Immunization Newsletter

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The Cold Chain

Introduction

Every year, the national immunization programs (NIP) of the Americas plan and set ambitious targets to vaccinate thousands of children. The objective is to prevent children and the susceptible population from being affected by or contracting diseases that can be prevented using a specific vaccine. It should be known that **vaccination** is not the same thing as **immunization**, and it is here that the cold chain plays a major role.

We consider **the cold chain** the foundation for ensuring that vaccines are stored within adequate temperature ranges to guarantee the immunogenic quality expected of the biologicals used by NIPs.

The global success achieved with smallpox vaccination and the high index of cases of polio and other vaccine-preventable diseases in the 1970s led to the creation of NIPs throughout the Americas, ushering in the era of immunization, with Dr. Ciro de Quadros as the main protagonist in a saga that today is a dream come true.

Development of the cold chain

When the Expanded Program on Immunization (EPI) was launched in the Americas, the cold chain and other methods to store and conserve the basic vaccines used in our countries were in their infancy. The concept of storing and keeping vaccines within rigid temperature ranges was unknown, since very few people working in the health systems of the day knew about it.

Proper procedures to store and conserve vaccines under stable temperature conditions and how to do so was the privilege of the staff working in vaccine manufacturing laboratories or highly skilled health workers trained to handle vaccines in different workplace settings, usually at the upper levels of health facilities.

Victor Gómez.

Refrigeration equipment

The refrigeration equipment used to store and conserve vaccines in the countries' health centers had a vertical design for domestic use with the door at the front. There were two types of refrigerators, differentiated by the way they worked: **by compression**, powered by an electric motor (compressor) that ran only with stable, uninterrupted electricity; and by absorption.

Absorption refrigeration systems require a heat source to work and generate cold, requiring them to use **liquid fuels such as kerosene** or **gaseous fuels such as propane gas**. This equipment does not cool as well as compression systems, which are more efficient.

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What I Have Learned from the Immunization Newsletter

By Carolina Danovaro, former editor of the Immunization Newsletter

I was born in 1974, the year that the World Health Organization's (WHO) World Health Assembly adopted the resolution establishing the Expanded Program on Immunization (EPI).[1] Adoption of the EPI took a little longer in our Region, occurring in 1977[2]. Two years later, our EPI Newsletter was born, reaching maturity in 2005, when it became the Immunization Newsletter.

It has been an honor for me to be part of this family for immunization in the Americas and to have been able to help disseminate information, experiences, and good practices through "our" Immunization Newsletter. Nearly four years ago — when I moved from PAHO to WHO — I went from being a contributor for the Newsletter to an avid reader, to stay connected to our Region.

In order to share what I learned as an associate editor (2004-2010) and then editor of the Newsletter (2011-2015), I should give you a little more information about my background. I began my career in immunization in 1998 and, as often happens in life, I did so by a fluke. Having graduated from medical school in my country, Chile, and during a professional crisis knowing that my future would not be as a clinician, I had an opportunity to participate in a fellowship program under the national immunization program (NIP) of the United States at the Centers for Disease Control and Prevention (CDC). My dream at the time was to be able to do some rotations in the CDC laboratories, thinking that I would devote myself to the hard sciences or laboratory work; a few months' work in public health would not be so bad if it enabled me to end up in a laboratory. However, my rotation began in the NIP's Epidemiology and Epidemiological Surveillance Division, and I soon fell in love with epidemiology and public health. I marveled at being a witness and party to how science, statistics, and practical considerations were combined with public policy. Attending a meeting of the National Immunization Technical Advisory Group (NITAG)[3] was a mind-blowing experience. I was astounded to see how, in addition to presenting scientific evidence, researchers listened to patients and members of society and discussed each recommendation down to the comma to ensure its clarity. I learned that it was not only important to do science and make policy, but to communicate accurately, precisely, and clearly to different audiences.

During my time at the CDC, I decided to do a master's degree in epidemiology, and to broaden my horizons at the London School of Hygiene and Tropical Medicine, with a major focus on statistics. In London, in addition to studying, I began learning French (who studies

[1] The immunization programme that saved millions of lives. Bulletin of the World Health Organization. www.who.int/bulletin/volumes/92/5/14-020514/en/

[2] https://www.paho.org/journal/en/special-issues/immunization

[3] https://www.cdc.gov/vaccines/acip/index.html

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Cold chain standards

Current cold chain standards have been based on the use of conventional refrigerators, however, it is necessary to update and adapt the standards to the use of new refrigeration equipment.

Back then, the countries of the Region had serious power problems, and the lack of stable electricity in 80% of their communities required them to use absorption refrigeration equipment that ran on liquid fuels (kerosene) or liquefied gas (propane gas), making transport and distribution logistics difficult and complicated due to the serious problems bringing fuel to remote areas where health centers needed refrigeration equipment to store vaccines.

Moreover, lack of resources prevented countries from procuring the heating elements and fuel needed to operate absorption refrigerators.

Invention and development of thermally insulated equipment for vaccine transport

Prior to advent of the EPI, vaccine transport was a critical problem. There were no thermoses or coolers with high-quality thermal insulation. Vaccines were transported in metal, wooden, or cardboard crates with an internal and external wall with an insulating layer of cork or fiberglass between them. In remote areas, it was sometimes necessary to improvise, using shredded newspaper as an insulator to maintain the temperature inside the heavy transport crates.

In time, the classic thermoses with polystyrene foam insulation for household and other uses appeared on the market, bringing with them the introduction of other high-quality thermal insulation media. This led to the invention and development of coolers with an appropriate design for EPI use (1980/1981). Today, we have coolers and other thermal equipment that **stay cold for extended periods**.

