

Brunel's Revolutionary Hospital

An important response to the Covid-19 pandemic was the establishment of Nightingale emergency hospitals in Britain within suitable buildings. Almost 170 years earlier, the nurse who gave her name to the hospitals led the nursing effort to reduce patients' deaths during the Crimean War of 1853-56. The war pitted an Anglo-French alliance in support of the Ottoman Empire, against the might of Tsarist Russia. Naval actions were largely concentrated in the Black Sea, while the land campaign was conducted on the peninsula, which gave the conflict its name. By late 1854 the war had exposed the inadequacy of the British Army's medical arrangements for aiding their sick and injured soldiers. War correspondents on the spot, especially from *The Times*, reported vividly on the incompetence and corruption of the medical commissariat and engendered a public furore.

The parlous situation was reflected in the casualty figures for the winter of 1854-5. Incredibly, 34,000 of 56,000 soldiers, 61%, died in the first 6 months of the campaign from disease and wounds. The only hospital comprised old Turkish barracks at Scutari. These buildings were completely unsuitable and yet, through perseverance and iron determination, Florence Nightingale and her nurses improved the sanitary conditions sufficiently to save many lives, and became national heroines in the process. Nightingale was a convincing and vociferous campaigner and, with the statistics depicted in her revolutionary pie chart, she squarely blamed the Permanent Undersecretary for War, Sir Benjamin Hawes. Through her devoted service at Scutari she reduced the mortality level to 42% with very little help from the army or government. She regarded Hawes as incompetent and her worst enemy.

Hawes, however, had a major asset, he was brother-in-law to Isambard Kingdom Brunel, the Victorian engineer who built the Great Western Railway and the SS *Great Eastern*, the world's biggest ship for 50 years, amongst many other works. On the 16th February, 1855, when the true scale of the disaster became clear, Hawes contacted him for help. Brunel replied immediately stating that his 'time and best exertions would be, without any limitations, entirely at the service of government.' He set aside all other design work and undertook a typically whirlwind round of meetings, consulting other engineers, together with architects, doctors and physicians, and naval officers.

On the 5th March, just over two weeks after Hawes' request, Brunel presented his plan to the War Office. He envisaged nothing less than the world's first flat-pack modular hospital. He commented, 'It is most gratifying to be able to state that from everybody I have received the most zealous and cordial assistance, and found it sufficient to mention the object of my enquiries to obtain immediately every assistance I could possibly require.' He then explained 'that the aggregate of the buildings should consist of such parts as might be conveniently united unto one whole under great variations of conditions of the form and nature of the site. That the several parts must be capable of being formed into a whole united by covered passages, and that it should be capable of extensions by the addition of parts of any size.'

Brunel's concept comprised identical self-contained wards together with stores and general-purpose buildings. His specifications for the wards were that all components were portable and easily constructed,

capable of being adapted to whatever ground was available, and easily extended in any direction using identical standard units, containing all required facilities. Within a few days he erected a prototype ward on land at Paddington.

A standard unit had two wards each for 26 patients. Brunel designed wide and high wards to ensure air circulated to all beds, and to avoid crowding. They had bathrooms, nurses' rooms, washbasins, flushing water closets and drainage. In fact, these were better facilities than most houses in Britain at the time. At the opposite end to the WCs, a hand-operated fan forced air movement and helped to stop smells coming in to the wards. Victorian medical opinion suspected noxious vapours spread disease. Brunel followed their lead and designed his wards to reduce this possibility. He intended each patient would receive about 1,000 cubic feet of fresh air every day.

Brunel was also concerned that his patients benefited from natural light, always a problem at Florence Nightingale's barrack buildings at Scutari. His wards were painted with tinted lime wash to reduce glare, and the unglazed windows were set in clerestories along the eaves. They were fitted with hinged shutters to control airflow and prevent patients suffering in very bright direct sunlight – a feature of the Black Sea region. Unlike most Victorian hospitals, Brunel's wards were not to become crowded. Beds were fixed at a set distance so that his specially-designed portable invalid bath could be placed between. Brunel even designed some of the bed linen. The lowest canvas sheet had especially wide hems into which poles could be inserted. This turned it into a stretcher for moving a patient into an invalid bath alongside.

