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History of Neurology

Jules and Augusta Dejerine, Pierre Marie, Joseph Babiński, Georges Guillain and their students during World War I

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ABSTRACT

World War I (1914–1918), however tragic, was nonetheless an “edifying school of nervous system experimental pathology” not only because of the various types of injuries, but also because their numbers were greater than any physician could have foreseen. The peripheral nervous system, the spine and the brain were all to benefit from the subsequent advances in clinical and anatomic-functional knowledge. Neurosurgeons took on nerve sutures, spinal injury exploration, and the localization and extraction of intracranial foreign bodies. Little by little, physical medicine and rehabilitation were established. A few of the most famous Parisian neurologists at the time—Jules and Augusta Dejerine, Pierre Marie, Joseph Babiński and Georges Guillain, who directed the military neurology centers—took up the physically and emotionally exhausting challenge of treating thousands of wounded soldiers. They not only cared for them, but also studied them scientifically, with the help of a small but devoted band of colleagues. The examples presented here reveal their courage and their efforts to make discoveries for which we remain grateful today.

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1. Introduction

“There is nothing more wounding for the soul [or] more painful than to hear the delirium and suffering of men with brain injuries”, wrote Georges Duhamel (1884–1966) [1].

The first major worldwide conflict shattered not only the preexisting military frame of reference, but also the foundations of public health. The nascent war industry, with its machine guns and cannons, led to immediate, unexpected and significant losses. Soldiers with neurological injuries flooded the hospitals, far outnumbering what had been

anticipated in the deplorable initial planning. Neurological injuries were responsible for around 20 % of deaths in combat. Among the wounded, 10 % suffered from nervous system damage and half of them were brain injuries. However, with widespread use of the Adrian helmet, which replaced the ‘cervelliere’, a steel skull cap worn under the standard army kepi, the number of brain injuries decreased [2]. As for psychological disorders, no one had anticipated them before the war began. Their treatment remained sporadic throughout the conflict and for many years thereafter; physicians feared simulation more than misunderstanding the organic causes.

“If war taxes were applicable to scientific discoveries, of all medical fields, neurology would be the most heavily taxed...

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The war was a painful but edifying school for experimental pathology of the human nervous system. Projectiles that penetrate, cut or cause contusions multiplied mercilessly and subjected our soldiers to experiences that, up until then, only laboratory animals had undergone. Immediately striking back, surgeons identified the lesions, allowing them to accurately determine their location and type. Procedures performed after some delay also revealed the later stages of repair or degeneration of nervous tissue. Offensive and defensive experimentation was thus carried out on human beings, who swiftly taught us a great many lessons” [3].

In an attempt to improve the care of neurological injuries, the army health service under Justin Godart (1871–1956), deputy secretary of the military health department from 29 October 1915 to 18 January 1920, created military neurology and neuropsychiatry centers, the management of which was assigned to the most high-profile hospital clinicians.

The purpose of the present report is to emphasize the contributions of some of the great leaders of the Salpêtrière Hospital Medical School as well as other Paris hospitals, such as the Bicêtre. Leaders in other countries, beyond the scope of this paper, include: Tatsuji Inouye (1881–1976) in Japan; Gordon Morgan Holmes (1876–1965) and George Riddoch (1888–1947) in Great Britain; Karl Bonhoeffer (1868–1948) and Otto Binswanger (1852–1929) in Germany.

2. Jules Dejerine and Augusta Dejerine-Klumpke

Jules Dejerine (1849–1917) experienced the Franco-Prussian War of 1870 when he was a student in Geneva, where he cared for wounded French soldiers with *l'ambulance des Dêlices*. During World War I, he was at the peak of his career, having held the Chair of Nervous System Diseases at La Salpêtrière since 1910. In April 1877, nephritis immobilized Dejerine for 6 months, leaving him with chronic proteinuria. In 1913, he fell ill, probably due to kidney failure, and had to step down for a few months from overseeing clinical neurology at La Salpêtrière. He returned to his duties in 1914, even though he continued to suffer from his illness (Fig. 1). Starting in October 1914, La Salpêtrière became a military neurology center staffed by André Thomas (1867–1963), Joseph Jumentié (1879–1928) and Gustave Clarac (1884–1917). Edouard Krebs (1883–1971) was the official interne (resident medical student), Jean Mouzon (1892–1964) the temporary interne, and Yvonne Dejerine (1891–1986), daughter of Jules and Augusta, an externe (non-resident student).

The department initially had 58 beds, but included 325 beds by the end of 1915 [4]. As Edouard Gauckler (1858–1924) reported: “The boss went to great pains. With Mrs. Dejerine initially and Mouzon, he was in charge of a vast department. And even once he had the help of several physicians, he spared no effort, despite his illness, in the care, study and examination of the wounded. He refused to rest, a necessity at his age, and because he overworked himself at a time when the symptoms of the illness that would take his life were making themselves felt, he, too, could be considered a victim of national duty, a war victim. He had his first attack of uremia



CLINIQUE DES MALADIES DU SYSTÈME NERVEUX - HOSPICE DE LA SALPÊTRIÈRE 1912.
Professeur et Mme J. Dejerine ; Tinel, Chef de Clinique ; Jumentié, Chef de Clinique Adjoint ; Gallié, Heuyer, Quérac et
Mlle Pauline, Internes ; Host, Chef de Service et Bourguignon, Chef de Service Adjoint du Service d'Electrologie.

