The Transformation of Surgery
1845-1918
Revision Guide

Produced by
Homewood History Department
<table>
<thead>
<tr>
<th>Topic</th>
<th>After completion of the course</th>
<th>After first time of revising topic</th>
<th>After second time of revising topic</th>
</tr>
</thead>
</table>
| Surgery before 1845 | - What were the Key problems? Explain.  
- What techniques were used?  
- How might people feel about having surgery in this period?  
- Describe the role of Barber surgeons.  
- What anaesthetics were available to use at the beginning of the 19th C? | | |
| Dealing with Pain | - Why was pain a problem in the 19th Century?  
- Why was speed needed? How did this cause further problems?  
- Explain the discovery of anaesthetics between 1799-1850.  
- Explain the importance of the discovery of ether and chloroform.  
- What factors influenced Simpson – chance; genius and science.  
- Why did some people oppose the use of anaesthetics?  
- What was the argument for anaesthetics – Queen Victoria...? | | |
| Dealing with Infection | - Why was infection a problem?  
- How was Semmelweiss’ work a turning point in dealing with infection?  
- Describe Joseph Lister’s measures to reduce infection.  
- Who opposed Lister’s work and why? | | |
| Dealing with Blood Loss | - Explain how the problem of blood loss was overcome.  
- Identify the key stages in dealing with the problem of blood loss - Landsteiner?  
- Explain how key factors played a part in solving the problem of blood loss. | | |
| Factors influencing developments in surgery | - War  
- Technology  
- Science  
- Chance  
- Communication  
- Religion  
- Government | | |
| Key individuals | - Ambroise Pare  
- James Simpson / John Snow  
- Ignaz Semmelweiss  
- Joseph Lister  
- Karl Landsteiner | | |
UNIT 3A : The transformation of Surgery 1845-1918 – How to answer exam questions.

Your third exam is the Transformation of Surgery 1845-1918 paper. The results of this paper make up 25% of your final grade.

The exam lasts for 1hr 15mins. You need to answer 5 questions from this paper and there are a total of 50 marks for the answers and 3 further marks available on the last question for Spelling; punctuation and grammar. Very roughly, you should allow 1.5 minutes per mark.

Types of questions you will be asked:

Use the source Overlay to help with all of these questions – which can be found here: http://www.homewood-school.co.uk/sites/default/files/Source%20Border%20sheet_0.pdf

**Question 1 (6 marks)** This question is asking you to select evidence from the source to show evidence of a particular topic and explain what this shows about that topic.

- **Make 2 supported inferences**

  ‘They used huge marches’

  *I can infer that ... because ...*

  *This suggests that... because...*

**Question 2 (8 marks)** This question asks you explain what the purpose of the representation is by using the evidence from the representation and your own knowledge.

- **Identify 3 or 4 pieces of evidence to show the opinion expressed in the representation.**
- **Draw inferences to explain what it is saying.**
- **Use the evidence and your knowledge of who wrote it or the time it was written in to explain why the representation was produced.**

  *It shows that... / Source B states ‘.......’*

  *This is saying... / This suggests...*

  *This is important because at the time...*

  *Therefore it shows that the purpose is to...*
**Question 3 (10 marks)** This question will ask you to explain something so you must give reasons for it.

- Give a reason from your own knowledge.
- Give examples from the source to show each reason.
- Use your own knowledge to explain the reason linking it to the time period.
- Use own knowledge to provide additional reasons.

*Source C states that ‘……’*

This suggests that one reason for .... was....

This was successful / unsuccessful / partially successful because... which shows they did this because...

The views held by... were... / From my own knowledge I can say that...

**Question 4 (10 marks)** This questions asks you to assess ‘How reliable’ two pieces of evidence are. Use the source evaluation sheets to help you with this question they can be found here: [http://www.homewood-school.co.uk/sites/default/files/Analysing%20and%20Evaluating%20sources.pdf](http://www.homewood-school.co.uk/sites/default/files/Analysing%20and%20Evaluating%20sources.pdf)

- Use the sources evidence to show what they say about the topic of the Q.
- How does (NOP + date) affect the accuracy, completeness and comprehensiveness of the point of view given?
- Based on NOP + date analysis reach a judgement about how reliable the different views are.

‘Source D states that...’ and Source E contrasts / supports this and says ‘......’

This is accurate because from my own knowledge I know that...

It is from..... which is reliable in showing...

However, it’s not comprehensive as it does not show.... which was also important and the time.

Also, it was produced for.... shown by ‘......’ so this makes it completely / partially / not very reliable because...

Overall....

**Question 5 (16 marks + 3 SPaG)** This question asks you to assess the extent to which a statement cab be agreed with by cross referencing the different points of view given by three sources and using your own knowledge. For top marks you also need to take into account the strength of the evidence (e.g. reliability of its opinion) to support your conclusion.

- Identify similarities and differences in the sources interpretations of Q topic e.g. ‘main reasons for opposition to Lister’s methods’.
- Use Source evidence + own knowledge to explain similarities + differences between the ‘focus source’ and the others and other factors.
- Use NOP + date to how much the evidence can be relied on. Conclusion linked to Q using all sources.

