Bulletin of the World Health Organization, 58 (2): 285-291 (1980)

Injections and paralytic poliomyelitis in tropical Africa

BERNARD GUYER,[1] ANDREW ATEM EBAKO BISONG,[2] JUDITH GOULD,[3] MARYSE BRIGAUD,[4] & MICHELE AYMARD[4]

A case-control study was conducted in Yaoundé, United Republic of Cameroon, to evaluate the hypothesis that intramuscular inoculations predisposed young children to paralysis if they were later exposed to poliomyelitis virus. Thirty-three cases with lower motor neuron disease and 66 neighbourhood controls were studied. Poliovirus was isolated from 39% of the paralytic cases but from only 18% of the comparison group. Controls were more likely to have had serological evidence of previous exposure to all three poliovirus types while most of the paralytic cases had been exposed to a poliovirus for the first time. Two-thirds of the paralytic cases but only 11% of the comparison group had been ill, visited a medical facility, and received multiple injections, primarily with quinine and penicillin, in the month prior to the onset of poliomyelitis. There was a strong temporal relationship between these injections and the onset of paralysis. The increased relative risks (15 and 32, respectively) of paralysis associated with inoculations in the two weeks immediately prior to onset of disease were felt to represent the treatment of symptoms related to poliomyelitis. However, the increased relative risks (13 and 27, respectively) three and four weeks prior to onset were felt to be consistent with the hypothesis that intramuscular injections provoked paralysis. Overestimation of this measure of the effect because of bias in the control group is discussed.

In their case-control study of poliomyelitis in England in 1949, Bradford-Hill & Knowelden demonstrated an association between paralytic disease and intramuscular inoculations of diphtheria or combined vaccines within 28 days prior to onset (*6*). Further, they showed that the injected limb (usually an upper extremity) was more likely to be paralysed than the uninjected limb. Similarly, McCloskey observed that paralysis sometimes followed intramuscular inoculation of vaccine antigens during a poliomyelitis epidemic in Australia (*13*). Bodian provided a model for this "provoking" effect of inoculations in monkeys in whom poliomyelitis viraemia had been experimentally induced (*4*). In his animals, paralysis occurred preferentially in the injected limb and more frequently with caustic substances and multiple injections. Bodian hypothesized that the paralysis resulted from a reflex hyperaemia of the segment of the spinal cord associated with the area injected (*5*); other hypotheses, including Wyatt's theory of genetic susceptibility to, and the auto-allergenic nature of, poliomyelitis have also been proposed (*18*). These observations were all made in developed countries during the era of epidemic poliomyelitis. In Africa, Townsend-Coles & Findley first called attention to the association of paralytic poliomyelitis with injections of intramuscular quinine in a report of 8 cases from Sudan (*17*). Collis et al. suggested that injections predisposed young Nigerian children to paralytic poliomyelitis (*7*).

In Yaoundé, United Republic of Cameroon, poliomyelitis is endemic, with 70% of children exposed to all three poliovirus types by 5 years of age, and 80% of paralytic disease occurring in children under 2 years of age (*3*, *10*). The incidence of paralytic disease is high (48 per 100 000 population per year between 1973 and 1975), paralysis occurs overwhelmingly in the lower extremities and the calculated ratio of paralytic disease to inapparent infection is higher than expected (*11*). Finally, since a history of prior intramuscular injections (usually in the lower extremities) is common in these cases, we hypothesized that inoculations predispose children infected with poliomyelitis virus to paralytic disease. The purpose of this study was to examine the association between paralytic poliomyelitis and intramuscular inoculations during the month preceding onset using a case-control design.

[1] Medical Epidemiologist, Bureau of Smallpox Eradication, Center for Disease Control (CDC), Atlanta, GA 30333, USA, and l'Organisation de Coordination pour la lutte contre les Endémies en Afrique Centrale (OCEAC), Yaoundé, United Republic of Cameroon. *Present address*: Massachusetts Department of Public Health, 39 Boylston, Boston, MA 02116, USA. Requests for reprints should be addressed to Dr B. Guyer at this address.

