FREDERIC DURAN I JORDÀ
DURAN METHOD

The eponym

Duran method. A set of procedures that enable blood to be extracted aseptically while conserving it and keeping it biologically active until it can be administered[1]. For the first time, this method enabled the extemporaneous use of extracted blood, gradually substituting the direct transfusion practised before. Conservation of blood for more than two weeks enabled its use far from blood banks and immediately saved an incalculable number of lives in the Spanish Civil War, the Sino-Japanese War, and the Second World War.

Frederic Duran i Jordà (1905-1957)

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Frederic Duran i Jordà was born on 25 April 1905 in Barcelona in the working-class Barceloneta neighbourhood. He was the youngest of five children of Amadeu Duran, a salesman from Martorell who moved to the Catalan capital in search of better opportunities for his family. Though chemistry was his greatest love, Duran eventually graduated in medicine from the *Universitat de Barcelona* in June 1928[1]. During his studies he was an intern in Antoni Trias i Pujol's Surgical Pathology Department and was in charge of the clinical analysis section of the Digestive Apparatus Dispensary from 1926 to 1934[1,2].

After graduation, he began to work for a general medical consultancy on Hospital Street, which later moved to Urgell Street. At 26 he published *Anàlisi i tècnica coprològica* (Coprological technique and analysis, 1931) as a medical monograph through the *Acadèmia de Ciències Mèdiques* and three years later he published a new volume entitled *Anàlisi i tècnica exploratòria de la glàndula hepàtica* (Exploratory technique and analysis of the hepatic gland, 1934). He gradually abandoned clinical practice to spend more time in the clinical analysis laboratory and was appointed municipal physician of *Institut Frenopàtic de les Corts* in 1934. By the following year, he became the director of this institution's clinical analysis laboratory[2].

The outbreak of the Spanish Civil War caught him in Barcelona. A vehement man, of firm left-wing, pro-Catalan politics, he had joined the *Unió Socialista de Catalunya* some years earlier and continued in the *Partit Socialista Unificat de Catalunya* (PSUC) when the former merged with the latter. So it was no surprise when, in the turbulent days following the military coup, the PSUC and *Unió General de Treballadors* (UGT) appointed him to create a blood transfusion service. It was on 10 October 1936 and installed in the clinic that the *Caixa de Pensions*

Hospital d'Urgències nº 18 ("the 18th") on Montjuïc (Barcelona), nowadays the premises of the *Institut Cartogràfic i Geològic de Catalunya*

savings bank had on Montjuïc, now the premises of the *Institut Cartogràfic i Geològic de Catalunya*. It was immediately collectivised and placed under the control of the UGT and the PSUC. Duran was appointed director. The clinic was known as *Hospital d'Urgències nº 18*, popularly dubbed "the 18th", since there were already 17 military hospitals in the city. Initially, the hospital's function was to organise a blood transfusion service for the PSUC and UGT columns fighting on the Aragon front. But shortly afterwards, the Catalan government's *Consell de Sanitat de Guerra* was formed, incorporating this hospital and leading to a change in its organisation and functions[1-3]. In recognition of his merits, Duran was commissioned as a major in the Republican army[1].

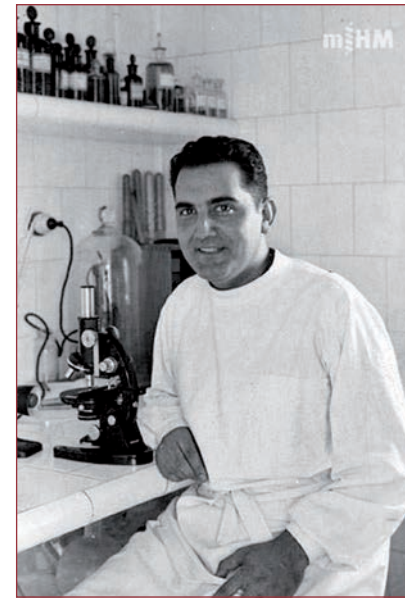
Some time later, the hospital staff was incorporated into the *Cos de Sanitat de l'Exèrcit de Llevant* and transferred to a building at 216 Mallorca Street, a clinic that had been expropriated from the gynaecologist Carreras. This move was motivated by donors' difficulties in accessing the hospital and the need to expand the centre's functions. The new premises were officially inaugurated on 5 February 1938 with the name *Institut de Barcelona del Servei de Transfusió de Sang de l'Exèrcit de l'Est*[1]. Duran made an appeal on radio for donors, offering an increase in food rations in exchange for blood. The response was extremely positive and he soon had hundreds of people amassed before

Duran i Jordà (upper centre of the photograph), extracting blood in the *Hospital d'Urgències nº 18* ("the 18th"), one of the clinics of the Transfusion Service

the laboratory door. The Transfusion Service was an overwhelming success. By the end of the Spanish Civil War, it had taken 20,000 extractions and obtained 9,000 litres of blood[2]. According to Broggi[4], Duran outlined his idea to Joaquim Trias i Pujol, a member of the *Consell de Salut Militar* created by the Catalan government, who quickly understood the project and extended him all manner of aid.

