Half-Lives of Antibiotics

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Area of Science: Agriscience, Veterinary Science

Computer Software: NetLogo

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Executive Summary

This year our team wanted to study a more in-depth project in agriculture than we have in the past, which led us to choose a project regarding the half-lives of antibiotics in cattle. This is a problem which has great application in our area. Many people in our area run cattle or are tied to the cattle industry in some way, including the landowners, vets, truckers, feed stores, and many more.

When a beef animal is vaccinated to prevent a sickness, or given antibiotic to treat a sickness, there may be a slaughter hold on that medicine, meaning that the animal cannot be processed for human consumption for thirty to ninety days. For herd animals, a slaughter hold may be no big deal, but in a feedlot setting it will more than likely cost the producer. Also, we all know that when an antibiotic is overused it can have adverse effects, or lose its effectiveness (similar to penicillin). This ‘antibiotic resistance’ that occurs as their effectiveness is lost can have serious consequences to humans. These are the problems our model will address.

Problem Statement

This year our team has studied and attempted to replicate the half-lives of antibiotics and their effect on humans and animals. A half-life is how long it takes for half of the antibiotics to die or become invalid. We chose this project because we wanted to know how antibiotics spread through the animals systems and how long it takes for the antibiotic to leave the animals systems so that it is safe to consume.

Another reason that we chose this project is that in our rural area almost everyone runs cattle. In fact most of us on this team are directly tied to cattle ranching. However, many people over use antibiotics certain antibiotics that are extremely effective at the start, but over time, pathogens can become immune. This immunity can then be passed on to pathogens that affect humans.   Preventing this transmission has major consequences to human health.

With this project, we set out to try to find a solution to this problem, by finding the most efficient method to give the medications, whether this be ingestion if feed or injection by shots. We want to find the best use of antibiotics, while ensuring consumer’s safety.

Method

We have modeled three different divisions of this problem in three programs. Two programs display a couple of different ways of how to distribute the antibiotics into livestock, such as feeding and/or injecting. One program models this method in a pasture/range environment, and the other in a feedlot setting. Our third program displays how fast the antibiotics break down over time.

Validation/Verification

In order to validate our model, we are in the process of amending our code to show two groups of sick cattle in our pens model. One group will be kept in a sick pen until there is no trace of antibiotics in their systems, one pen will be “sold” at random. This will represent the flow of cattle into the market that may have been recently treated for an illness, and may still have traces of that medication in their systems.

Testing for traces of medication is not often done at a sale facility. Typically, the responsibility of keeping up with vaccination dates is left to the producers. Also, in a livestock auction setting, an animal may be bought by a feedlot operator, and then sold to a packing facility anywhere within two weeks to three months, depending on the situation. Packing facilities, such as Caviness in Herford, Texas, do test for these types of things, as well as diseases. However, testing results are not always 100%.

Results

We expected to obtain results pertaining to the movement of antibiotics through the internal systems of cattle. With this information, we planned to find the optimal way of distributing antibiotics through a herd while keeping it at safe levels for consumers and market animals. This would be useful by making it more efficient for producers and consumers. We have not quite achieved this with our project.

Up to this point we have been receiving positive feedback from our coding. We have been able to make this model realistic, which is something that is not always easy. We have also determined through our preliminary code that this problem can be addressed. An example of this is how we have made our program. If a calf gets a disease it can spread it to other cattle like they would in the real world.

Conclusions

At this point in time, we cannot draw any definite conclusions. What we can say is that, while this project has taken a few more left turns and quite a bit more code than we anticipated, is that we are seeing positive results with what we have now. We have seen that this is a project with merit, that is easily represented computationally. Based on what we have so far, we are still optimistic that we will see desirable results with the practices we intend to implement in our model. We hope to have something more by the time of the expo.

Software, References, Tables

We used two Netlogo models to represent this project. Members of our team are well versed in Netlogo. We used one Netlogo model to simulate this problem in a pasture/range environment, and another to simulate this problem in a feed lot setting. In our area both of these applications are present, with many ranchers running feed out and range operations, so we knew that addressing both situations would be important. Also, members of our team have used Netlogo for agricultural based models, such as Pasture-ization, Pasture-ization 2.0, and Pens in the past so we were familiar with Netlogo's capabilities concerning this project.

