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for
 National Committee for
 the Certification of Wild
 Poliovirus Eradication

Surveillance of acute flaccid paralysis in Hong Kong: 1997 to 2002

急性弛緩性麻痺的監測：1997至2002年香港的情況

Objectives. To describe the characteristics of patients reported with acute flaccid paralysis between 1997 and 2002, and to evaluate the performance of the acute flaccid paralysis surveillance system using indicators recommended by the World Health Organization.

Design. Retrospective study.

Setting. Department of Health, Hong Kong.

Participants. Children aged younger than 15 years who were reported to the Department of Health between 1997 and 2002 with acute flaccid paralysis.

Results. Of 120 children with acute flaccid paralysis reported between 1997 and 2002, 42% were younger than 5 years of age. None of the cases were acute poliomyelitis or polio-compatible. A neurological cause was identified in 67.5% of cases, of which the most common was Guillain-Barré syndrome (42%), followed by transverse myelitis (15%). All except one of the performance indicators consistently met World Health Organization requirements and thus demonstrated the effectiveness of the acute flaccid paralysis surveillance programme. The acute flaccid paralysis notification rate consistently exceeded 1.0 per 100 000 population below 15 years of age. The requirement for adequate stool investigation was the single indicator that did not satisfy World Health Organization requirements. This highlighted the importance of maintaining physicians' awareness of acute flaccid paralysis surveillance.

Conclusion. Hong Kong should remain vigilant for acute flaccid paralysis. The effective surveillance system and its evaluation may serve as a model for surveillance of other infectious diseases.

目的：陳述 1997 至 2002 年急性弛緩性麻痺病例的特點，並評估其按世界衛生組織而設立的監測系統的表現。

設計：回顧研究。

安排：香港衛生署。

參與者：1997 至 2002 年，報呈衛生署患上急性弛緩性麻痺的 15 歲以下兒童患者。

結果：1997 至 2002 年期間，衛生署共接獲 120 名兒童報稱患上急性弛緩性麻痺，而 42% 的患者是五歲以下。當中沒有急性脊髓前角灰質炎和小兒麻痺症同類的案例。病例中，67.5% 的病因確診為神經系統的問題，當中以吉蘭—巴雷綜合徵最常見 (42%)，橫貫性脊髓炎次之 (15%)。只有一個預報因子的表現未能經常達到世界衛生組織的要求，反映出香港的急性弛緩性麻痺監測系統是相當有效的。急性弛緩性麻痺通報率經常達至超過十萬分之一的標準 (按 15 歲以下人口計)。未能達標的預報因子為足夠糞便的測試，這突顯了在急性弛緩性麻痺監測工作中，醫生需要保持警覺的重要性。

結論：香港的醫務界應維持對急性弛緩性麻痺的警覺，並用對該症有效的監測系統及其評估作為其他傳染病監測工作的參考模式。

Key words:

Evaluation studies;
 Guillain-Barre syndrome;
 Paralysis;
 Poliomyelitis;
 Sentinel surveillance

關鍵詞：

評估性研究；
 吉蘭—巴雷綜合徵；
 麻痺；
 小兒麻痺症；
 哨點監測

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Introduction

Poliomyelitis (polio) is a highly infectious disease caused by the poliovirus. It affects mainly children under 5 years of age and causes paralysis in one of every 200 to 1000 infections.^{1,2} Poliomyelitis has been a statutory notifiable infectious disease in Hong Kong since 1948,³ with peak incidences reported in 1958 and 1962 (262 and 363 cases; incidence rate, 9.2 and 11.0 per 100 000 population, respectively). The last case of poliomyelitis was reported in 1983. The last vaccine-associated case of poliomyelitis occurred in 1995, but was not notified until August 2000.

Polio eradication is achieved through intensive immunisation, vigilant surveillance for acute flaccid paralysis (AFP), and laboratory containment.⁴ According to the World Health Organization (WHO), certifying a country as polio-free requires that there are no reports of new cases caused by the indigenous wild poliovirus for a period of at least 3 consecutive years under the conditions of high-quality surveillance for polio.⁴⁻⁶ Hong Kong is part of the WHO Western Pacific region and was certified polio-free in October 2000.⁷ In the post-certification period, it is vital to maintain effective and sensitive surveillance for AFP so that any importation of wild poliovirus, or inadvertent introduction of wild poliovirus from failure of laboratory containment is detected.⁸⁻¹⁰ In the past, the use of the oral polio vaccine had been associated with emergence of vaccine-derived poliovirus (VDPV) that caused outbreaks of disease in areas with poor vaccine coverage.¹⁰⁻¹² Recent bioterrorist attacks have also highlighted the need to detect poliovirus being used as a biological weapon.