Design of Iceline refrigeration equipment (1982/1983)

The difficulties at the time also led us to develop a new design for refrigeration equipment that would make it possible to prolong and maintain the internal temperature of refrigerators even after an electrical power outage, enabling health workers to take the necessary steps to guarantee the quality of the vaccines. The result was Iceline refrigeration equipment, refrigerators with a wall of ice whose operating principle was based on the thermal behavior of a vaccine thermos or cooler. These refrigerators can store vaccines for extended periods with the proper use of ice packs, safely maintaining the temperature required by the vaccines.

Diagnosing the expansion of vaccine storage capacity in Guatemala, 2011. Source: Nora Lucía Rodriguez.

Increase in refrigeration capacity

Over time, the EPI introduced other vaccines, thus increasing number of doses stored, leading to the need for greater storage capacity. This need increased with population growth, requiring the gradual replacement of small refrigeration equipment, such as refrigerators, with larger equipment with greater capacity, such as cold storage rooms for warehouses that handle large volumes of vaccines to meet the needs of the service.

Considering the national immunization systems' need to procure and increase the number of refrigerators to conserve vaccines, the problem would not wait; the countries of the Region generally had serious economic constraints that kept them from procuring high-quality and new refrigeration equipment in enough quantities to meet the needs of their developing NIPs.

As a result, a rapid survey was conducted in the countries (1981) to determine the number of refrigeration units available at the time and their working condition to guarantee proper conservation of vaccines. The results were alarming. The fact that 70% of the equipment was decrepit or not working properly and out of service was a problem, on top of there being a limited number of refrigerators available in each country to support an enormously important undertaking designed to protect the health of the population.

Without basic resources to develop and lay the foundation for a nascent program in our countries, it was necessary to introduce a series of strategies to consolidate actions. As a first step, we had to provide courses to train health program personnel in refrigeration equipment repair and maintenance for the conservation of vaccines (1980/1981). The purpose was to restore the decrepit refrigeration units in the countries' health services to good working order.

It should be mentioned that all aspects of PAHO's support and contribution during those years were laudable and very intense, since within a short time, 95% of the equipment in every country in the Region was up and running – an achievement buttressed with the procurement of new cold chain equipment and components.

The second step (1981/82) was to train technical staff in country NIPs in the proper procedures for safely and reliably handling biologicals so that the vaccines would reach the end user in the best conditions of conservation. This step has undoubtedly made this Region the first to be free of polio and other vaccine-preventable diseases, serving as an incentive to continue working in health.

We believe that ensuring ongoing training and adequate knowledge among EPI health workers will be the only way to move forward and overcome adversity, since lacking the basic means to procure the necessary elements and components for an efficient cold chain in the countries, the only tools for surmounting the daily problems that in-service health workers must face are their knowledge and moral commitment.

The countries' lack of economic resources to procure the right components to maintain and transport vaccines under adequate safety conditions has always been, and will continue to be, one of the most critical problems. Times were hard when the countries of the Region began setting up their NIPs, and quickly attaining the desired high levels of training and success was a real challenge. Today, we can see that the results are the product of hard work that only time will be capable of judging.

For the NIP workers of the Americas, the cold chain represents a religious rite, an act of respect and compliance with the mandates of the standards and recommendations implemented over the years. These principles must be respected to consolidate our actions.

Future of vaccines

The advent and inclusion of new vaccines in our countries' immunization systems, the preparation of vaccines by cellular splitting, and genetic engineering will soon be a reality. Scientists today already manipulate the human genetic code, and it will not be long before the results no doubt will be genetic

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compounds that acting as single vaccine, can protect humanity against all the diseases that ever were and will be in a single dose. Unlike the vaccines in current use, which require moderate refrigeration temperatures, they will require ultra-low temperatures of **under 60°C** conditions necessary for their conservation over lengthy storage periods.

Future of the cold chain

The sweeping advances in science and technology should prompt us to prepare ahead of time, so that when the moment comes, we not only have the technology, refrigeration capacity, and other knowledge that the vaccines of tomorrow will demand, but access to information about the new technologies that health workers are currently requesting and the knowledge they will need to meet the challenges of the future.

Developing an efficient immunization system and cold chain in the Americas has not been as simple and easy a task as might have been thought. It has taken a long time to eliminate polio. There is no doubt whatsoever that the path would have been shorter and more efficient had the authorities of the day at the highest level in the countries all been of one mind to achieve the proposed objectives in a timely manner.

Alignment with technology development

Thanks to the concerns and problems of yesterday, technology currently has features and tools to safely guarantee cold chain operations. The mercury or alcohol thermometers capable of monitoring temperature only at a given moment are a thing of the past, since they can be replaced by state-of-the-art electronic thermometers that constantly register the temperature.

Determining the quality of a refrigerator in current use and replacing it with a safe and reliable refrigeration system to store and conserve vaccines is a matter that is in our hands. Having a refrigerator in remote areas where there is no reliable electricity to guarantee the operation of the refrigerator for our vaccines is a simple problem that can be solved with solar-powered refrigerators. The responsible health authorities should make the necessary decisions to begin the process of examining the features and conditions of the cold chains they oversee and make the right ones to bridge the gaps of the past.

