Bacillus Calmette-Guérin Vaccine: Supply and Demand Update

UNICEF Supply Division

August 2019
Bacillus Calmette-Guérin Vaccine
Supply and Demand Update – August 2019

This update provides revised information on Bacillus Calmette-Guérin vaccine supply availability and demand. Following a period of constrained supply, there is now sufficient availability to meet all country requirements for 2019 and beyond from diverse sources of affordable and flexible supply. Despite high vaccination coverage rates, tuberculosis remains one of the leading causes of death worldwide.

1. Summary

- Tuberculosis remains one of the world’s leading causes of death, and the greatest cause of mortality by a single infectious agent.\(^1\)
- UNICEF procures Bacillus Calmette-Guérin (BCG) vaccine on behalf of countries in support of child vaccination. Following a period of constrained supply, BCG vaccine supply is now stable and sufficient to meet all current country requirements both globally and through UNICEF. Global demand for BCG vaccine is estimated to be approximately 300 million doses a year,\(^2\) of which UNICEF procures approximately 50 per cent on behalf of 70 countries.
- Procurement through UNICEF increased during a constrained supply period from 2015-2016, to reach 160 million doses in 2017 as countries sought to replenish depleted country stocks from the previous years’ constrained supply. UNICEF now anticipates country demand channelled through UNICEF to rebalance and revert to its previous average of between 135-155 million doses on account of improved country stock availability for 2019 and beyond.
- UNICEF concluded its recent 2019-2023 BCG vaccine supply tender in 2018. UNICEF awarded five manufacturers to secure improved vaccine supply by diversifying its sources of affordable and flexible supply, ensuring sufficient buffer production capacity, and stabilizing BCG vaccine pricing.
- UNICEF, in collaboration with its partners, will continue to work with countries to share knowledge and develop country capacity to ensure greater vaccine demand forecast accuracy, effective vaccine supply, timely budgeting and financing, as well as improving vaccine management efficiency and effectiveness. UNICEF encourages countries to expand country supply security by licensing additional vaccine products from multiple manufacturers, and requests countries to communicate any changes in their demand forecasts and choice of procurement channel as early as possible to ensure requirements can be met in a timely manner.

2. General Brief and Background

Tuberculosis (TB) is one of the top ten causes of global mortality and is a leading cause of death in people infected by HIV.\(^3\) It is a curable and preventable bacterial infection caused by the Mycobacterium (M.) tuberculosis which mostly affects the lungs, and is transmitted from person to person via respiratory droplets from the nasopharynx. Approximately one-quarter of the world’s population (1.7 billion people) has latent TB, which means people are infected by TB but do not manifest any symptoms or transmit the disease,\(^4\) of which 5-15 per cent will develop the disease in their lifetime. Whilst there are TB cases in all countries, and in all age groups, eight countries account for two thirds of all new reported cases of TB. These are India (27 per cent), China (9 per cent), Indonesia (8 per cent), the Philippines (6 per cent), Pakistan (5 per cent), Nigeria (4 per cent), Bangladesh (4 per cent), and South Africa (3 per cent).\(^5\) In 2016, an estimated 10.4 million people developed active TB, of which about one million were children.\(^6\) Other populations at high risk of TB include people with HIV infection, as well

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2. Data is based on global cohort included in WHO/UNICEF Joint Reporting Format (JRF).
as vulnerable populations such as refugees. Even though the global incidence of TB is decreasing by about two per cent a year, it is not fast enough, and it remains the world’s third highest cause of mortality by infectious disease as well as the world’s greatest cause of mortality by a single infectious agent. At the same time, multidrug-resistant TB (MDR-TB) continues to present a growing threat to global public health.

The United Nations (UN) Sustainable Development Goals (SDGs) seeks to end TB epidemics by 2030 (Goal 3). The End TB Strategy, endorsed in 2015 by the World Health Organization (WHO), seeks to reduce the number of TB deaths by 95 per cent by 2035 compared to 2015 rates. The main health-care interventions to prevent new TB infections are the treatment of latent TB and the vaccination of children with BCG vaccines. The strategy targets the vaccination of infants as one of its main components, as WHO estimates that widespread BCG routine infant immunization could prevent over 100,000 deaths per birth cohort from TB during the first 15 years of life.