Acute flaccid paralysis surveillance should involve detecting, reporting, and investigating suspected cases, collecting and analysing data from reporting sites, as well as reporting the findings to clinicians, field investigators, and interested parties.⁶ In 1997, the surveillance in Hong Kong began.⁷ The National Committee for the Certification (NCC) of Wild Poliovirus Eradication, comprising paediatricians, government officials, and epidemiologists, was set up to oversee the certification process and, later, to provide strategic advice for maintaining vigilant surveillance and monitoring performance. The NCC communicates directly with the WHO with regard to AFP surveillance and receives secretariat support from the Department of Health (DH) of the Hong Kong Special Administrative Region Government.

A paediatrician has been identified as the 'key

physician' in each of the 14 public hospitals in Hong Kong. His/her remit is to ensure that cases of AFP are promptly identified and reported, and to submit nil returns to the DH on a monthly basis ('zero-case reporting'): this serves to distinguish zero-reporting from non-reporting. The NCC also solicits support from doctors in the private medical sector who are members of the Hong Kong Society of Child Neurology and Developmental Paediatrics, and the Hong Kong College of Paediatricians.

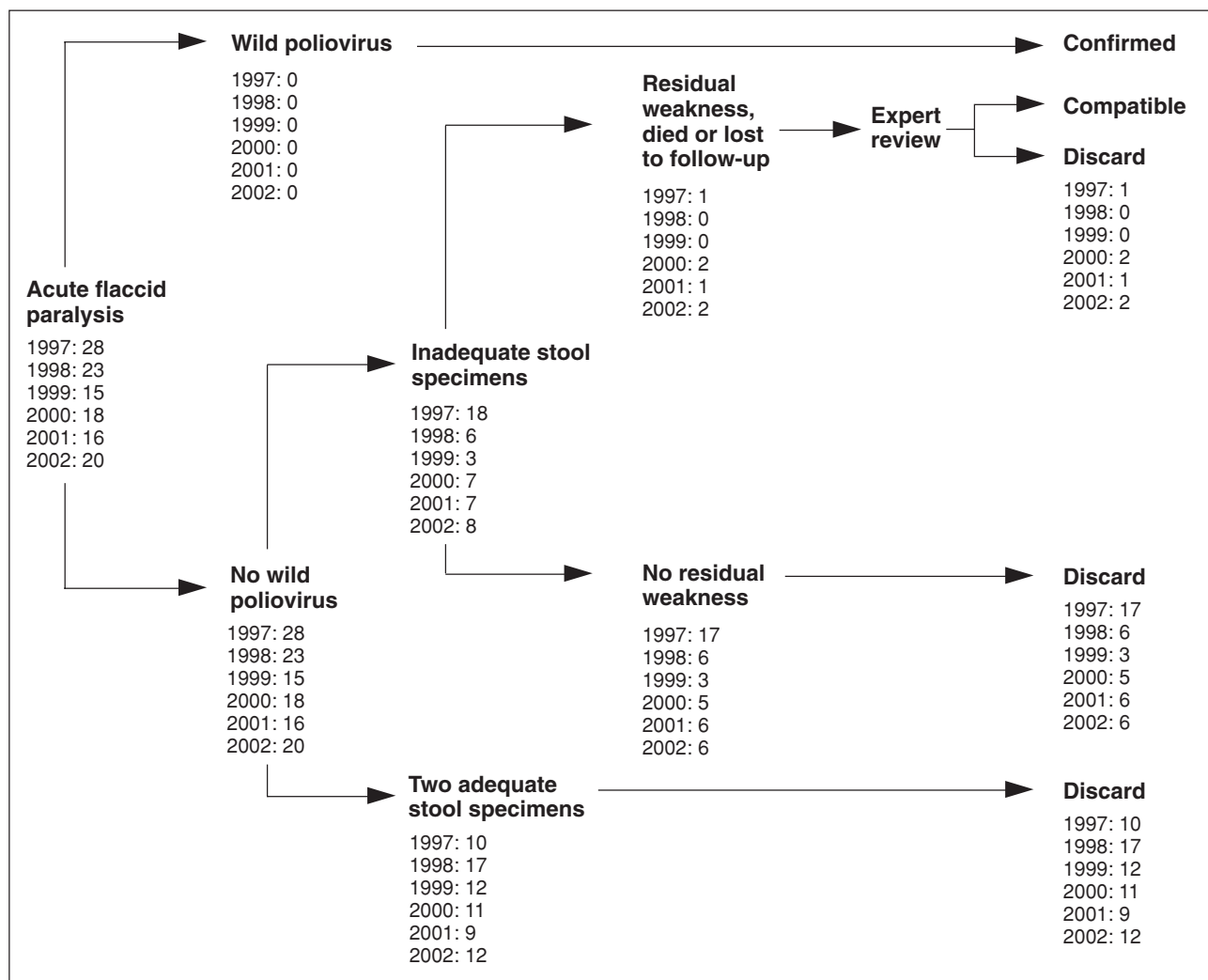
Virological testing for poliovirus is performed by the Public Health Laboratory Service Branch (PHLSB) of the Centre for Health Protection under the DH, and is accredited by WHO. To encourage all clinicians to adequately investigate cases of AFP, there is no charge for the virological-testing service. The statistics on performance indicators were disseminated to all reporting 'key physicians' and other stakeholders on an annual basis.