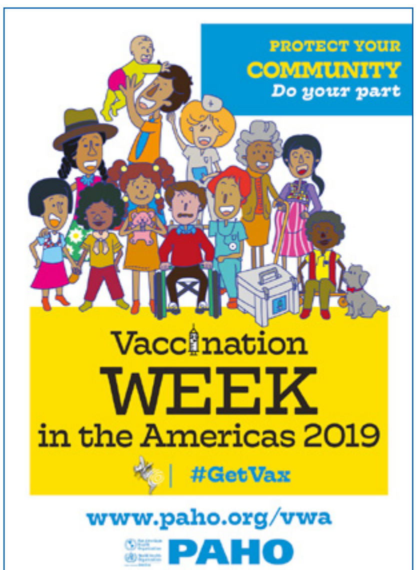
Finally, we cannot fail to mention and remember the work, determination, and unconditional support of people such as the late Dr. Ciro de Quadros, Peter Carrasco, John Fitzsimmons, the EPI authorities and workers in the countries, and others who step-by-step and anonymously trod the most difficult paths to build and strengthen the solid wall that will enable us to control and eradicate the enemies of health from the face of the earth, so that someday, all humanity can enjoy a life free from the ghosts of yesterday.

National Biological Center (CENABI) in Nicaragua, 2015. Source: Nora Lucía Rodriguez.

May God give me the opportunity, however short, to see that my efforts and dreams in hard times over the years become a reality tomorrow. ■

Contribution of:
Engineer Víctor Gómez Serna.

Vaccination Week in the Americas 2019



Poster for VWA 2019.

From April 20 to 27, Vaccination Week in the Americas (VWA) celebrated its 17th anniversary with active participation from 45 countries and territories. The goal of the campaign was to vaccinate 70 million people against vaccine-preventable diseases such as measles, polio, influenza and human papillomavirus, among others.

"Protect your community. Do your part" was this year's theme, with a special focus on ending measles outbreaks and protecting the Region's achievements. Around 22 countries in the Region planned to vaccinate more than 2.25 million children and adults against this disease, which has reported outbreaks in several countries. PAHO Director Carissa F. Etienne stated: "It is the duty of each one of us to do our part in promoting vaccination, whatever our role: from health workers to authorities, but also as parents, grandparents, teachers, mayors, and community leaders."

At least 19 countries and territories intensified national immunization program activities in order to update or complete vaccination schedules in children. A variety of strategies will be employed, including fixed and mobile vaccination posts, vaccination brigades going house-to-house, communication efforts encouraging parents to bring their children to the nearest health centers, and the administration of school-based vaccination to reach older children and adolescents for booster doses.

"We all benefit from the protection offered by vaccines. However, we must ensure that all populations are vaccinated, as is their right. For that, we must make special efforts to reach people who live in remote areas, more deprived neighborhoods, indigenous communities, migrant populations, and people who do not have regular access to health systems, leaving no one behind," added Etienne.

In the last 17 years, more than 740 million people of all ages have been vaccinated against a wide range of diseases during VWA. In addition to this, within the framework of the initiative, many countries allocate health personnel and additional economic resources to vaccinate people living in remote areas, indigenous communities, and those with limited access to health services.

The official launch of VWA was held on 22 April in Cuiabá, Mato Grosso, Brazil, with participation from Dr. Etienne and the highest health authorities in the country, among others. Other launches were held, both nationally, binationally, and even trinationally throughout the Region. ■

PAHO's Technical Cooperation in the Cold Chain Motivates Countries to Reach Objectives of the Region's Immunization Programs

Starting in 1979, PAHO's regional immunization program (IM) has consolidated cold chain operations on four pillars: training in program management, research and testing in the development of refrigeration equipment for the safe keeping of vaccines, flow of information and program evaluation.[6] Today, except for researching and testing refrigeration equipment, IM continues to strengthen the other three pillars by working with Member States to scale up their cold chain operations.

To assist the ministries of health, PAHO's technical cooperation has focused on meeting requests from governments in three management areas: providing technical cooperation to build new cold chain facilities and/or put up new cold storage rooms; evaluating cold chain and supply chain operations and providing training courses to national immunization staff.

1) Providing technical cooperation to build new cold chain facilities and/or put up new cold storage rooms

Starting in the 2000s, the introduction of new and expensive vaccines like the rotavirus, single-dose measles, mumps, rubella (MMR), PCV and HPV vaccines, as well as the concomitant increase of the population in each country, gave ministries of health in the Region of the Americas the challenge of rapidly increasing their cold chain storage capacities for different vaccines. This provided a model for many countries to follow in planning the increase of their cold chain storage capacity in other regions.

Since the early 2000s, Paraguay, Colombia, Honduras, Nicaragua and others have built new warehouses for national vaccine storage at the central level, including installation of new cold rooms at sub-regional facilities to increase vaccine storage capacity. More importantly, having additional vaccine storage space at sub-regional levels has provided program managers with more flexibility in managing supply chain operations and responding to unplanned service level requests for additional vaccine supplies.

In recent Effective Vaccine Management (EVM) evaluations in Guyana (2014), Nicaragua and Honduras (2015) and Bolivia (2016), sites requiring additional vaccine storage capacity were identified. These EVM evaluations allowed countries to purchase new refrigeration equipment and/or improve existing storage facilities.

2) Evaluating cold and supply chain operations

PAHO has always advocated for health equity and in this respect, the countries in the Region have extended their immunization services to more populations, especially to those living in remote areas. Where the electricity grid was non-existent and where a secured supply chain for fossil-based fuels was extremely difficult to manage, IM developed projects and/or assisted countries in the introduction and use of solar-powered refrigerators.

