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Application of Differentiation in Medical Science

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Abstract
Calculus is the numerical investigation of changes. Medicine is characterized as the science and/or practice of the anticipation, analysis and theory of physical or mental illness.Calculus has been by and large used in the clinical field to better the after effects of both the investigation of medication similarly as the usage of medication as treatment. Analytics is utilized in medication to quantify the cardiac output, blood flow, determination of population genetics and tumor growth among numerous different applications in both biology and medicine.
Calculus has been applied widely in medical fields especially in determining changes and providing cure at right time and effective manner.

Keywords-Blood flow, Growth of tumor, HIV medicine.

3.Introduction

3.1 Tumor Growth rate :

A tumor is aunusual development of cells and have 3 levels.

Benign tumor [First level]:

It doesn't enter the tissues which are in the surroundings or open out to various parts of the body yet they can posses serious issue to the main structures like nerves and blood vessels.

Premalignant [subsequent level]:

This level is in the process of becoming malignant and is known as pre-cancerous tumor.

Malignant Tumor [last level]:

These tumors slowly become worse and can finally result in death. Unlike the first level malignant tumors grow fast and are in search of new territory and they metastasize. This last level is cancerous tumor.

3.2 Velocity Gradient of Blood flow:

Hypertension can impact the limit of the walls to open and close.

B.P. high →walls of artery greater →less space for blood flow

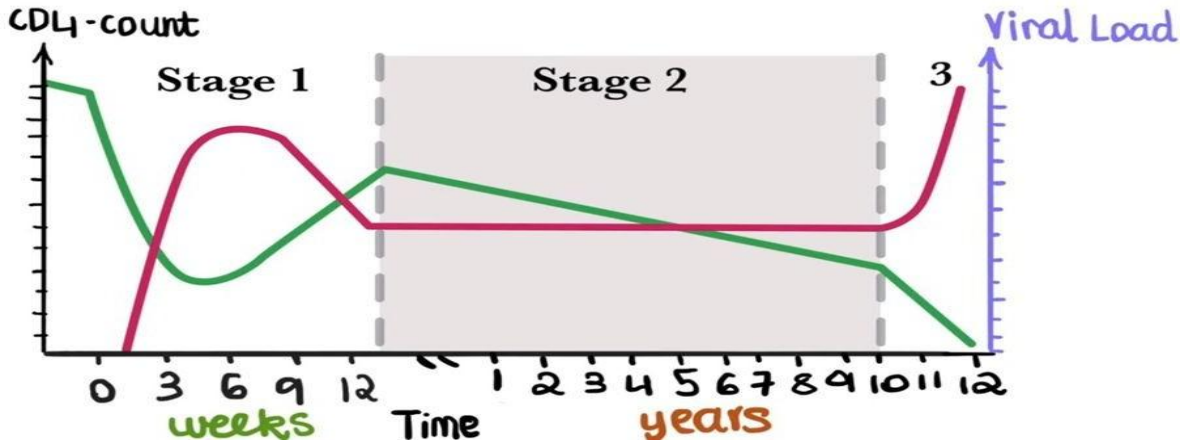
We can compute the velocity of blood stream with the assistance of differentiation and distinguish in case there are some kind of problem with the B.P. or the walls of the blood vessel.

3.3 Differentiation in medicine:

Arranged by right dosage of a drug, the drug concentration over time is determined by utilizing differentiation. This stops under and over-dosing. Indeed, course over time can be determined utilizing a differential equation.

3.4 Detect the stage of HIV/AIDS:

This disease breakout in 1980, the HIV virus enters the body and targets the particular immune cell called CD-4 Lymphocytes (maintaining the body's immune system) and infiltrates the cell machinery causing them to produce more viruses these lymphocytes also often die and also kills other immune cells. HIV has 3 stages



Stage1:Sharp increase in viral load and decrease in CD-4 count

Stage 2: Suddenly the patient is stabilizing, symptoms disappear. This stage lasts for nearly 10 years and is called long term stage of infection & CD-4 count was slowly decreasing till 3rd stage.

Stage 3: The number of CD-4 cells falls beneath a certain limit of 200 cells/uL then the person is said to have AIDS and has nonfunctional immune system and can be infected by many diseases and final stage is death.