*Source E gives an example of... it says / shows ‘........’*
Source G seems to agree that... because it states ‘........’

This can be supported because from my own knowledge I know..... suggesting that...

Source E also suggests that.... when it says ‘........’

However, Source G disagrees with this completely / partially because it says ‘........’

Frome my own knowledge I know that... which suggests that Source E is only accurate when looking at... but this was only a small part because...

In conclusion we can agree that.... and.... However, this is not completely accurate / does not give the whole picture because...
Also, the point of view that Source E puts forward is not to be completely agreed with as.... affect the reliability of its view because....
Surgery before 1845

What were the Key problems?

- Infection
- Bleeding

Listen to the podcast on the site below to revise how surgery developed over time:

http://www.bbc.co.uk/schools/gcsebitesize/audio/history/

Medieval Surgery

Surgery made some surprising leaps forward in Medieval times. This was thanks partly to ingenious barber-surgeons on the battlefield, and partly to the discovery of some natural and herbal anaesthetics and antiseptics.

Progress of Medieval surgery

During the Middle Ages, doctors often left surgery was left to low-paid assistants or even to untrained barber-surgeons.

It was a time of frequent warfare, and the constant fighting meant that surgeons' skills were much in demand. Perhaps as a result, surgery actually progressed in Medieval times. Certainly Theodoric of Lucca, in the 13th century, wrote how:

“Every day we see new instruments and new methods [to extract arrows] being invented by clever and ingenious surgeons.”

Theodoric of Lucca

Hugh and Theodoric of Lucca discovered the antiseptic properties of wine for cleaning wounds in the early 13th Century, but their ideas did not catch on.
In 1363, the French surgeon Guy de Chauliac wrote his *Chirurgia Magna*. This became the most important medieval book on surgery.

In 1376, John of Arderne used an early form of anaesthetic (a mixture of hemlock, opium and henbane), but if the doses were not carefully controlled the patients often died.

This is completely different from the **normal picture of stagnation** given to us about Medieval medicine.

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**Renaissance surgery**

Early Modern surgery was a gruesome procedure, but physicians and surgeons such as Paracelsus and Paré started to make further progress, and passed their knowledge on.

**Ambroise Paré (1510-1590)** changed people's ideas about surgery in the long-term although his work had little impact at the time. He developed his ideas during his 20 years as a barber-surgeon, when he accompanied the French army on its campaigns.

Despite the unpleasant procedures that were part of medicine in his day, it is clear from his writings that Paré cared deeply about his patients.

- In **1534**, Pare worked for a public hospital. Then, in 1537 he became an army surgeon – a position through which he gained much experience.
- In **1536** he discovered by chance (when the *cauter* oil he used to *cauterise* the wounds of his patients ran out) that wounds healed better if they were treated with a 'soothing digestive' (boiled *poullice*) of yolk and rose oil.
- He used catgut / silk ligatures to tie arteries during amputations instead of cauterising the wound. However, this influenced few doctors – most stuck to traditional methods. As there were no antiseptics, Pares use of silk threads or *ligatures* actually increased the chance of wounds going septic while the lack of reliable anaesthetics meant surgery still had to be quick and simple.
- In **1575** he published his *'Apology and Treatise'* , which advocated changes to the way surgeons treated wounds and amputations.
- Pare’s books (e.g. Method of Treating Wounds, 1545, and Works on Surgery, 1575) had little influence.
- **Paracelsus**, a famous German *alchemist* and surgeon of the period, discovered that *laudanum* (a derivative of opium) was a *painkiller* that could be used to help his patients. For many years it was used for general pain such as headaches and period pain (and many people became addicted to it).

**What techniques were used?**

Medieval surgeons realised how to use wine as an *antiseptic*, and they used natural substances (mandrake root, opium, gall of boar and hemlock) as *anaesthetics*.

Medieval surgeons could therefore do *external surgery* on problem areas such as facial ulcers and even eye cataracts. There was also, surprisingly, some *internal surgery* undertaken (eg to remove bladder stones).
However, they still had no idea that dirt carried disease, and most operations of Medieval times, if carried out today, would end in a suit for criminal negligence. Deep wounds still caused death from bleeding, shock and infection. Some surgeons even believed it was good to cause pus in wounds.

A medieval surgeon might cure an epileptic patient by trephining the skull to let the demon out.

13th-century artwork of a patient undergoing trephination (surgery to the skull), possibly being performed by a surgeon's apprentice

How might people feel about having surgery in this period?

One famous surgeon, James Simpson said:

“the man laid out on the operating tables of our hospitals has more chances of death than the English soldier on the fields of Waterloo.”