As the immunization cold chain and supply chain became more complex, it was imperative for countries to examine their operations and assure that the managers at all levels had "end-to-end visibility" of all their operations. To this end, IM has introduced two management tools: the Web-based Vaccine Supply Stock Management (wVSSM) software and EVM, which is an evaluation tool that measures performance based on nine criteria for the continuous improvement of best practices in cold and supply chain operations and vaccine management. wVSSM[7] is a vaccine and commodity inventory application, allowing managers to receive information on stocks of vaccines and other commodities, their location and expiration dates and other important information to assure that no immunization services suffer from stock-outs. Moreover, wVSSM allows for a traceability of vaccine and syringe lots needing to be recalled. The major challenge management has faced for an effective wVSSM is assuring that all health service points have access to the internet. Initially, 14 countries installed the non-web version of the software (VSSM), six of these are now using wVSSM (Honduras, Jamaica, Mexico, Dominican Republic, Nicaragua and Paraguay).

National Vaccine Warehouse in Bogotá, Colombia.
Source: Nora Lucía Rodriguez.

To document and improve the performance of the cold chain, supply chain operations and vaccine management, WHO developed the EVM tool. As was previously mentioned, the EVM collects information based on nine criteria to evaluate and document operational performance and conditions that allowed good performance, and to highlight areas that need improvements to assure that these operations achieve their objectives in supporting immunization services to meet country/regional goals and vaccine coverage goals. To date, five countries (Bolivia, Guyana, Haiti, Honduras and Nicaragua) have completed EVM evaluations. Honduras and Nicaragua achieved the highest EVM scores when compared to other countries in other regions of the world (as of May 2019), that have also carried out EVM evaluations.

The Achilles heel affecting cold chain and supply chain operations is the disrupted flow of information within the system, due to the lack of digital equipment and access to the internet at lower levels of the cold and supply chains. Together, EVM and wVSSM can provide the required information to make the best decisions and prepare effective budgets as part of each country's annual plans of action. It is worth noting that the meeting of the Technical Advisory Group (TAG) on Vaccine-preventable Diseases in Panama (2017) recommended the implementation and use of EVM and wVSSM.

3) Providing training courses to national immunization staff

Because of the progress and the introduction of expensive vaccines, the need to continuously monitor vaccine temperatures to assure that each person is vaccinated with a potent vaccine became a priority. Therefore, IM advocated for and supported the introduction of remote temperature monitoring devices for cold rooms and continuous temperature monitoring devices for facilities using refrigerators/freezers. With the new digital technologies, the PAHO/IM began training national staff from all countries in either international (4) or national (8) workshops. Participants were trained in continuous temperature monitoring devices and remote temperature monitoring using cell phone technology to receive temperature deviations from the monitored equipment. This has facilitated not only better management, but also allowed for rapid response to act in the event of energy or mechanical failures in the equipment.

Another key in obtaining outstanding program performance is having well-trained and informed health workers and managers, including being updated on the latest technologies. To this end, IM has recently conducted the following training events:

- **Cold chain, supply chain and vaccine management courses**
  Five training workshops carried out in Colombia (2016 and 2017), Dominican Republic (2017), Jamaica (2018), and Nicaragua (2012). A total 783 people were trained.
- **Vaccination Supply Stock Management (VSSM) courses**
  Fourteen courses were carried out between 2010-2018 in: Bermuda, Bolivia, Dominican Republic, Haiti (2), Honduras (2), Jamaica, Mexico, Nicaragua, Paraguay, Peru, Suriname and Venezuela. A total of 448 people was trained.
- **VSSM and wVSSM evaluations**
  Eight evaluations were carried out between 2011-2018 in: Dominican Republic, Haiti, Honduras (2: VSSM and wVSSM), Jamaica, Mexico, Nicaragua and Paraguay.
- **EVM training events**
  Seven courses were conducted between 2013-2018 in: Bolivia, Cuba, Guyana (2), Honduras (2) and Nicaragua. A total of 185 people was trained.

Additionally, IM has updated the Cold Chain Module and the Modules for the Use, Installation, Maintenance and Troubleshooting of Solar Refrigeration Equipment. A total of 540 people has been trained in using, installing, maintaining and troubleshooting solar refrigeration equipment.

As was stated in the EPI Newsletters in 197911, governments need to provide the required funds to support their immunization program operations. Managers at all levels need to prepare their annual plans of action (emphasizing new technologies, cold chain equipment, temperature monitoring devices, among others) and their corresponding budgets to assure that required funds are allocated by the budgetary authority. Providing potent vaccines will prevent vaccine-preventable outbreaks and premature deaths in the present and future. ■

[6] EPI Newsletter Volume 1 Numbers 1-4, 1979, available at www.paho.org/immunization/newsletter

[7] In 1997, PAHO introduced an inventory software called Commodities and Logistics Management (CLM) in a few countries. The US-CDC and Management Sciences developed CLM to manage medical supplies in public health warehouses. VSSM was introduced in 2010, beginning with Nicaragua and Paraguay.

