26 FEBRUARI 2019

CORONARY ARTERY DISEASE

NAME: BRITT RIEDIJK
TEACHER: MISTER TAKKENBERG
Class: bth5b Subject: physics

Index

Preface

I started on the kick-off with no ideas at all and left with too many ideas. However I finally decided to do my report on coronary artery disease.

I decided on this particular topic because my mother had coronary artery disease herself and not everything went well (you will read more about this in the introduction).

Now looking back on everything, I am still happy I chose this topic. Because I chose this topic for my report I understand better what my mother has been through, what went wrong and what she is still going through.

I started with doing a lot of research and then I deciding on doing an experiment. When I finally decided on my experiment it took some time arranging everything, and there went a lot of things wrong during this time, I even ended up changing my entire experiment.

However I thought of a new experiment and I worked my way through it. And now I am proud of what I have done, how I have done everything, and the report I made.

Introduction

Your heart is one of the most important organs of the (human)body, but just like every other organ there can be some difficulties with it. Heart diseases are the most common cause of death in the Netherlands

There are different heart and vascular diseases, including Atherosclerosis. Atherosclerosis, also known as cardiovascular disease, is a serious heart condition where a plaque hardens and narrows the arteries. When severe, it can lead to coronary artery disease, this condition puts blood flow at risk, and therefor causes heart attacks, angina(chest pain) and strokes. It can also result in abnormal heart rhythms or spasm of the heart arteries, both can be life-threatening. The plaque that narrows the artery is usually made up of calcium, fat, cholesterol and other substances found in blood.

My mother had coronary artery disease. She had breast cancer in the past, and was exposed to ionising radiation. This radiation was part of the reason my mother developed atherosclerosis in her coronary artery. However the plaque was discovered very late, because of this she had several heart attacks. Eventually the narrowing was discovered, and my mother was treated. But since it was discovered so late, she has lasting symptoms and will have difficulties with her heart for the rest of her life.

This made me think, why was it discovered so late, and how can this mistake be avoided in the future?

There are different tests to discover, to see the narrowing in more detail or to help with the treatment of atherosclerosis or coronary artery disease, including blood test (to see if they have an increased cholesterol), Doppler ultrasound (measures blood pressure), a 'normal' ultrasound, electrocardiogram (record electrical signals traveling through heart) or stress test (how your heat works during physical activity). However, the standard procedure in most hospitals is first an X-ray or a CT-scan, and only if you can see a narrowing there, you will have further treatment and tests.

My mother also had an CT-scan first and after some research I found out that they didn't see the narrowing on the scan, and therefore she wasn't treated. My mother had a narrowing without calcium. Later I found out that this was the reason they didn't see the narrowing on the CT-scan.

This lead me to do research on why a plaque without calcium is so difficult to be seen on a CT-scan and what would be a better option than the standard CT-scan or X-ray.

Ultrasounds work with sound waves instead of radiation. When the sound waves bounce back on the tissue, liquids and bones in your body. The longer it takes for the waves to be back, the deeper the tissue is. And the more waves that bounce back, the higher the density of the tissue. Because the ultrasound works with these sound waves it is able to detect soft tissue. This lead me to my research question, and the topic of my experiment; would an ultrasound be able to detect both a narrowing with calcium and a narrowing without calcium.

I first analysed this with the following sub questions:

- What is coronary artery disease, what are the causes and what are the symptoms?
- How does a CT-scan/X-ray work, why is a narrowing without calcium difficult to see on a CT-scan or X-ray?
- How does an ultrasound work and why do I think it is able to detect both a narrowing with and without calcium?

Then I did an experiment myself to get an answer on my research question.

Hypothesis

My hypothesis for my research question is that an ultrasound would be able to detect a plaque with and without calcium. I believe this is so because the sound waves used in an ultrasound, would echo or bounce back on any tissue or material it meets. Therefore I believe it should be able to detect any kind of soft tissue, meaning it would be able to detect a narrowing without calcium.

Relevance of my experiment.

If my hypothesis is correct and an ultrasound is indeed able to detect both a narrowing in the arteries with and without calcium, an ultrasound would be a better option than an X-ray or CT-scan. Not only will it be easier for the doctors to make a diagnosis, but the patients who have a narrowing without calcium would be helped in time, have a lower chance of dying, heart attacks and lasting symptoms.

