

## **Development of blood transfusion in Spain during the Spanish Civil War (1936-1939): the contribution of British doctor, Reginald Saxton**

### **Abstract**

When a failed military coup provoked civil war in Spain, in July 1936, the tremendous numbers of casualties obliged the Spanish government to make a worldwide plea for medical assistance. Many thousands of people around the world rallied to the call, transforming the Republican Medical Service into a truly international effort. Some of those volunteers worked in emergency blood transfusion facilities, carrying out pioneering transfusion work in primitive and often dangerous conditions. Among the most notable of these volunteers were Canadian surgeon Norman Bethune and British doctor Reginald Saxton. Working alongside them were American, Italian and Spanish assistants, many of whom remain nameless. All played vital roles in the saving of lives and all took their lead from one man – young Catalan haematologist, Frederic Duran Jordà, director of the Blood Transfusion Service of the Republican Army, and indisputable pioneer of civil war blood transfusion medicine.

**Key words:** blood transfusion wartime medicine Spain Republican volunteers

On 17 and 18 July 1936 a military coup was launched in Spain against the legitimate republican government. The rebels, led by General Francisco Franco, failed to take complete control of the country and three years of bloody civil war ensued – a war in which an estimated half a million people died. The Spanish Civil War is considered to be the first war in which civilian losses exceeded those of combatants, with the first massive aerial bombardment of civilian populations. The powerful bombs and artillery employed caused more serious wounds than those dealt with during the First World War, thus, improved and innovative methods had to be found to deal with them. Such treatments were made possible by the systematic use, in the front line hospitals, of bottled blood – a pioneering move that marked the creation, for the first time in history, of army blood transfusion services.

Unable to cope with the tremendous numbers of casualties, the Spanish government made a worldwide plea for medical assistance. Many thousands of people around the world rallied to the call, Britons included, transforming the Republican Medical Service into a truly international enterprise. Some of those volunteers worked in emergency blood transfusion services. Among the most notable of these were Canadian surgeon Norman Bethune and British doctor Reginald Saxton. They and others helped carry out transfusion work in primitive and often dangerous conditions, playing a vital role in the saving of lives. All took their lead from one man – young Catalan haematologist, Frederic Duran Jordà, director of the Blood Transfusion Service of the Republican Army, and pioneer of civil war blood transfusion medicine. It was Duran who would spearhead wartime blood transfusion therapy and who would create the first reserves of blood from volunteer donors for military and civilian use. Duran's considerable knowledge and practical expertise also inspired, informed and ultimately laid the foundations for the provision of blood transfusion in Britain on the eve of the Second World War.<sup>1</sup>

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<sup>1</sup> And yet, to most, the name Duran Jordà remains unfamiliar. When the Francoist rebels finally took Barcelona, and with it Duran's laboratories and transfusion facilities, they not only put paid to his pioneering work in the field, they also effectively silenced his scientific achievements. In what can only be described as a remarkable display of political and professional jealousy, Frederic Duran Jordà was effectively written out of Spanish blood transfusion history.

By the time Civil War broke out in Spain in July 1936, the value of blood transfusion was widely acknowledged in cases of haemorrhage and also in stabilizing patients in shock. The major obstacle to the practice was the naturally occurring phenomenon of the coagulation of blood, once outside the body. Ways and means of overcoming this obstacle would have to be sought, and an alternative found to the technically difficult and potentially dangerous method of direct arm-to-arm transfusion that was far too precarious and time-consuming in moments of total war. There were constant modifications to apparatus and technique, culminating in the development of the two-way syringe, but the many disadvantages of direct arm-to-arm transfusion rendered it unsuitable for general use and it would eventually (but not quickly) be abandoned in favour of the use of indirect methods using anticoagulants.

In transfusions where anticoagulant was used, speed was rendered less important. Blood could be extracted and then put on one side until the moment arrived for its use. It could also be carried to the patient and administered almost without disturbing them. Furthermore, the donor was not exposed to the mental shock of lying for some time side by side with a patient who might be in extremis, or who might even die during the operation. Nor would they have to suffer an incision of the arm in order to dissect the vein, will all the attendant risks involved.

By the end of the First World War indirect transfusion with citrated blood was being used by some pioneering surgeons such as US Army captain Oswald Hope Robertson, who realized that blood could be collected during lulls in the fighting and stored for use in times of urgent need. By the 1930s in Spain, doctors and surgeons were firmly convinced of the therapeutic and surgical value of transfusion, but satisfactory techniques for its administration were still to be developed.<sup>2</sup> Tragically, it was the outbreak of civil war that would prove the definitive impulse to such progress.

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<sup>2</sup> The first course on blood transfusion was carried out at the Hospital de la Princesa in Madrid, by doctors José Blanc Fortacín and Martínez Piñeiro, in 1927. The course was subsequently published in *El Siglo Médico*: Blanc Fortacín, J. y M. Martínez Piñeiro, 'Curso de transfusión de sangre', *El Siglo Médico* 1927; 79: 171-2; 207-10; 240-4; 270-2; 302-8; 329-32; 355-8; 383-5. In Avelino Franco Grande, Julián Álvarez Escudero and Joaquín Cortés Laíño, *Historia de la Anestesia en España 1847-1940* (Madrid: Arán Ediciones S.L., 2005), Chapter 16, 'Historia de la transfusión sanguínea en España (1874-1940)' pp. 227-242.

Four days after the uprising, Dr Gustavo Pittaluga was appointed head of the Transfusion Service of the Republican Army in Madrid. It was a small group of his brightest pupils, however, who would fulfill the task with which he had been entrusted, and which he was about to abandon. With modest facilities and meager equipment, the young doctors took up the challenge. Meanwhile, in Barcelona, Republican blood transfusion work was placed in the hands of Frederic Duran Jordà.

At the outbreak of war, Dr Duran was just 31 years of age but had already established himself as a skilled clinical analyst. He witnessed the large numbers of wounded that were dying because of the lack of blood with which they could be transfused, and he realized the need for a system in Spain whereby supplies of blood could be created and sent to front line hospitals, where it was most needed.<sup>3</sup> Joaquim Trías, Duran's superior, in the Barcelona hospital where he worked, recognized immediately the potential value of the project and arranged for every facility to be put at Duran's disposal.

### **Barcelona Blood Transfusion Institute**

Duran dedicated himself indefatigably to the complex task he had been set: to obtain blood, test, classify and preserve it and then transport it to the front for eventual transfusion into patients. He worked at such a pace that in less than a month he was able to deliver the first batch of blood (a modest seven litres) to the front, thus launching a new era in the history of blood transfusion.