We have referenced the Mereck Veterinary Manual, as well as consulted area ranchers and feedlot operators. The Veterinary Manual is a useful source because it tells what symptoms of various diseases are and what you can do to treat specific diseases. It also supplies general information about how the bovine's body systems work and common problems that can occur.

Acknowledgments

First off, our team would like to mention all the support, suggestions, and assistance that Mr. D has given this team. We would not be able to make it to the expo every year without Mr. D's contributions. We would also like to recognize the following area ranchers/feedlot operators; David Rush, Danny Fish, and Rand Perkins. We have found their input to be a very valuable resource. Also, Dr. Logan with the Clovis Veterinary Hospital has advised our team as to certain veterinary practices and procedures.

Code

We have two separate programs. We have our "Pens" program, which simulates this problem in a feedlot environment, with antibiotics given only in feed. Our other model is our "Pasture" program, simulating this problem in the pasture/range setting. In this model, antibiotics are represented by injection. We are currently working on programing both methods into both models.

"Pens" Model

```
breed [cows cow]
;breed [sick sicks]
breed [humans human]
breed [cattle]
breed [infection]
breed [meds med]
breed [bug bugs]
breed [control controls]

to setup  ;;Following commands draw outline of pens
  __clear-all-and-reset-ticks
  ask patches
  [
    set pcolor brown
  ]
  create-turtles 1
  ask turtles
  [
    set color green
  ]
  ask turtle 0
  [
    setxy 5 16
    set heading 90
    repeat 11
   [
   set pcolor red
   fd 1
   ]
   set heading 180
   repeat 10
   [
```

```
    set pcolor red
    fd 1
    ]
    set heading 270
    repeat 11
    [
    set pcolor red
    fd 1
    ]
    set heading 360
    repeat 10
    [
    set pcolor red
    fd 1
    ]
]
ask turtle 0
  [
   setxy 5 6
   set heading 90
   repeat 11
  [
  set pcolor red
  fd 1
  ]
  set heading 180
  repeat 10
  [
    set pcolor red
    fd 1
    ]
    set heading 270
    repeat 11
    [
    set pcolor red
    fd 1
    ]
    set heading 360
    repeat 10
    [
    set pcolor red
    fd 1
    ]
 ]
  ask turtle 0
  [
```

```
  setxy 5 16
  set heading 270
  repeat 11
  [
    set pcolor red
    fd 1
  ]
  set heading 180
  repeat 20
  [
    set pcolor red
    fd 1
  ]
  set heading 90
  repeat 11
  [
    set pcolor red
    fd 1
  ]
  set heading 360
  repeat 10
  [
  set pcolor red
  fd 1
  ]
]
 ask turtle 0
 [
  setxy 5 16
  set heading 270
  repeat 2
  [
    set pcolor red
    fd 1
  ]
  set heading 180
  repeat 20
  [
    set pcolor red
    fd 1
  ]
  set heading 90
  repeat 2
  [
    set pcolor red
    fd 1
```

```
    ]
    set heading 360
    repeat 20
    [
    set pcolor red
    fd 1
    die
    ]
 ]
end

to work   ;;creates agents, within confines of the pen
create-cows 10
  ask cows
   [
     set color black
     set shape "cow"
     setxy (random -5 + 2) (random 15 + -3)
   ]
end

;to sick1
;  create-cattle 5
;  ask cattle
;   [
;     set color green
;     set shape "cow"
;     setxy (random 6 + 9) (random 7 + 7)
;   ]
;
;end

to movecattle   ;;cattle move about pen, an can become infected.  The rate at which infection occurs is a bit high, we need to adjust these variables
  ask cows
    [
      ifelse any? turtles-here with [ breed = bug ]
        [
          if (breed != bug) and (random 100 < infectionchance)
          [
            set breed infection
            set xcor 10 ;ycor 10 11
            set ycor 11
]
]
```

```
            ;;considering possible "division".  When an agent becomes infected, that agent apears in
sick pen (top right corner)then "splits" and another agent apears in bottom right pen.  That pen
would be "sold" periodically, to represent what happens when antibiotics are not given time to
fully leave animal's system
           [go]
       ]
end

to go  ;;movement procedure followed by cattle
  ask cows
  [
      if any? patches with [pcolor != red] in-cone 2 90
        [ fd 1]
      if any? patches with [pcolor = red] in-cone 2 90
        [bk 1 rt 180 rt random 45 lt random 45  ]
      if any? turtles with [breed = humans] in-cone 3 360
        [ set heading  random 360 rt random 30   ifelse patch-ahead .5 != red [rt random 35 lt
random 25 fd 1] [rt 120] ]
      if ycor < -14 [set ycor (ycor + 1.5)]
    ]
end

to sickcattle
  ask cattle
    [
      if any? patches with [pcolor != red] in-cone 2 90
        [ fd 1]
      if any? patches with [pcolor = red] in-cone 2 90
        [rt 180  bk 1]
      if any? turtles with [breed = humans] in-cone 3 360
        [ set heading  random 360 rt random 30   ifelse patch-ahead .5 != red [rt random 35 lt
random 25 fd 1] [rt 120] ]
      if ycor < -14 [set ycor (ycor + 1.5)]
    ]
end

to infect  ;;creates "sickness" which cattle can contract
  create-infection 1
  ask infection
  [
    set color blue
    set shape "bug"
    set breed bug
    setxy (random -5 + 2) (random 15 + -3)
  ]
end
```

```
to sick
  ask cows  ;; changes agents color, so visual identification between sick vs. healthy can be made
  [
    if any? turtles with [breed = infection] in-cone 1 360
      [ set color 55 ]
    if any? turtles with [color = 55] in-cone 1 360
      [ set color 55 ]
  ]
;  ask infection
;  [
  ;  if any?
  ;]
end

to antibiotic  ;;creates "feed tubs" laced with antibiotic medication, representing one method of
delivering meds to cattle
  create-meds 1
  ask meds
  [
     set color yellow
     set shape "circle"
     setxy 1 0
     set heading 0
     hatch 1
     fd 6
     hatch 1
     fd 6
  ]
end

to heal  ;;represents the healing process, still need code here
  ask cows
  [
    if any? turtles with [breed = meds] in-cone 1 360
      [set color 54]
  ]
end
```