H1 Coronary artery disease

1.1 What is coronary artery disease?

Coronary artery disease, also called coronary heart disease or ischaemic heart disease is a term used when your heat's blood supply is blocked or interrupted. Coronary artery disease is the most common of the cardiovascular diseases.

Coronary artery disease causes the reduction of blood flow to the heart muscle. The arteries, which are normally smooth and elastic are now more rigid and narrowed, this happens because of the build-up of plaque in the arteries of the heart. The process is which the plaque builds up in the arteries is called atherosclerosis.

This plaque that narrows the artery is usually made up of calcium, fatty deposits called atheroma, cholesterol and other substances found in blood.

Coronary artery disease is the leading cause of death for both men and women worldwide. It is said that every 40 seconds, someone in the United States has a heart attack as a result of coronary artery disease.

1.2 What causes coronary artery disease?

Atherosclerosis, the build-up of the plaque, and therefore coronary heart disease is usually caused by lifestyle factors, but genetics, aging or the exposure to radiation may also play a part.

The most common causes of atherosclerosis (the build-up of plaque in your arteries) are smoking, lack of exercise, high blood pressure, high cholesterol, diabetes, being overweight and stress.

Because radiation can also be a cause of the build-up of plaque in the artery, and therefore breast cancer patients or survivors have an increased chance of getting heart and vascular diseases. This is because radiotherapy for breast cancer involves some incidental exposure to ionizing radiation.

The plaque that is build up in your artery makes the inner walls of your blood vessels sticky, this causes other things, like inflammatory cells, cholesterol, lipoproteins and calcium, to mix with the plaque. This causes for the plaque to increase, making the vessels narrower.

1.3 What are the symptoms of coronary artery disease?

Symptoms can vary per person, however there are some main symptoms that can occur in someone with coronary artery disease.

The most common symptom is angina (chest pain). Angina has different forms, depending on the patient, it can be describes as heaviness, pressure, aching, burning, numbness, fullness, squeezing and painful feeling. It is difficult to diagnose someone with angina as a patient with coronary artery disease, since it can be easily mistaken for indigestion or heartburn.

Indigestion, also called dyspepsia, is usually a sign of an underlying problem, such as gallbladder disease or ulcers, however it usually defined as a persistent or recurrent pain or discomfort in the upper abdomen. Coronary artery disease can be mistaken for indigestion since the angina for both diseases comes from the same neural pathway.

A heartburn, can be triggered by certain foods, medications, obesity or even stress. Symptoms can include chronic cough and chest pain. Because of this chest pain it could be mistaken for coronary artery disease.

Other symptoms of coronary artery disease could be; pain in arms and/or shoulders, a stroke, shortness of breath, pain in the neck, a faster heartbeat, nausea, pain in the back, pain in the jaw, sweating and dizziness. These symptoms can occur in both women and men, however the symptoms are often subtler in women.

In some cases when the plaque narrows the artery enough, a blood clot may block the heart's blood supply completely, causing a heart attack.

1.4 How is coronary artery disease discovered and what are the treatments?

The first investigation in most hospitals to see if someone has coronary artery disease is first an X-ray or a CT-scan, and only if they can see something they expect to see when you have coronary artery disease, you will have further treatment and tests.

Treatments for coronary artery disease include placing a coronary stent in your artery, a coronary artery bypass, medical treatments and/or lifestyle changes (since coronary artery disease is usually caused by smoking, eating unhealthy, an high cholesterol etc.

These 'further tests' could consist a blood test (to see if they have an increased cholesterol), baseline electrocardiography, Doppler ultrasound (measures blood pressure), a 'normal' ultrasound or stress test/exercise ECG (how your heat works during physical activity). These test could for example help with placing the stent.

The medicine used to cure or decrease coronary artery disease could be statins (reduce cholesterol), nitroglycerin or calcium channel blockers.

H2 CT-scan and X-ray

As you have read in paragraph 1.4 are CT-scans and X-rays the standard tests to see if someone has coronary artery disease, but how do these test work? And why is a plaque without calcium difficult to see on these test like you have read in the introduction?