Initially, like many of his medical peers, Dr Duran was not an advocate of using preserved (citrated) blood in transfusions. After a brief period of intensive research and experimentation, however, he became convinced of its advantages: it did not clot, it lasted several days, if refrigerated, and donors did not have to be found at the moment of need – often

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<sup>3</sup> Doctors Wenceslau Dutrem Dominguez and Serafina Palma were members of the Unified Socialist Party of Catalonia (*Partido Socialista Unificado de Catalunya*, or PSUC). They worked together in 1937 in the transfusion service on the Huesca front. At the outbreak of war, Dutrem was working on Erotil, the prototype of what is today known as Viagra. He went to Paris in 1939 and later went into exile in Mexico where he was Professor of Pathology at the School of Rural Medicine of the *Instituto Politecnico Nacional*. He founded the Laboratory Farber and became doctor to Leon Trotsky. Doctor Palma was a fellow student of Dr Duran, during their medical studies in Barcelona. After the war, she was also exiled in Mexico where she worked in various pharmaceutical laboratories.

in extreme circumstances when time was of the essence. The chief task was to provide large amounts of blood on a regular basis, in order to meet the requirements of a campaigning army. Direct transfusion was clearly inadequate, as in a rush of wounded it would be impossible to give all the required transfusions, both on account of their number and the amount of blood required.

Duran's starting point was the work by Russian Sergei Yudin on the storage and transfusion of human cadaveric blood into living humans. By the beginning of the Spanish Civil War, the practice of transfusing cadaveric blood had already been acknowledged as scientifically sound, but colleagues of Duran in Barcelona encountered 'insurmountable' obstacles to its use. In addition to the practical difficulties, there were moral objections and an important legal impediment: the prevailing law in Spain forbade the extraction of blood from corpses less than 24 hours after the pronouncement of clinical death, by which time the blood was contaminated and thus unusable.<sup>4</sup> Duran concluded that the use of cadaveric blood in transfusion was 'no longer considered practicable'.

Faced with the urgent need for massive supplies of blood, Duran concluded that the only logical way forward was to appeal for living donors among the civil population. The precedent for this kind of institution had been established on a much smaller scale by Percy Lane Oliver in Britain in 1921, in conjunction with the Red Cross. Duran and his team had to create blood reserves that would go far beyond peacetime needs. Thanks to energetic propaganda campaigns, including radio appeals, there was no shortage of volunteers.

People became blood donors for a variety of reasons – some out of pure altruism, or solidarity with the cause; others, as a result of peer-pressure. A further motive was the nutritional benefit that donating blood entailed, as donors were given allowances to buy extra staple foodstuffs. (Something very much valued in Spain at the time, given the wartime conditions). Whatever the motives involved, the fact is that once the campaign was underway it

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<sup>4</sup> Moisès Broggi, 'Sobre Frederic Duran Jordà', *Gimbernat*, 1977, 27, 188-191, p. 185.

would elicit tremendous public response, ensuring, thenceforth, a steady supply of blood.

American doctor Sidney Vogel described what he saw when he visited the Barcelona Blood Transfusion Institute:

Stretching from the corner of the street to the entrance of the hospital was a long line of workers, waiting . . . Beyond the entrance, winding for two flights up the stairs, the line continued, ending before a large white door. I had seen many things in Spain, many magnificent examples of the people's heroism and courage that a doctor does not forget. But I had never seen anything to equal the sight in that room beyond the waiting line. It was a big room and bare. Four tall windows flooded it with light. On the floor, arranged in two rows of four, were eight wooden tables draped with hospital sheets. And on each table lay a patient. They were giving blood. . . From eight human bodies the life blood was flowing, with quiet and orderly precision, into eight glass bottles, guided and controlled by eight white-robed assistants. And beyond them, running the show, the doctor in charge, a white-gowned impresario. . . Bottled blood for transfusions in war time!<sup>5</sup>

Blood distributed to the front line and base hospitals was chiefly from blood group O (universal), crucial in situations where the blood group of the wounded could not be determined. In order to maximize potential resources, blood donor centres were established in large, densely-populated cities (Barcelona, Madrid, Valencia and Jaen). Donors gave blood at regular periods of not less than three weeks, though many were keen to give frequently and often appeared before the required time. Blood was generally accepted from any healthy individual between the ages of 18 and 40. A reference index was created whereby the details of each donor were recorded in terms of name, address, hematic group and the results of diagnostic tests carried out for tuberculosis, malaria, syphilis and other diseases.<sup>6</sup> By means of cross-indexing, the staff of the Service could check exactly when they had taken blood from any given donor, as

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<sup>5</sup> Sidney Vogel, 'Voices From the Past', *American Journal of Public Health*, December 2008, Vol. 98, No. 12, pp. 2148-2149.

<sup>6</sup> Due to the lack of raw materials with which to carry out the specific test required, the donor was often simply asked to testify that they had never suffered from malaria.

well as the latter's personal details and state of health. By July 1937 3,000 donors had been registered.<sup>7</sup> By the end of the war there was a bank of 28,900 donors.<sup>8</sup>

The actual process of extraction was not far removed from the procedure carried out today. It was simple, though the strictest care had to be taken to avoid bacterial infection. A rubber ligature was placed around the sterilized arm of the donor and the practitioner punctured the vein of the forearm with a large-calibre needle of the type used for intramuscular injection that had been cut down and sharpened. The blood was collected in a specially designed matrass containing 15 c.c. of the preservative citrate solution. Blood was pumped into the matrass by creating a slight suction inside it by means of a vacuum pump. Duran developed the apparatus from earlier designs, for example, by Brown and Kimpton, in the United States and by Dr Josep Grífols I Roig, in Spain.

The filled and labelled receptacle was placed in the refrigerator, then, after a period of 24 hours incubation, the test samples were examined for presence of pathological bacteria and the usable bloods were filtered and bottled. The filtration was carried out to avoid the formation of small clots. The apparatus developed by Duran prevented the blood from coming into contact with the air, thus allowing for totally aseptic conditions. This vacuum-sealed tube became known as the *Auto-injectible Rapide*.<sup>9</sup> The filled containers were then each packed individually, in a cardboard box. Both flask and box were labeled with the particulars of the blood group/donor/date, etc., together with the warning that the colour of the blood should be ruby red, otherwise, it was likely that it was contaminated and should therefore be discarded. The flasks of blood were then stored in a refrigerator, at no higher than one or two degrees (Centigrade) above zero. This temperature was maintained during the transportation of the blood to the front, using a specially adapted truck equipped with refrigerators. Advanced

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<sup>7</sup> El *Diari de Barcelona* 15 July 1937.

