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Shock at the Front

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By
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To

A. S. P.

BIOGRAPHICAL NOTE

[After graduating from The Medical School of Washington University at St. Louis, William Townsend Porter took post-graduate courses at the Universities of Kiel, Breslau, and Berlin. He has been a teacher of physiology at St. Louis Medical College and at the Harvard Medical School, and has given much time and thought to the development of educational apparatus designed to individualize the work of students, and render them less dependent upon the formal instruction of the lecture-room. Recognized as an authority on blood pressure, and as a man of ingenuity and shrewdness of mind, he was selected by the Rockefeller Institution to undertake the investigations which he so interestingly describes in the pages which follow.]

SHOCK AT THE FRONT

CHAPTER I

In an upper room of a marble palace inscribed to the memory of Junius Spencer Morgan, 'a merchant of Boston,' a dog lay dying of pneumonia. Without, the first glow of a July dawn faintly touched the great court of the Medical School. Within, the lights still burned, marking the shadows beneath the eyes of three men, sleepless for forty hours. They had kept their watch by day and night, from the moment at which the terrible Friedländer bacillus had entered the bronchial tubes, until this present hour, the hour of death. They had seen the fever rise point by point, until the impersonal column touched 106°. They had seen these fires maintained and then, the toxines finally triumphant, the sudden wonderful fall to

2

below normal,—the fatal *descensus Averni*,—and now the coma, image and precursor of eternal sleep.

Tired were these men, but happy. A smile was on their lips, in their eyes a reverent joy. For they saw before them a new Truth, shining, resplendent, born with the day, unknown since the beginning of time.

In this dog, whose sacrifice had been so fruitful, the vagus nerves, the great strands that connect the lungs with the brain, had been painlessly severed before the disease began. There had never been a pneumonia like his. The furious respiration,—sixty, seventy, even eighty to the minute,—painful and exhausting, was absent. In spite of the mortal inflammation of the lungs, the breathing of this poor vagrant had been from beginning to end as calm, as peaceful, as that of a dog lying on a rug before the fire. It was, then, through the vagus nerves, the normal controllers of breathing, that the respiratory storm of pneumonia was let loose.

This was a truth which threw a new light on the mechanism of the disease, enlarged our knowledge of normal respiration, and gave a lead for methods of relief hitherto unimagined.

How far that seemed from the trenches! But trust in the improbable underlies all creative effort. Hope, in this life the capital of the poor and the medicine of the sad, rests on the unexpected. And most unexpected was the coming of a letter from the Rockefeller Institute for Medical Research, asking if I would consent to go to France to search for the cause of 'shock' and for a remedy. In half an hour I wired consent. After thirty months of thinking, controlled by rigid experimentation, on the one subject of pneumonia, the spring fret was strong in my blood, and the great game of war had a deep appeal.

The disorder against which I was to take the field was not the mental derangement known as 'shell shock,' which comes typically without a wound, and is the

result of an overwhelming jarring of the nervous system. My research would have to do with 'traumatic' shock, a condition seen only after certain injuries, the accidents of peace as well as of war.

Shell shock is marked by strange paralyses, by protean negations of our ordinary powers. Some patients cannot speak. Others tremble at a touch or a sound, however gentle, as the leaves of the quivering aspen tremble in the soothing airs of spring. Fabulous contractures appear — strong youths are bent into distorted figures like a rheumatic Nibelung. The human nerves cannot always withstand the vandal touch of war. The slow instruction of uncounted ages is forgotten; the measured harmony of functions is destroyed; the bonds of the physical body politic are broken — confusion reigns, and groups of muscles, mere hewers of wood, freed from the long control of the intelligent brain, show forth unbridled strength in powerful but uncouth forms.

Compared with this swash-buckling malady, traumatic shock is a sober, serious disease. In traumatic shock, the patient is utterly relaxed, pale as the dead, with eyes like those of a dead fish; he is apparently, but not really, unconscious; his breathing is shallow and frequent, his heart-beat rapid and feeble, and his pulse scarcely to be felt at the wrist. Much of the blood has collected in the great veins, the heart is poorly filled, the driving pressure of the blood in the arteries is less than half the normal—too low for the maintenance of a proper circulation of blood to the brain; the brain-cells suffer for lack of food.

Men rarely die of shell shock. The methods of cure are sometimes as interesting as the disease itself. In the summer of 1916, there was a spirited discussion among the French as to the right of a soldier to refuse treatment for shell shock. The treatment in question was directed against the deformities resulting from the

continued contraction of certain groups of muscles. A soldier, bent like a rag-picker searching in the dust of Montmartre, was grasped under each arm by a stout assistant surgeon. To the muscles opposing the contracted group, the chief surgeon then applied a strong electric current in such a way that the resultant contraction would inevitably cause the patient to straighten up. The instant this occurred, the assistants walked off with the astonished patient, now in the erect position. The malign spell was broken. The patient saw that he could stand erect, and the battle was won.

The electric current used was irritating and certainly surprising, but it was not dangerous, or even very painful. Cures were many, and the method got into the newspapers. There it was called 'torpedoing.' Phrases may be more harmful than artillery fire. They should rightly be detained until their virus is measured. This phrase worked mischief.

One day there came a soldier who refused to be torpedoed. The chief surgeon insisted. The patient struck out wildly. From words they came, alas, to blows! The surgeon was an educated man; he had defended a Thesis; he knew *la boxe;* he was versed in what Littré terms the *pugilat anglais*. And, since knowledge is power, he prevailed — without electricity. The result was a resounding scandal, and the complete cure of the patient. The affair came at length before the Academy. It was decided that a soldier should suffer the surgeon, as a patriotic duty.

Men rarely die of shell shock, but traumatic shock is usually fatal when skilled assistance is not at hand. Not less than twenty thousand men are dying each year of traumatic shock in the English and French armies.

Surgeons had long recognized this calamitous condition as a formidable adversary. The cause of the disease was unknown. There had been many hypoth-

eses; the two most important survived for more than a generation. One of these hypotheses declared that shock was due to the exhaustion of the brain-cells which regulate the blood-flow by controlling the bore of the small arteries; the other discovered the cause of shock in the irritation of the sensory nerves. Both these hypotheses I had overthrown by experiments in the laboratories of the Harvard Medical School. It was these investigations which procured for me the opportunity to study shock at the front in this war.

The remedies for shock left much to be desired. It was the hope of those who sent me, that some new remedy might be found.

My adventures in the search for the cause of shock and for a remedy are set forth in these pages.

Candid friends will urge that the book must have at least one merit: it has set bounds to the growth of a traveler's tale —a virtue of the printed page not suffi-

ciently celebrated. In my case, let me hasten to declare, the implied suspicion is unfounded. The picture is painted as the author saw it. More than thirty years of experimentation have taught me to love the sweet security of facts. Sweet they undoubtedly are to the friend of measured relationships — their security is another matter. The world is after all *nur Schein und Vorstellung* — the half-lit shadow of the mind.

CHAPTER II

We were off the coast of France. It was a caressing day. The sun sank into the western wave with a splendid competence, the result of long practice. Our last sunset, perhaps. The ports were sealed. No lights were shown. The boats were swung out — their covers off, the davits greased, food and the precious water-keg in place. The gun crew stood to quarters. Full speed ahead.

I decided to stay on deck until we reached the mouth of the Gironde. Many of the passengers were of the same mind. My cabin was in the lowest tier, and if we should hit a mine, minutes might count. At 4 A.M., we picked up a magnificent revolving light; before long, two other first-class lights, turning on the horizon from the top of ghostly towers. Pres-

ently, we saw a powerful beam searching the waves. Its dazzling glare rested on the ship, moving with us. For many minutes we endured an almost shameful publicity.

The East was now lighted for the coming of the day. Anchored vessels bordered the fairway. Their hulls were black against a tone of silver gray; admirable motive for the etched plate. So lay the black ships of the Greeks, on another sea, in those Trojan days when the causes of war were easier to understand.

The approach to the river is very fine: the Gironde is handsomely dressed for her bridal with the sea. At 7 A.M. we were gliding along the narrow stream through fields green with the promised harvest.

It was time for the dreaded inquisition. Were our papers correct? Would we be allowed to land? The passengers were much disturbed. We were packed, some hundred of us, in the vestibule leading to the dining-saloon. There we stood, the

strong and the infirm, for two long hours. I was jammed against two young girls who were going out for the Red Cross. Conversation began, due to the strong play of natural forces. You remember my Uncle Toby. My Uncle Toby found the Widow Wadman's eye very compelling. But Laurence Sterne was a clergyman. Had he been a scientist, he would have observed that the power of the Widow Wadman's eye was inversely as the distance. Now, the distance of these ladies from my ear was the same as the distance of the Widow Wadman's eye from my Uncle Toby—about five inches. The power exerted was therefore twenty times as great as if the social insulation had been the usual hundred inches. There can be no doubt that distance, mathematically speaking, is a 'function' of behavior.

But this verges dangerously on reflection; to mix thinking with conversation is to spoil two very good things. Well, nature could not be denied; the ladies

began to talk. At a range of five inches, the execution was considerable. They told me, in these two hours, their opinion of Shelley and much of their past history; though, to be sure, when a woman talks of her past, she hasn't any. It was a curious friendship: it began, it ran its intimate, almost clandestine, course, and was finished, within a radius of fifteen inches.

From time to time, while these measurements were being collected, the door into the dining-saloon opened a crack and a wilted suspect was dragged in to confront five officials who spoke torrential French and dribbling English. By that hour, the more feebly engined passengers were suffering from what at the front would have been called shell shock. One man, born in Smyrna, a Greek by nationality, said he was a manufacturer in America. 'What do you make?' he was asked. 'I make sickles.'—'Sickles! Qu'est-ce que c'est que çà? Can you show us one?—'But certainly,' replied the flustered pas-

senger. Whereupon he reaches into his pocket and fetches out — not a sickle, but a pack of playing cards, which it is forbidden to bring into France. Behold a Greek in a cold sweat! The bystanders grin largely, and even the officials relax their severe gloom.

After the good-natured ineptitude of the custom-house, I took a cab. The cab was ancient and groaned appealingly, but I presently found that the carnivora were modern. They had the unfailing mark of high efficiency; they had eliminated all lost motion.

At the Hotel Bayonne, I got a large clean room, admirable cooking, and the true wine of Bordeaux. The bed seemed insecure; it was soft; it gave somewhat when my weight rested upon it; whereas my bed on the Rochambeau had been apparently founded on a rock.

In spite of these suspicions, I had a pleasant walk in the town. The builders of the cathedral, with tender regard for

the amateur of architecture, have combined an exquisite Gothic choir with a fine Romanesque nave.

The statues in Bordeaux were not always appealing, as works of art. But public monuments should be distinguished from works of art. The distinction is usually easy. Public monuments should be raised only to men who create in the mind an immense historic vibration, an emotion too profound to admit so small a matter as the ability of the relatively obscure artist. In such cases, it is a positive disadvantage to have the artistic question obtrusive. Æsthetically, it is a fault to have two points of supreme interest in the same composition. It is fitting that the statue of Bartolomeo Colleoni should be a great work of art; but when I looked upon the statue of Vercingetorix, in Bordeaux, I saw the rush of the Arverni and heard the clash of Roman swords. Again high patriotism and dauntless courage went down before a deadly dull tech-

nique. Cæsar, when he murdered Vercingetorix, gave him deathless fame. To summon the dead is accounted a miracle, but to keep a dead Gaul alive for twenty centuries with a page or so of easy prose, is great indeed.

I stood reverently at the tomb of Michael, Seigneur of Montaigne, where he lies in marble mail. He sleeps in an Academy — in the hall of entrance, a place of dignity. Life passes in review before him. As I watched, youths and maidens entered from the unknown, moved across the scene, now smiling, now anxious, and vanished on the farther side. They went to judgment, to account for the use of their talents. Their footsteps died away. I knew them no more.

Epitome of our existence. We pass hurriedly from void to void, while the patient hills slowly wonder at our feverish inconstancy.

Not so Montaigne. Deathless, incorruptible, he rests unchanged, while gen-

erations break like waves against his pedestal.

Were I a practicing physician, this appreciation of Montaigne would be magnanimous. He did not love practitioners. He quotes with approval Nicocles' 'Physitians have this happe, that the sunne doth manifest their successe, and the earth doth cover their fault.'

Therapeutics in Montaigne's time did not lack imagination. 'The very choyce of most of their drugges is somewhat mysterious and divine. The left foote of a tortoyze, the stale of a lizard, the dongue of an elephant, the liver of a mole, blood drawne from under the right wing of a white pigeon, some rattes pounded to small powder, and such other foolish trash, which rather seeme to be magike spells or charmes than effects of any solide science.'

As I wandered in Bordeaux, I came upon a street named for Paul Bert. Paul Bert was a physiologist. On entering his

street, there sprang into my mind the experiment devised by him to answer the important question whether a nerve will carry a message in a direction opposite to that ordinarily taken. In other words, will a nerve that usually carries impulses from the brain to the hand, carry them also from the hand to the brain?

Paul Bert's method was ingenious. He made a small incision in the back of a rat. He then freshened the tip of the rat's tail and sewed the tip into the wound in the back. In a few days the tip had grown fast to the back and the wound was healed — the tail was attached at both ends. This accomplished, Bert severed the base of the admirable organ. In the third state of the tail, that which had been the tip was become the root; the tail was reversed; the erstwhile tip could no longer delicately explore its environment.

What would happen? Would the former base, now moving in a giddy and unaccustomed element, receive and trans-

mit the throng of new sensations? It was an absorbing question. Absolutely without precedent. Our rat had never seen or even heard the like. Female relatives could not advise him by pointing out what father had done under similar circumstances.

