Lead Poisoning Removal

Team number - 1018

Team members: Krysta Carabajal krystacarabajal6@gmail.com
Cassidy Chau cassidychau24@gmail.com

Teacher: Sharee Lunsford lunsford@aps.edu

Sponsor: Patty Meyer pmeyer2843@gmail.com

Mentor: Meghan Hill
Dr. George Frodsham

Area Of Science: Biology

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Executive Summary

Lead poisoning can be easily removed by soaking blood in (CaCo3) then attaching magnetic nanoparticles and removing them with a magnetic filter. The model was unfinished when we submitted the report. We did start it and we were a fifth of the way through it. We planned to simulate the way we were removing lead from the body. We are considering continuing to do this project next year. If the team continues we need to look at the long term effects of calcium carbonate in the body.

Problem Statement

Currently there is a crisis in Flint, Michigan where children and adults have been drinking contaminated water with lead since 2011. This is still going on. The water crisis in Flint, Michigan became a problem because they changed their water system to save money by switching from lake water to river water. The water pipe system delivered the water through lead pipes. These pipes were old and rusty which poisoned the water. The city and state government tried to cover up the issue over a period of 10 years.

The level of lead poisoning in Flint's children is still three times the normal limit for humans. Lead poisoning collects in the teeth, bones, blood, kidney and liver. The intestines absorb approximately 10-20% of lead. Taken in large enough doses, lead can cause paralysis, brain damage, and stillbirth.Children are generally more sensitive to lead poisoning than adults. The greatest risk is to brain development, where irreversible damage occurs.

Lead Poisoning is currently removed from the body by Chelation Therapy. In chelation therapy, a patient is given disodium ethylenediaminetetraacetic acid (EDTA) through a series of weekly intravenous (IV) treatments, each lasting about 30 minutes.In general, the medication seeks out and sticks to metals and minerals in your bloodstream, creating a compound that your body removes when you urinate. This is a long process of therapy.

In 2019, a Chinese study was done by soaking mice blood cells in calcium carbonate (CaCo3) to get rid of lead in the mice bodies. The scientists injected blood cells with nanoparticles made from calcium carbonate. The scientists discovered the calcium carbonate did not affect the blood cell growth rate, cell membrane, or it’s ability to multiply. The nanoparticles didn’t remove other minerals such as iron, magnesium, and zinc which EDTA does. The Calcium Carbonate turned into Lead Carbonate inside the cell. At the end of the experiment, the mice had little to no lead in the major organs. This was discovered through an autopsy.

Dr. George Frodsham of Medisieve Inc. is currently applying for a patent for his magnetic nanoparticles and filter. His filter system is attached to a dialysis machine. He is using magnetic nanoparticles with connected antibodies to attach to cells and remove them with a magnetic filter.

Lead is not magnetic. Our project combines boths studies to make lead magnetic, then attach a magnetic nanoparticle, and then remove it outside of the body with a magnetic filter. We propose this as a safer, less toxic way to remove lead from the body.

Model Plan

In our model we want it to show how our lead poisoning removal works. We plan to show a blood vessel with blood cells going through the vein collecting lead from the body tissue. The blood cells will have already been coated in (CaCo3). Then it will be run through the Medisieve filter and then returned to the body. We plan to model our system similar to a double blood cell machine except with a magnet to pull magnetic nanoparticles that are bound to the lead.

We have begun coding in NetLogo.

