Assessment of the quality of the Acute Flaccid Paralysis (AFP) reporting system, Mpumalanga, South Africa.

(Assessment of the Acute Flaccid Paralysis (AFP) reporting system in Mpumalanga Province, South Africa, and implications for polio eradication.)

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I certify that the report is my own work and
all references are accurately reported.

BN Harris

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Assessment of the Acute Flaccid Paralysis (AFP) reporting system in Mpumalanga Province, South Africa, and implications for polio eradication.

Summary

Keywords: AFP, acute flaccid paralysis, surveillance, infection control nurse, hospital record review, poliomyelitis, eradication, EPI, South Africa, evaluation.

The WHO member countries undertook to eliminate poliomyelitis globally by the year 2000. Acute flaccid paralysis (AFP) surveillance finds paralytic cases of polio so that swift action can be taken and shows that wild poliovirus has been eliminated when polio cases no longer occur.

Mpumalanga Province, a rural province in the north-east of South Africa, developed a rapid reporting system where infection control nurses at the public and private sector hospitals report weekly to the AFP surveillance Officer, including zero reporting, on 9 infectious disease syndromes that require rapid action on clinical presentation alone. This system was implemented in 1998 and included AFP. The non-polio AFP reporting rate increased from 0.37 in 1997 to 0.55 during 1998 with more than 80% of the units reporting weekly. The binomial exact confidence intervals however include 1. A hospital record review of all paediatric admissions revealed that only 2 AFP cases were missed by the system. The AFP reporting rate remains below the international standard of 1 per 100 000 children under 15 years of age despite an adequate reporting system.

The role of chance variation, particularly in small geographical areas, has not been discussed in official polio-eradication guidelines but it is imperative that population size be taken into account when judging the rate of AFP case detection. With the low international reference rate and play of chance variation it is possible that regions with relatively small populations, low non-polio AFP detection rates and no cases of polio detected for an extended period may have adequate surveillance systems supporting polio free certification. In these areas additional criteria for determining the adequacy of the surveillance system should also be considered.

Evaluering van die Akute Flasiede Paralise (AFP) siekte toesig stelsel in Mpumalanga Provinsie, Suid-Afrika, en die implikasies vir die uitroei van polio.

Opsomming

Die WGO lidlande het onderneem om poliomyelitis teen die jaar 2000 wêreldwyd uit te roei. Akute Flasiede Paralise (AFP) siekte toesig vind gevalle van polio verlamming sodat vinnig opgetree kan word, en wanneer geen polio gevalle meer voorkom nie, bewys dit dat die wilde polio virus geïlimineer is.

Mpumalanga Provinsie, 'n landelike provinsie in die noord-ooste van Suid-Afrika, het 'n siekte toesig sisteem ontwikkel waar infeksie beheer verpleegkundiges van publieke- en privaatsektor-hospitale weekliks verslag deurgee aan die AFP toesigbeampte. Dit sluit in nul verslae oor 9 infektiewe siektebeelde wat onmiddelike optrede op kliniese presentasie alleen verg. Hierdie stelsel is in 1998 ge-implimenteer en sluit AFP in. Die nie-polio AFP koers het verhoog van 0.37 in 1997 tot 0.55 gedurende 1998 met meer as 80% van eenhede wat weekliks verslag gee. Die binomaal spesifieke vertrouens interval sluit egter 1 in. 'n Hospitaalrekord-oorsig van alle paediatriese opnames dui daarop dat net 2 AFP gevalle deur die stelsel gemis is. Die AFP koers bly onder die internasionale standaard van 1 per 100 000 kinders onder die ouderdom van 15 jaar ondanks 'n voldoende siekte toesig stelsel.

Die rol van toeval-verandering, in veral klein geografiese gebiede, is nie bespreek in amptelike polio-uitroei handleidings nie, maar dit is noodsaaklik dat bevolkings grootte in ag geneem word wanneer die koers van AFP geval opsporing beoordeel word. Met die lae internasionale verwysings koers en die rol van toeval-verandering is dit moontlik dat streke met relatief klein bevolkings, 'n lae nie-polio AFP opsporings koers en geen gevalle van polio vir 'n verlengde periode ten spyte van voldoende toesig stelsels, polio vrye sertifisering regverdig. In hierdie gebiede moet addisionele kriteria vir die toereikendheid van die siekte toesig stelsel in ag geneem word.

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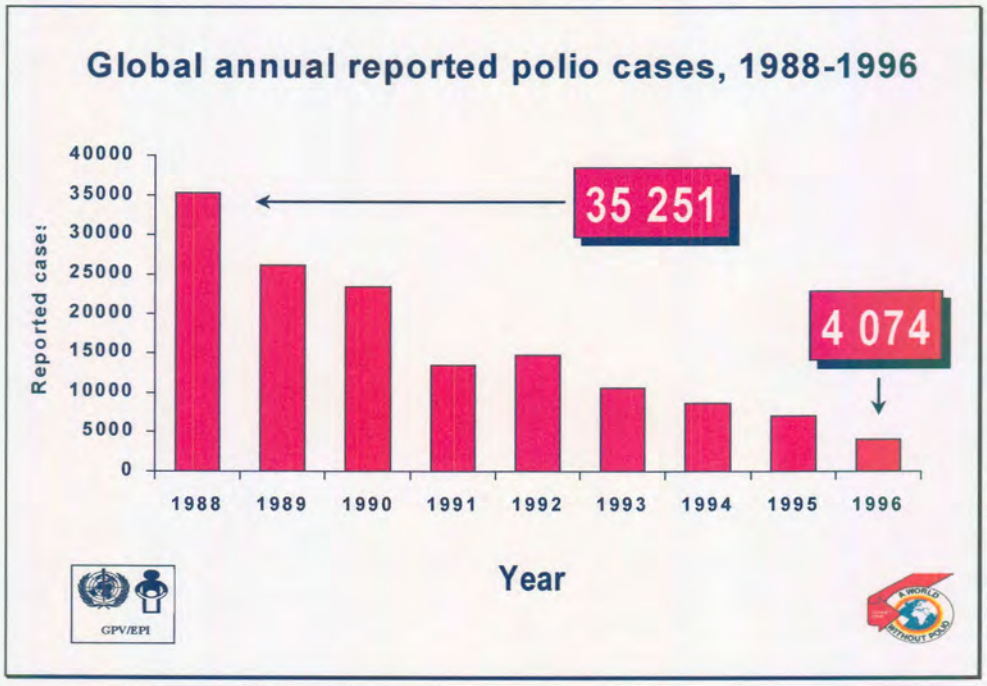
CHAPTER 1: Introduction

1.1 Global poliomyelitis eradication initiative

In May 1988 the World Health Assembly adopted a resolution calling for the global eradication of poliomyelitis by the year 2000.[1] The eradication initiative has been embraced by all six World Health Organisation (WHO) regions and is one of the primary goals of WHO member states.[2]

The four principal strategies to eradicate polio are: achieving and maintaining high routine immunisation coverage to reduce disease to low levels; conducting national immunisation days (NIDs) in all polio endemic countries to interrupt circulation of wild polio viruses; implementing a system of surveillance of acute flaccid paralysis (AFP) with laboratory investigation to identify the final reservoirs of wild virus; and conducting mopping-up immunisation to eliminate the final chains of transmission.[3] Implementation of these strategies has led to a 90% decline world-wide in the number of reported polio cases, within a decade, from 35 251 in 1988 to 4 074 in 1996.[4] (Figure 1)

Figure 1: Global annual reported polio cases, 1988 – 1996



Source: World Health Organisation. Global Programme for Vaccines and Immunisation; Expanded Programme on Immunisation

1.2 Surveillance for eradication

Surveillance for eradication of wild poliovirus relies on the identification of children with AFP. Laboratory isolation of wild poliovirus from the stools of children with AFP is necessary to confirm wild poliovirus transmission because AFP has multiple causes, including Guillain-Barré syndrome and transverse myelitis. However, relying on AFP identification underestimates the extent of wild poliovirus transmission among asymptomatic infected persons. For every child afflicted by paralytic poliomyelitis, approximately 200 children may be infected with wild poliovirus without becoming paralysed. It is therefore crucial that all cases of AFP be detected, investigated, and appropriate control measures, including vaccination in the affected area, be implemented immediately.[5]

Effective surveillance depends on establishing sensitive systems for epidemiological and virological detection to corroborate that the ultimate goal of the programme, zero cases of polio, has been achieved.[6] The WHO guidelines indicate that this system must be sensitive enough to detect 1 case of AFP per 100 000 population under 15 years of age. This reference rate has its origins in the Americas where it was used as an indicator of a sensitive AFP surveillance system.[7]

The International Certification Commission on Polio Eradication (ICCPE) has indicated that every country's surveillance system for AFP and wild poliovirus should meet five key surveillance indicators.[8] These indicators fall into two groups:

Indicators of completeness of reporting of cases:

- At least 80% of all reporting units should report each week.
- The rate of AFP cases should be at least 1.0 case per 100 000 population < 15 years of age per year.

Indicators of completeness of case investigation:

- At least 80% of all AFP cases should be investigated within 48 hours of reporting.
- At least 80% of all reported AFP cases should have two stool specimens taken for virus culture within two weeks of paralysis onset.
- At least 80% of all reported AFP cases should have stool investigation of at least 5 contacts. This has been changed so that contact stool

specimens should only be collected in special circumstances such as where there is a failure to collect adequate specimens from the case itself and in high risk areas with poor surveillance (e.g. refugee populations).[9]

1.3 AFP surveillance in South Africa

South Africa last reported wild virus-confirmed poliomyelitis cases in 1989 associated with an outbreak in KwaZulu/Natal.[10] In September 1994, a team conducted the first WHO sponsored review of the immunisation program in South Africa. This review found that South Africa relied on routine reporting of physician diagnosed poliomyelitis and recommended that AFP become a statutory notifiable condition.[11] AFP was regulated as a notifiable condition in 1994.[12] Training manuals were prepared and training conducted in all provinces. AFP case investigation and response in accordance with the WHO guidelines had not been fully implemented.

The annual target of AFP cases was not detected for 1995-1997. This elicited concern at the Expanded Program on Immunisation (EPI) of the National Department of Health who approached Rotary International to sponsor an AFP Officer in each province. The first appointments were made early in 1998.

1.4 Statement of the problem

Despite this initiative the AFP rate for 1998 remained below the reference rate in all provinces except the Western Cape and the Free State.[13] In Mpumalanga only one case had been detected in 1995 and three in 1997 with the AFP rate for 1997 and 1998 well below 1 per 100 000 children under 15 years of age. The National Department of Health prepared a basic protocol for conducting hospital record reviews in the 7 provinces that had not achieved the reference rate for surveillance.[14] This protocol was further developed for this study.

1.5 Purpose of this study

The purpose of this study was to assess the quality of the AFP surveillance system in Mpumalanga between 1 January 1997 and 31 August 1998 to address the concern that Mpumalanga was not meeting

the WHO surveillance target of one case of AFP per 100 000 children under 15 years of age per year.[15] The National Department of Health suspected that the surveillance system was not sensitive enough to detect all cases of AFP.

The study had two approaches. Firstly, a desktop analysis of the reporting system was conducted using internationally standardised indicators as set out in *1.2 Surveillance for eradication*. Secondly, a comprehensive review of all the paediatric admissions at the private and public hospitals in Mpumalanga from 1 January 1997 to 31 August 1998 was conducted to assess the completeness of AFP reporting in children under 15 years of age. It was recognised that the study would result in increased awareness of polio eradication and AFP surveillance.

1.6 Organisation of the remainder of the report

CHAPTER 2: Poliomyelitis provides an overview of poliomyelitis disease, its global impact and control measures. *CHAPTER 3: Polio eradication* explores the change in paradigm from control to eradication. The eradication strategies are summarised and smallpox eradication briefly described to show how it provided impetus for polio eradication but also how smallpox eradication strategies differed from those needed for polio eradication. *CHAPTER 4: Certification*, considers the prerequisites for certifying countries polio free, while *CHAPTER 5: Progress toward polio eradication*, describes strides made in eradicating polio.

CHAPTER 6: Study setting, describes Mpumalanga Province and the local AFP reporting system. The methods used in the study are set out in *CHAPTER 7: Methodology*. Results are presented in *CHAPTER 8: Results*. *CHAPTER 9: Discussion* discusses findings while CHAPTER 10: Conclusions presents conclusions drawn from the findings.

CHAPTER 2: Poliomyelitis

2.1 Global importance

Poliomyelitis is one of the first diseases to be recorded. An Egyptian tomb carving of the Nineteenth Dynasty shows the dead man to have had a drop-foot deformity typical of paralytic poliomyelitis.[16] Polio is an infectious disease of humans caused by poliovirus. The disease occurs in all age groups, but children are usually more susceptible in endemic areas because of acquired immunity in the adult population. Seventy to 80% of all cases occur in children under 3 years of age and 80 to 90% in children under five years of age. Paralysis in humans follows infection with one of three related RNA viruses: polioviruses type 1, type 2, or type 3 of the family Picornaviridae and genus Enterovirus.[17]

The virus usually enters through the mouth and then multiplies inside the oropharynx and intestinal tract. Once established, poliovirus can enter the bloodstream and in a small percentage of victims invade the central nervous system by spreading along axons of peripheral nerves. Here it continues to progress along the fibres of the lower motor neurons to increasingly involve the spinal cord or the brain. As it multiplies, the virus may damage or destroy anterior horn cells of the spinal cord and in severe cases the intermediate grey ganglia and even the posterior horn and dorsal root ganglia.

Exposure of a susceptible individual to the virus results in asymptomatic infection or mild illness (> 90%), aseptic meningitis (about 1%) or paralytic poliomyelitis (<1%).[18] One response may merge with a more severe form as the disease progresses resulting in a biphasic course. Only about one percent of infections are recognised clinically. The incubation period is usually 1 to 3 weeks, but may range from 4 to 35 days. The initial symptoms include fever, fatigue, headache, vomiting and constipation or less commonly diarrhoea. This mild illness is known as abortive polio and the patient recovers in a few days. In non-paralytic polio (aseptic meningitis) the above symptoms and signs are accompanied by stiffness and pain in the neck and back. The disease lasts two to ten days and recovery is rapid and complete. In a small percentage of cases the

disease advances to paralysis.[19]

The major illness may occur with or without the preceding symptoms described above. The predominant complaint is flaccid paralysis resulting from lower motor neuron damage. However, incoordination secondary to brainstem invasion and painful spasms of non-paralysed muscles may also occur. The amount of damage varies greatly, from a part of a single muscle to virtually every skeletal muscle. Usually the full extent of disability is apparent within 72 hours of the first signs, although a reasonable prognosis cannot be made for about a month by which time most reversible neuronal damage will have disappeared and the residual permanent damage can be assessed.

The legs are affected more often than the arms. More extensive paralysis, involving the trunk and muscles of the thorax and abdomen, can result in quadriplegia. In the most severe and often fatal cases, poliovirus attacks the motor neurons of the brain stem, reducing breathing capacity and causing difficulty in swallowing and speaking. This is known as bulbar polio. Without adequate respiratory support, bulbar polio can result in death by asphyxiation. During the polio epidemics of the 1940s and 1950s in industrialised countries, people with this form of the disease were immobilised inside "iron lungs" to regulate their breathing and keep them alive.

