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A Mathematical Model for Combination of Chemotherapy and Targeted the rap yin Breast cancer treatment

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Abstract

Breast cancer has impacted the majority of women in India and around the world. HER2 positive breast cancer is one of the most common forms of the disease. Those malignancies spread more quickly than other breast cancers do. It is possible to treat certain types of cancer by using a combination of chemotherapy medications such as cyclophosphamide, Adriamycin, and 5-Fluorouracil, together with Herceptin(trastuzumab). Analysis of the Gompertz tumor growth, chemotherapy and Herceptin medication levels is the focus of this study.

Keywords:Breast cancer, Herceptin, HER2, and targeted therapy

Introduction

Breast cancer is the most common type diagnosed in Indian women. More than one million women in India are diagnosed with breast cancer each year. According to a poll, one woman in India is diagnosed with breast cancer every four minutes, and one woman dies of breast cancer every eight minutes. Only a few guys have been diagnosed with breast cancer. Women between the ages of 30 and 50 are increasingly being affected by the disease. A variety of breast cancers exist, and not all are the same. Triple negative breast cancer is one of the most common forms of the disease. There's no mistaking the distinction. e

a specific location in the breast. Breast cancer that has been shown to be HER2 positive is one of these. This form of cancer and its therapy will be the focus of this research project..

Human Epidermal Growth factor Receptor 2 (HER2) The HER2 protein is made by the HER2 gene. Breast cells have receptors for these proteins. Her2 receptors are involved in

regulating how quickly breast cells grow, divide, and heal. However, the HER2 gene may not function adequately in all circumstances. It's a lot like making a lot of duplicates of yourself. Her2 overexpression causes excessive cell growth and division in breast cancer patients who carry this gene mutation. In breast cancers that express the HER2 gene, the tumors develop and spread more quickly. These are HER2 positive cancer cells, which means they produce more of the protein. As a result, the cancerous cells multiply rapidly. Stages of cancer treatment for this form of malignancy. The tumor's size, location, and extent are used to categorize it into stages.components of the body (metastases). HER2 positive breast cancer can be treated with surgery, radiation therapy, chemotherapy, hormone therapy, and targeted therapies. Chemotherapy can be used as the primary treatment and in combination with targeted therapy for metastatic breast cancer. There are two strategies to treat non-metastatic

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breast cancer. A good place to start is with localized treatment. In other words, you're taking measurements of the tumor in preparation for surgery and radiation treatment. Systemic therapy is the second option. Chemotherapy, Hormonal therapy, and targeted therapy are all included. In the coming months, we'll look into the possibility of using chemotherapy in conjunction with targeted therapy. This is the case here. paperweconstructamathematicalmodel fortumor growthand drugconcentrations.

Treatmentsfor HER2 positivebreastcancer
Chemotherapy and Herceptin (trastuzumab) can be used to treat HER2 positive breast cancer. There are no distinct differences in the treatment of HER2 positive breast cancer from those of other types of the disease. As a result, cancer-killing medications can be used to halt tumor growth. In this case,of cancer elders had a poorer prognosis because the side effects of targeted drugs. In thiscombinationgetthe positiveresultsfromtheage below65 andthetumor sizelessthan5cm.

Chemotherapyforbreastcancer
There are many different ways to treat cancer, and chemotherapy is one of them. Intravenous infusions, injections, and pills are all forms of breast cancer chemotherapy medications that may be administered. Breast cancer patients will receive this type of systemic treatment. Oncologists employ these drugs to stop the growth of cancerous cells by preventing DNA damage and the synthesis of aberrant proteins. Normal cells are also affected. Breast cancer is a common target for several chemotherapy treatments. Some medications are administered on their own, while others are given in combination with one another. The term regimen refers to the combination of Chemotherapy treatments. For our model, CAF (Cyclophosphamide, Adriamycin, and Fluorouracil) was the best regimen. To get the most benefit from chemotherapy, patients should only receive it once every 21 days, giving them time to replenish their blood levels.