Duran knew of the experiments done by Serguei Judine, who he had met when the Russian physician visited Barcelona shortly before the Spanish Civil War[4]. In a number of conferences, Judine explained his method, which consisted of transfusing the blood of corpses to patients. But in Barcelona the method did not work very well, since the blood haemolysed, becoming quickly altered, and was therefore not useful for transfusions, perhaps due to a legal prohibition against touching corpses until a few days after death, which made their blood completely useless. So the blood of live donors was required, though this was not the only problem. It also had to be stored in such a way that it could be transported to where it was needed. Because of the war, a way of administering it easily was required, if necessary, on the front itself. Duran published the method in a small monograph in English in 1938[4] and later disseminated it in an article published in *The Lancet*[5] when he was in exile.

Frederic Duran i Jordà in the laboratory at the Transfusion Service



Changing political fortunes on the Republican side did not stop Duran from continuing his efforts until the end of the Spanish Civil War. The last blood bank was set up in the schools of the town of Amer, in Girona province, on the retreat to France[1]. Duran crossed the French border in February 1939. His reputation and his friendship with Josep Trueta helped him reach Great Britain, invited by the British Medical Mission through Janet Vaughan, of the British Red Cross. Yet his early days in exile were not easy[2].

Duran had to work as a laboratory technician at Ancoats Hospital until the British authorities recognised his degree in medicine in 1941. He continued working at the same centre as a pathologist, investigating digestive diseases and burns[1]. In Catalonia, the internal exiles did not forget him, and in 1947, the *Institut d'Estudis Catalans* awarded him the Prat de la Riba Prize for a study on digestive histology, a field far from his

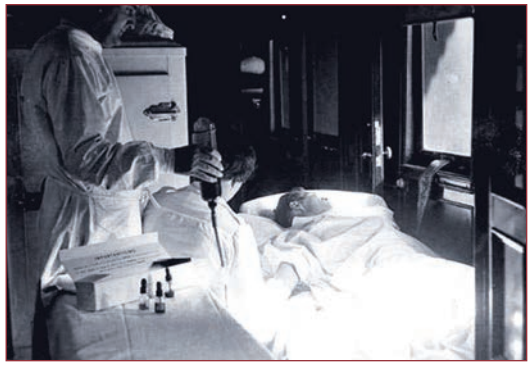
haematological studies[6]. In 1950, he became a British citizen and began returning to Catalonia on holiday. Unfortunately, some years later, he contracted leukaemia, which he himself diagnosed. He died on 30 March 1957 at Manchester's Royal Infirmary[2]. He was just 51.

Duran Method

The idea of transfusing blood from one person to another was not new, and numerous experiments had been tried. It had even been tried in the early nineteenth century, albeit rather unsuccessfully, when James Thomas of London attempted it on 22 December 1818. However, that patient died, as did the next three on whom he tried it. The fifth, however, survived[2].

In the early twentieth century, things were not much better. It would be several years before the technique of employing a sodium citrate solution to avoid coagulation was used, special syringes were employed to administer it, and the beneficial effects of cooling the blood extracted from the donor were discovered. Yet the problem of how to keep the blood in perfect condition, to transport it from one place to another, persisted. This was crucial in wartime, since the wounded requiring blood on the front did not generally have a donor on hand to give it to them. So a method was needed that allowed blood to be extracted, stored, transported where needed, and administered quickly.

Duran soon recognised the problem of transfusions: you must obtain the blood, then classify it, store it, and transport it to the field hospitals at the front. How to do this? A few days after the outbreak of the Spanish Civil War he began to organise everything. Jars and other material were obtained from *Laboratoris Pujol i Collell*, who brought their experience to bear on the task Duran proposed[1].