No one knows why only a small percentage of infections lead to paralysis but several key risk factors have been identified that are associated with an increased likelihood of paralysis. They include immune deficiency, pregnancy, tonsillectomy, intra-muscular injections, strenuous exercise and injury.[18, 20]

Although most people infected with poliovirus are asymptomatic and are not seen by a health worker, they can spread poliovirus to close contacts. Transmission is principally faecal-oral, but pharyngeal spread also occurs. Cases are most infectious during the seven to ten days before and after the onset of symptoms. The virus is shed intermittently in faeces for several weeks. These factors enable the rapid spread of poliovirus, especially in areas where hygiene and sanitation are poor and in any

environment where young children, who are not yet fully toilet-trained, congregate. Polio can also be spread when faeces contaminate food or drink, but the role of flies in disease transmission is not well established.[17] There is no non-human animal reservoir for polioviruses but the virus may persist in the environment, e.g., in sewage, for 3 months at most.[21]

Poliovirus circulates silently at first, potentially infecting up to 200 people before the first case of polio paralysis emerges. Because of this silent transmission and rapid spread of poliovirus, a single confirmed case of polio paralysis is a sentinel event and should be considered an outbreak, particularly in countries where very few cases are occurring and the disease is close to being eliminated.

There are three epidemiological patterns of poliovirus distribution in populations. Firstly, in the endemic pattern all three serological types have infected most children by the age of five after an initial 6-month period of passive immunity conferred by maternal antibodies. The average age of acquisition in more affluent communities was, in the days before mass immunisation, much later. Secondly, an epidemic situation is created, in which every few years, outbreaks occurred among the accumulated susceptibles in the population. Thirdly, the advent of mass immunisation ushered in the vaccine era, in which the behaviour of poliomyelitis has again changed to sporadic outbreaks in unvaccinated communities and isolated vaccine associated cases.

2.2 Polio vaccines

Protective immunity against polio is established through immunisation or as a result of natural infection with poliovirus. Polio infection provides lifelong immunity to the disease but the protection is limited to the particular type of poliovirus involved with no cross-protection against the other two types of poliovirus.

Two different kinds of polio vaccine are available: an inactivated injectable polio vaccine (IPV) originally developed in 1955 by Dr Jonas Salk and a live attenuated oral polio vaccine (OPV) developed by Dr Albert Sabin in 1961. Both vaccines are trivalent and highly effective against all three types of poliovirus. Different mechanisms of action favour use of a

particular vaccine in a specific environment.[22]

Oral polio vaccine induces both serum immunity and secretory immunity, particularly inside the intestines, the primary site for poliovirus multiplication. Therefore in addition to inducing individual protection against polio, OPV also limits the multiplication of "wild" (naturally occurring) virus inside the gut. Immunisation with OPV therefore creates an effective barrier against circulation of wild poliovirus by reducing faecal excretion of the virus. An additional benefit of immunisation with OPV is the short-term shedding of vaccine virus in the stools of recently immunised children. In areas where hygiene and sanitation are poor and the incidence of polio is high, immunisation with OPV can result in passive immunisation of close contacts through the spread of vaccine virus shed in stools. There is also displacement of wild poliovirus in the environment by vaccine virus.

An added advantage is that OPV is an oral vaccine. It does not have to be administered by a trained health worker nor does it require sterile injection equipment. It is also relatively inexpensive (available at 9 US cents a dose through the UNICEF vaccine purchasing system), a major consideration when governments have to purchase massive quantities of vaccine for use in national immunisation days.[23] For these reasons OPV has been favoured as the vaccine of choice for eradication. The downside is that, although OPV is safe and effective, very rarely (in about one in every 2.4 million doses administered) the live attenuated vaccine virus can cause paralysis in either the vaccinated child or in a close contact.[24, 25]

Inactivated polio vaccine (IPV) produces protective serum antibodies preventing the spread of poliovirus to the central nervous system. It induces only very low-level immunity to poliovirus inside the gut. As a result, it provides individual protection against polio paralysis but only marginally reduces the spread of wild poliovirus. Wild virus can still multiply inside the intestines of a person immunised with IPV and be shed in their stools and therefore IPV cannot be used to eradicate polio. IPV can, however, play an important role in limiting vaccine-associated paralysis once elimination of the disease is achieved in a country.

CHAPTER 3: Polio eradication

Polio is one of a limited number of diseases that can be eradicated with public health tools that are currently available. Factors favouring polio eradication include: polio only affects humans; an effective vaccine is available; immunity is life long; there are no long-term carriers of the disease; no animal or insect reservoir exists; and the virus can only survive for a very short time in the environment.[26] Poliovirus multiplies only by invading a cell and hijacking the cell's own mechanism for replication. The virus will rapidly die out if deprived of human hosts through immunisation.

As the level of routine immunisation coverage increases, the circulation of wild poliovirus is reduced but does not stop altogether.[27] When the goal changes from control to eradication, a more aggressive strategy is needed. The WHO adopted a polio eradication strategy that involves mass immunisation campaigns, door-to-door immunisation, rapid response to suspected polio cases, investigative work to identify cases that may have been missed, and viral detective work in the laboratory to isolate poliovirus and pinpoint the original source. In areas where polio no longer occurs, the same investigative methods are used to provide conclusive evidence that wild poliovirus is no longer in circulation.

The strategy has four key elements. These are: high routine immunisation coverage with OPV; supplementary immunisation in the form of national immunisation days or mass campaigns; effective surveillance; and in the final stages, when very few or no cases are occurring, door-to-door immunisation campaigns ("mopping up") in areas where the virus persists.[28]

3.1 Routine coverage

A cornerstone of the polio eradication strategy is the need to ensure a consistently high level of routine immunisation coverage with oral polio vaccine among children under one year of age, reaching children even in the most inaccessible places. High immunisation coverage reduces the incidence of polio and makes eradication feasible. Unless high immunisation coverage is maintained, pockets of non-immunised children build up, creating conditions conducive to the spread of poliovirus. The

WHO has established a global target of at least 90% immunisation coverage with all vaccines used in the Expanded Programme on Immunisation (EPI), including OPV, by the year 2000.[29]

By 1995, global immunisation coverage for polio was over 80% but coverage in some countries, especially those affected by war, was much lower.[30] Fewer than 25% of children were immunised in Afghanistan and less than 20% in Chad. In Chechnya, in the Russian Federation, a bitter conflict succeeded in halting immunisation for three years and in 1995 there was an outbreak with more than 150 cases of polio reported.[31] Elsewhere, even short-term decreases in immunisation coverage, e.g. in Albania,[32] Azerbaijan[33] and Bulgaria,[34] led to epidemics of polio.

When polio has been eradicated globally, immunisation against polio will no longer be needed. In the meantime, countries in the Americas, where polio has been eliminated since 1991, must continue to ensure high levels of routine immunisation coverage to prevent the re-establishment of poliovirus by re-introduction from other countries.

3.2 Mass campaigns

The second part of the strategy involves supplementary immunisation in the form of mass campaigns. National immunisation days (NIDs) are intended to complement routine immunisation. The aim is to interrupt the circulation of poliovirus by immunising every child in the highest risk age group (normally children < five years old) as rapidly as possible.[35] In countries where polio is endemic, this usually involves two rounds of national immunisation, one month apart, each year, over a period of at least three years.[36] This captures children who are non-immunised, or only partially protected, and boosts the immunity of children already immunised. Every child in the most susceptible age group is protected against polio at the same time, simultaneously depriving the virus of the host population on which it depends. Two rounds of immunisation are needed to maximise sero-conversion to all three poliovirus sero-types.

Record years for mass immunisation campaigns against polio world-wide were set in 1995 and 1996. Three hundred million children were immunised during national immunisation days during 1995, almost half the

world's children under five years of age.[37] In December alone, 160 million children were given oral polio vaccine during campaigns in China and India.[38,39] The number of reported polio cases in China dropped from over 5000 in 1990 (an epidemic year) to only 3 in 1996.[40] All 3 were classified as cases imported from other countries. In India, which had accounted for more than 62% of the world's polio cases in 1994, over 75 million children under three years of age were immunised in the country's first national immunisation day in December 1995.[41] A year later, when the target group was extended to include all children under five years of age, 127 million children were immunised on a single day.[42] During 1996, over 420 million children were immunised during national immunisation days. This represents almost two thirds of the world's children under five years of age.[43]

3.3 Surveillance

The third part of the strategy is surveillance, the intelligence network that underpins the entire eradication initiative. Without this investigative framework, it would be impossible to pinpoint where and how wild poliovirus is still circulating or to verify when it has been eradicated.

Effective polio surveillance requires an expert team of virologists, epidemiologists, clinicians, and immunisation staff, backed up by a global network of laboratories. The first links in the chain are health workers in health facilities who are asked to report promptly every case of acute flaccid paralysis in any child under 15 years of age. In addition, a health officer is expected to visit hospitals and rehabilitation centres to search for any AFP cases that may have been misdiagnosed, overlooked, or never reported. This involves reviewing inpatient and outpatient records, as well as interviewing key staff. Contact should also be established with community leaders, teachers, and social workers to inquire about cases of recently paralysed children.

All cases of AFP should be reported. AFP cases occur at all ages, due to causes other than polio. The number of cases reported each year is used as an indicator of the sensitivity of a country's surveillance system, even in countries where polio no longer occurs. The WHO instructs that a

country's surveillance system should be sensitive enough to detect at least one case of non-polio AFP for every 100 000 children under 15 years of age. This minimum annual rate was based on the fact that in the absence of wild poliovirus transmission, cases of AFP due to other causes will continue to occur.[44]

In the early stages, polio may be difficult to differentiate from other forms of acute flaccid paralysis. Doctors are urged to report every case of AFP, even when they are confident, following a clinical examination, that the case is not polio. Demonstrating that these children are not paralysed by wild poliovirus is crucial evidence for documenting the eradication of polio. As polio disappears under the pressure of national immunisation days, almost all AFP cases will be due to other causes. At least half of all AFP cases will be due to Guillain-Barré syndrome, a disease of unknown origin, which affects people of all ages but occurs mainly in adults. Guillain-Barré syndrome is usually a symmetrical form of paralysis and complete recovery commonly occurs. Polio usually results in asymmetrical, permanent paralysis. Among the many other causes of acute flaccid paralysis are transverse myelitis and infections by other enteroviruses.

To exclude the possibility of polio, faecal specimens have to be obtained and tested for the presence of poliovirus. Because shedding of the virus is variable, two specimens taken at least 24 hours apart, within fourteen days of onset of paralysis, are taken for laboratory analysis. Speed is essential as the highest concentrations of virus are found during the first two weeks after the onset of paralysis.

Stool specimens have to be carefully sealed in clean containers and stored immediately inside a refrigerator or packed between frozen ice packs at 4-8°C in a cold box, ready for shipment to a laboratory. Undue delay or prolonged exposure to heat on the way to the laboratory may destroy the virus. Specimens should arrive at the laboratory within 72 hours of collection. If this is not possible they must be frozen (at -20°C), and then shipped frozen, ideally packed with dry ice or cold packs also frozen at the same temperature. This procedure is known as the "reverse cold chain".

At the laboratory, specimens are inoculated onto cell culture to isolate poliovirus and identify which, if any, of the three types is involved. If viruses grow in the cell culture, poliovirus must be differentiated from any other viruses that may be present. Antibodies specific to individual viruses are introduced to block the growth of these viruses enabling virologists to single out poliovirus.

The next step is to distinguish between wild (naturally occurring) and vaccine poliovirus, if poliovirus is isolated. One way of doing this is to introduce antibodies specific to either vaccine or wild strains of the virus to detect subtle differences in their surface properties (an Elisa test). Another way is to introduce a specific genetic "probe" which identifies a virus by binding to its genetic material when it is exactly matched (PCR).

Once it has been established that a wild virus is involved, immunisation personnel are notified immediately for local response. Specialised reference laboratories perform genomic sequencing of epidemiologically important polioviruses. The sequencing information can be used to; distinguish between imported and indigenous polioviruses, estimate the temporal link between cases, identify reservoirs sustaining poliovirus endemicity, track chains of virus transmission and recognise potential laboratory contaminants.[45] The virus is checked against a reference bank of known polioviruses. Mutations occur at a relatively stable rate with the genetic structure of the virus changing by up to 2% during a year. When differences of greater than 10% are identified between viruses, they are no longer considered to belong to the same genetic family.

Precise information on the patterns of poliovirus circulation is essential for determining the most cost-effective strategies for global eradication.[46] Where the geographical zone identified extends across national borders or regions, inter-regional action may be needed to synchronise national immunisation days and maximise their effectiveness. In the Mekong Delta Region of Vietnam and Cambodia, for example, polio cases occurring in both countries are caused by closely related polioviruses. National immunisation days were co-ordinated on both sides of the border to maximise their impact.[47]

The WHO, in collaboration with national governments, has established a network of accredited laboratories to provide virological surveillance. The network comprises 67 national laboratories, 14 regional reference laboratories, and six global specialised laboratories.[48] When no polio cases are occurring, the laboratory network will play a crucial role in certifying the eradication of polio by establishing the absence of wild poliovirus.[49] At this advanced stage, surveillance may also entail analysis of stool specimens from healthy children in high-risk areas and possibly of sewage and wastewater.[50] Environmental surveillance, for example, detected wild poliovirus circulation in high-risk communities in Colombia.

The quality of surveillance in many countries is still not satisfactory. By the end of 1996, 15 of the recently endemic countries had not officially established surveillance systems for acute flaccid paralysis, a crucial requirement for assessing the impact of national immunisation days and for the certification of polio eradication. During 1996, only 25% of the 116 countries where polio is still, or was until recently, endemic, met the WHO criterion of reporting at least one case of acute flaccid paralysis for every 100 000 children under 15 years of age.[43]

3.4 Mopping up

When very few or no cases of polio are occurring, the final strategy is implemented. This involves door-to-door immunisation ("mopping up") in high-risk districts where the virus is known, or suspected, to still be circulating. Priority districts include those where polio has occurred in the previous three years and where access to health care is difficult. Other criteria include overcrowding, high population mobility, poor sanitation, and low routine immunisation coverage. In Peru for example, after the last case of polio was reported in 1991, almost two million children were immunised in a one-week door-to-door campaign.

3.5 Smallpox eradication

When the global smallpox eradication programme was launched in 1967, there were an estimated 10-15 million cases of smallpox a year, although only 1% of them were ever reported. Of these, at least two million died

and a further 100 000 were blinded by the disease. More than 10 million remained severely disfigured.

The global onslaught on smallpox ended in 1979, two years after the last case involving naturally occurring wild virus was reported in the town of Merca in Somalia where, on 22 October 1977, 23-year old Ali Maow Maalin developed smallpox and survived. The last two cases of laboratory acquired smallpox occurred in Birmingham, England, in 1978.

The 12-year smallpox eradication campaign and the global certification of the eradication of smallpox in October 1979 established many of the basic principles now being used for certification of the eradication of polio. In many ways variola virus was similar to poliovirus. It caused a disease that affected humans only, immunity was life long, there was no long-term carrier state, no animal or insect reservoir, and a vaccine was available that effectively prevented disease. There are however several very significant differences.

Firstly, smallpox vaccine is thermostable and only a single dose was needed to produce immunity. Although the polio vaccine used has the advantage of oral administration, it is heat sensitive and children need four doses, preferably during their first year of life.