Fig. 1 – La Salpêtrière, 1912: Jules Dejerine and Augusta Klumpke-Déjerine are standing in the middle; Jules Tinel is to the right of Jules, and Joseph Jumentié is to the left of Augusta. (BIU Santé Paris, with kind permission; public domain.)

upon returning from the meeting of military neurologists in Doullens on 26 January 1916.”

His daughter Yvonne performed bloodletting to save him from pulmonary edema. “Even when his illness affected him most profoundly, he always dreaded abandoning his department and leaving his hospital duties to others. He suffered intensely from being unable to fulfil his role as chef de service and, to his dying day, the hospital, the department and the wounded were his major concern. He nonetheless took solace in seeing his military duties assigned to André Thomas, one of his oldest and most faithful students. His clinical teaching duties were handled by Lereboullet [5], whose devotion and finesse he often praised” [6].

Jean Camus (1872–1924), another former interne, provided a personal portrait of his teacher’s thinking. “When the war started, Dejerine, who wanted to hold on to his position and his army rank, was mobilized. A year later, he had to request leave on account of illness, and this deeply saddened him. He had always believed that war was possible, and maintained his hope for revenge. Younger soldiers might have mocked this passionate patriot’s devotion to the army were it not for the profound respect they had for him. Despite our pacifist dreams, he never lost sight of the truth. During these thirty-one months, regardless of fears surrounding his health, regardless of alarming attacks, and regardless of the repeated and cruel losses inflicted on him and his entourage, he continued to focus on the welfare of his country. He had several French and foreign newspapers spread out on his deathbed until the final hours. It was a heart-rending spectacle to see: enfeebled though he was by constant, violent dyspnea, he analyzed with perfect lucidity the successive phases of his illness, but nonetheless insisted on reading the news about the war. He was eager to learn of any progress our troops had made and convince himself that we would ultimately prevail”

[7]. Dejerine died on 26 February 1917 of acute pulmonary edema as the war raged on.

Mrs. Dejerine-Klumpke (1859–1927) also took an active role in caring for the wounded, as related by Edouard Long (1868–1929), who was Swiss and a former interne in the department: “War broke out. It caused a great deal of sorrow and suffering, and laid bare the moral fibre of everyone involved. From the very start, Mrs. Dejerine demonstrated her strength and energy; after accompanying a group of Red Cross nurses to Belgium, she took over the duties of Pélissier [André Pélissier, 1882–1914], a chef de clinique who was mobilized and unfortunately killed shortly thereafter. The department was a challenge: the young men had joined the armies, whereas the Charcot department had to treat civilians, and make more and more room for nervous system injuries” [8].

According to André Thomas, “Mrs. Dejerine abandoned some of her laboratory duties for hospital duties, re-prioritizing her scientific concerns and devoting all of her energy, knowledge and compassion to treating the wounded at the Salpêtrière department, then later at the Hôpital des Invalides.”

After serving as *chef de clinique* (senior house officer) of the Charcot military department from 1914 to 1917—a special administrative status enabled her to practise in a military ward—Mrs. Dejerine cared for convalescents in an annex of the Val-de-Grâce Hospital (V.G. 83) at Château de By in the village of Thomery (Seine-et-Marne department, east of Paris), owned by her sister Anna Klumpke (1856–1942) [9], who “donated it to the Fontainebleau military authorities after the Marne victory” [10]. From 1918 to 1919, she was also named a physician at the Institution Nationale des Invalides: “Mrs. Dejerine was called upon by the health-department management to organize the serious-injury department at the Hôpital des Invalides. She was assisted by the following former students of Dejerine: Ceillier, Regnard, Jumentié and myself. After the war, this department was definitively assigned to Regnard, but Mrs. Dejerine continued to be involved” [11]. She implemented a novel organization for the department by creating a physical medicine and rehabilitation center. It even offered occupational therapy and served the seriously wounded who were transferred, after initial treatment, to the *Grand Palais* in Paris and the *Asile de Maison Blanche* for continued rehabilitation and medical equipment.

One of the goals declared when the first patients arrived was to locate intracranial bullets and shrapnel in order to remove them. In 1897, Gaston Contremoulins (1869–1950), a student of Etienne-Jules Marey (1830–1904), invented ‘metroradiography’ for finding intracranial foreign bodies. His equipment pre-figured today’s stereotactic systems [12]. At La Salpêtrière, Charles Infroit (1874–1920) used serial sectioning to locate intracranial foreign bodies; his technique was a forerunner of tomography. Eber Landau (1878–1959), who graduated from Dorpat (Tartu) University in Estonia, entered Dejerine’s Salpêtrière department in 1913 to complete his training as a neurologist and neuropathologist. On 2 March 1916, Mrs. Dejerine and Landau introduced a method of cranial-cephalic topography. It was simpler and involved only the equipment found in radiological vehicles nicknamed ‘petites Curies’. The name refers to their inventor Marie Curie (1867–1934), whose design called for vehicles with Röntgen radiation equipment that could be used close to combat zones [13].

As André Thomas reported: “It is once again peripheral nervous pathology which interests her. Along with Dejerine and Mouzon, she is studying the various syndromes involving lesions to large nerve trunks caused by projectiles: syndromes with complete interruption, recovery, irritation or dissociation.” At the 6 January 1916 session of the *Société de Neurologie*, they presented a description of successful functional recovery of the hand after median-nerve suture; the patient underwent surgery seven months after his elbow was shattered by a bullet. They concluded that surgery was indisputably useful in cases of an injured nerve [14].