2.1 What is an X-ray and how does it work?

X-rays make up X-radiation or Röntgen radiation and is a form of electromagnetic radiation. X-radiation was discovered by the German scientist Wilhelm Röntgen in 1895. He named it X-radiation for a reason, since the letter X is commonly used to signify an unknown number, he used the same X to signify this unknown type of radiation.

X-rays can be roughly divided into two groups, soft X-rays and hard X-rays. The wavelength of soft X-rays is around the 10 nanometres(one billionth of a meter), they are shorten than those of UV rays but they are usually longer than gamma rays. Hard X-rays have a wavelength of about 100 picometers (one-trillionth of a meter).

X-radiation can be used to form images of the inside of the body, such as broken bones, cancer or your heart (for example atherosclerosis/coronary artery disease). X-rays are sent out to capture a single image of your anatomy. X-radiation works with density, the more dense it is the more radiation it blocks and the whiter it appears on the X-ray picture. Softer tissue has a lower density and therefore lets more X-rays through, appearing darker on the X-ray picture. An X-ray picture is relatively seen very low-cost and even though is makes use of radiation, the radioactive contamination for the person is low, making it more safer and more popular to use.

2.2 What Is a CT-scan and how does it work?

A CT-scan is similar to an X-ray, it combines the power of an x-ray with computers to make a 360 degree view of the body, producing a more detailed picture.

A CT-scan works, just like an X-ray, with radiation and density. A CT-scan sends out a series of radiation beams through the human body. These beams travel through the body and faces certain types of tissue. And just like on an x-ray the more dense the tissue is, the more radiation it blocks and the whiter it appears. And the lower the density of the tissue is, the more beams it lets through, making the tissue appear darker on the picture. Sometimes, a contrast dye is used to show certain structures and tissue even more clearly.

CT-scans are popular to use since it makes a clear 3D image, it is painless, non-invasive and it takes only a few minutes to make the image.

2.3 Why is a narrowing without calcium difficult to see on an X-ray or CT-scan?

Both a CT-scan and an c-ray work with density, the higher the density the whiter it appears on the image. A plaque or narrowing is usually up of calcium, fatty deposits called atheroma, cholesterol and other substances found in blood.

Because the plaque contains calcium, which has a higher density then your blood and your vessels, your plaque will have a higher density as well and therefore you can see the plaque on both an x-ray and CT-scan.

However, some people do not have calcium in their plaque, this makes the narrowing have a similar (a little lower) density as your blood vessels. Therefore the plaque appears almost just as dark as a normal blood vessel on the image, making it very difficult to see.

Because of this the narrowing can be discovered very late, and sometimes too late. This puts the patients who have a plaque without calcium in a life-threatening situation. The longer it takes for the patient to be treated the more chance there is for the patient to have lasting symptoms and heart attacks.

H3 ultrasound

In my hypothesis you have read that I believe an Ultrasound would be the best option to discover coronary artery disease, instead of the standard X-ray or CT-scan. But how does un ultrasound work? And why do I believe it is able to discover both a narrowing with and without calcium?

3.1 What is an ultrasound and how does it work?

An ultrasound scan uses high-frequency sound waves to create images of the body. These sound waves have frequencies higher than the upper limit of human hearing. Besides that humans cannot hear it, the physical properties of ultrasound are not different from 'normal' (audible) sound.

The sound waves will be send into the body by an instrument called a transducer. The sound waves will bounce back when they hit tissue, arteries, bones etc. then the transducer will record the echoes of those sound waves, determining the size, shape and consistency of all the different tissues in the body.

When a Doppler ultrasound is used instead of the 'normal' ultrasound, it means you can determine how fast your blood is flowing.

All the information that is determined by the transducer is put into a single image on a computer screen. This picture is in black, grey and white shades and is difficult to read. Therefore ultrasound operators/technicians have special training to both read and perform an ultrasound.

3.2 Why do I believe an ultrasound is able to discover both a narrowing with and without calcium?

As you have read in 3.1, ultrasounds work with high-frequency sound waves. These sound waves bounce back, and therefore make an ultrasound picture.

However, because an ultrasound works with these sound waves, it is also able to detect soft tissue. Ultrasound scans are therefore commonly used in pregnancies, but also to detect problems in the liver, heart, kidney, or abdomen.