More importantly, although smallpox was a highly infectious disease, it did not result in asymptomatic infections, as polio does. Virtually every case of smallpox was clinically apparent. Infection with variola virus was highly visible, involving a characteristic rash that was easily recognised even by a lay person and not likely to be confused with other diseases. The smallpox eradication team could therefore produce a smallpox recognition card that could be shown to people to facilitate the search for cases. Smallpox also left distinctive, permanent scars on the faces of as many as two thirds of its victims. During the certification stage, scar surveys of young children were carried out to confirm that variola virus was no longer in circulation. The youngest children would bear evidence of recent disease.

Finding evidence of recent polio cases is more difficult. Although polio paralysis is highly visible, some cases of polio can be confused with other

forms of paralysis even by expert neurologists. While recent cases of polio paralysis indicate where polio is occurring, the absence of cases does not necessarily prove that poliovirus is no longer in circulation. Wild poliovirus can circulate "silently", only producing recognisable clinical disease (polio paralysis) in less than 1% of children infected. For every child who is paralysed by polio, about 200 other children will either appear well or have an illness not easily recognised as polio, despite being infected with poliovirus. As a result, exhaustive surveillance is required to ensure that, if cases are occurring at a low level, they will be detected, and that wild poliovirus is not continuing to circulate at a low level among healthy children.

CHAPTER 4: Certification

A 13-member Global Commission has been appointed to certify the global eradication of polio. Its members were selected on the basis of their scientific expertise and objectivity. They do not work directly within the polio eradication initiative but are all eminent doctors, scientists, or academics working in related fields. Commission members share responsibility for verifying that polio has been eradicated globally.

Certification will be carried out on a regional basis. At national level, each country is requested to establish a National Polio Expert Committee (PEC), with responsibility for assessing and verifying polio surveillance data before their submission to the Regional Commission. Final certification will not be considered in any region until at least three years after the last virologically confirmed case of polio involving wild poliovirus. The Global Commission, which met for the first time in February 1995, has produced standard guidelines for data collection, drawn up a timetable for the certification process, and established criteria on which certification will be based.[51] It has drawn on the experience of the International Certification Commission on Polio Eradication in the Americas, which certified that polio had been eradicated from every country in the western hemisphere in August 1994, three years after the last case occurred in Peru.

Surveillance for both acute flaccid paralysis cases and wild polioviruses forms the basis of the documentation needed for certification. The Commission must be satisfied that, if polio cases had occurred, they would have been detected, reported, and rapidly and thoroughly investigated. Performance indicators for surveillance have been established to confirm this. Where reports are not submitted, the reasons must be clearly documented and analysed.

Surveillance for acute flaccid paralysis must meet five stringent criteria before certification can be considered.[8]

- Surveillance should be sensitive enough to detect at least one case of AFP for every 100 000 children under 15 years of age.

- Adequate stool samples should be collected from at least 80% of

these cases.

- Detailed investigation of suspected polio cases should include clinical, epidemiological, and virological examination as well as a follow-up examination for residual paralysis after 60 days.

- A committee of experts should make a final classification of the case on the basis of these examinations.

- At least 80% of monthly surveillance reports (including zero reporting) should be submitted on time.

Virological surveillance is also regulated. The results of virus isolation tests will be accepted only from network laboratories, and these laboratories must undergo regular proficiency testing. Specimen collection, transport, and testing procedures are monitored through the use of performance indicators and proficiency testing. Stool specimens from close contacts under the age of five may also need to be tested in some areas, particularly those with poor surveillance systems. After the last case of polio in the Americas in 1991, over 25 000 stool samples were collected from about 6 000 paralysed children and their contacts over three years to test for the presence of wild poliovirus. Eradication could not be certified without proof that no indigenous polioviruses were circulating in the region.

Environmental testing for poliovirus through sampling sewage and wastewater may only be feasible in countries with organised sewerage systems. However, the Global Commission decided that environmental sampling could be used to provide supporting evidence of the absence of wild poliovirus.[50]

CHAPTER 5: Progress toward polio eradication

5.1 Global progress

During 1988 the Polio Eradication Initiative (PEI), a global partnership, was formed involving the WHO, Rotary International, the United Nations Children's Fund (UNICEF), the US Centres for Disease Control and Prevention, non-governmental organisations, donor governments, and ministries of health in the polio-endemic countries. These partner agencies provide funding, technical expertise, advocacy, and volunteers to expedite global eradication.

Highlights in the polio eradication initiative

1985

- The Pan American Health Organisation (PAHO) launched an initiative to eradicate polio in the Americas by 1990.

1988

- In May the World Health Assembly resolved to eradicate polio by the year 2000.
- Over 60% of children throughout the world were fully immunised against polio, diphtheria, whooping cough, tetanus, measles and tuberculosis before their first birthday.
- An estimated 350 000 polio cases occurred world-wide

1989

- About 26 000 cases of polio reported world-wide.

1990

- World Summit for Children in New York endorsed the polio eradication goal.
- The global target of routinely immunising at least 80% of children before their first birthday surpassed.
- 25 000 polio cases reported to WHO.

1991

- Routine immunisation coverage remained consistently over 80% of children by their first birthday.

- Number of reported cases below 13 500.
- Emerging polio-free zones identified, including the Pacific Rim, southern and eastern Africa, North Africa, the Middle East, and Western Europe.
- The last case of polio diagnosed in the Americas, in a three-year old boy in Peru.

1992

- Routine immunisation coverage remains unchanged.
- A slight rise in global case numbers due to a 45% increase in India.
- WHO Revised Plan of Action for polio eradication urged greater political commitment, increased funding, and improved surveillance systems.

1993

- About 10 500 polio cases reported.
- More than half the countries reporting to WHO recorded zero cases for the past three years.
- Imported wild poliovirus from the Netherlands detected in Canada but no cases of polio paralysis occurred.
- Outbreaks of polio occurred in Azerbaijan, Central African Republic, Namibia, Pakistan, Sudan, and Uzbekistan.
- Eighty-two million children under four years of age immunised in China's first NIDs.[52] The Philippines and Vietnam also held NIDs.[53,54]

1994

- In January, China immunised 83 million children under four years of age during a mass campaign.[55]
- Thirty-six countries carried out NIDs.
- Almost 120 countries reported zero cases of polio for three years.
- On 29 August an International Commission certified polio eradication throughout the Western Hemisphere.[56]
- Number of reported polio cases below 9 000 (75% of them in Bangladesh, India, and Pakistan).

1995

- In February, the Global Commission for the Certification of the Eradication of Poliomyelitis met for the first time in Geneva.

- On 7 April, World Health Day refocused world attention on the polio eradication initiative.
- 300 million children in 62 countries were immunised during national immunisation days representing about half the world's children under five.[57]
- The number of countries conducting AFP surveillance increased to 120, but only 35 met the WHO criteria for satisfactory surveillance.
- Outbreaks of polio occurred in Chechnya (Russian Federation), Namibia, Pakistan, and in the former Zaire.
- Number of reported polio cases down to 6 179 representing an 82% decrease since 1988 (35 251 cases).[58]
- China reported fewer than 200 polio cases, including only one caused by wild poliovirus (imported from Myanmar). Five years earlier, 5 000 cases were reported.

1996

- A record 420 million children were immunised during national immunisation days, almost two thirds of the world's children under five.[59]
- In December, 118 million children immunised on a single day in India. This was the largest health event ever organised by an individual country.
- An outbreak of polio occurred in Albania that spread to Greece and the Federal Republic of Yugoslavia.
- Imported wild poliovirus from the Indian Subcontinent detected in Canada. No cases of paralysis resulted.
- 3 995 polio cases were reported during 1996, the lowest number on record.

1997

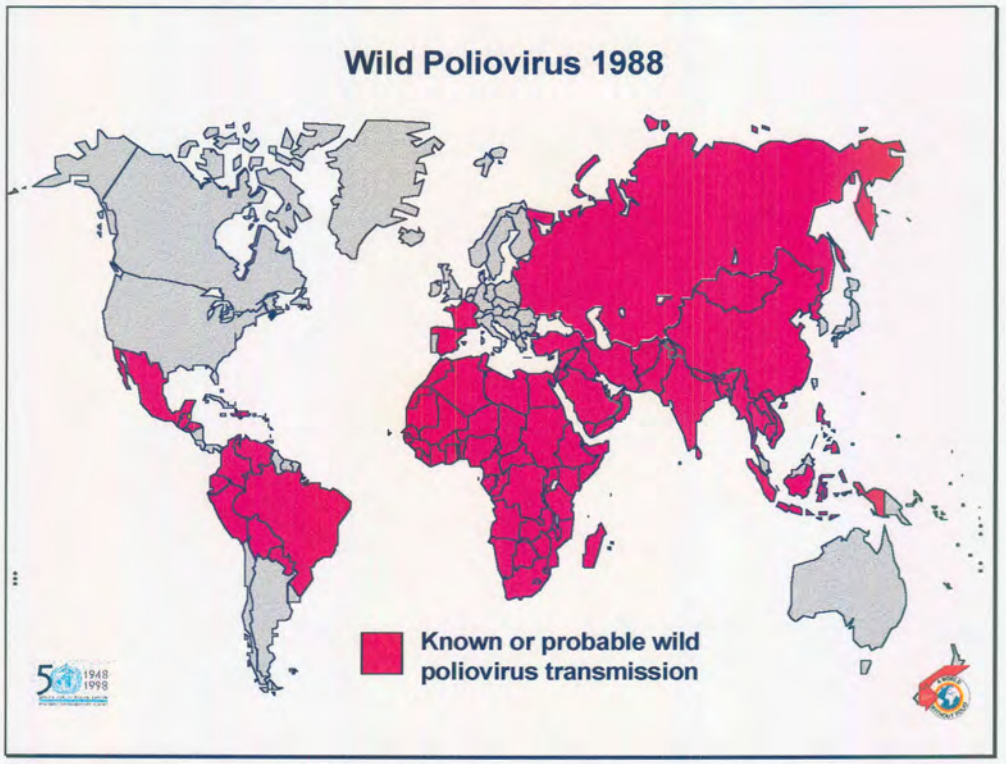
- Globally 4 116 polio cases were reported.
- Global coverage with 3 doses of OPV among infants was 82%.
- Approximately 450 million children less than five years of age in 80 countries were vaccinated during NIDs.[60]
- The global non-polio AFP rate increased from 0.6 in 1996 to 0.8 in 1997.

1998

- Globally reported polio cases increased to 6 227 due to improvements in AFP surveillance, particularly in India.
- Global coverage with 3 doses of OPV among infants remained above 80%.
- Approximately 470 million children were vaccinated during NIDs (74 countries) and Sub-National Immunisation Days (SNID) (in 16 countries).[61]
- The global non-polio AFP rate increased to 1.1 in 1998. The rate more the doubled in the African Region from 0.16 in 1997 to 0.42 in 1998.

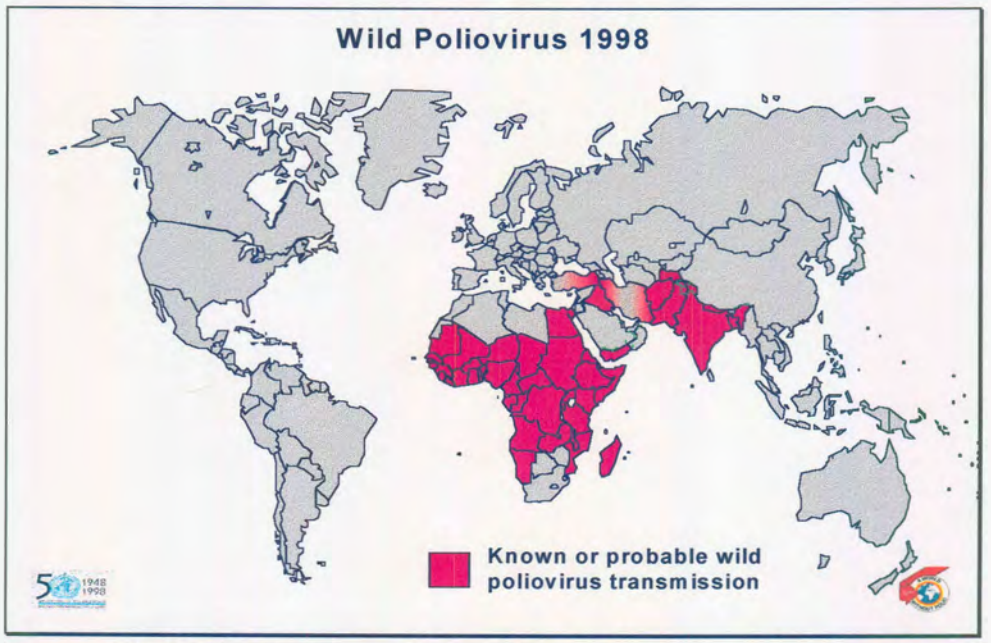
The change in the global distribution of wild poliovirus between 1988 and 1998 is shown in Figure 2 and Figure 3.

Figure 2: Global distribution of wild poliovirus, 1988



Source: World Health Organisation. Global Programme for Vaccines and Immunisation; Expanded Programme on Immunisation

Figure 3: Global distribution of wild poliovirus, 1998



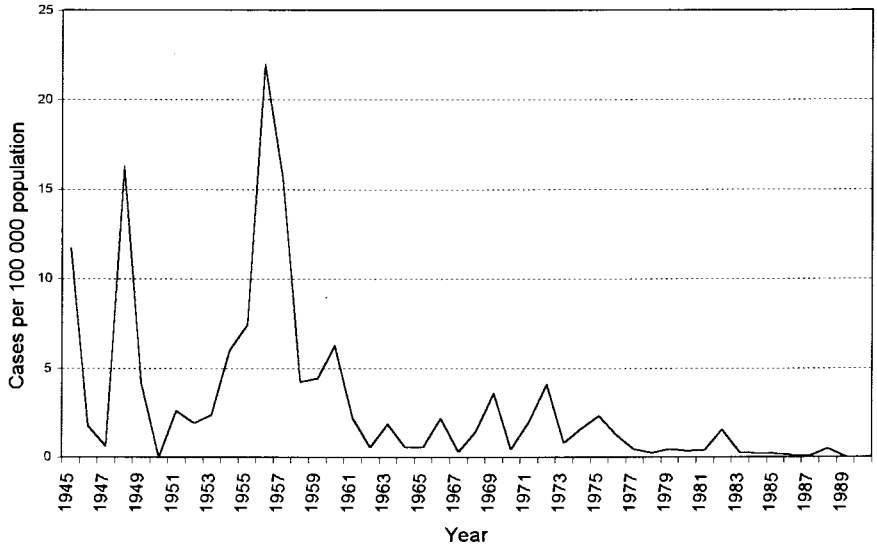
Source: World Health Organisation. Global Programme for Vaccines and Immunisation; Expanded Programme on Immunisation

5.2 Progress in South Africa

Incidence of poliomyelitis

Poliomyelitis has been notifiable by law since 1919. Salk vaccine and oral Sabin vaccine were introduced in 1957 and 1960 respectively and vaccination was compulsory from 1963 to 1988.[62] Figure 4 shows the annual incidence from 1945 – 1990.[63]

Figure 4: Annual incidence of poliomyelitis, South Africa, 1945 - 1990

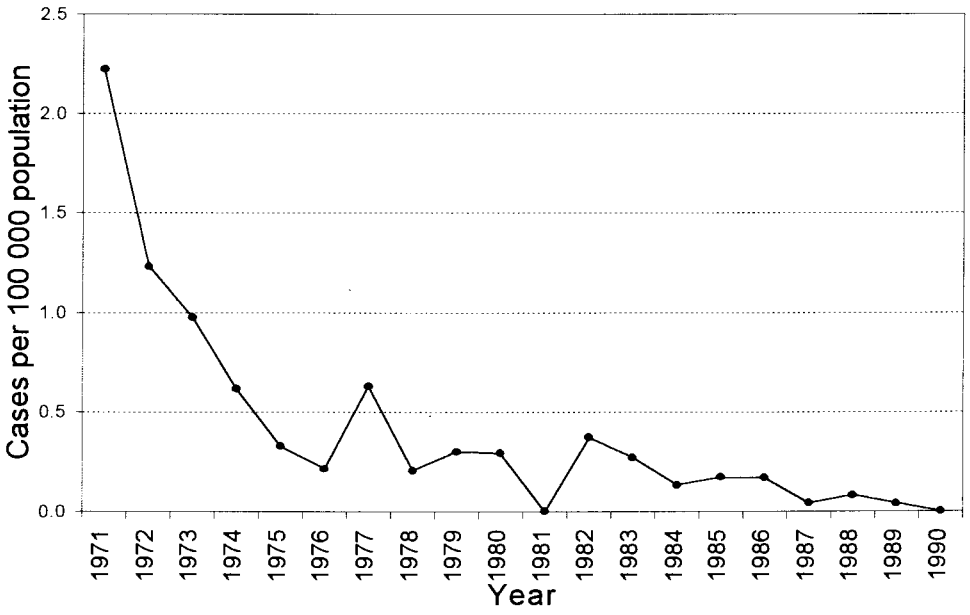


Source: Statutary disease notifications received by the Department of Health, South Africa.