Nor could aid be derived from his extensive knowledge of the lower animals; unless, possibly, from the elephant, whose tail was so amusingly placed in front—no doubt, a temporary arrangement—while its true place was kept for it by an otherwise useless appendage. The elephant perhaps had been changed in his sleep, like our rat, who had sniffed a sweetish odor and had straightway fallen to dreaming, from which dream he had waked to find his tail fast at a point he could neither see nor touch. He had had one recurrence of this attack. He dreaded another. His tail might be moving to a position on his nose. It would never do to look like an elephant—quite humiliating.

The rat knew of course that the world was made for rats; every young rat committed that to memory in his Sunday school. The other animals were inferior and for his use and pleasure. Each was of value according to its kind. Even man, one of the slowest and clumsiest of creatures, cruelly handicapped by the absence of a tail,—a beast whose whiskers, scarcely sentient, obviously dying, were proof of rapidly approaching extinction, —even man had one delightful quality. As the source of a delicacy indispensable to *gourmets*, some means must be found of preventing his further decline. The sole producer of garbage could not be suffered to die out.

But the world, so blessed with intoxicating odors, was difficult for cripples. What a reversed tail would do was a problem especially serious to an animal whose love of privacy led him to prefer narrow passages beneath the earth. With his starboard whiskers touching one wall and

his port whiskers touching the other, he could navigate a forward course with ease. If, by chance, he met an older and more distinguished rat, he could back to the next cross-passage, guided by his perceptive tail. But now! Who could say? If he met a lady rat, and tried to back, without the aid of a tail, he would probably tear his skin. To lose his integument in the presence of a lady would be embarrassing.

These painful apprehensions were suddenly set at rest by Paul Bert, who sharply pinched the free end of the tail, once the base, now the tip. The rat cried out. The observation was made. Nerves would transmit impulses in both directions.

The rat cried out, but not from pain; nor from the rage which, as a gentleman, he naturally felt at such a liberty. No. He cried out for joy. 'Glorious!' he exclaimed; 'I have recovered 180° of my sensory horizon. "There's a Divinity that shapes our ends, rough-hew them how we will."'

Cheered by these reflections, I sought my inn, well satisfied with a town which drives a roaring trade, drinks largely of a famous wine, and keeps in pious memory Vercingetorix, Montaigne, and Paul Bert.

After a good night's sleep, I arrive at the station for Paris. The first-class ticket office is not open. Meanwhile, the train is filling. I buy a ticket at the military window. On the *perron*, the guard is surrounded by a clamorous crowd. He says that all the first-class compartments are reserved. I give him a franc. He finds that this monsieur has reserved a good place. I take it. The corridor fills with people who have paid first-class fares and have no seats. Alarums and excursions! The spectacle of this misery imparts a special flavor to the fruit of corruption. I must overhaul my morals —when I get to Paris. The train leaves twenty-five minutes after the schedule.

At ten o'clock, a dining-car is put on. The waiter says there are no seats, except

at 11.15 and 2.30, too early and too late. The solution is simple. I shall go without my lunch; I shall draw on my reserve calories. To my French companions I explain biologically about the camel and his useful stores. There is some laughter. I am informed that the camel has no social status in France. Poor camel! These cruel distinctions are repellent to a physiologist—almost impious. To be sure, the camel has a hump. Some camels have two. It is unfortunate. One hump is pardonable. It is, so to say, the animal's first offense. About the camel with two humps I am not sure.

Opposite me is a man evidently in poor health—an intelligent kindly face, lined by premature old age. He has two collapsed air-cushions, but breath only for one. I blow up the second cushion. We fraternize.

'You must know,' says he, 'that I am a Frenchman living in Canada. I have come over to be ready for my call. They

have called the class of forty-seven. My age is fifty. Soon they will need me. Of course,' he adds, carefully adjusting the air-cushions to support his ailing back, 'of course, I cannot hope for the first line, but perhaps I can slip in just behind.' It is the celebrated French *esprit.*

CHAPTER III

WE reach Paris at dusk. I go in a taxi to the Hôtel des Saints Pères. I find this refuge of the Holy Fathers strategically situated on the left bank, in the Quartier Latin, a neighborhood in which religious devotion is not always a working hypothesis. The hotel is closed for the summer. *C'est la guerre.* What to do? I appealed to the *cocher.* I remembered a young English friend, also a physiologist, who believed himself defrauded by a Paris cab-driver. My colleague prided himself on his ability to swear in French. On this occasion, he displayed his full powers. When he paused, from exhaustion, the *cocher* made him a low bow and said, 'Monsieur, you speak French like an Academician.'

Perchance my driver also was a gentle-

man and a scholar. In the event, he showed the sound common sense of his race. 'Go for the night, monsieur, to the Continental.' Now the Hôtel Continental is Chicago at its best, set down on the corner of rue Rivoli and rue Castiglione. There I went, but it was awkward, for Dr. Carrel, the representative of the Rockefeller Institute, was to have met me at the Hôtel des Saints Pères, and he being at Compiègne, in 'the zone,' no private telegram would be accepted and a letter would be delayed by the censor. In fact, it was several days before I saw him.

Having settled my quarters, I went over the Seine to the 'left bank' to dine in the Latin Quarter. My dinner consisted of bouillon, a *membre* of chicken, *haricots verts*, Romaine salad, camembert, coffee, and a pint of Barsac—at a total cost of seven francs.

It was the usual French scene of the *rive gauche*. A room crowded with small

tables, at most of which sat bourgeois families. Here and there an officer, in most cases with ladies. At a table quite alone, a demure *cocotte*. Her eyes gleam at the sight of my French gold, which the war has made a rarity.

In Paris, even the homely midday meal is touched with art. Once, at the lunch hour, I found myself in rue Cambon. An elaborate commissionnaire stood before a small restaurant. Curtains of some thin stuff guarded the rites within from the sacrilegious glance. I entered. The proprietor, with effusive dignity, bowed and shook my hand. I was in a room perhaps twenty feet square. There were six small tables and five elderly waiters. Several apoplectic old gentlemen, with the red ribbon of the Legion of Honor, were slowly gorging. From a raised dais, defended by a desk, two formidable old women surveyed the scene. When one of the old gentlemen had finished his *poulet rôti*, these secretaries recorded the fact

upon their tablets, with frequent consultation, that no important detail might be omitted. Evidently I had unwittingly broken into a *temple de gourmets.*

One of the attendant priests presented a paper on which were written a few hints as to the mysteries, without mention of the pecuniary consequences. 'What does Monsieur desire?' Monsieur desires a plain omelette. Consternation, with a camouflage of grief! Monsieur is *encore jeune*, yet so depraved? There is hot-house melon, thin soup, of an excellence, and old, but very old, wine.

Monsieur will not relent. A long and ghastly pause, while the pariah sips from a glass of water, forgetful that in such places water is a symbol and not a beverage. At length the omelette arrives, assisted by three grieving men. It is shrunken and plaintive. It is furtively and hastily swallowed. The old women note the fact in their smallest hand. Five francs. Monsieur dies game, with a hand-

some tip to Alphonse. Alphonse weeps for monsieur, and prays that light shall break on this misguided man.

The day after this strategic defeat I went to the Ministry of War. It would be interesting to see whether a stranger could get permission to enter the Zone, that land of blood, bright with lightnings and vibrant with thunderous sound. There, the King's writ did not run. In the haste to kill — the sharp insistence upon murder — the casual foreigner had short shrift. No doubt mistakes were made. The innumerable *saucisses*, hanging like carrion-birds above the lines from Switzerland to the sea, sometimes looked down on innocent men blindfolded against a wall. The percentage of error was larger than in trial by jury. But then, under the circumstances, — the obvious necessity for haste, — even the innocent victims would readily excuse an occasional inaccuracy. The Ministry of War, with an infallible system of documents, were

certain of this. Their files were clear. No victim had ever complained. Still, it would be well to have my papers in order.

On entering the great portal of the building on Boulevard Saint-Germain, I was shown into a large waiting-room filled with people. It was a cross-section of the French nation—a mixed but grave assembly. Upon the table were blanks on which one wrote his business. The statement was then given to a subaltern behind a wicket in the corner. From time to time, names were called and permits of entry were handed out. After waiting forty minutes, I received a printed slip directing me to the office of the Under Secretary of State. As there were no signs or other guides, I presently fetched up in a hospital ward. The attendants disentangled me, and I at length found the right corridor. A smart young attaché comes out, debonair, polite, profuse. Monsieur will no doubt get papers,

but in three days. Desolated to keep me waiting. He will try to hurry them. He hopes that Monsieur will be patient.

Three days pass, silent as the grave. I try the American Ambassador; surely he can help. The Embassy is well managed. In two minutes I am received by Mr. F——, a secretary. In five minutes, I depart with a letter of recommendation from the ambassador to a high official in the Ministry of War. I go at once to his office. Nobody there. All at lunch from eleven-thirty till two. Promptly at two o'clock, I am again in the anteroom. My card and the ambassadorial letter are taken in. I wait one hour. Then I write on another card. It is swallowed up, like the first. But shortly there is a reply. Mr. L—— is not in. He has not been here this day; he will not return until to-morrow. Another day lost.

On the following morning, while I sat in the court of the Hôtel Continental, there entered with a quick nervous step

a compact and energetic figure about the size of Napoleon. It was Carrel. In a few moments, we were standing by the fine military car in which he had come down from Compiègne. I was greatly struck by two soldiers who acted as chauffeur and orderly. Both were unusual. One of them was remarkable—tall, handsome, intelligent.

'Where in the world, Carrel, did you get anything as beautiful as that?' I asked.

'That man!' he replied, 'he is one of the first five comedians in France.'

And so he was. Then I remembered that men of every intellectual and social degree serve side by side in the French ranks.

I go in this car once more to the office of Mr. L——. Another courteous and charming young officer receives me. He regrets that his office cannot hurry the permit. They can act only on advices received from the *Service de Santé*, to which my application will have been re-

ferred by the Secretary of State. He will telephone. He returns to say that the *Service de Santé* has never heard of my application. Very queer. Is Monsieur sure that he made one? Yes, quite sure. Then Monsieur had better go to the Bureau Piessac.

After a prolonged search, I discover the Bureau Piessac in another wing. Now somewhat dazed, I seem to see a great functionary with a red beard, which in my disordered state looks like a crumpled ring of Saturn. This portentous organism is apparently of the variety known to naturalists as 'sessile,' that is, adhering by a broad base to its environment. I was afterwards to find this apparition a simple and pleasant gentleman, from whom I was to receive much friendly assistance.

Carrel came in. I was presented to Monsieur M——, who spoke English perfectly and was kindness personified. To him I related my interview with the

courteous assistant of the Secretary of State.

'*Tiens!*' said M——. 'In France, when they are as polite as that, nothing is ever done. Do you think we could find the office of the polite young man?'

I replied that we could try, though there had been no number or other distinguishing mark upon the door. So we set out and after ten minutes of corridors, Monsieur M—— left me in a room in which four elderly scriveners were shepherding large flocks of papers. They also were polite. It appeared that my young man might perhaps return in half an hour.

I sat in a corner and listened to the rodent pens as they tried to gnaw through the net of red tape in which the official lion was enmeshed.

Suddenly one of the ancient men said, 'Are you not the Professor Tonson Portaire?'

'Yes,' I replied.

'*Très bien!* Here is something for you.'

And he handed me a letter that had by chance turned up in the crowd on his desk. 'The Secretary of State presents his compliments and regrets infinitely that Grand General Headquarters, greatly to its disappointment, is unable to extend to Professor Porter the permission to go to Compiègne.'

This letter I took to M——, who said, 'What did I tell you? When they are so polite as that, nothing is ever done. We must begin again. I will get you a *carnet d'étranger*, but it will take at least five days. It must go through two bureaux besides Grand General Headquarters.'

The *carnet d'étranger* is the celebrated Red Book which enables the foreigner to enter the Zone.

A delay of five days was sufficiently painful, but it would give time for French conversation. I could read French, of course, and I possessed a large vocabulary almost useless for everyday talk. It was years since I had lived with Mon-

sieur and Madame Jacques on the Lake of Geneva.

Monsieur Jacques was the pastor of Villeneuve and the official chaplain at the Castle of Chillon, then in use as a prison. Monsieur and Madame dwelt in a wide old house set in a large garden fronting the lake. Madame being childless, alas! had adopted seven cats. The ugliest, possibly distinguished by a graceful mind, was called La Fleur de la Famille.

In the garden was a large tree which bore sickel pears, small, round, and sweet. Beneath its grateful shade we spread our frugal board. Two wires led overhead from a branch of the tree to the kitchen window. Grace being said, Monsieur Jacques would call, 'Hola!' in his deep voice. There would be a rattle of dishes, and a little wooden car laden with corporeal cheer would slide down the wires to sustain the pastor and his guest. It was in late August. The declining sun, seeking his couch beyond the Jura, painted

the lake with purple and gold. Warm odors rose from the flowers about us, and the sickel pears, dead ripe, fell in a slow and gentle rain.

Those were far-off days. My memory held the virtues of the excellent Baucis and Philemon still undimmed, but their French was as the sound of a distant bell.

In my present poverty I sought alms. I went to the efficient Director of the American Relief Clearing-House. 'Mr. B——,' I said, 'my French is feeble, to a degree. Behold me presently with French officers who have no English. The success of my mission rests on you. I must speak the language in five days. Find me a gifted and patriotic French family who will give up all their engagements for this period and cause this barren ground to bloom like the gardens of Babylon.'

Mr. B—— was a real executive. He did not turn a hair. 'Come back to-morrow morning at nine o'clock,' he said.

On the morrow, at the appointed hour,

he produced the family, per specifications. I bear this public witness to their devotion. He told them that I was a great savant; a lie for which I shall always love him. I joined them every morning at ten o'clock and rarely left before midnight. Then, on reaching my bed, I fell into it more dead than alive. But I learned more French in five days than one would learn ordinarily in five months.

