10 The revolution in surgery

10.1 How have operations changed?

Before

Surgery in the early 19th century is dangerous and painful. There is no way to relieve the pain felt by patients during operations. Surgeons do not yet know how to control blood loss or infection, and operating theatres are dirty and dangerous places to be.

Some surgeons superstitiously prefer to wear their ‘lucky’ coat in the operating theatre – a coat worn during a successful operation in the past. They do not wash their ‘lucky’ coat between operations in case this breaks their run of luck.

The operating table is often blood-stained. The floor around it is sprinkled with sawdust to stop the surgeon from slipping on blood and other waste as he speeds around the table, carrying out his operation at breakneck speed!

Surgery is usually a last resort, and the most common operations are amputations, which can be completed quickly. Robert Liston amputated a leg in two and a half minutes. Unfortunately, such was his haste that he cut off the patient’s testicles as well. Patients are lucky to survive operations without any harmful side effects.
The revolution in surgery

After

Modern operating theatres are clean and safe. State-of-the-art equipment helps surgeons to perform delicate and intricate operations using techniques like keyhole surgery. Some surgeons are experimenting with robotic parts to help them carry out operations. High-technology scanners enable surgeons to probe deep inside parts of the body.

Surgeons today can carry out operations that could only have been dreamt of 40 to 50 years ago. Although the first human heart transplant operation only took place in 1967, heart transplants are carried out quite frequently now. Transplants of other body organs are common. Many people agree to donate their organs when they die so that they can be used for transplants, helping other people to recover from illness and to stay alive. Some medical scientists hope that it will become possible to clone human organs for transplants.

Activities

1. Look at the pictures. One shows an operation in about 1790. The other shows an operation in the early 21st century. What are the main similarities and differences between the two operations? Make a detailed list. This chapter will help you to understand the changes that brought about modern surgical techniques.

2. Some scientists want the government to change the laws on organ donation to make it easier for doctors to obtain organs from patients who have died in hospital. This is a controversial subject. What do you think are the arguments for and against these proposed changes? You might organise a class debate.

Key Words

Amputation – cutting off (all or part of a limb or digit of the body) through surgery.

Clone – to make an exact copy (a genetically identical copy) of cells or an organism. In recent years, scientists have been able to clone animals such as sheep.

Keyhole surgery – operating through a very small incision, perhaps only a few centimetres in size.
The problem of pain

Surgeons had long had to face the problems of pain, infection and bleeding. This was still true in the early 19th century. There were no effective anaesthetics. To help numb the pain during an operation, surgeons gave their patients drugs like opium and mandrake, or tried to get them drunk. A few surgeons used ‘mesmerism’ (hypnosis), hoping this would lead the patient to ignore the pain. Surgery had to be quick. Deep internal operations were out of the question. Most surgery was limited to removing growths or amputating limbs. Even so, many patients died from the trauma of the excruciating pain.

During the late 18th century the science of chemistry had made some progress. In 1772 Joseph Priestley (1733–1804), an English chemist, discovered that oxygen was a gas. Other chemists were also investigating the properties of different substances. In 1799 Humphrey Davy (1778–1829) discovered that pain could be relieved by inhaling nitrous oxide (‘laughing gas’). He wrote a pamphlet saying that nitrous oxide might be successfully used by surgeons as an anaesthetic. The medical profession ignored his suggestion.

### KEY WORDS

**Anaesthetics** – drugs given to patients to prevent them feeling pain. There are two types. **General anaesthetics** are usually inhaled and make the patient unconscious. **Local anaesthetics** are usually injected and have the effect of numbing the feeling in one particular part of the body, such as a tooth. They do not make the patient unconscious.

### ACTIVITIES

1. What problems of surgery are shown in Source A?
2. How reliable is Source A?
3. Imagine you are a relative of the person having the operation. Write an entry in your diary describing what you see, hear and smell during the operation.

A cartoon drawn by Thomas Rowlandson, showing an operation in 1793.
Early successes

During the early 1840s a number of experiments were made to find an effective anaesthetic. In 1842 an American doctor, Crawford Long, found that ether was a useful anaesthetic, but he did not publicly announce his discovery.

On 10 December 1845 an American dentist, Horace Wells (1815–48), watched people inhaling nitrous oxide as an amusement at a fair. He noticed that, under the influence of the gas, they could injure themselves and feel no pain. The next day, Wells had a tooth painlessly taken out after inhaling the gas. He tried to demonstrate painless tooth extraction to some medical students at a hospital in Boston, USA. What he did not know was that some people are not affected by nitrous oxide. Wells' volunteer yelled as the tooth was taken out and the students left the demonstration shouting 'Humbug! Humbug!'

On 16 October 1846 William Thomas Green Morton (1819–68) persuaded John Warren, the head surgeon at Boston Hospital, to carry out an operation in public, using ether as an anaesthetic. Morton gave the ether through an inhaler to the patient, Gilbert Abbott. Then Warren removed a tumour painlessly from Abbott's neck. Warren turned to his audience and announced, 'Gentlemen, this is no humbug!'

