



Acute flaccid paralysis in North East Delta, Egypt: A retrospective analysis of prospectively collected surveillance data

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ABSTRACT

Background: Effective acute flaccid paralysis (AFP) surveillance is crucial in countries approaching the final phase of polio eradication. Thus this study was conducted to highlight the epidemiological pattern of AFP as a surveillance tool for polio in Egypt.

Methods: A record-based descriptive study was conducted to include all AFP cases (599) reported in the last 9 years starting from January 2009 to December 2017 in Dakahlia, North East of Delta, Egypt.

Results: The overall non-polio AFP rate in less than 15 years old children was 2.99/100,000 during the study period. The majority of cases (98%) were notified within 7 days from onset of the disease, and investigated within 48 h of reporting. The commonest diagnoses were encephalitis (21.3%), myositis (20.2%), neuropathies (19.2%) and Guillain–Barre syndrome (17.8%) with no recorded cases diagnosed as poliomyelitis. The mean annual vaccination coverage rate was 96.1 ± 1.6 .

Conclusions: AFP surveillance system in Dakahlia, Egypt was effective in meeting the WHO surveillance performance indicators ensuring polio-free status and absence of wild polio virus transmission over the last 9 years in this locality. High routine immunization coverage, maintenance and improvement of current levels of surveillance performance are required for optimum surveillance.

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Introduction

Poliomyelitis is an acute viral infectious disease spreading from person to person, primarily through the fecal-oral route [1]. The poliovirus (PV) causes gastrointestinal and oropharyngeal infection whereas 95% of infections are asymptomatic. Infection may spread to the nervous system and cause acute flaccid paralysis (AFP) in about less than 1% of cases [2]. AFP is defined as any case of new onset of hypotonic weakness in a child less than 15 years of age. Fortunately, polio is one of a limited number of diseases that can be eradicated. This is due to the availability of an effective, inexpensive vaccine and the immunity against it is life-long. In addition, there is no long-term carrier of the disease, no animal or insect reservoir and the virus can survive in the environment only for a short time [3]. In 1988, wild poliovirus (WPV) was endemic in more

than 125 countries with estimated 350,000 cases. So, the WHO was committed to achieve the goal of its global eradication by the year 2000. This goal is defined as no cases of clinical poliomyelitis associated with wild poliomyelitis, and no WPV found worldwide. In 2006, Afghanistan, India, Nigeria and Pakistan were declared by the WHO as the only four countries that had not interrupted indigenous transmission of WPV; and accounted for 94% of all new cases of poliomyelitis with estimated less than 2000 cases. The remaining 6% of all new cases of poliomyelitis occurred in countries into which PV has been reintroduced [4,5].

Effective surveillance is important because WHO certify a region to be polio-free after 3 years without isolation of WPV from a case of AFP in this region, and that in presence of high-quality AFP surveillance [6]. Surveillance of AFP is the intelligence work that supports the entire eradication initiative. It is difficult to differentiate polio in the early stages of the disease from other forms of AFP. Therefore, to be sure that there is no case of polio passes undetected, surveillance targets a symptom of AFP rather than polio itself as a disease. The aim of AFP surveillance is to detect PV wherever it may still exist and to detect re-importation of poliovirus into polio-free areas. High quality AFP surveillance is crucial in

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countries approaching the final phase of polio eradication and is the base of the documentation needed for certification of being polio-free. Without high quality surveillance, it is impossible to prove the successful prevention of transmission of the wild PV. All AFP cases in children less than 15 years and all suspected poliomyelitis cases in individuals of any age should be reported. All AFP cases should have a full clinical, epidemiological and virological investigation [3].

In Egypt, the last case of poliomyelitis due to transmission of indigenous WPV was in 2004 and the WHO declared Egypt as polio free in 2006. However, it is important to guarantee a high quality surveillance as there is always a risk of importation of cases from these areas where polio is endemic. In 2012, positive sewage samples for PV were found in slum areas: Al Haggana and EL-Salam near Cairo, Egypt. Thus stopping PV transmission is accomplished through a combination of high coverage of infant immunization and good surveillance for WPV through reporting and laboratory testing of all cases of AFP in children less than 15 years of age [7,8].

There are few studies on AFP in some areas in Egypt [9,10], to the best of the authors' knowledge; there is no study about AFP surveillance performed in Dakahlia. Thus the present study highlights the epidemiological pattern of AFP as a surveillance tool for polio in Dakahlia Governorate, Egypt in the past decade.

