
Research / Recherche

Rehabilitation of the Expanded Programme on Immunization in Sudan following a poliomyelitis outbreak

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In 1993 a large outbreak of paralytic poliomyelitis occurred in Sudan as a result of an accumulation of large numbers of susceptible children that was accelerated by faltering immunization services. The extent of the outbreak led to the rapid rehabilitation of Sudan's Expanded Programme on Immunization (EPI); the government began financing vaccine purchase, operational aspects of EPI were decentralized, vaccine delivery was changed from a mobile to a fixed-site strategy, a solar cold chain network was installed, in-service training was resuscitated, and social mobilization was enhanced. National immunization days (NIDs) for poliomyelitis eradication were conducted throughout the country, including the southern states during a cease fire in areas of conflict. Measles immunization coverage was increased by offering measles vaccine during the second round of NIDs and subsequently through routine immunization services. Supplemental tetanus toxoid immunization of women of child-bearing age began in three provinces at high risk for neonatal tetanus. From 1994 to 1996 reported immunization coverage increased and the incidence of all EPI target diseases fell. Trends in coverage, disease incidence, financing, and the implementation of WHO-recommended disease-control strategies suggest that more sustainable immunization services have been re-established in Sudan.

Introduction

Childhood immunization is one of most cost-effective public health interventions available, and a mainstay of primary health care services (1). The WHO Expanded Programme on Immunization (EPI) began in 1976 and achieved enormous success, resulting in dramatic decreases in the incidence of lethal childhood diseases (2). Global immunization coverage rose from less than 5% in 1975 to 80% in 1990, achieving the Universal Child Immunization (UCI) goal; however, by 1993 reported immunization coverage in 25 countries had fallen (3). This decline has been attributed to a combination of factors including "donor fatigue", unsustainable strategies, poor management, and/or aging cold chain/logistics equipment, as well as integration and decen-

tralization of primary health care services (3). In the early 1990s, Sudan suffered such a decline resulting in an outbreak of poliomyelitis (4). This article describes the implementation of measures in Sudan to rehabilitate the national immunization programme and achieve the global goals of poliomyelitis eradication, measles control, and neonatal tetanus elimination (5).

Materials and methods

Sudan is a vast country of area 2.5 million km², with a population of 31 million and a population density of only 12.4 persons per km². Since 1983 the southern third of the country has suffered from civil war, resulting in massive population movement and hardship.

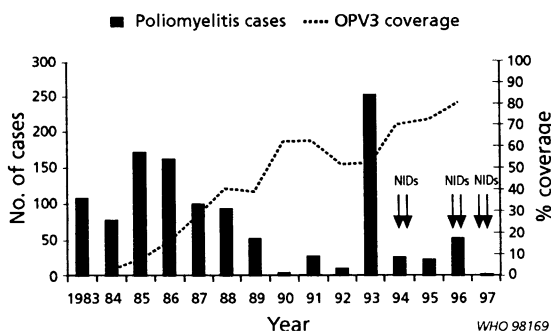
Sudan's national immunization programme began in 1976. Immunization coverage for three doses of oral poliovirus vaccine (OPV3) increased from 3% in 1983 to 62% in 1990 nationwide (80% for six of the former nine regions), with a concomitant decline in reported cases of poliomyelitis (Fig. 1). However, by 1993 coverage had declined to

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Fig. 1. Reported coverage of infants with a third dose of oral poliovirus vaccine (OPV3), number of poliomyelitis cases, and national immunization days (NIDs) in Sudan, 1983–97. Data for 1997 are for up to 30 June.



52% nationally (and to 58% in the same six former regions). An outbreak of paralytic poliomyelitis occurred first in Darfur region, where reported OPV3 coverage was 20%, and subsequently affected most of the country (4). The decline in coverage was attributed to poor management and an inability to sustain a resource-intensive strategy of mobile teams to immunize rural populations because of a sudden decline in donor support to the immunization programme; support from the largest donor decreased by 89% from US\$ 8 million in 1990 to US\$ 850 000 in 1993.