In 1920, Michel Regnard (1883–1936) and Mrs. Dejerine described the progression of a severed spine: “When the spine is totally severed, the excitation of a cutaneous territory situated above the medullary lesion causes painful irradiations in the totally paraplegic and anesthetized territory. In fact, there only seems to be an incomplete interruption of the spine with persistence of visceral sensitivity and deep protopathic sensitivity. Their pathophysiological hypothesis is based on irritation of the central sensory sympathetic tracts and a switching error in nerves undergoing regeneration” [15].

At the 7 March 1918 session of the *Société de Neurologie*, André Ceillier (1887–1954) and Mrs. Dejerine proposed the term ‘para-osteo-arthropathy’ to describe a phenomenon that was apparently unknown at the time following medullary trauma: the development of exuberant bone growths within muscles or near joints in certain injured patients immobilized over a long period of time due to fractures. They indicated the frequency of growths in the medial femoral condyle and coxofemoral region, the integrity of the appendicular skeleton, the absence of hemorrhage or infection and the histological benignancy of the osteophytes. For each novel description, Mrs. Dejerine advanced a pathophysiological hypothesis: “Although the pathology is not at all well understood, we have nonetheless tried to outline certain elements. Based on the facts, we have attributed an important role to both deep subcutaneous edema, which modifies the resistance of the connective tissue, and to functional irritability of nervous elements of the intermediate-lateral sympathetic column in the spinal segments adjacent to the traumatic lesion. These two phenomena perhaps lay the groundwork, but they are not sufficient to explain the osteogenesis in para-osteo-arthropathy” [16].

In 1914–1915, Mrs. Dejerine was the first chairwoman of the *Société de Neurologie*. On 23 February 1921, she was promoted to *Officier de La Légion d’Honneur*. This was a military distinction earned by her dedication for caring for the wounded [17], in which she applied “the benefits of her clinical experience and the wealth of her charitable soul” [18].

It should also be noted that, from August 1917 to February 1918, Krebs and Mouzon were among the team of French physicians sent to Russia because of mutual alliances formed before the war. They worked at the French hospital in Kiev [19].

3. Pierre Marie and Chiriachitza Athanassio-Bénisty

Concerning Pierre Marie (1853–1940), “the finest period of his scientific life was from 1885 to 1910, during which he was an

important founder, teacher as well as the head of an international neurological school” [20]. In 1918, he took over the much sought-after Chair of Nervous System Diseases at La Salpêtrière, previously occupied by Dejerine, who had succeeded his teacher Jean-Martin Charcot (1825–1893). After ruthlessly and swiftly removing any memory of his predecessor, Pierre Marie oversaw his students in the study and care of war injuries. However, his most productive period, filled with novel work, was over, replaced by the duties that the conflict necessitated [21]. As Pierre Mollaret (1898–1978) related in 1940: “Times had changed; the ambience no longer allowed the methodical and slow work of the laboratory, and the students had left for the army. At La Salpêtrière, with the collaboration of Henry Meige, Charles Foix, Chatelin and Bouttier [22], Pierre Marie studied war injuries and trauma. He provided useful documentation and made important theoretical and practical conclusions on war neurology. In this eminent way, he served our injured soldiers” [20].

Here is how Gustave Roussy (1874–1948) described him: “Not only was he undeniably authoritarian to the point of intransigence and pride, [but] he liked to apply the ideas he developed, if only over the course of a discussion, to which he brought formidable skills. The men of my generation will never forget the Société de Neurologie sessions dedicated to aphasia, hysteria and war neurology” [23] (Figs. 2 and 3).

In the preface of a book written by his student Jules Tinel (1879–1952), Dejerine explained: “All of the surgeons and neurologists still remember how surprising it was, during the first months of the war, to see so many peripheral nerve injuries flooding our hospitals” [24]. Pierre Marie (Fig. 4) was in complete agreement: “It goes without saying that all of us would have observed over time a few cases of radicular paralysis, radial or cubital [ulnar] paralysis, or paralysis in the sciatic nerve territory. But these cases were few in number; we saw them in an isolated fashion, generally without being able to compare them. Comparing cases is the very basis of clinical medicine, the main component of progress. Alas, the war



Fig. 2 – La Salpêtrière, 1915: Pierre Marie is standing in the middle, with Charles Foix to his right between two uniformed soldiers; in the second row, Charles Chatelin is to the left of Pierre Marie, Henri Bouttier is standing on the right and Chiariachitza Athanassio-Bénisty is seated on the left. (Private collection of the author.)



Fig. 3 – Internes at La Salpêtrière in 1910, including several of the physicians mentioned in this article. (BIU Santé Paris, with kind permission; public domain.)



Fig. 4 – La Salpêtrière internes in 1920, including several of the physicians mentioned in this article. (BIU Santé Paris, with kind permission; public domain.)

remedied this problem, and on such a tragic scale! Faced with this avalanche of new facts, neurologists began to study them. Their impartiality was absolute, not skewed by any preconceived ideas. They applied their usual observational methods, which had proven their value again and again” [25]. He also highlighted the novel research of his student, Chiriachitza Athanassio-Bénisty (1885–1938; Fig. 5): “Through her repeated, in-depth examinations of our many injured patients, Mrs. Athanassio-Bénisty has used her fine clinical sense to establish new findings, whose importance should not be underestimated. For example, we owe her the description allowing clinical differentiation of the various nerves in the limbs, the study of various types of pain resulting from lesions in the limbs, and also the importance of vascular lesions associated with nerve lesions. Recently, she also helped to demonstrate the role of sympathetic pathways in symptoms observed in cases of limb injuries.”