We can give medicine at right time of stage 1 and reduce the chances of AIDS. This study was possible only with the help of differentiation.

4.Growth Rate of Tumor:

Tumor grows at a rate which is directly proportional to its volume. Large tumors develop rapidly and small tumors will growslow.

In order to find the tumors volume we use the exponential growth model stated as

$V(t) = V_0.e^{kt}$

V_0 = introductory volume

e = exponential growth

t=time

k= growth constant

Volume equations derivative is required to determine the rate change in tumors growth

$V(t) = V_0.e^{kt}$

$dV/dt = V_0.d(e^{kt})/dt$

Because $e^{kt}$is a convoluted capacity, utilizing chain rule to derivative it.

$e^{kt}\frac{dy}{dt} = \frac{dy}{du} . \frac{du}{dt}$

$u = kt\frac{dy}{dt} = k. e^u$

$y=e^u\frac{dy}{dt} = k. e^{kt}$; du/dt = k ; $dy/du=e^u$

This calculation performed above, gives the derivative of

$e^{kt}=k. e^{kt}$

$V'(t) = V_0 .k .e^{kt}$

Since V(t) itself is equivalent to $V_0 .e^{kt}$ we may conclude

$V'(t) = k .V$

To prove this theory we have an example:

- LARGETUMOR

Determine the rate change of tumor having a growth constant of 75/1000 when its initial volume is $10cm^3$ over 7 years of time period.

$V(t) = V_0 .e^{kt}$

$V(7)=10.2178^{(0.075)7}$ $V(7)=1505/100\ cm^3$

$dV/dt = k . V$

$dV/dt = 75/1000 * 1505/100$

$dV/dt = 113/100\ cm^3$/ years

Now calculate rate change of smaller tumor having similar time period and growth constant.

- SMALL TUMOR

Determine the rate change of tumor having a growth constant of 75/1000 when its initial volume is $2cm^3$ over 7 years of time period.

$V(t) = e^{kt}*V_0$

$V(7)=2.2178^{(0.075)7}*2$

$V(7) = 301/100\ cm^3$

$dV/dt = V*k$

$dV/dt = 75/1000* 301/100$

$dV/dt = 23/100\ cm^3$/ years

This calculation clearly shows that it is important to detect a tumor in its early stage. It is critical to provide right treatment which slows down or stops the tumor growth because larger tumor will grow and may become cancer which negligible chance to be cured.

5.BLOOD FLOW

We can process the speed of the blood stream and recognize the pulse. The vein is cylindrical with radius R and length L. Because of the rubbing at the dividers of the vessel, the speed of the blood isn't something very similar in each point.

The Law Laminar Flow gives us relation between radius and velocity this law was given by Jean Louis Marie Poiseuille, France Physician, in 1840

$V = \frac{1}{4}\frac{p}{L\eta}(R^2 - r^2)$

V= volume [initial]

η = blood consistency

P= difference in pressure [between the end points of the blood vessels]

L= vein length

R= vein radius

r= explicit point radius [point inside the vein]which is to be determine

The law of laminar flow is derived in order to calculate the rate of change of the specific point in the vessel of blood [i.e. the velocitygradient]

$$v = \frac{1}{4}\frac{P}{L\eta}(R^2 - r^2)$$

$$\frac{d\upsilon}{dt} = \frac{P}{4L\eta}\frac{d\upsilon}{dt}(R^2 - r^2)$$

$$\frac{d\upsilon}{dt} = \frac{P}{4L\eta}(0 - 2r)$$

$$\frac{d\upsilon}{dt} = \frac{-2rP}{4L\eta}$$

Example: The radius of left radial artery is 2.2 mm[approx.] and the bloods consistency is 0.0027Ns/m^2. The vessel length is 20 mm and the difference in pressure is 0.05 N. Determine the speed angle at radius 1mm from focus of the vessel?

V' =

$-2rp\ 4\eta L$

$$V' = \frac{-2.1*0.001*0.05\ 4*0.0027*20*0.001}{-10^{-4}2.16*10^{-4}}$$

$$V' = \frac{}{}$$

V’ = -0.46m/s

The value of velocity Gradient(V’) is -0.46m/s. If the V’ is too high, the individual may have a narrowing in his/her vein and needs further treatment and assessment.