A WHO team visited Sudan in 1993, 1995, and 1996; together with staff from the Sudan Ministry of Health, they reviewed the measures adopted since 1993 to rehabilitate the national EPI. Assessed also was the impact of rehabilitation efforts based on a review of national immunization coverage data determined from the reported number of doses administered, surveillance data from the weekly reporting system, case investigation reports of suspect poliomyelitis cases, and reports from national/international assessments.

Results

The findings of the study are summarized below, under two broad categories.

Rehabilitation of the Sudan EPI

Several measures were implemented to rehabilitate the Sudan EPI (see Table 1).

Renewed political and financial commitment. During the 1993 poliomyelitis outbreak, the Sudanese government partially financed the purchase of poliovirus vaccine to implement emergency response measures. In 1994, EPI became, for the first time, a line item in the national budget. Previously, all vaccine had been paid for by external donors. In 1997, the federal government began financing 25% of the routine vaccine needs.

Table 1: Rehabilitation measures taken and indicators of the impact of EPI in Sudan, 1993–97

Year	Rehabilitation measure	Disease control/programme milestones
1993	Government finances OPV ^a purchase for emergency use during poliomyelitis outbreak	—
1994	Presidential decree issued declaring that state governors are responsible for EPI Line item established in national budget for purchase of vaccine Vaccine delivery strategy changed from mobile team to fixed site strategy Solar refrigeration network established In-service EPI training for mid-level managers and cold chain technicians revitalized Social mobilization enhanced	Reversal of downward trend in immunization coverage Reversal of upward trend of EPI target diseases NIDs ^b conducted throughout country with inclusion of measles vaccine and vitamin A; days of tranquility negotiated in southern states permitting immunizers to move in areas of conflict Surveillance for suspect poliomyelitis (acute flaccid paralysis) begun
1995	Federal EPI holds interstate planning workshop	Supplemental neonatal tetanus activities begun 19 states began financing some of the operational costs for EPI
1996	Federal EPI develops 5-year strategic plan/budget	Second NIDs conducted
1997	—	Supplemental neonatal tetanus activities begun in southern states Third NIDs conducted

^a Oral poliovirus vaccine.

^b NIDs = national immunization days.

Decentralization of EPI responsibilities. In 1994, a presidential decree was issued making the state governors responsible for EPI operations, including transport for supervision and vaccine delivery to peripheral cold chain points. Lack of transport had been crippling EPI, since by 1993 only 110 (35%) of the original 318 vehicles purchased by UNICEF between 1986–90 were still functioning.

Strategic planning at national and state levels. In 1994 the administrative boundaries in Sudan were modified and the former nine regions were reorganized into 26 federal states (16 in the north and 10 in the south of the country), resulting in the creation of 17 additional state ministries of health with jurisdiction over smaller geographical areas. The federal EPI held workshops to ensure that each state had an action plan for immunization services including cold chain maintenance, logistics, transport, injection safety, and supplementary immunization activities. In 1996, the federal EPI developed a 5-year strategic plan and budget, with clearly defined unmet resource needs that were then presented to potential partner agencies.

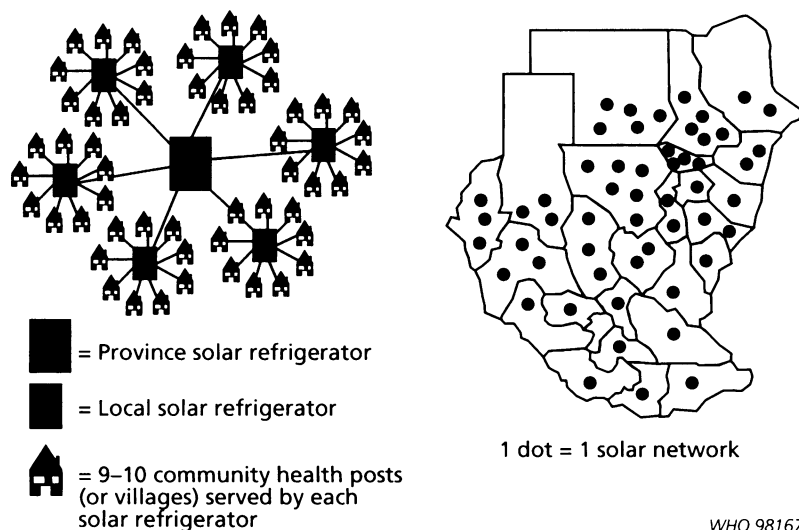
Change of immunization delivery strategy. The primary strategy for vaccine delivery was changed from one involving mobile teams, which visited villages to immunize children at or near each home, to a fixed site strategy with limited outreach services. The fixed site strategy provides immunization services from