The WHO has devised a set of performance indicators to ensure that AFP surveillance is properly maintained. Unlike many countries, the results of the surveillance system in Hong Kong have not been published.^{13,14} This paper summarises the AFP surveillance findings from 1997 to 2002, evaluates the system, and identifies aspects that require improvement.

Methods

The WHO defines AFP as "any child under fifteen years of age with acute flaccid paralysis (including Guillain-Barré syndrome)".¹⁵ From 1997 to 2002, all cases that fulfilled the WHO definition were included in this study. All AFP notifications received by the DH were subjected to full epidemiological and laboratory investigations. Field investigations were initiated within 24 hours of notification. The WHO guidelines require that two 'adequate' stool samples be collected within 14 days of onset of paralysis.¹⁵ Contacts of the patient were traced to ensure that they had been fully immunised. All cases were evaluated 60 days following onset of symptoms to identify signs of residual weakness. Investigation results including demographics, dates of investigations, diagnosis and follow-up, and laboratory findings were collated.

The data were analysed to generate statistics based on the WHO performance indicators. Statistical Package for the Social Sciences (Windows version 10.0; SPSS Inc., Chicago [IL], United States) was used for analysis.



* Data are shown as year: No. of cases

Fig 1. Virological flowchart and case classifications*

The NCC has formed an Expert Panel of four consultant paediatricians who are responsible for the classification of AFP cases according to WHO recommendations. The WHO protocol for case classification (Fig 1) was followed to determine which cases should undergo Expert Panel review. This included patients whose stool specimens were insufficient for laboratory diagnosis, who yet suffered from residual weakness, or who had not been followed up. A detailed case report was given to each panel member who independently evaluated each case. Panel members' views and comments were documented and a consensus was reached for the final classification of each case.

Results

A total of 120 cases of AFP (73 male and 47 female)

aged from 1 month to 14 years were reported between 1997 and 2002. Those below 5 years of age accounted for the largest proportion (42%) of cases (Fig 2). None of the cases were classified as acute poliomyelitis or polio-compatible. A variety of causes were identified: neurological (67.5%), musculoskeletal (8.3%), psychiatric (7.5%), cardiovascular (5.8%), miscellaneous (including Kawasaki's disease, leg-length discrepancy, etc) [3.3%]. The cause was undetermined in 7.5% of cases. The most common neurological diagnosis was Guillain-Barré syndrome (42%), followed by transverse myelitis (15%) [Fig 3].

The peak incidences of AFP occurred in the months of June (17 cases) and August (18 cases), coincident with higher enterovirus activity associated with the summer months (Fig 4). Most children had an uneventful recovery, but 13 (11%) presented with

