



Healthcare | Thematic Research

# Covid-19 vaccines, the beginning of the (still distant) end

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## Company Note

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## Healthcare | Thematic Research

### Covid-19 vaccines: the beginning of the (still distant) end

#### Powerful pandemic has sparked unprecedented demand for vaccines

This research piece has a different purpose. We hereby don't intend to bring up stock ideas and recommendations, but rather present a useful report about something that all of us talk about in current days: Covid-19 vaccines. In this note, we shed light on the twelve most advanced vaccines (their differentiations, developments, technologies and challenges), in addition to show how the immunization should work in Brazil (a country that historically was a benchmark on controlling pandemics) and what are the main challenges that the country is set to face now.

#### Massive damage so far: 1.9mn deaths worldwide; 200k in Brazil

Given the scale of the damage from this unprecedented crisis, with 1.9mn deaths worldwide and 200k in Brazil, vaccines are clearly the most powerful remedy. Out of +200 vaccines under study globally and +50 in preliminary tests with humans, there are 12 vaccines in phase 3 (when the vaccine is tested on a broader scale; *see page 5*) and 10 vaccines already approved by at least one national regulator. Finally, at least 50 countries have approved one of the vaccines, with ~17mn doses already applied (according to Bloomberg Vaccine Tracker).

#### What about Brazil? Now it all depends on emergency approval

Today, Brazilian government detailed the immunization plan, guiding to start the vaccination in the most bullish scenario on January 20th. But the timetable depends on ANVISA (health regulator), which still has to approve the 'emergency use' of the vaccines. As per Brazil's health ministry, official requests were submitted to ANVISA by: (i) Butantan Institute (entity linked to SP state government responsible for producing 65% of all vaccines distributed in Brazil) that should produce CoronaVac (China); and (ii) Fiocruz (Brazil's federal public health research institute) that should manufacture Oxford vaccine (UK). In addition to other potential agreements (more on page 6), the immunization plan of these two vaccines should assure 354mn doses for Brazil in 2021. Moreover, federal government published a provisional measure yesterday (so-called MP #1026), which authorizes the purchase of vaccines/supplies for immunization prior to ANVISA's official approval.

#### Brazil used to be a reference in vaccinations

Brazil is a tad behind the curve this time, but used to be a global benchmark in vaccination, with immunization coverage superior to developed countries in several epidemics (*see pages 7-8*). As a large, tropical country with universal access to the public health system, Brazil has a large vaccination network (38k vaccination centers), annually applying ~110mn doses (153mn in a peak year). Despite recent global progress on Covid-19 immunization, we will still see uncertainty given the doubts regarding permanent immunity, new strains, rare cases of reinfection and the lack of infrastructure to carry out the immunization campaign.

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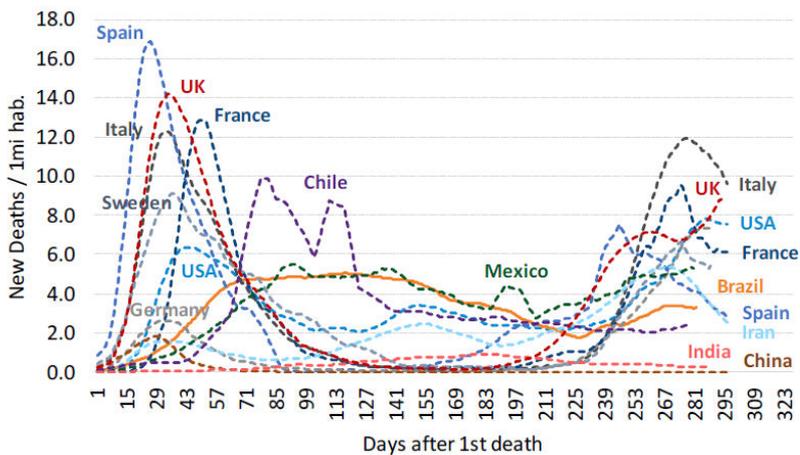
## Covid-19 vaccines: the beginning of the (still distant) end

### Coronavirus damage so far: 1.9mn deaths worldwide; 200k in Brazil

At the end of 2019, Covid-19 broke out and the world needed to close its doors due to a contagious virus capable of killing mostly the elderly and people with comorbidities. As per John Hopkins University, 88mn people were infected worldwide and 1.9mn died from Covid-19, while in Brazil 7.9mn were infected and the death toll was 200k – see chart 1.

7.9mn Brazilians were infected by Covid-19, while the death toll is 200k

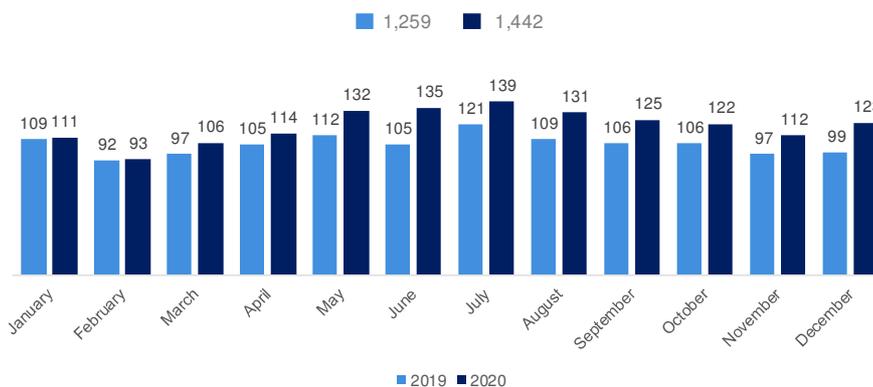
Chart 1: New deaths per 1 million inhabitants since 1<sup>st</sup> death (smoothed curves)



Source: Bloomberg and Health Ministry

As per Civil Registration information, the # of deaths (by any cause) in Brazil was 1.4mn in 2020, 14.5% more than in 2019 (see chart 2). Given the scale of damage of this unprecedented crisis, vaccines are naturally the most potent remedy.

