The Transformation of Surgery c.1845 - c.1918

Revision notes on;
(a) The problems of Surgery pre 1845
(b) Dealing with pain
(c) Dealing with infection
(d) Dealing with blood loss
(e) Factors influencing these developments
Problems of Surgery pre 1845

- **PAIN** – No (reliable) anaesthetic, despite earlier discovery of nitrous oxide (laughing gas) in 1799. Patients held down during operations despite use of alcohol etc. Speed was of the essence which led to mistakes. Death from Shock was fairly common. Only basic surgery was possible – no internal surgery, only amputations.

- **INFECTION** – The greatest killer before the Germ Theory (1861) was understood. Death rate was approx 50%. Surgeons practised in blood-stained coats or in their own clothes and surgical instruments may not have been even washed. They didn’t even wash their hands and often re-used the same bandages. Operations were often observed by trainees (operating THEATRE) and the chances of spreading infection were greater. Many operations also took place in the patient’s home.

- **BLOOD LOSS** – A tourniquet was used to stem the flow of blood and ligatures had replaced the use of the cautery iron or boiling oil to seal wounds. Ligatures were silk threads which were used to tie up blood vessels, yet these were not sterilised at first which meant they could carry infection.
Early Attempts to Control Pain

- **Nitrous Oxide (Laughing gas)** was developed from 1799; **Ether** from 1846 and **Chloroform** from 1847.
- In 1799 a British man called Humphrey Davy used **laughing gas**. It was used for removing teeth by dentists.
  - + It eased the pain a lot and made you feel happy
  - - It did not knock you out properly and could not be used for serious operations.
- In 1846 **ether** was used for the first time by Morton in a hospital in America. Ether is a chemical liquid. When you breath it in it knocks you out completely.
  - + It does knock you out properly – and you feel nothing. It can be used for serious operations.
  - - It is flammable. It also damaged the lungs and could cause coughing & vomiting during the operation. The effects could also last for days.
- In 1847 a doctor called James Simpson used **chloroform** for the first time. He tried it out on himself and two other doctors and all went totally unconscious. He used it first to help women in labour – but soon it was used for operations.
  - + It was the most long lasting and reliable anaesthetic – it could knock people out for long operations. It gave surgeons the chance to do longer and more complicated operations.
  - - but this often just made the chances of infection afterwards even greater.
Dealing with Pain – The importance of Simpson’s work.

• What happened? – Simpson, a young surgeon from Edinburgh, experimented with chemicals after inviting other doctors to his house. After inhaling Chloroform, they fell unconscious. Chloroform seemed to put them to sleep without the negative side effects of ether. Simpson soon begun to use chloroform to ease the pain of childbirth and wrote articles about it so that other surgeons could copy his ideas.
Dealing with Pain – Why was there opposition to Simpson’s work?

1. Chloroform was a new and untested gas. Would there be any long-term side effects?
2. Hannah Greener died in 1848 after having been given chloroform in an operation to remove a toenail.
3. Some surgeons preferred their patients awake so that they could fight for their lives.
4. Many religious people felt that pain (particularly in childbirth) had been sent by God and should therefore not be tampered with.
5. It was difficult to get the dose of chloroform right. This was until John Snow developed an inhaler in 1848 to regulate the dosage.
6. Chloroform could affect the heart. A number of young, physically fit patients died after being given to large a dose. A large dose was needed to put them and ‘fearful’ people to sleep.
So, was Simpson that important? - No

- **Opposition** – see previous slide – meant that many surgeons didn’t use chloroform straight away.
- Simpson discovered chloroform by **chance** – it could have been anybody.
- It was **Snow** who made Chloroform safe.
- The use of chloroform led to the ‘**Black period of Surgery**’. The death rate actually went up. Without their patients writhing in agony, surgeons could now take their time over operations and could do ‘invasive’ (inside the body) surgery. The potential for infection without the later understanding if the Germ theory was massive!
- Other anaesthetics were deemed to be more effective later. **Cocaine** was used as a local anaesthetic from 1884 and **Novocaine** as a general anaesthetic from 1905.
So, was Simpson that important - Yes

- Simpson ‘dealt’ with a major problem of Surgery – pain.
- In the long term, after the introduction of antiseptic and aseptic surgery, many more complex and ‘invasive’ operations could be carried out. Many operations today clearly need an effective anaesthetic!
- Very few now died from shock
- Surgeons could take their time over operations. Fewer mistakes were made.
- Operations were easier for the surgeon to carry out as the patient wasn’t moving!
- Simpson’s contribution was recognised. He was the first man to be knighted for services to medicine and 30,000 attended his funeral.
Why was Simpson able to make an impact?