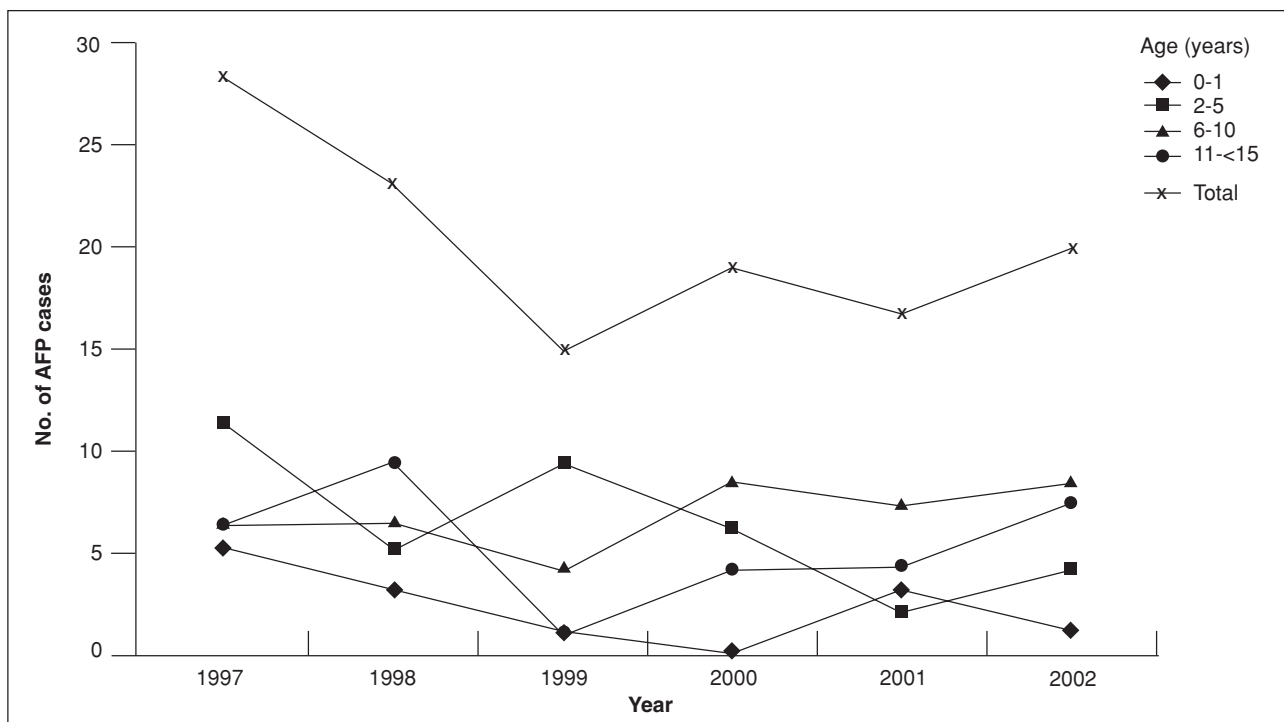


Fig 2. Age distribution of acute flaccid paralysis (AFP) cases reported to surveillance system from 1997 to 2002

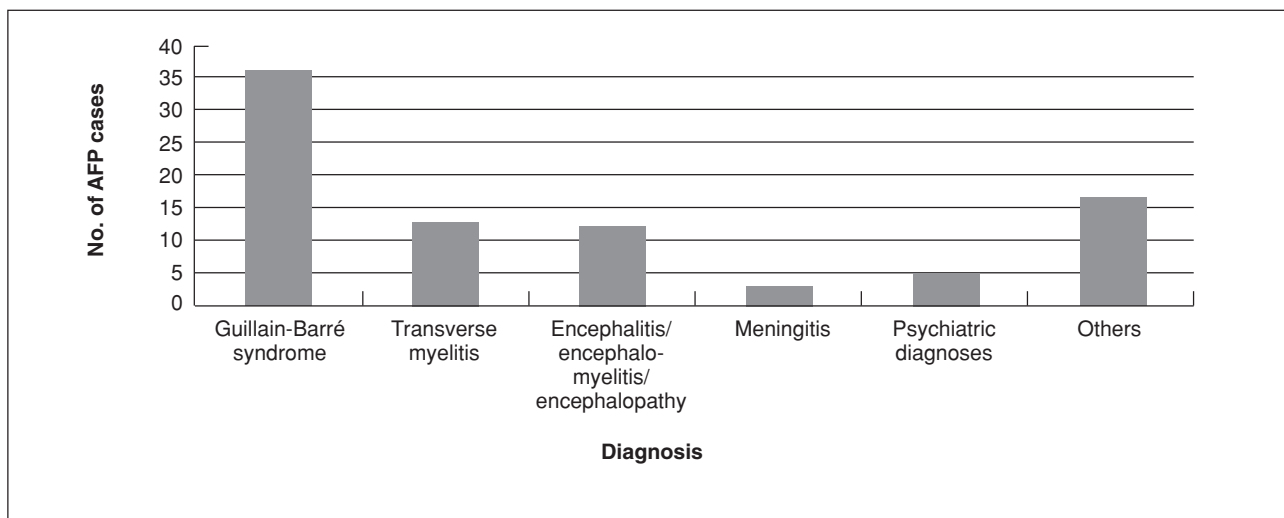


Fig 3. Neurological and psychiatric diagnoses of acute flaccid paralysis (AFP) cases reported from 1997 to 2002

residual weakness. One child with transverse myelitis died.