Chart 2: Total number of deaths in Brazil, 2019 vs. 2020 (000's individuals)



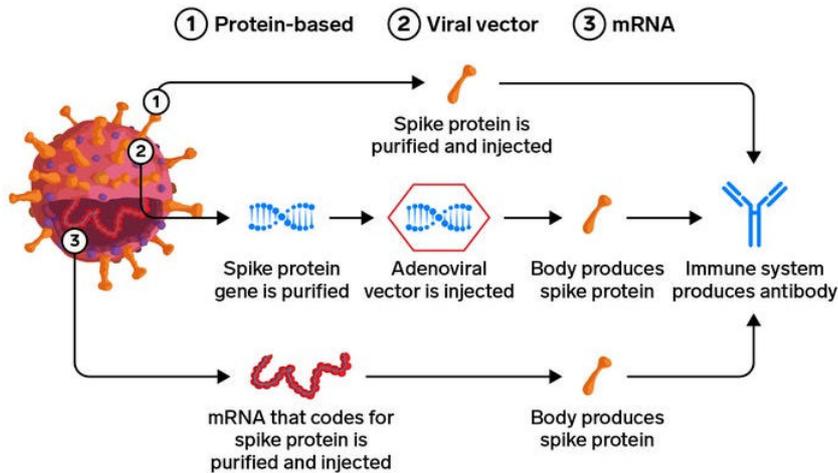
Source: Brazilian Civil Registration, BTG Pactual

### Race for the vaccine

Although the race for the vaccine has a single objective (immunize as many people in the shortest period of time), there are different ways to produce an effective vaccine. There are four main methods that are at an advanced stage or in application: protein-based, adenovirus, inactivated viruses and mRNA – see figure 1.

There are three methodologies behind the advanced stage vaccines: inactivated virus, adenovirus and mRNA

Figure 1: Types of coronavirus vaccines in development



Source: Nations Institutes of Health presentation at U.S. Senate hearing on September 9, 2020  
The figure does not explain the inactivated or attenuated virus method

The first consists in synthesizing the spike protein, which will trigger the immune system to produce the Covid-19 antibody, as exemplified by Vector and Novavax vaccines.

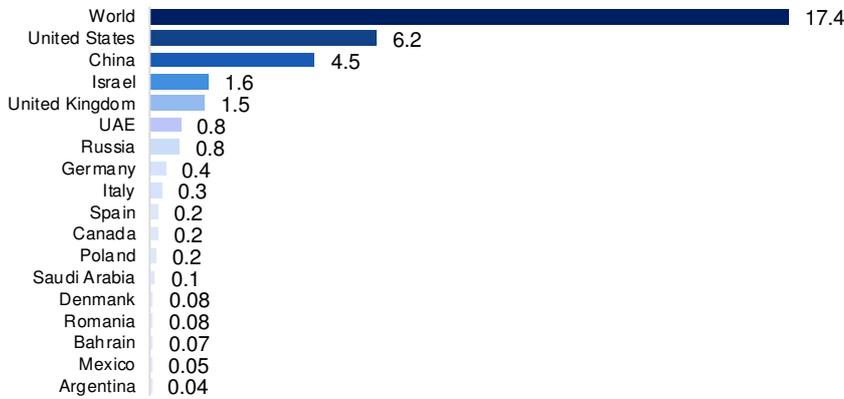
Adenovirus vaccines are produced by adding the gene for the coronavirus spike protein to another virus called adenovirus, which are common viruses, typically causing colds or flu-like symptoms. These viruses will influence the body to produce the aforementioned spike proteins, triggering the production of antibodies. Adenovirus vaccines include Oxford-AstraZeneca, J&J, Cansino and Sputnik.

Vaccines from inactivated or attenuated viruses are created from weakened coronaviruses or coronaviruses that have been killed with chemicals: e.g. Sinovac, Sinopharm and Baharat Biotech.

mRNA vaccines use messenger RNA to make human cells' genetic material produce proteins (specifically the Covid-19 protein), which triggers the immune system to produce antibodies. The most advanced mRNA vaccines are Pfizer's and Moderna's.

As per scientists, vaccines from the inactivated virus are the safest method (less probable to cause mutations), but their effectiveness is usually lower. As per Bloomberg Vaccine Tracker, 17.4mn people were already vaccinated in 38 countries (see chart 3), while more than 50 countries have already approved at least one of the vaccines (see tables 1-2). The vaccines most used so far are Pfizer (US, Canada, Israel, Germany and UK), Sputnik V (Russia, Argentina and Belarus), Moderna (US and Canada) and Oxford/AstraZeneca (Argentina, England and Ireland).