<sup>8</sup> Dr Federico Durán Jordà, 'El Servicio de Transfusión de Sangre de Barcelona: Técnicas y utillaje', *Revista Sanidad de Guerra*, Año 1, Nº 8, December 1937.

<sup>9</sup> These were supplied free of charge, along with other material, by the company Laboratori Químic Biològic Pelayo. The container held a capacity of 300 c.c. of blood, but if more than this was needed another container could be easily attached to an adaptor on the needle.

military posts and front line hospitals were fitted with fridges run on electricity, petrol or paraffin. The first reserves of blood from the Barcelona service were dispatched to the front in a refrigerated van that had been used, before the war, for the delivery of fish.

One of Duran's most considerable achievements was the simplification of the transfusion technique, which enabled it to be carried out by any experienced auxiliary worker. The pre-packed tube, the *Auto-injectable Rapide*, was completely ready for use. The apparatus terminated in a hypodermic needle, sterilized and also sealed in glass. Once the seal was broken and the needle inserted into a vein, the blood began to flow as a result of the air-pressure inside the flask. It was much quicker to execute than other techniques, since all the material was sterile and no additional sterilization was necessary.<sup>10</sup>

Duran's remarkable work quickly gained notoriety. Accidents did occur, however. Blood transfusion provoked some minor reactions including fever, rigors, urticaria and headache – dirty apparatus being among the possible causes. More serious accidents were occasionally also recorded, such as that involving Republican physician Dr Vives Mañé that very nearly cost him his life. He was responsible for blood transfusion in a front-line hospital. One day a wounded man was given a blood transfusion and died from acute shock. There were clear indications that the blood administered had been contaminated and Dr Vives was tried for negligence, by a military court. It was eventually discovered that on what had been an extremely hot day, a military officer had put some bottles of beer in the fridge used for the storage of blood. As they would not all fit, he removed some flasks of blood and left them out at room temperature for a few hours, until the beer had cooled. When the alternative therapy had reached an acceptable temperature the officer returned the flasks of blood to the fridge, but the damage had already been done.<sup>11</sup>

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<sup>10</sup> Contrary to prevalent opinion as to the amount of blood that could be safely transfused (between 300-500 cc.), Duran carried out transfusions with up to 3,000cc. of blood in a single, exsanguinated patient.

<sup>11</sup> J. Vives Mañé, 'Resultados obtenidos en 130 transfusiones con sangre citrada, método de Duran', *Revista Sanidad de Guerra* 1938; 2: 101-5.  
J. M. Massons, *Historia de la Sanidad Militar española*. Barcelona, Pomares-Corredor, 1994; 2. No mention is made of what became of the military officer involved.



In November 1936, renowned Canadian thoracic surgeon Norman Bethune arrived in Spain at the head of a delegation from the Canadian Committee to Aid Spanish Democracy. A Maverick personality, he left some eight months later, amidst complaints about his antagonistic behavior, heavy drinking and unabashed womanizing. Nevertheless, though his whirlwind stay was fraught with controversy, Bethune's contribution to the Republican Blood Transfusion Service was unquestionably one of monumental proportion. After seeing the blood transfusion service of Barcelona in operation under the direction of Dr Duran, Bethune decided he would create a similar service in Madrid. The *Socorro Rojo* (International Red Aid) allocated the new service somewhat luxurious headquarters in one of the more select areas of the city, thought to be relatively safe from rebel bombing.<sup>12</sup> Funded by the CASD from donations from the Canadian public, the institute would be named the *Servicio Canadiense de Transfusion de Sangre*.

Once again, a campaign was launched to appeal to the people of Madrid to give their blood to help save the lives of those fighting in the defence of the city. On the morning after the first radio broadcast for donors, Bethune's young assistant, Hazen Sise, describes the scene in the street outside the Institute:

Over two thousand people filled the street, with more arriving every minute. They stood close together, from sidewalk to sidewalk, eyes fixed on the Institute. There were men and women, young and old, gaunt and portly, civilians and soldiers, poorly-clad workers and well-dressed housewives. They were waiting patiently, silently, without laughter . . . this long, long line of people right around the corner of the block . . . It was a very moving thing . . . It was a very exciting moment. We never had any trouble the whole time we were there. Blood donors would flock to us. This was something which appealed to the Spaniards very deeply emotionally, the replenishing of blood at the Front.<sup>13</sup>

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<sup>12</sup> Franco was reluctant to bomb the more exclusive residential areas inhabited by the rich who were largely Nationalist supporters. In an interview in 1966 Hazen Sise comments: 'I think this was done deliberately because it had been observed that this quarter, a very large area actually, was never bombed or shelled except accidentally, perhaps, and it was known that there were a great many fifth column(ists) hiding out in that area and that was probably the reason it was never shelled.' Osler Library Archives, Norman Bethune Collection, File Acc. 331.

<sup>13</sup> Interview with Hazen Sise, 1966. Osler Library Archives, Norman Bethune Collection, File Acc. 331. The fact that blood was always plentiful was not quite accurate. There were times when there was desperate need, despite the transfusion services in Madrid and Barcelona.

Bethune's team could not always adhere strictly to procedures established by Duran, as Sise explains: Normal medical procedure would be that every donor would be tested for syphilis and malaria. We didn't have the means at that point. We didn't know how to go about getting this testing done and we coldly made the decision that a man would prefer to have a dose of syphilis than lose his life. The syphilis might be cured later. So for the first few weeks we did no such testing.<sup>14</sup> Later, when the necessary facilities were available, the appropriate tests were carried out. Those who had syphilis or malaria or were in poor general health were rejected, and an institution was recommended for the treatment of any disease discovered.

Young doctor, Reginald Saxton, was working at St. Bartholomew's Hospital, London, when civil war broke out in Spain. Saxton had a strong social conscience and he was keenly aware of the need to confront the disturbing wave of fascism that was surging throughout Europe at the time.<sup>15</sup> He immediately offered his services with the Spanish Medical Aid Committee (SMAC), a British fund-raising body set up to purchase medical supplies and send them to the Spanish Republic along with medical personnel. As part of the *Servicio Sanitario de la República*, and within this, of the International Brigades' Medical Service, the SMAC unit would play a vital role during many of the major battles of the war. In early February 1937, it was sent to help in the defence of Madrid with the XIV International Brigade. There were tremendous losses, and wounded flooded into the emergency hospital that the British unit had set up near the front. Saxton was in charge of triage, prioritizing the wounded and preparing them for surgery.<sup>16</sup> It was here that he first became seriously concerned about the lack of provision for blood transfusion.