Major outbreaks occurred from the early 1940's to the early 1960's. Smaller outbreaks followed mandatory vaccination. The incidence has further decreased as the EPI Programme gained strength. The last laboratory confirmed case of wild type poliovirus occurred in 1989 in KwaZulu/Natal.[64]

The incidence of poliomyelitis in Mpumalanga dropped from 2.22 per 100 000 population in 1971 to 0.33 in 1975 (Figure 5). No cases have occurred since 1990.

Figure 5: Annual incidence of poliomyelitis Mpumalanga, 1971-1990



Source: Statutary disease notifications received by the Department of Health, South Africa.

Routine Polio vaccination coverage

In 1994 a national survey was conducted to determine the vaccination coverage in the first year of life in children aged 12 to 23 months. Coverage of oral polio vaccine was found to be relatively high with 89.1%, 84.5% and 71.5% with vaccinated with OPV_1, OPV_2 and OPV_3 respectively by their first birthday.[65] The 1998 South African Demographic and Health Survey found national coverage rates of 91.0% with OPV_1, 82.7% with OPV_2 and 72.1% with OPV_3 among children aged 12 to 23 months.[66]

A district level survey of the routine immunisation coverage with EPI antigens in children aged 12 to 23 months in Mpumalanga during 1997 showed a high coverage of 96% with OPV_1, 94% with OPV_2 and 90% with OPV_3 according to child health card and/or history.[67]

Mass Immunisation campaigns

The outcomes of the mass immunisation campaigns conducted in SA during 1995-7 are shown in Table 1.[68] The campaigns took place in all provinces except the Western Cape Province, which did not participate in 1995 and 1997.

Table 1: Vaccination coverage rates and number of doses administered, polio mass immunisation campaigns, South Africa, 1995-7

Year	First round		Second round	
	No vaccinated (Million)	% coverage	No vaccinated (Million)	% coverage
1995*	3.8	89.6	3.3	78.0
1996	4.8	90.0	4.1	77.2
1997*	4.1	81.1	3.9	76.2

* Western Cape not targeted

Mpumalanga Province participated in the three mass polio campaigns with all children under 5 years of age being included. The last campaign in May and June 1997 resulted in an average of 382 000 children immunised during the two rounds with 85% coverage for the Province. The denominator is a rough estimate and the actual coverage could in fact have been much higher. The coverage was 87% and 58% for the two rounds in 1995 and 101% and 90% for the two rounds in 1996.[69] (Final report of the 1996 Polio mass immunisation Campaign, Mpumalanga Department of Health)

AFP surveillance

The rate used in the Americas was also adopted for the Afro Region. The AFP detection rate throughout most of Africa is low and this has been attributed to poor surveillance systems.[70] The possible heterogeneity of AFP incidence due to differences in underlying aetiology of non-polio AFP and the role of chance variation, particularly in small geographical areas, have not been assessed.

Zimbabwe is the only country where an independent audit of the AFP surveillance system has previously been done. The assessment was conducted in 1992 by teams consisting of national health officials, WHO staff and consultants, and Rotary International, and was the first systematic attempt to determine the rate of AFP in a sub-Saharan African population. The annual rate in Zimbabwe (0.17 per 100 000 children under 15 years of age) was low in comparison with the reference rate.[71] The investigators, however, paradoxically concluded that the true rate of non-polio AFP in Zimbabwe was unlikely to be lower than in populations in

the Americas. A study in the Western Cape Province of South Africa found an average annual incidence of Guillain-Barré syndrome, the most common non-polio cause of AFP, to be 2.14 per 100 000 children under 15 years of age.[72]

The non polio AFP rate per 100 000 children under 15 years of age per province and for South Africa from 1995 to 1998 is shown in Table 2.

Table 2: Non polio AFP rate per 100 000 children under 15 years of age, South Africa, 1995 - 1998

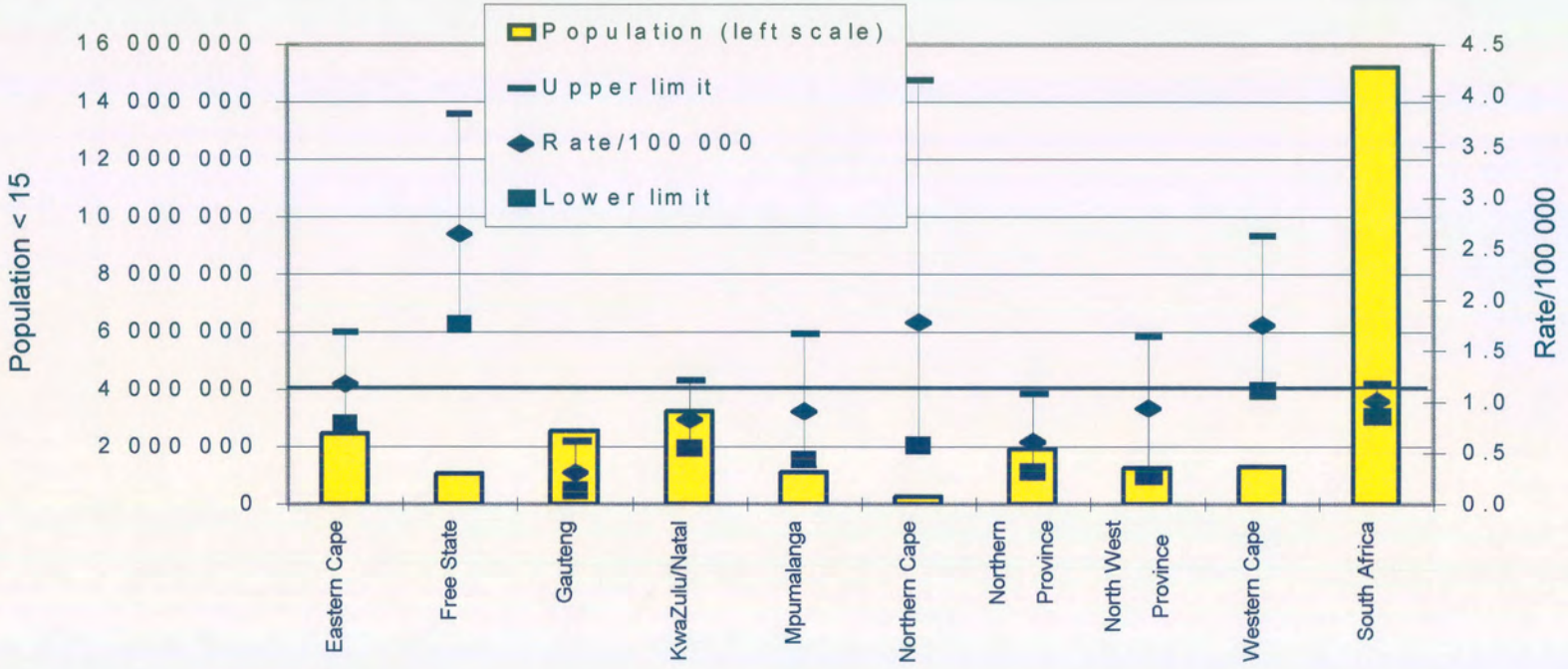
Province	Year			
	1995	1996	1997	1998
Eastern Cape	0.04	0.30	0.91	1.18
Free State	0.00	0.00	0.58	2.64
Gauteng	0.12	0.36	0.28	0.31
KwaZulu/Natal	0.16	0.13	0.35	0.83
Mpumalanga	0.19	0.19	0.56	0.91
Northern Cape	0.00	1.83	0.72	1.78
Northern Province	0.17	0.22	0.53	0.62
North West	0.08	0.25	0.24	0.94
Western Cape	1.59	1.10	0.77	1.75
South Africa	0.24	0.33	0.52	1.01

Source: SA Department of Health AFP reporting system.

AFP reporting was very low during 1995 and 1996 with only the Western Cape achieving a rate more than 1 per 100 000 for both years and the Northern Cape for 1996. Rates increased in 5 provinces in 1997 but no province achieved a rate of 1 per 100 000 children younger than 15 years of age. All provinces improved in 1998 with 4 provinces and the country as a whole achieving or exceeding the required rate. This coincided with the appointment of dedicated AFP officers.

Figure 6 shows the non-polio AFP reporting rates per 100 000 children < 15 years of age per province for 1998. It should be noted that four provinces achieved the specified rate, although the 95% confidence intervals of detection rates included or exceeded 1 in all but one province. The confidence intervals are wider for the areas with small populations.

Figure 6: Non-polio AFP rate per province, South Africa, 1998.



CHAPTER 6: Study setting

6.1 Mpumalanga Province

Mpumalanga Province is situated in the north east of South Africa, bordered by Mozambique and Swaziland to the east, the Northern Province to the north, Gauteng Province to the west and KwaZulu-Natal and the Free State Provinces to the south.

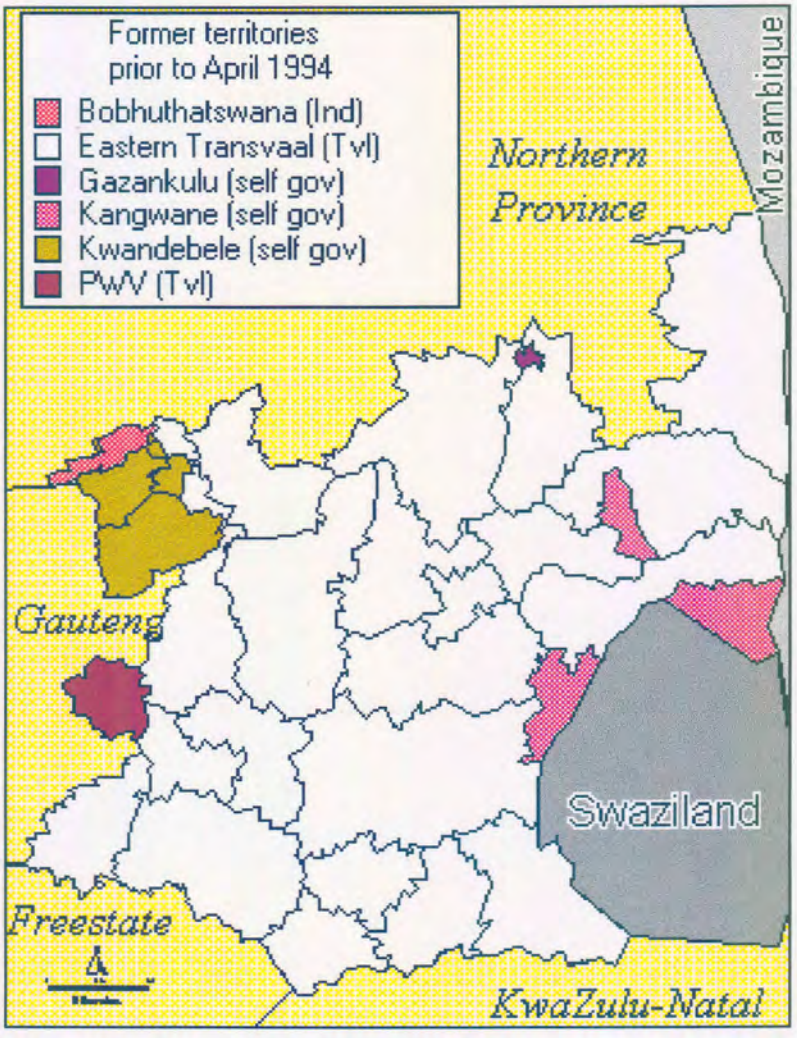
It has a population of 2,8 million and covers a surface area of 79 490 square kilometres.[73] This constitutes 7% of the population and 7% of the surface area of South Africa. Sixty one percent of the population lives in rural areas, 51% of the population is female and 89% are black. The Province has a relatively young population with 37% being under 15 years of age. The average population density is 35 people per square kilometre.

Five percent of the population aged 20 years or more, have tertiary qualifications, whilst 29% have had no formal education. A third of people aged 15-65 years are unemployed, while 36% of employed people earn R500 or less per month and only 8% earn more than R4 500 per month.[73] The average per capita annual income in 1994 was R2 164.[74]

The inhabitants of Mpumalanga are particularly vulnerable to the importation of diseases that are endemic in neighbouring countries, like Mozambique and Swaziland, as the Province provides large-scale informal employment opportunities, particularly in the agricultural sector. This is of particular importance in the context of polio eradication.

The Province was formed in 1994 from the eastern part of the Transvaal Province, two self-governing territories - KwaNdebele and Kangwane, part of a third self-governing territory, Gazankulu, and part of an independent homeland, Bophuthatswanna, with resulting heterogeneity in population density and health service provision. Figure 7 shows the administrative boundaries before the first democratic elections in 1994.

Figure 7: Areas that were amalgamated to form Mpumalanga Province.



The Province is divided into three health regions that are further subdivided into 16 districts. These administrative divisions are currently under revision. Figure 8 shows the current health districts with the distribution of public and private sector hospitals.

The vast majority of the population is served by the public health sector consisting of 300 fixed and mobile clinics, and 25 state hospitals. Private general practitioners and 5 private hospitals complement these services. There are 11 full-time and 19 part-time infection control nurses (ICNs) appointed in the 30 hospitals. The hospital distribution is reflected in Figure 8 and bed capacity is tabulated in Table 3.