6.Calculus in medicine

- The measure of medication in a milliliter of a patient's blood is given by the condition: $M(t) = 2t - (t^2)/4$, where M is the measure of medication in mg and t is the quantity of hours passed since organization. decide the pace of progress in medication 5 hours after the organization.

$M(t)=2t-(t^2)/4$

Rate of change = $M'(t)=2-2t/4$

At t =5

$M'(t)=2-5/2=2-2.5$

=-0.5 mg/hr

Rate of change in medicine 5 hours after administration is decreasing at 0.5 mg/hr

“Although the equation for each drug looks unique depending on its properties and the patient’s anatomy, differentiation is necessary for medical professionals to have the ability to map the relationship between drug concentration in the body over time.”

7.Differentiation in fight against HIV/AIDS:

In 1994 a new class of drugs called Protease Inhibitor were discovered they prevented newly formed HIV virus from maturing leaving them harmless and non-infection less. In 1995, scientist "David Hoe and Alan Parkinson" administer these drugs to patients who had stage-2.

Hoe and Parkinson were looking for unknown function.

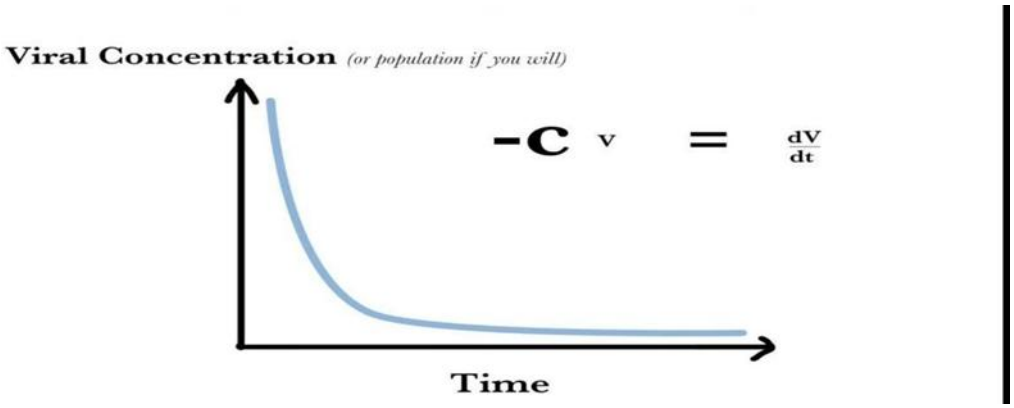
$V*(-c) = \frac{dv}{dt}$

V(t) = time after drug administered V= current viral concentration

-c = clearance rate of the virus

dV/dt = rate of change of viral focus over the long run

since rate of clearance is consistently bad this implies populace is continually diminishing.



$-c*V = \frac{dV}{dt}$

dV/V=-c*dt

$\int(-c)dt = \int dV/V$

-ct +D = ln[V(t)] + C

-ct + A = ln[V(t)]A = D-C

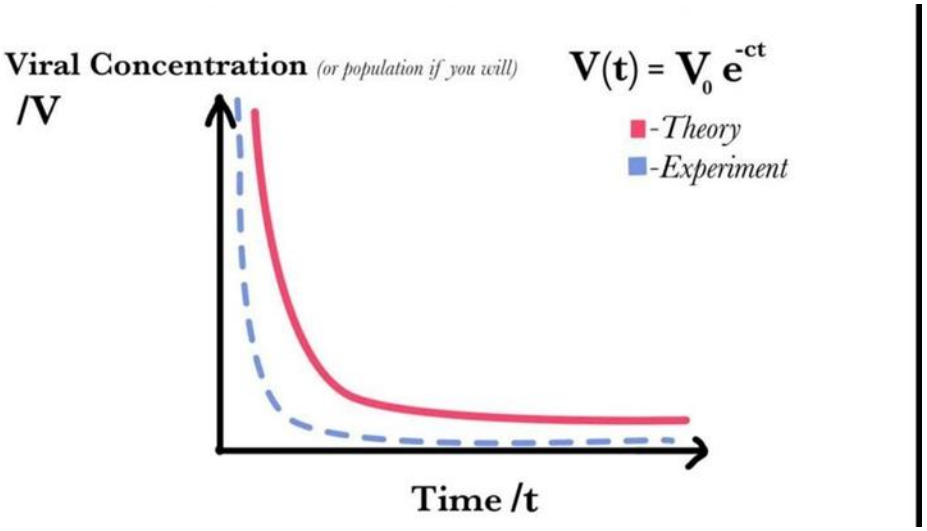
$V(t) = e^{-ct+A}V(t) = e^{-ct}*e^{A}$

T=0, time at beginning of experiment when no drugs are given $V(0) = e^{-c*0}e^{A}$