[2] Centre universitaire des Sciences de la Santé, Université fédérale du Cameroun, Yaoundé, United Republic of Cameroon. *Present address*: Kumba Hospital (PMI), Kumba, United Republic of Cameroon.

[3] OCEAC, BP 288, Yaoundé, United Republic of Cameroon.

[4] World Health Organization Collaborating Centre for Virus Reference and Research, and Laboratoire national de la Santé et Epidémiologie virale, Lyons, France.

MATERIALS AND METHODS

Study site

Yaoundé, a city of 250 000 people, is the capital and administrative centre of the United Republic of Cameroon. The population under 5 years of age is estimated to be about 50 000. The population is mixed ethnically but consists mainly of Ewondo and Eton peoples.

Sanitation in the city is poor with open drainage canals carrying untreated waste into the city's streams. Growth of the city over the last 10 years has been rapid, and construction of the sanitation system has not kept pace. Although the central water supply is chlorinated, water is delivered to community stand pipes through an old, unreliable system of pipes; frequent breaks in service occur and many people use urban wells.

Immunization programmes

Before 1975, poliomyelitis immunization was available only to a small number of children whose families purchased vaccine (inactivated, injectable) from local pharmacies.

Since November 1975, a community-wide multiple antigen childhood immunization programme has provided trivalent oral poliomyelitis vaccine (TOPV) at neighbourhood health centres, on a convenience schedule, and free of charge to children 1–35 months of age (*1*). By August 1976, 27% of children in the target age group had received a single dose of TOPV, and 10% had received three or more doses (*9*). The programme continued to deliver about 2000 doses of TOPV per month through 1978.

Surveillance of poliomyelitis

A surveillance system was established through a childhood rehabilitation centre, all paediatricians, and the central hospital. All new cases of paralytic disease reported between December 1976 and April 1977 were investigated by two of the authors (Atem and Gould).

A case of paralytic poliomyelitis was defined as a child with the acute onset of flaccid paralysis, lasting at least 30 days, in the absence of sensory changes.

Epidemiological investigations

Epidemiological information was obtained about age, sex, residence, history of illness (including date of onset), recent visits to medical facilities, all treatments received (including injections), contact with known paralytic cases, and prior immunizations. This history focused on the month prior to onset of paralysis, but often included several preceding weeks. An effort was made to confirm all such information through examination of the medical notebooks commonly carried by parents. A clinical assessment was also made.

Rectal swabs for viral isolation were obtained from all patients at the time of the first visit, and where possible paired sera were obtained. Progression of clinical disease was followed through the medical records at the centre where these patients were treated.

When the home of each case was visited, an attempt was made to select two well children from either the same house or neighbouring houses to form a comparison group. In the field, an attempt was made to match for sex and age to within a few months, but often this was not possible among the children in the vicinity. Among these, the most closely matched were obtained. Siblings were used if they met these criteria. Because controls were not available at some sites, additional comparison children were taken from other case neighbourhoods. Thus, the comparison groups cannot be considered age and sex matched, and consequently, matched analysis was not undertaken. The same epidemiological information was obtained as from cases. "Date of onset" for the comparison group was taken as the date of the interview. Rectal swabs and, where permitted, a single serum specimen were obtained from these controls.

Virus isolations

Rectal swabs were immediately placed in cooled Hanks' solution, frozen and stored at −20°C, and transported frozen to the World Health Organization Collaborating Centre for Virus Reference and Research in Lyons, France.

Serological examinations

Sera were prepared in the standard manner and stored and transported frozen to Lyons. In the laboratory, sera were inactivated and diluted from 1:10 to 1:1280 for testing. Serum neutralization titres were determined in a tissue culture system using strains of Sabin attenuated poliomyelitis virus types 1, 2, and 3 at a concentration of 100 $TCID_{50}$ per 0.05 ml. All neutralization titres were determined in duplicate. Cytopathic effect was read on the second, fifth, and seventh days. Titres below 1:10 were reported as negative.