Cases from 1997 to 2002 were classified according to the virological flowchart (Fig 1). Stool examination was adequate in 71 cases and thus able to exclude the diagnosis of poliomyelitis. The Expert Panel reviewed six cases: all were classified as non-polio.

Public hospitals were the source of 93% of the notifications, whereas private hospitals for the remaining 7% (consistent with this, public hospitals were responsible for 93% of total hospital admissions in Hong Kong). No notifications were received from private clinics, presumably because of the acute nature of the illness that led patients to present directly or to be immediately referred to hospital.

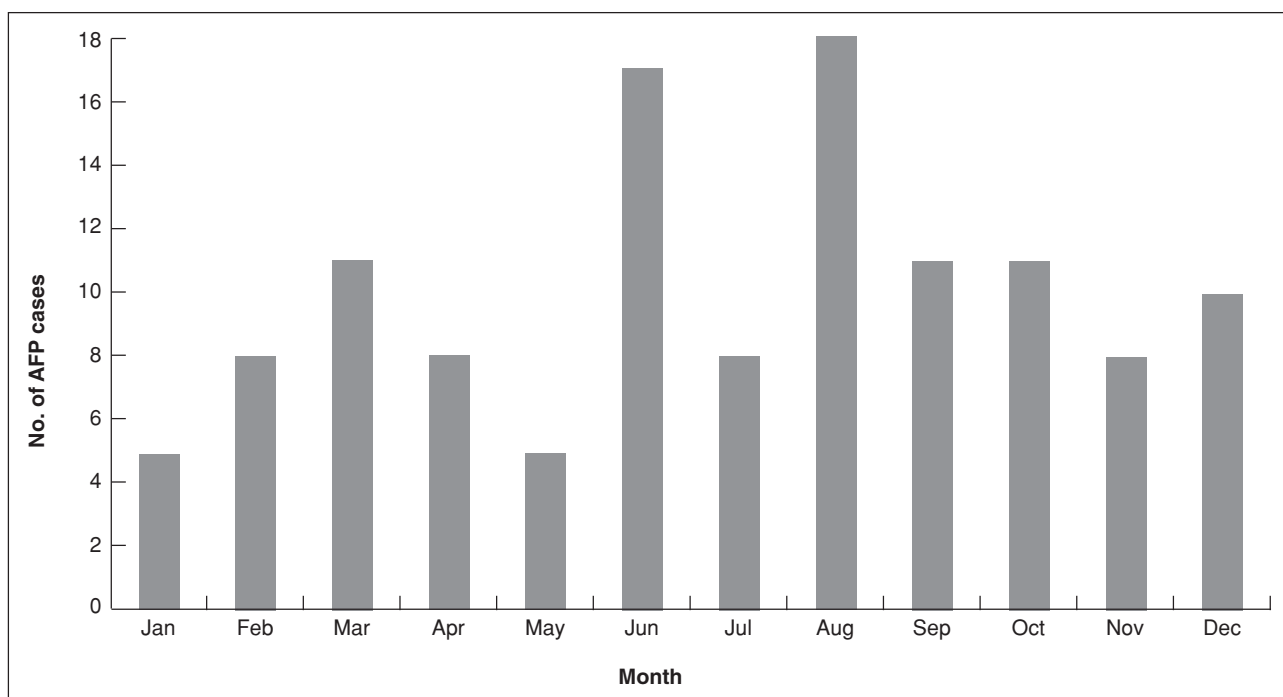


Fig 4. No. of acute flaccid paralysis (AFP) cases reported by month from 1997 to 2002

Stool examination in 17 cases revealed coxsackieviruses and adenoviruses as the most commonly isolated pathogens.

Evaluation of acute flaccid paralysis surveillance

The performance of a surveillance system can be judged using a series of qualitative (eg acceptability, flexibility, and simplicity) and quantitative attributes (eg sensitivity, timeliness, representativeness, positive predictive value, and costs and usefulness of the system).¹⁶⁻¹⁸ Evaluation of AFP surveillance was based on the WHO-recommended indicators.^{5,6}

Qualitative attributes

Acute flaccid paralysis surveillance was integrated into the secondary health care system by means of the 'key physician' network. The system consists of a simple diagnostic algorithm for case classification as defined by WHO (Fig 1). All physicians were made aware of the system in order to avoid diagnostic confusion. Integration of laboratory and epidemiological findings was also possible.