Frederic Duran i Jordà doing a blood transfusion to a wounded soldier during the Spanish Civil War

The proposed method involved taking the donor's medical history and analysing the blood to ascertain the blood type and screen for transmissible diseases such as malaria and syphilis. In Duran's words[3]:

> "The scientific foundation of our organisation is as follows: the blood is mixed with a 4% sodium citrate solution (nine parts blood to one part solution). It is then preserved in a refrigerator at no higher than 1 °C or 2 °C. The same temperature is maintained during the transportation of the blood to the front, using for this purpose an especially constructed vehicle equipped with a refrigerated chamber and the necessary mechanism for its operation. The vehicle is a lorry with electric refrigerators that run off a set of batteries, a dynamo for charging the batteries, and an internal combustion motor to propel the vehicle."

From each donor, 300 ml to 400 ml was extracted every three or four weeks. Extractions were done in the morning with the patient fasting to avoid "postprandial colibacillary septicemia" or too many albuminous substances in the blood during the digestive process. Duran explained it thus[3]:

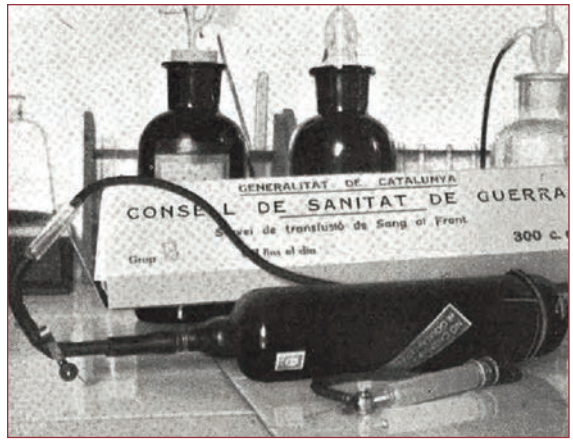
> "The technical process is very simple. The blood is collected in a matrass invented by us to avoid certain microbiological

> inconveniences. The suction-pump is first employed to place in the matrass some fifteen c.c. of the citrate solution. The arm of the patient is then punctured with a needle specially adapted for the purpose by us [...]. Once the vein is punctured, the blood is extracted by creating a slight suction inside the matrass by means of the aforesaid vacuum pump [...]. When the necessary amount of blood has been extracted, an additional 15 c.c. of the sodium citrate is pumped in, the whole is thoroughly shaken, and the filled receptacle is placed in the refrigerator."

At the end of the day, bacteriological cultures were taken from each sample and a test was done to establish the blood group so as to avoid any error that might have fatal consequences. The process ended by attaching labels stating that the blood had passed all controls. Twenty-four hours later, the cultures enabled accidental contamination when obtaining and handling the blood to be ruled out. Afterwards, the blood was prepared using a filtration process with a device of his own invention that allowed the blood to pass through a filter using a vacuum procedure to avoid contact with the air. Next, blood from several extractions was blended for the reasons that Duran explained[3]:

> "We make a mixture of various bloods, usually of six, for two reasons: one, that of technical simplification, and the other of a biological nature. There exist in the human race hematic groups insufficiently determinate [...]. If we mix the blood with other definitely determined bloods of the same groups, we find ourselves in the position as that the receiver is injected, at most, with a small amount of wrongly classified blood, an amount equivalent to that of the injection used as a biological test in direct transfusion, with the consequent slight ill effects. The larger injection which might have serious consequences is thus avoided."

The auto-injector designed by Duran i Jordà for performing transfusions on the front[3]



Once the blood was obtained and stored adequately, the problem was how to get it to the front using a system that enabled easy administration. Duran's ingenuity was notable yet again[3]:

> "The intubation of the blood is also done without contact with the air, thanks to the use of a vacuum, and the instruments invented by us for this purpose. The blood is envased in a tube known commercially by the name of 'Auto-injectible Rapide', placed at our disposal by the commercial house *Laboratori Químic Biològic Pelayo*, which supplies us, entirely gratis, with all the material for our front. This container has had to be modified in certain minor details, to make it useful: special filter, pressure clamp, and a gauge in the form of a two-way faucet, which places itself automatically in communication, either with the vein of the receiver or with the blood in the container, without need of any other operation."

The auto-injectable bottle that Duran prepared was transparent and had two compartments: the first containing blood and the second with filtered nitrogen under pressure. The two compartments were connected by two tubes. When the needle was inserted in the vein, the blood could

flow freely into the patient that needed it; thus, anybody who knew how to give an intravenous injection could administer it and no specialist was required[2].

