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Vaccinating Africa: What Governments Can Learn From Rwanda's Effective Rollout

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Introduction

In a race to save lives and livelihoods, the scientific and medical communities around the world undertook an unprecedented endeavour when they set out to create a safe and effective vaccine for Covid-19. With extraordinary resources and dedication, researchers have produced in a matter of 12 months what normally takes years, if not decades. Moreover, there are not one or two viable vaccines, but nearly ten and counting, three of which have officially received Emergency Use Listing (EUL) from the World Health Organisation (WHO) with others under authorisation in a number of countries. This remarkable feat is laudable and has given the world much-needed hope. However, the pandemic does not end with successful vaccine development. It ends with successful vaccine *deployment*.

The unprecedented efforts by scientists must be met equally with unprecedented efforts by governments when it comes to vaccination rollout. The work done to produce a vaccine cannot be undermined by lack of preparedness. Yet, like with vaccine development, vaccine deployment is of a scale unlike anything undertaken previously. The end-to-end logistics necessary for a population-wide vaccine campaign are highly complex. The rollout will require a vastly coordinated and sustained effort among diverse actors. It will involve strategic and tailored delivery structures enabled by digital technology and data systems. But those efforts will be futile if the public is uninformed or unwilling to receive the jab. This complexity is especially challenging in sub-Saharan Africa, where infrastructure critical to vaccine deployment, like cold-chain refrigeration and digital data collection, is more limited.

For most countries in Africa, procuring enough vaccines has been an added challenge. In terms of doses administered per 100 people, North America leads the world with 17.4, followed by Europe with 10.2. Latin America and Asia have dispensed 4.7 and 2.6, respectively. In comparison, Africa has administered just 0.4 doses per 100 people on a continent of 1.3 billion, with Morocco accounting for the bulk of those doses. [1] This global divide is partly because vaccine nationalism among high-income countries has boxed many lower- and middle-income countries out of access to the initial limited global supply. Although COVAX (the Covid-19 global access initiative, co-led by Gavi, the WHO and CEPI) has now started delivering its first shipments to the continent and bilateral donations are trickling in, large-scale shipments are not expected for months.

Governments that have not yet put in place the necessary infrastructure to deploy a mass vaccination campaign must seize this moment to fully prepare. According to the WHO Africa Vaccine Readiness tracker, just 51 per cent of 46 countries assessed are equipped overall to deliver vaccines to their populations. [2] Given that the order in which COVAX ships available vaccines factors in readiness, governments in Africa need to get to work urgently, validating their distribution frameworks and mitigating gaps in preparedness. [3]

If countries are not equipped to implement mass vaccinations, the consequences are far-reaching. An inadequate cold chain will lead to vaccine spoilage. An inadequately trained workforce and uninformed public will lead to vaccine wastage. Premature expiration of vaccines will result in financial loss from the investment in those doses as well as in underserved communities, lower coverage rates and, ultimately, a slower timetable to reaching population immunity. The inability to efficiently deliver vaccines to the population means the virus will continue to spread, causing needless excess morbidity and death. It could also mean the segmentation of lower-coverage countries from the global economy, leading to huge economic losses and exacerbating global inequities. And with every new transmission, the virus has an opportunity to mutate. The longer the virus is allowed to spread, the more probable a mutation will occur that renders existing vaccine regimens ineffective. The stakes are high and there are risks at every step along the way.

Governments must ensure that the enormous efforts to develop a vaccine are not undercut by insufficient efforts to deploy them. What will it take to ensure effective vaccine deployment in Africa?