Since ultrasounds can detect soft tissue, I believe it would be able to detect the fatty substance the plaque consists of without the calcium (including atheroma and cholesterol). If an ultrasound is able to detect these kind of substances, it would be able to detect a narrowing without calcium.

H4 The Experiment

Introduction of the experiment

In the previous chapters I have analysed the subject and the research question of my report. However to have a final, trustworthy answer to my research question, there also needed to be an experiment.

Since I wanted to know if an ultrasound would detect both a plaque with and without calcium I needed to I needed to recreate three arteries. One artery with a 'calcium plaque', an artery with a 'fat plaque' and an artery without a narrowing as a control group. This control group is needed to see if the narrowing are in fact detected by the ultrasound, or if they are just the same as a normal 'clean' artery.

Then I needed to take an ultrasound of those recreated arteries. Luckily midwifery VIA in Amsterdam offered that I could use their Ultrasound device for my experiment.

Experiment set up

To have an trustworthy experiment means that the experiment should only be able to be influenced by (in this case) the plaque itself. To achieve the goal where the results would only be influenced by the plaque itself (depending on if it contains calcium or not) all the other factors, like density of the 'artery', volume of the plaque, the material used for the 'artery', etc. ; had to be the same.

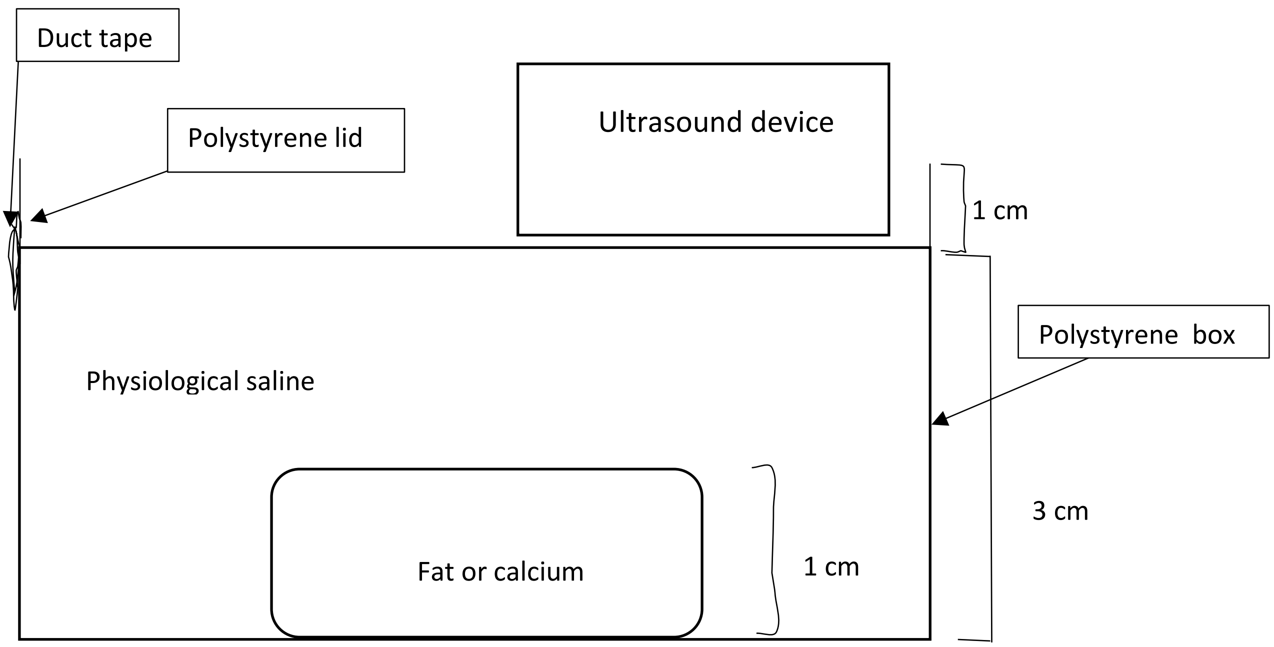
For the 3 arteries I used a little polystyrene box, since polystyrene has the same density as an artery (a density of 1,06 g/cm^3). All 3 boxes had the same length, width and height (length: 11,8 cm x width: 7,8 cm x height: 3 cm).