Research questions

The study objectives were to examine the annual incidence of reported AFP cases, the seasonal and geographical variations of AFP, the level of AFP surveillance performance indicators and the differential diagnosis of reported AFP cases during the study period.

Methods

Study setting

This study was carried out in Dakahlia governorate, north east of Delta, Egypt. Dakahlia governorate consists of 18 health districts. Dakahlia is the fourth Egyptian governorate with a total population of more than 6.5 million according to Egypt census 2017. The estimated number of children less than 15 years is about 2,425,525.

Study design and duration

This study was a record-based descriptive study starting from January 2009 to December 2017.

Target population

According to the WHO definition of AFP as any child under 15 years of age with AFP or paralysis in a person of any age in whom polio is suspected [11], all 599 cases reported as AFP cases in Dakahlia governorate in the past 9 years were included in this study.

Data collection approach

The data were collected from AFP records kept at Dakahlia Directorate of Health. Six groups of data were abstracted. First were socio-demographic data as age, sex, residence, season of onset, and reporting site (MOH hospital, PHC, university hospital, insurance hospital, and health district or health directorate). Second were clinical data as clinical manifestation, and paralysis site. Third were data about date of notification, and investigation by medical personnel. Fourth were laboratory data as specimens' adequacy, and laboratory results. Fifth were data about vaccination status as num-

ber of vaccination doses, and districts coverage rate. Lastly were data about outcome of AFP as results of 60 days follow-up, case classification, and diagnosis.

Data management

The collected data were coded, processed and analyzed using the SPSS program (Version 20). The following 7 indices were calculated: annual non-polio AFP cases rate, percentage notification within 7 days, percentage investigated within 48 h of report, percentage specimens collected within 14 days from starting of paralysis, percentage with adequate specimens, percentage specimens to lab. within 3 days and percentage with 60 day follow-up completed [12].

According to the WHO the adequate specimen is defined as; 2 specimens collected from the case at least 24 h apart, within 14 days of onset of paralysis, each specimen volume at least 8–10 g and are sent to the WHO-accredited laboratory within 72 h of collection of the 1st sample, in adequate cold chain and in good condition without leakage or desiccation of the specimens and with adequate documentation [11].

Results

Out of 599 AFP cases that were registered during the study period, 56.1% were males. The mean age of cases was 3.6 ± 3.3 years whereas the majority (75.1%) was below 5 years old. Most of AFP cases (77.6%) were from rural areas. The highest proportion of AFP cases was reported during spring (28.5%), followed by summer (24.9%) then winter (23.9%) and finally the lowest (22.7%) was during autumn (**Data is not shown in table**).

Table 1 shows that the overall paralysis through the study period appears mostly in the lower limbs: 74.0% in right leg and 67.8% in the left leg, and to less extent in upper limbs. Fever at onset of paralysis was recorded in 68.5% of cases. Paralysis was asymmetrical in 58.3% of cases, while paralysis was completed in 3 days among 31.5% of cases. The majority of cases (96.3%) had preserved sensation.

Table 2 shows that MOHP hospitals were the main source of AFP case reporting (57.1%) of cases. Private sector came as the second source of reporting (13.9%) followed by PHC units and health offices (11.0%), and lastly insurance hospitals (2.8%), with only one case discovered by the health directorate in 2009, and 11 cases were discovered and reported by different health districts teams. All the 18 health districts reported AFP cases; the highest proportions were reported by Mansoura (13.9%), Meet Ghamer (10.7%), El-Sinpelawin (10.4%) and Belqas (9.3%).

Table 3 shows that the reported non-polio AFP rate was at least 2.8/100,000 every year. The majority of cases (97.7%) were notified within 7 days from onset of the disease, and 97.6% of cases were investigated within 48 h of reporting. Specimens were collected within 14 days of onset of paralysis in 96.8% of cases, 99% of specimens were sent to the central laboratory within 3 days of the 1st stool specimen, and 97.3% of specimens were adequate specimens. Follow-up after 60 days was completed in 99.8% of cases. Laboratory results showed that non-polio enterovirus were isolated in 15% of cases. WPV was not present in any specimen while attenuated Sabin-strain polio virus was isolated from 2.2% of stool specimens.