The AFP surveillance is also flexible and robust: objectives can be expanded from merely certifying polio-free cases to including detection of imported cases of poliovirus and VDPV.^{10,12}

Since the introduction of the 'key physician zero-

reporting' system in 1997, more than 80% of the reporting hospitals have been able to provide reports on time. The acceptability of the surveillance system to patients and their families can be measured to some extent by their response to clinical and epidemiological investigations. Since 1997, questionnaires have been completed for all of the cases referred from hospitals. Surveys of user acceptance have not been conducted, but no complaints have been made about the procedures or the nature of information sought.

Quantitative attributes

1. Ability to identify all cases of AFP

The proportion of cases detected by a surveillance system is affected by several factors: the likelihood that the disease requires medical attention and is correctly diagnosed; the availability of a diagnostic test; and the chance that the case is then reported to the surveillance system.¹⁶ A case of paediatric AFP should come to the attention of the health care system because of the severity of the condition. The WHO defined completeness of reporting as "documentation of the timely receipt of >80% of expected routine AFP surveillance reports, including zero reporting where no AFP cases were seen. The distribution of reporting sites should be representative of the geography and demography of the country."¹⁵ Between 1997 and 2002, 87% to 98% of the surveillance sites for

Table 1. Performance of acute flaccid paralysis (AFP) surveillance in Hong Kong, 1997-2002

Performance indicator	Target	Attribute	Actual performance					
			1997	1998	1999	2000	2001	2002
1. No. of non-polio AFP cases per 100 000 population aged <15 years	>1	Sensitivity	2.4	2.0	1.3	1.5	1.5	1.8
2. % of surveillance site providing routine report (including 'zero reports') on time	>80%	Completeness of reporting	92%	88%	88%	92%	98%	87%
3. % of AFP cases investigated	>80%	Completeness of investigation	100%	100%	100%	100%	100%	100%
4. % of AFP cases investigated <48 hours	>80%	Timeliness	100%	100%	100%	100%	100%	100%
5. % of AFP cases followed up at 60 days	>80%	Completeness of follow-up	100%	100%	100%	100%	100%	100%
6. % of AFP cases with two adequate stool specimens	>80%	Timeliness	36%	74%	80%	61%	56%	60%
7. Average annual score of the laboratory on standard WHO proficiency panel testing	>80%	Laboratory performance	100%	89%	100%	100%	100%	100%
8. % of specimen results sent from national laboratory within 28 days of receipt of the specimen in the laboratory	>80%	Timeliness of laboratory investigation	100%	100%	95%	97%	100%	100%

routine or zero-reporting submitted timely reports. All AFP cases notified to the DH were investigated and were followed up at 60 days. This satisfied the requirement for completeness of investigations and follow-up (Table 1). Although completeness of AFP reporting was supported by availability of both passive and active surveillance, retrospective reviews of hospital records were not carried out routinely. Such reviews may reduce under-reporting and raise public awareness.^{13,14,19}

2. Sensitivity and positive predictive value

The WHO defined the target of at least one AFP case per 100 000 in children under 15 years per year as a proxy of the sensitivity of AFP surveillance.¹⁵ This target was consistently achieved from 1997 to 2002—between 1.3 and 2.4 per 100 000 population. Despite this, the trend of AFP notification has been slowly declining (Table 1).

Assessment of the sensitivity of the surveillance system ideally requires information on the true occurrence of AFP in Hong Kong that can then be compared with the rates reported by the surveillance system. As the diagnosis of AFP is made entirely on clinical grounds, a two-source capture-recapture method can be used to estimate the incidence of AFP cases and to evaluate case

ascertainment with respect to the data in routine surveillance system.^{19,20} This estimation method has been employed in epidemiological studies of the incidence and/or prevalence of a given disease or injury as well as in evaluating the completeness of case ascertainment. It compares two or more independent lists of cases in order to estimate the total number of cases in a given population, for example, primary ascertainment source of a national register of AFP cases compared with a secondary data source of hospital discharge records. A statistical model can be applied based on the number of cases that is ascertained by either or both sources, or that is not ascertained by both sources. In Hong Kong, limited resources prevented the introduction of a second case ascertainment source (eg retrospective review of hospital discharge records).