My rapid progress was due in part to a simplification that I earnestly recommend to other ardent spirits. I made all the verbs regular and of the first conjugation, and I confined my remarks entirely to the historical present. The astonishing success of this procedure is another proof that the French are a gifted nation.

CHAPTER IV

At length Compiègne, historic, beautiful. I walked in the wonderful beechen forest. I stood upon the terrace of the Château, where Napoleon's Austrian bride had looked amazed along the entrancing vista cut in one night through miles of billowing green by her all-powerful spouse. Compiègne fell to the Huns when the wave of invasion rolled over northern France. But they did not harm the place. It was the Kaiser's plan, it is believed, to receive on the celebrated terrace the submission of the dignitaries of France. Instead, one fateful day, during the battle of the Marne, there came over the wire words pregnant with the fate of civilization: 'Foch has pierced our centre. Fall back at once.'

The Carrel Hospital—*l'hôpital temporaire 21*—was in what had been the princi-

pal hotel of Compiègne, at the edge of the forest. The hospital was specialized for the study of infection. The worst cases from the trenches for miles around were collected there. Yet there was no infection. In the morning, at the dressing hour, when the bandages were removed, and the ghastly wounds exposed, the eye was struck by the great display of stripped muscle, as fresh and wholesome as the meat in a shop.

Some months later, I found myself in a large hospital in Amiens, where there lay in splints, in one room, more than fifty men with fractured thighs torn asunder by exploding shells. Not a man but was the color of dirty parchment, dull-eyed, listless, with foul tongue, and a low continuous fever, the mark of a relentless suppuration. At Compiègne every eye was bright, every cheek was clear, and the temperature charts were as level as the Elysian Fields. Happy the patient who has no history!

All this came from the application of exact measurements to the problem of suppuration. Carrel, himself a scientist of a high order, had organized his hospital on an original idea. He began by attaching to his staff a great chemist and a mathematician. The chemist, Doctor Dakin, discovered that the hypochlorite of soda, prepared without free alkali and used in a special way found out by Carrel and his surgeons, had an almost miraculous effect on the foulest wound. The mathematician, the Comte du Nouy, worked out the rate of cicatrization. He measured day by day the lessening surface of the wounds and plotted his measurements in the form of a mathematical curve. Such a curve serves for prediction. If, in a man of known age, the area of a wound is fifty square centimetres on the first day of the month, it will be ten square centimetres at a date which can be read on the curve. If the observed rate of healing does not follow the theoretical curve, it is because

the nurse has failed to keep the Dakin solution in contact with all parts of the healing surface.

I saw recently[1] in New York a man who had had for twenty-five years a large ulcer on the leg. He entered the War hospital of the Rockfeller Institute July first. His wound was measured and the theoretical curve was drawn. It was seen that the curve would strike the normal at August 6. 'On August 6,' the man was told, 'You will be healed'; and on the promised day, the last square centimetre closed.

In Compiègne we lunched and dined—the Carrels, the surgeons, and the guests, for the hospital was a place of pilgrimage—in the garden of a villa commandeered for that purpose. There was good talk there, and a gayety protective against the strain of the wards. When any one cracked a joke, there was a moment's stillness, then each of us grasped his knife and

[1] September 1917.

in concert we gravely beat upon the table the refrain of a merry French song.

We were never free from the sound of cannon. All day long and often half the night they thundered from the trenches six kilometres away. But Compiègne, unscarred, slept in the milky sunshine, bedecked with flowers. There was a tennis-court, green-walled with flowering shrubs. We played each day at half-past four; light laughter and pleasant voices floated into the soft sky to meet the satanic overtones of war. To a green bank at the side, men would crawl from their beds to watch the game. There they sat, a smiling, mangled row. One day I found a pipe. It appeared that it belonged to a mass of bandages, a mere remnant of a man, armless, blind. We stop the game, we fill the pipe, light it, and place the stem in the groping mouth. The man laughs, his comrades laugh, everyone laughs—such fun! No man talks of his wounds—his pride and his secret grief.

The surgeons at Compiègne had noticed that shock came on chiefly after wounds of the great bones, such as the thigh-bone, and after multiple wounds through the skin and subcutaneous fat, as from a shower of shell-fragments. These facts seemed very significant, although I little knew at the time that they would at length lead me to the discovery of the cause of shock.

A question of urgent importance seemed to press for immediate reply: does the life in the trenches, under fire, predispose to shock? The bombardments in this war were of a new and strange intensity. It might be that certain men were sensitized by this highly abnormal environment. In that case a wound not historically grave might bring on shock. If the low blood-pressure and other symptoms of shock appeared immediately after the wound, a preëxisting sensitization was probable. Remedies should then be employed before the wound was dressed. If, on the con-

trary, there was a significant interval between the wound and the onset of shock, sensitization was not the explanation, and shock must be the result of forces set free by the wound itself. On the length of this interval would depend the character of the treatment and the moment at which it could be most profitably applied. On the length of this interval rested the serious practical question whether treatment must be given in the dressing-station or in the nearest field hospital.

It was therefore my first duty to measure the blood-pressure immediately after the wound. The wounded at Compiègne arrived too long after their injury. Besides, the hospital was too small. To solve my problem without undue loss of time, it was necessary for me to place myself in a stream of wounded, for shock attacks only one or two men in every hundred casualties. I accordingly applied for permission to go to La Panne.

Getting to La Panne was not so easy as

it had seemed. The Bureau Piessac in the Ministry of War at Paris addressed the Belgian authorities. The famous head of the great hospital at La Panne, high in the favor of the King, made formal request that I should be appointed as physiologist to the hospital. The clumsy wheels of the administrative machine began protestingly to grind. Day after day went by, each day marked by deaths from shock, deaths possibly to be prevented by just such a research as we had planned, while the Belgian police, thick with dull suspicion, were goaded into action. The papers at length arrived. I went to the station to buy my ticket. The window was guarded by two gendarmes. 'A spy,' their fixed glare seemed to say. Science, humiliated, passed beneath the military yoke, and found a temporary refuge in the long and crowded train for Calais.

As we approached the coast, the signs of war were multiplied. Immense camps stretched on either side: thousands and

thousands of conical tents upon clean, sandy soil, faintly spotted with countless men in khaki.

In Calais I stayed the night at a hotel called Grand. The next morning I was taken to see the hospitals. There was one youth of twenty-two whose right arm hung like a flail, quite healed, but useless. He had lost three inches of the humerus, the bone in the upper arm. If, at the first operation, the two separated ends had been joined by plates of steel, the limb would have been restored.

'Don't you "plate" these cases?' I inquired.

'Oh, no,' replied the surgeon; 'we are afraid of suppuration.'

'But the Carrel-Dakin method would prevent suppuration,' I ventured.

'We do not use that here.'

At four o'clock arrived the military car which was to take me to La Panne. Two friendly officers strapped my bags to the running-board. We waited at the railway

station for a lady expected on the Paris train. A lonely English Tommy, bored almost to tears, gratefully returned my smile. He was a chauffeur of the Red Cross and had been on the job since the beginning of the war. His pent-up talk burst forth like oil from a tapped 'gusher.'

'The Huns, sir, are careless-like about their little friends. When we took X, they left their pets shut up in the houses. I found two thirsty canaries, and Miss Coxe,—you know Miss Coxe, sir? she had two hens. Miss Coxe, she says to me, "We had better divide. Give me a cock and I'll give you a hen." So we did. They sing beautiful, those two cocks. The women chauffeurs drive too slow, sir. They let the auto bump on one side of the rut and then on the other. Of course I'm a male chauffeur, but it does seem to me it would be easier on the engine—and on the wounded—if they drove a little faster.'

At this moment, Madame, the expected, emerged from the station, red in the face

and as indignant as such a small lady could well be. She is Belgian. Her husband is an officer. Her *permis* was correct, but the station guards would not let her through. They wanted to take away her papers. Women are not allowed to visit their husbands, if it can be prevented. Naturally, a woman is furious when deprived of her lawful prey.

Finally, we are off. Our way lies through farms and villages. The fields are covered with standing crops ready for harvest. We go through Gravelines, where we meet a convoy of fresh Boches, gathered in a few days ago. The road is a typical Belgian highway, smooth, dusty, tree-lined. The trees on the west side are all bent by the ocean wind. The car is quiet and very fast. We fly across the great flat meadows. It is cool. Madame shivers, even under my blanket on top of her own. My military overcoat keeps me warm. Near Dunkirk, the dunes appear—white sand, green trees, low steep-pitched roofs

of red tile. We stop for purchases in front of buildings wrecked by Zeppelins. Again the motor purrs. Again we wind the miles upon our reel. We reach the outskirts of La Panne. A last inquisition by the guards—the seventh since we started. Like all half-educated persons, they do not see the danger of generalizations. It is true that all men are liars. But it is not true that all the people lie all the time.

I went to sleep in a room on the top floor of a villa directly fronting the North Sea. Several hundred mosquitoes shared the room with me. They did not sleep. They tasted a new flavor—exotic, but distinctly pleasing. Presently, what physiologists call the summation of stimuli produced its inevitable result. The threshold value was crossed and I awoke. I left the murdered Sleep upon her desecrated couch and watched the sea.

A broad beach, furrowed by artillery wheels and pitted by the galloping cavalry. The busy waters, lighted by a phosphores-

cent surf, strove to efface these marks of the struggle for existence, *der Kampf um Dasein*. Softly they murmured at their priest-like task. The mooring posts, far out, were black against the wave. Black fishing-boats slept on the beach, like cattle in a field. A moon, largely decayed, touched with silver gleams the bayonets of the patrol. Three lines of barbed wire snarled along the tide-mark.

CHAPTER V

La Panne is the extreme left of the Allied line. It is the seat of a hospital of eight hundred beds, ably directed by the celebrated surgeon, Doctor de Page. I was stationed in the *salle de réception*, the receiving ward to which the ambulances bring their loads directly from the firing-line.

There comes a rumble on the stone-paved street, an ambulance drives up, the word *blessé* passes down the corridor, and the *brancardiers* appear with the long staves. A group of dark forms gathers about the motor-car in the starlight, the curtain is unbuttoned, the loaded ambulance stretcher is pulled out, an empty exchange stretcher is shoved in, and the ambulance departs for the trenches.

The mass of dirty cloth and bloody bandages is carried into the ward. A surgeon comes, rubbing his eyes. The wounded man is radiographed. This done, the radiographer places his hand over the supposed site of the fragment. A great magnet is let down upon the hand. If the embedded steel is not more than seven centimetres deep, the metal object is shaken by the magnetic waves and its vibration can be felt. The radiographer writes for the surgeons a report, giving the location and depth of the fragment.

Meanwhile a nurse shakes my bed, where I lie fully dressed, sound asleep, tired with fourteen days and nights of continuous service. I open sleepy eyes. 'A bad *blessé*. You are asked to take the pressure.'

I find the patient in the operating theatre. An intense light floods the trim surgical nurses, the bloodstained bandages, the patient half-naked on the table,

—the leg and foot so oddly at variance with the broken thigh,—the three surgeons, in white, their shoes in white sterile wrappers. They wait silently while I put the hollow cuff on the upper arm and the ausculting tambour at the fold of the elbow. The air is pumped into the cuff; the artery is stopped; I slowly diminish the air-pressure; a faint sound in the stethoscope, like a far-off cry for help. I read the gauge—140 millimetres, the maximum blood-pressure. The air escapes again; slowly the recording needle passes along the dial; the sound of rushing blood increases for the moment; as the artery takes its full size, the sound fades away—92 millimetres, the minimum blood-pressure. The normal is 97; there is no shock yet.

The patient is turned and a hollow needle is passed into the vertebral canal. Cerebro-spinal fluid is sucked into a syringe containing the anæsthetic novocaine; and slowly the mixture is driven

back into the canal. The tourniquet above the wound is tight; but little blood escapes from the torn vessels. The wound is opened freely. Bruised flesh, fragments of dirt, pieces of cloth, and splinters of bone are scraped out. The bleeding points are ligated. The Carrel tubes are placed for the Dakin solution.

I am at the pulse. Suddenly it fails. He is pulseless. His abdominal arteries have dilated. Through the open gates the arterial blood is rushing into the veins. The man is bleeding to death in his own veins. He becomes deathly pale; the whites of the eyes show; he is scarcely conscious. The nurse hurries the bandage about the padded splint. He is borne to his bed, wrapped in blankets, surrounded with hot bottles. The foot of the bed is placed on two chairs, so that the blood may drain by gravity from the congested abdominal veins back to the heart. The vein at the elbow is prepared. He gets a few drops of adrenalin

solution: the pulse comes back, color floods the face; the eyes become natural, they open; he speaks—he is saved.

But no—he is pale again, he vomits, the pulse is irregular. The adrenalin is attacking the heart. Will he die? Shall we have failed him? I pray silently. The ward is hushed. Two, three minutes pass, dragging like hours. The pulse strengthens. The heart is again regular. Youth has its day. He lives. Now, to make sure. Warm serum[1] is passed into a vein. The blood-pressure rises. The arm is bound up. The electric reflector is brought by two men, and placed astride the bed, covered with blankets. Miss T——, a Scotch angel of uncertain age and unfailing devotion, stands by. I wait at the wrist. A single shaded light burns in the great ward; the screens round my bed rise ghostly in the gloom.

[1] A solution of common salt and some other substances in the proportion in which they normally occur in the blood.

We watch, while beat by beat the ebbing flood returns. The clammy hands and feet feel again the warm and healing tide. He lies like a cocoon in his warm blankets. His face is calm. He has cheated the grave. He tells us of his two children. The mother is dead; the waifs are in an orphan home; one is eight years old, the other six; he has not seen them for two years—not since the war began.