Table 4 shows that 97.7% of cases were cured, 1.7% cases died, and only 0.7% of cases showed persistent paralysis after 60 days of follow-up. Case classification showed that all cases (100%) were discarded with no confirmed or compatible cases. Case diagnosis revealed that the most common cause of AFP was Encephalitis (21.3%) followed by Myositis (20.2%), while Guillain–Barre syn-

Table 1
Paralysis sites and clinical manifestations of AFP cases.

Clinical data	Year									Total
	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Paralysis sites ^a										
Right arm	9	15	11	9	4	1	9	2	5	65 (10.9%)
Left arm	10	15	8	8	3	1	10	3	6	64 (10.7%)
Right leg	52	52	53	41	44	42	48	55	56	443 (74.0%)
Left leg	48	51	44	44	42	34	46	44	53	406 (67.8%)
Clinical manifestations										
Asymmetrical paralysis ^b	34	34	36	36	37	50	42	39	35	343 (58.3%)
Fever at onset ^c	31	41	44	36	44	55	50	47	57	405 (68.5%)
Paralysis in 3 days ^d	35	27	27	27	24	10	17	11	3	181 (31.5%)
Preserved sensation	68	68	68	61	57	62	61	65	67	577 (96.3%)

^a Categories are not mutually exclusive.

^b 11 missed cases were excluded (total 588 cases).

^c 8 missed cases were excluded (total 591 cases).

^d 25 missed cases were excluded (total 574 cases) and 68 cases (11.8%) with unknown time for completeness of paralysis.

Table 2
Healthcare sectors and districts of AFP cases reporting.

	Year									Total n (%)
	2009 n (%)	2010 n (%)	2011 n (%)	2012 n (%)	2013 n (%)	2014 n (%)	2015 n (%)	2016 n (%)	2017 n (%)	
Total	68	70	68	61	61	64	68	67	72	599
Sectors										
- Ministry hospitals	33(48.5)	27 (38.6)	37 (54.4)	35 (57.4)	43 (70.5)	49 (76.6)	37 (54.4)	34 (50.7)	47 (65.3)	342 (57.1)
- PHC	15 (22.1)	8 (11.4)	6 (8.8)	7 (11.5)	6 (9.8)	7 (10.9)	1 (1.5)	9 (13.4)	7 (9.7)	66 (11.0)
- University hospital	7 (10.3)	11 (15.7)	15 (22.1)	8 (13.1)	5 (8.2)	3 (4.7)	12 (17.6)	9 (13.4)	9 (12.5)	79 (13.2)
- Insurance hospitals	3 (4.4)	9 (12.9)	1 (1.5)	0 (0.0)	2 (3.3)	0 (0.0)	1 (1.5)	0 (0.0)	1 (1.4)	17 (2.8)
- Private	8 (11.8)	11 (15.7)	6 (8.8)	10 (16.4)	5 (8.2)	5 (7.8)	17 (25.0)	15 (22.4)	6 (8.3)	83 (13.9)
- Health directorate	1 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)
- Health districts	1 (1.5)	4 (5.7)	3 (4.4)	1 (1.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.8)	11(1.8)
Districts										
- Mansoura	9 (13.2)	9 (12.9)	8 (11.8)	8 (13.1)	11 (18.0)	8 (12.5)	8 (11.8)	10 (14.9)	12 (16.7)	83 (13.9)
- Talkha	4 (5.9)	3 (4.3)	4 (5.9)	5 (8.2)	5 (8.2)	5 (7.8)	3 (4.4)	6 (9.0)	4 (5.6)	39 (6.5)
- Belqas	6 (8.8)	7 (10.0)	4 (5.9)	6 (9.8)	6 (9.8)	7 (10.9)	7 (10.3)	7 (10.4)	6 (8.3)	56 (9.3)
- Sherbin	5 (7.4)	4 (5.7)	4 (5.9)	3 (4.9)	3 (4.9)	2 (3.1)	3 (4.4)	4 (6.0)	4 (5.6)	32 (5.3)
- Meet Ghamer	8 (11.8)	9 (12.9)	7 (10.3)	7 (11.5)	5 (8.2)	7 (10.9)	6 (8.8)	6 (9.0)	9 (12.5)	64 (10.7)
- El-Sinpelawin	7 (10.3)	9 (12.9)	8 (11.8)	7 (11.5)	6 (9.8)	6 (9.4)	6 (8.8)	8 (11.9)	5 (6.9)	62 (10.4)
- Aga	3 (4.4)	4 (5.7)	8 (11.8)	3 (4.9)	5 (8.2)	3 (4.7)	13 (19.1)	4 (6.0)	5 (6.9)	48 (8.0)
- Nabarou	3 (4.4)	2 (2.9)	2 (2.9)	2 (3.3)	2 (3.3)	2 (3.1)	2 (2.9)	2 (3.0)	3 (4.2)	20 (3.3)
- El-Manzala	4 (5.9)	3 (4.3)	3 (4.4)	3 (4.9)	3 (4.9)	5 (7.8)	4 (5.9)	3 (4.5)	3 (4.2)	31 (5.2)
- El-Mataria	4 (5.9)	4 (5.7)	3 (4.4)	1 (1.6)	2 (3.3)	1 (1.6)	3 (4.4)	1 (1.5)	2 (2.8)	21 (3.5)
- El-Gamalia	1 (1.5)	1 (1.4)	1 (1.5)	1 (1.6)	1 (1.6)	1 (1.6)	1 (1.5)	1 (1.5)	1 (1.4)	9 (1.5)
- Meniat El-Nasr	2 (2.9)	2 (2.9)	3 (4.4)	4 (6.6)	2 (3.3)	2 (3.1)	1 (1.5)	3 (4.5)	3 (4.2)	22 (3.7)
- Temai El-Amidid	4 (5.9)	4 (5.7)	4 (5.9)	4 (6.6)	3 (4.9)	3 (4.7)	4 (5.9)	3 (4.5)	4 (5.6)	33 (5.5)
- Dekernis	3 (4.4)	5 (7.1)	3 (4.4)	3 (4.9)	3 (4.9)	5 (7.8)	2 (2.9)	4 (6.0)	4 (5.6)	32 (5.3)
- Gamasa	0 (0.0)	2 (2.9)	1 (1.5)	1 (1.6)	0 (0.0)	3 (4.7)	1 (1.5)	1 (1.5)	2 (2.8)	11 (1.8)
- BanieEbid	3 (4.4)	1 (1.4)	2 (2.9)	1 (1.6)	2 (3.3)	2 (3.1)	2 (2.9)	2 (3.0)	3 (4.2)	18 (3.0)
- Meet Salsiel	2 (2.9)	1 (1.4)	2 (2.9)	1 (1.6)	1 (1.6)	1 (1.6)	1 (1.5)	1 (1.5)	1 (1.4)	11 (1.8)
- MahaletDamana	0 (0.0)	0 (0.0)	1 (1.5)	1 (1.6)	1 (1.6)	1 (1.6)	1 (1.5)	1 (1.5)	1 (1.4)	7 (1.2)