- Surgery in the early 1800s was dangerous and painful and many people were suspicious of new techniques either because they were untested or they objected on religious grounds.
- Surgeons had to work quickly. At the Battle of Borodino in 1812 Napoleon’s surgeon, Dubois amputated 200 limbs in 24 hours.
- It was not possible to replace blood by transfusion, although blood vessels could be tied with ligatures.
- Sometimes operations went dreadfully wrong.
- Robert Liston was a famous London Surgeon who once amputated a leg in two-and-a-half minutes but worked so fast that he accidently cut off his patients testicles as well!
- During another high speed amputation Liston amputated the fingers of his assistant and slashed the coat of a spectator, who fearing he had been stabbed, dropped dead with fright. WORSE! – Both the patient and the assistant died from infection either caught during the operation or on the hospital wards.
- Infection was the greatest danger to patients after an operation. Germs might enter the wound and cause blood poisoning. Almost half of all patients who had leg amputations died from blood poisoning.

Barber surgeons

These were surgeons who would cut hair and remove abscesses and bleed patients. Barber surgeons were trained on the job and were popular among the poor.
What anaesthetics were available to use at the beginning of the 19th C?

- There was no way of completely relieving the pain suffered by the patient.
- Natural drugs like alcohol, opium, mandrake or techniques like hypnotism had long been used to reduce pain – but effective anaesthetics that didn’t make the patient very ill were more difficult to produce and hypnotism took a long time.
- *Nitrous oxide* [laughing gas] was identified as a possible *anaesthetic* by Humphry Davy in 1799 – but he was ignored by surgeons of the time.
- The gas had been relegated to use as a fairground novelty before Horace Wells suggested its use in dentistry. He did a public demonstration in 1845 but was unlucky enough to pick a patient unaffected by *nitrous oxide* – it was again ignored.
- In 1842, Crawford Long discovered *anaesthetic* qualities of *ether* – but he didn’t publish his work.

**Revision Task**

Recap on the problems with surgery in the 19th Century by watching the video link below:

http://www.youtube.com/watch?v=4ghMB4yH6nw&feature=related
Dealing with Pain

Why was pain a problem in the 19th Century?
Anaesthetics made life easier for all concerned. Before anaesthetics people were often fully conscious during an operation and could feel everything! Natural drugs like alcohol, opium and mandrake had long been used to reduce pain – but effective anaesthetics that didn’t make the patient very ill were more difficult to produce.

Why was speed needed? How did this cause further problems?
Operations were so painful they needed to be carried out as quickly as possible. Patients thrashed about making the operations difficult and assistants were needed to hold them down. Complex operations that took a long time or went deep into the body were impossible and surgery tended to be seen as a last resort.

Explain the discovery of anaesthetics between 1799-1850.
Nitrous oxide (laughing gas) was identified as a possible anaesthetic by Humphry Davy in 1799 – but he was ignored by surgeon at the time.

The gas had been relegated to use as a fairground novelty before Horace Wells suggested its use in dentistry. He did a public demonstration in 1845, but had the bad luck to pick a patient unaffected by nitrous oxide – it was again ignored.

The first public demonstration of ether as an anaesthetic was carried out in 1846 by William Morton.

Ether is an irritant and is also fairly explosive, so using it in this way was risky due to candle light and gas lamps. In 1847 James Simpson experimented on himself to find an alternative. He discovered the effects of chloroform.

Chloroform was widely used in operating theatres and to reduce pain during childbirth – but it sometimes affected the heart, causing patients to die suddenly.

General anaesthesia (complete unconsciousness) is risky, so local anaesthetics (numbing of the part being treated) is better for many operations. In 1884, William Halsted investigated the use of cocaine as a local anaesthetic. Unfortunately, his self-experimentation led to a severe cocaine addiction.

John Snow developed an inhaler that regulated the dosage and reduced the number of deaths.

Explain the importance of the discovery of ether and chloroform.
Ether and chloroform were important because they enabled operations to be undertaken without the patients feeling pain. They also meant surgeons could take more time because the patient was not thrashing about and screaming.

However, Surgeons were keen to perform more and more complicated operations which lead to increased death rates amongst patients because the dangers of bleeding and infection had not been overcome.
The period between 1846-1870 is sometimes called the “Black Period” of surgery.

What factors influenced Simpson – chance; genius and science.

Simpson invited some other doctors to his house, where they experimented by inhaling various chemicals. When his wife found them unconscious they knew they had discovered and anaesthetic and that is did not appear to have any side effects. This was a chance discovery. Simpson’s individual genius helped as he was prepared to experiment and try new things.

Why did some people oppose the use of anaesthetics?

Some people were suspicious of doctors using anaesthetics as they objected to anything new, or objected on religious grounds. Others were afraid of the side effects and the dangers of overdose.

What was the argument for anaesthetics

Anaesthetics enabled operations to take place without patients feeling pain. Queen Victoria used chloroform during the birth of her eighth child in 1853 which made its use more widespread.

Revision Task

Recap on the significance of Simpsons work by watching the video on the link below

http://www.youtube.com/watch?v=iWDqicC66nM

Draw a six-frame storyboard of the major events leading up to the discovery of Chloroform. The first frame should show the problems surgeons faced due to the lack of anaesthetics. Remember to include laughing gas and ether in the story.
Dealing with Infection

Why was infection a problem?
The problem of infection was that surgeons did not yet understand about infection and germs; therefore many people survived the operation but died a few days later from gangrene or sepsis – infection and decay that produced a strong smell of rotting flesh.

