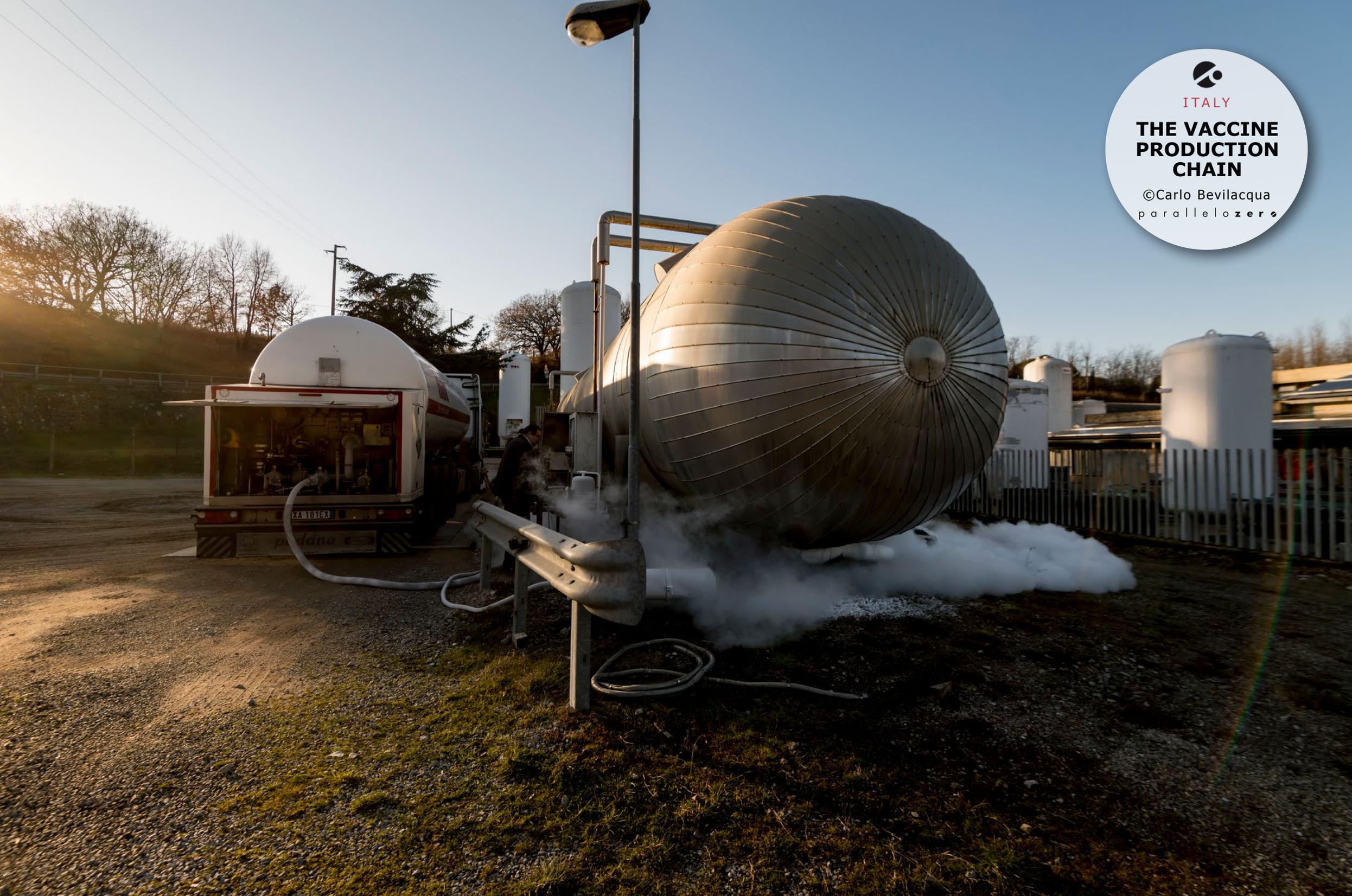




ITALY

# THE VACCINE PRODUCTION CHAIN

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The Bormioli Pharma factory in San Vito al Tagliamento (Pordenone). One of the challenges of fighting the pandemic concerns the production of millions of ampoules and phials using borosilicate glass that can be pressed into shape in extremely high temperature furnaces to ensure the highest levels of safety on contact with pharmaceutical products. Bormioli Pharma is one of the few companies at global level that can offer complete packaging solutions with ampoules and phials.

## **Manufacturing, storage, transport and refrigeration, not to mention scientific research**

On the frontline against Covid-19 can be found a world that is all Italian. An extensive production chain composed of diverse businesses is engaged in the fight against the pandemic, beginning with scientific research and moving through transport, storage, and the extraction of carbon dioxide to produce dry ice for refrigeration, to the manufacture of syringes for administering the vaccine.

This world is little known but spans from Triveneto to Campania, Piedmont to Tuscany, taking in Lazio and Abruzzo. The common goal is to complete the vaccine plan to immunize the majority of the population as quickly as possible. A fight against time that begins at the laboratories of the biotech company ReiThera, engaged in the production of the first all-Italian vaccine, and in those of the Fondazione Toscana Life Science, which is working to develop monoclonal antibodies to respond to the virus. But there are also large and small firms of acknowledged excellence, such as Bormioli in Parma, Desmon in Avellino, Ceam in Florence, Melform in Cuneo and many, many others.