Using Electronic Immunization Registries to Improve Vaccination Coverage and Timeliness: Experience of the City of Villa María in Córdoba, Argentina

Introduction

Immunization is one of the most important tools we have in public health. The protective action of vaccines against vaccine-preventable diseases is essential for controlling them and reducing their morbidity and mortality[8] and depends strictly on the achievement of high[9] vaccination coverage and adherence to immunization schedules, since delays in the administration of vaccines create avoidable risks.[10] Delayed vaccination is a particularly serious multifactorial[11] problem in children, since contracting a vaccine-preventable disease can impair their physical and cognitive development.[12,13]

Electronic immunization registries (EIRs) are one of the most successful strategies adopted to improve vaccination coverage and timeliness, as they make it possible to evaluate the situation of each individual in the registry and prepare vaccination appointment schedules. Recent automation of these registries has helped facilitate this task.[14, 15, 16, 17]

Since July 2015, the city of Villa Maria (in the Córdoba Province of Argentina) has had a comprehensive health program information management system (SIGIPSA) for listing vaccinated people by name. This city has an estimated population of 86,610 (Source: Villa Maria Statistical Center) and averages 1,800 births annually. Approximately half its population is served in the 14 vaccination centers of the municipal Ministry of Health (13 primary health care centers [CAPS] and one public assistance center). Each month, these centers administer around 3,700 vaccinations corresponding to all the vaccines in the national vaccination series, some 1,700 of which are for children under two years old. The vaccines administered in the city are provided by the Directorate of Vaccine-preventable Disease Control (DiCEI), an entity of the Secretariat of Health of Argentina's Ministry of Health and Social Development.

In June 2016, under the Comprehensive Territorial Management Program (PGTI) proposed by the city's Ministry of Health and adopted by the Villa Maria Municipal Deliberative Council, the adoption of a strategy to use an EIR was proposed to make progress toward the target of 95% vaccination coverage for all vaccines and to improve the timeliness of vaccination.

Methodology

The strategy focused on vaccinating children under two years old and on vaccination at school entry, combining an analysis of the information from the SIGIPSA EIR with monitoring and an active search for children vaccinated in the municipal services who attended Villa Maria schools.

Villa Maria vaccinators with the Secretary of Health (Dr. Humberto Jure) after meeting the target of vaccination on school entry at the last school that had not yet achieved 95% coverage. Source: Ministry of Health, Municipality of Villa Maria, Córdoba, Argentina.

SIGIPSA is used at all city vaccination centers, both public and private. Uploading the immunization information related to the national vaccination series is mandatory, since it is linked to the distribution of doses by the Córdoba Province immunization program. The strategy consisted of the following steps:

- **Step 1: Construction of the target population (TP)**

For children under two years old, the TP was all children born in January 2016 onward and residing in Villa Maria who were registered in SIGIPSA as having received at least one dose of any vaccine. This TP was divided into two subpopulations: (1) children who had received a dose of vaccine in Ministry of Health services and (2) children who had not been vaccinated in those services. Children in the first group were considered the primary target population (PTP), since due to their prior contact with the municipal vaccination centers, the centers had information to monitor their adherence to the vaccination schedule. A list of the names of all newborns in this PTP was compiled.

For incoming students, the TP was all incoming first-graders in Villa María's 29 public and private schools, beginning in 2017 (the year the procedure launched in 2016 for children under two was expanded to schoolchildren). This criterion was adopted in this case because children from neighboring areas also attended these schools, and the target to be met was for 95% of these children to have an up-to-date vaccination card. If, during the vaccination period, a child ceased to attend one of the schools because the family had moved elsewhere, that child was excluded from the denominator (a situation that occurred in less than 1% of the children).

- **Step 2: Identification of children in the PTP with incomplete vaccination series**

2.1 Preparation of the vaccination card of each child in the PTP

For both children under two and incoming students, each child's vaccination card was completed using the information from SIGIPSA. In cases where information was lacking, the vaccination card was confirmed directly by conducting a home visit for children under two or requesting the card through the school.

2.2 Preparation of the list of children with complete and incomplete vaccination series

Two lists were prepared: one for children with a complete series for their age, which was used to monitor administration of the vaccines; and another for children with incomplete series, which was used to organize activities to bring their vaccinations up to date.

- **Step 3: Distribution of children by vaccination service**

Each child under two was assigned to one of the city's 14 vaccination services, based on the service in which the last dose of vaccine had been administered or the child's address. Each service was given the list of children assigned to it.

The lists for the schoolchildren were sent to the health services, based on the location of their school.

- **Step 4: Vaccination of children with incomplete series**

The health services organized the vaccination of the children with incomplete series that had been assigned to them. The re-uptake work involved telephone contacts, an active search, and vaccination in the home for the children under two and vaccination at the schools, subject to parental consent, for the schoolchildren.

- **Step 5: Monitoring vaccine administration and progress in meeting the target**

A weekly report was prepared on the change in the vaccination status of children under two with incomplete series for the entire city and by health service. A similar report was prepared by the school.

At the same time, weekly vaccination schedules for the next three weeks were prepared, along with lists of unrecorded vaccinations, including for all children who had been vaccinated the

[8] World Health Organization. Global Vaccine Action Plan 2011-2020. Geneva, Switzerland: WHO; 2013.
[9] Nature Communications. Vaccines work. 2018;9:1666.
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[12] Bloom DE, Canning D, Shenoy ES. The effect of vaccination on children's physical and cognitive development in the Philippines. Applied Economics. 2012;44:2777–2783.
[13] Samudio Domínguez GC, Correa Fretes AL, Ortiz Cuquejo LM et al. Retraso del esquema vacunal en niños menores de 5 años en zona marginal. Rev. Nac. (Itauguá). 2017; 9(1):35-48.
[14] Loeser H, Zvagulis I, Hercz L et al. The Organization and Evaluation of a Digital, Centralized Immunization Registry. AJPH. 1983;73:1298-1301.
[15] Szilagyi PG, Bordley C, Vann JC et al. Effect of Patient Reminder/Recall Interventions on Immunization Rates: A Review. JAMA. 2000;284(14):1820–7.
[16] Odone A, Ferrari A, Spagnoli F et al. Effectiveness of interventions that apply new media to improve vaccine uptake and vaccine coverage. Hum Vaccines Immunother. 2014;11(1):72–82.
[17] Nature Editorials. Vaccine boosters. 2018;553:249-250.