Epidemiological analysis

The effect parameter used in this study is the relative risk (RR), this being estimated as the common odds ratio. Test-based 90% confidence limits of RR were estimated by the method of Miettinen (*14*).

RESULTS

Description of cases and comparison group

Thirty-seven children with paralytic disease were reported to the surveillance programme between December 1976 and April 1977. Of these, 34 were confirmed, by physical examination, as having lower motor neuron disease. All patients had paralysis of one or both lower extremities and two children also had paralysis of the truncal muscles; none of the children had paralysis of the upper extremities.

Between September 1976 and April 1977, 33 cases and 66 controls were studied. The mean age of cases was 22.1 months and controls 25.6 months; 55% of cases and 59% of controls were males. The proportion of children with confirmed prior poliomyelitis immunization was low, but controls were more likely to have received TOPV than cases (Table 1). More controls were known to have been in contact with a child with paralytic disease.

Table 1. Characteristics of paralytic poliomyelitis cases and comparison group

Characteristic	Paralytic cases	Comparison group
Number studied	33	66
Mean age (months)	22.1	25.5
Standard error	2.3	1.5
Range of age (months)	8–60	7–60
Sex: male	18 (55%)	39 (59%)
female	15 (45%)	27 (41%)
Confirmed poliomyelitis immunization	4 (12%)	12 (17%)
— oral	0	7
— injectable	3	5
Known recent contact with paralytic case	5 (15%)	36 (55%)

Poliovirus exposure and prevalence

All cases and controls had rectal swabs for viral isolation (Table 2). Poliovirus was isolated from 39% of the poliomyelitis cases, type 2 being the most common, while poliovirus was isolated from only 18% of the controls (RR = 2.9). Carriage of other viruses was similar in the two groups. None of the ten poliovirus strains tested had the temperature-dependent growth characteristics of the vaccine viruses.

Sera from 21 cases of paralytic disease and 27 controls were tested for poliomyelitis neutralizing antibodies (Table 2). In 10 cases serological studies confirmed that paralysis was related to the virus type isolated (i.e., either a fourfold rise in titre or an elevated titre to a single poliovirus type). While 67% of the paralytic cases had serological evidence of exposure to a single poliovirus type and only 14% to all three poliovirus types, 48% of controls had evidence of prior infection with all three types ($\chi^2 = 9.4$, $P < 0.01$).

Table 2. Poliovirus isolations and serological results in poliomyelitis cases and comparison group

Characteristic	Paralytic cases		Comparison group	
	No.	%	No.	%
Number studied	33	—	66	—
Rectal swabs done	33	100	66	100
Viral isolates:				
poliovirus type 1	2	6	4	6
poliovirus type 2	7	21	4	6
poliovirus type 3	4	12	4	6
all polioviruses	13[a, b]	39	12[c]	18
non-polioviruses	4[b]	12	14	21
no virus isolated	17	51	41	62
Sera examined	21	64	27	41
antibodies to 1 poliovirus	14	67[d]	6	22[d]
antibodies to 2 polioviruses	4	19[d]	7	26[d]
antibodies to 3 polioviruses	3	14[d]	13	48[d]

[a] Ten cases with poliovirus isolates had infection confirmed by either fourfold antibody titre rise or single high titre to the same poliovirus type as isolated.

[b] One case had both poliovirus type 1 and echovirus 17 isolated.

[c] One control had both poliovirus types 1 and 2 isolated.

[d] Percentage of sera examined.

Antecedents of paralysis

Cases were more likely to have had an illness and visited a health facility in the month prior to onset of paralysis than were children in the comparison group (Table 3). Even among those children who had visited a health centre, 79% of the cases had received at least one inoculation compared with 35% of the comparison group.