Locatelli Meccanica, Subbiano (Arezzo). Dry ice, carbon dioxide in its solid state, is obtained by reducing the pressure of liquefied CO<sub>2</sub>, some of which vaporizes, reducing the temperature of the remaining liquid, which solidifies into a snow-like consistency. The CO<sub>2</sub> snow is then pressed in hydraulic machines, creating pellets of dry ice that are ideal for reducing and maintaining the temperatures inside the containers used for transporting pharmaceutical products and vaccines.



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The Melform factory in Monasterolo di Savigliano (Cuneo). A rotating pressing machine, a low-pressure, high-temperature method for producing the body shells of isothermal containers used for storing and transporting pharmaceutical products and vaccines.



A production line machine for filling vaccines at the Marchesini Group factory in Monteriggioni (Siena). Machines like this have been purchased by the main international pharmaceutical companies, including those that produce the Sputnik V vaccine in Saint Petersburg.



Claudia Sala, manager of the Monoclonal Antibody Discovery (MAD) Lab at Toscana Life Sciences (TLS) in Siena, works on the development of monoclonal antibodies to combat bacterial and viral infections, for the treatment of coronavirus SARS-CoV-2.



Technicians from Tecnam, a renowned Italian aeronautical company. Tecnam has signed an agreement with Desmon, a company which produces ultra-low temperature freezers for transporting vaccines. The partnership will make it possible to reach areas that are not accessible for traditional logistical vehicles, such as isolated communities, airstrips not suited to large aviation or areas where the chilled distribution chain might have to face particularly high temperatures.



The clean room at the Bormioli Pharma factory in Vasto, where rubber stoppers for vaccine phials are produced in addition to other pharmaceutical equipment.



The Bormioli Pharma factory in Vasto (Chieti). Rubber stoppers destined for pharmaceutical companies all over the world are produced in contamination-controlled areas.



At Pentaferte in Teramo all phases of the production of syringes take place in contamination-controlled environments. The factory is one of the largest of its kind in Europe and is being transformed in order to meet global demand for medical production and to comply with the most stringent certifications.



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Simone Campinoti, president of Ceam Group (Empoli, province of Florence) holds a probe and microchip from a system developed by the company. Thanks to the interface with a specially created application, this system enables the sharing in real time of the temperature parameters of the vaccine containers, monitoring them during the entire transfer phase.



The factory of Marchesini Group in Monteriggioni (Siena). Phials in the tray of a machine for filling the vaccines. Every machine is built to meet the specific requirements of individual pharmaceutical companies and is subjected to hours and hours of testing and trials before being delivered and installed at the production facilities.



Sheet metal is cut and shaped at the Desmon factory in Nusco (Avellino). The company, which already produced refrigeration plants for the health sector, currently manufactures ultra-low temperature freezers of various sizes for storing vaccines.



Castel Romano. Researchers carry out tests in the laboratories of ReiThera, a biotech company dedicated to the development and production of biopharmaceutical products based on an adenoviral vector derived from gorillas and modified until it can no longer replicate within the body. This vector, which has been patented by the company, codifies the spike protein, which enables the new coronavirus to enter human cells and produce the necessary antibodies.



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Subbiano (Arezzo). Two technicians test a Dry Ice Box, the machine for producing dry ice created by Locatelli Meccanica. The Dry Ice Box is capable of maintaining the chilled distribution chain intact at temperatures that can reach  $-78^{\circ}$ .



The prototype of an ultra-low temperature freezer at the factory of Pluris Desmon in Nusco (Avellino), where special ultra-low temperature cabinet freezers are produced. These are capable of generating and maintaining cold temperatures even in the absence of electricity, in order to facilitate the transport and storage of vaccines.



Dario Cardamone, researcher at Fondazione Toscana Life Sciences (TLS) in Siena. The sequences and data acquired in the biotech laboratory are elaborated by applying mathematical models, utilizing systems of Machine Learning and High Content Imaging. Many of the researchers are from overseas or have expertise acquired at prestigious foreign research institutes.



The Pentaferte factory in Teramo. As well as manufacturing a diverse range of medical devices, the company produces various types of syringe for vaccines destined for France and Italy. The syringes must be produced in large quantities and to tight deadlines.



An employee at the production facility of Bormioli Pharma in Vasto (Chieti) that makes rubber and aluminium stoppers for pharmaceutical containers.



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At the Corima Marchesini Group factory in Monteriggioni (Siena), two technicians test a machine for filling containers. Marchesini produces machines for packaging and filling vaccines and pharmaceutical products destined for pharmaceutical companies worldwide. The production of the Russian vaccine Sputnik V in Saint Petersburg uses Marchesini Group machines.



A technician approaches the window to display a bag containing a cell culture of gorilla adenovirus in suspension used for the production of a vaccine developed in the ReiThera laboratories in Castel Romano.

Parallelozero, via Donatello 19/a, Milano Italy  
info@parallelozero.com - www.parallelozero.com  
+39 02 89281630

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