- **Technology** – Snow’s inhaler
- **Individual genius** – Simpson was **dedicated** and **convincing** that his discovery would work, despite the opposition.
- ‘**Govt.**’ – Acceptance of chloroform after **Queen Victoria** used chloroform during the birth of her 8\(^{th}\) child in 1853.
- **Science** – **Experimentation** with chemicals
- **Chance** – Unconscious by chance
- **Religion** – Hindering factor. See childbirth point earlier.
- **Attitudes** – Initially negative (see opposition). More positive later. See above.
- **Communications** – Simpson wrote **articles** about his discovery.
Dealing with infection – The importance of Lister’s work

• Who was he? -

  • Lister, the son of a famous Scientist who invented powerful microscopes, studied medicine and rose quickly – he became Professor of Surgery at Glasgow University.
  
  • He was introduced to the ideas of Louis Pasteur by a colleague at the University.
  
  • He became very concerned about the high death rate during surgery, particularly during ‘The Black Period of Surgery’.
Dealing with infection – the importance of Lister’s work

• What did he do? (Antiseptic Surgery – killing off the germs which were already there)

• Lister studied Pasteur’s idea that there were germs or bacteria floating in the air. When these germs settled on something they caused it to rot or go off. Lister thought that THESE SAME GERMS WERE SETTLING ON WOUNDS AFTER AN OPERATION AND INFECTING THE PATIENT. SO – somehow you had to prevent the germs getting into the wound – or kill the germs off.

• Lister had seen CARBOLIC SPRAY used to treat sewage – it killed all the germs.

• So, during the operation on an eleven year old boy, he sprayed the wound with carbolic acid – it was done using a spray bottle next to the operating table. This was the first ever ANTISEPTIC. Then, after the operation, he covered the wound up with carbolic-soaked bandages to stop any more germs getting in.
Dealing with infection – the importance of Lister’s work

• What did he do? (Aseptic Surgery – prevention of germs)
• Lister can also be credited with a number of developments in aseptic surgery.
• From the late 1880s, operating theatres and hospitals were rigorously cleaned.
• From 1887, all instruments were steam-sterilised.
• In 1894, sterilised rubber gloves were used.
• Lister also developed sterilised cat-gut ligatures.
• Masks and closed operating theatres all followed later.
Dealing with infection – Why was there opposition to Lister’s work?

- Surgeons did not like the fact that the carbolic acid was smelly and caused their skin to crack. This made their job more unpleasant.
- Carbolic spray slowed down operations and created more work. Many surgeons still thought that speed was all important to stop bleeding, if the patient was to survive.
- Some surgeons who copied Lister by using the carbolic spray did not get the same results – so they stopped using it. In fact, they were less systematic.
- Many surgeons still refused to believe that infection was caused by microbes in the air – this still sounded ridiculous to them.
- Many simply refused to believe Lister’s figures about how few of his patients died – they thought he was exaggerating.
- Lister himself was cold and arrogant and this put some people off his ideas.
- Lister was always looking for a chemical better than carbolic to save even more lives. He thus changed his methods – this made some think that carbolic spray did not work at all.
- Above all – many surgeons were stuck in their ways and resisted change of any kind – they preferred to stick to what they knew.
- The equipment was expensive and heavy.
- The nurses resented the extra workload.
So, was Lister that important? - No