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Field work of a Villa María Ministry vaccinator. Active vaccination in private homes was used to complete the vaccination series of children with longer delays. Source: Ministry of Health, Municipality of Villa Maria, Córdoba, Argentina.

previous week and whose vaccination had not been entered in SIGIPSA. The purpose of the two lists was to improve the timeliness of the children's vaccination.

A report on the coverage and timeliness of the vaccination of each monthly cohort born in January 2016 onward and the children entering school in 2017 and 2018 was distributed monthly to all vaccination services and uploaded to the municipal website. Coverage was calculated using the PTP assigned to every CAPS as the denominator, and timely vaccination was defined as administration of the vaccine within 14 days of the date indicated by the national vaccination schedule.

To evaluate the results of the procedure, the third dose of the pentavalent vaccine (DTP-Hib-Hep B) was used as the reference. The indicator used was the average days without protection, calculated as the number of days between each child's date of birth and the date the vaccine was administered, which according to the national vaccination schedule, should have been at the age of six months.

A time series was constructed by dividing the children by birth cohort. The time series began with the children born in January 2015 (the first cohort whose vaccination at six months was recorded in SIGIPSA) and included all children who had received the third dose of the pentavalent vaccine up to a year after reaching six months. This criterion was used for all cohorts in the series, up to those born in April 2017, to ensure comparable results.

For the schoolchildren, the indicator was vaccination coverage with all the vaccines required for school entry (DTP, MMR, and Sabin oral) for all the schoolchildren and by school. The denominator used in calculating the coverage was the TP defined in step one of the procedure.

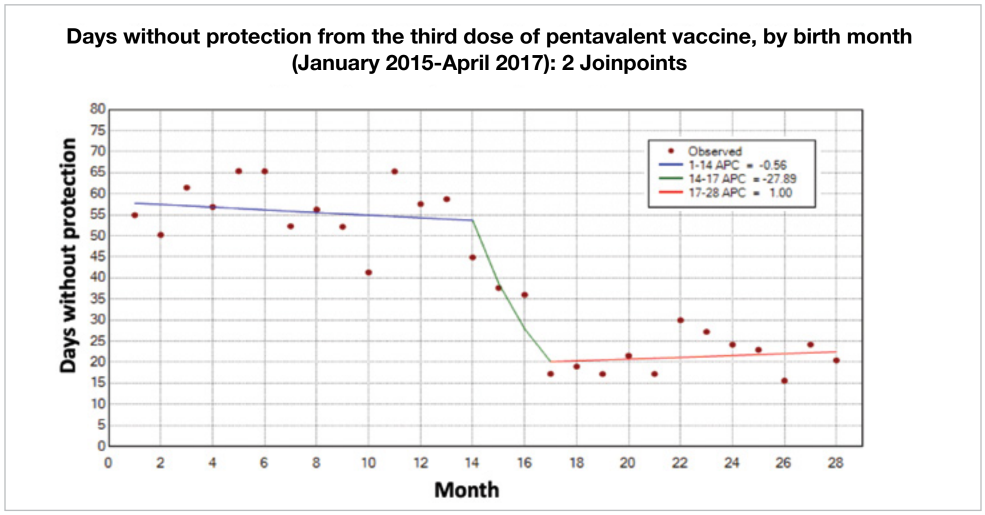
Results

- **Child under two**

The average days without protection with the third dose of the pentavalent vaccine were calculated for each monthly cohort of children born in Villa Maria between January 2015 (month 1) and April 2017 (month 28). See **Figure 1**.

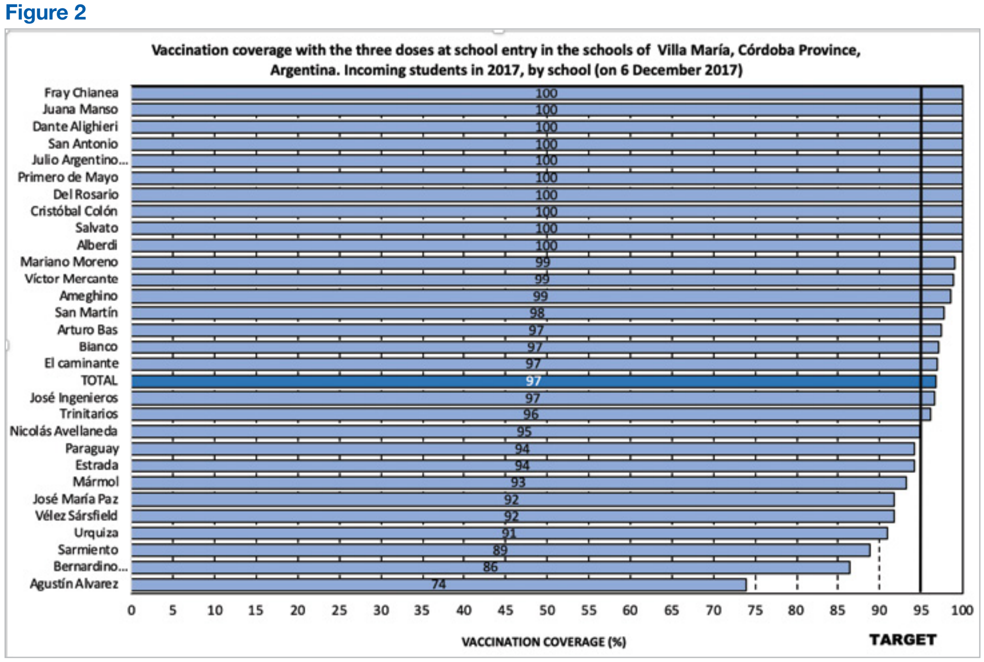
This time series was examined to identify breakpoints in the trend using a joinpoint regression (National Cancer Institute).[18] Two breakpoints (p=0,0002) were identified, differentiating three periods: the first prior to implementation of the strategy (children born between January 2015 and January 2016: 785 children), the second coinciding with implementation of the strategy (children born between February 2016 and April 2016: 204 children) and, the third, post-implementation of the strategy (beginning with children born in May 2016: 910 children).