Antiseptic methods are used to kill germs that get near surgical wounds.

Aseptic surgical methods aim to stop any germs getting near the wound.

How was Semmelweis’ work a turning point in dealing with infection?

Ignaz Semmelweis (1818-1865) had used chloride of lime solution as a hand wash for doctors to control the spread of puerperal fever, an infection suffered by many women following childbirth. However, it was very unpleasant, so wasn’t widely used.

Describe Joseph Lister’s measures to reduce infection.

Joseph Lister had seen carbolic acid sprays used in sewage works to keep down the smell. He tried this in the operating theatre in the early 1860s and saw reduced infection rates. Having heard about the germ theory in 1865, he realised that germs could be in the air and on surgical instruments and people’s hands. He started using carbolic acid on instruments and bandages. This produced further improvements.

Who opposed Lister’s work and why?

Many doctors and nurses did not like or use carbolic acid because it is unpleasant to get on your skin (dries out skin) or breathe in. The equipment was expensive and heavy. Some surgeons had good results without carbolic acid. Some doctors did not accept germ theory. Carbolic solutions slowed down the operation, which could lead to problems of blood loss. Doctors who copied Lister’s ideas did not always do so properly and then, if they did not get an improved survival rate after operations they said Lister’s ideas were wrong. Lister kept changing his methods in an attempt to further improve his work – many doctors though this meant he was not sure of his ideas.

Asepsis reduced the need for nasty chemicals. By going from killing germs to making a germ-free (aseptic) environment, surgeons have been able to avoid using large amounts of antiseptic in the theatre. Instruments are carefully sterilised before use. Theatre staff sterilise their hands and wear sterile gowns, masks, gloves and hats. Surgical gloves were invented by William Halsted in 1889.

Revision Task

Recap on the role played in the development of surgery by the discovery and use of antiseptics by watching the video links below:

http://www.youtube.com/watch?v=U6-FjtpdePA
http://www.youtube.com/watch?v=T73PYNyyeI
Dealing with Blood Loss

How was the problem of blood loss was overcome?
- Blood loss has always been a major problem in surgery.
- Bleeding makes it difficult for a surgeon to see what he is doing, but there is also the problem that if a patient loses too much blood then the blood pressure drops, which affects his heart and then the body cannot function and dies.
- During the 17th Century there were experiments with transfusions using blood from animals (usually sheep) as well as from humans.
- Jean-Baptiste Denys carried out a cross-species transfusion to a human (1667). The problem was that sometimes it worked and sometimes the blood of the recipient clogged – they died and no-one knew why.
- Once anaesthetics and antiseptics made it possible to perform more complex operation, there was a renewed drive to find a way of dealing with the two problems of blood loss – CONTROLLING BLOOD LOSS and REPLACING BLOOD – Transfusions.

Identify the key stages in dealing with the problem of blood loss - Landsteiner?
- Blood circulates rapidly, so it doesn’t take long to bleed to death if a major blood vessel is cut. Surgery often cause heavy bleeding.

Controlling Blood Loss
- The usual way of dealing with wounds or amputation was to seal the blood vessels by placing a hot iron onto the wound or pouring hot oil over it. This process was called cautery and was extremely painful.
- In the 16th Century Pare developed metal clips (Tourniquets) to place on arteries during an operation in order to reduce the blood flow.
- Pare also tried using silk thread to tie the blood vessels after an amputation 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. Furthermore this was before Pasteur developed the germ theory and therefore there was no understanding of the way that a surgeon’s dirty hands inside a wound could cause infection – as a result this often led to a higher death rate.
- So... Cautery continued to be the main way of dealing with bleeding because – ligatures seemed to cause a higher death rate and why replace something that has worked for hundreds of years, especially when survival rate using cautery seemed to be higher.
- However, Joseph Lister further developed Pares silk ligature idea in the late 19th Century.

Replacing Blood - transfusions
- Then in 1900, Karl Landsteiner discovered blood groups: -A, B and O; a fourth group AB was added in 1902. He saw the importance of compatibility. He found that certain groups of blood couldn’t be mixed together as they would clog the blood vessels.
• However, even with Landsteiner’s breakthrough, there was still the problem that a donor needed to be present to provide the blood whenever it was needed. This was not very practical and therefore his work did not have a big immediate effect on surgery.
• During the First World War (1914-1918) many soldiers died in the trenches from blood loss even when the wound itself was not fatal. As a result, there was a new emphasis on the search for a way to store blood for use at a later date.
• In 1915 the American doctor Richard Lewisohn found that adding Sodium Citrate was found to stop clotting when blood came into contact with the air. This allowed the blood to be stored more easily and meant that the donor did not have to be present and therefore more transfusions could be carried out.
• Although it was found that the blood cells would deteriorate if the blood was not used soon afterwards but this discovery still saved the lives of thousands of wounded soldiers.
• Richard Weil found that this blood could be stored in refrigerated conditions. Doctors discovered that the liquid part of blood (plasma) could be separated from the tiny particles in the blood (corpuscles). The cells could be bottled, packed in ice and stored where they were needed. The cells only had to be diluted with warm saline solution and usable blood was ready.
• In 1916 Francis Rous and James Turner found that adding a citrate glucose solution allowed blood to be stored for longer. This meant that when an attack was planned, the army could ask for donations of blood from the public, so that they were available for transfusion to treat the wounded.
• The first blood depot was established in 1917 for the Battle of Cambrai using blood group O, which can be safely given to all patients, whatever their blood type.
• In 1946 the British National Blood Transfusion Service was established.