Though Saxton had some basic knowledge of transfusion techniques and some rudimentary equipment, there was simply not enough blood to give all the necessary

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<sup>14</sup> Interview with Hazen Sise, Osler Library Archives, P156 Norman Bethune Collection, File Acc. 331, p. 31.

<sup>15</sup> Reg Saxton, transcript of interview for the Imperial War Museum, accession no. 008735/0, pp. 6-14.

<sup>16</sup> Triage was the system whereby the incoming wounded were sorted into three classes: those needing immediate attention, those who could be 'patched up' and evacuated to base hospitals and those for whom nothing could be done except ease their pain until they died.

transfusions. There were very few local people to draw upon as donors and all members of the medical staff were already giving to their absolute limits. Saxton was at the point of despair when, ‘like a fairy god-mother’, Canadian doctor Norman Bethune appeared.<sup>17</sup> Norman Bethune was, at that time, in charge of the Republican blood transfusion service in Madrid. When Bethune appeared at the little hospital in Villarejo, with a refrigerator of stored blood, Saxton was the only one not involved in major surgery and, as such, was designated the team’s transfusionist. ‘I was the only medically qualified person in our hospital who was not mixed up in major surgery,’ explains Saxton.

We had three surgeons there working all the time they could, just doing surgery. The medical students that we had with us were the anaesthetists and then there were the nurses who were working all out. And I was not a surgeon – well, minor surgery of course I could manage – but I was not capable for major surgery. I just hadn’t got it in me, that’s it. I wasn’t a major surgeon. I mean, I hadn’t got the skill and knowledge, understanding, experience to do major surgery, abdominal surgery or what-have-you or major amputations. I had to do all the rest. And so I was the only person available and they said, ‘Saxton, you must do the transfusion work’. So I got down to seeing what Norman Bethune had to offer us and I gladly took everything he could give us or advise.’<sup>18</sup>

Despite having the necessary basic knowledge about blood groups, Saxton had almost no practical experience and was grateful for Bethune’s help, as well as the refrigerator full of blood that he left. As for equipment, for the moment the young doctor would have to improvise. ‘We had at that time no transfusion syringes and no satisfactory needles’, explains Saxton. ‘I collected, however, two sets of instruments to enable me to dissect a vein and insert a cannula.’

I had a long rubber tube and a funnel. So I delivered the blood into the patient by pouring it into a funnel and it came down a tube and it went through a cannula into the patient’s vein. And it worked. It worked very well but, of course, it was a bit tedious and troublesome and the sterilizing wasn’t too easy or even too perfect. But still, we just

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<sup>17</sup> Reg Saxton, transcript of interview for the Imperial War Museum, accession no. 008735/09, pp. 33-39.

<sup>18</sup> *Ibid.*, pp. 39-40.

had to wash it out and boil it up and do it again. And this is how I was transfusing our severely exsanguinated patients.<sup>19</sup>

Bethune later returned to Villarejo with more instruments. These included a Jubé two-way syringe for arm-to-arm transfusion and basic equipment that would enable Saxton to begin taking blood from volunteer donors among the local population. These were the tentative beginnings of Saxton's contribution to blood transfusion during the Spanish Civil War. From here, he would go on to steadily develop his knowledge and expertise in transfusion medicine and would provide a blood transfusion service in all of the war's major battles.

Saxton continued to receive refrigerated blood from the Blood Transfusion Institute in Madrid, and later (after Bethune had left Spain) from the Barcelona Blood Transfusion Service, under the direction of Frederic Duran Jordà. In addition, he set about devising an alternative source for when supplies were short. As well as classifying the blood of all the medical personnel, as potential donors, he also tested that of troops and of the local population where the medical unit was stationed.

For the battle of Brunete, just outside Madrid, Saxton was sent to El Escorial, to the northwest of the capital, to help establish what would be the main field hospital. The building chosen, a monastery on the hillside below El Escorial, was spacious, though the sanitation was far from adequate and the steep stairs up to the wards made life very difficult for the stretcher-bearers. There were three operating theatres, a small X-ray unit and a blood transfusion service of which Saxton was in charge. The medical teams worked with little respite as thousands of casualties flooded the hospital. Many were seriously wounded and in shock and Saxton's team was barely able to keep up with the transfusions required. Saxton himself was doing a twelve-hour stint and then joining the following shift. Conditions almost intolerable. The forward aid

posts were subjected to incessant shelling and aerial attack, as were the ambulances, the Republican forces gaining some 75 square kilometres at the price of over 20,000 lives.<sup>20</sup>

After the battle of Brunete, Saxton made a brief visit to England where he was able to obtain more essential transfusion equipment. This included several Jubé syringes and a device for pumping blood at a steady rate from a bottle (or from the arm of a donor, in the case of direct transfusion) into the arm of the patient.<sup>21</sup> Before returning to his laboratory work, Saxton dedicated some time to writing up a report for the British scientific journal, *The Lancet*, on the method of blood transfusions that he had used, to that date, on the Madrid front.<sup>22</sup> The work in question covered two periods: the first, February 1937 and the second, July of the same year. Saxton reports that patients were normally given 400c.cm. of citrated blood: Groups I and II (Moss) receiving Group II, and Groups III and IV, Group IV. Direct transfusions of smaller quantities of uncitrated blood (about 300 c.cm.) were given to a smaller number of patients, usually using the same blood group. In addition to blood, casualties often received quantities of glucose, insulin, saline and/or adrenalin.

The instruments usually employed were French – the Jubé 10 c.cm. 2-way transfusion syringe for citrated blood, and the Henri-Jouvelet apparatus for arm-to-arm transfusion, though others were used in the absence of these. As adequate instrumentation was acquired in sufficient quantity, the speed and efficacy of transfusion improved to the point where a straightforward case would take only half an hour to complete. Saxton underlines the need for duplication of instruments and takes the opportunity to make a public appeal:

it is the cleaning and sterilizing of the small set of instruments that wastes a great deal of time that could be saved if spare sets were always at hand while the first were being cleaned. The Spanish Medical Aid Committee (24, New Oxford Street, London)

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<sup>20</sup> The Nationalist losses of over 10,000 should be added to this figure, making the cost in human lives somewhere in the region of 35,000.