health posts that are within walking distance (≤ 2 hours) of the community. The limited outreach services involved local immunizers carrying vaccine on foot, animal or bicycle to immunize in nearby villages (>2 hours walking distance).

Solar cold chain. Since 1993, 53 solar electricity networks, with an average of six local solar refrigerators per network, were established to operate the cold chains needed for vaccine storage in communities that had demonstrated a commitment to EPI (Fig. 2). Commitment was usually defined as an agreement between the state EPI and local governing councils that the latter would cover local vaccine transport costs. Each local refrigerator served an average of nine to ten communities.

Training. Beginning in 1994, in-service training of mid-level staff and cold chain technicians was revitalized. The federal EPI, with the support of WHO and UNICEF, intensively retrained 93 (41%) of 229 mid-level EPI managers, including 20 from nine of the southern states. The federal EPI also instituted a system of “training of trainers” and then decentralized the basic EPI training responsibilities to the states themselves. Surveillance training also began and is being maintained by the federal EPI. Since 1994 a total of 25 cold chain technicians have been trained, with a special emphasis being placed on solar refrigeration. Thereafter, the plan is to train an additional five or six technicians annually to main-

Fig. 2. Solar cold chain networks and their location in Sudan, 1997.



tain two or three technicians per state and counteract the high turnover of trained technicians who, once trained, are often attracted to the private sector. In 1996, service contracts for at least 3 years were made with each trained technician to reduce the rapid turnover.

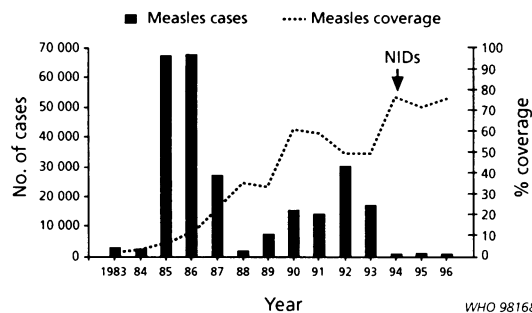
Social mobilization. Social mobilization activities for immunizations were enhanced and refocused. These activities sought to re-orient the population towards fixed-sites for immunizations, raise demand for immunizations, and increase community participation in the delivery of immunization services. Women's organizations, youth clubs, the Red Crescent Society, as well as other nongovernmental and community organizations were recruited to help with local social mobilization activities. In addition, in 1994, 1996, and 1997, in 20 states the Ministry of Information broadcast radio and TV public service announcements publicizing national immunization days (NIDs) for poliomyelitis eradication as well as for EPI, in general. The Sudan News Agency also provided publicity about NIDs and emphasized the latest achievements of EPI in Sudan.

Disease control and programme milestones

Introduction of disease control strategies. As part of the global effort to eradicate poliomyelitis by the year 2000, Sudan successfully conducted NIDs in 1994, 1996, and 1997, achieving high coverage except in the southern states (4). A ceasefire (days of tranquility) was successfully negotiated in these war-torn southern states so that immunizers could move into the areas of conflict during NIDs (6). During the second round of the 1994 NIDs, children aged 9–59 months were targeted for measles immunization to boost coverage rapidly and avert a potential measles epidemic. The momentum from this campaign was then sustained through the routine immunization programme (Fig. 3). In 1995, surveillance for suspect poliomyelitis (i.e. acute flaccid paralysis) was introduced (4).