To make sure that the volume and shape of the plague with calcium were exactly the same as that of the plaque without calcium, I needed a mold to put the plaque in. This mold is also made of polystyrene to not make sure the density couldn't influence the experiment. In the experiment we used one mold with fat and one with calcium. Both molds have the same shape, height etc. (height: 1cm and diameter: 4,6 cm)

An artery however, also contains blood, and therefore I also needed to find something to pose as blood, without possibly changing the results. To do so I used physiological saline, since it has the same density as blood, and it is used more often in other experiments to recreate blood.

Since the ultrasound needed to be directly on the material (usually the belly), our little boxes needed a lid. This lid was made from polystyrene, and on the outside attached with duct tape to the box.

In picture 1 on the next page, you can see how this artery looked and therefore how the experiment was set up.



Picture 1- experiment set up

Necessities for the experiment:

- 3 polystyrene boxes (length: 11,8 cm x width: 7,8 cm x height: 3 cm).
- 3 polystyrene lids for the boxes
- Calcium
- animal Fat (I used pig fat for this, you can get it at any local Butcher)
- 4 Polystyrene cups (you can get these ‘plastic’ cups at any local supermarket)
- Duct tape
- Physiological saline (distilled water and kitchen salt)
- Glue, preferably 1 second glue
- A microwave
- A pair of scissors
- An ultrasound device and an ultrasound operator

Execution of the experiment

1. For this experiment we needed molds so that the volume and shape of both plaques would be the same, this is necessary to have trustworthy results. I started by making these molds out of 4 polystyrene cups. I cut two cups so that it was one cm high. For the other two cups I only cut out the bottom, this would go over the molds (first two cups) as a lid.

2. After the molds were done I started melting the animal fat in the microwave and wetting some of the calcium pouder to make a paste like substance. This is needed so that both the calcium and the fat would take the shape and volume of the mold. Do make sure the fat isn't too hot to make the molds melt.

3. Then I started with filling the mods with the calcium and the fat.

4. After both of the molds were filled, I put a lid on each mold. I then let it rest for some time so that the fat would harden again and so that the water in the calcium would evaporate, leaving a smooth calcium 'block' in the mold.

5. Then I glued both the molds upside down to the bottom of one of the polystyrene boxes. There is one box left with no mold in it, this is the control group.

6. After the glue dried I added the physiological saline to all of the three boxes, till they were completely filled.

7. Then I put the lids carefully on the boxes so that as little air bubbles as possible would get in. I immediately taped it to the boxes so that it wouldn't move either.

8. Lastly the ultrasound itself needed to be done. This I did with the help of the ultrasound operator of midwifery VIA. We made an ultrasound picture of all the three arteries.

Results

In picture 2, 3 and 4 you can see the ultrasound images of all three arteries. In these pictures you see a clear difference between the image of the narrowing with calcium and the narrowing without calcium. In the picture of the plaque with calcium (picture 3) you see the edge of the narrowing (mold), however it is repeated several times in the picture.

When an image repeats itself several times on an ultrasound picture, it is called an artifact. The artifact in picture 3 is probably caused by the layering of either the polystyrene lid or the calcium plaque itself.

You can also see that the picture of the artery with a narrowing without calcium (picture 2) however looks almost exactly the same as picture 4 (the artery with no plaque at all), meaning that the ultrasound couldn't detect the plaque without calcium.

Picture 2- ultrasound of the artery with a fat narrowing (without calcium)

Picture 3 – ultrasound of the artery with a narrowing with calcium

Picture 4 – ultrasound of the 'clean' artery (without a plaque)

Conclusion

After my research and analysis I had thought an ultrasound would be able to detect a plaque without calcium.

However, in my experiment I saw that on the ultrasound the plaque without calcium looked almost exactly the same as the control group. And on the image of the plaque with calcium appeared an artifact.

Because of these results, I come to the conclusion that an ultrasound is not able to detect both a plaque with and without calcium, and therefore it is not a better option than an X-ray or CT-scan.

Discussion

My experiment and conclusion is not very reliable. This is because an report, experiment and conclusion can only be reliable if the experiment is executed more than once.