The BCG vaccine is a live attenuated freeze-dried vaccine. It should be stored at temperatures between 2 to 8 °C and not be exposed to direct sunlight or heat. It is a lyophilised vaccine to be reconstituted with diluent that can be stored outside of a cold chain. WHO has prequalified five BCG vaccines for neonatal and infant vaccination from five manufacturers in four countries, all of which come in 20-dose vial or ampoule presentations (Table 1).

**Table 1 WHO Prequalified Bacillus Calmette-Guérin Vaccines**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>WHO PQ</th>
<th>Formul.</th>
<th>Schedule</th>
<th>Presentation</th>
<th>Shelf Life</th>
<th>Cold Chain Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AJ Vaccines (Denmark)*</td>
<td>1994</td>
<td>Lyophilised</td>
<td>1 ds</td>
<td>20 ds vial</td>
<td>12-24 months</td>
<td>0.665 cm³</td>
</tr>
<tr>
<td>BB-NCIPD (Bulgaria)**</td>
<td>1991</td>
<td>Lyophilised</td>
<td>1 ds</td>
<td>20 ds ampoule</td>
<td>24 months</td>
<td>0.990 cm³</td>
</tr>
<tr>
<td>Green Signal Bio Pharma (India)</td>
<td>2015</td>
<td>Lyophilised</td>
<td>1 ds</td>
<td>20 ds vial</td>
<td>24 months</td>
<td>0.540 cm³</td>
</tr>
<tr>
<td>Japan BCG Laboratory</td>
<td>1987</td>
<td>Lyophilised</td>
<td>1 ds</td>
<td>20 ds ampoule</td>
<td>24 months</td>
<td>0.720 cm³</td>
</tr>
<tr>
<td>Serum Institute of India</td>
<td>2003</td>
<td>Lyophilised</td>
<td>1 ds</td>
<td>20 ds vial</td>
<td>24 months</td>
<td>0.878 cm³</td>
</tr>
</tbody>
</table>

*Note*: Formerly Statens Serum Institut.
**Note**: Buł Bio-National Centre of Infectious and Parasitic Diseases of Bulgaria, formerly sold by Intervax.

BCG vaccines are immunogenically interchangeable, even though their use depends on separate national regulatory authority (NRA) licensing in different countries, and different administrative and programmatic training based on whether they choose a vial or ampoule presentation. Most BCG bulk is used in the production of immunotherapy for early stage bladder cancer, for which supply and dosage indications differ from that used in TB prevention, and which are not described or included in this note.

**Table 2 Non-exhaustive List of non-Prequalified Bacillus Calmette-Guérin Vaccines**

<table>
<thead>
<tr>
<th>Bio Farma, Indonesia</th>
<th>Merck (the United States of America)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomed Lublin (Poland)</td>
<td>Microgen (the Russia Federation)</td>
</tr>
<tr>
<td>China National Biotec Group, Chengdu (China)</td>
<td>National Institute of Infectious Diseases and Vaccinology (Taiwan)</td>
</tr>
<tr>
<td>China National Biotec Group, Shanghai (China)</td>
<td>Pasteur Institute of Iran (Iran)</td>
</tr>
<tr>
<td>Fundacao Ataulpho de Paiva (Brazil)</td>
<td>Taj Pharmaceuticals Limited (India)</td>
</tr>
<tr>
<td>Institut Pasteur de Tunis (Tunisia)</td>
<td>Thai Red Cross Society (Thailand)</td>
</tr>
<tr>
<td>La Administración Nacional de Laboratorios e Institutos de Salud (Argentina)</td>
<td>The Institute of Vaccines and Medical Biologicals (Viet Nam)</td>
</tr>
<tr>
<td>Medgamal (the Russian Federation)</td>
<td>Torlak Institute (Serbia)</td>
</tr>
</tbody>
</table>

Source: WHO / The Global Vaccine Market Model / UNICEF Supply Division

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Several other manufacturers in fourteen countries produce non-WHO prequalified BCG vaccines, mainly for their own markets. These include Brazil, China, India, Indonesia, Iran, Poland, the Russian Federation, Serbia, Thailand, Viet Nam, and the United States of America, amongst others, and which include products in 5-, 10-, and 20-dose vial and ampoule presentations (Table 2). None of these manufacturers have indicated plans to pursue WHO prequalification.