drome (GBS) was the cause in 17.8% of cases, with no recorded cases diagnosed as poliomyelitis (Table 5).

Discussion

Egypt has been certified polio-free by WHO in 2006, but there is always a high risk of importation of WPV because of the arrival of people from countries in which polio is still endemic so, there is a need for a strong surveillance system [8]. All countries must be aware that the adequate results of national surveillance can mask the weakness in the sub-national AFP surveillance. Accurate monitoring of the sub-national levels performance indicators is very critical to identify any gap allowing WPV circulation [13].

This study showed that most cases (75.1%) were below 5 years old and this was similar to other countries [14–17]. The higher proportion among the under 5 years children may be due to the

low standards of hygiene with more exposure to infections. The present study showed that most of AFP cases (77.6%) were from rural areas and this was consistent with the previous results from India [18]. This result coincided with the distribution of Dakahlia population whereas poor hygienic conditions were common in rural areas which need more attention during routine immunization and national immunization days (NIDs). The present study also found little seasonal variation of reported AFP cases except for some increase in spring which could be explained with the higher enterovirus activity associated with spring months. This was similar to Turkish [19] and Iranian [20] studies.

Cases of this study showed different variation in the clinical presentations that may be related to variation in causes of AFP whereas encephalitis and myositis were the most common ones. Fever at onset of paralysis was recorded among 68.5% of our cases. In contrary, much lower rate of fever was reported among cases in South

Table 3
AFP surveillance performance indicators and Laboratory results of stool specimens.