From 1993 to 1995, Sudan had an estimated annual neonatal tetanus (NT) incidence of 5 per 1000 live births, and was one of the 25 countries that accounted for 90% of the global neonatal tetanus burden. Since NT cases tend to cluster according to specific problems with clean birth delivery and umbilical cord care, enhanced efforts at tetanus toxoid (TT) immunization are needed in areas with high NT risk (7). During 1995, the EPI in Sudan used surveillance data and other indicators to identify 20 of 79 provinces at highest NT risk and to plan supplemental TT immunization in these provinces. One

Fig. 3. Reported immunization coverage of infants and reported measles cases, Sudan, 1983–96. Measles vaccine was administered to eligible children during the second round of national immunization days (NIDs).



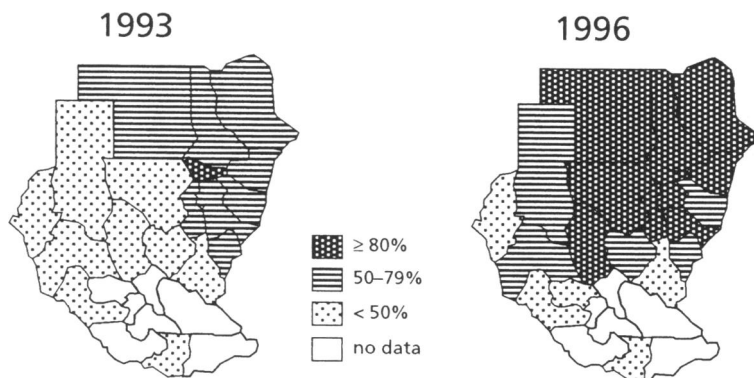
high-risk province eliminated NT in 1995 using targeted supplemental immunization activities financed by the local governing council. In 1996, supplemental TT immunization was conducted in one high-risk province in Southern Darfur State, and in 1997 in one accessible area of southern Sudan. A plan of action has been written and funds are currently being sought to eliminate NT in the other 16 high-risk provinces.

Immunization coverage, disease incidence and financing of EPI. From 1993 to 1996, infant immunization coverage increased for all antigens with a concomitant decrease in the reported incidence of all EPI target diseases (Fig. 1, 3 and 4). In particular, coverage for the third dose of diphtheria–tetanus–pertussis (DTP3) increased from 51% to 79% nationally, with variations especially for the southern states (Fig. 4). Of the 26 states in the country, 19 are now successfully financing some of the operational costs for EPI. In eight states (Gedaref, Gezira, Kassala, Khartoum, Northern, Nile, Sinnar, and White Nile) EPI is fully financed by the state or more local budgets. Resources for about 50% of the total national EPI transport costs are generated at sub-national levels. In seven war-affected states, immunization services still depend completely upon federal support and NGOs. By the end of 1996, approximately 70% of immunizations were delivered by a fixed-site approach with selected outreach, compared with approximately 35% in 1993, and all solar refrigerator networks were still maintained by the community.

Discussion

The tragic 1993 poliomyelitis outbreak in Sudan stimulated increased national commitment to reha-

Fig. 4. Reported coverage of infants with a third dose of diphtheria–tetanus–pertussis (DTP) vaccine, Sudan, in 1993 and 1996.



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biliterate the national EPI before outbreaks of other target diseases occurred. The sudden increased demand for immunization services during the poliomyelitis outbreak created an opportunity to re-emphasize the importance of immunization and reorient the population towards fixed immunization sites. Sudan embarked on a more sustainable approach to provide immunizations during a period of decentralization in health service delivery that included decentralization and a dramatic increase in the number of state-level ministries of health.