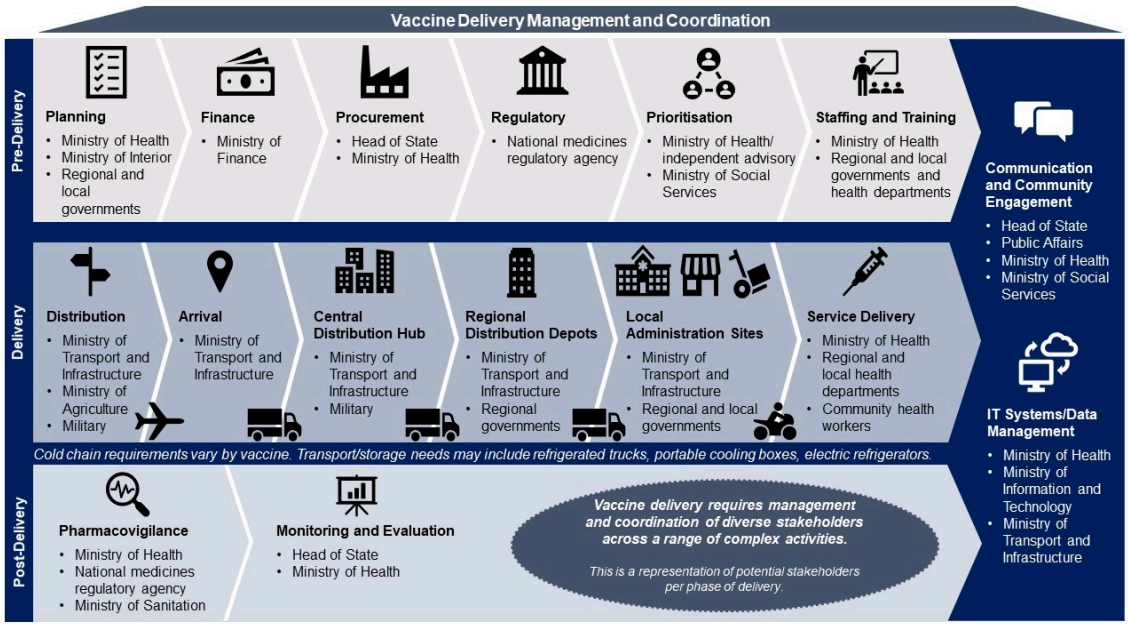
The early success of Rwanda's rollout illustrates four essential pillars for effective deployment:

1. Whole-of-government coordination
2. A tailored delivery approach
3. Digital data and technology infrastructure
4. Proactive communication with the public

Whole-of-Government Coordination

To vaccinate the entire population of a country as rapidly as possible will take the participation of nearly every ministry and every level of government. The to-do list is extensive, meticulous and multifaceted. Moreover, given what is at stake, all eyes will be on the rollout, underscoring that there is little margin for error. Taking a whole-of-government approach will not only ensure that no item on the checklist is forgotten, but it will also facilitate a more competent, transparent and accountable process.

Although existing structures used for routine immunisations should be leveraged, the scale and speed of the Covid-19 campaign calls for leadership beyond the Ministry of Health. Start-to-finish vaccine delivery demands management and coordination of diverse stakeholders across a range of complex activities.



Deployment must be adequately financed either through budget allocations or external funds, requiring senior oversight by the head of state and Ministry of Finance. Costs range from vaccine procurement and improvements in relevant infrastructure, for example, cold-chain storage, transport systems, electricity coverage and internet reach, to workforce recruitment and funding for incentives. If funding gaps to operationalise rollout activities are not closed, there are significant risks, including vaccines expiring while sitting unmoved from central warehouse shelves and insufficient administration sites, resulting in low coverage.

Vaccines received through COVAX will have WHO emergency use authorisation, but under the facility arrangement, national regulatory requirements must also be satisfied, indemnification and liability

agreements signed, national deployment and vaccination plans validated, and export and import authorisations approved. Authorising agencies in governments must prevent bureaucratic procedures from holding up rollout by getting a head start on safe fast-tracking processes and documentation when possible.

Because very few vaccines are currently manufactured on the African continent, supply will need to be delivered from abroad. Once cleared through ports of entry, the vaccines will need to be inventoried, batch tested, allocated for regional distribution based on population demographics, and then transported around the country. The process calls for military-like precision and will reoccur until the country achieves population immunity, and potentially beyond if Covid-19 vaccinations require periodic boosters.

Regional and local governments will have considerable input, especially when it comes to "last-mile" logistics and service delivery. For example, local contexts will dictate the best locations for setting up administration sites and strategies for communicating with the public. Quality of technology and data-management infrastructure will affect both local and national processes. Safe waste disposal cannot be neglected.