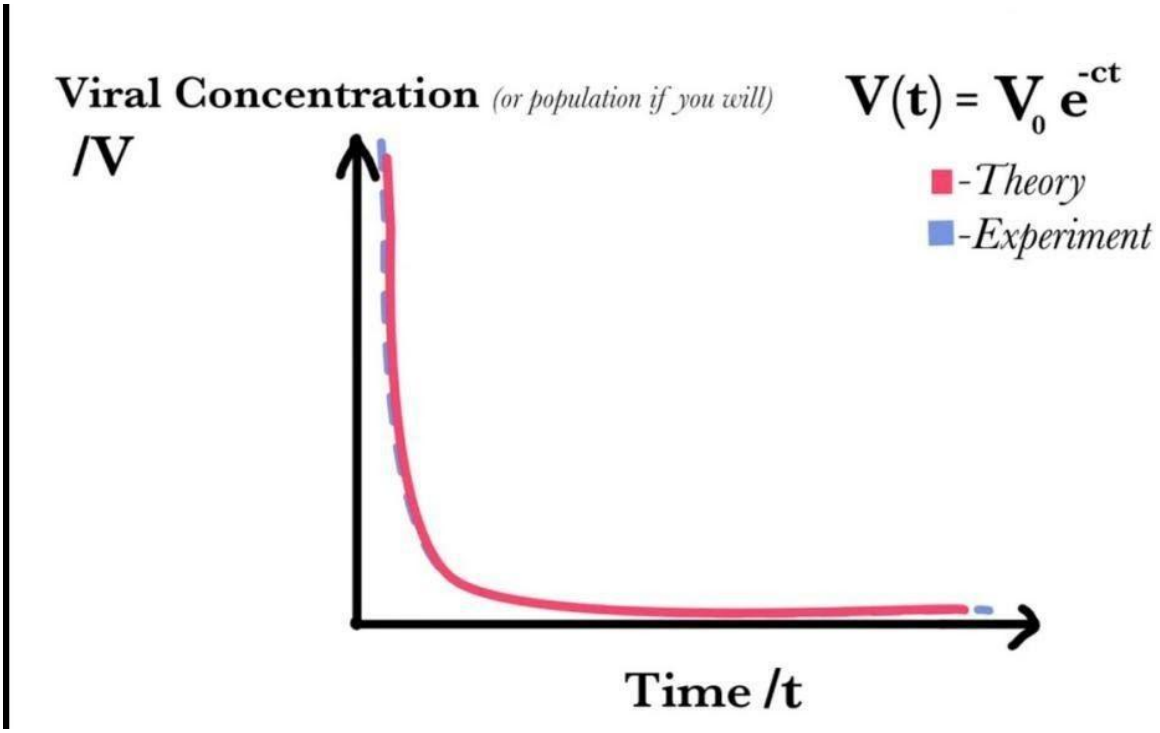
$V(0) = e^{A}$

e^A= initial population of the virus $V_0 = e^A$

$V(t) = V_0 * e^{-ct}$



Known data was used to gauge the worth of c so that the theoretical graph & experiment could fit perfectly.



Differentiation shown here how quick the populace diminished with the impact of protease

inhibitors.