War
• In peacetime surgeons sometimes work alone and in competition with each other. In war time they unite and share ideas to help their own soldiers.
• In wartime industry devotes resources to developing new surgical equipment.
• Surgeons do more operations and are prepared to work harder in wartime than in peacetime.

Scientific Knowledge
• Landsteiner makes the first step by eliminating the element of chance of death by realising there were different blood groups and that to avoid clotting blood that was transfused needed to be compatible.
• As scientific knowledge progressed it became possible to do more transfusions as it was gradually possible to store blood for longer and longer when plasma could be separated from corpuscles meaning the donor did not have to be present and more patients could be treated. A further discovery that Blood type O could be given to any patient made it possible to save even more lives.
Explain how key factors played a part in solving the problem of blood loss.

- Overcoming the problem of blood loss was an important stage in the development of surgery. It depended on increased scientific knowledge but its development was also accelerated by the casualties of war.

**Revision Task**

Recap on Pare’s solution to blood loss by watching the video on the link below: [http://www.youtube.com/watch?v=e049-TgXaQ0](http://www.youtube.com/watch?v=e049-TgXaQ0)

Factors influencing developments in surgery

- War
- Technology
- Science
- Chance
- Communication
- Religion
- Government

### Pre-History

<table>
<thead>
<tr>
<th>War</th>
<th>Trephining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Setting broken bones.</td>
</tr>
<tr>
<td>Science</td>
<td>They understood that removing some bone from the skull could release pressure and often did this because for severe headaches or an injury to the skull.</td>
</tr>
<tr>
<td>Chance</td>
<td>Surprisingly sometimes the patient would survive trephining – there is archaeological evidence to show skulls that have healed after this operation.</td>
</tr>
<tr>
<td>Communication</td>
<td>It’s difficult to understand exactly why some of the early surgical methods were carried out because there is not written evidence to prove any theories.</td>
</tr>
<tr>
<td>Religion</td>
<td>Trephining – it was believed that making a hole in the skull would release evil spirits making you better.</td>
</tr>
<tr>
<td>Government</td>
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</tbody>
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### Ancient Egypt

<table>
<thead>
<tr>
<th>War</th>
<th></th>
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<tbody>
<tr>
<td>Technology</td>
<td>Specialist craftsman made fine bronze instruments for doctors.</td>
</tr>
<tr>
<td>Science</td>
<td></td>
</tr>
<tr>
<td>Chance</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Papyrus (a kind of paper) and a simpler and quicker form of writing (hieroglyphs) – ideas could be written down and passed on.</td>
</tr>
<tr>
<td>Religion</td>
<td>Belief in the afterlife led to embalming meaning that internal organs were explored.</td>
</tr>
<tr>
<td>Government</td>
<td>Pharaohs doctors spent much of their time trying understand how to improve medical ideas.</td>
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</table>

### Ancient Greece

<table>
<thead>
<tr>
<th>War</th>
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<tbody>
<tr>
<td>Technology</td>
<td>A Greek doctor named Erasistratus discovered the heart was like a new technology ‘The Pump’ This idea though, was not developed for another 1800 years.</td>
</tr>
</tbody>
</table>
**Science**

- In 250BC Herophilus’ dissections allowed him to find out that the brain controls the body, there was a difference between arteries and nerves and he identified parts of the stomach such as the duodenum and the prostate.

**Chance**

**Communication**

- Medical writings from Greece, India, China, Egypt and Mesopotamia were collected together in the University Library of Alexandria. Eventually there were 700,000 different items in the library.

**Religion**

- Most Greek doctors believed it was wrong to dissect the dead.

**Government**

- Built a library with medical writings collected together.

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**The Roman Empire**

**War**

- Many surgeons gained their skills of amputation in the army.
- Galen gained experience as a surgeon in Gladiator school. They fought each other and wild animals so lots of different types of injuries were sustained.

**Technology**

- They used iron bladed scalpels, artery forceps and saws.

**Science**

- Opium was widely used as a sedative in surgery.
- Galen’s public experiment on a pig proved that it was the brain that controlled the body and not the heart.

**Chance**

**Communication**

- There were many books written such as ‘De Medicina’ concerning the training of surgeons. Galen’s book ‘On Anatomy’.

**Religion**

- People didn’t question Galen for a long time as he was supported by the Christian Church because many of his ideas fitted in with their religious teachings.