Figure 8: Distribution of hospitals in Mpumalanga, South Africa, 1998

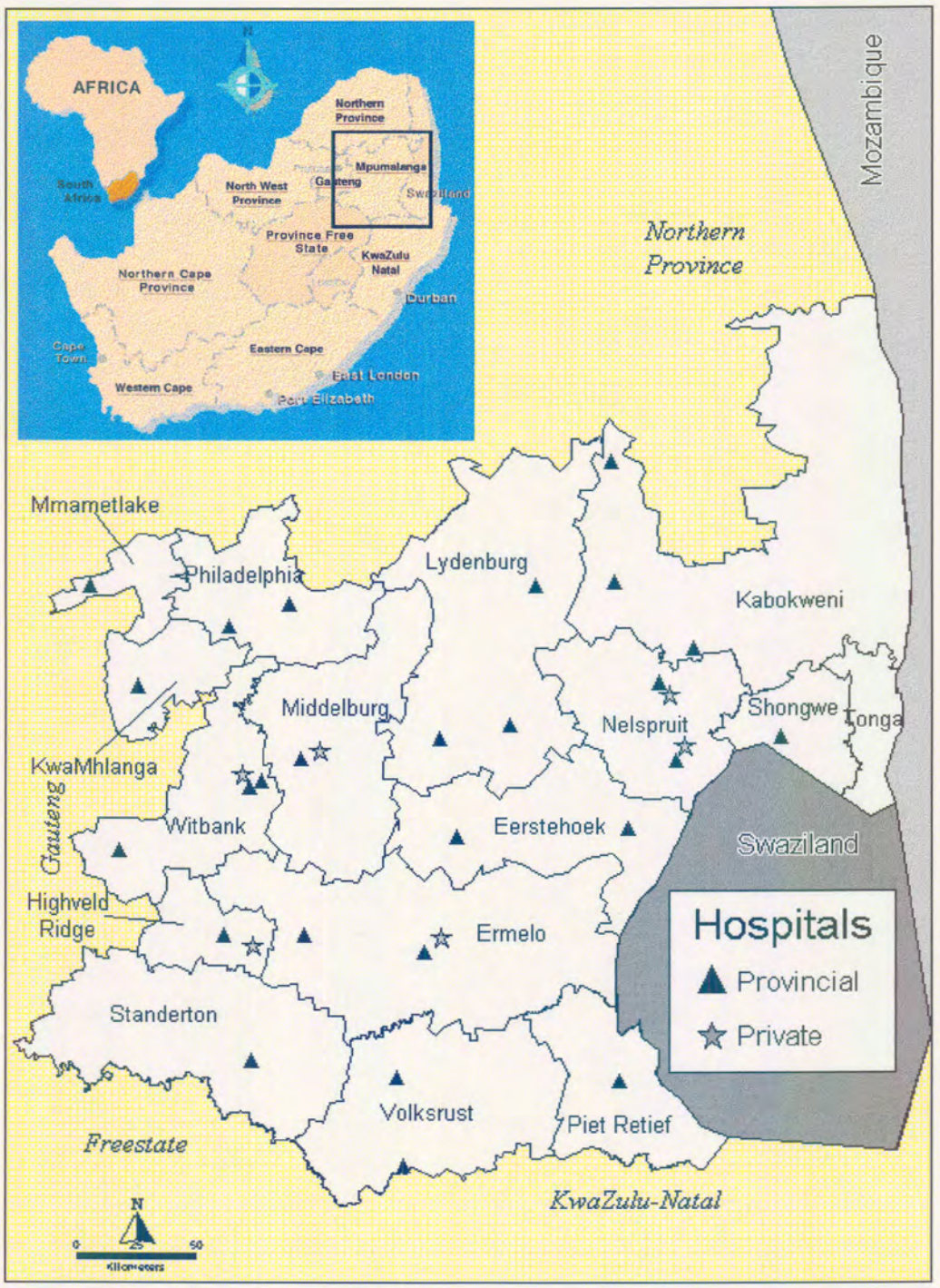


Table 3: Mpumalanga Hospitals, authorised beds and ICN status, 1998

District	Facility	Beds		ICN Status
		Auth[a]	Peads[b]	
	Eastern Highveld Region:			
Bethal	Bethal Hospital	180	29	Part time
Delmas	Bernice Samuel Hospital	29	3	Part time
Eerstehoek	Carolina Hospital	80	6	Part time
	Embhuleni Hospital	250	23	Part time
Ermelo	Ermelo Hospital	242	42	Full time
	Ermelo Private Hospital	40	4	Part time
Highveld Ridge	Evander Hospital	60	14	Part time
Piet Retief	Piet Retief Hospital	227	34	Part time
Standerton	Standerton Hospital	237	30	Part time
Volksrust	Amajuba Memorial Hospital	250	22	Part time
	Elsie Ballot Hospital	16	0[c]	Part time
	Highveld Region:			
Groblersdal	Groblersdal Hospital	23	3	Part time
KwaMhlanga	KwaMhlanga Hospital	21	0[c]	Part time
Lydenburg	H A Grove Hospital	16	2	Part time
	Lydenburg Hospital	112	15	Part time
	Waterval Boven Hospital	17	3	Part time
Middelburg	Middelburg Hospital	360	32	Full time
	Midmed Private Hospital	127	24	Part time
Mmamethlake	Mmamethlake Hospital	50	6	Part time
Philadelphia	Philadelphia Hospital	528	88	Full time
Witbank	Cosmos Private Hospital	176	30	Full time
	Witbank Hospital	361	21	Full time
	Lowveld Region:			
Barberton	Barberton Hospital	227	41	Full time
	Eureka Private Hospital	30	5	Part time
Kabokweni	Themba Hospital	580	124	Full time
Nelspruit	Nelspruit Private Hospital	167	29	Full time
	Rob Ferreira Hospital	301	36	Full time
Sabie	Sabie Hospital	99	10	Full time
	Matibidi Hospital	120	40	Full time
Shongwe	Shongwe Hospital	360	76	Part time

a. Authorised beds. The number of beds the facility was registered to accommodate, including paediatric beds.
b. Paediatric beds
c. No specific paediatric bed

Mpumalanga has 1.8 acute hospital beds per 1 000 population, with 2.2 in the Lowveld, 1.7 in the Eastern Highveld and 1.6 in the Highveld. This does not include mining hospitals. The South African national average is 4.0 per 1 000 population.[75]

It is provincial policy that a hospital should have one infection control nurse (ICN) for every 250 beds. The function of the ICN is to develop and implement an effective infection surveillance system, draft policies and regulations aimed at controlling nosocomial infections, and train health workers and students in the prevention and management of nosocomial infections. The surveillance and training aspects of her/his function makes the ICN an ideal candidate to conduct AFP surveillance within the hospital.

6.2 Mpumalanga AFP surveillance system

Mpumalanga included AFP surveillance in the routine disease notification system following gazetting of amended regulations in April 1994.[12] Routine passive reporting in Mpumalanga during 1995 and 1996 produced disappointing results with only one case in 1995 and three in 1996 of the predicted eleven per year. This picture was similar to the rest of South Africa where only 24% of estimated cases were found in 1995 and 33% in 1996 (Webb E. AFP cases expected and found, 1995 – 1998, EPI(SA), South African Department of Health, personal communication). An enhanced AFP surveillance system was initiated during February 1998 in Mpumalanga Province with the appointment of a Rotary International sponsored AFP Surveillance Officer. Her duties included establishing and maintaining a hospital network that provided weekly reports on AFP cases. The ICNs of the 25 provincial and 5 private hospitals were trained during January 1998 in preparation for the appointment of the AFP Surveillance Officer. They were trained to complete a simple weekly report (Appendix 1: Rapid reporting form) after scrutinising all admission diagnoses, and to fax it to the provincial AFP Surveillance Officer. The AFP Surveillance Officer would immediately be informed when a case of AFP, as defined by the WHO case definition (Appendix 2: WHO case definition) was detected. The ICN should complete a case investigation form (Appendix 3: AFP case investigation form) with the help of the attending medical officer. A stool specimen would then be sent immediately, and another within 24 –

48 hours, to the National Institute for Virology (NIV), the country's WHO accredited laboratory. If there were no cases in a specific week a zero report would still be submitted.

The AFP Surveillance Officer recorded receipt of the weekly reports on an Excel spreadsheet. Monthly reporting rates were calculated as the proportion of weeks in a month that each facility reported. Feedback was provided through monthly reports to all ICNs and the district Communicable Disease Control Co-ordinators (CDCCs), who are responsible for the management of public health programmes, including the Expanded Programme on Immunisation, in the community. The AFP Surveillance Officer, the provincial Communicable Disease Control (CDC) Surveillance Medical Officer and/or the Provincial Consultant in Communicable Disease Control held monthly training and support meetings with the ICNs, to discuss AFP reporting and provide provincial support for other infection control activities. Details of this system including additional functions of the ICNs in surveillance of communicable disease have been described elsewhere.[76]

CHAPTER 7: Methodology

After a complete literature review to establish the current global status of AFP surveillance and methods used to evaluate surveillance systems, discussions were held with regional, national and international experts to ascertain the feasibility and relevance of the study.

A study protocol was prepared and approval obtained from the Mpumalanga Department of Health Ethics Committee and the Ethics Committee, Faculty of Medicine, University of Pretoria and Pretoria Academic Hospitals. Both committees approved the survey protocol (Appendix 7: Provincial ethical approval and Appendix 8: Approval Ethics Committee, Faculty of Medicine, University of Pretoria and Pretoria Academic Hospitals). Confidentiality of patient records was strictly observed and anonymity of patients ensured in all reports.

7.1 Reporting system evaluation

A desktop evaluation of the AFP reporting system was conducted using the ICCPE indicators to assess the completeness of reporting. The weekly reports from all reporting units were analysed to evaluate completeness of reporting. Reported cases detected through this system were used to calculate the annual rate of AFP cases per 100 000 children under 15 years of age in Mpumalanga.

7.2 Hospital record review

All 25 provincial and 5 private hospitals were included in the study. The hospital admission/discharge registers from 1 January 1997 to 31 August 1998 of all wards where children younger than 15 years of age were admitted were scrutinised for possible AFP cases. The patient records of possible cases identified were carefully studied, using standardised lists of keywords (Appendix 4: Key words) and diagnoses (Appendix 5:), to determine conformity with the definition of an AFP case (Appendix 2: WHO case definition) from the history and clinical findings on admission.

All hospitals in Mpumalanga Province were visited during September and October 1998 by a team consisting of the nurses responsible for infectious disease control and surveillance in the hospital and health district in which

the hospital was located. The ICN of the specific hospital, the CDCC for the health district and the provincial CDC Surveillance Medical Officer were members of the team.

The CDCCs were trained in the review procedures at a routine monthly CDC meeting. The ICNs received training in the use of the standardised lists of keywords and diagnoses from the provincial CDC Surveillance Medical Officer at the start of the hospital visit. The provincial CDC Surveillance Medical Officer was present at each hospital visit.

Members of the National Expanded Programme on Immunisation (EPI/SA) and the Mpumalanga CDC Programme randomly joined the team during hospital visits as a quality assurance measure. The observers visited at least one hospital per Region to ensure a standard approach and careful adherence to the study protocol throughout the Province.

The district manager and hospital superintendent were contacted prior to the visit to explain the purpose and procedure; to obtain permission to screen patient records; to establish which wards admitted children younger than 15 years of age and the whereabouts of clinical notes, patient files and daily patients records.

During the visit the team met the superintendent and senior matron of the hospital and explained the reason for the record review. A copy of the protocol was provided to hospital management. The team also attempted to speak to the paediatrician or medical officer responsible for paediatric cases to explain the purpose of the case search.

The team then visited the paediatric ward(s), special neurological paediatric wards, the physiotherapy section and any other wards where eligible children are admitted. The team explained the reason for the study to the sister-in-charge, and requested permission to screen the ward(s) admission registers.

Both admission and discharge diagnoses were screened for key words. This was done in the ward(s) using the admission/discharge registers. None of the hospitals had a computer system with file details that could be queried by searching for keywords or the age of patients. Patient records

were selected according to the following criteria based on the surveillance definition of an AFP case:

- Under 15 years of age
- Key words (Appendix 4: Key words)
- Admission diagnosis, discharge diagnosis, ICD9/10 codes (Appendix 5:)

When a case fulfilling the search criteria was identified, all relevant details were recorded on a line-list form (Appendix 6: Line listing form), to facilitate retrieval of the patient file from the medical records unit.

The patient's medical file was then screened for the following details:

- History of current episode,
- clinical signs and symptoms on admission,
- specific dates e.g. date of onset of paralysis or symptoms, dates that samples were taken (e.g. CSF and stools)
- nerve conduction studies, where performed.

A case investigation form (Appendix 3: AFP case investigation form) was completed for cases conforming to the AFP case definition.

No stool specimens were taken as all cases found occurred more than a month prior to the review visit. Follow up was performed by the District CDCC who visited the child at home, where feasible, to assess residual paralysis. This served as a proxy for the prescribed 60-day follow-up examination.

Hospital visits were concluded with a report back session to the Medical Superintendent and Senior Matron. There were no refusals and excellent co-operation was experienced during each visit.

A report was formulated and circulated to the hospitals, ICNs, District CDCCs and EPI(SA) at the National Department of Health.

CHAPTER 8: Results

8.1 Desktop analysis of reporting system (01/02/98 – 31/08/98)

One of the indicators of the quality of a surveillance system is the completeness of weekly reporting by facilities where AFP cases might be admitted for diagnosis and treatment. The target is that 80% of reporting facilities must report weekly.

Table 4 shows the percentage of weekly reports received per facility from 1 February to 31 August 1998 in Mpumalanga Province. Only 76% of facilities provided reports during February and March, 93% of facilities reported for April to June while 88% reported for July to August. The proportion of facilities with more than 80% reporting was 83% and 87% for April - June and July – August respectively compared to 60% for February - March. The median percentage reporting for all units was 100% during all three time-periods.

Table 5 provides some details of cases reported by the AFP surveillance system from 1 January 1997 to 31 August 1998. Sixteen cases were reported during the study period with seven in 1997 and nine in 1998. Six cases were denotified: four were over 15 years of age (MP-97-004, MP-97-006, MP-98A001 and MP-98A002) and two did not have acute flaccid paralysis (MP-97-003 and MP-98-001). These cases are excluded from further analysis because they do not meet the AFP case definition.

Of the 10 remaining cases, seven were male and five were under 5 years of age. The admission diagnosis for five cases was Guillain Barré Syndrome (GBS).

One case was classified as compatible with polio due to death within 60 days of paralysis onset. Nine cases were discarded as not being polio.

Table 4: Percentage of weekly reports received per facility, Mpumalanga AFP reporting system, 1 February to 31 August 1998.

	% reporting		
Hospital	Feb-Mar	Apr-Jun	Jul-Aug
Amajuba Memorial	100	100	100
Barberton	100	100	100
Bernice Samuel	71	92	86
Bethal	86	100	100
Carolina	100	100	100
Cosmos Private	14	100	100
Elsie Ballot	100	100	100
Embhuleni	100	100	14[a]
Ermelo	71	100	86
Ermelo Private	71	100	100
Eureka Private	86	100	100
Evander	57	100	57
Groblersdal	29	100	86
H A Grove	57	100	100
KwaMhlanga	14	77	43[b]
Lydenburg	100	92	86
Matibidi	71	46	100
Middelburg	86	77	100
Midmed Private	43	100	100
Mmamethlake	100	100	86
Nelspruit Private	100	100	100
Philadelphia	86	100	86
Piet Retief	86	100	71
Rob Ferreira	86	100	100
Sabie	100	69	86
Shongwe	86	85	86
Standerton	100	100	100
Themba	86	92	100
Waterval Boven	14	69	0[c]
Witbank	86	100	100
Total	76	93	86
% facilities > 80% reporting	60	83	87

a. Designated ICN on night duty with no access to fax machine.

b. Human resources limited with difficulties in designating an ICN

c. Very small hospital where the matron resigned followed by the delayed appointment of a new matron.