Table 3. Previous illness, medical care and injections among the 33 paralytic poliomyelitis cases and the 66 individuals in the comparison group during the 30 days prior to onset

	Paralytic cases		Comparison group	
Ill and visited health facility	28	85%	20	30%
Received injections[a]	22	67%	7	11%
Not ill and did not visit health facility	5	15%	46	70%

[a] Three additional cases of poliomyelitis and five additional controls reported having had injections, but this history was not confirmed.

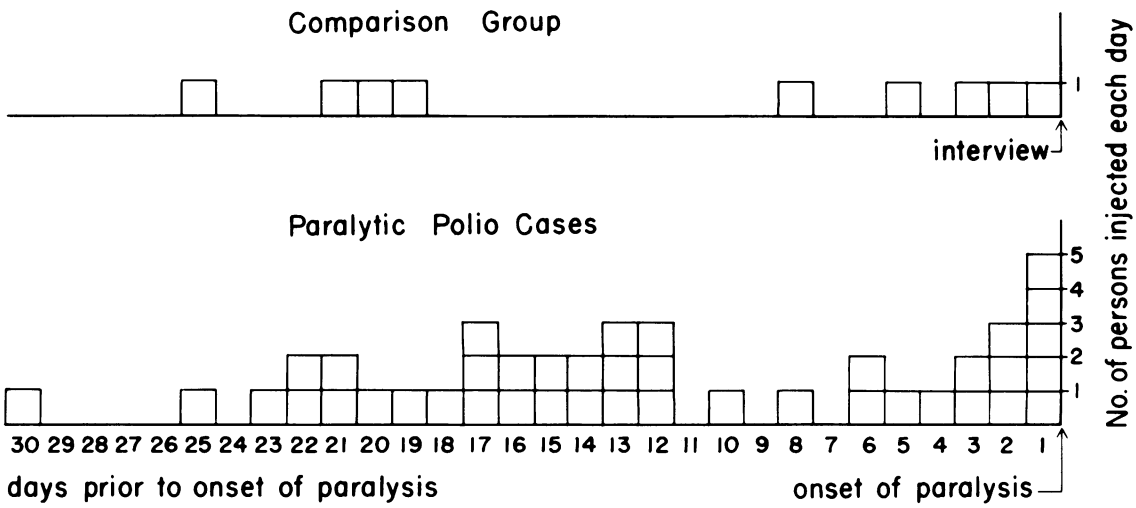

Fig. 1. Number of children injected on each day of the 30-day period prior to the onset of paralytic disease or prior to the day of interview for the comparison group.

However, this overall finding was not surprising considering the likelihood of paralytic poliomyelitis cases having received some treatment for the symptoms which usually precede the onset of paralysis in poliomyelitis. In order to differentiate those inoculations received prior to the onset of any minor symptoms from those received as a consequence of poliomyelitis, the temporal relationship between injections and onset of paralysis was examined.

Fig. 1 shows the day (or days) on which each paralytic case or comparison group child was injected during the month prior to onset of paralysis (or prior to the interview of comparison group children). The 22 cases received inoculations on 41 days and 7 of the controls received inoculations on 9 days over this period. In the case series, inoculations clustered first, in the 6 days immediately prior to paralysis, and again in the interval 12–23 days prior to the onset of paralysis. Inoculations in the comparison group were sporadic. To analyse this temporal association between injections and paralysis, the month was divided into one-week intervals. Relative risks (RR) were calculated for children injected during each interval separately using those not injected during the 30-day period as the referent group to whom an RR of 1.0 was assigned (Table 4). These relative risks are elevated in each of the intervals indicating a strong association between paralytic poliomyelitis and intramuscular inoculations. While it may be true that the elevations in RR observed during the first two weeks immediately prior to paralysis are due to disease, it is unlikely that this explanation accounts for the elevation in RR observed in the preceding two-week period. Even when the analysis is restricted to the period 18–30 days prior to the onset of disease (a period which clearly precedes the early symptoms of the illness) the RR of paralysis associated with inoculation is 11.