HerceptinTherapy(TargetedTherapy)forBreast Cancer

Treatment for HER2-positive breast cancer involves the use of the chemotherapy drug Herceptin, which is administered intravenously. Anti-HER2 medication Herceptin is a humanized monoclonal antibody. In essence, it is a protein that specifically attaches to and targets HER2. The use of targeted medicines is particularly prevalent in the treatment of breast tumors that test positive for HER2. Improved survival rates have resulted from this. Herceptin inhibits the tumor's ability to receive nutrients and blood by reducing blood flow. Herceptin is a medication given to patients undergoing chemotherapy as part of their treatment regimen. Chemotherapy was administered after the initial Herceptin dose of 6 milligrams per kilogram, and the cycle was repeated every 21 days for a year.

Mathematicalmodel formulation

Considerthe Gompertzgrowthmodelfortumorgrowth

$$\frac{dT}{dt} = aT\ln(k) - \alpha C_i(t)T - \beta HT$$

Chemotherapydrugactingin anexponential function is

$$C_i(t) = D_i e^{-bi(t-n\omega)}, k\omega \leq t < (k+1)\omega$$

$$\frac{dH}{dt} = h(t) - 5H$$

Where T is the tumor volume, $i(t)$ is the Chemotherapy drug concentration and H is the Herceptin drug and the remaining parameters are

a-Tumor growth parameter

k-Carrying capacity of tumor growth

α-Death of tumor cell due to Chemodrugs

β-Death of tumor cell due to Herceptin

D-The amount of drug in the dosage form

k-Dose number

ω- Length of the dose

$h(t)$- The amount of Herceptin drug

5-Decay rate of Herceptin in drug

The stability of equilibrium

Let's take a look at some of the breast cancer model's characteristics. Consider that all of the parameters are in the affirmative. Take a look at the starting points. At t = 0, T(t) = T0 - 0 akd T(t) At t = 0, H(t) = H0 0, and so on. The first equation's solution is T 0.

dH = h(t) - 5H means that there is no solution of H(t) with H(t) > 0 that can be zero.

dt

Based on our calculations, we have TE.

In other words, the equation is:

In other words,

yAccording to J = (1 e), the Jacobian matrix

(C (t)+h (t)) is
It is important to note that the
One is equal to one, while five is more than zero.
As a result, an unstable equilibrium exists in the system.
Treatment observation
Fourteen patients' records were gathered for this study, according to the best hospitals in Chennai. HER2 positive breast cancer was found in all of the patients, with tumors ranging in size from 1 cm to 4.5 cm. This regimen is comprised of 600mg/m2 IV cyclophosphamide and Adriamycin (60mg/m2) IV and 5-fluorouracil (500 mg/m2) IV every 21 days for a total of four cycles. Trastuzumab (6 mg/kg) IV should be administered to patients on day one and every 21 days for a year. The following table contains information on the patient. Treatments must be discontinued if they cause intolerable harm to the patients. In this treatment period, 11 of the 14 patients had a positive outcome. In the second round, three patients had to stop their regimen.because they had cardiac adverse events.The patients P1,P2 and P7 had not continued this

regimen because of their age and toxicity of the drugs. Other patients had little side effects.

Patients	Age	Tumor size(cm)	HER2	C	A	F	T
P1	68	4.5	POS	600	60	500	6
P2	66	4.2	POS	600	60	500	6
P3	55	4	POS	600	60	500	6
P4	47	3.5	POS	600	60	500	6
P5	51	3.2	POS	600	60	500	6
P6	42	3.2	POS	600	60	500	6

P7	71	2.7	POS	600	60	500	6
P8	60	2.5	POS	600	60	500	6
P9	48	2.5	POS	600	60	500	6
P10	38	2.3	POS	600	60	500	6
P11	56	2.2	POS	600	60	500	6
P12	41	2.1	POS	600	60	500	6
P13	58	2	POS	600	60	500	6
P14	49	1.5	POS	600	60	500	6