Governments will not only need to coordinate among themselves, but with private and non-governmental actors as well. These partnerships are critical to successful deployment. Vaccine and medical-supply manufacturers, health-care professionals, logistical companies, technology providers and media are among the key private-sector stakeholders. Non-governmental stakeholders range from massive multilateral partners like the WHO and African Union to local civil-society groups and religious institutions.

Governments will need a dedicated team to support the whole-of-government coordination from planning, to real-time tracking and reporting, to data analytics and deployment evaluation.

Rwanda's Rollout: Cross-Government Cooperation for Vaccine Delivery

To optimise synchronisation of actors and activities, the government of Rwanda established a coordinating mechanism at the national level that brought together decision-makers from each of the relevant offices. Months before the arrival of the first vaccines, the Scientific Advisory Group and National Task Force for Covid-19 vaccination began meeting weekly to establish a rollout strategy, identify gaps and mitigate risks in the delivery chain, and make key decisions. From these decisions, activities were organised across ministries and regional and local authorities. The committee reports regularly to the head of state on the status of planning and delivery.

Rwanda's whole-of-government approach was instrumental in the successful transport of AstraZeneca vaccines from the central distribution hub in Kigali to 14 remote areas of the country within 24 hours on 4 March and with little advance notice. In Kigali, the Ministry of Health

organised the allocation of vaccines, which were then transferred to hospital vehicles and Ministry of Defence helicopters. The Ministry of Defence helicopters transported the vaccines to the district hospitals. From there, with the support of the Rwanda police, the vaccines were distributed to area health centres. The effective cross-government coordination ensured that Rwanda would be ready to begin administering vaccinations across the country the next day.

Ministry of Health | Rwanda @RwandaHealth · Mar 4

Helicopters from @RwandaMoD & @RwandaPolice now delivering COVID-19 vaccines to remote parts of 14 different Districts. They will be picked up by District hospitals for distribution to area health centres. All vaccine shots will be administered within 48 hours starting Friday.

Tailored Last-Mile Delivery

Although there are a multitude of decisions and standards that will be set at the national level, effective vaccine rollout will require a tailored approached to the last mile of delivery (what it takes to get the vaccine from its last distribution hub and into people's arms). Local population demographics, cold-chain capacity and staffing resources all vary by community, influencing how last-mile logistics and service delivery play out.

Detailed Demographic Data

In many countries, core demographic data at the community level is not up to date. Yet, without current information on total population, age distribution, occupations, and aggregated high-risk comorbidities and non-communicable diseases, determining vaccine demand will be dangerously imprecise. To ensure vaccines are properly allocated at the regional and community levels, new population data will need to be collected, including on refugee, migrant and stateless populations. Collecting this level of data for all communities is unprecedented in some countries and will require a collaborative effort by the Ministry of Health, local government, community leaders, and local and international non-governmental organisations. This is a significant undertaking that should be initiated immediately.

Rwanda's Rollout: Rapid Nationwide Demographic Screening

The government of Rwanda is committed to vaccinating at least 60 per cent of its population* within the next two years. However, like most countries, it has established a tiered prioritisation list that provides vaccines to those at highest risk first: frontline health-care workers, the elderly and people with underlying chronic conditions. In order to calculate how many vaccines would be needed in each community according to this prioritisation, the government conducted a mass, rapid national screening process. Recognising that in more remote village settings, village leaders would have the most up-to-date information on community members and household structures, over the course of two months a cross-government operation was undertaken to survey communities and collect this information from local leaders. With updated population demographics and an up-to-date non-communicable diseases screening, the government of Rwanda can now accurately procure and allocate vaccine supply. Vaccines were pushed from the central stock warehouse out to all 50 district hospitals and cascaded onwards to more than 500 health centres based on this allocation.

> As a result, in the opening days of vaccinations Rwanda was able to effectively target priority populations – starting with frontline workers, the elderly, people with co-morbidities or disabilities, teachers, prisoners and refugees.
>
> **Based on current WHO threshold for attaining population immunity globally*

Variable Cold-Chain Capacity and Accessibility

Determining suitable points of care (where vaccine administration takes place) is influenced by local cold-chain transport and storage capacity. A vaccine must be maintained at its specified temperature to remain potent; if the temperature requirements are not maintained, the vaccine spoils and becomes useless. Cold-chain requirements vary by vaccine from normal refrigeration to ultra-frozen temperatures. Consequently, their transport and storage needs differ too, such as the type of refrigerator, power source, specialised trucks or transportation, and portable cooling boxes needed.