News of Warren's success spread quickly to Europe. By 18 October, Dr Bigelow, who had seen the operation, had published an article about it. On 3 December a steamship carried a letter from Bigelow to Dr Boot in London. By 19 December Dr Boot had extracted a tooth using ether – and had written an article about this. On 21 December the surgeon Robert Liston successfully amputated the leg of Frederick Churchill (a butler), using ether as an anaesthetic. Liston removed the leg in 26 seconds! With the leg already on the floor, Churchill raised his head and asked Liston when he was going to begin the operation.

What impression does Source A give of operations in the late 18th century?

Study Source B.

This is a painting completed after the event. Is it a reliable source of evidence for a historian? Explain your answer.

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**10.3 Developments in anaesthetics (2)**

**James Simpson and chloroform**

James Young Simpson (1811–70), Professor of Midwifery at Edinburgh University, wanted to find something to relieve women's pain during childbirth. He disliked ether because it was flammable, had a pungent smell and irritated the lungs when it was inhaled, making the patient cough. He began to test the effects of different chemicals. On 4 November 1847 Simpson and two other doctors discovered the effects of chloroform (see Source C).

Simpson found chloroform easier to administer than ether. Less of it was needed and it appeared to take effect more quickly. By the end of November 1847 he had given chloroform to more than 50 patients and he declared himself pleased with the outcome.

**Opposition to anaesthetics**

The first anaesthetics meant painless operations, but they were not welcomed by everyone.

- Some people worried that surgeons were inexperienced in using the anaesthetics, and therefore unsure about the correct amount to give and about any side effects the drugs could have. There were even instances of explosions in operating theatres caused by the use of ether. Such fears appeared to be realised when, in 1848, 15-year-old Hannah Green died from an overdose of chloroform. Deaths also occurred from the overuse of ether.
- Members of the Calvinist Church in Scotland were outraged at the use of chloroform in childbirth. They pointed to the book of Genesis in the Bible, where God says to Eve: ‘In sorrow shalt thou bring forth children.’ To them, this meant that God intended women to bear pain when giving birth.
- Some people worried that anaesthetics placed patients under the total control of the surgeons. What if a surgeon did something against the patient’s will?
- In the army, some officers regarded the use of anaesthetics as ‘soft’. In 1854 John Hall, Chief of Medical Staff in the Crimea, told his team of doctors: ‘A good hand on the knife is stimulating. It is much better to hear a fellow shouting with all his might than to see him sink quietly into his grave.’

**LEARNING OBJECTIVES**

In this lesson you will:

- investigate how opposition to anaesthetics was overcome
- compare sources of evidence that describe the same event.

**SOURCE C**

*Late one evening Dr Simpson with his two friends and assistants, sat down to their somewhat hazardous work in Dr Simpson’s dining room. Having sniffed several substances, but without much effect, it occurred to Dr Simpson to try a material which he had regarded as likely to be of no use whatever; that happened to be a small bottle of chloroform. It was searched for and recovered from beneath a heap of waste paper. [They inhaled the chloroform and passed out.] On awakening Dr Simpson’s first thought was, ‘This is far stronger and better than ether.’*

From H.L. Gordon, *Sir James Young Simpson and Chloroform*, 1897

**GETTING STARTED**

By 1846, the problems of overcoming pain during operations had been solved. Do you agree with this statement? Take a class vote.
The royal seal of approval

Some of the opposition to anaesthetics disappeared after Queen Victoria was given chloroform during the birth of her eighth child, Prince Leopold, on 7 April 1853. The anaesthetist was Dr John Snow (1813–58), who later did vital research into cholera. The Queen wrote in her journal that chloroform was ‘soothing, quietening and delightful beyond measure.’ As a result of her experience, chloroform became socially more acceptable. It became the most popular anaesthetic until about 1900, when it was realised that it could damage the liver. Surgeons then returned to using ether.

Anaesthetics from the late 19th century to the present day

Anaesthetics became accepted but problems remained in using them. Massive amounts were often needed, not to prevent pain, but to relax the muscles. Patients became saturated and slept for hours, even days. Recovery was slow and there were frequent complications.

From the end of the 19th century, anaesthetists became specialists. New substances were discovered and put into use. In 1884 cocaine was first used as a local anaesthetic, numbing one part of the body while the patient remained conscious. In Germany, in 1905, novocaine was proved to be more effective than cocaine. In 1942 curare, a South American poison, was first used as a muscle relaxant during operations; it remains in use today. A skilled anaesthetist is now a crucial member of every surgical team, responsible for monitoring the patient's well-being during operations.
The first transfusions

The practice of blood transfusion – transferring blood from the circulation of one person to that of another – is relatively recent. It only became a practical possibility during and shortly after the Second World War, and yet the concept of transfusion has origins much further back in history. The first successful attempts came in the 1670s. In 1628 William Harvey had proved that blood circulates (see page 75). This encouraged scientists to experiment with the idea of blood transfusion. Dr Richard Lower, a doctor in Oxford, performed one of the first transfusions from an animal to an animal. Then the first transfusion from an animal to a man was carried out by Jean Denys, a French doctor, in 1667.