For lighting, Brunel decided candles would be adequate and sufficiently safe as they were a common feature of everyday life with which nurses and patients were familiar. He also provided railway-type lanterns for them. To combat any fire a hose was fitted at one end of each ward, supplied from a cistern. The wooden frame wall structure was sufficiently deep to take an internal lining if the hospital was required to operate over winter 1855, i.e. Brunel's hospital was designed for cavity wall insulation. A similarly designed store room and apothecaries' dispensary was supplied fully equipped. For location nearby, Brunel provided an iron-framed kitchen capable of providing all meals for 500 patients and staff every day, plus a tin-clad washhouse with baths and drying rooms to supplement the invalid baths. Brunel included water-pumps, a reservoir tank and water main piping for each set of buildings. The innovative wooden pipes were push-fit, joined together without solder or cement. The drainage system linked into each set of buildings.

The standard central corridor, open at the sides for ventilation, immediately and drastically reduced air-borne infection and isolated each ward from the others, forming a first-line of defence. Brunel said, 'if I have a monomania, it is a belief in the efficacy of sweet air for invalids'. The flushing water closets were supplied with lavatory paper. These were very innovative for the mid-nineteenth century and few soldiers would have encountered them before. Handbills informed them how to use the facilities correctly and exhorting them to do so to help reduce disease; the instructions were also pre-pasted onto the walls. Simultaneous with designing his hospital buildings, Brunel designed the process for mass-producing the component parts. He drew plans for the best utilization of the construction material so as to minimize waste, and for their efficient

construction and erection. They were the cheapest and lightest buildings ever made in relation to the area covered. Each constructional unit was designed to be carried by just two men.

In consultation with Brunel, Hawes appointed Doctor Parkes as Chief Medical Superintendent for the new hospital. Parkes decided to build at Renkioi, southeast of Scutari, on the Dardanelles. This was a raised location, about 100 feet above sea level, with a constant breeze which helped keep temperatures down in the wards, but was not cold at night. Importantly, the level site had good drainage; no terracing or excavation was required. He described the site in a report to the Secretary of State for War. It was a shelving bank of light, porous soil, comprising about 270 acres on a peninsula stretching into the Dardanelles, and is now a suburb of modern Istanbul. Bays to the north and south provided good anchorages and were comparatively calm in the prevailing winds.

Without authorization and ignoring the timid War Department and its usual obfuscations, Brunel ordered parts for a 1,000-bed hospital on his own initiative. He appointed one of his trusted assistants, Brunton, to control assembly on site. It quickly became apparent that the army was unable to provide suitable men to erect the hospital so Brunel decided to intervene immediately and direct operations from London through his own subordinates at Renkioi. Consequently, Brunel 'instructed' Hawes to provide 1,800 tons of shipping space for mid-April, based on his estimate of about 1¼ tons shipping capacity per bed.

On 2nd April, Brunel wrote to Brunton with his instructions. 'All plans will be sent in duplicate ... by steamer *Hawk* or *Gertrude*. I shall send a derrick and most of the tools, and as each vessel sails you shall hear by post what is in her. You are most fortunate in having exactly the man in Dr Parkes that I should have selected – an enthusiastic, clever, agreeable man, devoted to the object, understanding the plans and works and quite disposed to attach as much importance to the perfection of the building and all those parts I deem most important as to mere doctoring.

'The son of the contractor goes with the head foreman, ten carpenters, the foreman of the WC makers and two men who worked on the iron houses and can lay pipes. I am sending a small forge and two carpenter's benches, but you will need assistant carpenters and labourers, fifty to sixty in all ... I shall have sent you excellent assistants – try and succeed. Do not let anything induce you to alter the general system and arrangement that I have laid down.'