If local cold-chain capacity is robust and mobile, pop-up sites in markets, intersections or community centres may be the most visible and accessible points of care. However, if cold-chain infrastructure is constrained, points of care will be limited to locations with existing dependable refrigeration systems, such as hospitals, labs and health centres. These locations may be scarcer and harder to reach for certain populations. In reality, for countries that are procuring more than one type of vaccine, there may need to be a mixed approach to distribution, taking into account differing requirements for storage and available cold-chain capacity.

Geography and environment can also influence cold-chain capacity and point-of-care access. For example, annual rainy seasons may impede deployment to more remote areas. Contingency plans with alternative delivery mechanisms should be established. In Sierra Leone, there is a pilot programme distributing vital medication to cut-off communities through airborne drones. Drones may be an effective alternative for vaccine deployment.

Currently, the WHO weighted indicator for average cold-chain readiness on the continent is 56, indicating that cold-chain capacity is considerably constrained. To maximise ease of access for the population, governments should facilitate improvements to cold-chain infrastructure wherever possible in advance of rollout. Still, because cold-chain capacity must be considered when determining the best administration sites, points of care should be decided locally, not at the national level.

Rwanda's Rollout: Strategic Cold-Chain Utilisation

Rwanda completed a cold-chain capacity assessment in late 2020. Based on that assessment, the government was able to identify areas that would be more suited to certain vaccines than others. On 3 March, Rwanda received 240,000 AstraZeneca jabs and 100,000 Pfizer jabs though COVAX. To manage risk to local settings, the government decided to ship AstraZeneca, which requires normal refrigeration between 2 and 8 degrees Celsius, to more remote areas with weaker cold-chain capability. The Pfizer vaccine, which requires colder refrigeration of -25 to -15 degrees Celsius*, was distributed in the capital Kigali, where the cold-chain infrastructure was better equipped to handle a colder vaccine with five newly acquired ultra-cold freezers. In advance of vaccines arriving, Rwanda ensured it had enough storage with 437 new refrigerators recently deployed to hospitals and health centres, and acquisitions of refrigerated vehicles and cooler boxes.

**On 19 February, Pfizer revised its cold-chain temperature from its original ultra-cold requirement of -70 degrees Celsius.*

Other factors influence accessibility. For example, some members of the community may not be mobile, especially the most vulnerable elderly population, or are impeded in other ways from travelling to points of care. Where cold-chain infrastructure will permit, door-to-door vaccination may be effective. Some countries may consider incentive structures to increase vaccine access and uptake. For example, in some past immunisation campaigns, families were incentivised to show up for medical appointments through

the free distribution of long-lasting insecticide-treated bed nets. Incentives may differ across localities based on accessibility and community priorities, but must still be distributed equitably.

Sufficiently Skilled Staff

Failure to comprehensively map population data will result in a mismatch between vaccine demand and the supply of trained and available health-care workers to administer the jab. To roll out an immunisation programme at this scale, additional staff and resources for training will be needed. Supplementing the existing workforce is a critical step for successful implementation for two key reasons: to ensure target populations are reached as and when planned, and that routine vaccination and health-care services are not compromised during this time.

Demographic data will uncover communities with health-care worker shortages relative to the size of priority immunisation groups, helping governments determine how many additional staff are needed and facilitating reallocation of staff at the regional level. Staff will need to be skilled in vaccine administration, logistics, data entry and monitoring for safety. They will need to be both swift and vigilant. In Israel, multidisciplinary health teams were recruited to quickly operationalise the rollout, and retired nurses and military paramedics were reemployed to close the capacity gap.