Denys continued to perform animal-to-human blood transfusions, some more successful than others.

Doctors in the 17th century did not understand why some blood transfusions went well, while others did not. Despite Harvey’s discoveries, many doctors still believed Galen’s ideas about how blood was produced (see page 44) and they continued to practise bloodletting. The most popular reason for carrying out a transfusion was to try to alter the mental state of the patient. Many believed that it could restore youth to the aged, and it was even suggested that marital discord might be settled by transfusing the blood of husband and wife! In
1679, the Pope issued a ban on blood transfusions, and interest in this area of research declined.

The work of James Blundell
James Blundell (1790–1877) was a noted doctor and obstetrician. He was the first to transfuse human blood and has been described as ‘the father of modern blood transfusion’. The first documented transfusion of human blood took place on 22 December 1818. The patient was a 35-year-old man who was near to death. Blundell gave him approximately 14 ounces of blood from several donors. The blood was administered by syringe, in small amounts, at intervals of 5–6 minutes. Although his condition improved at first, the patient died 56 hours later. His disease was incurable and nothing could really have been expected from the transfusion. Between 1818 and 1829, Blundell established many techniques in blood transfusion which would continue to be used.

Further developments
Despite Blundell’s work, the success of blood transfusions still seemed a matter of chance. One difficulty was that blood coagulates, or clots, making it impossible to transfuse. In 1860, J. Neudorfer recommended adding sodium bicarbonate to the blood to stop it clotting. Another problem was the danger of infection from unsafe transfusion methods, but this began to be resolved when Louis Pasteur proved that germs cause disease (see page 92) and Joseph Lister pioneered antiseptics (see page 124). As a result, doctors began to sterilise instruments and use antiseptic methods.

In 1900 Dr Karl Landsteiner (1868–1943) discovered different blood groups. It was then recognised that only compatible blood types could be successfully transfused. Scientific and technological advances became more and more involved in the development of transfusion during the 20th century. The voluntary blood donor scheme was pioneered in London, after the Red Cross, which had set up a blood transfusion service in 1926, had requested two blood donors at short notice. Shortly after the introduction of electrical refrigeration, the first ‘blood bank’ was set up in Barcelona in 1936. Many other major developments in transfusion medicine during the 20th century were given impetus by wars and major conflicts. Freeze-dried plasma was developed in 1940. ACD (acid citrate dextrose) anticoagulant solution for the storage of blood was developed in 1943, and the development of a method of freezing blood followed in 1944.

Why do you think 17th-century blood transfusions had limited success?

Increase your knowledge of the history of blood transfusion by investigating one or more of the following topics.

1 Blood transfusions during the Franco-Prussian War (1866–70)
2 The work of Norman Bethune during the Spanish Civil War (1936)
3 The development of blood transfusions after the Second World War.

You should then prepare a presentation about your chosen topic for the rest of the class.

Donated blood is loaded onto a truck to be refrigerated, in the Second World War.
10.5 Developments in antiseptic surgery

LEARNING OBJECTIVES
In this lesson you will:
• understand why there was opposition to antiseptic surgery and how that opposition was overcome
• make cross-references between two sources to explain why they appear to contradict each other.

The problem of infection
The period between the first use of ether as an anaesthetic in 1846 and about 1870 has been called the ‘black period’ of surgery. Being able to remove pain made surgeons over-confident and they performed many operations that they would not have attempted before. However, operations were still carried out in unhygienic conditions, by surgeons wearing their everyday clothes. Instruments were not sterilised between operations. Before Pasteur proved the germ theory (see page 92), people did not understand the need for cleanliness. As a result, many patients died from infections that developed after an operation.

Ignaz Semmelweiss
Ignaz Semmelweiss was a young Hungarian doctor working in Vienna in the 1840s. He was worried about the high death rate of women from puerperal fever, an infection which set in after childbirth. Some doctors believed it was spread by miasmas (unhealthy smells or vapours) in the air of hospital wards. In 1847 Semmelweiss suggested that the doctors themselves might be spreading the infection by examining patients immediately after dissecting the bodies of women who had died from the fever. He ordered the doctors to wash their hands in a solution of chloride of lime before examining patients. This was unpleasant and many doctors resented it. But the death rate from puerperal fever in their wards fell dramatically. Other doctors did not accept Semmelweiss’ method. The high death rates continued in most places.

Joseph Lister
The breakthrough in preventing infection was made by Joseph Lister (1786–1869). He had read of Pasteur’s research and realised that the infections killing his patients were caused by germs. He knew that the operating theatre smelled similar to rotting sewage. To kill any germs that were present, he decided to use carbolic acid, a disinfectant that was used to combat the smell at sewage works. First Lister used bandages soaked in carbolic acid. Then he developed his technique to
include a spray of the acid that drenched the air, the surgeon’s hands, the instruments and the patients. This was unpleasant for surgeons but the results were remarkable. Mortality plummeted. Between 1864 and 1866, of the amputations performed without antiseptics, 46 per cent of patients died. Between 1867 and 1870, when antiseptics were being used during amputations, only 15 per cent of patients died. By 1912, when Lister died, ten times as many operations were being performed as in 1867. For the first time, surgeons were able to operate without fear of infection killing the patient. The combination of anaesthetics and antiseptics meant that surgery was now much safer.