Similarly, the positive predictive value (PPV) of AFP surveillance requires information on 'true' outcomes, that is, 'true AFP' cases. As the criteria required for diagnosis are entirely symptom-based, the number of reported cases that are incorrectly labelled as AFP is difficult to ascertain. A retrospective search of field investigation notes found no incorrect reporting between 1997 and 2002, thus PPV was estimated to be close to 100%. The capture-recapture method to estimate the

Table 2. Indicators of timeliness

Indicator of timeliness	WHO* requirement	Average value attained from 1997 to 2002
1. % of AFP cases investigated within 48 hours of notification	>80%	100%
2. % of AFP cases with two adequate stool specimens [†] collected 24-48 hours apart and <14 days of onset	>80%	57%
3. % of specimens arriving at a WHO-accredited laboratory within 3 days of being sent	>80%	100%
4. % of specimens with laboratory results sent within 28 days of specimen receipt	>80%	100%

* WHO World Health Organization

[†] Two specimens collected 24 hours apart and within 14 days of onset of paralysis, arriving at the laboratory in good condition (ice present)¹⁸

current annual incidence of AFP could not be applied because of the absence of hospital policy to support retrospective review of hospital records for AFP. In addition, the capture-recapture method presumes a stable population. This cannot be presumed in Hong Kong because of continuous inflow of immigrants from Mainland China. The capture-recapture method also assumes that the two ascertainment sources are independent of each other.^{19,20} Again this is not the case in Hong Kong: both routine surveillance systems rely on notification by paediatricians via the 'key physician' network and reporting hospital discharge data are also their responsibility. The two sources are thus positively dependent.²¹

3 Representativeness

The AFP surveillance network covered 14 public hospitals across the whole territory. Almost all (93%) hospital admissions were to public hospitals, thus most cases of AFP were captured by the 'key physician' surveillance system. The remaining cases admitted to the private hospitals were detected by laboratory surveillance because all poliovirus testing was performed by the PHLSB for free. Underreporting could nonetheless still occur if insufficient clinical information was entered on laboratory forms that then evaded laboratory surveillance.

4 Timeliness

Timely reporting of an infectious disease is vital to public health if specific action is required to prevent transmission of infection.^{16,17} The timely detection and reporting of a single case reflects the response of the public-health system to an outbreak and its ability to deal with an emergency. Surveillance of AFP in Hong Kong satisfied WHO requirements (>80%) on all indicators of timeliness (Table 2): all of the notified AFP cases were investigated within 48 hours of notification

and followed up 60 days from onset. The system scored less well on the performance indicator that required 'adequate stool specimen' from more than 80% of AFP cases: 1997 (36%), 1998 (74%), 1999 (80%), 2000 (61%), 2001 (56%) and 2002 (60%) [Table 1].

Between 1997 and 2002, specific phone enquiries were made to the paediatrician in charge of each of the 47 cases without adequate stool examination to establish the reason for not meeting WHO requirement. In most instances, this was due to delayed or improper collection of samples, because of the lack of awareness of the attending physician.

5 Costs

The WHO has estimated that between 1988 and 2005, 5 million people worldwide who would otherwise have been paralysed were able to walk because of the Global Polio Eradication Initiative.²² Without eradication of the disease, the costs would have been enormous: most of those affected would have been children who would have required hospitalisation and suffered long-term neurological disabilities. Additional costs would arise from absenteeism from work and school. Surveillance of AFP has been integrated into the routine health care system without incurring extra costs. It thus provides a cost-effective means of preventing the disastrous sequelae of poliomyelitis through early detection.

6 Usefulness of the system

The usefulness of the system can be judged by how well it supports public health policies and interventions related to eradication and prevention of poliomyelitis. Since its inception, AFP surveillance has resulted in the documentation and subsequent certification of Hong Kong as polio-free. The system continues to fulfill most attributes

requested by WHO in proving that Hong Kong remains polio-free. The WHO has praised the system in Hong Kong and has recommended that the current network be used as a model for surveillance of other infectious diseases and their ultimate elimination, such as measles.^{23,24}

7 Quality of laboratory surveillance

Laboratory performance is critical to AFP surveillance. The PHLSB has satisfied the performance requirements of the WHO for poliovirus diagnosis and characterisation in terms of average annual score and specimen submission (Table 1). All polio and non-polio enterovirus isolates were typed and results reported within 28 days. The laboratory has acquired both antigenic and molecular techniques for intra-typic differentiation as well as nucleotide sequencing so that all poliovirus isolates from AFP and non-AFP cases can be tested in a timely manner to exclude non-Sabin-like poliovirus. In 2000, laboratory surveillance was sufficiently sensitive to isolate an immunodeficient excretor of VDPV from a routine stool sample taken from an immunocompromised infant.