To avoid spoilage, inoculators must know the temperature requirements and shelf life of every vaccine they are handling. To offset wastage, vaccinators must know how to maximise the dosing per vial and use low dead-space syringes, if available. Insufficient or poorly trained staff and planning will result in vaccine and resource waste and, ultimately, missed target goals. Millions of Pfizer doses are expected to be wasted in Japan because these special syringes, which are needed to extract six doses from a Pfizer vial instead of the normal five, have not been sufficiently procured. [4]

Rwanda's Rollout: Health-Care Workers on Standby

Because the arrival date of Rwanda's first COVAX shipment was not confirmed until a few days before delivery, it was essential that health-care workers administering shots were recruited and trained in advance of the rollout. At least two vaccination teams were appointed at each hospital and health centre across the country more than a month before the immunisations commenced. Virtual and, where feasible, in-person service-delivery training was rolled out in the month before the campaign. Hospital directors, doctors, nurses, data managers and surveillance officers were trained on service delivery and data management, with a training surge across the country in the days before the campaign. Each vaccination site was given a checklist to ensure the requisite staffing, logistics, supplies and digital tools were in place the day before. This ensured that workers were on standby and ready the moment the vaccines arrived.

Digital Data and Technology Infrastructure

A vaccine programme of this magnitude will require digital data-management tools and technology infrastructure. To beat Covid-19, radical reform of data infrastructure is needed now. From rapidly updating nationwide demographic data sets to managing health information, from monitoring distribution operations to rejoining the global economy, robust information systems are needed end to end. The technology is ready, and in some countries may already be in hand. But for others, planning, delivering and monitoring a mass-vaccination programme will involve acquiring new tools.

Digitalising Systems for Real-Time Data

Wherever possible, countries should digitalise their operational and health-management systems. Digitised, up-to-date demographic data will significantly improve pre-delivery planning, including accuracy of demand and supply forecasting. In the delivery and post-delivery phases, digitisation of data will enable real-time situation monitoring and swift issue mitigation.

In the logistics space, there are significant risks to not having real-time data for situation monitoring. For example, without real-time data, a transporter who experiences a cold-chain refrigeration malfunction may not be able to communicate the problem in time to avoid vaccine spoilage. Digitally integrated national and local systems will improve operational agility. Real-time visibility will enable faster remediation of supply-chain disruptions and the reallocation of resources as needed. Electronic tracking and verification of vials and proof-of-delivery mechanisms are key tools for combating counterfeiters and safeguarding supply-chain security. Governments and private-sector providers must work together to improve digital technology infrastructure ahead of the rollout.

On the health system side, without real-time data, timely reporting of adverse events as part of essential pharmacovigilance is hindered. For example, with the right health-data infrastructure and reporting mechanisms in place, governments are better positioned to stay ahead of and respond to variant strains. Without a digital record, authenticating proof of vaccination becomes difficult. To rejoin the global economy, countries must be able to demonstrate that they have in place a health-management system for documenting vaccinations that meets global standards. This requires that a digital health record be created for every person as they get vaccinated. The registry should allow individuals to electronically certify proof of vaccination to others, such as when entering airports, schools or places of commerce. Data on vaccinations needs to be secure and portable, allowing individuals to authenticate their identity and acquire unique digital proofs that in turn can be validated or voided as required, all without leaking personal data to third parties.

The African Union and Africa Centres for Disease Control and Prevention are working on an integrated continent-wide approach to a travel pass for vaccines, which would pull verified information from national registries into a mobile app, serving as a digital passport.

Governments can pair their digital system for recording Covid-19 vaccines with travel passes, enabling individual insights alongside cross-border decision-making. A digital vaccine and testing passport will enable a safe and sustainable return to normality.

Rwanda's Rollout: Prioritising Digitalisation Nationwide

Technology and the use of data has been at the heart of Rwanda's Covid-19 response from the very start. As part of its rollout, Rwanda is pushing to digitise its record-keeping on health countrywide. Though getting staff trained on and accustomed to a new system can create initial process lags, still, the vast majority of vaccinations were tracked in real-time in a digital database that makes data available to decision-makers and citizens. Eliminating paper records is enhancing the ability of health teams and government to track health indicators in real-time and to digitally certify the status of those who have been vaccinated.