From antiseptic to aseptic surgery

Antiseptic surgery had its drawbacks, not least being the discomfort felt by surgeons and nurses as the carbolic acid burnt their skin and the spray irritated their lungs.

Rather than trying to fight germs, surgeons in Germany developed techniques for keeping them away. This is known as asepsis, and aseptic surgery quickly became the normal procedure in operating theatres. The idea of scrupulous cleanliness originated with Professor Gustav Neuber and was developed by Ernst von Bergmann (1836–1907). Surgeons’ hands, clothes and instruments were all sterilised. A chamber was used to pass superheated steam over the instruments, thus killing the germs without the need for disinfecting chemicals.

The ‘father’ of American surgery, William S. Halsted (1852–1922), introduced a further innovation. In 1889 his nurse, Caroline Hampton, complained that antiseptic chemicals were harming her hands. Halsted asked the Goodyear Rubber Company to make some gloves. He had a particular interest as he was to marry Nurse Hampton in 1890. Halsted realised that the gloves were protecting the patient as well as the nurse. He followed this by introducing caps, masks and gowns for surgery. Halsted also investigated cocaine as an anaesthetic but became a drug addict, taking both cocaine and morphine.

Today instruments are pre-packed in sterile containers. The air is sterilised before it enters the operating theatre. Some operations, especially on babies or for joint replacement, take place in sterile ‘tents’ to ensure that there is no risk of infection.

**Source J**

Despite the [support] of statistical evidence, Lister’s method met with interference and even violent opposition . . . Fully twenty years of patient trial, improvement, demonstration and education were needed before British surgeons were won over to the idea, and not before many senior members of the profession had been replaced by a younger generation.

Leo M. Zimmermann and Ilza Veith, Great Ideas in the History of Surgery, 1961
10.6 Modern surgeries (1) – plastic surgery

In this lesson you will:
- investigate the development of plastic surgery techniques
- compare the usefulness of written and visual sources.

Plastic surgery

Grafting skin to repair damaged features was practised in ancient India and during the Renaissance, but infection was a major problem. In the 20th century, the development of new weapons led to an increase in the number and types of facial and skin wounds. In Britain, Harold Gillies set up a unit to treat horrific wounds inflicted during the First World War. He was the first plastic surgeon to consider the patient's appearance. Gillies' assistant was a New Zealander, Archibald McIndoe. In the Second World War, McIndoe set up a unit at East Grinstead in Sussex, where he treated over 4000 patients, mostly airmen, whose faces and hands had been disfigured by blazing petrol. His patients, known as 'guinea pigs', were helped by developments in drugs like sulphonamides and penicillin which helped to prevent infection. Since then plastic surgery has become a vital branch of surgery, giving a better quality of life to people whose lives would otherwise be shattered by injury or birth defects.

Grafting – transplanting or implanting (living tissue, for example) surgically into a bodily part, to replace a damaged part or to compensate for a defect.

Why did 20th-century warfare speed up the development of plastic surgery?

Archibald McIndoe 1900–60
Born: Dunedin, New Zealand.
Career: Studied medicine at Otago in New Zealand, the Mayo Clinic in the USA and St Bartholomew’s Hospital in London. After the First World War he worked with the British surgeon Harold Gillies, treating patients who had suffered disfigurement as a result of wounds received in the war.

He continued his work throughout the Second World War at East Grinstead, Sussex. (An example of his work was described in 2002, in the obituary of a former RAF pilot: ‘the pilot’s fuel tank caught fire, spilling fuel over the cockpit and the pilot himself. He was taken to East Grinstead, where the pioneering surgeon Sir Archibald McIndoe, rebuilt his hands and carried out skin grafts.’) Knighted in 1947 (became Sir Archibald McIndoe).

After his death, as a symbol of gratitude, his ashes were buried in the RAF church in London.
Plastic surgery is much more common today. It can be used to repair skin damage from burns, disease or injury. High-technology tools are used to join up nerves and repair the skin. Plastic surgery can also be used to repair hands and fingers that have been torn off in accidents.

**Face transplants**

In 2006 French woman Isabelle Dinoire became the first person in the world to undergo a partial face transplant, after she had been savaged by a dog three years before. The procedure caused great controversy. Some people argued that it was wrong for surgeons to develop techniques that could enable people to switch their identity or ‘trade their face’. There is still fierce debate today about whether it is ethical to transfer a key part of someone’s identity from a dead body to a living person.

The doctors who treated Isabelle were convinced that they were justified in carrying out the operation. Professor Bernard Devauchelle, who led the operation, said: ‘The transplant was very rapidly integrated into her life – it became a part of who she was.’ French doctors have carried out more such operations. But although there are clear benefits for people who no longer have to live with a horrific disfiguration, there is strong opposition to face transplants.