Trembling, I go out on the beach and watch the sea—that northern sea which has looked unvexed on so many foolish wars. The tide is low. The wide sands are smooth and firm. Two officers are out for a morning gallop. In the distance a battery is drilling. The horses are of heroic size in the early mists. I hear the faint thud of hoofs on the hard beach. Above, a solitary aeroplane swoops low, while the observer searches the depths for a lurking submarine.

So the days and the dreadful nights went by, with their unceasing stream of

broken men. Often I lay sleepless through the dark hours, while next me howled a *blessé* mad with subconscious agony and the last wild ether dream. But there were compensations. One gave and gave and gave—a blessed thought.

And there were spectacles of poignant interest. Late one afternoon a nurse came running to tell me that there was an English monitor off the beach. We hurried out, full of the charitable hope that she would shell Ostend. The sun was setting. A golden light touched soothingly a half-tamed sea, still sulkily mumbling. A ship of no great size lay a mile from shore, circled by two torpedo-boats. They kept untiringly a ceaseless round. We strained our eyes. Suddenly there burst from her side a flame as big as a house, followed by an immense cloud of black smoke. We held our breath. In a few seconds there was a sound that was more than a sound. It was a commotion in all that part of Belgium.

And then, a moment later, a faint boom, fifteen miles away, where twelve hundred pounds of trinitrotoluol wrought ruin in Ostend, the resort of tourists.

Presently there was another dim sound, like the low curse of a malevolent fairy,—

> Strange terrors seize thee
> And pangs unfelt before,—

and down from the sky fell a great shell. A huge column of broken water towered above the waves, and all was once more peace.

The spotless nurses walked upon the beach, and we heard the maids laying the table for our evening meal. Again the monitor shook heaven and earth, and again there came the great reply, more threatening than before.

It was enough. A German plane hovered far in the blue and guided with a gesture these mighty thunderbolts. The monitor ceased firing, turned her prow, and made for England, still circled by her tireless guard.

The receiving ward was staffed with four day and three night nurses. They were socially of the class called ladies. The two chiefs, one for the day and one for the night, were professionals; the others had volunteered for the war. As I was on duty continuously for more than a fortnight, I became well acquainted with them all, especially the four who served by day. One of these was a very intelligent Scotchwoman who had studied at the University of London. A second was a shy comely creature from the north of Ireland, with the loveliest red-gold hair ever seen. The third assistant looked as if she had just stepped out of a Delft plaque. She was a rosy young Belgian, daughter to a successful physician in Ghent. This girl spoke four languages with almost faultless ease. Scrupulously neat, her pride was in her immaculate hands. Often, on mere suspicion, as it seemed to my coarser perceptions, she would say: 'It is time for me to wash my pows.'

One morning, I found Miss B——, the chief of the day squad, very sad. Weeping, she told me that it was the anniversary of her brother's death,—shot through the abdomen,—a gallant youth. The afternoon of our sad talk, there came to us another youth, of her brother's age, mortally wounded. When she undid the emergency dressing, the intestines were found outside the body. He died within an hour. Screens were placed about his bed and I heard the four nurses in earnest conversation. I came nearer. 'We cannot send him to his grave like this.' It was Miss B——'s voice, rich with unshed tears. They brought me needles and forceps. After a hard struggle, the protruding bowel, swollen with post-mortem gases, was put within, and the gaping wound sewed up. Nobly, gratefully, the stricken woman dressed the poor clay for the last sleep. After a long, long year her chance had come, to lay vicariously her hero in the tomb.

One of the assistant night nurses used to say 'But, *sister*,' in a tone exactly like the bleating 'ma-aster' of Pascalon in *Tartarin de Tarascon*. Doubtless, a bad accent is sometimes mortal, and at first this good soul markedly lowered my vitality. The more so that for a time she thought me cruel. It is extremely important in shock that the patient should rest in the inclined position, with the body higher than the head. When this kindly but uninstructed girl would approach with the three fatal pillows, I would shoo her away. Finally, she helped me ease a soldier with a broken leg. Quite without cause, she was suddenly converted. 'You are so gentle,' she said. Her heart being gained, what she would have termed her reason was open to attack. She consented to listen to the indictment of the three pillows. The human understanding behaves exactly like the oyster. Almost immovably attached to the rock of prejudice, its shell is firmly closed at the

approach of a new idea,—strange, and therefore suspicious,—possibly foreign.

Last night, August 30, 1916, was my first quiet night since I began to sleep with the wounded, more than two weeks ago. I slept from 11 P.M. to 6 A.M. and am much refreshed. The night before was really terrible. A man shot through both lungs, half-crazed, shouting and groaning, with bubbling sounds inexpressibly ghastly. I can sleep now in the strangest turmoil, but this was too much. I went for a walk, but it was a mistake. When I came back, a breathless nurse told me that she had looked everywhere for me—there was a fresh *blessé*, very bad—please hurry. It was Sergeant Édouard G——, about twenty years old,—the thigh crushed by a shell.

This morning I have been engaged in two cognate pursuits, visiting the police and hunting the 'chamois.' A plague on both their houses! The Belgian police are—But I will tell this another time,

if holding in is not fatal. As for the chamois, the pleasant land of counterpane, in the receiving ward, is naturally thick with them. Myself, I am not skillful at catching them. When they are very full, I can sometimes seize one by the horns, but usually they escape, leaving an equator of low eminences. This differs from the other equator in two respects: first, it is not an imaginary line; second, I do not speak disrespectfully of it.

The most affecting spot in La Panne was the room where the maimed were fitted with artificial legs. Any morning, one might find sitting there several men, who waited patiently their turn, with their naked stumps sticking straight out before them. A little English boy, nineteen years old, but looking scarcely fourteen so worn and frail was he, had lost his leg above the knee by a shell that had struck in the heavy artillery post. 'You know, sir, I wasn't looking for anything like

this.' Inconsequent human nature! How should a little English boy divert the inexorable course of the great law of cause and effect!

The outcome of the work at La Panne was an organization for the systematic treatment of shock, employing all the remedies then known, basing them on repeated measurements of the minimum blood-pressure. These special measures saved two thirds of the cases, but the questions with which I had come to La Panne were still unanswered. The difficulty was again the interval between the wound and the arrival in the hospital. It was obviously necessary to be actually on the firing-line. Doctor de Page accordingly arranged that I should meet General P——, then colonel commanding the 58th French brigade, in the sector which included Nieuport.

This distinguished officer was a veteran of the Moroccan campaigns. He was brave, gay, and highly intelligent. Like

so many of the French, he had an appreciation of physiological science unusual in less favored nations. Claude Bernard had not lived in vain.

CHAPTER VI

One happy day the general arrived in his gray limousine and took me to brigade headquarters. It was in a villa which had belonged to a Belgian of some taste. There was a large living-room, some good prints on the walls, and at one end a billiard-table, now used for military maps. At the other end was the table at which we dined. By this time our friendship had made great strides. The general was enchanted to find that I smoked a pipe. Himself, he adored *la pipe*. His tobacco left something to be desired: it was a species of Algerian hay. I gave him of my choice Virginia leaf. We were brothers. He would visit me in Boston when the war was over.

The dinner was superlatively good. I asked him how he managed. 'Oh,' he

replied, 'my chef before the war was the chef of a great New York hotel. But this is easy,' he continued; 'you should have seen him at Verdun. Eight of us and the chef in a hole thirty feet under ground. He had for his art a space only two feet square,'—and the general marked such a space on the tablecloth,—'but we lived just the same.'

He led me to the maps. 'You will like to see what we are doing to-day. Observe this salient. We make a curtain of fire behind it, so that the Boches can neither get in nor get out. Then our shells destroy their defenses. Every hour an aeroplane makes a photograph. Here are the photographs. You see they are quite large and very clear. Even the posts of the barbed wire show. We do not send our men forward until we see that all the wire is down.'

A dozen steel helmets were brought. The general and his staff helped me to find one that would fit. Then we set out

for Nieuport. There I was consigned to Colonel D——, of the 3d French Line, another veteran of the Moroccan wars. Eight delightful days I lived with this dear man beneath the shells.

Nieuport lies upon the Yser, the tidal stream that stopped the German rush for Calais. That June before the world went mad, the peaceful town drowsed in the sun—the pearly Belgian sun that painters love. The men went down to the sea in their fishing boats, or worked their fields; old women, their lace upon their knees, sat in a patch of shade before the door and plied their bobbins; children, with shrill sweet voices, darted about like birds; the creaking wain went to and fro piled high with harvest. Four thousand simple folk! Not one remains. Their houses too are gone. Their ancient church, their historic tower, are mounds of ruin. And still the hissing shells, hour by hour, day by day, tear down the crumbling walls, adding fresh ruin to a scene most desolate. The

people of the sun are gone. Another race inhabits there. They live in holes beneath the ground. They come not forth except to kill.

I too lived in a hole beneath the ground. I came not forth except to save. At least that would have been the wiser part, but the life was so interesting that in truth I roamed about like a boy at the fair. By day the soldiers lay *perdu*. The streets were empty. It was incredible that the blast of a trumpet would raise two thousand men. With the night they swarmed. The place was full of horses and carts, bearing water-casks, sand-bags, gabions, beams, chloride of lime, barbed wire, ammunition—a hundred articles needed in the trenches. There was no light except the moon. Strange shadows crept along the roads.

One morning I walked with Lieutenant N——. 'Suppose we ask Captain B—— to show us a seventy-five,' he said.

We found Captain B—— in a dugout

lined with beautiful maps. He led us to a passage that dipped beneath the ruins. It was perhaps twenty-five feet long and eight feet wide. At the lower end was the celebrated *soixante-quinze*, poking its shining nose out of a hole in the wall. I sat in the gunner's seat and trained the cross wires on a distant object, opened and closed the breech, and examined the recoil.

My pleasure was so evident that kind Captain B—— was touched. 'Perhaps you would like to see some practice on the Boches?'

'I most certainly should,' I answered, much gratified.

So the gun crew took their positions, we stuffed our ears with wads of cotton, and Captain B—— went to his post, a short distance away. There he called up an observation tower. The observing officer gave him the number of a square in the German lines, where a few shells might have a salutary effect. The captain called

to us the number and the range, 4350 metres. A soldier opened a cupboard in the wall, seized one of the shining brass shells, placed it nose down in a fuse-adjuster, and turned a handle round a graduated scale until he reached 4350. By this operation, the fuse was set to explode the shell at the given range. In an instant the shell was in the piece, the breech-block swung shut, there was an ear-splitting crash, and away flew our compliments to the Boches. The barrel slid swiftly back, spat out the shell-case at our feet, and returned to its position, passing on the way over a cushion of grease. The observer telephoned the result, the range was corrected slightly, and off went another shell. After twelve shots were fired, Captain B—— returned with a pleasant smile to receive our thanks for his courtesy.

This battery was so skillfully masked that I never saw it again, though it was not more than three hundred yards from

the cellar where I lived. No wonder the Huns could not find it. There was a ruined garden, with pear trees, in front of my quarters. I used to read in the garden while the enemy tried to silence these guns. Five or six times a minute the familiar curving hiss would rush toward the suspected spot; there would be a loud explosion and a cloud of black smoke. But the seventy-fives were never struck. Sometimes the great shells from our heavy artillery would pass high above me, seeking some distant objective. They gave a new flavor to Daudet. Imagine: three pear trees and an optimist—above, filling all the upper air, the vast soft weary groaning of an eleven-inch shell. This was not bravado—far from it. To stay all day in a damp black cellar was insupportable; outside, one place was as safe as another.

In fine weather we ate our meals—the colonel, three officers, and myself—in one corner of a half-destroyed court. Punctually to the minute, brushed and combed,

we arrived at the small round table. Through the centre of the table rose the trunk of a tree, the branches of which were trimmed flat about ten feet from the ground, to make a canopy. We sat ourselves gravely down. The good colonel would fumble in the pocket of his tunic until he fetched out his great horn spectacles. He would place them carefully upon his martial nose. Then he would proclaim, '*Ordre*,' in a deep, serious voice, and reaching forward would take up a glass holder containing the menu. This he would read to us slowly, from hors d'œuvres down through cheese and coffee. It was a way of giving thanks for the food that was set before us. After this ceremony, he would nod to the orderly, whose white coat and brass buttons illuminated the middle distance. The hors d'œuvres would advance. It was the signal for conversation.

Meanwhile, the shells went over, singly or in flocks. I sat on the colonel's right,

about eighteen inches from him. He had two voices—one for giving commands to his twenty-five hundred men, the other for ordinary talk. He always addressed me, as a foreigner, in the tone in which he commanded the regiment. The dinner proceeded sedately through seven excellent courses, undisturbed by the artillery.

During my stay at Nieuport two shells fell in that court; one slightly wounded our valuable pump, the other just missed our treasure of a cook. The stove was at the other end of the court, in a recess. The shell exploded outside this retreat. In that neighborhood not a square foot but got its piece of steel. The hurtling storm swept by the culinary shrine. Fortunately, the chef was at the stove, his post of duty; his deserts were great and he escaped unharmed.

On stormy days we dined in the colonel's cave. It was a tight fit. Through an open door we saw our commander's bed, alongside a stove in which the fire never was

allowed to go out. Even with this, the walls were always damp.

One evening the soup had just been served when the telephone rang. Lieutenant C——, who was acting adjutant that day, saluted the colonel and reported that a party of Boches were cutting grass behind their third line.

'Tell Captain F——,' said the colonel, between two spoonfuls.

Captain F—— was of the artillery. Before the soup was taken away, we heard the seventy-fives at work on the Boches. This speed and accuracy were due to the ever-watchful observers. I loved to go to the observation towers, especially at night. They were usually at the top of some ruined building. One stumbled up two or three ladders and at length entered a little wooden cage which held two men, elaborate telephones, and several powerful telescopes. With these you could have seen the buttons on a man's waistcoat miles away. The enemy was, however, rarely

visible; he stuck closely to his communication trenches. When darkness fell, the flares began. The French flare had a parachute, and for several minutes lighted up hundreds of yards as bright as day. As far as the eye could see, up and down the lines, these witchfires burned.