<sup>22</sup> R. S. Saxton, M. R. C. S., 'The Madrid Blood Transfusion Institute', *The Lancet* Sept. 4, 1937, pp. 606-607.

furnishes what it can, considering the tremendous calls for materials and personnel with which it has to deal, but with further support it would be able to supply this need.<sup>23</sup>

In the earlier of the periods under discussion, in about half the cases the vein was exposed via dissection, and a maximum of ten transfusions were given in any one day. In the second period, with improved instrumentation and more efficient method, the dissection of the vein (which wasted time and carried the risk of sepsis) was reduced to between 5 per cent and 10 per cent of cases, and the maximum number of patients transfused in a day was 12. Arm-to-arm transfusion was used when blood of the appropriate group of citrated blood was unavailable or when the patient had already received so much citrated blood that it was thought inadvisable to give him more citrate.<sup>24</sup>

The mortality among transfused patients was a little over 60 per cent, but at least 90 per cent of the transfused cases were expected to die without the transfusion, 'so that the saving of a life in which blood transfusion may be considered to have been a necessity,' explains Saxton, 'would amount to about 30 recorded cases.'<sup>25</sup> Among the fatalities there were also patients with very severe shock, some of who would probably have been saved with large and repeated transfusions, a treatment not practicable under prevailing circumstances because of the limited supply of blood. Saxton's conclusion underlines his interest in pursuing the practice of using cadaveric blood for transfusions.

one is reduced to direct donors in the present conditions obtaining in Spain. The choice of these is further limited in large transfusions to members of the same group, owing to the probability, otherwise, of reverse agglutination. For every litre of blood one would have to have at least two donors, and to obtain such a liberal supply of donors at the right time and place would be extremely difficult. In fact, in dealing with large numbers of patients, this treatment is impracticable. The only possibility of saving these lives rests with the use of stored cadaver blood as described by S. S. Yudin (*The Lancet*,

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<sup>23</sup> *Ibid.*

<sup>24</sup> Saxton worked on the basis that sodium citrate in doses over 5 grammes was likely to produce a toxic state resembling shock. As a litre of citrated blood contained nearly 4 grammes, it was not considered advisable to give much more than this amount.

<sup>25</sup> R. S. Saxton, M. R. C. S., 'The Madrid Blood Transfusion Institute', *The Lancet* Sept. 4, 1937, pp. 606-607.

August 14<sup>th</sup>, p. 361). In my opinion it is the duty of the *Sanidad Militar* of the Spanish Republic to organize the large-scale supply of cadaver blood, which of course is readily available, to their front line hospitals in the same way as they now supply citrated blood.<sup>26</sup>

An important addition to Saxton's transfusion team, in the autumn of 1937, was young American pre-medical student, Henry (Hank) Rubin. Rubin was studying at the University of California when civil war broke out in Spain. Concerned about the spread of fascism, he decided to join the International Brigades, arriving in Spain in August 1937. Rubin's time in Spain, however, was complicated by his ill-health.

To call the sanitation in wartime Spain 'primitive' is to be polite... Outside the cities, toilet facilities were often limited and almost always inadequate. In the field, at best there were only trench latrines, most often without disinfectant to control insects or odour – only a pile of loose dirt and a shovel. All of this, combined with the prevalence of flies, the lack of any other sanitary practices and facilities, and the absence of enough *potable* water, made diarrhea and dysentery widespread. During the seventeen months I spent in Spain, I had either one condition or the other almost a third of the time.<sup>27</sup>

After recovering from a bout of yellow jaundice, Rubin was sent to join the SMAC unit, under the guidance of Dr Saxton, who taught him all he needed to know about the clinical aspects of lab work. The young American soon learned to take blood samples by extracting blood from a vein with a syringe and he became a skilled lab technician. Saxton sent him to Barcelona for a short while, to study the pioneering blood transfusion work of Dr Duran Jordà. Rubin was clearly impressed:

with the work of Jorda in Barcelona and the organizing drive of Bethune in Madrid, a modern medical miracle came into being. For the first time it was possible to transfuse wounded soldiers safely near the front; but, as there was no refrigeration at aid stations, blood would not be available there. In our forward hospitals, however, only a kilometer or so back from the front lines, this new miracle worked. This new system, with

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<sup>26</sup> R. S. Saxton, M. R. C. S., 'The Madrid Blood Transfusion Institute', *The Lancet* Sept. 4, 1937, p.607.

<sup>27</sup> R. S. Saxton, M. R. C. S., 'The Madrid Blood Transfusion Institute', *The Lancet* Sept. 4, 1937, pp. 85-86.

contributions made by thousands upon thousands of donors, made many surgical procedures feasible and saved countless lives.<sup>28</sup>

In addition to training Rubin, Saxton was obliged to instruct his Spanish driver, Paco, in the rudiments of transfusion work. 'The great increase in work suddenly descending on us at a time when one of the two laboratory workers had been invalided home threw a great strain on our resources,' explains Saxton. 'The chauffeur quickly learned to do many of the simpler tasks, and took a great burden off us in cleaning and drying glass-ware, and ultimately doing all the simpler urine analyses.'<sup>29</sup>

During lulls in the fighting, and often with the co-operation of local left-wing organizations, Saxton recruited blood donors from among the local townspeople, persuading them of the vital importance of donating blood for the wounded soldiers at the front, and encouraging them to visit the hospital to have their blood tested. The first donor was a girl of 19 whose blood was transfused into a soldier who had to have his leg amputated. The man made an excellent recovery and the news spread quickly among the local population, ensuring a good response to the team's next appeal for donors.<sup>30</sup>

In September of 1937, Saxton conceived the idea of creating a travelling laboratory and blood transfusion unit. This would enable analyses and transfusions to be carried out nearer the front lines, where they were most needed. The idea was eventually put into effect when the transfusion team was given a large Ford evacuation ambulance. The body of the vehicle had been practically destroyed but the chassis and engine were still in excellent condition. Saxton later describes how a new body was built to the specifications of the team's Italian lab technician, Jean Picone.<sup>31</sup>

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<sup>28</sup> R. S. Saxton, M. R. C. S., 'The Madrid Blood Transfusion Institute', *The Lancet* Sept. 4, 1937, p. 109.

<sup>29</sup> Reg Saxton in interview for IWM, accession no. 008735/0, pp. 6-14.

<sup>30</sup> B. Dingle, 'Blood transfusion in Spain'(report, 1938)in the Archives of the Trades Union Congress (Warwick Digital Library: Document reference 292/946/42/13).

<sup>31</sup> The work was carried out at a workshop in Albacete during late November and early December 1937.