**Government**

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**The Middle Ages**

**War**

- People like John of Arderne (one of the most famous Medieval surgeons) served as an army surgeon in the wars between England and France in the early 1300s – his methods were based on careful anatomical study and practice. He used methods that are still used today.
- Theodoric of Lucca went on the crusades and found new surgical instruments and ideas about healing wounds.

**Technology**

**Science**

**Chance**

**Communication**

- People became surgeons by being apprenticed to another surgeon. Even women could become surgeons and a number did.
- Ideas about surgery were communicated in numerous medical books. Theodoric of Lucca also chronicled his experiences of surgery in other cultures.

**Religion**

- People still following Galen’s ideas because they fit in with the Christian religion.

**Government**
### The Medical Renaissance

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
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</table>
| War        | • Pare spent 20 years as a surgeon at war and saw many different types of wound and was able to experiment – begins to use ligatures instead of hot irons to cauterise but this does not catch on for another 100 years.  
  • Richard Wiseman treated soldiers in the Civil War and was able to experience treating lots of musket wounds. |
| Technology | • Vesalius wouldn’t have been able to produce his book 100 years before as printing hadn’t been invented. He used ‘the best printers’ in Switzerland.  
  • Printing also meant Pares works could be published. |
| Science    | • Through dissection of lots of human bodies, Vesalius found that Galen was wrong about some things for example that blood does not move through the septum of the heart.  
  • William Harvey proves the heart works as a pump in the 1600s. |
| Chance     | • Pare ran out of boiling oil to treat wounds with so he started to use a mixture of egg yolks, oil of roses and turpentine (been used since Roman times). He found it more effective than the boiling oil as wounds healed better. |
| Communication | • Vesalius studied at universities Paris and Italy and read many of Galen’s ideas. Vesalius wrote his own book called *The Fabric of the Human Body* this was well illustrated by artists.  
  • Pare wrote a book *Works on Surgery*  
  • Wiseman taught younger surgeons and wrote two lengthy books the most famous being *A Treatise on Wounds* |
| Religion   |         |
| Government | • Richard Wiseman was surgeon to Charles II who supports his technique. |

### 1750-1900

<table>
<thead>
<tr>
<th>Category</th>
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| War        | • Wars in this period led to practice on wounds that had been caused by new weapons.  
  • Experiments with blood transfusions began. |
| Technology | • New weapons had been developed as a result of the Industrial Revolution leading to new types of wounds in battle.  
  • Snow’s chloroform inhaler to administer correct doses of anaesthetic.  
  • Carbolic spray to clean the areas that are being operated in, wounds, equipment and bandages.  
  • Use of improved microscopes. |
| Science    | • Opposition to chloroform as it was a new and untested gas – they didn’t know how it would affect the bodies and minds of their patients.  
  • Hannah Greener died after being given chloroform – surgeons were unsure of quantities.  
  • Acceptance of Germ Theory in the 1861 – hands were washed and clothes and instruments were sterilised. It took a long time to catch on though.  
  • Lister discovers silk does not absorb carbolic acid and therefore cannot be sterilised.  
  • Lister uses catgut stitches to reduce the risk of infection as they dissolve after several days. |
| Chance     | • Davey Discovers Laughing Gas (Nitrous Oxide) relieves the feeling of pain in 1799.  
  • Liston then begun to use ether as an anaesthetic. |
- James Simpson invited colleagues to his home and they sat around his dining table experimenting with different chemicals. They inhaled chloroform and after passing out they realised its properties as an anaesthetic.
- Lister found that carbolic acid was used to treat sewage and that it killed parasites. He was able to test his ideas on a patient that happened to come in with a compound fracture (the bone punctures the skin allowing infection to get in.)

<table>
<thead>
<tr>
<th>Communication</th>
<th>Simpson wrote articles which led to other surgeons using chloroform.</th>
</tr>
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<tbody>
<tr>
<td>Religion</td>
<td>There were moral and religious argument against using anaesthetics. Some people believed it was unnatural to ease the pain of childbirth because it was what God had intended. Dying from surgery increased after the discovery of anaesthetics which strengthened arguments against its use. Surgeons were not aware of the quantity to give to begin with.</td>
</tr>
<tr>
<td>Government</td>
<td>Queen Victoria accepted the use of chloroform during the delivery of her eighth child in 1857. She publically praised ‘that blessed chloroform.’ This doomed any opposition to anaesthetics. In recognition of the importance of all his work Lister was given the title of baronet in 1883 – becoming Baron Lister.</td>
</tr>
</tbody>
</table>

