

Analysis of the Effect of Prognosis Factors for Breast Cancer

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Research article

Keywords: Prognosis Factor, Logistic Regression, Breast Cancer, Bio Statistics

Posted Date: August 20th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-44838/v1>

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Abstract

Background: The idea of Prognosis factor is based on the variables that can be used to assess the chance of recovery from a disease. It is also considered as the prior knowledge about any disease before treatment. The concept is applied to the cancer patients to get an idea of how cancer will affect the body and how it will respond to the therapies.

Method: In this paper, selective prognostic factors (Age, Node and Tumour size) are analysed by logistic regression in patients who are suffering from Breast cancer based on data collected from Cachar Cancer Hospital and Research Centre, Silchar, Assam, India.

Results: The study claims that there are 50.1 percent and 65.8 percent chance of remission of cancer for patients of age above 50 in case of breast cancer with below poverty line and above poverty line respectively.

The present study has focused on this cut-off value of 2 cm as the determining prognostic factor in relation to tumour size. Thus, the chance of remission from cancer is 22.3 percent and 34.7 percent for below poverty line and above poverty line patients respectively, if tumour size is greater than 2 cm.

It also endeavours to ascertain that there are 10.9 percent and 18.1 percent chances of remission of cancer, if the disease has metastasized to regional lymph nodes, with below poverty line and above poverty line respectively.

Conclusion: The parameters viz. Tumour size and Node status, which measure the stage of the cancer patients, are significant prognostic factors that help in predicting tumour behaviour and survival outcomes for breast cancer patients.

Background

Prognosis factors are defined as the variables that can be used to assess the chance of recovery from a disease. It is also considered as the prior knowledge about any disease before treatment. The concept is applied to the cancer patients to get an idea of how cancer will affect the body and how it will respond to the therapies. It is difficult for the common people to take decision about treatment methods due to lack of knowledge and different socioeconomic backgrounds. Thus, the prior knowledge will benefit the common people to participate in clinical and health policy decisions through prognostic and economic evaluation of cancer treatments. Although many prognostic factors have been identified over the last few decades, affecting the survival outcomes for breast cancer, there are some that have been proven to be of definite significance through various statistical methods. These include – tumour size, nodal status, distant metastasis, histologic grade, histologic type, mitotic figure counts, hormone receptor status like Estrogen Receptor (ER) and Progesterone Receptor (PR) positivity and age of the patient (*Russo.et.al, 1987*). The present study will focus on tumour size, nodal status and age in relation to survival outcomes for breast cancer. Though these factors are already proven to be of significant importance in various

studies, the present study will bring out their importance so as to guide future treatment decisions. In addition, the economic status of the patients has been evaluated as a possible demographic factor affecting choice of treatment and the resultant survival outcomes.

It is a matter of serious concern that new cases of the breast cancer are growing up day by day all over the world (*Ali.et.al, 2011*). Thus, the effect of the prognosis factors on this site of cancer should be studied scientifically so that the patients can get an idea of economic and health policy decisions during the ongoing treatment processes. A comparative study was performed by *Kroman.et.al*, in the year 2000, among the women who treated through adjuvant cytotoxic treatment and who did not in case of breast cancer. Thus, it is found that there is a negative prognostic effect of young age in women diagnosed with low risk disease who did not receive adjuvant cytotoxic treatment (*Kroman.et.al, 2000*). Thus, the present paper is mainly focused on the analysis of prognosis factors (Age, Node and Tumour size) for the patients suffering from breast cancer and the findings of present research work will benefit the society for better treatment of cancer.

Objective Of The Study

The paper is designed keeping in view the following objective:

1. To study the effect of prognosis factors on the breast cancer patients by logistic regression model.

Methods

The entire data, used in this present study is a secondary source that is collected from Cachar Cancer Hospital and Research Centre, Silchar, Assam, India. The dataset is stratified on the basis of poverty line (BPL – below poverty line and APL – above poverty line) for normalization. It is necessary to normalize the dataset as the patients included in this study belong to different economic backgrounds. Thus, the patients, who have the BPL card are considered as Below Poverty Line category and those treated without these facilities as Above Poverty Line category.

In this study, data was collected from a total of 400 female patients, half of which belonged to BPL group and the other half to APL group. The following table gives a glimpse of the dataset.