Figure 1



For both the first and third period, a stable trend in average days unprotected by the vaccine was observed (p=0.6650 and p=0.5530, respectively). The average days unprotected before implementation of the strategy was 56.75 (CI95%: 52.57-60.93) and in the post intervention period, 21.39 (CI95%: 18.56-24.22). The change observed in the averages for the first and third period was statistically significant (p<0.0001), and a 62.31% reduction in average days without vaccine protection was achieved, meaning that the cohort of children in the period prior to the intervention received the vaccine 35 days on average

Figure 2



[18] Kim HJ et al. Permutation tests for joinpoint regression with applications to cancer rates. Stat Med 2000;19:335-51 (correction: 2001;20:655).

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after the post-intervention cohort.

- **Incoming students**

The percentage of schoolchildren who had received each of the three vaccines (DTP, MMR, and Sabin oral) on entering school was calculated by the school and for all schools.

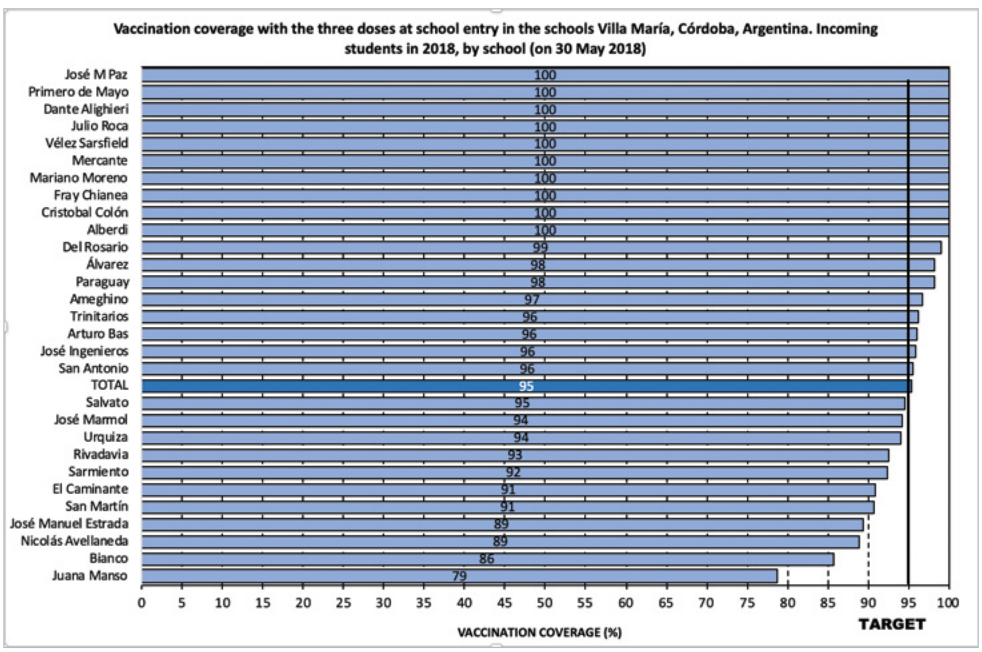
Among the children who entered in 2017, the coverage evaluation was done on 26 September of that year: of the 1,597 schoolchildren, 1,299 (81.34%; CI95%: 79.40-83.28) had received the complete series. After the intervention conducted in the ensuing months, the number of vaccinated children on 5 December 2017 had risen to 1,538 (96.79%; CI95%: 95.89-97.69) out of a total of 1,589 schoolchildren (eight had transferred to other locations). The increase in coverage was 19.07% (p<0,0001). See **Figure 2**.

For the children who entered school in 2018, the first evaluation was conducted on 29 April 2018, and it was found that of the 1,733 schoolchildren, 1,162 (67.05%; CI95%: 64.81-69.29) had the complete series. Vaccination activities were carried out in the ensuing months, increasing the number of children with complete vaccination series on 31 May 2018 to 1,686 (97.29%; CI95%: 96.49-98.08) out of a total of 1,733 schoolchildren. The increase in coverage was 45.10% (p<0.0001). See **Figure 3**.

In this case, incoming students' time without vaccine protection had been reduced. The fact that the intervention had begun early in 2018, in contrast to 2017, was essential to achieving this. In 2017, the goal of 95% coverage was achieved 272 days after the start of the year (6-3-2017), while in 2018, it was reached in 87 days (5-3-2018), more than a two-thirds reduction in the time without protection.

Furthermore, on 6 December 2017, 19 of the 29 schools (65.5%) had met the target, while, on 30 May 2018, 22 of the 29 schools had done so (75.9%).

Figure 3



Conclusions

The strategy of using the SIGIPSA EIR was effective for individualizing the target population, ascertaining its vaccination status, and facilitating the organization of active searches to complete the series. Systematic use of the EIR to update vaccination information and rapidly identify children with incomplete vaccination was key to reducing delays in the administration of the vaccines.