The third challenge was getting the blood to the front before it went bad. To achieve this, Duran fitted out a fish distributor's refrigerated truck, in which he installed two generators to keep the temperature low if required. By late August, this system was used to transport blood over a distance for the first time (300 km). As a precaution, only type O blood was sent. With certain technical improvements, the blood could be stored for up to 18 days, which meant considerable progress and the chance to save thousands of lives. The truck was able to carry up to 30 L on each journey. The success of Duran method was recognised by the Republican army, which officially adopted it on 9 July 1937[2].

In the Central Republican Army, the official in charge of organising the blood bank was the Canadian physician Norman Bethune (1890-1939), who learned and incorporated Duran inventions, such as the mobile unit for taking blood to the front. Bethune, however, never recognised the Catalan physician's contributions in his publications. Due to conflicts with the Republican authorities, Bethune went to China in 1937 to help Mao's army in its fight against the Japanese who had invaded the country, dying there of an infection contracted while operating[2]. From then on, Duran also provided blood to the entire Republican Army.

The truck used to carry blood to the front, dubbed "el Rasgo"[3]

Despite the system's success, Duran still fielded critical considerations levelled at his own method[3]:

> "Nor is this the moment to discuss whether preserved and citrated blood is better or worse than blood from arm to arm. Logic makes it clear that direct transfusion is much more biological than the indirect, and still more so than with preserved blood; but the technical simplification that we have brought to transfusion (nine blood transfusions of blood made personally required less than two hours), to have the donor always at hand, without fear of complications in moments of extreme urgency, when life or death may hang in the balance, is a matter which makes us be very cautious in our judgment; and if we go over the therapeutics again, we see that in the case of severe anaemia, the physician has only the choice between arm-to-arm transfusion and an injection of a saline solution. It is therefore necessary to think whether between these two there is not an opening for indirect transfusion with preserved blood. And I offer as witnesses my colleagues who acted as transfusors in the days of last July, moments in which with all the preserved blood, direct transfusions and indirect were insufficient, as were all of ourselves, to supply the need."

Little could Duran have known that preserved blood would eventually become the standard for blood transfusions or that in the future direct transfusion would be used only in exceptional situations.

Duran i Jordà: an example of the recovery of historical memory

The figure of Duran i Jordà exemplifies the situation of systematic oblivion practised against the losing side in the Spanish Civil War. For years, his contribution to creating blood banks was ignored, kept alive only in the memory of those who knew him, such as Moisès Broggi[4]. That is, apart

from a reference to Duran's works by Augusto Assia in *La Vanguardia* newspaper in 1946[7], where he stated that "for Dr Duran Jordá, the foremost authority on blood transfusion", the University of Manchester "has set up a clinic like those appearing in films". Very probably, the first modern reference to Duran was by Josep Carol, a writer from Martorell and the son of one of Duran's friends from school, also in an article published in *La Vanguardia* in 1976, after several decades of silence in the communications media[8]. Later on, his reputation continued to grow, and the true importance of his discoveries became known again. Carol published a short biography of Duran in 1978[9] and Joan Grífols wrote a comprehensive one several years later[1].

Duran's importance as a historical figure was finally recognised with an exhibition and series of events organised by the *Col·legi Oficial de Metges de Barcelona* upon the centenary of his birth in 2005[10]. This received extensive coverage in the press. On 28 April 2005, *La Vanguardia* published *El doctor Duran i Jordá vuelve a casa* (Dr Duran i Jordà returns home)[7] and Lluís Martínez devoted an article in his excellent historical series on medicine published in the supplement of the newspaper *Avui*[2]. In reference to the recognition that Norman Bethune had received in Canada and China and the oblivion forced upon Duran's figure at home, Martínez wrote[2]: "There are prominent personages who have been lucky enough to have been born in countries that honour them, remembering them with the means they have available." What would have become of Duran if the other side had won the Civil War or even if he had not been a member of the PSUC? Probably few discoveries that have been awarded the Nobel Prize for Medicine have saved as many lives as the method Duran invented.

In the end, the prophet Duran was recognised in his own land. On 26 July 2010, the president of Catalonia and the mayor of Barcelona inaugurated the new headquarters of the *Banc de Sang i Teixits de Catalunya*, which they named after Frederic Duran i Jordà. Thus, reparations were finally

Banc de Sang i Teixits de Catalunya
Dr. Frederic Duran i Jordà (Barcelona)

made for the years of disregard for one of the most important twentieth-century physicians in Catalonia's history, who had disappeared prematurely. His daughter, Carlota Duran, should be recognised for making this official recognition possible.

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