- A lot of credit has to go to Ignaz Semmelweiss, who worked before Lister. He was a Hungarian doctor working in Austria with women giving birth. He noticed that when midwives helped the women give birth, few of the women were infected – but when medical students did it they did. He thought this was because midwives washed their hands – but medical students did not and had been doing autopsies. So he made all of them wash their hands – and cut down the rate of infection. His ideas were not taken seriously, however, as people didn’t understand about germs.
- The only reason why Lister’s ideas were accepted is because Pasteur had come up with the ‘Germ theory’ in 1861.
- Lister merely applied Pasteur’s ideas to surgery.
- There was a lot of opposition to Lister (see earlier slide).
- It was Koch who gave a boost to Lister’s ideas. He was the one who found the bacterium to blood poisoning (septicaemia).
- It was also Koch who introduced the steam sterilizer for equipment in 1878.
So, was Lister that important? - Yes

- Before using antiseptic – 67% of patients who had amputations died of infection after. After using antiseptics only 15% died.
- **Even longer operations were now possible** because there was less danger of infection – in the 1880s the first appendix operations were carried out and in 1896 the first heart operation took place.
- Lister was given an [award at the Sorbonne University in Paris](https://www.sorbonne.univ-paris1.fr/en) for his contribution to the fight against disease.
- Lister was made [Professor of Surgery at King’s College Hospital](https://www.kingcollegelondon.ac.uk) in London in 1877.
- Lister became a [Baron](https://www.parliament.uk/careers/parliamentary-career/1503) in 1897.
- He had his funeral in [Westminster Abbey](https://www.westminsterabbey.org).
- [Hospitals](https://www.hospitals.org.uk) have been named after him since.
- See the points on the earlier slides about what Lister did for antiseptic and aseptic surgery.
Why was Lister able to make an impact.

• **Technology** – Carbolic spray, Steam sterilizer.

• **Individual genius** – Lister’s determination that he was right despite all the doubters.

• **Scientific Thinking** – The link with the Germ theory. Chemistry – the use of carbolic acid.

• **Attitudes** – Hindering factor. Very negative at first.
Problem of blood loss

- One of the biggest problems of surgery was the loss of blood – which could kill the patient. Bleeding makes it difficult for the surgeon to see what he is doing and if a patient loses too much blood, his blood pressure drops and his body cannot function so he will die.

- In the 1800s there were experiments with blood transfusions using blood from animals as well as from humans. Although patients occasionally survived, in most cases they died and the procedure was banned.

- The usual way to deal with wounds was to seal the blood vessels by placing a hot iron onto the wound or by pouring hot oil over it. This process was called cautery and was extremely painful. A 16th century surgeon, Ambroise Paré developed metal clips to place on arteries during operations. He also used silk thread to tie the blood vessels instead of using heat to seal them. This was far less painful but the ligatures did not always stop the bleeding if they were not tied properly and introduced infection deeper into the wound (this was before Pasteur’s germ theory). Therefore cautery continued to be the main way of dealing with bleeding until Paré’s ideas were further developed in the 19th Century by Joseph Lister.

- In 1902 Karl Landsteiner identified different blood groups A, B, O and AB. Landsteiner showed that blood transfusions had to be between people of the same blood group or else the patient died. But the donor needed to be present to be able to provide the blood whenever it was needed and this was not practical and therefore the development did not have an immediate effect surgery because there was no way to STORE the blood.
Problem of blood loss

WHY DID THIS CHANGE?

- Again – it was the FIRST WORLD WAR which led to the change – so many wounded soldiers needed blood that you could not get donors to them in the trenches!
- In 1915 Richard Lewisohn found that adding sodium citrate stopped blood from clotting. This meant that the donor did not have to be present and more transfusions could be carried out.
- Richard Weil found that this blood could be stored in refrigerated conditions.
- In 1916 Francis Rous and James Turner found that adding a citrate glucose solution allowed blood to be stored for longer periods and when an attack was planned the army could ask for donations of blood from the public to help meet the need.
- The first blood depot was established in 1917 for the Battle of Cambrai.
The role of war in the development of surgery

Faced with massive casualties and difficult conditions surgeons were forced to take risks and improvise new techniques and therefore war accelerated improvements in surgery.