The aeroplanes liked to fly near sunset, when the air was quiet. Then we would hear our pompoms, fifteen staccato barks, and a pause. I would rush up the cellar-steps and search the sky. There, a mile aloft, would be a German plane. Off would go a pompom, fifteen rounds. A moment later, fifteen soft white fleecy little clouds of shrapnel, like puffs of thistle-down, would break out one after the other, about the flying plane. The planes were often hit, but seldom in a vital place.

The officers' caves were alike in one respect: they all contained mirrors in immense gilt frames. These mirrors had been found in the deserted houses. The

major's cave was rather a show place. It consisted of two tiny rooms, dressed with flowers, and very neatly kept. On a table in the 'salon' was a marble bust, a derelict.

'You must not miss my garden,' said the major, swelling with pride.

I looked for the garden; it was not in the room.

'No,' said my friend, with an indulgent smile at my little irony, 'it is not in here. It is outside. You can see it through the window.'

Now, the window was a cellar-window and opened into a little 'area,' where for the light the earth had been dug away in a space twenty-four inches by twelve. Here, indeed, was the garden.

'Of course,' continued the major, 'with the ground at my disposal, you would not expect me to go in for shrubs. I have had to content myself with a lawn.'

A perfect lawn it was—not a weed—a battalion of tiny bright green grass-blades; very refreshing.

I went into the trenches to measure the blood-pressure. The trenches lay on the other side of the Yser. We crossed a pontoon bridge. Spare pontoons were anchored in the river, in case the bridge should be struck by a shell. We entered a communication trench. Here and there were signs, where men had been killed often enough to show that a German sniper had marked that particular spot: 'Obligatory'; 'Forbidden'; 'In view of the enemy'; 'To grand redan.'

Our trench is narrow and it is deep enough to protect the head. It winds through fields covered with grass and poppies. These overhang the edge and brush our faces. The bottom of the trench is covered with a slatted walk about eighteen inches wide. We meet great pots of hot food, borne on a pole hung between two men. Happily, we are not fat; we slide by without being burned.

Soon we are in the lines. Here are real defensive works, heavily timbered, and

with space for many men. At frequent intervals are the burrows in which the men live. Telephone wires run near the bottom of the trench, on the side next the enemy; they are fastened to the earth with long wire staples. From time to time we peep through an observation-hole, but we do not stand more than two minutes in any one spot; always there are aeroplanes and tower observers on watch, and we may get a shell. The shells are now flying over us, with a noise like the tearing of a great sheet. Presently, we reach the point nearest the enemy. It is near indeed; about the length of a tennis-court. I look through a periscope and there, as clear as in a clean looking-glass, are long mounds of earth and sand-bags — the German 'trenches,' one hundred and fifteen feet away. Apparently deserted, absolutely silent, they lie heavily upon the unkempt fields, mile upon mile. Their sinister quiet speaks louder than the screaming shells.

The *poilus* are delighted with the blood-pressure apparatus. It is like a game. Their faces are wreathed with smiles. They take off their tunics, roll up their sleeves, and are proud to be told they are 'normal.' We keep our voices low and hug the front wall of the trench, but otherwise we might as well be in the Boulevard des Italiens, although, now I think of it, that also is a dangerous place. We are about to return, when the surgeon is telephoned that an officer is wounded. Bicycles are ordered to meet us at the third line, and we run back. The surgeon is younger, but he is a trifle too plump. I keep him in sight. As we approach the machines, he calls over his shoulder, 'Can you ride a bicycle?' 'Perfectly,' I reply. I do not say that it is thirty years since my last ride. We mount, and he hurries off without looking behind. I follow. It is a wild ride. The roads are filled with débris — low heaps of brick and plaster from the tumbling walls. When I go over

a heap, my helmet flies into the air; it requires nice calculation to be under it when it comes down. Clerk Maxwell is right: science is indeed a matter of grammes, centimetres, and seconds.

I had now based the treatment for shock on exact measurements of the blood-pressure, and I had determined that the habitual bombardment does not predispose. There remained the study of the blood-pressure in the fury of an assault, the question of the cause of shock, and the hope of a new remedy. Nieuport was exhausted. The war at Nieuport was all in the day's work. After two years, the daily round was the daily round, and it was nothing more. My comrades told me that, when they were at Verdun, there had sometimes been emotions, if their memories were not at fault. So I went to Verdun, that 'name of thunder.'

CHAPTER VII

On the stroke of twelve, October 13, 1916, I arrived at Bar-le-Duc, the base for Verdun. A chill rain monotonously fell upon slimy streets, innocent of cabs. I hired a small boy to pilot me a mile through the mud to the Lycée where Surgeon-General W—— had his headquarters. My little guide was cold, wet, and hungry, but his depression vanished when I addressed him as 'Sir,' and asked his opinion of the war. To General W—— I presented a letter from Dr. Tuffier, consulting surgeon to that Army, praying that I be given every aid.

'But your pass is only to Bar-le-Duc, sixty kilometres from the front!'—

'Please, then, telephone to General Joffre's headquarters and ask for full powers.'

After a gasp or two, the suggestion was accepted. General W—— went to consult the general commanding at Bar-le-Duc. In half an hour, he told me that the chief surgeon at Grand Headquarters knew of the research and that there was hope of a pass. 'Come back to-morrow morning at nine o'clock.'

I departed for one of the loneliest days and nights I have ever spent. The two dens of chief repute in the town were filled. I put up in a room beyond words. Too ill to eat my dinner, I went to bed at seven and shivered there until seven the next morning. At nine o'clock I reported, and to my surprise received a letter instructing officers of the Second Army to give me all possible assistance. At once I asked for a car. I got a magnificent high-powered Sedan. My first care was to be driven in state to the wretched hostel where I had spent the night. My hope was that all this splendor would teach them a lesson. Perhaps next time they

would not ask an American officer to bathe in a single pint of dirty warm water.

Soon I was flying along the great road that leads to the front from Bar-le-Duc. I was bound for the Mort Homme. Along this road passed the greatest transport the world had ever seen. Gangs of German prisoners toiled constantly to keep the road in repair. For more than thirty miles there was at the side a continuous ridge of broken stone. The working gangs drew steadily from these stores of road-metal and the losses were as steadily supplied. It was a task for Sisyphus, the son of Æolus. On this work hung the destiny of France.

The valley through which we ran is very beautiful—hills everywhere, brooks, green meadows, and cultivated fields.

We stopped some miles on this side of the Mort Homme; the road beyond was under fire, and by day it was too dangerous. I was given dinner in a kitchen with several agreeable officers. As soon

as it was dark enough to make the road safe, we left for Château Esne. After an hour or more, in the dark, without lights, in the rain, muddy beyond belief, we halted in a ruined village, and transferred to the black depths of a big ambulance. On we went, bumping over shell-holes.

The Château Esne is a *poste de secours*, at the third line of trenches, in a cellar of what once had been a glorified grange. It was a miserable hole, where one could stand upright only in the centre. The cold mists of late October drove through it, pursued by an eager, nipping wind. My *poilu*, a tall bearded man plastered with clay, showed me a sort of kennel set off with rough boards picked up in the fields. He brought a sack stuffed with straw for me to lie on. It was dark chocolate color. He surveyed it doubtfully. The honor of France demanded something more. He went to the case containing surgical dressings and cut off pieces of aseptic gauze, which he laid upon

the sack, overlapping them like shingles on a roof.

I lay down, but not to sleep. At midnight I was routed out to see a man who had been shot through the head. The bullet had drilled a neat hole through the back of his steel helmet and through his skull.

When day broke, a cold rain was falling. I looked out on the tragic slopes of Dead Man Hill. Craters and graves—graves and craters—in horrible confusion! During the Great Drive, twenty-five thousand wounded men had passed through the Château Esne, that wet dirty verminous hole. They often lay in rows outside, among the graves, waiting their turn.

But at the moment there was no great battle here, and I went to the Somme, still searching for emotions.

My way led through the base at Amiens. The Hotel du Rhin was filled with English and French officers. I was placed at lunch with an English captain, returning from a furlough. We talked, of course,

He made me a map on the back of the menu, so that I should be sure to find a small oyster-house that he liked. Yesterday he had bought two hundred oysters, as a present to the mess. Since then news had come that on that day the regiment had gone 'over the top,' and all the officers but four had been killed. He said that he was doing himself well, because he did not expect to last long; this, by way of apology for the Chateaubriand steak he was eating. The Epicurean philosophy fits well in this Roman war.

It appears that the Germans are at their old game, pushing hard at the liaison of the French and English lines — naturally a weak spot.

I supped with Tuffier, who had just come from Foch. The great strategist had said that his chief trouble was not the Boches — they were relatively easy; his chief anxiety was to find water every day for two hundred thousand horses and four hundred thousand men.

The next day Tuffier took me to the village of S——. There I was in a rough field hospital of twenty-five hundred beds. They had had twenty-seven hundred fresh cases in a single day. The courteous *médecin-chef* directed an officer to show me to my 'chamber.' I followed the officer. He led me to a low wooden building, somewhat worse than the rest. Within were two rows of tiny cubicles, with partitions of unplaned boards, and a blanket that served for front wall and door combined. Here the staff slept. Between the rows of cubicles ran a dark passage two feet wide. We reached my chamber.

'Be a little careful,' the officer remarked. 'Don't step in that hole in front of your door. The Boches were here last night. They dropped a bomb in there and it hasn't yet gone off.'

It was interesting. The French had sent a squadron to bomb a railway junction in Germany. The night was not very clear, and in the excitement an un-

lucky bomb had fallen on a hospital. In revenge the Germans had dropped twelve bombs on the hospital at S——. Fortunately, nine fell in the open, and two did not explode. Mine was one of these. The twelfth bomb burst in a crowded building, with very serious results.

Again I was disappointed. The same old mill of death ground steadily, but there was no great offensive. Winter was at hand, and I perforce took ship for home. It was the Espagne. Worn out, I went to bed at eight o'clock the first night out, although we were still in the submarine zone. At once I fell sound asleep. At ten minutes past eleven, I was roused by a voice shouting down the corridor, 'Every one on deck—the ship is sinking.'

I sprang from my bunk. Around me all was silence. The others had already gone. I reflected that no great ship ever sank in less than twenty minutes. I could dress in ten. It was a cold November night. In an open boat I should per-

ish without warm clothes. So I put on my uniform and my thick military overcoat, seized my life-belt, and rushed out. In the corridor I ran against a bolted steel door. Fortunately the bolts were on my side. I hastily drew them, closed the door behind me, and ran up the companionway.

Near the boat-deck I came upon the passengers. I had read of people gray with fear, but I had never seen them. Here they were,—an admirable observation,—a hundred women and some men, their faces the color of wet ashes. Seen in the mass, the effect was remarkable. The passengers behaved well. There was no screaming. But I was almost the only one dressed *comme il faut.* Most of the women had simply thrown a wrapper over their night-clothes. One man had on nothing but a suit of red pajamas—solid color. I went out on the boat-deck. The boats were swung out; two were already filled; the deck was littered with coils of rope, over which passengers were stum-

bling in the dark. A cold wind whipped a rough sea. I drew alongside the engine-room hatch. It was warm there, and one could look over the combing of the hatch and down into the bowels of the ship. A glance showed me that the ship was not taking water in that vital spot.

Before long, word was passed that we had been in collision: another steamer had struck us amidships, tearing a considerable hole just above the water-line. In half an hour we were told that we could go back to bed. I did so, and almost instantly fell fast asleep again. At four o'clock I suddenly waked. Something was wrong: the ship had taken a big list; the engines were stopped. I jumped up and looked out. The water was only a foot or two from my port. I dressed again and went on deck. The ship had been canted to keep the waves out of the hole, while the carpenters patched it.

Three days later we had a *tombola*—a sale for the Red Cross. The red pajamas

were put up at auction; they fetched six hundred francs.

At length the voyage was over. I hurried to my farm—sweet haven of rest. I visited my Guernseys. Incredible! I rubbed my eyes. The cows were quite unchanged. Ten million men were fighting for life and an ideal, but the herbivorous poise was not shaken.

For me, the old world had gone.

I could not rest. I was still pursued by the imperious fact that shock was most frequent after fractures and after multiple wounds through the subcutaneous fat. I took refuge in my laboratory, in experiment after experiment. The cause of shock was found, and a new remedy.

Fortune passed on, her ivory wheel half tarnished by the fumes of No Man's Land. I followed her again to France, to test this remedy, and to measure the blood-pressure in a fierce battle, during a barrage more violent than the worst in the great drive on Verdun.

CHAPTER VIII

THE mysteries of nature usually present themselves as mass problems. In this form they cannot be answered. They must first be resolved into their elements. But each mass problem can be so resolved only by minds specially trained in the particular field in which that problem lies. The layman cannot do this. It is for this reason that even a great scientist can rarely give a useful answer to a question put to him by a layman. The layman presents a dozen questions in one package. It is as if one should ask, What is the cause of the Great War?

What causes shock is also not a practical question. It is too vague. It is necessary to extract from it a series of questions, and then to devise for each of these a method by which it can be answered yes

or no. The observation that shock often follows fracture of the thigh-bone is an obvious *point d'appui.* The femur, or thigh-bone, is the largest in the body. When it is broken by a shell fragment, the rich bone-marrow is exposed. Perhaps some potent chemical substance is thereby set free, to be absorbed into the blood-vessels, through which it might reach the brain and spinal cord, and by poisoning the nerve-cells produce the phenomena of shock. But my efforts to bring on shock by the injection into the blood-vessels of chemical substances known to exist in the bone-marrow had no effect. It was necessary to pose another question.