The French doctors have been accused of ‘ethical crimes’. In particular, people question whether it is right to use surgery that was developed during wartime to save people’s lives purely for cosmetic purposes, to satisfy people who don’t like their appearance.

**ACTIVITIES**

2 ‘Without Pasteur, Fleming and Domagk, there might have been no McIndoe.’ Explain fully whether you agree or disagree with this view.

3 Carry out further research into Archibald McIndoe’s work at East Grinstead. In what ways were his methods unconventional?
Heart surgery
Before the Second World War, surgery on the heart was dangerous and rarely carried out. When surgeons opened the chest, the patient’s lungs collapsed and when the heart was touched, it stopped. It was thought that nothing could be done about this.

The Second World War provided the stimulus for further research, as some soldiers had bullets and fragments of shrapnel lodged in their hearts. A US army surgeon, Dwight Harken, had the courage to try to save them. He cut into the beating heart and used his finger to remove the fragments. The problem in surgery to correct defects in the heart was that the patient’s blood supply needed to be cut off when the heart was opened. Cutting off the blood supply for more than four minutes causes brain damage. A Canadian surgeon, Bill Bigelow, came up with the idea of lowering the patient’s body temperature to increase the length of time for which it is safe to cut the blood supply. Nevertheless the problem remained.

At the University of Minnesota, Norman Shumway led a team specialising in pioneering heart surgery but there was sometimes a 50 per cent death rate. In 1960 the Methodist Hospital in Houston, Texas, became the centre for heart surgery, under Michael de Blakey. He worked at immense speed and used knitted Dacron, an artificial fibre, to replace diseased arteries. The problem of how to transplant a replacement heart remained to be solved. Tissue rejection made it seem impossible. However, research continued, despite a shortage of human hearts. In 1967 Norman Shumway announced that he was ready to try a human heart transplant. In New York, Dr Adrian Kantrowitz prepared to operate on a baby on 3 December. That same morning he heard that Christiaan Barnard had performed the world’s first human heart transplant in South Africa.

KEY PEOPLE

Christiaan Barnard
1923–2001
Born: Beaufort West, South Africa.
Career: Walked five miles each day to study at Cape Town University and qualified as a family doctor.
1950s Went to the USA to study heart treatment at the University of Minnesota.
1967 Transplanted the heart of a female road accident victim into 59-year-old Louis Washkansky. Although Washkansky died 18 days later, Barnard had shown that the operation was possible. He became world-famous and was invited to meet the Pope in Rome and US President Johnson in Washington. He was surprised by the publicity. As he said, ‘I didn’t even inform the hospital superintendent what we were doing.’
Christiaan Barnard

Surgeons in the USA were disappointed, as they felt that they had done all the experimental work and Barnard had used their ideas. Barnard denied this. Shumway and Kantrowitz carried out their operations but their patients soon died. Barnard did another transplant and his patient lived for more than a year and a half. In Texas, Michael de Blakey and Denton Cooley also tried human transplants. Cooley was able to complete a transplant operation in 20 minutes. No one, however, could overcome the problems caused by the patient's immune system. The drugs the patients needed to take, to make their body accept the donor heart, left them open to infection. All the transplant patients died within a relatively short time.

Enormous public expectation had been shattered. The failure rate was too high. Barnard tried, without success, to keep transplants going. Some saw him as the villain. Heart transplant operations ceased. Some doctors turned to experimenting with artificial hearts and, in 1982, a plastic heart was given to Barney Clarke in Salt Lake City, USA. He died three weeks later.

The solution arrived by chance. In 1974, when looking for new drug substances in soil samples, a researcher in Norway came across the drug cyclosporin. It was found that cyclosporin controlled tissue rejection, but did not eliminate the body's resistance to disease. Cyclosporin then had a more dramatic effect on heart transplant surgery than the skills of Barnard and Cooley combined, because it meant that transplants were possible again. By 1987, 90 per cent of heart transplant patients lived more than two years. Heart transplants are now routine. Surgery, drugs, patient care and the control of rejection all interlink to give success.
**10.8 Modern surgeries (3) – high-technology surgery**

**LEARNING OBJECTIVES**

In this lesson you will:
- find out about developments in high-technology surgery
- recall and communicate your knowledge about modern surgery.

**Getting Started**

Look at Source P. Discuss with a partner how this source demonstrates the role of technology in the development of modern surgical techniques. How does it compare to the operating theatre in 1840? (10.5 page 124)

**High technology surgery**

Surgeons could often benefit from the rapid development of science and technology in the late 19th and 20th centuries. The increasing use of electricity meant that many machines could be developed to assist surgery. Plastics and steel enabled artificial joints to be made for replacement surgery.

**Source P**

A surgeon using an endoscope to look inside the patient. The endoscope is inserted through a small incision near the patient’s navel.