Table 4. Relative risk of paralysis by time period during which inoculated[a]

Period of injection[b] (days)	Paralytic cases ($N = 33$)	Comparison group ($N = 66$)	Relative risk	90% confidence intervals
1 – 7	11	4	15	6 – 39
8 – 14	6	1	32	8 – 124
15 – 21	7	3	13	4 – 37
22 – 30	5	1	27	7 – 108
Not injected	11	59	1.0	

[a] Relative risk was calculated separately for each time interval using the not injected cases and controls as the unexposed group. Therefore, four 2 x 2 tables were set up and each relative risk was calculated independently.

[b] Period during which children were injected is given here as number of days prior to the onset of disease.

Table 5 shows that children who received multiple injections during the month were twice as likely to develop paralysis as those receiving a single inoculation (χ for linear trend $= 6.1, P < 0.001$). The most frequent inoculations were of penicillin and quinine (Table 6).

Table 5. Frequency of inoculation within 30 days prior to onset of paralysis

Number of injections	Paralytic cases		Comparison group		Relative risk
	No.	%	No.	%	
2 or more	12	36	2	3	32
1	10	30	5	8	11
0	11	34	59	89	1
Total	33	100	66	100	

Table 6. Numbers of persons among the poliomyelitis cases and comparison group receiving different types of injection

Material injected	Paralytic cases (N = 33)		Comparison group (N = 66)	
	No.	%	No.	%
Penicillin	12	36	3	5
Quinine	14	45	4	6
DPT vaccine	1	3	1	2
Vitamins	4	12	—	—
Others	6	18	4	6

DISCUSSION

Bradford-Hill & Knowlden demonstrated the association between paralytic poliomyelitis and inoculations of DPT antigen in the month prior to onset (*6*). As their study focused only on a vaccine, which presumably would not be given once an acute febrile illness, such as poliomyelitis, had begun, they were able to propose a causal relationship between these inoculations and paralytic disease, although they did not calculate the relative risk of paralysis following inoculations. There is anecdotal evidence, however, that other injections, including penicillin and quinine compounds, may also predispose to paralytic poliomyelitis. In studying the relationship between injections of these substances and paralysis, however, it is necessary to separate "cause" from "effect." That is, it is necessary to separate injections given for the treatment of symptoms of poliomyelitis from those injections given prior to the onset of disease attributable to poliovirus exposure.

In Yaoundé, several observations of the epidemiology of poliomyelitis led us to study the association between exposure to any injection and the occurrence of paralytic poliomyelitis. First, the rates of paralytic disease and the ratio of paralytic disease to inapparent infection were unexpectedly high (*11*). Second, while poliomyelitis virus carriage remained at 10–20% of children throughout the year (*3*), paralytic disease was seasonal, occurring mainly from January to June. Third, in this community, injections were nearly always given in lower extremities, and paralytic disease occurred overwhelmingly in the lower extremities. We were impressed with the frequent reports by parents that injections "caused" the paralysis.

It should be re-emphasized that all the cases of paralysis used in this study had the clinical characteristics of anterior horn cell disease, i.e., normal sensory findings in the absence of deep tendon reflexes. These findings differentiate them from other children who were observed with clinical evidence of sciatic nerve damage. Although paralysis does occur following sciatic nerve damage from injections, and these cases were identified by our surveillance system, they were differentiated, clinically, from paralytic poliomyelitis and eliminated from this analysis.

Overall, our results demonstrate a strong association between paralytic poliomyelitis and inoculations. However, inoculations received in the days just prior to the onset of paralysis may have been a consequence of treating the symptoms of poliomyelitis. What then, is the period prior to the onset of paralysis that should be considered as the period of early symptoms? And consequently, what is the risk of "provoking" paralysis when inoculations are given prior to this period? In his review of the literature on poliomyelitis, Sartwell concluded that the average incubation period of poliomyelitis is 12 days with a range of 7–20 days (*16*). Krugman et al. showed the minor illness to begin about 11–12 days prior to the onset of paralysis (*12*). Finally, in the Bradford-Hill & Knowelden study the interval between the last DPT inoculation and the onset of paralysis was between 8 and 17 days. Therefore, we believe that in this study population, despite the problems with the comparison group used, the increased risks of paralysis in children inoculated in the 15–30 day interval prior to the onset of poliomyelitis are consistent with the concept of a "provoking effect" of non-antigen inoculations.