	Year										Total n (%)
	2009 n (%)	2010 n (%)	2011 n (%)	2012 n (%)	2013 n (%)	2014 n (%)	2015 n (%)	2016 n (%)	2017 n (%)		
Performance indicators											
- Non-polio AFP rate/ 100,000 children under 15 years	68 (3.4)	70 (3.4)	68 (3.2)	61 (2.8)	61 (2.8)	64 (2.8)	68 (2.9)	67 (2.8)	72 (2.9)	599 (2.99)	
- % Notification within 7 days	67 (98.5)	68 (97.1)	61 (89.7)	61 (100)	61 (100)	62 (96.9)	68 (100)	67 (100)	70 (97.2)	585 (97.7)	
- % Specimens collected within 14 days ^a	68 (100)	67 (95.7)	62 (92.5)	57 (96.6)	53 (93.0)	63 (98.4)	66 (97.1)	66 (98.5)	71 (98.6)	573 (96.8)	
- % Investigation within 48 h ^b	68 (100)	63 (94.0)	61 (92.4)	58 (96.7)	59 (98.3)	63 (98.4)	67 (98.5)	67 (100)	72 (100)	578 (97.6)	
- % Adequate specimens ^c	68 (100)	70 (100)	57 (87.7)	59 (100)	49 (92.5)	63 (98.4)	66 (97.1)	66 (98.5)	72 (100)	570 (97.3)	
- % Specimens sent to Lab. within 3 days ^d	68 (100)	70 (100)	63 (94.0)	59 (100)	55 (96.5)	64 (100)	68 (100)	67 (100)	72 (100)	586 (99.0)	
- % Completed 60 days follow-up ^e	68 (100)	69 (98.6)	68 (100)	61 (100)	60 (100)	64 (100)	68 (100)	67 (100)	72 (100)	597 (99.8)	
Laboratory results^a											
- Negative	49 (72.1)	56 (80.0)	59 (89.4)	45 (73.8)	50 (89.3)	55 (85.9)	57 (83.8)	56 (83.6)	63 (87.5)	490 (82.8)	
- Non-polio enterovirus	17 (25.0)	13 (18.6)	7 (10.6)	14 (23.0)	5 (8.9)	6 (9.4)	10 (14.7)	10 (14.9)	7 (9.7)	89 (15.0)	
- Attenuated virus	2 (2.9)	1 (1.4)	0 (0.0)	2 (3.3)	1 (1.8)	3 (4.7)	1 (1.5)	1 (1.5)	2 (2.8)	13 (2.2) ^f	
- Wild poliovirus	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	

^a 7 missed cases were excluded (total 592 case) & 9 cases (1.5%) with specimens collected from contacts only.

^b 7 missed cases were excluded (total 592 case).

^c 13 missed cases were excluded (total 586 case).

^d 7 missed cases were excluded (total 592 case).

^e 1 missed case was excluded (total 598 case).

^f 7 cases of them received OPV dose within 30 days from appearance of manifestations.

Table 4
Outcome and final diagnosis of AFP cases.

Performance indicator	Year										Total n (%)
	2009	2010	2011	2012	2013	2014	2015	2016	2017		
Result of 60 days follow-up^a											
- Cure	67	65	68	57	59	63	68	66	71	584 (97.7)	
- Paralysis	0	3	0	1	0	0	0	0	0	4 (0.7) ^b	
- Death	1	2	0	3	1	1	0	1	1	10 (1.7)	
- Case lost	0	0	0	0	0	0	0	0	0	0 (0.0)	
Case classification											
- Discarded	68	70	68	61	61	64	68	67	72	599 (100.0)	
- Confirmed	0	0	0	0	0	0	0	0	0	0 (0.0)	
- Compatible	0	0	0	0	0	0	0	0	0	0 (0.0)	
Case diagnosis^c											
- Encephalitis	4	3	20	10	16	32	19	9	10	123 (21.3)	
- Myositis	16	19	16	16	13	11	10	11	5	117 (20.2)	
- Neuropathies	13	8	10	10	6	9	18	19	18	111 (19.2)	
- GBS	18	21	14	9	9	2	10	10	10	103 (17.8)	
- Hypokalemia	3	3	5	4	6	6	10	9	15	61 (10.6)	
- Traumatic neuropathy	8	2	1	2	5	3	1	4	12	38 (6.6)	
- Muscle hypotonia	3	1	0	0	0	1	0	0	0	5 (0.9)	
- Early rickets	0	1	0	0	0	0	0	0	0	1 (0.2)	
- Brain tumor	0	1	0	0	0	0	0	0	0	1 (0.2)	
- Arthritis	0	0	1	0	1	0	0	0	0	2 (0.3)	
- Spinal cord tumor	0	0	1	0	0	0	0	0	0	1 (0.2)	
- Spinal cord abscess	0	0	0	1	0	0	0	0	0	1 (0.2)	
- Brain abscess	0	0	0	1	0	0	0	0	0	2 (0.3)	
- Botulism	0	0	0	1	0	0	0	1	0	1 (0.2)	
- Brain oedema	0	0	0	1	0	0	0	0	0	5 (0.9)	
- Transverse myelitis	0	0	0	1	0	0	0	3	1	2 (0.3)	
- Meningitis	0	0	0	1	0	0	0	0	1	3 (0.5)	
- Brain cell atrophy	0	0	0	0	3	0	0	0	0	1 (0.2)	
- Poliomyelitis	0	0	0	0	0	0	0	0	0	0 (0.0)	