- In 1895 Wilhelm Röntgen, professor of physics at the University of Würzburg, discovered X-rays.
- Marie and Pierre Curie discovered a new element, radium, in 1898.
- In 1903 the first electrocardiograph was developed by Willem Einthoven.
- The development of fibre optics and the creation of endoscopes.
- Efficient microscopes for surgeons to use when operating were developed in the 1960s.
- The first successful operation with a heart-lung machine, which enabled the heart to be stopped long enough for an operation to be carried out, took place in 1953.
- The first artificial kidney machine was developed in 1943 by the Dutch surgeon, Willem Kolff.

**High-tech surgery**

- These enabled surgeons to look at the inside of a patient without making any incision.
- Feeling can be returned to limbs that have been severed and damaged.
- This eventually led to improved treatment for cancer.
- This increased the success rate of open-heart-bypass operations, with the machine supporting the heart and lung functions during such operations.
- Along with fine sutures and needles, they have made it possible for doctors to join microscopic nerves and blood vessels and even to reattach severed limbs.
- The development of fibre optics and the creation of endoscopes.
- Eventually it enabled surgeons to monitor the heartbeat effectively.
- Eventually it enabled surgeons to monitor the heartbeat effectively.
- It is now possible to examine the inside of a patient’s body and to operate without having to make a large wound. This ‘keyhole surgery’ means that patients can have a local, rather than a general, anaesthetic. Their body suffers less shock and recovery is much quicker.

- The first artificial kidney machine was developed in 1943 by the Dutch surgeon, Willem Kolff.
- The first successful operation with a heart-lung machine, which enabled the heart to be stopped long enough for an operation to be carried out, took place in 1953.
- The development of fibre optics and the creation of endoscopes.
- Efficient microscopes for surgeons to use when operating were developed in the 1960s.
- In 1895 Wilhelm Röntgen, professor of physics at the University of Würzburg, discovered X-rays.
- Marie and Pierre Curie discovered a new element, radium, in 1898.
- In 1903 the first electrocardiograph was developed by Willem Einthoven.
Case study: the development of brain surgery in the early 20th century

American Harvey Williams Cushing (1869–1939) became a pioneer of brain surgery. He was probably the greatest neurosurgeon of the 20th century, and has been described as the ‘father of modern neurosurgery’.

He was an ambitious man who seemed driven to develop pioneering surgical techniques. His colleagues noticed his limitless energy and fanatical work ethic. He was said to be egotistical and mean, and ruthless in promoting the importance of his own work. He threw himself into all aspects of his life, becoming an expert surgeon, teacher and author of many medical books.

In 1907 Cushing began to study the pituitary gland, at the base of the brain. He was able to diagnose many of the conditions that affect the operation of this gland. He was unique in providing evidence that it was possible to deal with these conditions by operating on the gland. He developed new techniques that enabled surgeons to open the skull, expose the brain and attack and remove tumours. His success rate was much higher than previously known. He and his team achieved a record of treating more than 2000 tumours. Many of the brains on which Cushing operated were stored in an archive, for him to use in future research and development, and they are still housed at Yale University today. Neurosurgeons continued to rely heavily on the methods developed by Cushing until the 1990s, when even more advanced methods using keyhole surgery were developed. You can read about some more recent developments in brain surgery on pages 132–3.

Cushing was way ahead of his time in performing brain surgery with his patients given local anaesthetics only. In 1911 he introduced special sutures to control the severe bleeding that often made brain surgery impossible. Cushing turned neurosurgery into a separate and specialist field. His use of X-rays to locate the position and size of pituitary tumours paved the way for the use of more sophisticated scanners in more recent times.

**KEY WORDS**

**Pituitary gland** – a small organ at the base of the brain which controls the growth and activity of the body by producing hormones.

**Sutures** – surgeons’ stitches.

**HISTORY DETECTIVE**

Find out more about the work of Harvey Cushing, or any of the other pioneers whose work is briefly mentioned in parts 10.7 and 10.8 of this chapter. In writing a report of your findings, try to cover the ‘Five Ws’:

- **Who** is the pioneer you have investigated?
- **What** was their area of work?
- **Where** did they carry out their main work?
- **When** was their main work carried out, and in what circumstances?
- **Why** were they successful?
10.9 The impact of high-technology surgery

**LEARNING OBJECTIVES**

In this lesson you will:
- consider the advantages and disadvantages of high-technology surgery
- analyse the factors that have played a part in the development of surgery since 1870.

The work of pioneering surgeons such as Christiaan Barnard and Harvey Cushing has been important in expanding the boundaries of surgery. Improved technology has also had an enormous impact. For example, the use of lasers has quickly become an accepted part of treatment. Lasers are used in minor operations, such as to correct eye faults, and in treatment to control cancers, thus helping to save lives. Medical skills and technology have even increased to the point where it is possible to detect problems in an unborn baby and carry out corrective surgery before the child is born.

**GETTING STARTED**

Some obese patients have had fat sucked out of their bodies in a treatment called liposuction. Others have had their stomachs stapled, to make them smaller, so that they will only be able to eat small amounts of food. Should surgeons be spending time and money on procedures like these when people all over the world are dying from fatal diseases?