Athanassio-Bénisty’s richly illustrated book, published in 1916, reviewed all of the clinical presentations resulting from peripheral damage to the nerves of the limbs. Her contribution



Fig. 5 – La Salpêtrière internes in 1914: Chiariachitza Athanassio-Bénisty is seated in the middle, with Jean Mouzon standing on the left, in the second row, Théophile Alajouanine is seated on the right (BIU Santé Paris, with kind permission; public domain.)

to clinical neurology and functional neuroanatomy led to an English translation of her book in 1918, prefaced by the English neurologist Sir Edward Farquhar Buzzard (1871–1945) [26]. Athanassio-Bénisty, born in Brăila, was the first Romanian woman to receive a literature–philosophy degree from the *Académie de Paris* in 1906 [27]. After working as an *externe* in Pierre Marie’s department, she became his *interne* from 15 February 1914 to 30 April 1916, and later returned to help him from 1 April 1917 until the spring of 1918, during which time she was an invaluable member of the military neurology department at La Salpêtrière. Following her 1916 work, in 1917 she published a monograph on the surgical repair of damaged nerves, based on the experimental work of Jean Nageotte (1866–1948) [28], whom she praised. She devoted considerable discussion to rehabilitation, physiotherapy and medical equipment, while insisting on their potential risks [29]. This book was also translated into English shortly after its publication [30].

Athanassio-Bénisty is associated with an eponymous condition (with Auguste Monbrun 1885–1970): Monbrun-Bénisty syndrome. The clinical picture arises during the regressive phase of eye and orbit trauma, and is comparable to what Athanassio-Bénisty described during the progression of vascular-nerve injuries in the limbs associating causalgia and algodystrophy. Here is how she presented the clinical picture on 4 March 1916: “In some patients with eye and orbit injuries, several months after scarring, painful vasomotor and secretory phenomena developed. In all of these patients, there is an ocular stump that is consecutive to either imperfect enucleation, amputation of the anterior segment of the eye or atrophy of a ruptured eyeball. . . Attacks occur during which pain, heat, redness and sweating are simultaneously exaggerated. The pain is causalgic with a burning sensation and may be exacerbated by the slightest touch, or by emotion or effort. There is a significant psychic impact” [31].

Athanassio-Bénisty defended her thesis in 1918 with Pierre Marie presiding over the jury. Her work concerned brain damage, another major theme relating to the department’s activities, and was entitled ‘*Les lésions de la zone rolandique par blessure de guerre, contribution à l’étude clinique des localisations cérébrales*’; ‘Lesions of the rolandic area through war injury, contribution to the clinical study of cerebral localizations’) [32]. After this remarkable scientific work, Athanassio-Bénisty made the very surprising decision to abandon medicine in the 1930s and devote herself to writing. Three novels were published, all of which delved into feminine psychology: *La Femme et le Dictateur* in 1935, *Mirages* in 1937 and *Le Chant Désespéré* in 1937. “*Le Chant Désespéré* is a precious document for those wishing to explore the feminine soul. Mrs. Athanassio-Bénisty’s style is incisive, with the physiological precision that she once used to describe the symptoms of brain injuries,” commented Paul Hartenberg (1871–1949) [33].

For advances in anatomical and physiological knowledge, and for the clinical descriptions of nerve injuries and their consequences as well as the relevant treatments, we owe both Tinel (Fig. 5), author of a “monumental work on nerve injuries” [34], and Athanassio-Bénisty. Both were inspired by the writings of Silas Weir Mitchell (1829–1914), which dated back to the American Civil War (1861–1865) [35].

“Due to the significance and frequency of skull injuries, they clearly merited special study. In my department at La Salpêtrière, we examined nearly 5000 cases of skull injury in 1915 and 1916.” Pierre Marie explicitly characterized the advances in knowledge as “a step forward”: “Until that point, our understanding of brain pathology in humans, especially with regard to localizations, was based almost exclusively on confined stroke lesions resulting from hemorrhage and, above all, brain softening. In lesions of this type, which are vascular in origin, a considerable proportion of the gyri white matter is necessarily implicated. This makes it possible to say that the cerebral pathology we were familiar with was almost exclusively a white-matter pathology.

“War injuries have shown us a different set of facts: lesions of the cortex, with more or less complete exclusion of white matter. Consequently, this new pathology is infinitely closer to the data of experimental physiology than was the old cerebral pathology. . . I consider it my medical and social duty to restate that, at least in the early days of the war, we operated on skull injuries far too frequently, far too early, and far too close to the front” [36].

It is impossible to enumerate all of the studies that Pierre Marie oversaw between 1915 and 1920. Not only were they numerous, but they also covered a wide variety of topics, as the following titles suggest: ‘On the possibility of preventing the formation of bedsores in spinal trauma resulting from war injuries’ [37]; ‘Cranial-cerebral topography research’ [38]; and ‘War aphasia’, which he co-authored with Charles Foix (1882–1927) [39]. In 1915, Pierre Marie and his *chef de clinique* Charles Chatelin (1884–1948) completed a voluminous dissertation addressing all types of hemianopia and scotomas. Using an ingenious method whereby radiographs of cadaver skulls were superimposed on patients’ radiographs, they succeeded in localizing lesions and thus improved their understanding of the visual pathways.