Since the fracture of the bone is apparently a factor in shock, and since the absorption of a chemical substance was excluded, the mischief might be due to a mechanical agent. Now, the bone-marrow is very rich in fat, and it has long been known that after fractures of the femur large numbers of fat-globules appear in

the blood, in which the globules circulate until they enter the capillaries in the brain and other organs. When a large fat-globule enters one of these small, hair-like vessels, it sticks fast, the blood can no longer flow through that capillary, and the cells supplied by that blood can no longer get food and oxygen.

All this is well understood. For more than two centuries observations have been made by pathologists on changes in the tissues, following the injection of fat into the blood-vessels of animals. Indeed, a condition suggesting shock has incidentally been observed here and there in the course of these studies, although I did not know of these chance observations until long after my own experiments. No one, however, had declared or attempted to prove that the entrance of fat into the blood-vessels was the cause of shock as seen on the battlefield. The pathologists were after other game. They were interested in the anatomical changes

in the tissues following the blocking of the capillaries.

Since a falling blood-pressure is the outstanding symptom of shock, the proof demanded (1) that fat-globules should be injected into the vessels; (2) that the blood-pressure should be measured; (3) that the blood-pressure should fall gradually as it does in shock; (4) that the other symptoms seen in wounded soldiers should be accurately reproduced in the injected animal. These other symptoms are a feeble and rapid heart-beat, frequent and shallow respiration, pallor, low temperature, diminished sensibility, and apparent unconsciousness.

On February 2, 1917, the crucial experiment was made. An instrument for recording the blood-pressure in the carotid artery of an anæsthetized cat was arranged to write its record on a moving surface of smoked paper. When the normal pressure was in record, a little less than a teaspoonful of olive oil was injected into the

jugular vein. Thereupon the blood-pressure began to fall, and the animal soon showed all the phenomena of shock observed in the wounded soldier.

My attention was then directed to the discovery of a new remedy. Following the plugging of the capillaries by fat, the arteries and the heart are partially emptied, and the blood collects in the veins, especially in the large and numerous abdominal veins. In fact, the patient may be said to bleed to death in his own veins, since the quantity of blood left in the arteries does not suffice for the nutrition of the cells of the brain and other organs.

My first experiments were directed to altering the physical condition of the fat which had plugged the capillaries, so that it might pass through these narrow straits and thus free the channels for the nourishing blood. These experiments have not yet succeeded. Even if they had, they might not have proved of value in established shock. The plugging of the

blood-vessels undoubtedly sets in train the falling blood-pressure and other phenomena of shock. But the condition once established, the patient cannot be saved unless the excess of blood in the veins is brought back into the arteries. If that can be done, experience shows that the patient will usually recover. Either the stopped capillaries free themselves, or other capillaries take up the duties of their injured neighbors. The practical point is to draw the blood from the engorged abdominal veins into the chest, where it will fill the half-emptied heart and permit that faithful organ to fill the capillaries. To that end, I proposed the respiratory pump.

The air is drawn into the chest chiefly by the diaphragm, a large flat muscle which separates the chest from the abdomen. When the diaphragm descends in inspiration, the cavity of the chest is enlarged. If a squeezed rubber ball is allowed to expand under water, the sur-

rounding fluid enters the ball. So, when the cavity of the chest is expanded, surrounding fluids enter the chest: the air is sucked in through the trachea, and blood is sucked in through the veins. The blood is sucked into the chest with considerable force. If the normal quiet contraction of the diaphragm so aids the entrance of blood into the chest, its powerful contraction will aid still more. Powerful and frequent contractions are within our command. We have but to increase the carbon dioxide in the inspired air to call forth deep and rapid respiration. The necessary amount of carbon dioxide is not injurious.

These facts about the respiration and its influence on the circulation were known to every physiologist. My contribution consisted in applying them to shock. My remedy therefore was to increase greatly the action of the respiratory pump by having the patient breathe an atmosphere rich in carbon dioxide. Meanwhile he

was to be placed in an inclined position, with the abdominal vessels higher than the heart, so as to favor by gravity the flow of blood from the abdomen into the chest. In my animals with shock, this increased respiration raised the blood-pressure sufficiently to warrant the hope that valuable results would follow the treatment when applied to wounded men. Upon this hope the Rockefeller Institute for Medical Research sent me again to France.

CHAPTER IX

On the fifth of May, 1917, I sailed again for Bordeaux. The voyage was uneventful. Again I journeyed through famous towns and sunny fields in the pleasant land of France. The poppies cried their flaming message in the heart of the wheat — 'Thou shalt not live by bread alone.'

I got to Paris at sunset. My wife and daughter were at the Gare d'Orléans—a joyful reunion. Along the quai d'Orsay, under the plane trees beside the gleaming Seine, we walked to our rooms on the quai Voltaire. The river lay like a broad band of pale-green watered silk between the Louvre and the Quartier Latin. The noble arches of the Pont Royal were mirrored in the mocking stream. Faintly shot with gold and crimson, the evening light faded to a luminous haze. The *mar-*

chands de livres locked their begging wares in the little cases on the parapet. The gardens of the Place du Carrousel breathed like the sweet South upon the dying day.

Five days later I was walking with Major C—— under fire over the gently rising terrain leading to the Massif de Moronvillers. It was my purpose to try the new remedy, and to measure the blood-pressure in normal and wounded soldiers during a sharp offensive.

The meadow larks were singing. Even the major sang. And the air above was filled with the song of shells. The several harmonies were stratified. From the lush grass of early spring rose small chirpings and hummings; then came the major, having as it were a layer all to himself; then the meadow larks, numerous and undismayed; still higher were the hissing three-inch shells; and far, far up in the blue the mournful droning of the great projectiles.

'If you search these fields,' remarked

the major, 'you will find in every square metre at least one piece of shell.'

It was true. I looked through fifty square yards or more, and in each was at least one fragment of steel.

'It is forbidden to walk in these fields,' said the major. 'Perhaps we had better get into the trench.'

I took a last general view of our position. Behind us, the German fire was painting with dark smudges the village through which we had just come. Far across the plain — too far to see — lay Châlons-sur-Marne. To the left, miles away, was the Montagne de Rheims, bearing on its fruitful slopes the celebrated vineyards of Champagne. In front, rose the Massif de Moronvillers, crowned with its hills of fame — Mont Cornillet, Mont Blond, Mont Haut, the Casque, and the Téton. Their decent garments of green were torn away. Naked they lay. On their livid slopes the trenches crawled like great white worms. Streaks

of flame and sudden bursts of black smoke marked the constant fall of German shells. Thrown high in the air, the pale chalk-dust drifted with the acrid fumes among the riven pines.

We entered the communication trench — a deep and narrow passage writhing through the chalk like a snake in pain. When we came to the lines, the trench sank into a gallery. Dug by the Boche, it now served his enemy. The gallery was seven feet wide. At the farther end were four or five wooden bunks in which the Staff slept. In the middle were two tables. One supported a pair of type-writers, industriously nibbling at a mound of papers, under a small acetylene flare. On the other table was a row of aluminium porringers, salt, pepper, war-bread, and a small bowl of sugar.

We lunched. The colonel was a smiling, energetic veteran of forty-five, hard and fit. His face glowed like a dull red coal in the shadows of the cave. Six *galons* were

on his sleeve — one for each of his six wounds.

The food was simple but sufficient. The ritual of the déjeuner was scrupulously observed. It was as if a gentleman handed a poor relation into a carriage. The colonel and I sat side by side. Conversation flowed like milk in the Land of Canaan. The subject indeed was cows. It appeared that the regiment possessed a cow. This was unusual. The Marseillaise, the Ten Commandments, and Our Cow seemed to be on the same plane. As a breeder of Guernseys, these discerning people moved my heart. We were friends.

When night came, I took off my boots, belt, and helmet, and slept on a stretcher. At half-past three, an imperative hand shook my shoulder. 'Gas! Be quick!'

I seized the mask, which changes the man of peace into the ghoul of war. I pulled on my boots and put on my helmet. We ventured out. On the crest of the Massif, the stars of God paled before the

star-shells of the Huns. It was the hour before dawn. A lively bombardment was in play. Cocks crew, still faithful to their conviction that, but for them, the sun would not rise. I reflected that, but for us and our seven million comrades, the sun might set never to rise again. We sniffed the cool damp air for the odor of chocolate which betrays the creeping death. But the gas was not for us.

Far down on the horizon hung the gibbous moon. Across her chill and disapproving face passed black slim shapes incredibly swift — eight-inch shells plunging to their rending crash.

Back in Division Headquarters, General F—— had at first suggested that I should be stationed in the celebrated tunnel on Mont Cornillet, taken from the enemy four days before my arrival. The tunnel was deep in the chalk. It was very large — large enough to hold a dressing-station and six hundred German reserves. It had a big ventilating shaft. By a

strange chance, a sixteen-inch French shell passed through this ventilating shaft and exploded among the Boches. All were instantly destroyed. Comparatively few showed a wound — they were killed by the gas-pressure and the fumes.

The commotion made by an exploding shell is extraordinary. I have often felt the strong push of hot gas as if I had been struck by a flying cushion. Among my friends in Paris was a French aviator who had begun the war as an infantryman. His platoon held a first-line trench. A Busy Bertha fell among them. Some were killed by flying fragments, others by the concussion. A comrade of my friend was pushed by the blast against the hard clay wall of the trench, with such force that both the skull and the chest were crushed. They were visibly flattened.

The incident of the tunnel was certainly remarkable. But a still stranger accident had befallen the French a few days before my arrival. The regiment

brigaded with the 365th had its headquarters in a gallery thirty feet below the surface. It was apparently quite safe. Two large shells fell on that spot. The first made a crater fifteen feet deep directly over the gallery. The second fell exactly in the bottom of this crater, broke into the refuge, and killed the colonel and the officers who were with him.

I now transcribe from my diary.

May 23. It was fortunate for me that I was not put in the Mont Cornillet tunnel but in a cave on Mont Blond; had I been in the tunnel, I should have missed a wonderful experience — the battle on the crest. I was conducted to my new home the morning of the gas alarm. My cave was on the slope of Mont Blond, a little more than a thousand feet from the crest. Perhaps three hundred feet below us the slope ended in a path, and beyond rose another low hill, near the top of which was the regimental headquarters I had

just left. The cave had been dug by the Germans. The roof was almost flush with the surface. There was nothing to mark the spot, except that the universal wrack was there accentuated.

Battered tins, coils of barbed wire, scraps of leather, a broken stove upside down, rusted clips of cartridges, burlap sacks mired with clay, decayed bandages, a hopeless old rifle, intrenching tools, discarded helmets punched with shell-holes through which the owner's brains had probably oozed, old shoes, battered shell-cases, and a trench torpedo lay about, half-buried in the dirt thrown out of the craters.

Five or six steps screened with dead branches led into the cave. It was about six feet deep. The roof was supported by projecting beams. The sides were clumsily boarded. Here and there were openings dug farther into the earth and provided with shelves which were covered with accoutrements, flat circular wine-flasks in canvas, tin cups, *musettes* lumpy

with a miscellaneous kit, packages of food, bundles of dressings — all in great confusion and all thickly smeared with dirt. The furniture consisted of a couple of benches and a greasy table. The table stood against a wall. On one end were the surgical tools, bandages, packets of gauze, etc. On the other, three or four small cooking utensils and an alcohol lamp.

The room was full of men: three surgeons and eight or nine *brancardiers* in a space ten by twelve feet. A ladder led into a lower cave, six by seven feet, the floor of which was fifteen feet below the surface. Here were bunks of unplaned boards. Twenty feet away was another shelter, an overflow, still more primitive.

In our own cave, dinner was being prepared. Dinner was served here at noon, for greater convenience. Outside, the Boches were very active. The slope was being searched with shells in the thorough German way. The living heeded this mortal rain no more than the stoic

dead, who lay about us, beneath their crosses — two rough boards in the form the Prince of Peace had sanctified.

Through the hot fire appeared the major, very brisk, clean-shaven, immaculately clothed, plump and smiling. Under his arm was a long bottle, converted to the ways of innocence. The major made a gay salute. 'The colonel presents his compliments and hopes you will accept a litre of fresh milk.' Delightful colonel! O gentle cow, all red and white! We drank an English toast with gusto: 'To hell with the Huns!' Everybody laughed. The bearded *poilu* detailed as chef plunged his great spoon into the tub of solid alcohol at his feet and fetched up a huge lump to feed the flame under our crackling meat, as who should say, 'This for the Boches!'

Dinner was served. The few who could find a place sat down. The rest stood, each with his porringer. We had hors d'œuvres, consisting of sardines and sliced

onion with bread and butter, omelette, beef with sauce tartare, potato salad, oranges, and cakes. Jokes flew about, but they were harmless jokes. Neither then nor at any other time did I hear from French soldiers the coarse obscenity which too often mars the fighting men of other nations.

In the afternoon, I went with an *officier de santé* into the advanced trenches. But trenches is not the correct term. The Germans had been forced back and off the whole extent of the Massif de Moronvillers, until they had lost all the crest but the position immediately above our cave. The French first line lay beyond the old German trenches, in a series of shell-holes connected by hasty ditches. It was very warm here; in some places were more dead than living. The commandant of this section complained to my *officier de santé.* The dead were not removed quickly enough. He could *sentir* them. They had begun to rot.

We returned safely to the cave. As we stood at the entrance, a German plane passed high over us. We dived for shelter. None too soon. A moment later three shells fell, one after the other, close to our post. These caves are not proof against direct hits, though safe enough from fragments. Two days after my departure, a shell entered the *poste de secours* next to ours, killing the two surgeons and five *brancardiers*.