^a 1 missed case was excluded (total 598 case).

^b 3 cases with remaining paralysis were diagnosed GBS.

^c 21 cases with missed diagnosis were excluded (total 578 case).

Africa [17] versus higher rates of fever among cases from other countries [14,15,21]. Paralysis was asymmetrical in 58.3% of cases, which was lower than that found in Ghana [21], but higher than rates in Turkey [19], in Democratic Republic of Congo [14] and in South Africa [17]. Paralysis was completed in 3 days among 31.5% of cases which was lower than those from Ghana [21] and South Africa [17]. The overall paralysis in this study appeared mostly in

the lower limbs and to less extent in upper limbs and this agreed with result from Turkey [19].

The low notification of AFP cases by some health sectors in this study may be related to lack of doctors' knowledge and less interest about preventive issues, lack of incentives, politics and lack of resources, or may be due to operations management issues [9].

Fortunately, Dakahlia Health Directorate achieved and maintained the targets of the AFP performance indicators at the

Table 5
Yearly vaccination status of AFP cases.

Year	Total no. of AFP cases	AFP cases with missed doses according to age n (%)	Mean vaccination coverage rate
2009	68	2 (2.9)	96.47%
2010	70	1 (1.4)	96.27%
2011	67 ^a	15 (22.4)	– ^b
2012	61	0 (0.0)	95.96%
2013	61	3 (4.9)	96.07% ^c
2014	63 ^d	2 (3.2)	96.24% ^e
2015	68	6 (8.8)	95.86%
2016	67	2 (3.0)	95.67%
2017	72	0 (0.0)	96.11%
Total	597	31 (5.2)	Mean ± SD = 96.1% ± 1.6

^a 1 missed case was excluded.

^b Coverage rate was completely missed in 2011 (not recorded in the records).

^c 2 missed cases were excluded (total 59 case).

^d 1 missed case was excluded.

^e 1 missed case was excluded (total 63 case).

governorate level throughout the study period. In this study, the overall non-polio AFP rate/100,000 of under 15 years children was 2.99/100,000 during the study period. This rate was less than the Egyptian overall incidence rates for the years from 2009 to 2017 [22–25] but still above the minimum expected target of WHO [26]. The majority of cases (97.7%) were notified within 7 days from onset of paralysis and this was similar to notification rates of other countries [18,27,28]. Also, the majority of cases (97.6%) were investigated within 48 h of reporting which was exceeding the WHO target [11] and indicating effective surveillance. This was similar to other previous studies [15,27,29,30]. The present work found nearly all stool specimens (99%) were sent to the central laboratory within 3 days of collection of the 1st stool specimen and this was superior to the WHO target [11]. Dakahlia study also showed that the majorities of stool specimens were collected within 14 days from onset of paralysis and received in laboratory in a good condition throughout the study period. These findings were above the minimum expected WHO target [11] and were consistent with other studies [20,27,28,29]. The present study revealed that specimens were collected from contacts only and not from the cases themselves in 1.5% of cases. Possibly, this may be due to early death of the case, late reporting of the case or cases were reported in hospitals in other governorates and unavailability of data about the dates of case specimens' collection or sending to the laboratory. Dakahlia study also found that nearly all cases were followed after 60 days which was more than the WHO target [11] and was more or less similar to that found in Iran [20] and Malaysia [30]. Also, in Dakahlia study, the majority of AFP cases were cured and only 1.7% died while only 0.7% were cases with remaining paralysis that may be due to GBS or other causes. This was similar to finding of Turkish study [19].