Data for Decision-Making

Without the support of digital technologies to aggregate data for reporting, the challenges and risks related to overseeing an operation of this complexity are compounded. Systems with real-time data reporting, analysis and insights will help to inform timely decision-making, from early warning of pressure points to algorithmic optimisation of rollouts. An internal-reporting mechanism that tracks the progress of deployment from end to end strengthens transparency, which is in turn an asset for earning public trust and safeguarding uptake.

Rollouts in Rwanda and Israel: Real-time Reporting for Decision-Making

In Rwanda, vaccinations were reported multiple times a day by health centres and districts to give the National Covid-19 Task Force, command post, head of state and cabinet a picture of the rollout.

In Israel, a digital dashboard with real-time information on the progress of the rollout and daily Covid-19 metrics are available to the prime minister and utilised by central decision-making teams to regularly monitor and assess the situation and report the status to relevant stakeholders. A similar dashboard is published and updated daily on the Ministry of Health website, providing the public with all the Covid-19 metrics including vaccine-rollout status. With this data, the prime

minister is able to reassure citizens through public messaging of both the competency of the deployment and safety of the vaccines.

Internet Access

Governments will need to evaluate the state of existing technology infrastructure, including broadband mobile internet penetration. Just 22 per cent of sub-Saharan Africans have access to the internet. [5]

Achieving universal internet access must be a development priority. The benefits of investing in internet access yielded across all sectors from health care to education far outweighs the cost, and the vaccine rollout offers an opportunity to accelerate such an effort. Working with communications providers to expand and upgrade national broadband internet coverage is an important part of this.

Lack of internet access does not preclude the digitalisation of record-keeping and data management: Where there is no internet coverage, system users (such as health-care workers on a health-management system or transporters using a logistics system) should be able to store information offline on a mobile device and then sync the data once in range of broadband or WiFi, or have measures in place that mean paper-based records are ultimately digitised. However, lack of comprehensive, reliable internet access will considerably impede real-time monitoring, increasing risks to effective deployment.

Accelerating the digitalisation of public-health systems is an investment with dividends that pay out long after the end of the pandemic. Advanced technology infrastructure will help to screen future disease outbreaks earlier and enable more timely and targeted policy interventions from leaders. It will also support governments in addressing overall challenges in public-health management and beyond.

Proactive Communication With the Public

Despite the mammoth undertaking to get a vaccine from development to production and then delivered into an inoculator's hands, all those efforts are futile if there is no arm waiting to receive the jab. As to why an individual may not show up for a vaccination, there are three crucial reasons that can be mitigated by a proactive public communications and engagement strategy.

First, certain members of the population may be hesitant to take the vaccine. A December 2020 survey by the Africa CDC and London School of Hygiene & Tropical Medicine found that, on average, four in five African respondents were willing to take a Covid-19 vaccine if it was deemed safe and effective. This is a promising finding and, if indicative of actual uptake, suggests that hesitancy would not be a barrier to achieving population immunity (the required threshold is currently expected to be two-thirds of the population). [6]

However, the willingness across countries ranged from 59 per cent to 94 per cent, and there were notable disparities within countries based on age, population density and prior exposure to the virus. [7] Among those who are hesitant, their rejection was attributed to misinformation, an individual's conviction that they were not personally at risk (including because they had already recovered) and belief in alternative medicines. Hesitancy may also derive from lack of trust in the scientific process, especially given the unprecedented pace of the vaccine development, or lack of trust in government.

To reduce the risk of hesitancy, communities need to understand why the vaccine is important for them specifically, that it is safe and effective, that the government's tiered prioritisation is fair, and that their social and cultural norms will be respected.

Second, in spite of willingness to take the vaccine, people may not show up to be vaccinated because of a lack of readily available public information about when they are eligible, how to schedule an appointment, where to go and whether there is a cost. Finally, even willing individuals who know when and where to go for their free vaccine may be restricted from reaching that point-of-care site because of access barriers such as immobility, distance to travel, costs associated with travel or conflicting work hours.

Taken together, these factors represent a substantial barrier to attaining significant uptake, ensuring the vulnerable are protected and then achieving population immunity.