The validity of the effect measured above must be assessed in relation to the appropriateness of the comparison group. Under the limitations of the field situation, the characteristics of the group used were not "ideal". The ideal control group for this study would have been age- and sex-matched children who had had non-paralytic poliomyelitis. These ideal controls should have had evidence of a recent poliovirus infection, i.e., viral isolation and serological conversion, but *without* the development of paralysis. The control group selected in practice met some, but not all, of these "ideal" characteristics. Both groups had high rates of enterovirus carriage, although poliovirus was isolated from significantly more cases than con-

trols. Nearly two-thirds of cases had serological evidence of their first poliovirus infection, whereas 50% of controls were immune to all three poliovirus types. It is unlikely that these controls were infected during the immediately preceding month. Therefore, the comparison group did not have the same risk of developing paralysis as the cases. This feature of the comparison group would be expected to lead to an overestimation of relative risk. However, this overestimation would be expected to be greatest in the intervals closest to the time of onset of paralysis corresponding to the period of poliomyelitis symptoms. In the period prior to the presence of the minor illness, the overestimation of relative risk would be presumed to be less, thereby justifying the presentation of this relationship. The magnitude of this overestimation cannot be estimated.

Attempts to assess this bias in the control group were not successful. Dividing the comparison group by presence of poliovirus carriage or presence of an illness during the period leads to serious reduction in size of the group. It should be noted as well that the cost and operational difficulties of obtaining an "ideal" control group in an African setting may make such a study infeasible.

The public health implications of the findings presented here are important to the treatment of childhood illnesses in tropical Africa where poliomyelitis is endemic and now clearly recognized as an important problem (*8*, *15*). Injections of drugs must be avoided whenever an oral equivalent is available. This is especially true for quinine compounds, which are rarely indicated in preference to oral chloroquine in the treatment of suspected or confirmed malaria. Just as tonsillectomies were avoided and childhood immunizations delayed during poliomyelitis epidemics in developed countries to reduce the risk of paralytic poliomyelitis, medical practice must be altered in poliomyelitis endemic areas to reduce this risk. Further, more detailed studies of the epidemiology of poliomyelitis in these tropical settings need to be undertaken and designed to evaluate both the rates and risk factors for paralytic and non-paralytic disease. Finally, regardless of the relationship of inoculations to paralysis, poliomyelitis immunization in the first year of life must be included in comprehensive childhood immunization programmes in developing countries.

ACKNOWLEDGEMENTS

We wish to thank Dr Ebengué and the Staff at the Centre de Rééducation des Handicapés de Yaoundé, Dr S. Atangana, Dr B. Durand, and the other physicians and health centre personnel who cooperated in this study. We also wish to thank Dr Philip Cole, Dr David Nicholas, and Dr W. Schaffner for their critical reviews of the manuscript and suggestions.

Analysis of a portion of these data was included by one of the authors (AAEB) in his thesis for the degree Doctor of Medicine (MD) at the Centre universitaire des Sciences de la Santé (CUSS), Université fédérale du Cameroun, Yaoundé, United Republic of Cameroon (*2*).