3. Innovation

The BCG vaccine was developed nearly 100 years ago, and is one of the world’s most widely used vaccines, first used in humans in 1921.\(^{14}\) It has been part of the expanded programme of immunization (EPI) since initiated in 1974, which is a programme to ensure that #ForEveryChild, in all countries, benefits from life-saving vaccines.\(^{15}\) BCG vaccines have historically had a solid supply base. BCG vaccines are effective in preventing TB in infants and are recommended at birth in countries or settings with a high incidence of TB and/or high burden of leprosy, ideally together with a dose of Hepatitis B at birth. However, these vaccines have a limited effectiveness in older age groups, and in addition, the protection offered by these vaccines have not been consistent against all forms of TB, in all age groups.\(^{16}\)

Much more effective TB vaccines are needed to decrease TB mortality,\(^{17}\) particularly to prevent pulmonary TB, the most common form of the disease. Pulmonary TB mostly occurs in adolescents and adults, and is responsible for TB transmission. Considerable efforts are being made by international donors, manufacturers, and research institutions to develop second generation TB vaccines using different technologies. Several next generation TB vaccine candidates are currently in advanced stages of clinical development and studies. Whereas some pipeline products are designed for use as a booster dose following primary neonatal BCG vaccination, others are being evaluated for use in adolescents, adults, and in therapy.

According to the tuberculosis vaccine initiative (TBVI), there are twenty one different TB candidate vaccines undergoing different stages of development (Figures 1, 2, and 3).\(^{18}\) Researchers are investigating the effectiveness of these new TB vaccines to see if any can equally be used to prevent TB in infants, adolescents, and adults, prevent latent TB from becoming active, as well as to treat active TB, and to prevent transmission.

Researchers made some advancements in 2018 in the prevention of active pulmonary TB disease in adults, notably in the positive clinical trial outcome of one vaccine supported by GlaxoSmithKline (GSK),\(^{19}\) and Aeras (a nonprofit organization developing new, effective tuberculosis vaccines, which has since been acquired by the International AIDS Vaccine Initiative (IAVI), a global nonprofit, public-private partnership working to accelerate the development of vaccines to prevent HIV infection and AIDS).\(^{20}\) Further tests will continue through early 2019. However, there is currently no information on when any new vaccines will be available.

**Figure 1 Global Clinical Pipeline for TB Infant Neonate Vaccines**

<table>
<thead>
<tr>
<th>Infant / Neonate</th>
<th>Live, VPM 1002, SII, Max Planck, VPM, TBVI</th>
<th>Live, MTBVAC, Biofabri, University of Zaragoza, TBVI</th>
<th>Live, BCG-ZMP1, University of Zurich, TBVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preclinical</td>
<td>Phase 1</td>
<td>Phase 2a</td>
<td>Phase 2b</td>
</tr>
</tbody>
</table>

Source: TuBerculosis Vaccine Initiative

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\(^{15}\) The initial six standard EPI vaccines included *diphtheria / tetanus / pertussis (DTP)*, *measles, polio*, and *tuberculosis*. From 2010, depending on the country programme, EPI can include *pneumococcal conjugate, rotavirus, hepatitis B*, *haemophilus influenzae Type B, yellow fever, rubella, Japanese encephalitis*, and *meningococcal meningitis A* vaccines.

\(^{16}\) WHO. *BCG Vaccines: WHO Position Paper*. p. 84.

\(^{17}\) WHO. *Global Tuberculosis Report*. p. 159.

\(^{18}\) The *Tuberculosis Vaccine Initiative, Pipeline of Vaccines*, TBVI, Lelystad, October 2018.