To offset these factors, policymakers and public-health officials must commit to a concerted, rigorous, strategic and sustained communications campaign. The sooner a nationwide awareness-raising operation is launched, the better. This will contribute to sensitising the public to the upcoming mass vaccination process and will convey important high-level information. As countries receive their first shipments,

many are opting for a ceremonial, nationally broadcast kick-off event where the head of state and key cabinet members receive their initial jabs to signal a well-organised effort as well as robust political backing, boosting public confidence. Some, as in Senegal, have also publicised efforts to immunise health workers as part of the ceremony, thus showing how the prioritisation was being followed. As the rollout progresses, the head of state should regularly brief citizens on the status of deployment operations, sharing key mile-markers achieved and forthcoming, as well as roadblocks, all of which will require effective coordination and data-management systems. Transparency garners trust in the process.

At the regional and local levels, more tailored media and community engagement strategies should be employed. The most effective mode of engagement will vary by community; radio, newspaper, television and internet penetration differ among different demographics and geographies. Radio broadcasts may be especially effective in communicating with hard-to-reach populations. Messaging should be multilingual as needed. The support of community leaders, such as religious and traditional political figures, health-care professionals, celebrities and social media influencers will be pivotal. These figures have significant sway over public opinion and elevated platforms through which important, localised messages can be disseminated, such as when, where and how to get to a point-of-care site to be vaccinated.

Rwanda's Rollout: Prioritising Community Trust

Since the first COVAX shipment arrived on 3 March, the government of Rwanda has kept the public informed of the progress of deployment. Daily updates from the Ministry of Health and government of Rwanda on Twitter, TV and radio have allowed every citizen a window into the rollout operations. A key element included in the updates is the identification of the priority groups getting vaccinated that day with photos. For example, a tweet posted in both English and Kinyarwanda from the Ministry of Health on 9 March explained which essential frontline workers and high-risk community members had received vaccinations and was accompanied by photos of those participants and the process.

Regular newspaper articles and nightly radio interviews also track updates. Trusted community leaders have also been utilised to help those invited for vaccination know where to go and to understand the benefits of vaccination on their collective community.

Ministry of Health | Rwanda @RwandaHealth · 21h

Ejo abantu basaga 10,000 bahawe urukingo rwa #COVID19, abantu bose bamaze gukingirwa ubu mu Rwanda barenze 210,000. Mu bakingirwa uyu munsi harimo abamotari, abanyonzi, imfungwa n'abagororwa, DASSO, n'abakozi ba Leta barusha abandi ibyago byo kwandura COVID. #InkingoNiUbuzima

> **Ministry of Health | Rwanda** @RwandaHealth · Mar 9
>
> On Monday 10,000+ people got the #COVID19 shot, bringing total vaccinated to over 210,000. Priority groups being vaccinated today incl motorbike & bicycle taxi drivers, prison inmates, community public safety personnel (DASSO) & frontline public service staff. #VaccinesSavesLives
>
> Show this thread

Conclusion

The pandemic ends with successful global vaccine deployment. No country is safe from Covid-19 until the world achieves population immunity. Although there is no "one size fits all" approach, Rwanda's four pillars of success – leadership and collaboration across government, agile last-mile delivery approaches, proactive communications strategies that are tailored to the context of the communities being served, and the acceleration of digital record-keeping and new technology infrastructure – are essential to any rollout and can provide a blueprint for governments on the coordination necessary for successful vaccine delivery.

Footnotes

1. ^ https://www.nytimes.com/interactive/2021/world/covid-vaccinations-tracker.html
2. ^ https://app.powerbi.com/view?r=eyJrIjoiOTgzZDRkZWUtOTEwNC00N2E1LTllMDItMmM5ZTM2MmNhYzVkIiwidCI6ImY2MTBjMGI3LW
3. ^ https://www.who.int/publications/m/item/covid-19-virtual-press-conference-transcript---1-march-2021
4. ^ https://www.reuters.com/article/health-coronavirus-japan-pfizer/syringe-shortage-hampers-japans-covid-19-vaccination-roll-out-idUSL4N2KL1QS
5. ^ https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/cm-stories/cm-connecting-africa
6. ^ https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(21)00082-7/fulltext
7. ^ https://africacdc.org/news-item/majority-of-africans-would-take-a-safe-and-effective-covid-19-vaccine/

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