The primary vaccine delivery strategy of mobile teams used during the late 1980s and early 1990s was labour-, vehicle- and cost-intensive, and became unsustainable, particularly when external donor support for routine immunization services diminished. In 1990 the average cost of fully immunizing a child in Sudan was US\$ 30, with wide variations between regions and districts, suggesting opportunities for improved efficiency (8). Although a mobile-site strategy was generally more effective at providing immunization services, it was twice as expensive as a fixed-site strategy, and it was concluded that fixed sites represented an untapped opportunity for EPI in Sudan. Thus the EPI in Sudan sought to exploit this untapped opportunity for providing immunization services and began to rely more heavily on local resources, community participation, and decentralized decision-making.

Decentralization of health services has been implemented in various ways in different countries with divergent results. In Sudan, decentralization resulted in devolution of the financial and operational aspects of EPI to the state level. The federal level maintained the role of policy-making, central coordination, stra-

tegic planning, and management of certain aspects of training, supplies and equipment (i.e. vaccine, cold chain equipment, and some petrol). In Sudan, the decentralization process ensured that each state had a plan of action compatible with the overall national policies and goals, but permitted more local decision-making, resource allocation and management of immunization services through state ministries of health, provincial district health offices, and local governing councils. Moreover, a commitment to finance immunization services locally (rather than federally) has been easier because peripheral-level decision-makers are closer to the demand for and impact of immunization services. As local governing bodies have increasingly taken on primary health care responsibilities, a “healthy” competition has developed between local councils regarding the performance of primary health care services, particularly EPI. The concurrent change in administrative structure from nine regions to 26 states has led to an increased number of EPI mid-level managers being responsible for smaller workloads and geographical areas, thereby optimizing performance.

The selective use of solar refrigeration networks in communities committed to EPI appears to have been effective in Sudan, since all these networks are still functioning approximately 3 years after their introduction. The decision to establish solar refrigerator networks in areas with commitment to EPI (versus placing solar refrigerators randomly throughout the country) was a deliberate effort to foster community participation to sustain immunization services. Exchanging the costs of vehicles (to implement a mobile-team strategy) for those of solar refrigerators (to implement a fixed-site strategy) is

more efficient in a vast country like Sudan. The initial capital cost of a solar refrigerator (US\$ 4500–5500) is about a quarter of the price of a suitable motorized vehicle. Moreover, operating a solar refrigerator in Sudan costs approximately US\$ 1000 every 5–7 years, whereas operating a vehicle (petrol, repair and maintenance) amounts to US\$ 2250–4000 for the same period. The solar refrigerators replaced aging kerosene or propane refrigerators and enabled a vaccine cold chain to be established where it was previously not feasible due to a lack of fuel. The solar refrigerator networks are also giving communities experience in using and maintaining a source of energy that can be expanded for other local needs.

A major aspect of the rehabilitation process was the revitalization of managerial in-service training at the state and local levels. Mid-level EPI managers in Sudan had not received training since 1987, there was a shortage of cold chain technicians, and most staff had never been trained in disease surveillance. However, part of the decentralization process in Sudan included the integration of EPI training for immunizers with other primary health care training activities, thereby reducing a focused 7-day EPI course into a more general 3-day course. The result was that specific aspects of EPI training for peripheral level staff were “diluted”; more people received general EPI training but immunizers, who could benefit most from intensive EPI training, received less. It is too early to assess the impact of this dilution effect, and efforts are currently under way to revise and expand the EPI part of this course, based on the specific tasks of immunizers.

Despite the progress, a disparity in reported immunization coverage persists between the northern and southern states of Sudan (Fig. 4). Some of this may have been due to unaccounted vaccine doses administered by NGOs working in the war-affected states. Overestimated population figures for the southern states (since large numbers of people have moved away from war-affected areas) may also explain some of the disparity. Influx of large numbers of people to the northern states may have produced underestimates of the population there and overestimated coverage, making it seem that the population is adequately immunized in these northern states. Innovative approaches are needed to reach areas of Sudan that are inaccessible because of civil unrest; in particular, better coordination is needed among governmental and nongovernmental organizations having access to these areas.

The difficulties in estimating immunization coverage in Sudan underscore the need for effective surveillance to identify populations at high risk for EPI-target diseases. Substantial improvements in surveillance are urgently needed if these data are to

be used effectively to guide EPI activities in Sudan. In 1997, a cascade of accelerated surveillance training was carried out for state and province level staff and a system for monitoring surveillance performance was introduced.