Chart 3: People vaccinated around the world so far (mn people)



Source: Bloomberg

Table 1: Countries that already approved at least one vaccine

Country	Vaccine	Beggining
Canada	Pfizer-BioNTech e Moderna	Dec 14th
USA	Pfizer-BioNTech e Moderna	Dec 14th
UAE	Sinopharm-Beijing e Sinopharm-Wuhan	Sep 14th
Russia	Sputnik V e Vector	Dec 15th
Barhrein	Sinopharm-Beijing e Pfizer	Dec 16th
Saudi Arabia	Pfizer-BioNTech	Dec 17th
Israel	Pfizer-BioNTech	Dec 19th
Qatar	Pfizer-BioNTech	Dec 23rd
Switzerland	Pfizer-BioNTech	Dec 23rd
Chile	Pfizer-BioNTech	Dec 24th
Costa Rica	Pfizer-BioNTech	Dec 24th
Kuwait	Pfizer-BioNTech	Dec 24th
Mexico	Pfizer-BioNTech	Dec 24th
Serbia	Pfizer-BioNTech	Dec 24th
Germany	Pfizer-BioNTech	Dec 26th
Slovakia	Pfizer-BioNTech	Dec 26th
Hungary	Pfizer-BioNTech	Dec 26th
Austria	Pfizer-BioNTech	Dec 27th
Bulgaria	Pfizer-BioNTech	Dec 27th
Cyprus	Pfizer-BioNTech	Dec 27th
Croatia	Pfizer-BioNTech	Dec 27th
Denmark	Pfizer-BioNTech	Dec 27th
Slovenia	Pfizer-BioNTech	Dec 27th
Spain	Pfizer-BioNTech	Dec 27th
Estonia	Pfizer-BioNTech	Dec 27th
Finland	Pfizer-BioNTech	Dec 27th

Source: Our World in Data

Table 2: Countries that already approved at least one vaccine

Country	Vaccine	Beggining
France	Pfizer-BioNTech	Dec 27th
Greece	Pfizer-BioNTech	Dec 27th
Italy	Pfizer-BioNTech	Dec 27th
Lithuania	Pfizer-BioNTech	Dec 27th
Malta	Pfizer-BioNTech	Dec 27th
Norway	Pfizer-BioNTech	Dec 27th
Oman	Pfizer-BioNTech	Dec 27th
Poland	Pfizer-BioNTech	Dec 27th
Portugal	Pfizer-BioNTech	Dec 27th
Czech Republic	Pfizer-BioNTech	Dec 27th
Roménia	Pfizer-BioNTech	Dec 27th
Sweden	Pfizer-BioNTech	Dec 27th
Belgium	Pfizer-BioNTech	Dec 28th
Latvian	Pfizer-BioNTech	Dec 28th
Luxembourg	Pfizer-BioNTech	Dec 28th
Belarusian	Sputnik V	Dec 29th
Argentina	Sputnik V, Oxford-AstraZeneca e Pfizer-BioNTech	Dec 29th
Ireland	Pfizer-BioNTech	Dec 29th
Iceland	Pfizer-BioNTech	Dec 29th
Singapore	Pfizer-BioNTech	Dec 30th
Scotland	Oxford-AstraZeneca e Pfizer-BioNTech	Dec 8th
England	Oxford-AstraZeneca e Pfizer-BioNTech	Dec 8th
North Ireland	Oxford-AstraZeneca e Pfizer-BioNTech	Dec 8th
Wales	Oxford/AstraZeneca e Pfizer/BioNTech	Dec 8th
UK	Pfizer-BioNTech	Dec 8th
China	Sinopharm, CanSino e Sinovac	July

Source: Our World in Data

**How does the approval process work?**

The approval process for a vaccine follows international standards: pre-clinical phase (using animals or even cells grown in laboratories) and three mandatory phases. In phase 1, the safety of the vaccine is tested on a small number of people. Phase 2 measures the effectiveness of the vaccine with a larger number of volunteers. Finally, phase 3 is a mass test to verify the effectiveness and safety of the vaccine on different individuals. In all phases, the statistical test is performed to gauge the statistical significance of the observed differences in the outcomes between the treatment and control groups (typically a placebo).

**Phase 3 is the most important stage of the approval process!**

There are 12 vaccines in advanced stages (see table 3): 4 from US, 4 from China, 2 from Russia, 1 from India, and 1 from UK (see pages 11-15). 10 were approved by international regulators: e.g. Moderna and Pfizer/BioNTech (by FDA in US) and Oxford (by MHRA in UK). Most of the vaccines approved so far globally comprise two doses per individual, further hindering mass immunization plans.

**Table 3: The most advanced Covid-19 vaccines studies**

Developer	Type	Phase	Status
 Pfizer-BioNTech	mRNA	2 3	Approved in Canada, other countries. Emergency use in U.S., other countries.
 Moderna	mRNA	3	Approved in Canada. Emergency use in U.S., Israel.
 Gamaleya	Adenovirus	3	Early use in Russia. Emergency use in Belarus, Argentina.
 Oxford-AstraZeneca	Adenovirus	2 3	Emergency use in Britain, India, Argentina.
 CanSino	Adenovirus	3	Limited use in China.
 Johnson & Johnson	Adenovirus	3	
 Vector Institute	Protein	3	Early use in Russia.
 Novavax	Protein	3	
 Sinopharm	Inactivated	3	Approved in China, U.A.E., Bahrain. Emergency use in Egypt.
 Sinovac	Inactivated	3	Limited use in China.
 Sinopharm-Wuhan	Inactivated	3	Limited use in China, U.A.E.
 Bharat Biotech	Inactivated	3	Emergency use in India.