RÉSUMÉ

INJECTIONS ET POLIOMYÉLITE PARALYTIQUE EN AFRIQUE TROPICALE

Diverses études avaient déjà mis en évidence une relation entre la poliomyélite paralytique et l'injection intramusculaire de vaccin triple (DTC) au cours du mois précédant l'apparition de la maladie, et certains travaux sur l'effet "déclenchant" d'injections variées ont été réalisés de longue date sur un modèle simien. On ne dispose malgré cela, pour les régions tropicales, que de renseignements anecdotiques sur un lien éventuel entre la poliomyélite paralytique et divers types d'injections. C'est pourquoi une étude a été récemment effectuée à Yaoundé (République-Unie du Cameroun) afin d'évaluer l'hypothèse selon laquelle les injections intramusculaires prédisposeraient les jeunes enfants à la paralysie s'ils se trouvent exposés au virus de la poliomyélite.

Cette étude, menée de septembre 1976 à avril 1977, a porté sur 33 enfants présentant des signes cliniques d'atteinte des neurones moteurs inférieurs et 66 enfants appartenant à la même collectivité et constituant le groupe témoin. Elle visait à recueillir des renseignements sur les facteurs épidémiologiques présents au cours du mois précédant l'apparition de la maladie. Des prélèvements rectaux ont été faits en vue de l'isolement de virus, et un échantillon de sang a aussi été prélevé chaque fois que cela a été possible pour examen sérologique. Alors que des poliovirus ont été isolés chez 39% des cas paralytiques, 18% seulement du groupe témoin en étaient porteurs. Une proportion plus élevée des enfants de ce groupe (50%) ont présenté des caractéristiques sérologiques témoignant d'une exposition antérieure aux trois types de virus poliomyélitique; en revanche, les deux tiers des enfants paralysés étaient, selon l'examen sérologique, exposés pour la première fois à un virus poliomyélitique.

La plupart des enfants atteints ont présenté certains symptômes initiaux au cours du mois précédant l'apparition de la paralysie, et ceci a été à l'origine de leur visite dans un centre de santé. Parmi les enfants du groupe témoin qui ont eux aussi passé la visite, 7 (35%) seulement ont reçu une injection à cette occasion, alors que ce nombre s'est établi à

22 (79%) chez les enfants frappés ensuite de paralysie. Soucieux d'éliminer les injections qui ont pu être pratiquées en raison de symptômes précoces, les enquêteurs ont vérifié dans chaque cas le nombre de jours écoulés entre les injections et l'apparition de la paralysie.

Pour l'analyse de la relation temporelle entre les injections et la paralysie, on a évalué, pour chaque période permettant de remonter le temps de 7 jours en 7 jours jusqu'à un mois avant l'apparition de la paralysie, le risque relatif (RR) pour tous les enfants ayant reçu une ou des injections au cours de ladite période; le nombre total des enfants des deux groupes qui n'en ont reçu aucune pendant les 30 jours considérés ont constitué la base de référence et se sont vu affecter un RR de 1,0 (tableau 4). On a noté pour chaque période un risque relatif élevé, ce qui confirme l'existence d'un lien étroit entre la poliomyélite paralytique et les injections intramusculaires. Bien qu'on puisse attribuer à l'infection elle-même le niveau plus élevé du RR pour les deux semaines précédant immédiatement la paralysie, cette explication perd de son poids en ce qui concerne l'élévation du risque relatif afférente aux troisième et quatrième semaines avant son apparition. Même si l'analyse est limitée à la période de 18 à 30 jours antérieure—laquelle se situe de toute évidence avant qu'un symptôme quelconque de poliomyélite ait pu se manifester—le RR ne descend pas au-dessous de 11.

Les enfants qui ont reçu des injections multiples au cours du mois couraient, d'après l'étude, un risque de paralysie deux fois plus élevé que ceux qui n'en avaient reçu qu'une. Les injections de pénicilline et de quinine étaient les plus fréquemment pratiquées.