“The cortical vision center is located at the calcarine fissure and at the adjacent cortex. We can also state that the systematization of the cortical visual sphere is such that the upper quarter of the retina on one side projects to the upper bank of the calcarine fissure on the other side, such that the destruction of the latter leads to hemianopia in the lower quadrant; and that a limited lesion of the cortical visual sphere on one side results in a hemianopic scotoma in each half of the visual field on the opposing side... As to the much debated question of the projection of the macula on the calcarine cortex, our observations are clearly in favor of a posterior localization around the area of the occipital tip... Finally, we have found nothing to justify the existence of a special cortical center for the vision of colors,” they wrote [40].

In their 1917 book, after examining several patients with brain injuries, Chatelin and surgeon Thierry de Martel (1875–1940) re-examined and added to the results concerning, for example, aphasia, hemiplegia, various forms of blindness and cerebellar vertigo. The surgical part is illustrated with drawings showing the various approaches and methods of exeresis for intracranial foreign bodies. There is also mention of brain abscesses and situations requiring cranioplasty, a new development related to the war [36].

Henri Bouttier (1888–1923) [41], another of Pierre Marie’s favorite students, wrote a thesis in 1918 on recent cerebral trauma [42]. He included the initial and secondary disturbances of vigilance, and immediate and long-term psychic disturbances, but the most novel part of his thesis explored variations in arterial pressure before and after a surgical operation. This phenomenon was known as the ‘Cushing reflex’—named after Harvey Cushing (1869–1939)—from 1901 onwards [43], even though it had already been mentioned by Henry Duret (1849–1921) [44] in his 1878 thesis [45].

4. Joseph Babiński and Jules Froment

Joseph Babiński (1857–1932), *chef du service* (chief physician) at the Hôpital de La Pitié in Paris since 1895, was elected to the *Académie de Médecine* on 3 February 1914 by 75 votes out of 76, and occupied the place formerly held by Sigismund Jaccoud (1830–1913) [46]. As of the end of 1914, his department became the La Pitié military neurology department. Babiński also treated patients at Hôpital Buffon, where the management of the health department under the Paris military government set up its offices, thereby transforming the Buffon lycée (secondary school) into a hospital to handle the ever-increasing influx of injured soldiers. It was there that he met a neurologist from Lyon, Jules Froment (1878–1946; Fig. 6), a military-qualified assistant. The two men established a fruitful collaboration [47].

Maurice Loeper (1875–1961) described Babiński’s involvement this way: “During the war, he was under no obligation, but he was nonetheless among the first to volunteer his services and be accepted by the military government in Paris. I always saw him at Buffon, where Letulle had assigned him a department in August 1914 along with Landouzy, Legry and myself in one of the large classrooms they had turned into a hospital ward. Often, with his reflex hammer in hand, he was assisted by our confrere Vulpian and by poor Heitz [48]. He



Fig. 6 – Jules Froment in 1913. (Private collection of the author.)

examined nervous-system injuries, located their origins, described the lesions and their scope, and determined any necessary operations” [Maurice Letulle, 1853–1929; Louis Landouzy, 1845–1917; Théophile Legry, 1858–1936, Louis-André de Vulpian, 1871–1939; Jean Heitz, 1876–1930].

“Babiński was witness to the rapid dispersion of his disciples as a result of the mobilization on 2 August 1914. His hospital activities were transformed by a broader field of research, and the war had a profound emotional impact on him as well” [49]. Worried that his colleagues would lose their lives, Babiński was deeply distressed to see so many of them mobilized: Auguste Tournay (1878–1969); Jean-Alexandre Barré (1880–1967); Octave Crouzon (1874–1938); Jean Dagnan-Bouveret (1883–1918), who was his interne during the mobilization and who died on 18 August 1918 at Vitry-le-François; Clovis Vincent (1879–1947); Edouard Krebs; and Jean Jarkowski (1880–1929).

“Our chief physician was saddened by France’s fate and worried about what would become of his students. He took pride in their heroic conduct and their decorations, and was relieved to learn of their injuries because this meant they could leave the front. And above all, to avoid thinking about the fact he had been too old to accompany them (he was 57), he worked relentlessly,” wrote Richard Khalil [50]. Tournay also left a moving account: “He had learned many years previously what war entailed. From his memories of the conflict in 1871, he said he had been ‘struck by the horror of useless suffering’. As early as October 1914, he wrote ‘When will this misery be over?’ Then the following month, ‘When will I see my little Tournay? I think this war is far from ending.’ And then, as if he feared he might damage what he called my excellent outlook, he changed his tone and added: ‘I haven’t forgotten that we must go and eat snails.’ Obviously, a plan his brother had made, which was postponed indefinitely. Worrying constantly about his students and other young men, he focused his correspondence on their fate; he wrote to everyone and informed each in turn of what he knew of the others.”

On 20 October 1914, Babiński wrote: "I forgot to tell you that de Martel's left thigh was contused by a shell, but it has almost healed already. He demonstrated superb courage and dedication; he has been nominated for the Croix de Guerre." On 13 June 1915, he noted: "Vincent has been decorated at the battlefield of Vauquois for his exploits. An officer I know, who saw Vincent in action, told me he had never met a braver man." But Babiński did not really feel reassured until Vincent was stationed far from the front at the ninth military region's neurology center in Tours: "I'm very happy about this because, if he had remained with the 46th, he would have ended up getting killed, given his excessive temerity."