Initial dosagefor C=cyclophosphamide,A=Adriamycin(mg/m2),F=5-fluorouracil(mg/m2), T=trastuzumab(mg/Kg)
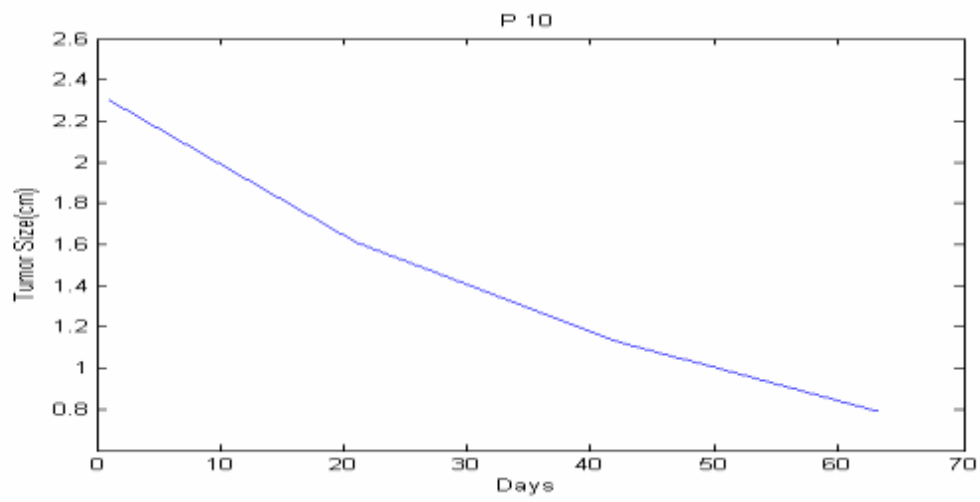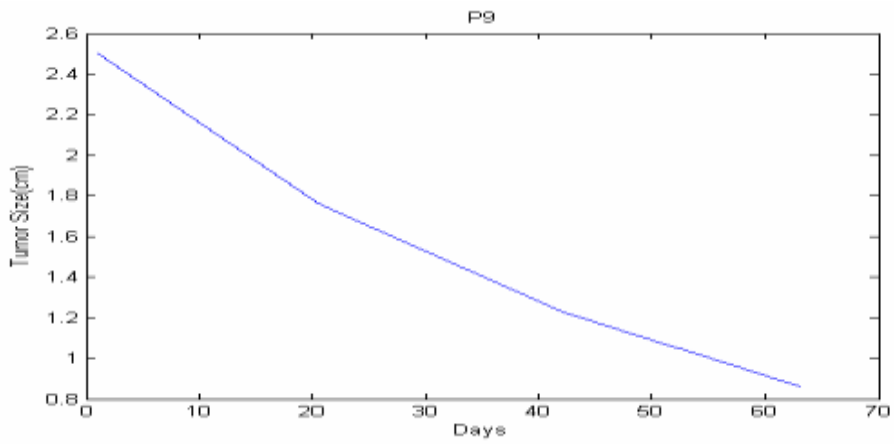Thedatawerefittedtoourmodelandfindtheshrinkageofthetumorforeachpatientas showninthefollowingfigures.
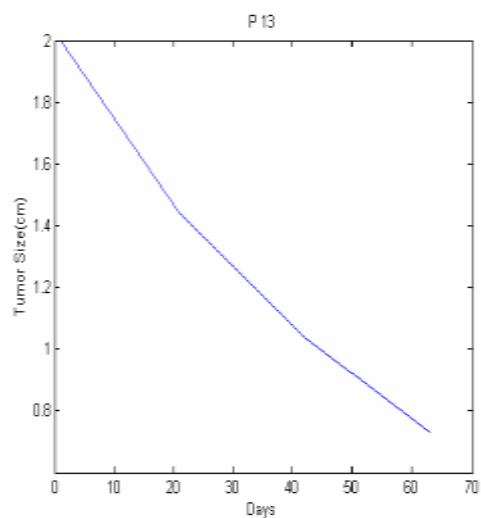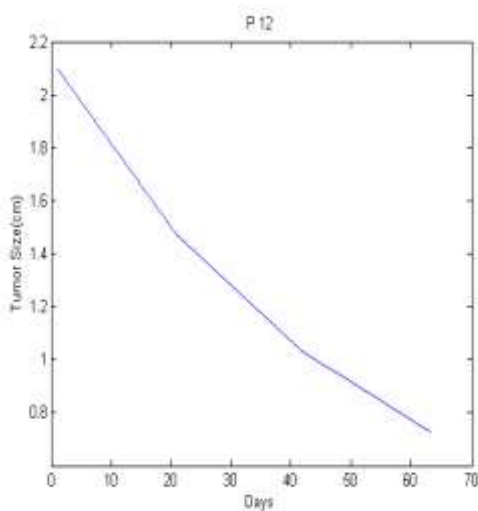Drugconcentration

Tumorshrinkagefor11 patientswas giveninthe followinggraphs.