Regarding laboratory results, it was reported that the isolation of Non Polio Enterovirus (NPEV) is an indicator used to evaluate the integrity and viability of stool specimen sent to the laboratory for viral isolation and this indicates the quality of the reversed cold chain [14,16]. In this study, the overall NPEV isolation rate was 15% and this was above the minimum WHO standard [14]. It was 17.6% previously in Egypt [31]. However the present rate showed a drop in the years 2013 (8.9%), 2014 (9.4%) and 2017 (9.7%) although, it was better than what was found in other countries [16,18,20,27]. This may be due to disturbance in the reverse cold chain or failure to adhere to standard procedures of collection, handling and shipment of stool specimens during transmission to laboratory [16]. Fortunately, WPV was not present in any stool specimen in this study while 2.2% of cases show attenuated Sabin-strain PV in their

stool specimens. This was similar to that found in other countries [16,19,27]. In the current study, 7 out of 13 cases received OPV dose within 30 days from appearance of manifestations, but no one of them was diagnosed as vaccine acquired polio paralysis (VAPP) as none of them had paralysis persisting after 60 days [19].

The present study showed that the most common cause of AFP was Encephalitis and this was similar to some studies [7,30] while it was different from others [20,27,28,31]. Myositis was the 2nd cause of cases which was much higher than that reported in Iran [20] and Malaysia [30]. This may be due to different diagnostic practices or a problem in the accuracy or recording of the final diagnosis. Neuropathies ordered as the 3rd cause in our cases. Poor nutrition causes vitamin B and E deficiency while bad hygiene leads to frequent infections [32]. Traumatic neuropathy was the cause in 6.6% of cases. This was higher than studies in Iran [20] and in Malaysia [30] while it was lower than Iraq [30]. The course of the sciatic nerve in the gluteal region places it at risk for injury from IM injections [33]. GBS was the cause of AFP in 17.8% of cases. Various data analysis of AFP cases has consistently reported GBS as the most common cause of non-polio AFP all over the world. Higher proportions ranging from 20% in Oman [34] to 72.2% in Central America [35] were reported. GBS was less common in Egypt as it is only about 0.6–0.8/100,000 of under 15 years children [36]. The reason for variation between countries was not clear but it may reflect differences in demographic backgrounds, environmental factors or different diagnostic practices. Also, may be explained by the higher rate of reported AFP cases due to other causes than other studies with total lower proportion of GBS cases. It was mentioned that the possibility of under reporting of GBS or a problem in the accuracy or recording of the final diagnosis of AFP cases cannot be excluded [30]. Hypokalemia was the cause of AFP in 10.6% of our cases. The main cause of hypokalemia in this study may be diarrheal attacks which could be related to poor hygiene. Also, no cases of poliomyelitis due to WPV were detected in this study. This was consistent with the report declared that no cases of poliomyelitis due to WPV have been found since 1998 in Dakahlia governorate [37], or all over Egypt since May 2004 [36].

The present study indicated good immunization coverage with only 31 out of 597 cases had missed OPV doses according to their age, 15 cases of them were in 2011 which may be due to political and security disturbances. This was better than the non-vaccinated proportions in other countries [14,18,27]. The present study also showed that the mean vaccination coverage rate was 96.1% ± 1.6 and this was more than the expected population herd immunity which was reported to prevent poliomyelitis outbreaks [38].

Limitations

The limitation of this study was mainly the poor quality of data as some data was missing, so they were excluded from the analysis. Despite this limitation, this study highlights important strengths and aspects for improvement of the AFP surveillance system.

Conclusions

This study concluded that AFP surveillance system was effective in meeting the WHO surveillance performance indicators and ensuring polio-free status in Dakahlia governorate, north east of Delta, Egypt over the last 9 years period between 2009 and 2017 as well as ensuring the absence of wild polio virus transmission at this subnational level. AFP electronic registry is recommended to insure available good quality data for policy makers and researchers. Finally, we think that high routine immunization coverage, adequate logistics support, training and supportive supervision are what we required for surveillance to perform optimally.

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Competing interests

None declared.

Ethical consideration

This study protocol was approved by the Institution Research Board (IRB) of faculty of medicine, Mansoura University (Code number; MS/16.09.34). Approval was also obtained from the Egyptian Ministry of Health and Population (MOHP). Confidentiality and privacy of information are respected and the collected data were not used for any other purpose.

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