Meanwhile, Brunel organized the manufacture, packing and despatch of the hospital units in Britain. The first consignment shipped at the end of April 1854 and was landed at Istanbul on 7th May. Altogether 23 steamers and sailing ships carried 11,500 tons of materials and stores, the last consignment arrived on 5th December 1855. Individual consignments included clear and organized detailed instructions for Brunton, these stressed the correct method and order of construction. The water supplies and drains were to be installed first and wards erected as the army medical services brought patients.

Brunel ensured that whatever befell the ships each one carried completely self-contained units, unlike the army's own notorious commissariat, it was a triumph of logical planning and organization. Each ship

transporting materials carried complete wards 'so that by no accident, mistake, or confusion, short of the loss of several of the ships, can there fail to be a certain amount of hospital accommodation, provided with every comfort and essential.' He had heard the stories of the army sending out left boots in one ship and right boots in another; inevitably, one sunk.

He wrote to Doctor Parkes that 'All the vessels with the entire hospital will I believe have left England before the end of next week ... I have added twenty shower baths, one for each ward, and six vapour baths. You will be amazed to find also certain boxes of paper for the water closets – I find that at a cost of a few shillings per day an ample supply could be furnished and the mechanical success of the WCs will be much influenced by this. I hope you will succeed in getting it used and not abused.' Brunel had designed, built and delivered on shipboard, an entire portable hospital, a completely unique development, in just 12 weeks. However, Major O'Brien of the army commissariat failed to assemble the stores required, so Brunel simply ignored the army's incompetence and ordered everything required through his own office staff.

Construction began at Renkioi on 21st May. Brunton relied on men sent from Britain yet, because of the design and clear instructions, work proceeded rapidly as they followed Brunel's plan without difficulty. By June, the first part of the hospital was ready with 300 beds. It had 34 wards extending down the peninsula either side of the 22 –foot-wide central corridor covered way, which ran almost a third of a mile. Water came from excellent fresh-water springs, which was fed, into a large reservoir built 70 feet higher up the slope. There was a constant supply to the baths, WCs and cisterns, and the excess constantly flushed the sewers.

By Christmas, 1,000 beds were occupied, treating patients in exemplary conditions, the mortality rate was just 4%. Even the notoriously critical Florence Nightingale approved of the hospital and referred to Brunel's hospital at Renkioi as 'those magnificent huts'. However, she remained unhappy that the nurses at the hospital were not under her control. Parkes commented that 'Nothing could exceed the simplicity of the whole arrangement; it was a repetition of similar parts throughout ... every necessary part was sent out by Mr Brunel ... [it] was admirably adapted for men recovering from illness.'

The hospital was in operation from October 1855 until June 1856 and treated 1408 patients with just 50 recorded deaths. It was never more than half-full because the army medical organisation was incapable of utilising it to its fullest extent. Despite this, Brunel also devised methods to increase each ward's capacity by 50% in case of a sudden influx of patients. The total cost was £22,000. In mid-1856, he sent instructions to Brunton regarding the hospital's disposal. 'I don't want the thing to be flung into a ditch when done with, but should prefer a useful end' Parkes reported that 'All the stores which were likely to be used or to sell well in England were sent home, and everything else was sold on the ground ... the sale of the buildings ... took place on September 20th.'

Brunel provided copies of his plans and instructions to the War Office, in the United States the Union army used the plans for their own temporary hospitals during Civil War, and they were eventually used by the German Imperial Army in the Franco-German War of 1871. It became the model for future temporary

military hospitals and its innovatory design was followed by military buildings of all types; aspects were later incorporated into the steel pre-fabricated huts designed by Major Peter Nissen RE, 1916.

In an extraordinary response to a national crisis, Isambard Kingdom Brunel designed, built, organised, transported and constructed a hospital in Turkey in just six months. It was a triumph for Victorian Britain's most innovative and accomplished engineer and remains one of his less-known significant achievements. He would have loved IKEA!

[Adapted from a session from my course 'The Little Giant: Isambard Kingdom Brunel']