There are hours when the fire is light, although it never ceases. Again, it will swell almost to drum-fire. It is not safe to go more than a few feet from the cave, lest you be caught in one of these sudden storms. When it is possible, I sit in the mild May sunshine on a burlap at the top of our steps. The probable course of a shell can be told from the sound it makes. When the hiss crescendo seems to be coming straight for you, a swift plunge is in order. A sharp watch for planes is necessary. In my first summer, at Nieuport

and elsewhere, the planes did not usually attack small groups of soldiers. But here, at the Massif de Moronvillers, they have a nasty habit of dropping suddenly from the sky, spitting steel from their mitrailleuses.

The gas-shells are very numerous and very deadly. My colonel — the one who sent the milk — was laid up three weeks from gas which had crept through a very small opening where, because of his high cheek-bones, the edge of the mask failed to press firmly against his face. Our masks contain several layers of gauze saturated with different chemicals to neutralize the various fumes.

When darkness came we prepared for bed. At half-past eight my orderly saluted. He had been before the war a teacher of Latin in the High School at Lille. His wife and two children were refugees. The wife had tuberculosis from her hardships. He informed me in his precise French that my couch was ready.

I climbed down the ladder to the lower cave, backwards and bent double, since the entrance was a low slanting shaft. Gérard pulled off my great trench-boots, hung up my belt and helmet, and folded my raincoat for a pillow. I lay down on the bare planks. He placed my heavy overcoat over me and wished me pleasant dreams. I told him that in my youth I had often been put to sleep by a teacher of Latin, but I had never before been put to bed by one.

During the night, the Boches bombarded points below us with gas-shells.

CHAPTER X

May 24. This afternoon, at three, the French began to prepare for storming the crest of Mont Blond. In the course of an hour the Germans made up their mind that an assault was intended. The artillery fire, which had been continuous before, now swelled to a torrent. Each side placed a barrage. The German barrage covered our slope and the little valley between us and the top of the next hill. Between four o'clock and midnight, more than 10,000 heavy shells fell within a radius of a thousand feet from our cave. I took the count from time to time with my watch.

We were driven at once into our deeper refuge. The little stuffy hole was packed with men, knee to knee: stretcher-bearers, surgeons, my orderly, and myself. The

three surgeons played baccarat. I sat on the edge of a plank and watched the game. We had an acetylene light. The shells fell all around, shaking the place and repeatedly putting out the light. The noise was remarkable. The air was filled with screams, hisses, and loud reports, followed by the slide of masses of earth. Many shells were so close that a strong push of hot gas was felt. At six o'clock the Moroccans took the ridge by storm. At midnight the bombardment slackened but did not cease.

With the dawn the wounded came in a stream. They were laid in the upper room. The wounds were of all sorts. The worst was a completely crushed jaw, in a man with a dozen slighter wounds. One man had a hole through the temple into the brain — a hole two inches long and half an inch wide. Another had a smashed leg, a bad head, and in the thigh a wound the size of a small orange.

I watched the blood-pressure carefully.

Imagine a cellar with a plank floor covered with clay an eighth of an inch deep. A horrible tub filled with bloody dressings. Two stretchers on the floor. Ten men in a space ten by twelve feet, shoulder to shoulder. Two candles. Sand-bag walls. The roof so low that I am always hitting my helmet against the beams. The air thick with the smell of blood, sweat, alcohol, iodine, vomit. Everywhere a smear of clay — the chalky clay of Champagne. The continuous scream, roar, crash of shells. A rain of small stones, dirt, pieces of steel. Every few seconds a profound trembling, as a shell strikes closer. Four men passing bandages and iodine in the half-light, over backs, under arms. The cries of the wounded. The litter of bloody garments. The fresh cases, obliged to lie outside, under the fire, until the room is cleared. The *brancardiers*, bent under the load of the stretcher, slouching off with the dressed wounded. The dawn, the failing moon,

the thick vapors and acrid stench of the barrage. The blasted hillsides smoking under the continual rain of death. Countless fresh shell-holes all around us. The graves reopened. They are bringing down the dead.—They lie sprawling on the slope just below us, half sewed up in burlap, like pieces of spoiled meat.

Such was the battle for the crest—a 'minor operation' in this great war, but an excellent example of the most violent artillery fire. The blood-pressure remained normal, not only in the unwounded men, but also in the wounded. As it happened, there were among them no fractured thighs and no case of multiple wounds through the subcutaneous fat.

May 25. To-day two or three rather elderly soldiers came in, with the plea that they were sick. The doctor, who has a soft full beard, large brown eyes, and a very gentle manner, said, 'You are not sick. You are only tired. But all the world is tired here.'

During the evening, one of our own shells fell short. It struck squarely in our own trenches near the crest of Mont Haut. Immediately went up two rockets, each with three green flares, meaning 'Great Jerusalem! Lift your nose.' Thus admonished, the humiliated seventy-five raised its muzzle and the next shell fell over the ridge.

May 26. Just before daybreak there was drum-fire—continuous roars from all the batteries. This lasted two hours. I got up and crawled into the upper cave, but was at once driven down again. After the fire slackened, I went out—about two feet out—and Gérard prepared my toilet—a shave and face-wash. I have not had any of my clothes off during three days and nights. After shaving, I went out to brush my teeth. The air was clear and brisk, the sun not yet fully risen. To stand on the open slope of the hill, in the keen wind of dawn, under fire, and use a tooth-brush was really exhilarating. It was the

first time I have ever enjoyed brushing my teeth.

At nine o'clock, we put a barrage on Fritz. At this he quite lost his temper. The noise was awful. Naturally, we went 'down' again. But his rage lasted only a short time. Then Gérard came to tell me there would be a Mass in the lower cave. 'Is there a priest among you?' I asked. 'Yes,' replied Gérard, 'we have two ones; the both very brave.'

The Mass was a touching ceremony. The early Christians worshiped thus in the catacombs of Rome. A very small portable altar had been placed at the end of the tiny passage. Two candles burned upon the altar. The men stood elbow to elbow or kneeled in the bunks—martyrs not yet dead. The priest was a private in the infantry. Over his dirty uniform of horizon blue—the faded symbol of worldly hope—he had drawn the vestments of the Church that teaches Hope eternal and unsoiled. His grave strong face

was lighted with sincerity and faith. The clear word of promise and of consolation mingled with the roar of German shells, beasts seeking whom they might devour.

About ten o'clock, the major turned up to fetch me to dinner, or *déjeuner*, at Headquarters. It was to be my farewell to Mont Blond. He had a great stereoscopic camera, with which he took my picture standing at the mouth of the cave. Then we went off, with Gérard and another orderly to carry my things. The major has a quick and almost jaunty walk. In ten minutes we arrived at the *poste*.

An officer went with me up to the observatory, a pit in the chalk on the top of the hill. The breeze was fresh, the sunshine delicious, and the view very extensive. Behind us, the slopes of Mont Blond and Mont Haut, smoking with shells, white with craters, trenches, and dust. In front, the plain of Châlons, green and smiling, with the spire of a church, and the villages of Mourmelon-le-Petit and le Grand.

To the right, the Montagne de Rheims, with Épernay and its vineyards.

After that diabolical cave all this was very sweet to me. I dozed in the sun, when suddenly a soldier, who was digging near us, threw down his tool, and with a warning cry rushed under cover. We jumped for our lives. An aeroplane sailed over us, half a mile up.

> A hawk is hovering in the sky—
> To stay at home is best.

After a delightful hour we returned to the gallery for lunch. It was quite a feast. There was one white plate, produced in my honor. The rest ate the whole meal out of one aluminium porringer apiece. It is useful to eat each course clean, to scour the porringer with bread, and then to eat the scourings.

After an excellent meal, I set out for Mourmelon-le-Petit. Two officers went a little way with me. It was hard to part with such kind friends. For success with

these people there are three points to be observed — to be perfectly brave, to be always smiling and gay, and to be enchanted with your bed, your food, the dirt — in short, with everything. Fortunately, I do not mind shelling; few men do.

The walk across the plain to the Farm of Constantine, where the motor-ambulances wait, was not unpleasant, though a battery of seventy-fives directly *en face* made a deafening racket. The ambulance driver, an Englishman, worn, prematurely gray-haired, covered with dust, had lived for years at Stockbridge, Massachusetts, and knew my friends there well. He was very cross about the gas-shells: he could not see to drive with his mask on. After a dazzling, dirty ride, we reached the *ambulance de triage* at Mourmelon-le-Petit. Here are brought all the wounded from the *postes de secours* at our immediate front. It will be a good place to try the respiration method for the treatment of shock.

CHAPTER XI

May 27. Mourmelon is a small village, justly called 'le Petit.' Its glaring streets are white with lime-dust, which indeed lies everywhere. The dirt is inconceivable. The ambulance consists of a number of old barracks in a walled compound. On my arrival, the médecin chef gave me a very kind welcome. He is a bacteriologist by profession, and before the war was Assistant Director of the Pasteur Institute in China, where he had met my colleague, Dr. Strong, during the pneumonic plague.

I sleep alone in a small ward. My ward has five beds, a wooden floor thick with dirt of all descriptions, and painted canvas walls. Naturally, the furniture is crude. But what a delight to strip once more and to bathe in clear cold

water—about one quart! Last night I slept hard, but to-day I feel the strain of the terrible scenes which I have been through.

After supper, the médecin chef and I took a long walk over the Field of Châlons. It is a green almost level expanse, traversed here and there by roads lined with trees. The sun had set, the air was cool and luminous. The cannonade seemed for the first time without sinister meaning. The plain was covered with small shell-holes. In the distance, on rising ground, against the horizon, galloped a train of limbers bearing ammunition for the insatiable cannon.

May 28. I am very tired. The glare, the dust, the endless stream of broken men,—ten thousand passed here in the last six weeks; one hundred and sixty-five last night between midnight and 6 A. M.,—the necessarily great inadequacy of treatment—all this, added to my reaction from the sickening scenes on Mont

Blond, is sufficiently depressing. I have had to think today. That was a bore.

The respiratory machine has undergone a transformation. It is now, in fact, a tomato-can with a tube ending in a rubber mouthpiece. It has been cut in two and each half shoves over a collar of tin, so that it may be drawn out like an accordion. The patient is to breathe in and out of this can, filling it with the carbon dioxide he exhales. As the gas increases, so will his respiration. To wash the can with fresh air, the two halves are pulled apart. Nothing could be simpler.

This hospital is a *triage*. It sorts the wounded. Those who can be moved are sent in suitable lots to Châlons and elsewhere. One hospital specializes in abdominal wounds, another in fractures, and so on. Only the most mangled are operated here. The shock cases are among them.

To-day I was presented to General X——, one of the high command here-

abouts. He is a man about five feet seven, very slim, very fit, intelligent, courteous, handsome uniform, great star on his breast. He was pleased at my having been in the barrage. He said it had been a very severe action—*acharné*.

Our médecin chef is very kind—much interested in my physiology—helps me with everything himself—says he is at my disposition day and night. But it is an awful load; there are such numbers of these battered fragments, and I know so little. It wrings the soul. A fine young officer came in to-day—shell in the abdomen. I wish I were at home, with you. I shall never be able to get these sights and sounds out of my mind, or the smell of rotting flesh out of my nose.

May 29. To-day, the chief and I tried an experiment on a *blessé* with multiple shell-wounds and very low blood-pressure. It was a failure. The respiration was not increased, and the blood-pressure was not raised. Neither was the chief's

opinion of the method, although he was much too wise to be skeptical. My spirits were not elevated by the occurrence. Last night I was very tired. Indeed, I am tired to-day also. My bed is next a great ward filled with wounded, only a canvas wall between. Promptly at day-break one of these sufferers begins to call, 'Garçon! Garçon!' The monotonous, feeble, penetrating wail rises with clock-like regularity every few moments until broad daylight. There are no nurses here, only ignorant *poilus*.

This afternoon I got a soldier as subject and tried the machine in the presence of several deeply attentive officers. Nothing doing. The breathing remained almost calm. Immense shrugs from all beholders. I do not see why it should work on animals and not on men. They brought me another man, a finely built youth, and intelligent. Another failure. This time the shrugs were so *exaltés* that I thought the spectators would put out

their tongues at me. Then the soldier said, 'But, monsieur le major, my nose is still open.'

O clever youth! Inspired young man! The officer whose duty it was to stand guard at the nose had put the clip too high up. Ten hands reach the recalcitrant organ. I look to see the nose pulled off. But no. It successfully resists. This time it is stopped for sure. The youth announces thickly that he can breathe only through his mouth.

The instrument is now applied to the mouth. Listening to the artery, I get for a base measurement a clear *bruit* just above the minimum normal blood-pressure. '*Commencez!*' I cry. Off we go. In fifty seconds, he is pumping merrily. The heart bounds. The blood-pressure goes up. Three cheers for *les États-Unis*. Bring back the first rebel. *His* nose is closed this time. It is all but squashed flat. Again a success. *Voilà! C'est fini.* Profuse thanks to the *expérimentés*. Con-

clusion: another triumphal demonstration that men are like dogs.

May 30. It remains now only to get a couple of smashed thighs with low blood-pressure. It is practically certain that we shall have a rise also with them. They may come in any minute. It is very calm to-day. No cannonade to speak of. This morning the Boches dropped three shells on the railway station about two minutes from here. But their aim was good; they did not hit us. Just above me is a hole in the roof through which a shell fell a few weeks ago. A fragment sailed out the front door, narrowly missing the médecin chef.

This waiting is slow work. I am writing in the big *pavillon de réception.* It was a soldiers' theatre. It is here that the sorting takes place. On the dirt floor, near my feet, lies a soldier on a stretcher. He has had a heavy thump on the chest and breathes with difficulty. Between us is a great brazier, half-full of red-hot coke.

The air is keen to-day. Tea is to be served for me at four o'clock. As I speak English, they fear I should die without my tea. I wave my hands, but it is no use. After our dinner, we drink a hot decoction of the blossoms of the lime tree. They firmly believe that it helps the digestion. Who can refute it! The connection between faith and peristalsis is too strong to be denied.