Source: New York Times

**What about Brazil? Preliminary outlook of 354mn doses for Brazil in 2021**

More than 50 countries have already initiated an immunization plan, including Latin American neighbors: Sputnik in Argentina (39k) and Pfizer-BioNTech in Mexico (53k doses) and Chile (11k doses).

In Brazil, the government detailed the immunization plan today, guiding to start the vaccination in the most bullish scenario on January 20th, while in the bearish scenario it should start mid-February or early-March. It all depends on ANVISA (health regulator), which still has to approve the ‘emergency use’ of the vaccines.

Immunization plans	Start date
Bullish scenario	Jan-20th
Base case	Jan-21st /Feb-10th
Bearish scenario	Feb-11th/Early March

As per Brazil’s health ministry, official requests were submitted to ANVISA by Butantan Institute (entity linked to SP state government responsible for producing 65% of all vaccines distributed in Brazil) that should produce CoronaVac (China) and Fiocruz (Brazil’s federal public health research institute) that should manufacture Oxford vaccine (UK).

Broadly boosted by its local production capacity, Brazil’s immunization plan already contemplates 354mn doses in 2021, as follows:

- i. 2mn doses imported from India of Oxford/AstraZeneca vaccine (to be received in 5-10 days);
- ii. 100mn doses to be manufactured locally by Fiocruz with imported API (active pharmaceutical ingredients) in 1H21;
- iii. 110mn doses to be fully manufactured locally with national API by Fiocruz in 2H21;
- iv. 42.5mn doses imported (likely of Oxford vaccine) as Brazil joined the Covax Facility in October, an international alliance of Covid-19 vaccines promoted by WHO, Gavi Alliance (international organization to improve access to vaccines in the poorest countries) and CEPI (Coalition for Epidemic Preparedness Innovations) with a contribution of R\$2.5bn, which should ensure enough doses to cover at least 10% of Brazil’s population.
- v. 46mn doses acquired of CoronaVac via Butantan Institute (10.8mn are already available);
- vi. option to acquire additional 54mn doses of CoronaVac to be manufactured by Butantan Institute.

As Oxford/AstraZeneca vaccine requires 1.5 doses per person, while CoronaVac requires 2 doses per person, these 354mn doses should cover (assuming no losses) more than 200mn people.

**Table 4: Brazil's Covid-19 immunization plan**

Vaccine	Acquirer/Manufacturer	Doses (mn)	Details
Oxford/AstraZeneca	FioCruz	2	Doses imported from India
Oxford/AstraZeneca	FioCruz	100.4	Doses manufactured in Brazil with imported API (Active pharmaceutical ingredients)
Oxford/AstraZeneca	FioCruz	110	Doses manufactured in Brazil with national API (100% national production); In 2H21
Sinovac	Butantan	100	46mn doses already acquired; 56mn doses with Buy Option
Covax Facility	Health Ministry	42.5	Doses likely from AstraZeneca being provided as per Covax Facility Agreement
<b>Total Doses Assured</b>		<b>354.9</b>	

Source: Brazilian Health Ministry

Furthermore, with 2mn doses imported of Astrazeneca (by Fiocruz) and 6mn vaccines of CoronaVac (by Butantan), Brazil should start vaccination with 8mn doses, if initiated in January.

In addition to CoronaVac and Astrazeneca, there are potential further vaccines that could complement Brazil's immunization plan as follows:

- i. Sputnik V vaccine: As per local newspaper *Valor Econômico*, drugmaker União Química will file a request for emergency use of Russian vaccine Sputnik V with the health regulator ANVISA next week. The vaccine Sputnik V will be produced in União Química's biotechnology unit Bthek, in Brasília. When operating at full capacity, the plant will be able to produce 8mn doses per month;
- ii. Pfizer and BioNTech vaccine: As per the information provided by Brazil's health minister at today's press conference, Brazilian government is negotiating 9mn vaccines (500k in January, 500k in February, 2mn per each month until June);
- iii. Janssen/Johnson & Johnson vaccine: Also, as per abovementioned press conference, 3mn doses are under negotiation with Brazilian government.

Finally, we recall that federal government published a provisional measure yesterday (so-called MP #1026), which authorizes the purchase of vaccines/supplies for immunization prior to ANVISA's official approval.