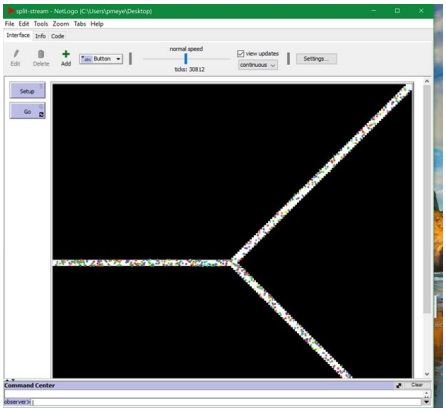

Diagram 1 lead removal model

Diagram 2 NetLogo Code

```
breed [corpuscles corpuscle]

patches-own [
  is-vessel?
]

to setup
  clear-all
  ask patches [
    set is-vessel? false
    ifelse (pxcor < 0) [
      set is-vessel? ((abs pycor) < 2)
    ] [
      set is-vessel? ((abs (abs pycor - abs pxcor)) <= 2)
    ]
    if (is-vessel?) [
      set pcolor white
    ]
  ]
  set-default-shape corpuscles "circle"
  reset-ticks
end

to go
  add-new
  ask corpuscles [
    move
  ]
  tick
end

to add-new
  ask patches with [pxcor = min-pxcor and is-vessel? and not any? corpuscles-here and
random-float 1 < 0.1] [
```

```
    sprout-corpuscles 1 [
      set heading 90
    ]
  ]
end

to move
  let :save-xcor xcor
  let :save-ycor ycor
  right ((random-float 10) - (random-float 10))
  if (not can-move? 0.1) [
    die
  ]
  forward 0.1
  if (not is-vessel? or any? (other (corpuscles in-radius 0.1))) [
    setxy :save-xcor :save-ycor
    ifelse (xcor < 0) [
      set heading (90 + (random-float 90) - (random-float 90))
    ] [
      set heading (90 + (ifelse-value (pycor > 0) [-45][45]) + (random-float 90) - (random-float
90))
    ]
  ]
end
```

Model Progress

We were able to create one vein that divides into two veins that go right and left. When you hit go you'll see blood cells flowing down the vein. When it hits the intersection, blood cells randomly flow left and right. Originally, blood got stuck on the outer ends of the vein and created a blood clot. We had made them randomly disappear on the edge of the model, then reappear at the beginning of the blood vessel. The blood cells kept on getting stuck on the edges of the veins, because of the outer edge design, so we had to change how the blood cells moved. We were only able to get this far in our coding before submitting the report.

Results/Conclusions

Lead poisoning is a real problem in some areas. We do think this way of removing lead poisoning from the body could save many lives. We think this is a better and more safe way to remove lead. We had to learn some chemistry, biology, and dialysis. We had to

learn this just to understand what we were researching. If we do this next year, we would spend more time on coding and determining how CaCo3 long term affects the body, because the researchers never saw how the mice reacted to long term Calcium carbonate in the body. We might be able to create a computational model instead of a simulation.

Most Significant Achievements

Krysta: The most significant achievement in this project for me was being able to learn about lead poisoning and how we might come up with this solution of how to get rid of lead pointing in a safer way.

Cassidy: I think the most significant achievement in this project is that we were able to get together and still learn a bunch more about lead poisoning and how it works.I hope we find the solution and get rid of lead.

Acknowledgements

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Works Cited

"Chelation Therapy." *HealthLink BC*, www.healthlinkbc.ca/health-topics/ty3205spec.

"Flint Water Crisis Fast Facts." *CNN*, Cable News Network, 2 July 2019, www.cnn.com/2016/03/04/us/flint-water-crisis-fast-facts/index.html.

"High Blood Pressure (Hypertension)." *HealthLink BC*, www.healthlinkbc.ca/health-topics/sth149819#sth149819-sec.

"Lead Poisoning and Health." *World Health Organization*, World Health Organization, www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health.

Ratini, Melinda. "Chelation Therapy: Purpose, Procedure, and Side-Effects." *WebMD*, WebMD, 22 Mar. 2019, www.webmd.com/balance/guide/what-is-chelation-therapy#1.

''Removal of lead from Aquatic solution using synthesized iron nanoparticles'' int. J. nanotechnol.,Vol. 13, no. 1, March. 2017, pp.83-90

"Synthesis of calcium carbonate nanoparticles in eruthrocytes enables efficient removal of extracellular lead ions." Ru,Guo, Bai, Xie, Ma, Zhu, Wang, Wang, Yang and Lu. https://doi.org/10.1038/s42004-019-0199-z

"Thrombophlebitis." *HealthLink BC*, www.healthlinkbc.ca/health-topics/stt11581#stt11581-sec.