Bien que le groupe témoin utilisé pour l'étude n'ait pas présenté des caractéristiques idéales aux fins de comparaison, les auteurs estiment avoir démontré qu'il existe un risque accru de paralysie pour les enfants ayant reçu une ou plusieurs injections 15 à 30 jours avant l'apparition d'une poliomyélite, et que ceci vient à l'appui du concept d'"effet déclenchant" attribué à des injections autre que celles d'antigènes. On voit les conclusions à tirer de ce fait en ce qui concerne le traitement des maladies de l'enfance en Afrique tropicale, où la poliomyélite est endémique et considérée maintenant comme un important problème de santé publique. Il convient d'éviter toute administration de médicament par injection—et celle de quinine en particulier—chaque fois qu'il existe un équivalent oral. Des enquêtes plus approfondies sur l'épidémiologie de la poliomyélite dans un environnement tropical sont certes encore nécessaires, mais on peut d'ores et déjà affirmer que la vaccination contre la poliomyélite au cours de la première année de la vie doit faire partie de tout programme complet de vaccination enfantine dans les pays en développement, et que la relation entre les injections en général et la paralysie n'affecte en rien ce principe.

REFERENCES

1. ATANGANA, S. & GUYER, B. A plan to protect children from disease. The immunization programme in Yaoundé. *WHO Chronicle,* **31**: 499-505 (1977).
2. ATEM EBAKO BISONG, A. Poliomyelitis in Yaoundé. Thesis, Université de Yaoundé, Centre universitaire des Services de la Santé, Yaoundé, Cameroon (1977).
3. BOCHE, R. ET AL. La poliomyélite au Cameroun. *Revue d'epidémiologie, médecine sociale et santé publique,* **21**: 79-93 (1973).
4. BODIAN, D. Viremia in experimental poliomyelitis. II. Viremia and the mechanism of the "provoking" effect of injections or trauma. *American journal of hygiene,* **60**: 358-370 (1954).
5. BODIAN, D. Viremia, invasiveness, and the influence of injections. *Annals of the New York Academy of Sciences,* **61**: 877-882 (1955).
6. BRADFORD-HILL, A. & KNOWELDEN, J. Inoculation and poliomyelitis. *British medical journal,* **2**: 1-6 (1950).
7. COLLIS, W. R. F. ET AL. Poliomyelitis in Nigeria. *West African medical journal,* **10**: 217-222 (1961).
8. GELFAND, H. M. & MILLER, M. J. Poliomyelitis in Liberia. *American journal of tropical medicine and hygiene,* **5**: 791-796 (1956).
9. GUYER, B. & ATANGANA, S. A programme of multiple-antigen childhood immunization in Yaoundé, Cameroon; first year evaluation, 1975-1976. *Bulletin of the World Health Organization,* **55**: 633-642 (1977).
10. GUYER, B. ET AL. The seroepidemiology of poliovirus in Yaoundé, Cameroon. *Journal of tropical pediatrics* (In press).
11. GUYER, B. ET AL. Surveillance de la poliomyélite de forme paralytique à Yaoundé, Cameroun—1973-1975. *Afr. Med.,* **15**: 697-704 (1976).
12. KRUGMAN, S. ET AL. *Infectious diseases of children.* St. Louis, C. V. Mosby Company, 1977.
13. MCCLOSKEY, B. P. The relation of prophylactic inoculations to the onset of poliomyelitis. *Lancet,* **1**: 659-663 (1950).
14. MIETTINEN, O. Estimability and estimation in case-referent studies. *American journal of epidemiology,* **103**: 226-235 (1976).
15. NICHOLAS, D. D. ET AL. Is poliomyelitis a serious problem in developing countries? The Danfa experience. *British medical journal,* **1**: 1009-1012 (1977).
16. SARTWELL, P. E. The incubation period of poliomyelitis. *American journal of public health,* **42**: 1403-1408 (1952).
17. TOWNSEND-COLES, W. F. & FINDLAY, G. M. Poliomyelitis in relation to intramuscular injections of quinine and other drugs. *Transactions of the Royal Society of Tropical Medicine and Hygiene,* **47**: 77-81 (1953).
18. WYATT, H. V. Provocation poliomyelitis and entry of poliovirus to the CNS. *Medical hypothesis,* **2**: 269-274 (1976).