When the Société de Neurologie resumed its activities at the start of 1915, Babiński made the first presentation on 7 January 1915. Addressing nerve lesions, he warned against mistaking severed tendons for paralysis, and mentioned the high frequency of vasomotor disturbances. Above all, however, and even at this early stage of the hostilities, he underscored the high frequency of hysterical paralysis and hystero-organic associations [51]. "So-called triggering agents, such as emotion, physical concussion, and various types of trauma, have been attributed a primordial influence. Given that current events provide an exceptional opportunity to explore their role in bringing about these disturbances, it is not surprising that work on hysteria has been undertaken in the present circumstances" [52].

At the first meeting of the wartime neurology centers, Babiński revealed his intense patriotism by declaring: "Care must be taken to avoid confusing hysteria and simulation. In some cases, it is possible to affirm the patient's sincerity. . . Only one thing matters in practical terms, and that is to put a rapid if not immediate end to the accidents in question and to never abandon the subject, whether he is hysterical or simulating, until his state is modified. Through a tenacious and firm approach, the goal is generally attained and, in this way, we have been mostly successful in putting an immediate or very rapid end to various phenomena, whether simulated or pithiatic, and sometimes dating back over a considerable period: mutism, deafness, deaf-mutism, psychic blindness, paraplegia, contractions and walking tics. Using this method, we have been able to return soldiers to their posts a few days after their first visit, even soldiers who have spent several months, in some cases over a year, in hospitals and were about to be declared unfit for service. Compared to slower psychotherapeutic methods, active and intense counter-suggestion eliminates the accidents in question much more easily. It works within the subject's mind ceaselessly until he is overcome and reports himself cured."

Babiński's views were to have a major impact on his student Clovis Vincent, whose role in the court case involving the Zouave Baptiste Deschamps (1881–1953) received significant press coverage [53]. To treat war-related hysterical phenomena, Vincent used an aggressive electrical method nicknamed 'le torpillage' (torpedoing) by the treated soldiers. Deschamps refused this treatment and hit Vincent; his trial in August 1916 for striking an officer became a *cause célèbre*. Vincent's colleagues rallied to him, but press and popular sympathy lay largely with Deschamps. The tribunal was forced to deal leniently with Deschamps, who received a suspended sentence of 6 months in prison. Morally,

Deschamps had won. As per his request, Vincent was sent back to the front [54].

According to Tournay, "In cases where the scientific conclusions were applied without proper understanding or justification, the decisions established a dangerous precedent. Boisseau [Jules Boisseau, 1877–1961], who was very keen to help the wounded soldiers recover in a specialized center, made the courageous move to alert Babiński to the negative impact that exempting competent men from their war obligations could have. What follows is the exemplary response of Babiński, a renowned teacher, to his similarly eminent disciple, on 14 May 1917: "My dear Boisseau, I was deeply moved by the information with which you provided me. If things are as you say, our work, despite the new data it affords us, could be harmful in the ways you describe. I don't blame you at all for your candor; on the contrary, it touches me profoundly. My gratitude is sincere and my friendship for you deepened" [49].

In addition to his strong attachment to his Polish roots, Babiński was a fervent nationalist who believed strongly in social order yet, at the same time, embraced democratic and republican values. According to Jacques Poirier [55]: "None of the Dreyfus affair documents mentioned Babiński by name. It is true that he was friends with the anti-Dreyfusard Léon Daudet, and that he appreciated the work of the caricaturist Jean-Louis Forain, a passionate anti-Dreyfusard and anti-Semite. In addition, he and his brother paid their dues every year to the *Action Française*. However, it is impossible to say for certain whether Babiński was in fact anti-Semitic or anti-Dreyfusard."

Babiński and Froment described "nervous disturbances affecting the reflexes" as lying between pure hysterical manifestations and indisputable organic lesions: "When the muscular atrophy syndrome is complete, we observe the exaggeration of tendon reflexes, modifications in skin reflexes that may include areflexia, hypotonia, mechanical overexcitability of the muscles with slow muscular jerk, quantitative modifications in the electrical excitability of the muscles, mechanical and, in some cases, electrical overexcitability of the nerves, disturbances in objective and subjective sensitivity, disturbances of heat regulation and vasomotor regulation, secretory disturbances, and various trophic disturbances in the skeletal system, the skin and skin appendages. . . Such phenomena can be called pathophysiological, indicating that neither hysteria nor any other psychopathic state can bring them about, and that, although they proceed from a physical, material disturbance in the nervous system, they are generally unrelated to any nerve lesion that our current means of investigation can detect."

Charcot mentioned this type of symptom in an 1883 lesson [56]. During his time as *chef de clinique*, Babiński wrote about "muscular atrophy in hysterical paralysis" [57]. Georges Gilles de la Tourette (1857–1904) and Adolphe Dutil (1862–1929) went on to broaden the clinical picture in 1889, referring to "trophic disturbances in hysteria" [58] and helping Alexandre Athanassio (1863–?) prepare his thesis on the subject, which Charcot took the trouble to preface [59]. Babiński highlighted the delay between the initial trauma and the vasomotor symptoms, in some cases in the order of several months, as well as the slow but often complete regression. After a lively

discussion at the *Société de Neurologie* on 6 April 1916, Babiński proposed the following definition of these pathophysiological disturbances: “Nervous accidents that are clearly distinct from hysterical accidents and are linked to real physiological dysfunction; their mechanism remains to be determined, but the observed reflex problems can be linked to articular lesions” [60]. During the discussion, Paul Sollier (1861–1933) [61] pointed out that he had reached the same conclusions as those in the report in 1907 and that Babiński had initially rejected them! The concept of algodystrophy can be considered to have originated at that time, and the debates surrounding the role of immobilization and the utility of physiotherapy currently involve the same terms as they did then—and remain as inconclusive.