**SOURCE**

Dr Khurana performs a pioneering brain operation in 2008.
Lasers in cosmetic surgery

Since lasers were discovered in 1958, they have been used increasingly in medicine. Lasers can cut through tissue without causing excessive bleeding. Surgeons can reach areas within the body more easily with lasers than with a scalpel. But the ability of lasers to ‘resurface’ facial skin was discovered almost by accident. Surgeons treating acne scars with a laser noticed that, after they had resurfaced the skin around the scar to make the scar less visible, small wrinkles in the skin were also greatly reduced.

Since then, laser resurfacing to reduce wrinkles has become very popular among people who can afford it. It is a way of refreshing the skin’s surface and can make patients look 10 to 20 years younger. The results can last for 8 to 10 years, provided that, after surgery, patients avoid sunbathing and so destroying their skin again. Patients can have a repeat treatment after one year, but usually the first procedure is so successful that a follow-up is not needed.

Lasers cannot rejuvenate skin on other parts of the body. Nor can laser treatment smooth out sagging neck skin. These conditions can still only be treated by traditional surgical methods.

Not everyone is suited to laser resurfacing. Certain people with very sensitive skin and those not mentally prepared for resurfacing are not good candidates. Patients can be left with bruising and swelling. It takes at least 10 days to heal before make-up can be used.

Brain surgery

In 2008 a pioneering surgical team in Canberra, Australia, led by Indian-born Australian neurosurgeon Dr Vini Gautam Khurana, performed a six-hour brain operation on a patient whilst he was still awake. His condition had been caused by the formation of a blister on a major vein in his brain, behind his right eye. Dr Khurana needed the patient to stay awake, because he needed to test his vision while the operation was progressing.

The surgical team was composed of three neurosurgeons, one plastic surgeon, two anaesthetists, and four nurses. Using keyhole surgery, they entered the patient’s brain through a tiny opening in the frontal bone above the eyes. The high-technology equipment used for the operation included an ultrasound probe to measure blood flow, eyepieces linked to scanners to display the head, and virtual reality software to create a three-dimensional image of the brain. The surgery was successful, and the patient was able to leave the hospital soon afterwards and make a good recovery.

The implications of modern surgery

The wide range of surgery now available has had a major effect on the finances of hospitals, and the National Health Service is facing great difficulties funding all the operations that could be carried out. A heart transplant is a wonderful thing, but is so expensive that it might take funds away from other, seemingly less important areas, such as hip replacements for the elderly. Many hospitals are forced to juggle their budgets to keep their operating theatres working. A tragic consequence of this is that surgeons sometimes have to ‘prioritise’ operations. There have been cases where treatment for ‘self-imposed illness’ (perhaps a condition that is a result of smoking) has been put lower down the list of priorities than other treatment. Surgeons and patients find this a very difficult situation to cope with.

SOURCE

Administrators decided we were spending too much. They had the enormous stupidity to suggest that, if we kept patients out, we could work within budget. I said, ‘No problem. We’ve got a shotgun. I’ll load it. You fire it, because that’s what you’re planning. Now, out.’

Denis Melrose, a leading British heart surgeon, describing a difficulty he faced in the 1960s

ACTIVITIES

1 Study Source R. Compare it with Source Q and the information about Harvey Cushing on page 131. What similarities and differences can you see between Cushing’s and Khurana’s work?

2 ‘Modern surgery is getting out of control. There have been too many advances in surgical techniques and the government should make new laws to control what surgeons can and cannot do.’ Write a short essay saying whether you agree or disagree with this view.
The source-based examination paper, Unit A952, involves studying a range of sources about an issue or personality in British medicine in the period 1200–1945. Some of the questions in the paper may involve considering more than one source; some may involve using cross-references to other sources on the paper or your own knowledge. All the questions will expect you to use your knowledge of the period to interpret the sources.

Enquiry

Below is an example of a question based around a consideration of the importance of anaesthetics in the development of surgery. Study the source carefully and then answer the question that follows.

**Source A**

When the dreadful steel was plunged into the breast – cutting through veins – arteries – flesh – nerves – I needed no injunctions not to restrain my cries. I began a scream that lasted unintermittingly during the whole time of the incision – I almost marvel that it does not ring in my ears still so excruciating was the agony! When the wound was made and the instrument withdrawn, the pain seemed undiminished, for the air that suddenly rushed into those delicate parts felt like a mass of minute but sharp and forked daggers, that were tearing at the edges of the wound, but when I felt again the instrument... I thought I must have expired, I attempted to open no more my eyes – they felt so firmly closed, that the eyelids seemed indented to the cheeks.

*From an account of a mastectomy (breast removal) operation in 1811 by the novelist Fanny Burney*

Study Source A. How useful is this source to an historian studying the role of anaesthetics in the development of surgery? Explain your answer.

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**Answering the question**

STEP 1: This is the same for any source work question you consider. Ask yourself ‘What is the source? When and why do you think it was produced?’ Here we have a really graphic account of an operation to remove a breast, written by a novelist in 1811.