It is impossible to distinguish which factors contributed most to the rehabilitation of the EPI in Sudan, as most were occurring simultaneously. In addition, more time is needed to fully assess the impact of the EPI rehabilitation efforts in the country. Nevertheless, the trends in coverage, disease incidence, financing, and the implementation of WHO-recommended disease control strategies suggest that more sustainable immunization services have been re-established in Sudan, a resource-poor country whose Ministry of Health is undergoing many changes, particularly decentralization.

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Résumé

La remise en ordre du Programme élargi de vaccination du Soudan à la suite d'une flambée de poliomyélite

En 1993, une importante flambée de poliomyélite avec séquelles paralytiques a éclaté au Soudan du fait qu'en raison des faiblesses des services de vaccination, le nombre déjà substantiel des enfants vulnérables s'était accru à un rythme accéléré. Devant l'ampleur de cette flambée, le Programme élargi de vaccination (PEV) a été rapidement remis sur pied; les pouvoirs publics ont entrepris de financer les achats de vaccin, la logistique a été décentralisée, des lieux fixes de vaccination ont remplacé les équipes mobiles, on a installé une chaîne de froid fonctionnant à l'énergie solaire, la formation sur le terrain a été remise à l'honneur et on s'est efforcé d'accroître la mobilisation sociale. Des journées nationales de vaccination (JNV) à vocation éradicatrice ont été organisées sur tout le territoire, y compris dans les états du sud, à la faveur d'un cessez-le-feu sur le théâtre des combats. Il a été possible d'augmenter la couverture vaccinale antirougeoleuse en proposant cette vaccination au cours de la seconde tournée de JNV, puis dans le cadre de la vaccination systématique ordinaire. Dans trois provinces où le risque de tétanos néonatal est élevé, les femmes en âge de procréer ont commencé à recevoir une vaccination

supplémentaire par l'anatoxine tétanique. Entre 1994 et 1996, la couverture vaccinale annoncée a augmenté et l'incidence des maladies cibles du PEV a reculé. Au Soudan, la couverture vaccinale, l'incidence des maladies, le financement des campagnes de vaccination et la mise en oeuvre des stratégies de lutte contre la maladie préconisées par l'OMS ont amorcé une tendance qui indique que le pays a restauré de manière plus durable ses services de vaccination.

References

1. *World development report 1993. Investing in health.* New York, Oxford University Press, 1993.
2. **Lee JW et al.** Reaping the benefits: getting vaccines to those who need them. In: Levine MM et al., eds. *New generation vaccines*, 2nd edit. New York, Marcel Dekker, 1997: 79–88.
3. *Sustainability of achievements: lessons learned from Universal Childhood Immunization. Report of a Steering Committee.* New York, UNICEF, 1996.
4. **EiZein HA et al.** Poliomyelitis outbreak and subsequent progress towards polio eradication in Sudan. *Lancet*, 1997, **350**: 715–716.
5. **World Health Organization.** *Strategic plan 1997–2001 and budget 1997: Global Programme for Vaccines and Immunization.* Unpublished document WHO/GPV/97.03 (available upon request from Global Programme for Vaccines and Immunization, World Health Organization, 1211 Geneva 27, Switzerland).
6. **Centers for Disease Control and Prevention.** Implementation of health initiatives during a cease fire: Sudan, 1995. *Morbidity and mortality weekly report*, 1995, **44**(23): 433–436.
7. **World Health Organization.** The “high-risk” approach: the WHO-recommended strategy to accelerate elimination of neonatal tetanus. *Weekly epidemiological record*, 1996, **71**(5): 33–36.
8. **Resources for Child Health Project.** *Report on the cost-effectiveness of the Expanded Programme on Immunization in the Republic of Sudan. Volume V: Summary Report of Surveys in Kordofan, Darfur, Middle and National Capital Regions.* Arlington, VA, John Snow, Inc., 1990.