The finished laboratory contained a table, cupboards, drawers, shelves, racks, sink and a water tank.<sup>32</sup> Spaces were left in the four corners of the van for the larger apparatus that would gradually be acquired, namely: autoclave, incubator, refrigerator, and oven; and the van was electrically fitted so that this equipment could be plugged in to any local electrical supply when the lab was stationary. The space between the driver's seat and the laboratory was occupied by large storage drawers that could be removed to make room for three bunks for sleeping purposes. 'On the dividing wall, just behind the driver's compartment,' recalls Rubin, 'an upper and lower bunk had been installed for the driver and me to use when we were at a first-line hospital. The height of the compartment was only about five feet, and the width of the bunks was slightly less than twenty inches. A second wall, with a door, separated these bunks from the working part of the *autochir*.<sup>33</sup> This space was so tiny that when we slept there we had to keep the door open or feel suffocated. Nevertheless, it was much better than having to sleep on the ground.'<sup>34</sup>

Equipping the lab completely was a very long and difficult process, starting with extremely few reagents and quite inadequate instrumentation. Over the course of some three months, the team gradually acquired enough material to do just about every kind of laboratory work that might be required near the front. 'We sent lists of requests to all possible sources in Spain and to Paris and London and Los Angeles, without result!' declares Saxton. 'In fact, the only way in which we could get what we have was by begging from those who had an excess.'<sup>35</sup> Further material was obtained by exchanges with other laboratories, and a certain amount was bought in hurried visits to Madrid, Valencia and Barcelona. Though still lacking a few small instruments and reagents, Saxton's team now had nearly all the major and expensive material that was needed for the laboratory.

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<sup>32</sup> There was also a 50-60 gallon water tank fixed to the roof of the van, with suitable connections for its use.

<sup>33</sup> The *autochir* was the name given to the travelling operating theatre.

<sup>34</sup> Hank Rubin, *Spain's Cause was Mine: A Memoir of an American Medic in the Spanish Civil War*, (Southern Illinois University Press, 1997), p. 111.

<sup>35</sup> Reg Saxton in interview for IWM, accession no. 008735/0.

The mobile laboratory was supplied with sealed ampoules of blood from the Blood Transfusion Service in Barcelona. These were carried to the front in the van's refrigerator and supplemented, in times of greatest need, with blood donated by the medical personnel. The two lab assistants, Rubin and Picone, were both eager to do what was possible with the material that was available, and to help acquire further equipment. Moreover, recalls Saxton, they were able to carry out practically every kind of laboratory examination that was demanded of them near the front, and often in very difficult conditions. They were hampered, but not defeated, by the lack of small but essential articles of equipment such as a water still (distilled water being unobtainable) and glass for making pipettes.<sup>36</sup> As the weighing machine was without weights, balancing had to be done (inevitably, somewhat inaccurately) with measured volumes of water. All these obstacles were compounded by the distressingly frequent presence of enemy aviation overhead.

Saxton saw the travelling laboratory as an essential addition to the blood transfusion service, and he was keen to continue his research in the field, particularly with relation to the use of cadaveric blood, following the work of Yudin.<sup>37</sup> Meanwhile, the Divisional Travelling Laboratory carried out other routine analyses including tests for TB, syphilis, malaria, typhoid and other diseases, as well as examining water supplies for possible contaminants. Upon one occasion, Saxton had occasion to test the milk being supplied to the hospital from a local source, and discovered that it was being watered.<sup>38</sup> In addition to the lab work, Saxton was concerned for the general welfare of the soldiers and medical personnel and actively promoted general good hygiene practices among the troops. He also supervised the building of trench refuges as protection from aerial machine-gunning.

One of the more persistent difficulties during work near the front was that of fuel. Sufficient electricity to operate the lab's equipment was a rarity, the most readily obtainable

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<sup>36</sup> Pure distilled water was vital for making up the sodium citrate preservative solution for blood.

<sup>37</sup> Like Bethune's team in Madrid, Saxton was prepared to try to overcome the obstacles presented by this practice, in view of the potential benefits to be gained.

fuels being alcohol and petrol. Petrol was used to run the lighting, heat the autoclave and oven, and to boil water, while the Bunsen burner and the water bath were fuelled by alcohol. In the absence of suitable electricity for the electric centrifuge, a hand one was used. The biggest problem for the transfusion team, however, was that of the refrigerator, a constant cause of exasperation:

With considerable difficulty we obtained one that burned butane gas and we were assured that we could always get more of the gas in Valencia. After the first cylinder ran out we have never managed to get any more! With some difficulty we adapted this machine to the use of an alcohol Bunsen burner, but this is a constant worry for the following reasons. It has no thermostatic control, and so requires frequent adjustment (by day and night). It is liable to blow out and then flood the floor of the laboratory with alcohol. It is dangerous, having already caused two small fires. It uses large quantities of alcohol, apart from any that may be wasted – something like 1<sup>3</sup>/<sub>4</sub> litres a day in hot weather. Butane gas is, in fact, a necessity.<sup>39</sup>

The lack of a functioning refrigerator prevented the storage of preserved blood for very long and, for a period, there was more reliance on direct transfusions. This put an unwarranted strain on the medical staff, most of whom had already given blood and who were usually working extremely hard when casualties were heavy. As was standard practice, where possible, donors were recruited from the locality in which the lab was stationed, but this was time-consuming and rarely resulted in sufficient quantities of blood being obtained.

It was Saxton's ultimate aim to establish a 'shock ward' where all cases requiring transfusions would be kept together, with an available stock of blood, salines and glucose at hand, as well as the necessary equipment to give continuous drip transfusions where needed. The lab carried all other available means for the treatment of haemorrhage and shock, such as blankets and large numbers of hot water bottles, blocks for raising the foot of the bed, etc.<sup>40</sup> From humble beginnings, the laboratory developed into something much more sophisticated,

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<sup>39</sup> R. S. Saxton, 'The Travelling Laboratory of a Division', *Ayuda Médica Internacional*, April 1938.

<sup>40</sup> Report signed 'R. S. Saxton, Doctor in charge of blood transfusions and travelling Laboratory; Jean Picone, Chief lab. worker; Henry K. Rubin, Assistant lab. worker.'

gradually becoming an integral part of the medical service. Like the *autochir*, the mobile lab could be quickly moved up to the front and begin functioning immediately, without the need to set up equipment from scratch. Saxton managed the only self-sufficient, travelling laboratory and transfusion unit in the Republican Medical Service.