This is how a significant reduction was achieved in the indicator of days without protection with the third dose of the pentavalent vaccine, used as the reference vaccine for evaluating the strategy's results. The average reduction between the cohorts of children before and after implementation of the strategy was 35 days.

For the vaccination of incoming students, 95% coverage with the three respective vaccines was achieved in 2017 and 2018. In 2018, the target was met more than six months sooner, since the analysis and intervention had begun early on.

The activities were carried out in the context of a firm commitment by municipal health authorities to meet the vaccination coverage and timeliness targets. This translated into the allocation of specific resources to guarantee access to vaccination in all services and encourage the population to use the vaccination centers.

A systematic review of SIGIPSA was necessary, including verification of the number of vaccinations administered and an active search for information from other records (vaccination cards) in cases where the vaccination had not been entered in the system.

Field work through all the services was also necessary, conducted by interdisciplinary teams with close ties to the community and who had the resources needed to do their job. This team received continuous updates on progress and achievements through the systematic production of vaccination coverage and timeliness indicators for the children and students assigned as part of the Ministry of Health's Comprehensive Territorial Management Program.

Although the benefits of these activities were important in terms of improving the coverage and timeliness of vaccination, this article did not include an assessment of the related costs, which is considered a future study topic to evaluate the scalability and replicability of the work.

The results of all this work demonstrate the usefulness of EIR systems for the organization of vaccination,[19] since they make it possible not only to evaluate the vaccination status of people in the registry and identify those with incomplete series, but to prepare vaccination schedules to reduce delays in the administration of the vaccines.

Better utilization of these registries is thus very important for capitalizing on their potential and improving the coverage and timeliness of vaccination in the population within the framework of the Pan American Health Organization's Plan of Action on Immunization.[20] ■

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[19] Dumit EM et al. The use of eHealth with immunizations: An overview of systematic reviews. Vaccine. 2018 Dec 18;36(52):7923-7928.

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Carolina Danovaro.

French in London?) and worked part-time in the surveillance of congenital infections at the Institute of Child Health's Paediatric Epidemiology and Biostatistics Unit. I then became a fellow at the International Vaccine Institute (IVI) in Seoul, South Korea, to do more field work. At IVI, I contributed to studies on typhoid fever and cholera vaccines, mainly in Hue, Viet Nam, and Calcutta, India, and I will never forget the month I spent in 2003 in Heichi, Guangxi, in southern China, during the raging SARS epidemic,[4] supporting typhoid fever vaccination. Then came my 11 years in the PAHO Immunization Program, which included the challenge of managing the Newsletter, which I will tell you more about, since they were the most gratifying years of my life.

I learned from my mother to be a complete person and from my grandmother, to be generous. During my high school and university years, with many trips to the field, I learned about solidarity and compassion (and to understand how it differs fundamentally from pity): with compassion, there is empathy, and we work with others on an equal footing, understanding that our "humanity" is our great common value. From my medical studies and short career as a general practitioner, I learned about clinical practice with its advantages and disadvantages, and from my patients, I learned a thousand life lessons. In my three years at the CDC, I learned about technical expertise and the importance of scientific rigor and the rigorous use of language to communicate clearly. In London, I learned about methods and theory, and in Asia, a lot of patience. There isn't enough space to list everything I learned from my time at PAHO from my PAHO and country colleagues, mentors, and the people in every community and health center I had the opportunity to visit: the EPI evaluations, the supervision of interns and trainees, the work in quality, data analysis, and name registries of immunized persons, the support for coverage surveys and rapid monitoring, epidemiological surveillance, the study of outbreaks of vaccine-preventable diseases (which at this point should not exist!), the support for vaccination in Haiti, especially after the earthquake of 2010 (it was worth learning French, after all). What I learned from my time at PAHO can be summarized in the three Ps: passion, patience, and persistence. Finally, by managing this Newsletter, first as an associate editor and then as the editor, writing the immunization chapters of "Health in the Americas[5]" and other publications, I learned that not only must we do things, we must document them to record our history and leave it for those who follow.

In some ways, the Immunization Newsletter is an attempt to honor our brilliant, devoted, humble, and passionate people, many of whom, such as the nurses and health workers of the Americas, deserve to be named "public health heroes." Sharing experiences and the knowledge generated is part of our work and our duty in public health.

Vaccines have saved millions of lives, and because of this, in some places they have become victims of their own success. At its birth, the EPI included vaccines for only six diseases; now we have so many more, including vaccines for hepatitis B and even cancers such as cervical cancer. New generations do not even know about some of the diseases that the vaccines protect them from; babies are no longer born blind, deaf, and with cardiovascular defects caused by congenital rubella, and people certainly have never seen anyone die of measles, diphtheria, or tetanus or who has been paralyzed by the poliovirus. Those of us who have seen it cannot forget. I am horrified and saddened to see coverage declining in some communities and how some people reject vaccines out of fear or ignorance. At the same time, however, I am optimistic, and it cheers me enormously to see that countries have rapidly introduced "new" advanced vaccines against pneumonia and meningitis, rotavirus, human papillomavirus, and other diseases.

I am also happy to see how new technologies promise to make us more efficient and, hopefully, more effective in our work to bring vaccines equitably to all. Once again, it is our duty to share what we continue to learn in this new context with the entire EPI family, especially those who bring vaccines to the community.

I hope that the Immunization Newsletter will continue to record our history and share it with the entire world.

Happy 40th birthday, Newsletter! And thank you, EPI!■

[4] https://www.cdc.gov/sars/about/fs-sars.html
[5] http://www.bvs.hn/php/level.php?lang=es&component=39&item=3