• The First World War 1914 – 18 - there was a huge need to treat wounded soldiers in the Western Front in France – so hospitals were built and equipped with X ray machines to allow surgeons to spot bullets and shrapnel inside the body – and remove them.

• Better way to mend broken bones.

• Repairing skin by skin grafting – this led to the development of ‘plastic surgery’. e.g. the New Zealand doctor, Harold Gillies, repaired the skin of over 2000 men injured in the Battle of the Somme 1916. He developed the new technique of pedicle tubes where a narrow layer of skin was lifted up from the body and stitched into a tube at one end. The other end was still attached to the body and continued to grow. When the tube had grown long enough it could be stitched in place to the new site. He helped to improve plastic surgery so that a more normal appearance could be maintained. He also kept careful records of his work.
The role of war in the development of surgery

Other developments in surgery as a result of the First World War include:

• Improved surgery of the eye, ear and throat
• The first brain surgery. Surgeons found themselves having to make early attempts at brain surgery because of the nature of some of the wounds that were received.
• Between 1914 and 1921 over 41,000 men in the British armed forces lost a limb. Advances in prosthetic limbs included use of light metal alloys and new mechanisms but there were long waiting lists for these.
• The use of explosive weapons meant that many soldiers suffered deep wounds and, when fragments of clothing entered the wound, it caused infection. Surgeons found that cutting away infected tissue and soaking the wound with a saline solution was the best way of dealing with this (although they could still not deal with serious infection until antibiotics were developed later).
The role of science in the development of surgery

- Chemistry played an important part in developing anaesthetics (ether, laughing gas, chloroform and novocaine) and antiseptics (carbolic acid). Chemistry also helped in the development of a suitable technique to store blood until it was needed for transfusions.
- Infection was controlled by using Lister’s carbolic spray, sterilising the instruments, wearing rubber gloves and by using sterilised catgut for ligatures. This was all based on Pasteur’s germ theory and through an understanding of chemistry and biology.
- The discovery of X-rays by Wilhelm Roentgen in 1895 made surgeons more confident about internal operations. Roentgen did not take out a patent on his discovery and so everyone could use x-ray machines free of charge. As a result the use of x-rays spread very quickly – the London Royal Hospital had its first x-ray machine in 1896. X-rays allowed surgeons to locate bullets and shrapnel from inside the body without the need to dig around inside a wound. This reduced the problem of bleeding and infection.
The role of technology in the development of surgery

• Developments in science are closely related to those in technology in the improvements of surgery.
• In 1848 Dr John Snow invented the chloroform inhaler which helped to deliver an accurate and controlled dose to the patient.
• The invention of the hypodermic needle by Alexander Wood in 1853 made it possible to measure an injection of a drug or a withdrawal of blood.
• In 1878 Koch developed the steam steriliser to ensure that instruments were free from germs.
• In 1865 Joseph Lister invented the carbolic spray which was being used in operations in the 1880s.
• In the first World War blood could be refrigerated and the first blood depot was set up.
• Mobile x-ray machines were also developed for use in WW1.
The role of communication in the development of surgery

- The emphasis on scientific methods and approached led many scientists to publish their ideas.
- During the 19th century there were many scientific and medical journals (such as ‘The Lancet’) which encouraged the discussion of new ideas and problems. For example the death of Hannah Greener was reported in ‘The Lancet’.
- Pasteur published his germ theory in 1861 and Lister read this work and applied it to his attempts to reduce infection. In this way, Lister built on Pasteur’s ideas.
- The reason why surgeons were able to make use of Roentgen’s discovery about x-rays and that his ideas spread so quickly was because he did not take out a patent to prevent other people from copying his ideas.
- Surgeons often wanted their work to be recorded so we have photographs and art work of key events such as field surgery in the First World War.
- The public were interested in developments in surgery so the papers reported the first use of anaesthetics, Queen Victoria’s use of chloroform and the removal of King Edward VII’s appendix.
- Sometimes surgeons and scientists would travel to meet each other. Lister travelled through Germany and around America discussing his ideas and he met Pasteur in 1892 at a conference of 2,500 scientists in which Lister paid tribute to the importance of Pasteur’s work.