Babiński published numerous works, among them his famous dissertation on defence reflexes, which appeared in the *Revue Neurologique* in March 1915 with the following note: “This dissertation was originally to be published in *Neurologisches Centralblatt*”. The outbreak of war had made that impossible.

In June 1918, Babiński sent a letter to his disciple Egas Moniz (1874–1955), the Portuguese representative to the signing of the Treaty of Versailles in 1919, which revealed his discouragement and may yet be considered prophetic: “Under the current circumstances amidst so many tragic events, one may be permitted to ask whether Science merits our faith. Our best expectations were belied when the most laudable creations of the human mind brought about destruction and carnage. It takes only a little pessimism to condemn knowledge and to fear that, one day, a discovery will be made that will result in humanity’s annihilation. I nonetheless hope that the forces of Good will eventually triumph over the forces of Evil and that human efforts, as guided by Charity, will succeed in drying the tears that flow too abundantly today” [62].

Charpentier made the following observations: “As a result of overwork and his patriotic concerns, the state of his nerves was a source of worry to his brother and his friends. At the end of 1917, he sent me a disillusioned letter in which he mentioned the possibility of giving up neurology once peace was declared in order to enter a laboratory at the Institut Pasteur. With the victory, he fortunately regained his health and renewed his ties with his beloved neurology, to which he had devoted his life.”

Tournay underscored the end of his pessimism with the following anecdote: “At the end of the war, Babiński viewed France as stronger and Poland in a state of resurrection. During the memorable days of July 1919 prior to the Victory parade, he informed his interne René Moreau that he would not be at *Hôpital La Pitié* the following day with these words: ‘It will be a magnificent spectacle and the Polish army will be in attendance, with its cavalymen and its flags’. And our witness added: ‘The eyes of this man, typically so cold, were full of tears’”.

In 1915, Froment reported on the “*signe du journal*”, which he dubbed the “*signe du pouce*” (thumb sign), now known as ‘Froment’s sign’. If a patient holds a piece of paper between the index finger and thumb, and the thumb flexes when the paper is tugged, this indicates ulnar nerve palsy [63].

5. Georges Guillain (1876–1961)

Born in Rouen in Normandy, Guillain (Fig. 7) achieved the highest scores on his entrance exams and began his time as an *interne* in Paris hospitals at age 21. After working under Fulgence Raymond (1844–1910) in 1900, he became the *interne* of Pierre Marie in 1902 and remained his favorite disciple. Following his internship, he traveled to complete his training, something which medical students rarely did at the time and which took him to the neurology departments of major American universities [64,65]. By 1906 and at the age of 30, he was a hospital physician. By 1910, he had passed the *agrégation* exam to become a professor and, by 1923, he held the Chair of Nervous System Diseases, 30 years after the death of Charcot [66]. Unlike the three neurologists mentioned above, Guillain did not know Charcot personally. When the war broke out, he was only 38 years old and his ambitious career was still in the making, based on this novel philosophy: “If the modern neurologist wishes to avoid limiting himself to morphological descriptions, the study of isolated symptoms, the somewhat artificial classification of rare clinical types, and the analytic pathological anatomy of various lesions, he must have a biological way of thinking” [67,68].

In 1916, Guillain was the chief physician of the sixth army’s neurology center. Starting in 1917, he was director of the medical and scientific department of the *Hôpital d’Origine d’Etapes* (HOE) in Bouleuse (in Marne, northeastern France); this was an evacuation center as well as a wartime school of medicine and surgery. He went on to direct the Longvic medical center for aviation units and, at the end of the war, the medical inspectorate for aviation units [69]. Yet, Guillain’s many responsibilities in no way hampered his scientific activities. On the contrary, he was constantly accumulating new clinical and biological data not only on war traumas, but also, starting in 1917, on epidemic encephalitis. He would continue to use these data in the years following the war. However, there are no direct accounts of his personal life or his



Fig. 7 – Georges Guillain in around 1910. (Private collection of the author.)

emotional responses during the war. The only mention on record is that he was moved to praise, during his 1923 inaugural speech for the Chair of Nervous System Diseases, the knowledge and intelligence of his first *interne* Jean-Georges Dubois (1886–1916), who died on the front, poisoned by toxic gases: “Injured on 10 July 1916 by an explosion during bombardment with asphyxiating shells that left him seriously contused; insisted on verifying the batteries himself and refused to be evacuated until he received formal orders. Died a few hours later as a victim of his own dedication” [70].

Guillain’s assistant was Jean-Alexandre Barré (1880–1967), another former *interne* of Pierre Marie. Guillain and Barré were brought together by the war and their collaboration was very fruitful, as evidenced by the impressive number of papers collected in their 1920 *Travaux Neurologiques de Guerre* (Neurological Warfare): “We were able to study the injuries of the nervous system at a very early stage and collate an exceptional body of documents on certain physiological and clinical questions” [71]. On 13 October 1916, they drew on the physics knowledge of André Strohl (1887–1977), a doctor of both physics and medicine, for their description of the “syndrome of radicular neuritis with hyperalbuminosis of the cerebrospinal fluid without cellular reaction” [72]. Transcribed without commentary, this paper appeared to be unimportant and was placed at the end of the ‘Varia’ chapter [73]. It wasn’t until 1936 that Guillain would refer once again to the syndrome to which he owes much of his posthumous fame [74].