The chief regrets that there are no women here. He thinks they would help the service. They would no doubt teach these *poilus* how to wash. Such dirt! The chief has lent me a clothes-brush. 'It is for the horse,' he explains, 'but I believe the brush for the horse is better for man than the brush of the shops.' *Mon avis:* I shall need a currycomb soon.

May 31. To-day there were several cases of shock. I tried the respiratory machine. It did not work. All the muscles of these poor creatures were relaxed. Their lips would not close on the

rubber mouthpiece. I am off for Paris to-morrow, to have made a frame enclosed in a kind of bag. The patient's head will go inside and carbon-dioxide gas will pass into the chamber from a pressure cylinder. The bag will be tied round the neck. The new device will have two advantages. First, the patient will have nothing to do but to breathe; he need not close his lips on a respiration tube. Second, the treatment need not be interrupted to wash out the apparatus with fresh air. There will be plenty of carbon dioxide and a hole can be left in the chamber, through which the patient can get all the oxygen he needs. But probably by the time this apparatus is made and tested, the fighting in this region will have quieted down. It would then be necessary for me to go elsewhere.

My stay at the Massif de Moronvillers has been very profitable. I have demonstrated that the blood-pressure is not altered by a barrage fire said to be as

violent as the worst in the great drive at Verdun. Further, I have myself examined more than a thousand wounded. Save a few wounds of the abdomen, in which the blood-vessels or their nerves in that great vascular region were probably directly injured, there has been no case of shock except after shell-fractures of the thigh and after multiple wounds through the subcutaneous fat. In these, closure of the capillaries by fat-globules is known to take place. This is strong support for my discovery that shock may be produced in animals by injecting fat into the veins.

CHAPTER XII

As might have been expected, the making of the new apparatus in Paris in wartime was a slow business. When it was finished, I tested it at the Collège de France in the laboratory of my kind friend, Professor Gley. It worked very well. A wire frame covered with a thin caoutchouc bag enclosed the head. Carbon-dioxide gas passed into this bag from a pressure cylinder controlled by a regulating valve. On its way, the gas bubbled through a flask half filled with water. The rate of passage could be told by counting the bubbles. When the inspired air contained about three per cent of carbon dioxide, the subject's respiration was doubled and the blood-pressure was plainly greater. Sufficient fresh air was obtained through an opening in the bag.

By this time the fighting at the Massif de Moronvillers had sunk to the habitual offensive; there were no longer enough wounded at Mourmelon-le-Petit. As only one in a hundred casualties has shock, I needed at least one hundred wounded a day. Since the point at which attacks might be made could not be foretold, it was necessary to obtain carte blanche to go anywhere on the French front. For this I went to Grand General Headquarters at Compiègne.

In my former days at Compiègne, the great Château had been a sleepy place, almost deserted. It was now the seat of Grand General Headquarters. No doubt it would be profoundly altered. There would be many guards, a stream of officers coming and going, a crowd of automobiles, a rush of aides bearing messages. To my astonishment, it was scarcely changed. This centre of perhaps the greatest intellectual activity in the world was as quiet almost as the grave. A

lonely sentinel guarded the iron gates. A single limousine stood within the court; the chauffeur dozed in the warm June sun.

Madam C—— and I were admitted to a tiny room, economically boarded off from one of the salons. Presently a soldier led us up the ancient stairway to the third floor, where we traversed interminable corridors paved with brick. We passed door after door, each of which bore a white paper stating the name and business of the inhabitant. We met not a soul.

Finally, we arrived at the door we sought. We found within a pleasant officer at a large desk. He might have been writing his memoirs, so easy and good-natured was he. I stated my case, while my benevolent companion made signs behind my back that I was some kind of rare bird. Even the good are full of guile. The officer did not penetrate this aura. Early the next day I received a magic square of blue paper, giving me full powers

and requiring every French officer to further my researches.

Returning to the Ministry of War, at Paris, on the Boulevard Saint Germain, I obtained an order of transport, providing free passage and all civilities on the railways. A message was telephoned to the front, ordering a limousine and an officer to meet me at a certain station. The next day I departed, in the company of an enormous cylinder of carbon-dioxide gas. I reached a station near Soissons and was most politely conveyed to Division Headquarters. Here the general brought out a map on which were marked the *postes de secours*, the sorting hospitals, and other administrative details. Soon I found myself just behind the Chemin des Dames, welcomed by a friendly médecin chef, in private life Professor of Surgery at the University of Marseilles.

June 24. This is a hill country. The road to the Ambulance crosses a fold in one of these hills. On the left is a cliff,

separated from the road by a narrow strip of ground holding a single line of low stone houses. On the right, a few others cling to the slope. It is Vauxtin. Below the village is a little valley containing barracks and stables. Beyond Vauxtin the road rises to a rounded summit on which are the great tents of the hospital. It is almost a motor-ambulance. Electric-light generators are mounted on an auto truck. There is an automobile dovecote, with homing pigeons. The tents have dirt floors, except in the operating-rooms. There is good air, much sunshine, a wide view, a large and competent staff. The surgical results are excellent.

The staff sleep in the village—in caves dug in the cliff. I live in a house. It has a small courtyard, shut from the road by a wall. There is a wide gateway, closed by iron doors. Upon this yard open sheds in which are cows, swine, poultry, dogs, and rabbits. In the centre is a dunghill, a pool of liquid manure, and several indolent open

drains. My room has a dirty brick floor, dirty walls with great cobwebs, and a dirty duvet, of a color once red. The sheets are coarse but clean. There is no soap-dish, no towel, no anything but a small battered tin basin and a rusty tin water-can. The door will not lock, or even latch. Two dogs, three cats, and all the chickens, wander at intervals through the manure and into the chamber of the interesting stranger. The cats find the duvet comforting.

I am writing on our mess-table in the adjoining courtyard. We eat in the open, protected from rain by some flimsy tarred paper. Near my bench is a rabbit-hutch. Two large and fluffy hens, each with many chicks, are trying to teach me how to manage a family. I should be more interested if they would show me how it is that my family manages me. The proprietors of this court are a wrinkled, leathery couple who are evidently moved by the example of the prudent Noah; they seem to have

at least one pair of each species of animal indigenous to these parts. Their owners think that, pending the arrival of the flood, it would be a waste of energy to clean the court. Our supper consisted of onion soup, omelette soufflé, hash in slabs, green peas, lettuce salad, confiture, toasted war-bread, and coffee.

At ten o'clock, the apparatus was tried on the médecin chef. If he does not complain, the soldiers will not. The experiment goes smoothly and the chief is entirely comfortable.

June 25. It is nine o'clock, and I am sitting at the door of my shock tent, writing on my knee. I was called at 5.45 A.M. and worked without food till 1 P.M. Then an hour for dinner, and after this, more work till 8 P.M. Then supper and a pipe, and here I am.

We have had five cases of shock. Three recovered; one was hopeless from the start; and the fifth could not be treated—constant vomiting and hemorrhage. A day

full of dreadful sights. The battles here are fiercely fought; there are more than ten German divisions on our immediate front. The carbon-dioxide treatment is undoubtedly an advantage. Probably it is of considerable advantage. Just how much, can be determined only after many observations. But at least a forward step has been taken.

Yesterday I went for a walk to the end of our plateau, separated by a few miles from the Chemin des Dames. It was dusk. The flashes of the guns, the flares, and the smoke-clouds were all visible. Many years ago, the ladies of the French court had villas there, and used to drive along the Chemin des Dames to get the view from the long, high ridge.

We had a grand lunch to-day. Tuffier and his aide were guests. The smoke from the green wood of the cook's fire mercifully deadened our capacity to smell his stove five feet away and the manure-pool ten feet away. After all, the rich agricul-

tural aroma of rabbit and cow is not so bad. The wrinkled peasants, proprietors of this demesne, enjoy these ancestral odors.

> Pomona loved the straw-built shed,
> Warm with the breath of kine.

The old dame has stolen out to catch a glimpse of the great surgeon. She stands with bared head before a plastered wall, on which a vine has drawn a pattern of classic beauty.

The lunch is interesting. An officer tells us his experience at Verdun. He might be describing the barrage on Mont Blond. I am comforted. He at least will know that I have spoken truth. Our feast has reached the cheese, eaten in the hope that its sharp savor may correct our earlier excesses, when the air fills with a series of loud bangs mixed with the barking of pompoms. A Boche is trying to hit the barracks and stables down the slope of the hill. Last week sixteen

horses were killed by a single bomb. This time the aviator is missing his mark. His bombs are falling at the edge of the low cliff above our heads. Our party leaves more or less hastily for the shelters under the cliff. The sensible ones run. Tuffier and I walk. After a minute or two we conclude that our German friend has done, and we sit down again. Our waiter fetches a jagged piece of steel that had struck about four feet from the plank on which rest my poor old bones at meal-time. But don't be alarmed. This is a quiet enough place. All the hills are bearing haycocks. The fields are poorly cared for, naturally, but there seems nevertheless much precious fodder.

Last night it rained, but to-day has been fine and cool. I hated to spend the long, sunny hours in an intolerably hot little room over the remains of what was once a whole man. The wounded are so patient, poor dears.

June 27. After writing you yesterday,

I went almost at once to bed. It was still light. The cows and the chickens were at rest, but the peasants were cackling, and soldiers and ambulances were constantly passing my open window. This window is three feet above an open drain at the side of the road. Nevertheless, I was soon asleep — fortunately, because at two o'clock a hoarse voice and a rattle at the shutter called me to a shock case. I dressed hurriedly and stumbled up the dark hill to the ambulance. I found the surgeons just bandaging the stump of an amputated thigh. The man was pulseless. The head surgeon turned him over to me — they always do: the more desperate the case, the more pleased they are to bestow him on some one else. The man was taken to my tent and all the surgeons stood by to see what would happen. He was placed head down on a sloping table. Six large electric lights were arranged between him and his blanket. The mask was put over his head and the carbon

dioxide turned on. In three minutes his pulse reappeared. Every one was much pleased.

I am anxious to get back to Paris to try out a new idea, an electrical method for raising the blood-pressure.

I had come down to the Chemin des Dames by way of Berzy. At that time Berzy was the railhead — passengers did not go through to Soissons. My colleagues at Vauxtin thought it unnecessary for me to go back the way I had come. There was a nearer station, the name of which has escaped me. I departed for this station, after the most friendly leave-taking. The amenities have attained in France a perfection that is the despair of other nations.

After an hour's ride I was deposited on the railway platform and the motor darted away. I asked the *chef de gare* if the train for Paris was on time.

'Train for Paris! What train? There is no train until tomorrow.'

'Oh!' said I, 'that is most unfortunate. My car has gone and I must be in Paris this afternoon.'

'Then you must go to D.; a train leaves there in about two hours. It is twenty-five kilometres.'

There was no time to lose. I ran out into the street. A lieutenant came along. 'I am in trouble,' I explained, 'my car is gone. There is no train here. I must be in Paris before night. There will be a train at D. Won't you please send me there without delay?'

At this he made large eyes. 'What, Monsieur, you ask me to—to confiscate an auto for you? I am desolated not to—'

Here I cut in: 'But I have an order from the Quartier Général'; and I produced the Magic Square of Blue Paper.

At that instant, a handsome limousine glided down the road, with two soldiers on the front seat. My lieutenant waved his hand. The car stopped. The soldiers saluted.

'Take this officer to Headquarters at C.' Turning to me he said, 'It is ten kilometres on your way. At Headquarters you can get another car.'

In I jumped, with a word of thanks and my very best smile, and we were off at thirty-five miles an hour. In less than fifteen minutes we were at Headquarters, a handsome old house in a small village. I was taken to a door, on which I knocked. It opened and revealed two charming gentlemen.

'I am Professor Porter,' I said.

'Ah,' they replied, with the pleased and deferential air of a naturalist confronted with a new species.

'I must be in Paris this evening. There is a train leaving shortly, fifteen kilometres from here.'

'Monsieur is well informed.'

A pause, with rather cryptic smiles.

'Pardon, messieurs, you have no autos?'

'But yes; we have. Only—Monsieur will excuse—our autos are not for the public.'

'Perfectly,' I rejoin, 'but, chers messieurs, I am not the public. I have an order from the Grand Quartier Général.'

The officers wasted no time. One handed me a chair; the other seized the telephone. In two minutes I was flying over the road in a powerful racing car.

In the zone, a magic square of blue paper is better than much gold.

It is not my present purpose to give an account of the busy weeks that followed my return to Paris, or to describe in these pages the long series of experiments in the Collège de France. I found an electrical method useful against shock in animals, but I have not yet succeeded in adapting this method for use upon man.

In August, 1917, I sailed for my own country, bearing with me the certainty that fat embolism is a frequent, if not the most frequent, cause of shock as seen on the battlefield; and the further certainty

that the carbon-dioxide respiration treatment is of advantage.

Continued investigation is a sharp and pressing need. These monstrous maladies devour our sons. Unchecked, they drag the stricken hero

> Through caverns measureless to man,
> Down to a sunless sea,—

a sea of sorrow — sad extinction of the tremulous hopes with which we crown our dear and precious youths. Pierced by the iron shards of a perverted science, they can be rescued only by science undefiled.

Our people drowse. They sleep, like fallen angels, on the marl that hides consuming fires. Awake! Arise! Multiply research! Forge the weapons which alone shall save the lives of those who fight our battles!

Our hearts are in their keeping.

THE END

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"Quite four nights of each seven in the week," he says, "there were other staff officers in to dinner, and we debated such trifles as German *Militarismus*, the hate of the world for Germany, American munitions for the Allies, submarining and Zeppelining, the Kaiser, the German people."

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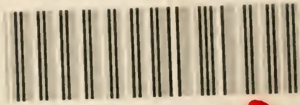
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