Discussion

Importation of poliovirus into Hong Kong remains a threat. It is vital to continue surveillance for AFP in children younger than 15 years. Guillain-Barré syndrome was the most common cause of AFP cases in Hong Kong, consistent with the findings of other countries.¹⁹ This syndrome occurs throughout the world with a median annual incidence of 1.3 cases per 100 000 population.^{25,26} No published data are available on the incidence of Guillain-Barré syndrome in Hong Kong, but AFP surveillance data suggest that around six cases per year will be diagnosed with paralytic presentations. Extrapolation of these data based on the 2002 population in Hong Kong gives an incidence of 0.6 per 100 000 population under 15 years of age. Thus the WHO global sensitivity indicator for AFP, which was affected largely by Guillain-Barré syndrome incidence, appears to overestimate the incidence in Hong Kong.

The number of reported cases was comparatively higher during the summer months due to higher enterovirus activity. Raising physicians' awareness by reminders and publicity campaigns may help capture cases of AFP during this period. Because of the wide range of diagnoses assigned to children presented with AFP, paediatricians in different subspecialties, with

the exception of neurologists, need to be reminded to report any suspicious case. Mandatory protocols or incorporating data fields into standard records should be considered.

A successful AFP surveillance programme depends on three factors: detection, investigation, and reporting of cases. Results from the AFP surveillance programme revealed that vigilance in case detection and reporting achieved international targets. Nonetheless, the reduction in notifications from 1997 (2.4/100 000 population below the age of 15 years) to 2001 (1.5) suggests a decline in the enthusiasm to report. This appears to have been due to a decline in physicians' awareness, as evidenced by a rebound in reporting rates to 1.8 per 100 000 population below 15 years of age in 2002 following repeated reminder letters to 'key physicians' and their paediatric departments, as well as personal contacts. Although the WHO takes this as a proxy indicator for sensitivity of the system, this study is limited by the lack of retrospective hospital discharge record reviews to cross-validate the known results. This shortfall can nonetheless be compensated by two factors: the acute nature of AFP that necessitates hospital admission for most cases and the existence of active surveillance by 'zero-reporting'. The assessment of completeness of reporting can be further improved by reviewing hospital discharge records as secondary data sources.

Physicians in clinical and public health systems demonstrated a timely response in routine reporting, investigations, and follow-up. The proportion of adequate stool investigation remained significantly lower than the WHO's targeted rate of 80%, although an exception occurred in 1999. There is clearly a need to increase physicians' awareness of the importance of timely adequate stool investigation. Clinical guidelines and standardised protocols help improve physicians' practice including diagnosis. Clinical audit to enhance compliance with guidelines should also be introduced.²⁷⁻²⁹

Since 2000, polio outbreaks caused by circulating VDPVs in Haiti, Madagascar, and the Philippines have conclusively demonstrated that the continued use of the oral polio vaccine (OPV) for routine immunisation may compromise the goal of eradicating all paralytic disease caused by circulating polioviruses.^{30,31} The WHO estimates that the risks of polio paralysis from continued use of the OPV and consequent circulating VDPVs is about 10 cases per year. The identification of VDPV in Hong Kong consistently highlights the importance of maintaining vigilance for AFP and the

possible need to use inactivated polio vaccine (IPV) instead of OPV in the post-certification period. The WHO recommends that to minimise the long-term risks associated with OPV, the routine use of OPV should cease as soon as possible after global eradication, while surveillance sensitivity and population immunity remains high. Universal introduction of IPV is not currently advocated as the WHO has not determined that under what conditions the use of OPV can be safely ceased.

The AFP surveillance system in Hong Kong compares well with many other systems in the Western Pacific region.^{23,24} The WHO recommends that a programme to eliminate measles should start with a surveillance network modelled on which exists for AFP.²³

Conclusion

Hong Kong continues to support the WHO global polio eradication initiative. Its AFP surveillance programme meets most of the WHO requirements in terms of epidemiological and laboratory performance. Maintaining physicians' awareness continues to be a top priority along with continued vigilance in all aspects of polio eradication, including monitoring of polio importation and VDPV.

Infectious diseases do not respect country borders. Hong Kong should reinforce the exchange of epidemiological data of poliomyelitis with neighbouring regions via WHO and the Mainland to prevent the importation of wild poliovirus.

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