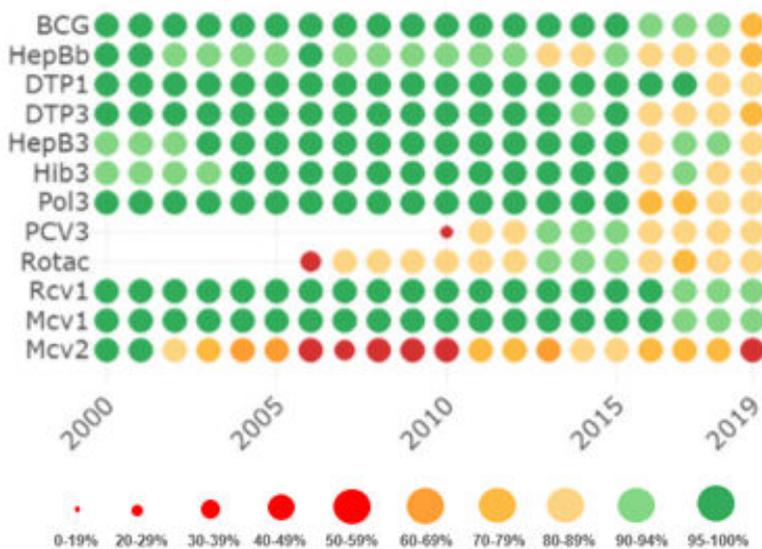
### **Brazil used to be a benchmark in vaccination**

A bold public healthcare system (SUS) and a history of government assistance to immunization programs made Brazil a benchmark in vaccination. Despite the recent wave of skepticism regarding vaccination programs, the country is historically known for its exemplary immunization programs and unique capability to structure large public vaccination campaigns with impressively high levels of success.

Brazil's first national immunization program was created in 1962, known as the "National Campaign against Smallpox". It was a huge success and eradicated the disease in the country after two decades (ending the mandatory vaccination against smallpox in 1981). As time went by, the Brazilian public healthcare system gradually

became more structured and received more resources, which led the country to launch the “National Campaign against Polio” in 1980 (eradicating the disease in 1989) and the “National Campaign against Rubella” in 2008, responsible for the vaccination of 65.9mn individuals, achieving an impressive 94% vaccination coverage rate. However, in the recent past we note that the vaccination coverage of several diseases has shrunk – see figure below.

Figure 2: Brazilian Immunization Coverage by vaccine



Source: Source: WHO

Today, Brazil’s immunization program is one of the largest in the world, offering 45 different vaccines. In fact, in the last 10 years, Brazil applied an average of ~100mn doses of vaccines per year (see table 5), reaching its peak in 2013 when it applied over 156mn vaccines, in response to the H1N1 outbreak.

BCG: Baccille Calmette Guérin vaccine

DTP1: First dose of diphtheria toxoid, tetanus toxoid and pertussis vaccine

HepB3: Third dose of hepatitis B vaccine

Pol3: Third dose of polio vaccine

Rotac: Rotavirus last dose

MCV1: First dose of Measles-containing vaccine

HepBP: HepB birth dose

DTP3: Third dose of diphtheria toxoid, tetanus toxoid and pertussis vaccine

Hib3: Third dose of Haemophilus influenzae type B vaccine

PCV3: Third dose of Pneumococcal Conjugate

Rcv1: First dose of Rubella containing vaccine

MCV2: Second dose of Measles-containing vaccine

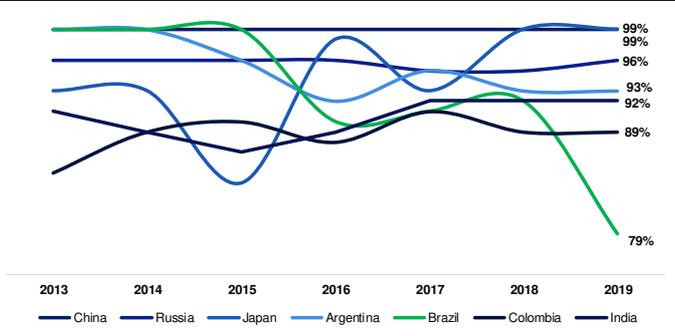
On avg. Brazil applied over 100mn doses of vaccines for the last 10 years

Table 5: # of vaccines applied in Brazil – at peak, as a result of H1N1 outbreak, Brazil applied more than 150mn doses in 2013

Immunobiologicals	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Double Adult (dT)	14.8	14.6	14.4	17.9	16.9	13.8	7.1	10.3	10.2	11.1	8.4
Hepatitis B (HB)	14.7	16.7	15.8	15.8	15.1	12.0	7.1	8.9	8.2	8.1	5.5
Triple Viral (SCR)	7.4	9.3	6.9	10.6	16.5	8.0	7.8	6.8	12.3	17.4	12.6
Pneumococcal	6.8	10.5	10.6	11.1	11.0	11.1	8.4	8.1	7.9	7.8	6.6
Yellow Fever	6.7	6.7	5.7	5.6	4.8	5.6	6.3	24.6	14.5	8.1	9.6
Conjugated Meningococcal - C	4.1	9.1	8.3	8.7	8.6	8.5	8.5	10.9	9.8	10.1	7.5
Pentavalent (DTP+HB+Hib) (PENTA)	0.0	0.1	2.5	8.6	8.5	8.7	9.4	8.4	8.4	7.1	7.5
Oral Polio	12.4	12.8	10.6	2.5	1.6	3.3	4.6	4.6	4.4	4.5	4.2
Oral Rotavirus	5.1	5.4	5.3	5.6	5.6	5.7	5.3	5.2	5.3	5.0	4.3
Triple Bacterial	5.5	5.7	5.9	5.8	5.1	5.0	3.9	4.6	4.2	3.1	4.8
Influenza (Campaign) (INF)	15.8	0.0	0.0	29.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inactivated polio	0.1	0.1	0.2	0.2	0.9	2.2	7.2	8.0	8.0	7.6	6.8
Others	44.7	17.4	30.5	34.6	33.5	32.0	17.3	20.0	19.6	19.1	18.6
<b>Total</b>	<b>138.2</b>	<b>108.5</b>	<b>116.7</b>	<b>156.3</b>	<b>128.1</b>	<b>116.0</b>	<b>92.9</b>	<b>120.4</b>	<b>112.9</b>	<b>108.9</b>	<b>96.5</b>