Table 5: Cases reported by the AFP surveillance system, 1 January 1997 to 31 August 1998

No	Region	District	Age Yrs.	Sex	Date of onset	Admission diagnosis	Final diagnosis	Classification by PEC	Reason
MP-97-001	Highveld	Philadelphia	0	M	21/02/97	Guillain Barré Syndrome		Compatible	Death within 60 days
MP-97-002	Eastern Highveld	Standerton	8	M	29/04/97	Guillain Barré Syndrome	Guillain Barré Syndrome	Discarded	Residual paralysis clinically not compatible polio
MP-97-003	Eastern Highveld	Eerstehoek	1	F	20/05/97			Denotified	No paralysis
MP-97-004	Eastern Highveld	Standerton	27	F	18/09/97	Flaccid Paralysis		Denotified	More than 15 years of age
MP-97-005	Eastern Highveld	Eerstehoek	9	M	02/10/97	Guillain Barré Syndrome	Guillain Barré Syndrome	Discarded	No residual paralysis, no wild-type polio in stool
MP-97-006	Eastern Highveld	Highveld Ridge	50	M	26/12/97	Guillain Barré Syndrome	Guillain Barré Syndrome	Denotified	More than 15 years of age
MP-97-007	Eastern Highveld	Eerstehoek	3	M	20/08/97	? polio	Pulmonary TB, TB of left hip, malnutrition	Discarded	Non-polio virus isolated
MP-98-001	Eastern Highveld	Ermelo	3	F	01/03/98	? Septicaemia	Leuco-encepholopathy HIV	Denotified	Not AFP
MP-98-002	Lowveld	Nelspruit	13	F	20/01/98	Spinal injury		Discarded	No residual paralysis, no wild-type polio in stool
MP-98-003	Highveld	Philadelphia	1	F	08/05/98	Guillain Barré Syndrome	Guillain Barré Syndrome	Discarded	No residual paralysis, no wild-type polio in stool
MP-98-004	Highveld	Lydenburg	5	F	10/03/98	Flaccid paralysis of lower limbs and hands	Cerebellar tumour, hydrocephalus	Discarded	No residual paralysis, no wild-type polio in stool
MP-98-005	Eastern Highveld	Standerton	2	M	27/07/98	Fever and convulsions with weakness	Convulsions and fever	Discarded	Non-polio enterovirus isolated
MP-98-006	Highveld	KwaMhlanga	11	M	14/08/98	?post traumatic, ? post viral paralysis	Transverse myelitis, Died (30/08/98)	Discarded	Not compatible polio
MP-98-007	Eastern Highveld	Standerton	8	M	21/08/98	Guillain Barré Syndrome	Guillain Barré Syndrome	Discarded	No residual paralysis
MP-98A001*	Highveld	Middelburg	18	F	10/01/98	Guillain Barré Syndrome	Guillain Barré Syndrome	Denotified	More than 15 years of age
MP-98A002*	Eastern Highveld	Highveld Ridge	35	M	10/02/98	Guillain Barré Syndrome	Guillain Barré Syndrome	Denotified	More than 15 years of age

* A refers to adult (15 years or older). New numbering system in 1998

A second indicator of the quality of AFP surveillance is whether the system is sensitive enough to detect 1 case per 100 000 children under 15 years of age. Table 6 shows the number of expected cases per region based on this reference rate. The number of cases reported through the AFP surveillance system is also shown with the rate per 100 000. The confidence intervals calculated binomial exact and are graphically displayed in Figure 9 and Figure 10.

Table 6: Number of expected and reported cases per region with rates per 100 000 children < 15 years of age per annum, Mpumalanga, 1997 and 1998.

	1997				95% CI	
Region	<15 population	Expected	Detected	Detection rate/ 100 000	lower limit	Upper limit
Eastern Highveld	338 292	3.4	3	0.887	0.183	2.590
Highveld	403 421	4.0	1	0.248	0.006	1.380
Lowveld	336 326	3.4	0	0	0	1.100
Total	1 078 038	10.8	4	0.371	0.101	0.949

	1998				95% CI	
Region	<15	Expected	Detected to 31/08/98	Detection rate/ 100 000	Lower limit	Upper limit
Eastern Highveld	345 573	3.5	2	0.579	0.070	2.090
Highveld	435 600	4.4	3	0.689	0.142	2.010
Lowveld	320 497	3.2	1	0.312	0.008	1.740
Total	1 101 670	11.0	6	0.545	0.222	1.190

Figure 9: Non-polio AFP rate per region, Mpumalanga, 1997

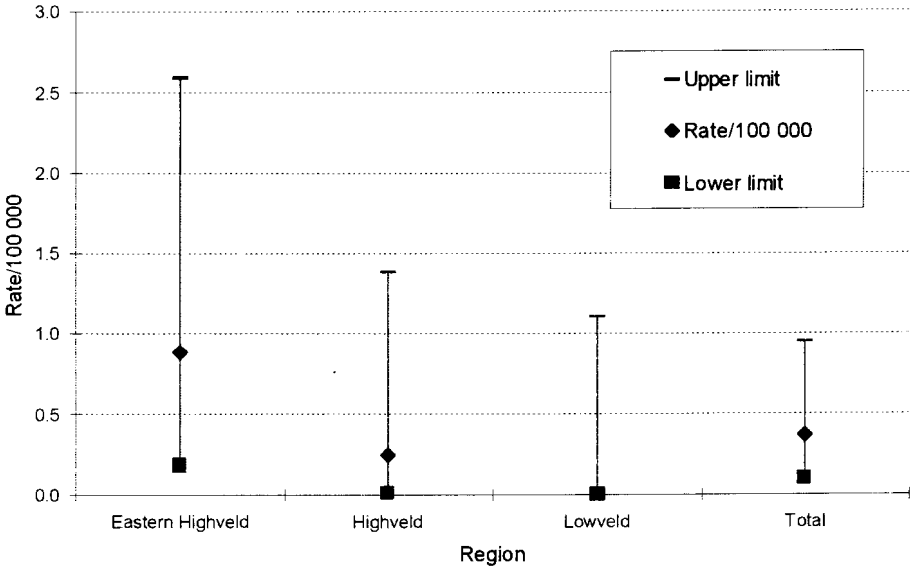
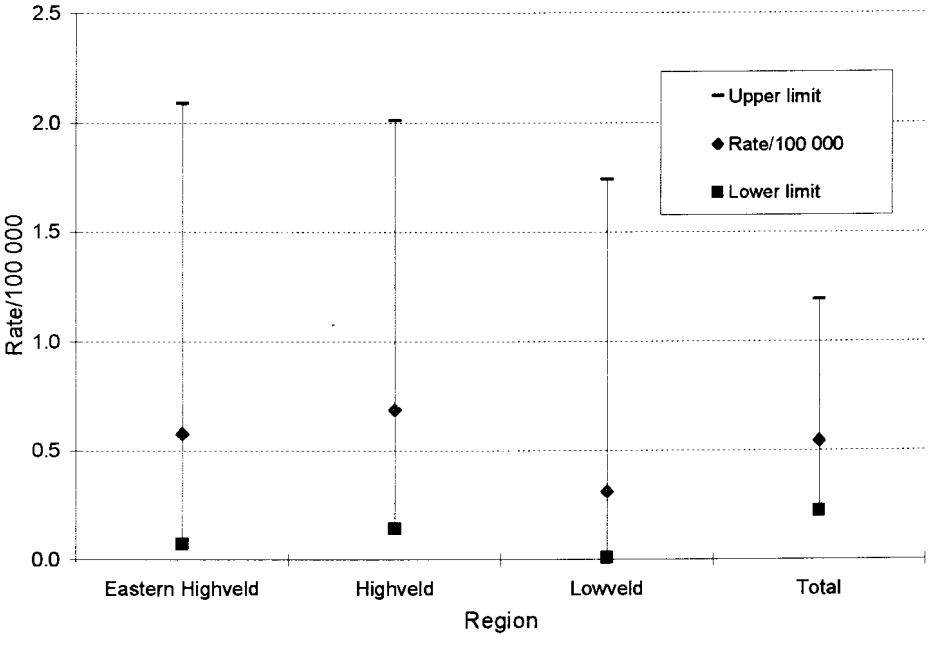


Figure 10: Non-polio AFP rate per region, Mpumalanga, 01/01/98 - 31/08/98.



The provincial rate increased from 0.37 in 1997 to 0.55 by 31 August 1998. The Eastern Highveld had a rate of 0.89 for 1997, while the Lowveld had very low rates of 0.0 in 1997 and 0.31 in 1998. The 95% confidence intervals of the regional rates for both years and for the Province for 1998 include 1 per 100 000 children younger than 15 years of age.

The population figures were extrapolated from the 1991 census by the then Directorate of Epidemiology of the National Department of Health. The availability of the 1991 census results allowed for adjustment of previous projections and the construction of new ones. The projections up to and including the year 2000 were accepted as the official Department of Health estimates.[77] These data are used in this report pending the National Department of Health acquiring the 1996 census data set (EM Webb, Assistant Director, EPI(SA), personal communication). As seen in the table, no region achieved the expected rate for either 1997 or 1998, although this rate fell within the 95% confidence limits of the rate detected.

A third indicator of the quality of the surveillance system is the collection of adequate stool specimens. Adequate is defined as two stool specimens from each case 24 to 48 hours apart within 14 days of onset of paralysis. The target is 80% of cases. It is of concern that adequate stools were only collected from 1 case during the study period. Table 7 shows the number of reported cases under the age of 15 years with at least one stool specimen collected.

Table 7: Number of reported cases < 15 years of age with at least one stool specimen collected, Mpumalanga, 01/01/97 – 31/08/98

		Days after onset of paralysis			
Year	Total cases	< 15 days	< 30 days	> 30 days	% < 30 days
1997	4	2[a]	1	1	75
1998	6	3	1	0	67[b]

a. One case had 2 stool specimens collected 24 to 48 hours apart within 14 days of onset of paralysis.

b. Two cases had no stool specimens collected.

Two cases had no stool specimens collected. One case was detected and treated in a Gauteng hospital while the other was a child with hydrocephalus due to a cerebellar tumour retrospectively identified as AFP. Five of the remaining 8 cases had at least one specimen collected within 14 days of onset of paralysis and a total of 7 cases within 30 days of onset of paralysis.

Table 8 shows the time elapsed between the onset of paralysis and

admission to a health facility, reporting to the province and collection of stools. The time lapse between onset of paralysis and admission was 4 days or more in all but 3 cases. One of these cases developed paralysis while in hospital (MP-97-001) and two cases (MP-98-006 and MP-98-007) were admitted to hospitals outside the province the day after the onset of paralysis.

One case was admitted 10 months after gradual onset of weakness (MP-97-007) and two stool specimens were collected within 24 to 48 hours of admission. MP-98-004 was admitted 3 weeks after onset of paralysis and was only reported after a district review of admissions. This case was initially not reported due to gradual onset of symptoms

Table 8: Time elapsed from onset of paralysis to admission, reporting and stool collection, AFP cases, Mpumalanga, 1997 – 31/08/98.

	Days elapsed from onset of paralysis to:			
Number	Admission	Report to province	Collection of 1st stool	Collection of 2nd stool
Reported before AFP Officer appointed				
MP-97-001	-9[a]	32	3	ND[b]
MP-97-002	9	10	11	12
MP-97-005	9	20	20	ND[b]
MP-98-002	4	5	10	14
Reported to AFP Officer				
MP-97-007	292	292	293	294
MP-98-003	4	5	9	80
MP-98-004	21	119	ND[b]	ND[b]
MP-98-005	11	25	17	24
MP-98-006	1	6	ND[b]	ND[b]
MP-98-007	1	17	4	ND[b]

a. Developed paralysis after admission
b. Not Done

8.2 Hospital record review

Table 9 shows the AFP cases younger than 15 years of age reported from January 1997 – August 1998 indicating whether the record review detected these cases and the reason why they were or were not detected.

Table 9: AFP cases < 15 years of age, reported from 1 January 1997 – 31 August 1998, Mpumalanga

Epid number	District (Region)	Date of onset	Admission Diagnoses	Final diagnosis	Found during review	Reason found or not found
MP-97-001	Philadelphia (Highveld)	21/02/97	Gastro-enteritis with 5-10% dehydration	Guillain Barré Syndrome	No	No key words in admission diagnosis
MP-97-002	Standerton (Eastern Highveld)	29/04/97	Guillain Barré Syndrome	Guillain Barré Syndrome	No	Admitted in Gauteng Province Hospital
MP-97-005	Eerstehoek (Eastern Highveld)	02/10/97	Guillain Barré Syndrome	Guillain Barré Syndrome	Yes	Key words in admission diagnosis
MP-97-007	Eerstehoek (Eastern Highveld)	20/08/97	? polio	PTB, TB of left hip, malnutrition	Yes	Gradual onset of diminished movement of leg on admission
MP-98-002	Nelspruit (Lowveld)	20/01/98	Spinal injury	N/a	No	No key words in admission diagnosis
MP-98-003	Philadelphia (Highveld)	08/05/98	Guillain Barré Syndrome	Guillain Barré Syndrome, No wild type polio	Yes	Key words in admission diagnosis
MP-98-004	Lydenburg (Highveld)	10/03/98	Flaccid paralysis of lower limbs and hands	Cerebellar Tumour with hydrocephalus	Yes	Key words in admission diagnosis
MP-98-005	Standerton (Eastern Highveld)	27/07/98	Fever and convulsions with weakness	Convulsions and fever	Yes	Key words in admission diagnosis
MP-98-006	KwaMhlanga (Highveld)	14/08/98	?Post traumatic, ?post viral paralysis	Transverse myelitis, Died (30/08/98)	No	Admitted in Gauteng Province Hospital
MP-98-007	Standerton (Eastern Highveld)	21/08/98	Guillain Barré Syndrome	Guillain Barré Syndrome	No	Admitted in Gauteng Province Hospital

Ten cases were reported in this time period of which 3 cases were admitted in hospitals outside the province. Five of the seven cases that were reported through the Mpumalanga reporting system were detected during the review. The two cases that were missed did not fulfil the AFP case definition on admission and would therefore not be detected during the review. Table 10 summarises the cases under 15 years of age

reported by the routine AFP reporting system from 1 January 1997 to 31 August 1998.

Table 10: Summary of cases reported 1997 - August 1998

Number of cases reported	10	Cases admitted to Gauteng hospitals	3		
		Cases admitted to Mpumalanga hospitals	7	Cases detected during review	5
				Cases not detected during review	2
				Cases not fulfilling AFP case definition on admission	2
				Cases missed	0

Table 11 shows the cases identified during the review using the key words and list of diagnoses. The second last column indicates whether the case fulfilled the AFP case definition when the admission clinical notes were reviewed. This provides a measure of how many true cases of AFP the review identified and helps set criteria for applying record review findings. The last column shows whether the case was reported by the routine system.

