new cases, and a rapid vigorous response to the occurrence of new cases.[19] To monitor these efforts, laboratory systems have been developed that identify which type(s) of polioviruses are circulating in a country or region, and to distinguish vaccine-virus from wild-virus,[14] but these methods need to be made more widely available. Countries without current access to such a laboratory system will face delay in being able to fully utilize the ELCPPC. However, even in the absence of such laboratory support, paralytic polio cases can be classified within the distinct epidemiologic categories of the ELCPPC.

TABLE 3—Comparison of Vaccine-Associated Paralytic Poliomyelitis Cases by Classification Category in the ECPPC and ELCPPC Systems

Category	System	Number of cases: Total	Number of cases: Vaccine-Associated (%)
Endemic*	ECPPC	53	47 (89%)
Sporadic*	ELCPPC	53	52 (98%)
Immunodeficient#	ECPPC	8	0** (0%)
Immunologically Abnormal#	ELCPPC	8	8 (100%)
Epidemic+Imported	ECPPC	5	0 (0%)
	ELCPPC	5	0 (0%)
All Categories	ECPPC	66	47 (71%)
	ELCPPC	66	60 (91%)

#Comparable categories
*Comparable categories
**Classification not available under ECPPC System

Conclusion

Advances in methods to characterize strains of poliovirus as vaccine-like or wild provided the stimulus to improve upon the ECPPC system which relies entirely on epidemiological information. In addition, the epidemiology of poliomyelitis in the United States changed substantially. Epidemic and endemic wild poliomyelitis disease no longer exists in the United States, and vaccine-associated disease is the most frequent form of paralytic poliomyelitis. Since 1980 an average of only eight cases have been reported annually. The new system, ELCPPC, corrects for misclassifications in the older ECPPC system in which some cases were categorized as "endemic, not vaccine-associated" even when laboratory confirmation of a vaccine-virus infection was available.

While the ELCPPC format is at first glance somewhat complex, the greater descriptive accuracy of each category and subcategory provides more specific and useful information particularly concerning vaccine-associated disease. Information on the relative occurrence of wild-virus and vaccine-associated cases within each epidemiologic category can be obtained rapidly from this tabular format.

As current worldwide efforts to immunize children against polio are expanded and the effectiveness of these efforts is documented by a sustained decrease in polio cases, the ELCPPC system will become useful as a standardized tool to track the success of these programs and eventually to help in certifying countries or regions as free of wild poliomyelitis.

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