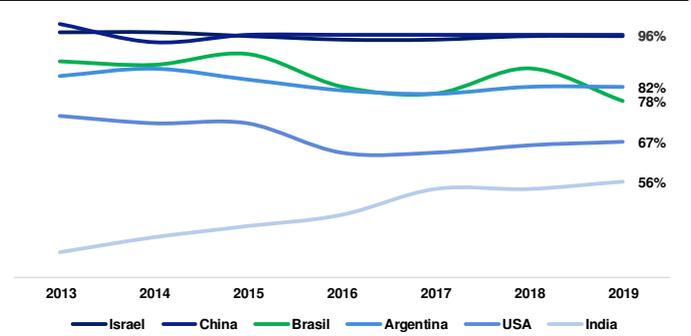
Source: DATASUS

**Chart 4: Coverage of BCG around the World (2013-2019). In the recent past we note that the vaccination coverage of several diseases has shrunk**



Source: Unicef

**Chart 5: Coverage of Hepatitis B around the World (2013-2019). In the recent past we note that the vaccination coverage of several diseases has shrunk**



Source: Unicef

**... but there are many challenges ahead for the country**

In addition to purchasing the vaccine, there is a need for other resources such as syringes, needles, trained professionals and vaccination centers. It's not an easy task, even for Brazil, a benchmark in vaccination.

As an example, the federal government recently launched a new bidding process to acquire 290mn syringes, following the recent purchase of 7mn syringes and needles. Anyway, as per Health Ministry's most recent official data (January 7<sup>th</sup>, 2021), there are already about 80mn syringes and needles available in the states that could be immediately used at the start of the immunization program.

**Resources could become a problem! Especially syringes and needles**

And there are additional efforts to increase the supply of this products, as follows: (i) the Health Ministry also made an administrative request for surplus inventories of these products to the national industry and expects to receive a further ~30mn in January; (ii) the government has already bought 40mn units of syringes and needles through OPAS (Pan-American Health Organization), to start being delivered between January and February, plus further 150mn units in negotiation (also through OPAS).

Source	Syringes (mn)
Bidding process 1	7
OPAS acquisition	190
Administrative request	30
Bidding process 2	290
<b>Total Syringes</b>	<b>517</b>

While the normalized vaccination campaigns total 110mn doses, we estimate that, to immunize just the priority groups (from COVID-19), it would take 105mn additional doses (considering two doses per person), as follows: 15mn health professionals/people above 75 y.o., 22mn Brazilians with 60-74 y.o. and 13mn individuals with comorbidities.

The table 6 shows the immunization strategy in Brazil, outlining the priority groups, and how numerous they are. Despite Brazil's huge success in vaccinations, it won't be an easy task.

**Table 6: Brazilian Immunization Plan for Priority Groups**

Phase	Target population	Est. Population (mn)	Est. Doses Needed (mn)
1	Health care workers, people +75, indigenous, other small communities	14.8	31.2
2	People with 60-74 years old	22.1	46.5
3	People with comorbidities such as: severe arterial hypertension, diabetes mellitus, kidney disease, cardiovascular and cerebrovascular diseases, cancer, severe obesity	12.7	26.6
<b>Total doses for the 3 Phases</b>		<b>49.7</b>	<b>104.3</b>

Source: Brazilian Health Ministry

### Long way until the end of the tunnel!

Although some vaccines are already available and being applied in some countries, the scenario in 2021 tends to be similar to 2020, with restrictions on trade and cultural activities, while maintenance of protective measures against contagion, like the use of a mask and social distancing, will continue. The vaccination of priority groups will take a few months and until 60-70% of the population is immunized. And the delay in presenting a detailed plan coupled with fake news has kept Brazil’s population skeptical.

According to a Datafolha survey, in August 9% of the population rejected the Covid-19 vaccine, while this number rose to 22% in December. Nevertheless, the recent decision from Brazil’s Supreme Court should ensure a more effective immunization plan, as the State might be empowered to establish sanctions on society, despite not being able to ‘force’ everyone to be vaccinated.

**In December 22% of Brazilians rejected the Covid-19 vaccine**

### Immunity period is the main question mark

Despite all the recent progress on Covid-19 immunization, only one thing is guaranteed: we will continue to face uncertainty. All we’ve had so far are several interim vaccine approvals to contain the pandemic. All studies will continue over the next few years, and all the scientists still can’t say how long immunity will last.

In addition, vaccines that have been approved protect the individual but do not guarantee that he/she will no longer transmit the virus. What is known is that individuals infected with Sars-Cov-2 lose immunity over time. There are cases of reinfection. They are rare, but it is a warning that vaccines may not generate permanent immunity. So, the path ahead remains uncertain.