“Pasture” Model

```
breed [ sick sicks ]
breed [ infected infecteds ]
breed [ cow cattle ]
globals [ dosage time ]

to setup
  __clear-all-and-reset-ticks
  reset-ticks
  create-turtles herdsize         ;;the variable "herdsize" used to set the number of agents
  set-default-shape cow "cow"     ;;on the screen
  set-default-shape sick "cow"
  ask turtles
  [
    set breed cow
    set color 0
    set size 1
    set xcor random 32
    set ycor random 32
  ]
  ask patches                 ;;green patch color representing grass
  [
    set pcolor 55
  ]
end

to infection
  ask cattle  0
  [
    set color 15  ;;red
    set breed sick
  ]          ;; represents when one animal in a herd becomes sick
end

to interact
  tick         ;;establishes interactions between healthy and sick members of herd
  ask turtles
  [
    go
    ifelse any? turtles-here with [ breed = sick ]
      [
        if (breed != sick) and (random 100 < infectionchance)
         [
           set breed sick
           set color red
```

```
          wait .10
          sickmove
          doctor
        ]
      ]
        [go]
  ]
end

to doctor  ;;sets procedures for antibiotics
  if medchoice = 1
  [ ivomec ]
  if medchoice = 2
  [ covexin8 ]
  if medchoice = 3
  [ draxin ]
end

to go
  rt random 360
  lt random 360
  fd 1
 ; wait 1
end

to ivomec  ;;as color changes and time goes on, sickness subsides
  ask infected
  [
    set dosage ( averageweight / 110 )
    set time ticks
    if time > ( time + 100 )
    [set color 16]
    if time > ( time + 200 )
    [set color 17]
    if time > ( time + 300 )
    [set color 18]
    if time > ( time + 400 )
    [
      set color 0
      set breed cow
    ]
  ]
end

to covexin8  ;;work in progress
  ask infected
```

```
  [
    set dosage 5
  ]
end

to draxin  ;;work in progress
  ask infected
  [
    set dosage 5
  ]
end

to sickmove  ;;cattle which are "sick" move slower
   rt random 180
  lt random 180
  fd .50
end
```