Besides that, the ultrasound used in my experiment was one that is normally used for pregnancies, maybe the results would be different if an ultrasound is used that is normally also used for the heart.

Also, on picture three there appeared an artifact, probably because of the layering of the polystyrene. This could mean it might still work on a real heart.

On top of that, an ultrasound can also be used to show the bloodstream. Therefore it might work on a real heart, since the blood will flow faster where the artery is smaller (due to the narrowing).

So, after everything I believe that further research and experiments are needed, since the standard procedure (an X-ray or CT-scan) still causes troubles for patients without calcium in their plaque and an Ultrasound could still very well work on a real heart due to the bloodstream and the absence of layering and therefore artifacts on the ultrasound image.

Evaluation/reflection

I did this report on my own instead of the usual groups/pairs, and I really underestimated the amount of work this report and experiment would take. Therefore I am extremely grateful that my mentor for this report, mister Takkenberg has helped me as much as he did, because without him I would have been nowhere. The next time I have to do a report like this I either will work in a bigger group or I will start earlier so that I have more time to finish it without having to rush anything.

Then there were also some difficulties during the experiment, I first wanted to do an experiment with an x-ray however I couldn’t find one I could use (and believe me I have tried very hard). This meant that I still had to change my experiment very late in the process, this caused a lot of stress and late nights trying to think of and arrange my new experiment and to finish this report.

Summary

In my report I tried to see if an ultrasound would be a better option than an X-ray or CT-scan to discover coronary artery disease. Coronary artery disease means that your heart's blood supply is blocked due to an plaque in an artery. This plaque that narrows the artery is usually made up of calcium, fatty deposits called atheroma, cholesterol and other substances found in blood.

The standard procedure to discover coronary artery disease is an X-ray or CT-scan, and only if they find something there you will have further treatments and tests.

Both a CT-scan and an c-ray work with density, the higher the density the whiter it appears on the image, and because the plaque contains calcium, which has a higher density then your blood and your vessels, your plaque will have a higher density as well and therefore you can see the plaque on both an x-ray and CT-scan.

However some people have a plaque without calcium, and these narrowing's are very difficult to see on an X-ray or CT-scan, meaning the narrowing will be discovered very late, putting the patients at risk.

Ultrasounds work with sound waves, the waves are sent into the body and bounce back on tissue, then the transducer reads the echoes of the sound waves, making an image. Because an ultrasound works this way, it is able to detect soft tissue as well and I believed that it therefore would be able to detect an ultrasound without calcium.

Then I did an experiment to find out if this is really the case, I recreated three arteries with polystyrene boxes. One artery with a 'calcium narrowing', one artery with a 'fat narrowing' (without calcium) and one artery without a narrowing as a control group.

When I made the ultrasound images of the arteries I found out that you could not see the artery with a 'fat narrowing' on the ultrasound, and that on the image of the 'calcium narrowing' a artifact appeared.

Therefore the answer on my research question is as followed: no, an ultrasound is not able to detect both an artery with and without calcium.

Logbook/journal

Here you can see what did for my report and when. When it says pws hour, it could be either a moment organised by school, or when I worked on my pws in cat hour (alone or with mister Takkenberg)

When?	What?
Pws kickoff	Think of 3 different subjects/ topics
Pws hour 1	Choose 1 final topic, do some research (x-ray and coronary artery disease)
Pws hour 2	Research (atherosclerosis, coronary artery disease)
Pws hour 3	Research (connection to cancer)
Pws hour 4	Research (standard procedure, x-rays and CT-scans)
Pws hour 5	Think about what I could do as experiment (recreate x-ray and artery)
At school 30 min.	Arrange an X-ray (after 'stralingspraktikum' for physics with university of Utrecht)