## Tracking Covid-19 vaccines around the world

We provide below a quick overview on the 12 vaccines already in most advanced stages of studies, including their principle/technology, overall info on clinical trials, preliminary production capacity and general challenges. Some of them are already being applied on a large scale among priority groups.

**Table 7: Summary of Most advanced vaccines**

Country	Vaccine	Type	Efficiency	Research beginning	Country tested	Doses	Est. Production in 21
	Pfizer/BioNTech	RNA	95.0%	March	Brazil, USA, Argentina, Germany	2	1.3 Bi
	Oxford/AstraZeneca	Viral Vector	62% - 90%	January	Brazil, South Africa, USA, UK	1,5	2 Bi
	Moderna	RNA	94.1%	January	USA	2	1 Bi
	Gamaleya	Viral Vector	91.4%	February	Belarus, UAE, Venezuela, India	2	-
	Janssen/J&J	Viral Vector	-	January	-	1 or 2	1 Bi
	Novavax	Virus Protein	-	January	USA, UK	2	2 Bi
	Sinopharm - Beijing	Inactivated	79.3%	-	UAE, Morocco and Peru	2	1Bi
	Sinovac	Inactivated	78.0%	January	Brazil, Turkey, China	2	0.6 Bi
	Cansino	Viral vector	-	-	China, Russia, Mexico, Chile	1	1 Bi
	Sinopharm - Wuhan	Inactivated	-	-	China, Peru	-	-
	Vector Institute	Virus Protein	-	-	Russia	2	-
	Bharat Biotech	Inactivated	-	-	India	2	0.7 Bi

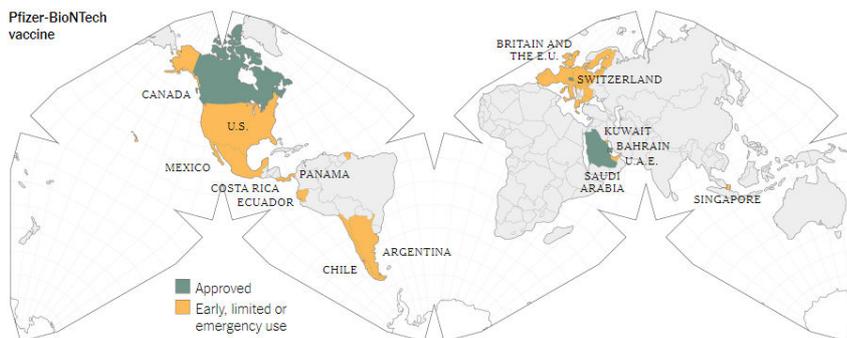
Source: New York Times, international press

### Pfizer and BioNTech

In January, BioNTech began designing the vaccine for the Covid-19 and Pfizer joined the project in March. Their vaccine, Comirnaty, is based on mRNA and, according to both companies, has achieved 95% effectiveness (after the second dose). This vaccine must be kept in -70C storage – which became a huge limitation for some countries like Brazil. The last clinical trial (out of three phases) was done with 44k people from US, Brazil, Germany, Argentina and others, mixing different ages and ethnicities. Pfizer expects to produce up to 1.3bn doses in 2021.



**Chart 6: Approval map of Pfizer/BioNTech**



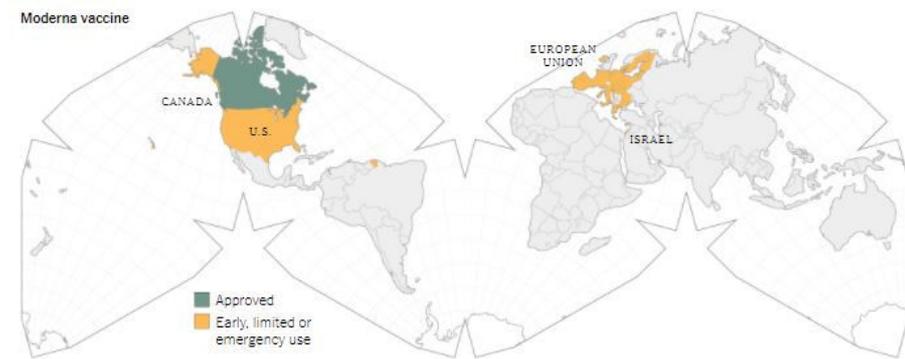
Source: New York Times

**Moderna**

In a partnership with the National Institutes of Health, Moderna has developed a vaccine based on mRNA. The company posted a 94.1% efficiency on their clinical trial (made with 30k volunteers). Moderna’s vaccine need to be stored in a -20C freezer and the immunization process requires 2 doses (with 4 weeks of interval). Moderna is expected to deliver 100-125mn doses of vaccine in 1Q21 (~1bn in 2021), while 80% of those should be delivered to the U.S.



**Chart 7: Approval Map of Moderna**



Source: New York Times

**Janssen/Johnson & Johnson**

This adenovirus-based vaccine is being developed by a Belgium-based division of J&J, Janssen Pharmaceutica, in collaboration with Beth Israel Deaconess Medical Center. The company started the third testing phase in September, but in October an adverse event stopped the study for 11 days. In November, they decided to carry out another phase 3 trial, but this time with two doses to see if the immunization process was more effective. In the trials, 45k volunteers were vaccinated, and Phase 3 results are expected for January. If the trial shows effectiveness, the vaccine may be passed by FDA in February and the company will be able to produce +1bn doses by the end of 2021.