**The 20th Century**

| War           | WWI in some ways hindered the development of surgical techniques. It stopped a great deal of medical research – in Britain 14,000 doctors were taken away from their normal work to cope with the casualties of war. It was also difficult to deal with infection on the battle field even though aseptic techniques had been developed by this point. The vast number of casualties allowed the surgeons to find out washing wounds with saline solution sterilised them. It helped more than it hindered. Facing dirty hospitals and vast numbers of wounded surgeons had to develop new techniques. WWI confirmed the importance of x-ray machines – they were installed in all the major hospitals along the Western Front and they immediately improved the success rate of surgeons trying to remove deeply lodge bullets and shrapnel which otherwise could have caused fatal infections. During WWI the vast amounts of blood needed and the fact that many soldiers bleed to death in the trenches before a donor could reach them forced scientists and doctors to consider how they could store blood effectively as on-the-spot donors were not practical. As a result of sheer numbers of casualties: New techniques were developed to repair bones. Improved methods of skin grafting were developed, which later formed the basis for plastic surgery. Improved surgical techniques on the eye, ear, nose and throat. Successfully attempted brain surgery. |
| Technology    | X-rays – discovered 20 years before the war in 1895 by Wilhelm Rontgen. Within 6 months hospitals installed x-ray machines. There were also portable X-ray machines. |
| Science       | In 1895 Wilhelm Rontgen, a German scientist, was experimenting with Cathode rays which cause splashes of light in a glass tube. He had covered
the tube with black paper but was amazed to find that the rays were still lighting up the other side of the room. They were passing through the paper. He investigated further and found they could also pass through wood, rubber and human flesh but not through bone or metal – X-rays were born.

- 1901 scientists discover different blood groups. They realised that transfusion only worked if the donors blood matched the recipients blood. This made transfusion practical.
- Science allowed doctors to look at blood more closely (on a molecular level) this led to the discovery of the liquid part of blood (plasma) and the particles in blood (corpuscles) doctors saw that the blood particles could be separated from the liquid and stored on ice until needed. They could then use saline solution to make the blood usable again.

| Chance | • When soldiers were wounded, fragments of clothing would enter the wound and bacteria from this would cause Gas Gangrene. By trial and error on the massive numbers of casualties, surgeons arrived at the answer to this problem. They cut away infected tissue and soaked the wound with saline solution. |
| Communication | • Wilhelm Rontgen published his findings on x-rays on 28th Dec 1895. It caused great public excitement and had an immediate impact on medicine. |
| Religion |   |
| Government | • During WWI the government devoted resources to developing new surgical equipment. |

**Revision Task**

Make notes to explain how each of the factors, War, Communication and Science and Technology affected:

- Pain
- Infection
- Bleeding
# Key Individuals

<table>
<thead>
<tr>
<th>Key Individual</th>
<th>Problem Addressed</th>
<th>How did they address it?</th>
<th>Influencing factors</th>
</tr>
</thead>
</table>
| Ambroise Pare        | Pain                               | • Spent 20 years as a surgeon on the battlefields and saw lots of different types of wound.                                                                                                                              | War
|                      | Infection                          | • Used treatment of boiling oil to seal wounds and stop infection wounds but when it ran out he used an ancient mixture of egg yolks, oil of roses and turpentine which allowed the patients wounds to heal better and soothed the wound rather than causing more pain and irritation. Some patients even died from the boiling oil treatment. | Chance
|                      | Blood Loss                          | • Instead of using hot irons to cauterise wounds after amputation he developed silk ligatures to tie off blood vessels these were called ligatures. They didn’t make much of an impact at the time as people were not really prepared to accept new ideas when old ones worked and this was before Germ theory so the ligatures themselves could carry infection into the wounds and because of this were seen to cause even higher death rates. It was later found, by Lister, that Silk did not absorb antiseptics like Carbolic acid and therefore could not be sterilised. | His own intelligence Printing|
|                      |                                    |                                                                                                                                                                                                                            |                                |
| James Simpson / John Snow | Pain                              | • Built on the work of Davy, Wells and Morton and by chance when experimenting with inhaling vapours from various chemicals he discovered the anaesthetic effects of chloroform.                                                                                           | Chance Individual genius Technology |
|                      |                                    | • Simpson used Cholorform in an operation in Edinburgh as early as 1847 but it became more widespread after he came to work in London and Queen Victoria used it during the birth of her eighth child in 1853.                                                                      |                                |
|                      |                                    | • It was difficult to get the dose of chloroform correct - too little and the patient could still feel pain, too much and it could be fatal (as shown by the case of Hannah Greener who died almost immediately after being given the anaesthetic. |                                |
- Chloroform affected the heart in a number of young, physically fit patients who died after inhaling it.
- In 1848, John Snow solved these issues by developing an inhaler that regulated the dosage and reduced the number of deaths.
- He was the first man to be knighted for his services to medicine. When he died over 30,000 mourners turned out and there is a plaque dedicated to him in Westminster Abbey in London it says ‘To whose genius and benevolence, the world owes blessings derived from the use of chloroform for the relief of suffering.’

### Ignaz Semmelweiss

**Infection**

- Hungarian doctor working in Austria.
- Focussed on deaths of what appeared to be healthy women after childbirth.
- Some doctors regarded this as inevitable but Semmelweiss observed that women whose babies were delivered by midwives were much less likely to die from infection (childbed fever) than women who were delivered by medical students. He thought this may be because medical students came straight to the delivery rooms from dissecting dead bodies. He thought if they simply washed their hands they would reduce the risk.
- It was tough to get doctors to adopt this practice and it was many years before they implemented these sensible measures – they didn’t see proof and they didn’t like washing their hands in chloride of lime because it made them sore.