Figure 2 Global Clinical Pipeline for TB Therapeutic Vaccines

Source: TuBerculosis Vaccine Initiative

**Figure 3 Global Clinical Pipeline for TB Adolescent and Adult Vaccines**

Source: TuBerculosis Vaccine Initiative

**Note:** The information is valid since October 2018, and there may have been further advancement and developments in these vaccines

### 4. Wastage Rates

Higher wastage rates are expected for reconstituted vaccines as they must be discarded at the end of an immunization session, or six hours after reconstitution, whichever comes first. It can result in some countries to consider wastage rates for BCG vaccines of up to 90 per cent in their UNICEF quantification and demand forecasts. Even though there are many factors linked to vaccine wastage rates, the main cause for the high wastage rates in BCG vaccines is the large vial size presentation, combined with having to discard remaining doses at the end of sessions, or six hours after reconstitution. Routine immunization sessions using 20-dose vials or ampoules often end up with considerable levels of wastage as there are frequently fewer children present at any given session requiring a BCG vaccine. The large vial and ampoule size presentation is considered a major factor in this vaccine’s low coverage and high wastage rate in community outreach strategies targeting home births in rural remote settings. Primary healthcare workers are often reluctant to open a 20-dose BCG vial or ampoule for a few children in attendance in order to avoid wastage, even if it leaves a child unvaccinated. WHO’s EPI policy guidelines encourage healthcare workers to immunize #ForEveryChild at every opportunity, as well as to discard any unused reconstituted BCG vaccine at the end of an immunization session or after six hours, whichever comes first, regardless of how few children there are in attendance.

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22 Ibid.
In 2001, UNICEF reviewed the cost-effectiveness of changing the vial size of BCG vaccines from a 20-dose presentation to a 10-dose presentation. Manufacturers at the time advised that making such a change was not a viable option, both economically, and technically, and provided calculations to show that there was only a two to eight per cent reduction in vial price using a 10-dose vial. The price difference was not considered sufficient and too marginal to offset any savings on account of reduced wastage rates, despite only containing half the product. Manufacturers calculate their economies of scale based on the cost of their production and lyophilization lines, the number of ampoules or vials produced, as well as the cost of the specialised glass used to produce the ampoules and vials, and not the actual cost per dose. As such, it is more cost effective to waste the product rather than reduce the vial size. Manufacturers also indicated that reducing the vial or ampoule quantity could affect the potency and stability of the vaccine, as it may be a challenge to fill the correct amount of freeze dried vaccine in a 10-dose vial.

5. Current Market Situation

In 2018, the production of BCG bulk represented a market value of 300 million USD, of which most (93 per cent) was used for the production of intravesical immunotherapy to treat early-stage bladder cancer from BCG vaccines. The Global Vaccine Market Model estimates revenues from BCG vaccines will reach approximately 63 million USD in 2019 with demand from MICs representing approximately 74 per cent (Figure 4), over an even geographical spread (Figure 5). However, UNICEF considers this estimate to be inflated, and estimates global revenues to be closer to between 40-50 million USD a year based on WHO’s vaccine product, price, and procurement data, and UNICEF global demand estimates.

![Global BCG Demand in USD per Classification 2019](source)

![Global BCG Demand in USD per Region 2019](source)

UNICEF procures BCG vaccines primarily for approximately 70 low- and middle-income countries (LICs and MICs), although in recent years several other MICs have sought to channel their procurement through UNICEF following the global supply constraints from 2015. UNICEF procured up to 160 million doses in 2017, representing an estimated 57 per cent share of the global market. Of this volume, 68 per cent was procured on behalf of MICs (Figure 6). Historically, UNICEF’s share of global demand is approximately 50 per cent, while self-procuring countries purchase approximately 45 per cent. Procurement estimates through the Pan American Health Organization (PAHO) represent approximately five to eight per cent.

![Low- and Middle-income Country BCG Vaccine Procurement through UNICEF 2017*](source)

Source: The Global Vaccine Market Model

**Note**: Current data is only available for 2017. WHO country self-reporting data may contain some inaccuracies.

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23 Ibid., p. 30.
24 Ibid.
In 2017, 158 countries and territories reported providing BCG vaccination for which 120 countries reported coverage rates reaching at least 90 per cent, and only 19 countries reached reported coverage rates of less than 80 per cent.\textsuperscript{27} Whereas most countries have adopted WHO’s recommendation of universal BCG vaccination of infants at birth, a few countries also provide a booster dose at the onset of adolescence. There are a few other countries, mainly those with very low TB endemicity, mostly in western Australia, Europe, and North America, that only vaccinate selected subgroups they consider to be at high risk of contracting TB.\textsuperscript{28}

UNICEF estimates the global production capacity of manufacturers with WHO prequalified BCG vaccine has increased to reach an estimated 580 million doses a year, notably on account of AJ Vaccines in Denmark (formerly Staten Serum Institut of Denmark), having resumed the production of BCG vaccines with an enhanced capacity. This brought the cumulative production capacity for BCG to over twice estimated global demand. The global supply of WHO prequalified BCG vaccines is also now covered by a wider geographically diverse base and NRA clearance range.