**Novavax**

Novavax is a US company, based in Maryland, that is developing a vaccine (two shots required) using the coronavirus protein. They carried out a phase 3 trial in the US with 15k volunteers (results expected in early 2021) and a phase 3 trial in the US with 30k volunteers (which started on December 28 due to a delay). Novavax has already signed an agreement with India’s Serum Institute to make 2bn doses a year. Once approved, the US will receive 100mn doses in 2021, the UK 60mn and Australia 40mn.



**Oxford/AstraZeneca**

In partnership with the University of Oxford, AstraZeneca is designing a vaccine based on the adenovirus, just like J&J's. During the clinical trial (done in UK, Brazil and South Africa) with +50k people, one of the volunteers died in Brazil, but the trial was not halted because AstraZeneca said the volunteer was using a placebo. All volunteers received 2 doses but, by mistake, some of them received only half of the first shot and, surprisingly, effectiveness was 90%, while the group that received both complete shots reached only 62% effectiveness (still compliant with international standard adopted by many governments). The company expects to produce up to 2bn doses this year, 212.4mn to be distributed in Brazil (in partnership with Fiocruz). Each vaccinated person will require 1.5 doses, at an expected price of US\$3-4/dose.



**Chart 8: Approval map of Oxford-AstraZeneca**



Source: New York Times

**Sinopharm (Beijin and Wuhan vaccines)**

Sinopharm, a Chinese government company, is developing two vaccines based on the inactivated virus method (one created by the Beijing Institute of Biological Products and another created by the Wuhan Institute of Biological Products). The first one started the last trial phase in the UAE and, later on, researchers announced 86% effectiveness. But the lack of details made the study conclusion unclear, and the company didn't provide final results on the study. In China, the government gave emergency approval to Sinopharm's vaccine and +1mn people were already vaccinated. The second vaccine is still in Phase 3 and is being tested in several countries.



**Sinovac**

Sinovac Biotech is a Chinese private company that is developing a vaccine based on inactivated virus. The inoculation process involves 2 doses (2 weeks apart) and the vaccine must be kept in refrigerated storage. In July, Sinovac launched a Phase 3 trial in Brazil and, later on, in Indonesia and Turkey. But its effectiveness is still a doubt for some international institutions. While Brazilian researchers found 78% effectiveness, Turkey reported 91%. In November, Brazil's government announced an adverse event not specified in the Coronavac trial, causing a delay in the process, which resumed after 2 days. Expected production for 2021 is 600mn doses and, since the beginning of the clinical phase, the São Paulo government has been



negotiating Coronavac doses. So far, 10.8mn doses have been delivered in Brazil, and a further 100mn are expected by the end of 2021.

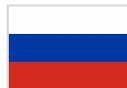
**CanSino Biologics**

Covidecia was developed by a Chinese company in partnership with the Academy of Military Medical Sciences. It is made from the Ad5 adenovirus and, unlike most vaccines in advanced stages, only needs one dose and can be stored in a refrigerator. Covidecia’s Phase 3 trial started in August and was tested in China, Parkistan, Russia and Chile. So far, researchers haven’t disclosed the vaccine’s effectiveness.



**Gamaleya Institute**

Gamaleya Research Institute, partly owned by Russia’s Health Ministry, created a vaccine developed with a combination of two adenoviruses. The clinical trial was done in Russia, UAE, Venezuela and India (with +31k volunteers) and showed 91% effectiveness. The vaccine must be stored in a freezer and the inoculation process includes 2 doses. The fast development of the vaccine and several changes during the clinical process sparked skepticism from some health agencies. In December, Gamaleya surprisingly joined forces with AstraZeneca (which also makes a vaccine with human adenoviruses). Both teams will combine their vaccine and results to see if they will reach an effective output. The Phase 1 trial of this combination was registered on December 24. Brazil, India, Mexico and Venezuela started negotiations to acquire the Sputnik V, and Russia and Argentina approved the vaccine for emergency use. So far, the institute received applications from 20 countries.



**Chart 9: Approval Map of Sputnik V**



Source: New York Times

**Bektop/Vector Institute**

The Vector Institute is a Russian biological research center that is producing a vaccine made of peptides (small portions of viral proteins). Phase 3 began in November and, according to Interfax News Agency, by December 1,438 volunteers had received the vaccine. Despite no final data available on the safety and effectiveness of the vaccine, the Russian government has granted regulatory approval.



## Bharat

Called Covaxin, the vaccine from Bharat Biotech in collaboration with the Indian Council of Medical Research and the National Institute of Virology is made from an inactivated form of coronavirus and requires two shots (4 weeks apart). Phase 3 began in October, with 25.8k participants, but no results were released yet. In December, they announced a partnership with US company Ocugen to enter the US market. Although there are no results available showing vaccine effectiveness so far, on January 3 the Indian government approved the vaccine for emergency use.



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Company Name	Reuters	12-mo rating	Price	Price date
SulAmerica <sup>1, 2, 4, 6, 10, 18, 19, 22</sup>	SULA11.SA	Buy	R\$41.30	7-1-2021

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### SulAmerica



Source: BTG Pactual and Economica. Prices as of 07 January 2021

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