### Joseph Lister

**Infection**

- Researched gangrene and infection and had a keen interest in the application of science to medicine. His father had been a pioneer and improved the microscope. Lister had read the work of Pasteur on Germ theory published in 1861.
- He saw Carbolic spray used to treat sewage and found that a thin mist of carbolic acid sprayed over the wound during surgery limited infection by following this with treated bandages the wound would heal and not develop gangrene.
- He did receive a lot of opposition but he moved to London to train young surgeons under his own supervision and in 1878 Koch found the bacterium that caused
septicaemia – this gave a great boast to Lister’s ideas.

- By the 1890s antiseptic methods became aseptic surgery which meant removing all possible germs from the operating theatre: Operating theatres and hospitals were rigorously cleaned; from 1887 all instruments were steam sterilised; in 1894 sterilised rubber gloves were used as however well surgeons hands were scrubbed they could still hold bacteria in the folds of skin or up nails.
- Surgeons could now attempt more ambitious operations. In the 1880s the first successful operation to remove an infected appendix came. The first heart operation was carried out in 1896 when surgeons repaired a heart that had been damaged by a stabbing.
- In 1892 Lister and Pasteur were given an award for their fight against disease.

<table>
<thead>
<tr>
<th>Karl Landsteiner</th>
<th>Blood Loss</th>
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<td>Revolutionised the solution of transfusion by dramatically increasing the success rate and understanding of why it worked or failed.</td>
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<td>Discovered different blood groups in 1901, - A, B and O and a fourth group AB was added later in 1902.</td>
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<td>He showed that blood transfusions were only successful if they were between two people who had the same blood type or the blood would begin to clot and the patient would die.</td>
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<tr>
<td></td>
<td>However, he was limited because a donor still had to be present to provide blood wherever it was needed – this was not very practical so his work did not have an immediate effect on surgery.</td>
</tr>
<tr>
<td></td>
<td>However, during WWI when methods were found to prevent blood from clotting and to store blood so a donor did not have to be present the discovery that Landsteiner had made saved thousands of lives of men in the trenches.</td>
</tr>
</tbody>
</table>

**Revision Task**

Create ‘Medical Megastars’ cards for each key individual - name on one side and the key points about the time period they were influential in, their key contributions and the short-term and long-term
importance of their work. Keep reading over them for 15 minutes each time – this will make them stick in your long-term memory.

Key Words

Anaesthetics – drugs given to produce unconsciousness before and after surgery.

Antiseptics – chemicals used to destroy bacteria and prevent infection.

Antiseptic surgery – killing germs on the wound.

Aseptic surgery – removing germs from the operating theatre.

Cauterisation – using a hot iron to burn body tissue. His seals the blood vessels and stops bleeding.

Gangrene – the infection of dead tissue causing foul smelling gas.

Ligatures – a thread used to tie a blood vessel during an operation.

Sepsis – also known as blood poisoning. The body is overwhelmed with infection and so it often causes death.

Tourniquet – A bandage used to apply pressure and restrict blood flow to an open wound.

Revision Techniques

Remembering key terms; phrases; people; places and events

• **Hide and seek** – You will need to create cards with a key term of phrase on one side and the definition or who said it and what was meant on the other. You can play this alone or with friends or family. Put all the cards face down either on the key term of phrase side or on the definition side and try to guess what is on the back. Check your guess – if it is correct take the card. The person with the most cards wins. If you are playing on your own then try to estimate how many you will get and try to reach that target. On subsequent turns try to beat your best score.

• **Guess Who / Guess What** – You will need to write out a set of clues for each person, place or event you are trying to remember and on the opposite side write the answer. You could play this on your own or with friends or family. If you are playing on your own it works in a similar way to Hide and seek. If you get someone to test you make sure you get them to cover up the answer. Again set yourself targets and try to beat best scores.

Remembering sequences of events; how and why things happened
- **Mastermind** – Write a series of questions on a topic and then later without any help from people or notes try to answer these questions. Set yourself a time limit to make it more challenging – this will help you get faster at information recall and will certainly help when you are working with time constraints in the exam. It is often a good idea to use **Cue Cards** with this revision technique. Write memory prompting bullet points on cue cards and revise these before answering your questions. It won’t be very effective if the cue cards are the specific question answers since you need to be able to be versatile with your memory recall as questions can be worded slightly differently.

- **Dominoes** – Write a series of questions and answers. Then make some domino shaped cards – at the top of the first card you should put the first question, then at the top of the second card write the answer to that question and at the bottom of that second card write the third question and so on until you reach the final question – the answer to that question should go on the bottom of the first card. You could play this in pairs or a group putting the cards down as you finish with them. Or you could play this on your own by spreading the cards out – asking the first question and then looking for the card with the answer and so on.

- **Target diagrams** – You can have a three or four section target diagram. Look at the example below to see how they work.