5.1 Demand

Historically, the demand for BCG vaccine through UNICEF has averaged 120 million doses annually until 2012 (Figure 7). From 2013 through to 2016 demand increased to between 135-155 million doses following supply interruptions from some WHO prequalified manufacturers. This reduced global supply availability and lead to a constrained supply of BCG vaccine on the global market. As several self-procuring countries could no longer secure their BCG vaccine requirements from their usual sources, they sought to channel their procurement through UNICEF, which increased the demand through UNICEF leading to a supply gap that was carried over to subsequent years as unmet demand.

Figure 7 UNICEF BCG Vaccine Supply from 2001 and Demand Forecast for 2019-2022

[Diagram showing BCG demand and forecast from 2001 to 2022]

Source: UNICEF Supply Division.

In 2015, UNICEF, WHO, and partners, took a number of actions to mitigate the interruption risks to country immunization programmes, which included extensive consultations with all 70+ countries that procured BCG through UNICEF, in addition to securing additional quantities from manufacturers where possible. Supply availability improved in 2016 as Green Signal of India entered the market with a new WHO prequalified product and a large production capacity, combined with other manufacturers resuming production after they had refurbished and upgraded their production facilities, which would further mitigate the risk of any production failures. In 2017, UNICEF registered a peak in demand from countries when it procured

\textsuperscript{27} WHO, \textit{Global Tuberculosis Report}, p. 3.
up to 160 million doses to replenish depleted country stocks (Figure 7). As many countries had consequently sufficient stock availability, they carried this over into 2018, resulting in a 34 per cent decrease in procurement through UNICEF.

Based on the current demand forecast estimates UNICEF received from countries for 2019 and beyond, UNICEF anticipates that country demand channelled through its procurement services will revert back to its previous balance of around 135-155 million doses per year (Figure 7).

Countries tend to prioritise well the support for their TB immunization programme. They have also historically forecasted their BCG vaccine needs relatively accurately with a maximum variance of less than 15 per cent. However, higher variances may occur when countries issue sudden requests to procure through UNICEF, mainly due to poor planning and or issues related to stock management. Due to the nature of BCG vaccine production, manufacturers have difficulty to accommodate sudden changes in country demand at short notice. As a result, UNICEF requests countries to communicate any changes in their demand forecasts and choice of procurement channel as early as possible to ensure requirements can be met in a timely manner.

5.2 Supply

Over the past decade, the BCG market suffered several manufacturer exits and supply interruptions from both local and global manufacturers. BCG Vaccine Laboratory in India ceased BCG vaccine production in 2008-2009; Sanofi Pasteur in Canada suspended the production of all BCG products in 2012; and several WHO prequalified manufacturers experienced temporary interruptions to their supply during 2013 to 2015. However, since 2016, the BCG vaccine market’s supply situation has substantially improved with a new WHO prequalified manufacturer entering the market in 2016 (Table 1) and one former manufacturer resuming production with enhanced capacity.

Around 60 per cent of WHO prequalified products supplied through UNICEF, and over 50 per cent of the global BCG supply, is produced by Indian manufacturers and cleared by the Indian NRA. This makes the BCG market highly dependent on one country’s regulatory capacity and susceptible to supply constraints should any disruptions occur.

In order to ensure that manufacturers have good visibility and certainty of country demand requirements through UNICEF, enabling them to plan and allocate their production capacities more accurately, stabilize pricing, and maintain affordability, UNICEF concluded its tender in 2018, awarding five manufacturers long-term supply arrangement (LTAs) for the period of 2019-2023 (Table 3).

Table 3 UNICEF BCG Vaccine Long-term Arrangements in Doses 2019-2023

<table>
<thead>
<tr>
<th>BCG Vaccine</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>140,000,000</td>
<td>124,200,000</td>
<td>127,200,000</td>
<td>127,200,000</td>
<td>TBD</td>
<td>518,800,000</td>
</tr>
</tbody>
</table>

Source: UNICEF Supply Division.