For Guillain, it was important to “insist on the utility of a neurology department at the front such as that of the sixth army, which enables quickly recognizing problems that are easily cured as well as more serious problems and serious organic lesions. It is then possible to be selective and set up proper triage of patients, keeping and curing those soldiers who, evacuated too quickly, would have been lost for the army.” In presenting his *Travaux Neurologiques de Guerre*, Guillain noted that, “as a result of the war circumstances, the cases compiled may be considered as human physiology experiments”. Building on this fact and pursuing his collaboration with Barré, Guillain refined neurological examination techniques and developed new tests for spinal reflexes. He also described a series of medial plantar, posterior tibiofemoral and biceps femoris reflexes that help to determine the level of spinal lesions.

“Although the central nervous system lesions caused by bullets and shrapnel have been studied for a long time, the nervous disturbances caused by large projectiles were unknown prior to the current war, and all of the authors who have written about them have considered them exaggerated or simulated hysterical disturbances.” But Guillain refused this simplistic explanation, and his meticulous and repeated clinical examinations led him to conclude that “the nervous accidents caused by deflagration of large projectiles are dependent on organic lesions in the central nervous system”. As examples, he cited epileptic attacks, hemiplegias, paraplegias, conditions mimicking multiple sclerosis, parkinsonian syndromes, choreic movements, mutisms and stupors. In all cases, neurological examination revealed abnormal reflexes, the Babiński sign, adiadochokinesis and other signs that the disturbances were organic. Clearly adopting a

compassionate stance, Guillain added: “Like all neurologists, I have observed what are known as hysterical or functional disturbances that can be cured rapidly through suggestion and persuasion; I have also seen exaggerated or simulated disturbances, but one mustn’t confuse the matter with overly simplistic diagnoses. Such cases are far from frequent... I prefer to admit my ignorance of the exact pathology and its temporary inhibitions of speech functions, the examples of which are too numerous and the environments in which they occur too varied not to recognize a real pathology” [75].

It is impressive to realize that, in 1916 during the Battle of the Somme, Guillain saw the admission of 225 spinal injuries: “With this unique documentation, as voluminous as it unfortunately is, we were able to make a contribution that we believe will be useful to the semiology of spinal injuries.” He noted that the initial mortality was considerable and that patients injured above the thoracic spine never survived long enough to reach him. Especially those due to shrapnel, posterior or posterolateral lesions resulted in more or less complete severing of the spine. Guillain described all aspects of the symptomatology, and highlighted the need to address urinary retention and anal incontinence. He recommended giving the trophic disturbances that influence prognosis early and constant attention. He observed that one of the frequent causes of death was secondary bacterial meningitis and admitted his disappointment that he could do nothing to prevent it. He believed that surgical exploration was indispensable, and should be systematic in treating associated vertebral fractures and for fine-tuning the diagnosis of spinal lesions such as hematomyelia, where the spine is not truly injured, and cases in which the spine is more or less completely destroyed. He coined the following aphorism: “In cases of an intrarachidian projectile, radiography determines the anatomical upper limit of the lower piece, whereas clinical medicine determines the physiological lower limit of the upper piece.”

Guillain also underscored the frequency and often-overlooked importance of meningeal hemorrhage after simple contusions, as well as scalp wounds without apparent fracture of the skull. He advised looking for them when faced with “slight mental confusion with amnesia, psychic obtundation, headaches, bradycardia, pupillary inequality with slowed reactions to light, and exaggerated response of tendon reflexes”. The clinical picture called for lumbar puncture: “I have observed the frequency of meningeal hemorrhage in aviators who undergo a turbulent landing or sustain a fall... Aviators who, subsequent to a fall, present several months later with persistent problems such as headache with amnesia, vertigo and inability to fly often had, at the time of the accident, meningeal hemorrhage that, in the absence of initial lumbar puncture, went undetected” [71].

In addition, Guillain never refused to treat civilians who remained close to the troops’ quarters. For example, he saved a child from tetanus by injecting him with high doses of antitetanus serum specifically into the cerebrospinal fluid [76].

As Guillain concluded: “In our neurological work, we attempted to wed the lessons of physiology with those of clinical medicine and to perfect our investigative methods by the study of new signs and thereby construct a rational foundation for establishing a prognosis; we also tried to

determine, in patients with nervous system injuries, the indications for and against surgery.”

6. Conclusion

All of these major names in neurology took an active role in treating a multitude of soldiers with neurological injuries, and all of them were guided by a strong sense of patriotism. Yet, Babiński was the only one among them to leave a more personal account, revealing the psychological difficulties of the medical care providers who had to deal with so many tragic cases. Stretcher-bearer Elie Chamard left a description of patient triage at Château d'Enes that is particularly edifying: “Each injured soldier represents a specific case that must be resolved conscientiously and almost instantly. For this poor devil, with his wounded abdomen, nothing can be done; that one, with his crushed legs, is hemorrhaging—it's too late; as for him, already in a coma, take him away quickly. Make way for the others who are less seriously injured and can be saved!” [2].

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