STEP 2: Now you are ready to answer the question. Your answer about how useful the source is should be based on what it tells you, what you can work out from it and what you already know that the source doesn’t tell you.

STEP 3: Now for the clever bit. In addition to Step 2, you need to know whether the source is reliable. If it is not reliable, that may make it less useful – or even useful in some other way!
Below are two students’ answers to the question. How do you think you could improve Answer 1?

**Answer 1**

I think this source is very useful. It tells me how it must have felt to have an operation in 1811. It describes the pain felt when the incision was made – the agony was ‘excruciating’. It describes how her body felt after the instrument was withdrawn – ‘the air that suddenly rushed into those delicate parts felt like a mass of minute but sharp and forked daggers’. However, the source does not tell me whether any anaesthetics were used or not, and it also does not say how the rest of the operation went and whether it was a success or not. I don’t know if I believe her account.

**Examiner’s comment**

This is quite a good answer, but it could have been very good. We are told how we learn about how it must have felt to have the operation. That is backed up with quotes from the source, which is good practice. It also explains what we can’t tell from the source, but it is a pity that no comment was made about the significance of the date. This candidate could have used knowledge of the development of anaesthetics to suggest that neither ether nor chloroform were likely to have been used. Most disappointing is the suggestion that ‘I don’t know if I believe her account’. Why not? This could have led to reliability being addressed, which would have brought higher marks.

**Answer 2**

I think this source is very useful. It tells me how it must have felt to have an operation in 1811. It describes the pain felt when the incision was made – the agony was ‘excruciating’. It describes how her body felt after the instrument was withdrawn – ‘the air that suddenly rushed into those delicate parts felt like a mass of minute but sharp and forked daggers’. However, the source does not tell me whether any anaesthetics were used or not. Since it was written in 1811, I know that this was before the use of ether and chloroform had become commonplace. This could give us a useful insight into the pain suffered by patients before anaesthetics were developed in the nineteenth century. It also does not say how the rest of the operation went and whether it was a success or not. This makes the source less useful than it might have been, since we cannot work out whether the lack of anaesthetics affected the outcome of the operation. I don’t know if I believe her account. She uses very dramatic language. She describes the surgeon’s instrument as ‘the dreadful steel’, and she goes on to add that when the air rushed in, it felt like daggers were ‘tearing at the edges of the wound’. Being a novelist, she seems to be writing to entertain her audience, and I think her account is exaggerated.

**Answer 2 shows how the student might re-work the response in the light of these comments. Answer 2 is worth full marks.**
Now it is time to revise your work on the development of surgery. It is important to be able to select the key dates, facts, personalities and events from the mass of detail that has been provided in this chapter. It is equally important to be able to analyse and explain the significance of the dates, facts, personalities and events. One way to do this is to summarise the information in a way that is effective for you. To get you started, make your own completed copy of this table.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Date</th>
<th>Details</th>
<th>Significance in the development of surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaesthetics</td>
<td>1845</td>
<td>Horace Wells uses nitrous oxide to extract a patient’s tooth.</td>
<td>The nitrous oxide does not mask the pain and his work is discredited.</td>
</tr>
<tr>
<td></td>
<td>1846</td>
<td>William Morton supervises an operation using ether.</td>
<td>The operation is a success and other surgeons in Europe carry out operations using ether.</td>
</tr>
<tr>
<td></td>
<td>1847</td>
<td>James Simpson discovers the effects of chloroform.</td>
<td>The use of chloroform leads to painless surgery, meaning surgeons can perform more complex and longer operations. There was strong opposition to the use of anaesthetics.</td>
</tr>
<tr>
<td></td>
<td>1853</td>
<td>Queen Victoria is given chloroform during the birth of her eighth child.</td>
<td>Opposition to the use of anaesthetics is overcome and chloroform becomes socially acceptable.</td>
</tr>
<tr>
<td>Antiseptics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood transfusion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modern surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary checklist

- The combination of anaesthetics and antiseptics meant that surgery became much safer after 1870.
- Aseptic surgery, when no germs are allowed to be present, soon replaced antiseptic surgery.
- The discovery of the different blood groups allowed safe transfusions, thus reducing the risks from blood loss in surgery.
- Surgeons began to specialise as surgery became safer. Plastic, brain and heart surgery were developed by pioneering individuals.
- Developments in science and technology contributed to new techniques in medicine.
- The wars fought in the 20th century speeded up developments in surgery.

Think about these key questions and how you would answer them in an exam.

1. How important have individuals been in the development of surgery since 1870?
2. How have science and technology helped surgery to develop since 1870?
3. What other factors have played a part in the development of surgery since 1870?
4. Which of the following was the biggest turning point in the development of modern surgery?
   a. Paré’s work on ligatures
   b. Lister’s carbolic spray
   c. Pasteur’s discovery of the germ theory of disease
   d. McIndoe’s work on plastic surgery.

In your answer, explain how each of these developments was a turning point, transforming what had come before and what was to happen after in the development of modern surgery.