UNICEF awarded the full demand for 2019 but retained 20 per cent of the projected demand unawarded for 2020-2022 pending more accurate demand estimates. The awards for 2023 also do not specify any quantities and will be finalized during the second quarter of 2022 subject to UNICEF having more accurate visibility on country demand requirements, and country plans on how to channel their procurement. UNICEF anticipates issuing its next BCG tender in 2023 for supply in 2024 and beyond.

6. Pricing

All countries procuring BCG vaccine through UNICEF access the vaccine at the same price irrespective of their per capita income levels, World Bank lending classification, and irrespective of whether or not they access donor support (e.g. from the Gavi, the Vaccine Alliance) for other vaccine programmes.

BCG vaccine prices have been relatively stable since 2004 through 2015, remaining at approximately USD 0.08 per dose. Over the previous 2016-2018 tender period, the weighted average price (WAP) per dose for BCG vaccines increased by 22 per cent, reaching USD 0.104 per dose (Figure 8). UNICEF’s recent tender for supply during 2019-2023 concluded with a similar WAP price increase of 22 per cent reaching USD 0.128 per dose. These increases in WAP reflect the increases in
business costs experienced by most manufacturers following their refurbishment costs during recent years, higher production costs, and increased regulatory requirements. However, UNICEF considers these increases brought the price of BCG to sustainable levels, which should remain stable over the next five years. UNICEF does not anticipate any further price increase in BCG vaccines over the next tender period.

Figure 8 UNICEF BCG Vaccine Weighted Average Price 2001-2023, in USD per dose

Source: UNICEF Supply Division

For further details on BCG vaccine pricing through UNICEF, please see here.

7. Issues / Challenges

- Due to the nature of the product and production processes, any sudden changes in demand or supply poses a challenge for manufacturers to accommodate supply availability, which can lead to interruptions in supply.
- Despite BCG vaccines being interchangeable, many countries tend to limit their choice of vaccine by only licensing one product, whether buying directly or through UNICEF. This limits their flexibility to receive alternative vaccines from multiple manufacturers and improve their vaccine security. By restricting licensing requirements as well as product preferences, countries reduce their ability to receive BCG vaccines from different manufacturers, and mitigate the risk of programme interruption in case of supply disruptions.23
- The supply of BCG is highly dependent on the Indian NRA, as it releases more than half of global BCG supply produced by Indian manufacturers.
- The large vial presentation, which leads to high wastage rates, remains a challenge, and although economically justifiable, results in behavioural barriers amongst health workers.
- Despite substantial investments in new TB vaccine product research and development, as well as recent advancements, there is as yet no information on when a new vaccine will be available.

8. Steps Forward

- UNICEF requests countries to inform UNICEF of any changes in their demand forecasts and choice of procurement channel as soon as possible, allowing manufacturers and UNICEF to adjust supply allocations accordingly where possible.
- UNICEF encourages countries to continue to improve their country planning and prioritise vaccine budgeting and financing to ensure accurate forecasting and timely access to vaccine.

• UNICEF advises countries to communicate any plans to change vaccine registration requirements, or switch vaccine presentations in a timely and explicit manner. Countries requiring vaccine registration are advised to consider applying expedited registration procedures for vaccines that are WHO prequalified. This would ease in-country registration requirements. Countries are also further advised to register more than one manufacturer per vaccine to ensure greater vaccine security and to mitigate any risk of interruption.
• UNICEF encourages countries to support the additional training of healthcare workers, where required, to ensure that #ForEveryChild is vaccinated at each opportunity and not to turn away any unvaccinated child regardless of wasting the unused contents of a BCG vaccine vial or ampoule.
• UNICEF advises there to be a review of wastage rates and to assess strategies to optimise BCG vaccine programme delivery in countries that have reported very high BCG vaccine wastage rates.
• UNICEF will closely engage with research institutions and industry to monitor progress towards next generation TB vaccine and will work with countries and programmes accordingly as developments progress.
• UNICEF anticipates to issue its next tender for supply of BCG vaccine in 2023.

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