Table 11: Cases detected during the review conforming to search criteria based only on key words

Hospital	Hospital number	Age	Sex	Date of admission	Admission diagnosis	AFP[a]	On system[b]
Embhuleni	10998/97	9	M	10/11/97	Guillain Barré Syndrome	Yes	yes
Witbank	1995/98	5	F	31/03/98	Guillain Barré Syndrome	Yes	yes
Philadelphia	215493	2	F	12/05/98	?Guillain Barré Syndrome	Yes	yes
Themba	98/202020	8	F	31/07/98	AFP/GBS	Yes	yes[c]
Standerton	55951	2	M	10/09/98	?Epilepsy	Yes	yes
Themba	97/712	14	M	07/01/97	Guillain Barré Syndrome	Yes	no
Themba	97/1181	12	F	10/01/97	Right hemiplegia	Yes	no
Nelspruit Private	97094075	12	M	17/03/97	Guillain Barré Syndrome	Yes	no
Shongwe	97/3608	0	M	17/06/97	Paralysis of right arm	Yes	no
Rob Ferreira	91096	1	M	27/05/98	Left hemiplegia	Yes	no
Shongwe	98/18818	3	F	12/09/98	?Lower motor neurone disease, ?Perthes disease	Yes	no
Witbank	20/97	1	M	23/04/97	Hypotonia	No	n/a
Themba	97/4314	0	F	08/05/97	Vomiting after polio vaccine	No	n/a
Amajuba	2997	1	U	22/06/97	AFP (acute abdomen)	No	n/a
Shongwe	93/15786	3	M	23/07/97	Lethargic	No	n/a
Themba	93/35260	11	M	31/07/97	? Muscular dystrophy	No	n/a
Themba	95/9397	4	M	05/08/97	? Muscular dystrophy	No	n/a
Themba	97/26416	14	F	05/09/97	Left leg weakness	No	n/a
Piet Retief	13525	6	M	18/09/97	?Polio (leg injury)	No	n/a
Shongwe	97/17803	1	F	18/09/97	Unable to stand	No	n/a
Shongwe	97/17131	9	M	17/10/97	Weakness of body	No	n/a
Amajuba	5054	10	U	21/10/97	Polio (infection in knees)	No	n/a
Shongwe	97/993	0	F	24/10/97	Unable to crawl	No	n/a
Shongwe	96/18312	1	U	03/11/97	Unable to stand	No	n/a
Philadelphia	189790	3	F	18/11/97	?Potts Disease	No	n/a
Shongwe	97/21969	0	U	24/11/97	Unable to sit	No	n/a
Piet Retief	13425	4	M	26/01/98	Poliomyelitis (not acute)	No	n/a
Witbank	22573/97	5	F	02/02/98	Body weakness	No	n/a
Rob Ferreira	40696	0	F	20/02/98	Right hemiplegia	No	n/a
Shongwe	98/4463	1	F	04/03/98	Unable to sit	No	n/a
Shongwe	98/326	1	U	04/04/98	Unable to stand	No	n/a
Shongwe	88/1636	0	F	06/04/98	Weak spine	No	n/a
Piet Retief	23342	7	F	23/04/98	?Polio (mental retardation)	No	n/a
Witbank	2642/98	1	M	03/05/98	Leg weakness	No	n/a
Piet Retief	12888	9	F	06/05/98	Paraplegia	No	n/a
Rob Ferreira	10281/98	11	F	24/05/98	Investigation right hip	No	n/a
Ermelo	53234	2	M	10/07/98	Right hemiparesis and gastro-enteritis	No	n/a
Shongwe	98/19182	13	F	14/09/98	Painful right hand	No	n/a
Philadelphia	247975	4	F	25/09/98	Hypertonia	No	n/a
Philadelphia	249183	11	F	08/11/98	Sudden collapse; ?epilepsy	No	n/a
Barberton	64384	3	F	N/a	Neurological appointment	No	n/a

a. Conforms to the AFP case definition.

b. Reported by the routine AFP reporting system.

c. Reported by Mpumalanga reporting system but classified as a Northern Province case by place of residence.

Forty-one cases were identified at 12 hospitals using the keywords and the list of diagnoses. No cases were detected at the remaining 18 hospitals. Thirty (73%) of these cases did not conform to the case definition of AFP when the admission clinical notes were reviewed. These included four cases with "polio" and one with "AFP" as admission diagnosis.

Eleven cases met the AFP case definition on perusal of admission clinical notes. Guillain Barré Syndrome was the keyword in four of the five cases that had been detected by the routine reporting system and in 2 of the cases that were missed. Paralysis (1 case) and hemiplegia (2 cases) were the key words in the other cases. Two cases did not have keywords in the admission diagnosis.

Five of the eleven cases that met the AFP case definition had also been detected by the routine reporting system. One of these cases resided in the Northern Province and was transferred to their AFP Officer for follow up.

Table 12 lists the cases that conformed to the AFP case definition on review of the admission clinical notes. The Northern Province case is not listed. The Mpumalanga review team detected ten cases. The eleventh case had the keyword "hemiparesis" in the admission diagnosis but spastic paralysis was present on admission. This obviously should not be considered as a case of flaccid paralysis but was reported by the Gauteng EPI team when the patient was referred to a Gauteng hospital. This case was denotified by the PEC.

Four of the six cases that were not reported by the routine AFP reporting system occurred in 1997 and two in 1998. Guillain Barré Syndrome was the admission diagnosis in two of the 1997 cases, AFP-MP-97-008 and AFP-MP-97-009. AFP-MP-97-010 and AFP-MP-97-011 were included as AFP cases by the review team because the clinical notes did not clearly state that acute flaccid paralysis was not present although it can be deduced from these notes that there probably was not flaccid paralysis. The first case had clinical signs of intracranial pathology and in the second

the immobility was caused by pain due to a fracture. These cases were denotified by the PEC.

The first of the two 1998 cases developed paralysis following an epileptic seizure and the second had a history of acute flaccid weakness of the right leg.

Table 12: Cases identified during the review that conformed to AFP case definition.

Epid	On system	Hospital	Number	Age	Sex	Date of admission	Notes	Admission diagnosis	Discharge diagnosis	Method of detection	Classification	Reason
AFP-MP-97-005	Yes	Embhuleni	10998/97	9	M	10/11/97	N/a	Guillain Barré Syndrome	Guillain Barré Syndrome	MO	Discarded	No residual paralysis, no wild-type polio in stool
AFP-MP-98-003	Yes	Philadelphia	215493	2	F	12/05/98	N/a	?Guillain Barré Syndrome	Refused hospital treatment	CDC	Discarded	No residual paralysis, no wild-type polio in stool
AFP-MP-98-004	Yes	Witbank	1995/98	5	F	31/03/98	N/a	Guillain Barré Syndrome	Cerebellar tumour with hydrocephalus	CDC	Discarded	No residual paralysis, no wild-type polio in stool
AFP-MP-98-005	Yes	Standerton	55951	2	M	10/08/98	Stool specimen 14/08/98. No residual paralysis	?Epilepsy	Coxaci B virus infection	CDC	Discarded	Non-Polio enterovirus isolated
AFP-MP-97-008	No	Nelspruit Private	97094075	12	M	17/03/97	N/a	Guillain Barré Syndrome	Guillain Barré Syndrome	Hospital Record review	Discarded	No residual paralysis
AFP-MP-97-009	No	Themba	97/712	14	M	07/01/97	Was recovering when discharged 21/01/97	Guillain Barré Syndrome	Guillain Barré Syndrome	Hospital Record review	Compatible	Lost to follow up at 60 days
AFP-MP-97-010	No	Themba	97/1181	12	F	10/01/97	11/01/97 – Right hemiplegia, left pupil fixed, dilated, neck stiffness	Right hemiplegia	Died at Garankua Hospital of haemorrhage from brain tumour	Hospital Record review	Denotified	Not AFP

AFP-MP-97-011	No	Shongwe	97/3608	0	M	17/06/97	2 week old baby suddenly doesn't move right arm anymore	Paralysis of right arm	Pathological fracture due to congenital syphilis	Hospital Record review	Denotified	Humerus fracture due to syphilitic osteitis
AFP-MP-98-008	No	Rob Ferreira	091096	1	M	27/05/98	Fitted 2 weeks ago. Strength 2/5 left arm, 4/5 left leg. Follow up at physiotherapy.	Left hemiplegia	unknown	Hospital Record review	Discarded	Residual paralysis not clinically or virologically compatible with polio
AFP-MP-98-009	No	Shongwe	98/18818	3	F	12/09/98	Transferred to Garankua. Acute onset of flaccid paralysis in right leg	? Lower motor neurone disease, ? Perthes disease	Soft tissue injury (telephonic enquiry to Garankua Hosp)	Hospital Record review	Compatible	Lost to follow-up at 60 day
AFP-MP-98-010	N/a	Ermelo	53234	2	M	10/07/98	Right arm spastic with 4/5 strength on admission	Right hemiparesis and gastro-enteritis	Thrombosis of middle cerebral artery secondary to dehydration.	Hospital Record review	Denotified	Not AFP

CHAPTER 9: Discussion

Value and sustainability of the reporting system

The record review revealed that the AFP surveillance system in Mpumalanga is functioning well with only 2 cases missed in the first 7 months following implementation in February 1998. The weekly reporting rates improved substantially during the initial months and have been sustained above 80% since April 1998 and remained 100% since May 1999 allaying fears that under-reporting is the cause of the low AFP rate in Mpumalanga. The reasons for initial low reporting rates at certain facilities were that the infection control nurse was doing night duty or was on leave. Fax machines are usually located in administration offices with no access at night. There is often no replacement designated to take over infection control duties if the ICN is not on duty. In many hospitals the ICN also has other duties with a higher priority to hospital management.

The system has further proved its value in the rapid detection and thus effective control of the other conditions included in the reporting form. Cholera and meningococcal meningitis are good examples.

A major cholera outbreak was averted with the detection of an index case in February 1999. Prompt detection allowed urgent deployment of control measures, with only 19 additional cases. During the first two years of the system being in place, an additional five cholera cases, of which four had exposure to infection in Mozambique, were detected by three public and one private hospital in Mpumalanga. Rapid notification by ICNs in three cases, and by a specialist physician and the laboratory in the remaining cases, allowed for appropriate institutional and community measures and no secondary cases.

Fourteen cases of meningococcal disease were proven in Mpumalanga Province during the first two years after introduction of the system. All but one were notified to the Provincial CDC Unit within 48 hours. On inquiry adequate control measures had been implemented in 6 of the 8 cases detected during 1998, and in all 6 cases diagnosed during 1999.

The performance of the ICN surveillance system in containing outbreaks

endorses it value, particularly if the recent history of cholera outbreaks in this area is considered. Introduction of cholera in 1980 and 1982, for example, resulted in an estimated 30 000 and 20 000 cases, respectively, and 3 786 and 7 638 cases were laboratory-confirmed, respectively.[78] The absence of any proven secondary meningococcal cases since introduction of the ICN surveillance system is also gratifying.

It is important that the surveillance system is sustainable. Monthly meetings of the ICN surveillance team for structured training (university accreditation is currently being sought), networking and feedback were introduced as important mechanisms for ensuring sustainability. This also addresses the finding of a critical appraisal of the notification system that health workers' motivation to report notifiable conditions was detrimentally affected by lack of feedback on action taken.[79]

The expansion of the ICNs' role in surveillance has not been difficult to achieve. Surveillance of nosocomial infections and close liaison with the laboratory usually based in the same geographic location, is an integral component of routine ICN functioning. Most of the conditions chosen for surveillance require specific infection control measures and so ICNs will of necessity be consulted and promptly learn of suspected patients. The calm and determined approach that characterises many ICNs makes them ideal candidates for the outbreak surveillance function.

Zero reporting is a key element of this surveillance system for demonstrating that the system is active. The high levels of reporting over an extended period are heartening, providing a further indication of the sustainability of the system.

Our approach shares some features with that recently described from North Arcot district in Tamil Nadu, India.[80] Their system combined government and private sectors with every hospital enrolled, sentinel laboratory surveillance, simple posted notification forms, defined responses and regular feedback. Features shared by the two systems include a limited list of priority conditions, syndromic case-definitions, an action-orientated focus and a system for providing regular feedback to the generators of the surveillance data.

The non-specificity of clinical syndromes characterising certain important infectious diseases makes it imperative to include laboratory reporting as a key element of a functional surveillance system.[81] Although this is not unusual in many other countries it is a new concept in South Africa. Reporting by local public and private laboratories of designated pathogens to the provincial Communicable Disease Control Unit in Mpumalanga commenced in January 1998 and the co-operation of the laboratories has been excellent.

The hospital-centred, syndromic approach focusing on a limited number of important conditions has a number of weaknesses. The syndromes have high sensitivity and relatively low specificity with attendant resource commitment to establish a definitive diagnosis. This must be balanced against the public health importance of the chosen conditions, and justifies the approach. The focus on the hospital results in a "tip of the iceberg" phenomenon for measles, one of the conditions selected for surveillance since very few measles cases require hospital consultation or admission. However, for the majority of remaining conditions, especially AFP, the severity or dramatic nature of the condition will lead to hospitalisation.

The decision to involve all hospitals in AFP surveillance is supported by the findings of a hospital record review conducted in Shadong Province, China, during 1991.[82] This review concluded that improvement of surveillance requires the co-operation of the hospital sector for this is where most patients initially attend. Active searching in hospitals and close relations between hospitals and epidemic prevention units were found to be essential to detect and investigate cases of AFP.

Although the serious state of dysfunction of many public health surveillance systems has been attributed to dwindling health resources, it may also, at least in part, be blamed on the inflexibility of health systems, particularly those with a legislative basis, or the maintenance of surveillance systems that are not action-orientated.[83,84]

The role of chance

The most commonly used indicator of the completeness of AFP surveillance is that the surveillance system should be sensitive enough to

detect at least one case of acute flaccid paralysis for every 100 000 children under 15 years of age annually. This indicator was used in the Americas and subsequently generalised globally. It is remarkable that the validity of this extrapolation has not been questioned in published literature. The possible heterogeneity of AFP incidence due to differences in underlying aetiology of non-polio AFP and the role of chance variation, particularly in small geographical areas, have not been assessed. It cannot be assumed that the GBS rate of North or South America can be applied blindly to the rest of the world i.e. areas with Japanese encephalitis or a greater burden of enterovirus infection, or lower population densities with a very different pattern of communicable diseases.

The low international reference rate and play of chance variation particularly in areas with relatively small populations are important considerations that have not enjoyed much attention as the goal of global polio eradication is approached. It is possible that certain regions with relatively small populations where no cases of polio have been detected and low non-polio AFP rates are found might well have adequate surveillance systems allowing polio free certification. Hospital record reviews performed in Australia found that the non-polio AFP rate in the sparsely populated Northern Territory was also below the WHO standard as was found in Mpumalanga for the past 3 years (Dr Angela Merianos, Director of surveillance and management, Federal Government, Australia, personal communication).

When 95% confidence intervals are applied to the achieved rates, 1 per 100 000 children younger than 15 years of age is included in these intervals for rates ranging from 0 to 2.64. It is therefore imperative that population size be taken into account when judging the rate of AFP case detection.