For Hank Rubin, becoming a transfusionist was sudden and accidental. At first, his daily routine included taking blood samples for analysis and carrying out blood typing. Then, one day, he received an urgent call for transfusion in the surgical ward of the base hospital. Dr Saxton was away, the senior lab technician was at the garage and there was no preserved blood left in the fridge. Rubin was forced to act on his own initiative. He took a blood sample from the patient who, fortunately, turned out to be of universal blood type. Meanwhile, an orderly was sent to find a volunteer donor. This turned out to be a young woman who was one of those already registered as of universal type. With no doctor or nurse available to carry out the transfusion, Rubin had no alternative but to attempt the procedure himself. He took the young woman to the ward and accommodated her on a bed next to the patient, then completed the procedure which, thankfully, turned out to be relatively straightforward, if somewhat nerve-racking for the novice transfusionist, as he later recalls:

The soldier's veins were not hidden or collapsed. I was familiar with the equipment, having watched Reggie use it and having cleaned and sterilized it countless times. As I drew the blood from her and transferred it into him, I kept talking to her. "*Calma, calma* (be calm, be calm)," I kept repeating. But in fact the words were more for me, inasmuch as she lay there perfectly relaxed. Fortunately, the job was done quickly and my anxiety turned to pride.<sup>41</sup>

Rubin's superiors, however, did not share his contentment. When the senior lab technician returned, he recalls, 'I told him what I had accomplished. He was so scared by what I might have done wrong that he had a fit, bawled me out in Italian, Spanish, French and English.

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<sup>41</sup> Hank Rubin, *Spain's Cause was Mine: A Memoir of an American Medic in the Spanish Civil War*, (Southern Illinois University Press, 1997), pp. 115-116.

Reggie, when he came back and heard of my exploit, did the same, although with very, very British reserve. Then, probably in the desperate hope that I wouldn't kill someone in the future, they began to train me.'<sup>42</sup>

The lack of suitable needles made routine transfusion work more complicated – those most often available being of a large bore, which made them extremely difficult to insert into the vein. And as even these were a scarce commodity, they had to be sharpened and reused, repeatedly. Though Saxton and his team he became skilled at the task, the recycled needles were never as good as the occasional new ones they acquired. In cases of severe shock the patient's veins were completely collapsed, which meant that the vein had to be exposed in order to insert the needle and begin the transfusion. This complicated the procedure, as Rubin later explains:

Maintaining a sterile atmosphere in such a situation was almost impossible. I would wash my hands as thoroughly as possible but sometimes there wasn't much water. A quick alcohol hand rinse followed. Then I would come back with my sterile scalpel and tincture of iodine to sterilize the patient's skin. To do the job I had to kneel in the dirt, with no assistant to hand me the scalpel or needle. If the patient moved or twitched, the gear, often of necessity balanced on his chest, could slide to one side or on to the ground, and that would be the end of sterility.<sup>43</sup>

Thanks to the generosity and the solidarity of thousands of civilian donors, blood supplies were created in Spain on an unprecedented scale. Nevertheless, there were still many extreme circumstances in which blood for transfusions was in short supply and the travelling team was able to recruit further donors from among the local population, near the battlefield.

In December 1937 Republican High Command planned an offensive to the north, in Teruel, with the idea of diverting rebel troops away from Madrid. Teruel, with an altitude of some 1,200 metres, is reputedly the coldest region in Spain in winter, and 1937 produced the lowest recorded temperatures of the century, ranging from six to twenty degrees below zero.

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<sup>42</sup> Hank Rubin, *Spain's Cause was Mine: A Memoir of an American Medic in the Spanish Civil War*, (Southern Illinois University Press, 1997), p. 116.

<sup>43</sup> *Ibid.*, pp. 126-127.

Along with biting cold, soldiers had to endure fierce winds, rain and snow and the suffering of the wounded was often compounded by exposure and frostbite that led, in many cases, to the need for amputation of limbs. The travelling laboratory was stationed near the hospital that Saxton had helped to establish in an old monastery at Cuevas Labradas, to the north of the city.

During the battle of Teruel, Saxton was desperately in need of blood with which to transfuse patients. Now with sufficient knowledge of the procedures for its extraction, he decided to resort to the use of cadaveric blood. He would first carry out several preliminary examinations to determine the properties of the bloods collected, with a view to their possible use in front line hospitals, but conditions prevented any later transfusion. Saxton's findings were reported in an article for *The Lancet*, 'Towards cadaver blood transfusions in war'.<sup>44</sup>

When massive nationalist attacks finally forced the Republican forces to abandon Teruel, the transfusion team set up the laboratory at the 500-bed base hospital in Valls. Work here was intensive and they were soon joined by a second American volunteer, Victor Tiship. Also forming part of the transfusion team at Valls was 17-year-old Catalan, Ramón Mauri.<sup>45</sup> Even convalescing patients were recruited to help. International Brigade volunteer John Henderson was a patient at the hospital. Henderson, a woodworker from Tyneside, had fought with the British Battalion at Jarama and at the beginning of Brunete, before being wounded. During his convalescence at Valls, he made a somewhat novel contribution to the blood transfusion service:

As a matter of interest, I don't think it's properly appreciated that it was the Republican doctors during the Spanish Civil War who were responsible for making the storage of blood in blood banks a routine thing. It was not common practice until they started doing it. I mention this because I spent some time rigging up wooden contraptions in

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<sup>44</sup> Dr Reginald Saxton, 'Towards cadaver blood transfusions in war', *The Lancet*, 19 March 1938, pp. 693-694.

<sup>45</sup> Seventeen-year-old Mauri went on with Reg to the hospital established in a large natural cave at La Bisbal de Falset on the river Ebro. At the end of the war, he managed to cross the border into France. In February 1939 they were with thousands of other refugees in the concentration camp on the beach at Argelès. Reg Saxton and Dr Len Crome (ex-Chief Medical Officer of the 35th Division) arranged for him to be sent money, as he had requested, along with the news that arrangements had been made for him to go to England. At the last moment, however, he was able to board a ship bound for home.

that hospital to hold up blood bottles, having to hold nails between my toes and then hammering them in with my one good hand.<sup>46</sup>

The next, and last, major offensive in which the transfusion team would serve was the battle of the Ebro – probably the most bitterly-fought battle of the entire war. In the summer of 1938 the Republic planned a massive offensive around the river Ebro, in a last desperate attempt to reunite the two divided areas of Loyalist territory. The medical unit was sent to an emergency hospital established in a large cave in the hillside near the town of La Bisbal de Falset, near the river. Reception and triage were housed in tents in the valley below the cave, which was the nearest the ambulances could get to it. Saxton's mobile blood transfusion unit was stationed in an adjacent olive grove.<sup>47</sup>

As the bridges had all been destroyed, thousands of troops crossed the river on pontoons, from the eastern bank. When the offensive began, wounded men often had to wait for several hours before they could be brought back across the river at night, under the cover of darkness. Thus, the time-lag for treatment rose from the desired five hours maximum to twenty and sometimes thirty hours. Understandably, many were in severe shock by the time they reached the hospital, and the death rate was high. Hank Rubin remembers conditions in the cave:

Its stone floor was partitioned into various rooms by curtains strung on wires: a surgical ward, recovery room, patients' area, and even sleeping quarters, although few of us had much time for sleep. As the battle progressed, the ambulances arrived at the cave in a steady stream from the river's edge ... Day and night they poured in; the field of stretchers seemed to expand every hour. The wounded on their stretchers were placed at the forward, open face of the cave, and at times this collection of wounded extended

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<sup>46</sup> In Don Watson and John Corcoran, *An Inspiring Example: The North East of England and the Spanish Civil War* (Middlesbrough: The McGuffin Press, 1996), p. 60.