P6

P5

P9

P 10

P 11
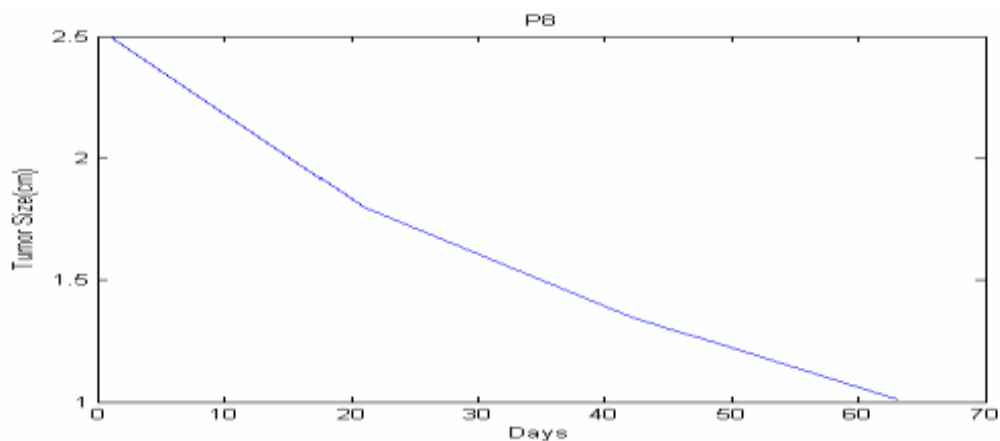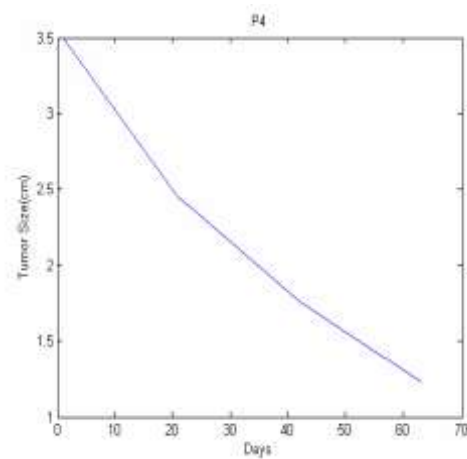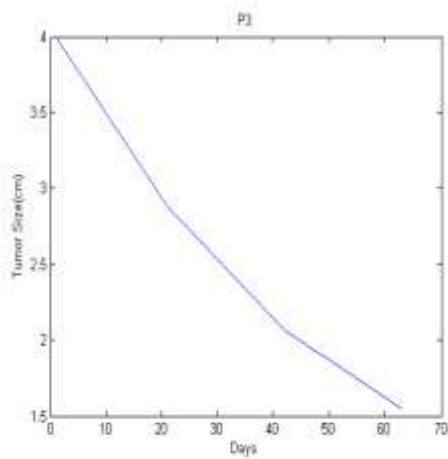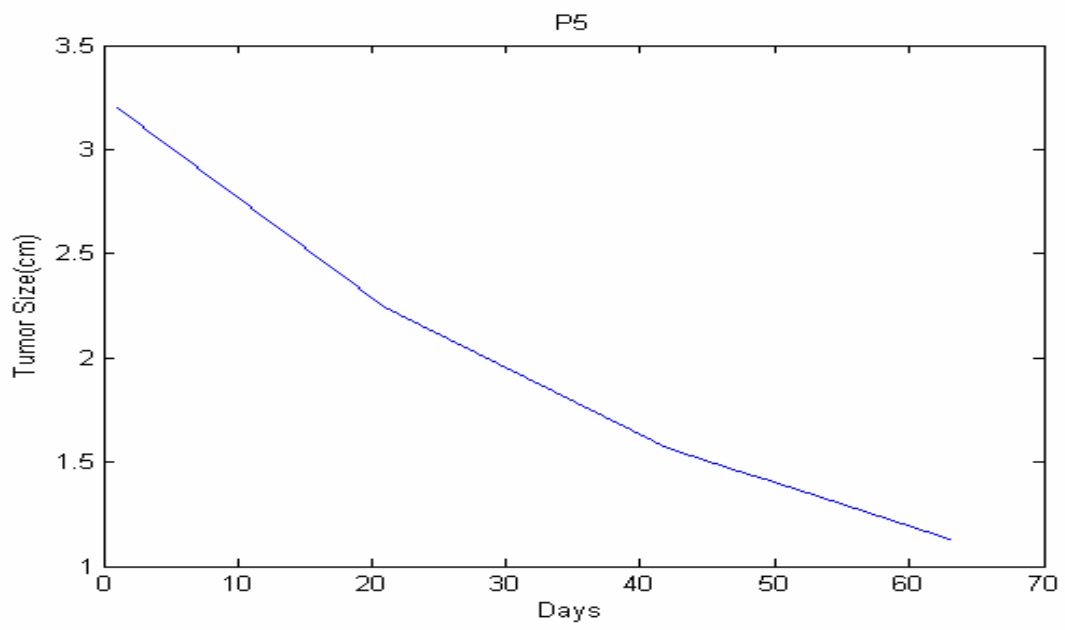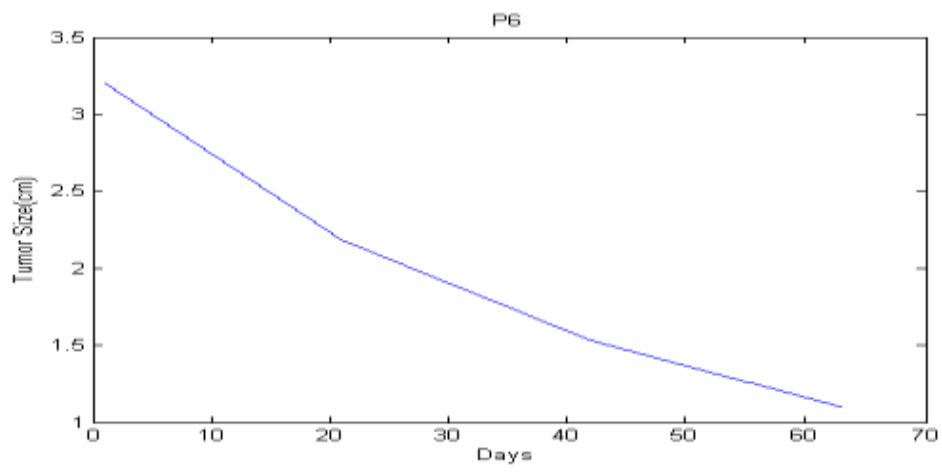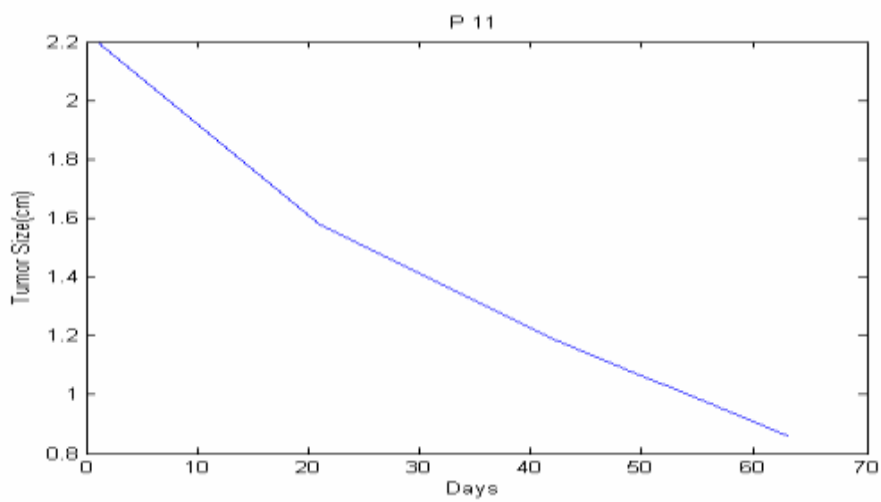
Conclusions

CAF+T is efficacious, and the cardiotoxicity profile is tolerable. Patients with HER2-positive breast cancer under the age of 65 and a tumor less than 5 centimeters in size should have the option of receiving trastuzumab in combination with chemotherapy as a standard treatment. We may be able to notice the favorable results from the survey in a one-year follow-up.

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