AFP definition and key words

If on the other hand, the international AFP rate is a true reflection of non-polio AFP incidence, the case definition might not be sensitive enough to detect cases and may need to be reviewed. Other possible explanations for the low rate in Mpumalanga may be that cases are admitted to

hospitals outside the province. In addition children may not always be brought to medical facilities.

No case of AFP reported by the routine system was missed by the record review. The keywords and case definition are therefore very sensitive for identifying cases of AFP. This method of screening the admission registers of wards should also be used for routine reporting.

The two reported cases not found by the review did not conform to the case definition of AFP. The fact that only one has been denotified by the PEC is disconcerting. There should be clear guidelines from the PEC on applying the case definition, as their own application may be inconsistent. This is further supported by recent correspondence. A member of the PEC was tasked to draft a letter to Mpumalanga Province explaining that all cases of paralysis, not only flaccid paralysis, be reported.[85]

This review has shown that the admission diagnosis alone is not sufficient to identify cases of AFP. A medical background is needed to interpret patient files. Although 41 cases were identified as possible cases by screening admission diagnoses for keywords, only 11 cases conformed to the case definition. Keywords alone are therefore insufficient to identify an AFP case but serve as a sensitive screening tool. The admission history and examination must be taken into account to avoid high rates of denotification. In addition it appears that sometimes the suspected admission diagnosis is recorded before a doctor sees the patient and this could lead to erroneous diagnoses.

Six cases not reported by the routine system were found during the review. Two of these cases were denotified by the PEC as one had a pathological humerus fracture and the other case, signs of raised intracranial pressure. Two Guillain Barré Syndrome cases were missed during 1997 when the reporting system was not in place. The two cases missed during 1998 had complicating circumstances that made it difficult to apply the case definition. One was a case of pareses following an epileptic seizure and the admission diagnosis of the second case was lower motor neurone disease / Perthes disease.

Strengths and weaknesses of the review methodology

The value of doing a hospital record review is firstly that acute flaccid paralysis is a dramatic presentation likely to result in hospital admission. Secondly the review process heightened awareness of polio eradication and the role of AFP surveillance in certifying areas polio free. The hospital record review was successful in reinforcing awareness of AFP among superintendents, matrons, and paediatric medical and nursing staff, infection control nurses and district CDCCs, as reflected by increased weekly reporting rates of 94% for September, 100% for October and November and 94% for December 1998.

A weakness in doing a retrospective review of hospital admission registers is that only cases with the specified keywords will be found. The proportion of reported cases detected during review reflects the accuracy of the review criteria for detecting AFP cases and provides a measure of the effectiveness and interpretation of the case definition for finding cases of AFP.

The keywords may not be sensitive enough to detect all cases. One of the missed cases had lower motor neurone disease as admission diagnosis. This should be added to the list of keywords. It is important to inform doctors of AFP surveillance. Their clinical knowledge will minimise missed cases.

Mpumalanga patients are often admitted to referral hospitals outside the Province. This is especially the case with private patients who may be admitted to these hospitals without first being seen in a Mpumalanga hospital. AFP surveillance can only be effective if all areas can maintain high quality surveillance.

Appendices

Appendix 1: Rapid reporting form

MPUMALANGA PROVINCE

DEPARTMENT OF HEALTH

FACSIMILE TRANSMITTAL SHEET

TO: **Dr Bernice Harris**	FROM:
COMPANY: **Dept. of Health**	DATE:
FAX NUMBER: **013 - 712 5837**	TOTAL NO. OF PAGES:
PHONE NUMBER: **013 - 712 5837**	
RE: **Rapid Report**	YOUR REFERENCE NUMBER:

Rapid reporting of conditions requiring immediate response on clinical presentation alone

Please complete and fax to Dr Bernice Harris on the Friday of each week.

Facility name:		
Signature:	District:	
Zero Reporting: Have there been any cases of:	No	Yes
Acute flaccid paralysis (polio)		
Meningococcal meningitis (meningitis outbreaks)		
Diarrhoea Outbreaks (>10 cases linked by person, place and time)		
Dysentery outbreaks (>10 cases linked by person, place and time)		
Measles syndrome (febrile disease with maculo-papular skin rash and coryza, or conjunctivitis or cough)		
Plague syndrome (febrile disease with suppurative lymphadenopathy)		
Haemorrhagic fever		
Yellow fever (heamorrhagic fever with jaundice)		
Cholera (profuse watery diarrhoea)		
Outbreaks of systemic febrile disease (>10 cases linked by person, place and time)		
If *yes* please phone 013 - 752 8085 x 2102 (Dr Dave Dürrheim) immediately		

PO BOX 149, BARBERTON, 1300

Appendix 2: WHO case definition

Any case of acute flaccid paralysis including Guillain-Barré syndrome in a child less than 15 years of age, for which no other cause can be found, or a physician diagnosed case of polio at any age.

DEPARTMENT OF HEALTH

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Case Investigation Form: ACUTE FLACCID PARALYSIS (AFP)

PLEASE COMPLETE ALL INFORMATION IN FULL, USING BLOCK LETTERS

Official use only: EPIDNUMBER Received on: ____ / ____ / 19____

IDENTIFICATION OF PATIENT

Surname: _____

First names: _____

Father/Mother: _____ / _____

Sex: Male | Female Date of birth: ___/___/19 ___ Age: ___ years ___ months

Res. address / contact information: Clinic/Hospital name: _____

_____ Town: _____

_____ District: _____

_____ Province: _____

NOTIFICATION/ INVESTIGATION/RESPONSE

Notified by: _____ Tel No: _____

Date district notified: ___/___/19___ Date case investigation: __/ __/19___ Date response: ___/___/19___

Detail of response: _____

ADMISSION TO HOSPITAL

Admitted: Yes | No Name of Hospital: _____

Date of admission: ___ / ___ /19 ___ Hospital No: _____

INITIAL CLINICAL HISTORY / SIGNS / SYMPTOMS

Symptoms:

Fever?	Yes	No	Unk
Nausea / Vomiting?	Yes	No	Unk
Diarrhoea?	Yes	No	Unk
Constipation?	Yes	No	Unk
Sore Throat?	Yes	No	Unk
Muscular Pain?	Yes	No	Unk
Headache?	Yes	No	Unk
Stiff neck?	Yes	No	Unk

Paralysis:

Date of onset of paralysis: ___ / ___ / 19 ___

Sudden?	Yes	No	Unk
Flaccid?	Yes	No	Unk
Asymmetrical?	Yes	No	Unk
Progressed within 3 days?	Yes	No	Unk
Ascending?	Yes	No	Unk
Case died?	Yes	No	Unk

If yes, date of death:

___ / ___ / 19 ___

INVOLVEMENT

					TONE ↑ N ↓	STRENGTH score out of 5	REFLEXES ↑ N ↓	SENSATION ↑ N ↓
Left leg?	Yes	No	Unk	→		___ /5		
Right leg?	Yes	No	Unk	→		___ /5		
Left arm?	Yes	No	Unk	→		___ /5		
Right arm?	Yes	No	Unk	→		___ /5		
Breathing?	Yes	No	Unk					
Cervical muscles?	Yes	No	Unk					
Facial muscles?	Yes	No	Unk					

↑ = increase N = normal ↓ = decreased

IMMUNISATION HISTORY

Immunisation card Yes | No | Unk Immunised against polio? Yes | No | Unk

If yes, date of: dose at birth: ___ / ___ /19 ___ 1 dose: ___ / ___ /19 ___

2 dose: ___ / ___ /19 ___ 3 dose: ___ / ___ /19 ___

If child received more than 4 doses OPV, give date of last dose: ___ / ___ /19 ___

Case Investigation Form
ACUTE FLACCID PARALYSIS (AFP)

Official use only: EPIDNUMBER:

HISTORY OF EXPOSURE / HOME VISIT

Sibling or contact recently immunised with OPV?	Yes	No	Unk
Patient travelled outside town/village last 30days?	Yes	No	Unk
Visitor from outside area in last 30days?	Yes	No	Unk
Festival/party/wedding/burial in area last 30days?	Yes	No	Unk
Other new cases of paralysis in same town/village?	Yes	No	Unk

FAECAL SPECIMEN COLLECTION

RESULT:

DATE:	Wild virus			Vaccine virus			Non-polio	Negative
	W1	W2	W3	P1	P2	P3	enterovirus	
1st stool: ___ / ___ / 19___								
2nd stool: ___ / ___ / 19___								

FOLLOW-UP CLINICAL EXAMINATION AFTER 60 DAYS

	Involvement			Diminished (Mark appropriate block if diminished)			
				TONE ↑N↓	STRENGTH score out of 5	REFLEXES ↑N↓	SENSATION ↑N↓
Left leg:	Yes	No	Unk	→	___ /5		
Right leg:	Yes	No	Unk	→	___ /5		
Left arm:	Yes	No	Unk	→	___ /5		
Right arm:	Yes	No	Unk	→	___ /5		
Breathing:	Yes	No	Unk				
Cervical muscles:	Yes	No	Unk				
Facial muscles:	Yes	No	Unk				

Date of 60-day follow-up ___ / ___ /19 ___

Investigator Name: _____ Title: _____

Tel No: _____ Fax No: _____

FINAL CLASSIFICATION

(Polio Expert Committee in consultation with National and Provincial EPI Managers)

Date: ___ / ___ /19 ___ (mark ✔)

Confirmed (wildtype)	wildtype polio virus found in stool sample of case or one of the contacts	
Confirmed (vaccine-associated)	vaccine-type polio virus found in stool sample of case which has residual paralysis at 60 day follow-up; and is confirmed clinically	
Compatible	loss to follow-up at 60 days	
	death related to the illness within 60 days	
	residual paralysis for which no other medical reason is evident	
Discarded	no residual paralysis and no wildtype polio found in stool samples	
	residual paralysis neither virologically or clinically compatible with polio	
	non-polio enterovirus isolated	
	no residual paralysis and no virological investigation, and a clinical picture incompatible with polio	

Appendix 4: Key words

- *Polio* and all its other names (acute anterior horn cell disease etc.)
- *Guillain-Barré Syndrome (GBS)* and all its other names (polyradiculoneuritis);
- *monoplegia;*
- *paralysis*
- *hemiplegia*;
- *unexplained or infantile paralysis*;
- *hemiparesis*
- *lameness*
- *paraplegia*;
- *weakness of limbs*;
- *hypotonia*
- *weakness in tone*;
- *quadriplegia*;
- *lowered muscle strength.*

Appendix 5: List of ICD codes for AFP like conditions

045.x	Poliomyelitis
232.2	Polio-encephalitis
323.5	Myelitis, post vaccinal
323.903	Transverse myelitis
323.901-323.905	Myelitis
323.906	Encephalomyelitis
323.909	Acute nerve root myelitis
344.0	Quadriplegia
344.1	Paraplegia
344.2	Diplegia
344.3	Monoplegia - upper
344.4	Monoplegia - lower
344.5	Plegia - unspecified
344.8	Plegia - other
344.9	Plegia - unspecified
353	Nerve root and plexus disorders
354.8	Mononeuritis, upper limb
354.9	Mononeuritis, upper limb
355.0	Mononeuritis, lower limb
355.2	Mononeuritis, lower limb
355.8	Mononeuritis, lower limb
355.9	Mononeuritis, lower limb

356.9	Polineuropathy, unknown
357.0	Guillain-Barré syndrome
357.6	Polineuropathy, Pharmaceutical
357.7	Polineuropathy, Toxic
358.0	Myasthemia gravis
359.3	Periodic paralysis
359.9	Flaccid muscle paralysis
710.4	Polymyositis
729.2	Neuritis and radiculitis
781.4	Transient paralysis of a limb
953, 955	Injury to nerve
956.0	Neuritis, traumatic
956.1	Neuritis, traumatic
956.9	Neuritis, traumatic
005.1	Botulism

Source: Dr Harry Hull, Expanded Programme on Immunisation, Global Programme for Vaccines and Immunisation, World Health Organisation.

Mpumalanga Health
Appendix 6

Suspected Case listing
AFP hospital review

Hospital:_____

Hospital no	Name	Age	Sex	Admission Date	Admission diagnoses	Discharge Diagnosis	File

BN Harris

11/10/00, Case listing

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

MPUMALANGA PROVINCE
DEPARTMENT OF HEALTH AND WELFARE

MEMORANDUM

TO: DR GULAM KARIM

FROM: DR ARIE VERBURGH

DATE: 19 MARCH 1999

SUBJECT: ACUTE FLACCID PARALYSIS CASE FINDING IN MPUMALANGA HOSPITALS FOR 1997/98

Attached protocol refers.

It was screened by Dr Durrheim and received his support. He indicated that he believed there were no ethical constraints to the study being conducted if it only consisted of reviewing retrospective hospital records as long as their identity was protected. The study objective is also certainly worthwhile.

I therefore advise that this protocol be approved.

DIRECTOR: HEALTH INFORMATICS

Approved / ~~not approved~~

CHIEF DIRECTOR: HEALTH SERVICES

Fax: 013 11C 5857.

GAUTENG PROVINCIAL GOVERNMENT

DEPARTMENT OF HEALTH
DEPARTEMENT VAN GESONDHEID

Tel: (012) 354 1560
Fax/Faks: (012) 354 1831
Ref/Verw: Ethics Committee
Enquiries/Navrae: Dr R Sommers
Ward 4 Room 13

Date : 30/06/1999

Nommer : S102/99

Titel : Assessment of the quality of the Acute Flaccid Paralysis (AFP) reporting system, Mpumalang, South Africa.

Aansoeker : Dr B N Harris: Dept of Community Health: Mpumalanga.

This Protocol and Informed Consent has been considered by the Ethics Committee,Faculty of Medicine,Univ.of Pretoria and Pretoria Academic Hospitals on 30/06/1999 and found to be acceptable.

Dr J.E.Davel	(female) MBChB:Hospital Superintendent
Prof G.I. Falkson	(female)MBChB;M.Med(Int);MD;Med. Oncologist
Prof G. Falkson	CHAIRPERSON; MBChB;M.Med(Int);MD;OSG: Medical Oncologist
Mrs C Gerber	(female)BA(FineArts)(U.P)(Unisa);Architectural Draughting (Bostom House College Pta)
Dr V.O.L. Karusseit	MBChB;MFGP(SA);M.Med(Chir); FCS (SA): Surgeon
Dr S.Khan	(female)MB.BCh.(Rand); Med.Adviser (Gauteng Dept.of Health).
Ms B.C.F.Magardie	(female) BCur:Matron/Senior Nursing-Sister
Snr Sr J. Moerane	(female) BCur(Et.Af)Senior Nursing-Sister
Dr P.Z.Njongwe	(female)MBChB;(Natal);D.P.H;DTMtH; DOH (WITS)F.F.C H(CM) S.A.Chief Med.Super of Pretoria Academic Hospital.
Prof H.W. Pretorius	MBChB;M.Med (Psych) MD: Psychiatrist
Prof J.R. Snyman	MBChB,M.Pharm.Med: MD:Pharmacologist
Prof De K.Sommers	BChB; HDD; MBChB; MD: Pharmacologist
Prof F.F.W van Oosten	BA; LLB(Potch); LLD (Pret);LLD (Unisa):Head of Department of Public Law and Prof in Criminal Law and Medical Law

PROF G FALKSON ; MBChB; M.Med (Int);MD;
CHAIRPERSON

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