<sup>47</sup> See Angela Jackson, *Beyond the Battlefield: Testimony, Memory and Remembrance of a Cave Hospital in the Spanish Civil War* (Pontypool: Warren and Pell, 2005).

beyond the sheltering overhang. Fortunately, it didn't rain, nor were we attacked by enemy aircraft.<sup>48</sup>

Saxton and his assistants worked with little respite as many of the wounded were in need of transfusion. On the second day without bridges, two surgical teams were ferried across the river to Mora del Ebro. The transfusion team was one of the first mobile medical units to cross the Ebro.<sup>49</sup> They went to a point on the opposite side of the river, near Flix, where a railway tunnel had just been bored into the hillside. Here they would be joined by other medical teams that would establish an emergency hospital. An area in front of the tunnel was leveled off so that ambulances could approach to load and unload patients. Leaving just the necessary room for stretcher-bearers to manoeuvre with the wounded, a wall of sandbags was erected at both ends, thus affording some protection from bomb blasts. The cramped space inside the tunnel was divided by curtains into three sections: triage, surgery and sleeping quarters. The mobile transfusion lab was stationed nearby. Casualties were heavy and the medical personnel worked day and night with little rest.

Shortly afterwards, work in Spain came to a halt for the transfusion team and for most other medical volunteers when, in September 1938, Republican Prime Minister, Dr Juan Negrín, gave the order for the withdrawal of all international volunteers.<sup>50</sup> Rubin was repatriated to America and Saxton was obliged to return to England in November 1938. The withdrawal left him feeling morally very low, 'like the rats running out of a sinking ship.'<sup>51</sup>

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<sup>48</sup> Hank Rubin, *Spain's Cause was Mine: A Memoir of an American Medic in the Spanish Civil War*, (Southern Illinois University Press, 1997), pp. 123-124.

<sup>49</sup> Doug Jolly's unit broke down and had to be towed the rest of the way by a truck.

<sup>50</sup> The International Brigades were withdrawn from Spain by Prime Minister Dr Juan Negrín, in order to demonstrate the purely national character of the Republican cause. It was hoped, thus, to facilitate the re-establishment of international law and the complete elimination of foreign intervention, including the 80,000 Italian and 10,000 German regular troops fighting with the rebel forces.

<sup>51</sup> Reginald Saxton in an interview for the Imperial War Museum, accession no. 008735/0. Saxton reflects upon the general effects of the war on the later lives of those volunteers involved in the medical services: 'It was terribly important to me at an emotional level, and to all of us, I'm sure. It engraves things so deeply on us that, even if we wanted to, we can't get rid of them. And it determined what sort of friends I made, what sort of people I rejected as friends and what I did with my life. It was a big driving force.'



Dr Reginald Saxton's work in the field of blood transfusion was published in various articles in *The Lancet* and was to be of vital importance in informing the setting up of blood banks in wartime Britain. Saxton also acknowledged the pioneering work of Dr. Duran. In a letter to *The Lancet*, in April 1939, he writes: 'I had the privilege of knowing Dr. Duran Jordà and his institute and colleagues in Spain, as I also knew the institutes and staff in Valencia and Madrid ... I should like first to offer a tribute to the excellent and life-saving work done by the Barcelona Blood Transfusion Institute ... we should be grateful for the way in which the Spanish Republicans have placed the fruits of their hard-won experience at our disposal.'<sup>52</sup> By the end of the Spanish Civil War, however, Saxton had gained both expert knowledge and abundant practical experience of transfusion – so much so that he felt qualified enough to question some of the methods previously employed by Duran. In Saxton's opinion, for example, the methods used in Barcelona to detect signs of bacterial infection in stored blood were not entirely reliable.<sup>53</sup> In his experience, the colometric tests employed by Duran's team would only indicate heavy growths:

...infections not great enough to cause this brown colour (which colour was seen all too frequently in the blood supplied for the Ebro offensive) will yet cause an unpleasant rigor in the recipient. I do not doubt that most of the blood supplied from Barcelona, at least in the summer months, had some slight initial infection which, owing to unsatisfactory refrigeration, increased, and caused the rigors observed in about half the cases transfused by me and my associates, in August, 1937 and 1938. The origin of this infection was possibly twofold: (1) from a bacteraemia of the donors, for bacterial dysentery is epidemic in Spain in the summer months; and (2) from some error of sterile technique that is likely to creep into collection, mixing and storage when rather complicated apparatus is used.<sup>54</sup>

At the end of the war, with Spain in the hands of the rebel victors, Duran was forced to flee into exile. British doctor Janet Vaughan facilitated Duran's invitation to Britain. Vaughan had been a medical volunteer in Spain where she became familiar with Duran's work. She was convinced

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<sup>52</sup> Reg Saxton, letter to *The Lancet*, 15 April 1939, p. 905.

<sup>53</sup> This would seem to corroborate Elósegui's earlier criticisms of Duran's method.

<sup>54</sup> Reg Saxton, letter to *The Lancet*, 15 April 1939, p. 905.

that his knowledge and experience would be invaluable in the creation of a similar blood transfusion system in London, given the imminence of another world war. With Duran's help, she conceived a wartime blood supply system that would be capable of serving the London hospital leading eventually to the establishing of a unified system for use throughout the British Army and for civilian care.<sup>55</sup>

Saxton was called up in the Second World War. He was posted to the Blood Transfusion Service of the Royal Army Medical Corps and took out to Burma a transfusion unit similar to that which he had operated in Spain. He served throughout the war, reaching the rank of major, later being mentioned in dispatches for his bravery.

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<sup>55</sup> Despite Duran's impeccable credentials and his important contribution to the British war effort, he had a difficult time in England. It took some considerable time before Duran's professional qualifications were recognized, allowing him to resume his medical career and to find solace in his 'new life'. Tragically, Duran detected the leukemia that was to cause his death on 30 March 1957, at the age of 51.