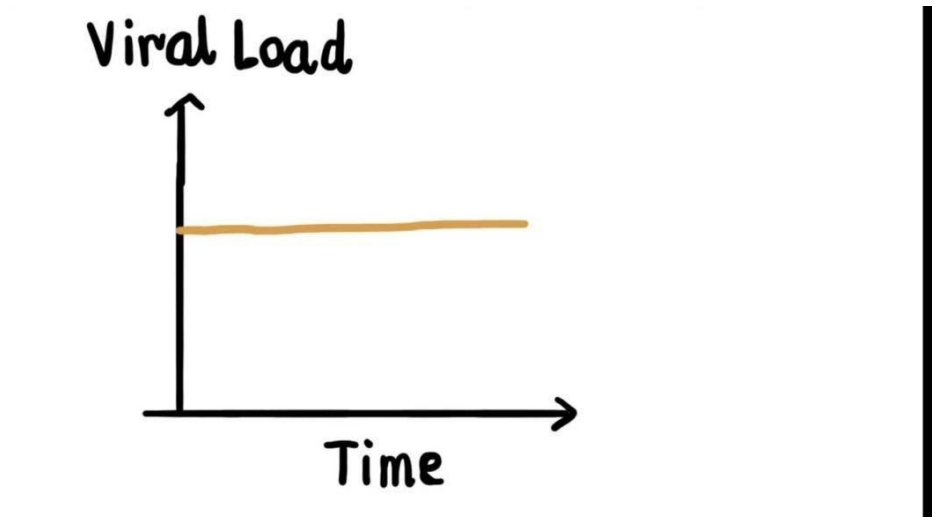
$\frac{dV}{dt}$=-cV

Anyway, they actually wanted to see what happened without using the drugs. As that would give clear picture of what happened in stage-2. To do this they remodeled the initial equation:

P* (-c)*V =

dVdt[Birth rate – Death rate = change in Population]

Here P = uninhibited rate of viral production / cells per day [without induction drugs]



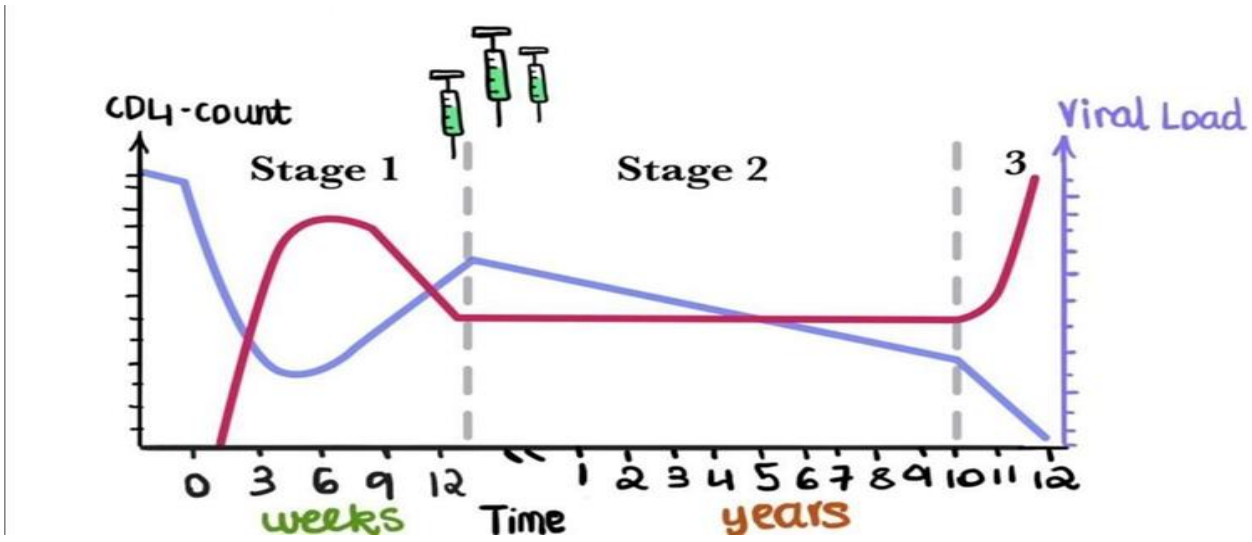
During chronic stage viral load remains constant i.e., no overall change in concentration (graph is a straight line)

$\frac{dV}{dt}$

$P - cV = 0 \quad P = cV$

P turned out to be 1 billion particles per day

If 1 billion particles are being produced during the chronical stage per day but the graph in this stage remains straight. This is only possible when those many viruses can be cleared by the body.



Thus, Hoe and Parkinson showed the world how the body is involved in a massive war during HIV from day one and till the very end. This Discovery was made possible only due to “Differentiation”.

8.Conclusion:

Medicine is a field of life sciences that is exceptionally subject to calculus as a strategy to investigate various angles. Calculus has been applied widely in medical fields especially in determining changes and providing cure at right time and effective manner.

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