When/where?	What?
Pws hour 6	Research (how can we recreate the plaques)
Pws hour 7	Research (how can I recreate the blood vessel itself- polystyrene)
Pws hour 8	Research/thinking about experiment (blood need flow? and how to recreate blood)
Pws hour 9	Thinking about experiment (how plaques have same shape etc.-mold)
Pws hour 10	Thinking about experiment (how control group, attach a ‘counter’ on the x-ray?)
Pws hour 11	Thinking about experiment (how will the artery look- recreating blood, mold, etc.)
Pws hour 12	Thinking about experiment and research (if my hypothesis is proved, how is it relevant, what should be done with the info and what do I suggest as a solution- ultrasound)
At home 1 hour	e-mailing about ultrasound with midwifery VIA
Pws hour 13 and 14	More contact about X-ray with university of Utrecht, more contact about ultrasound with midwifery VIA, thinking about how to put the ‘counter’ on the X-ray machine
Pws hour 15	Talk with toa’s about the polystyrene boxes, the molds etc. for recreating the artery
Pws hour 16 and 17	More talking with toa’s about the artery
At home 1 hour	e-mailing with university of Utrecht and researching about what kind of fat to use
At home 1 hour	More e-mailing with university of Utrecht – they come back on their decision and I can’t use their X-ray anymore.
Pws uur 18 and 19	Try to find another way to arrange an X-ray (via family friends who work in the hospital), more contact with toa’s and midwifery VIA
At home 3 hours	Start writing report
At home 2 hours	Writing report
School 1hour	In free hour Writing for report
At home 3 hours	Mailing, calling etc. to try and arrange X-ray with hospital Spaarnegasthuis via different people / contacts.
At home 2 hours	More contact about X-ray with hospital Spaarnegasthuis – they let me know I cannot use their X-ray
Pws hour 20	Thinking about how to fix the problem – different experiment – ultrasound?
At home 2 hours	Research about ultrasound, thinking about how to do new experiment
Pws hour 21	Thinking about new experiment, research question, everything
At home 4 hours	Start writing report for new experiment
Pws hour 22	Talk with toa’s about experiment and the ‘arteries’ (polystyrene boxes with mold)
home 7 hours	Writing report
A school around 3 hours	Preparing for experiment with toa’s, melting the fat, making the molds, thinking about how to close the lid of the box etc.
home 4 hours	Writing report
midwifery VIA 5 hours	Preparing experiment (filling boxes with physiological saline, closing the lid etc.), doing the experiment and the traveling
home 6 hours	Writing report
home 8 hours	Writing report
home 7 hours	Writing report
home 8 hours	Writing report

literature

https://www.hartwijzer.nl/ct-scan

https://www.medicalnewstoday.com/articles/245491.php

https://spaarnegasthuis.nl/specialisme/cardiologie

https://www.hartstichting.nl/risicofactoren

the new England journal of medicine

https://www.ahajournals.org/doi/abs/10.1161/CIR.0000000000000556

https://www.nhlibi.nih.gov

https://www.mycdi.com/knowledge_center/difference_between_mri_ct_and_x-ray/

https://en.wikipedia.org/wiki/Coronary_artery_disease

https://www.webmd.com/heart-disease/guide/heart-disease-coronary-artery-disease#1-2

https://www.healthline.com/health/coronary-artery-disease

https://www.nhs.uk/conditions/coronary-heart-disease/

https://www.webmd.com/heartburn-gerd/indigestion-overview#1

https://en.wikipedia.org/wiki/X-ray

https://www.livescience.com/32344-what-are-x-rays.html

https://www.medicalnewstoday.com/articles/153201.php

https://www.radiologyinfo.org/en/info.cfm?pg=bodyct

https://www.webmd.com/a-to-z-guides/what-is-an-ultrasound#1

https://en.wikipedia.org/wiki/Ultrasound

ultrasound operator of midwifery VIA

Beoordeling

Het profielwerkstuk wordt beoordeeld door jouw begeleider. De eindbeoordeling is een cijfer. Dit cijfer maakt deel uit van het combinatiecijfer. Het combinatiecijfer voor havo is het gemiddelde van maatschappijleer en het profielwerkstuk

Afdeling: havo Schooljaar:

Naam leerling: ________________________________

Naam leerling: ________________________________

Begeleider: .________________________________

Klas: _________

Titel werkstuk: ____
(let hierbij op de correcte spelling, dit komt op je diploma te staan!)

Vak: _____________________

Eindbeoordeling cijfer aan de hand van rubrics

Proces	10 punten	…………….
Verzorging	10 punten	…………….
Onderzoek	20 punten	…………….
Mondelinge presentatie	10 punten	…………….
Inhoud	50 punten	…………….

Totaal aantal punten............

het afgeronde cijfer van het profielwerkstuk : ☐