Table 1
Glimpse of dataset

Sites of Cancer	Variable		Frequency	Percentage
Breast Cancer (Below Poverty Line)	Gender	Male	0	0%
		Female	200	100%
	Age	Age above 50	113	56.5%
		Age below 50	87	43.5%
	Lymph Node	Cancer spreads to LN	70	35%
		Cancer not spreads to LN	130	65%
	Tumour size	Tumour greater than 2 cm	163	81.5%
		Tumour less than 2 cm	37	18.5%
Breast Cancer (Above Poverty Line)	Gender	Male	0	0%
		Female	200	100%
	Age	Age above 50	93	46.5%
		Age below 50	107	53.5%
	Lymph Node	Cancer spreads to LN	65	32.5%
		Cancer not spreads to LN	135	67.5%
	Tumour size	Tumour greater than 2 cm	146	73%
		Tumour less than 2 cm	54	27%

Binary logistic regression model was applied to observe the probability of remission of disease in the presence of these prognosis factors (Age, Node and Tumour size). It is the chance of an event occurring in a model based on individual characteristics. Because the chance is mainly a ratio, it can be computed as:

$$p = \frac{e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_m x_m}}{1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_m x_m}}$$

where p indicates the probability of an event, β_i 's are the regression coefficients associated with the reference group and x_i 's are the explanatory variables (Francis R., 2017).

In this present study, it will be convenient if we write our binary logistic regression model as follows:

$$p = \frac{e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3}}{1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3}}$$

where p = Probability of remission of cancer

x_1 = Age of the patients

x_2 = Node status of the cancer

x_3 = Tumour size of the cancer

Thus, we can write the model as follows.

$$\text{logit}(p) = \beta_0 + \beta_1 \times \text{Age} + \beta_2 \times \text{Nodestatus} + \beta_3 \times \text{Tumoursize}$$

Results

The purpose of applying logistic regression model is to observe the probability of remission from the cancer in the presence of the three prognosis factors viz. Age, Node and Tumour size. The analyses are done separately for both categories (BPL and APL) of breast cancer.

Table 2

Analysis of logistic regression model for breast cancer with below poverty line (BPL) category

Prognosis Factors	B	S.E	Wald	df	Sig.	Odds ratio	95% CI	
							Lower	Upper
Age above 50	0.663	0.291	5.203	1	0.023	1.501	1.098	3.432
Yes								
No®								
Cancer spread to Lymph Node	0.737	0.333	4.897	1	0.027	1.109	1.088	4.016
Yes								
No®								
Tumour size is greater than 2 cm	0.889	0.331	7.208	1	0.007	1.223	1.271	4.654
Yes								
No®								
Constant	0.392	0.259	2.293	1	.0130	1.480	-	-

Note: ® Denotes reference category.

We have obtained from Table 2 that in case of breast cancer with below poverty line category, there is 50.1 percent chance of remission from the cancer if the patient age is above 50, which is better in comparison to that for patient age below 50. Again, if the cancer has already metastasized to axillary lymph nodes, the chance of remission from the cancer is only 10.9 percent, which is worse as compared to the cancer that has not spread to the lymph nodes. The patients with tumour size greater than 2 cm have 22.3 percent chance of remission from cancer after the treatment, which is worse in comparison to the patients with the size of tumour less than 2 cm.

Table 3

Analysis of logistic regression model for breast cancer with above poverty line (APL) category

Variables	B	S.E	Wald	df	Sig.	Odds ratio	95% CI	
							Lower	Upper
Age above 50	1.043	0.366	8.111	1	0.004	1.658	1.384	5.817
Yes								
No®								
Cancer spread to Lymph Node	1.051	0.516	4.152	1	0.042	1.181	1.041	5.864
Yes								
No®								
Tumour size is greater than 2 cm	1.299	0.555	5.484	1	0.019	1.347	1.236	3.877
Yes								
No®								
Constant	-2.398	0.522	6.083	1	0.000	0.091	-	-

Note: ® Denotes reference category.

Similarly, from Table 3, it is obtained that there is 65.8 percent more chance of remission from the cancer if the patient age is above 50 in the comparison to the patient of age below 50. Again, if the cancer has already metastasized to axillary lymph nodes, the chance of remission from the cancer is only 18.1 percent as compared to the cancer that has not metastasized to regional lymph nodes. The patients with tumour size greater than 2 cm have 34.7 percent chance of remission of cancer in the comparison to the patients with the size of tumour less than 2 cm in case of breast cancer with above poverty line category.

Discussion

Preclusion of cancer is one of the most significant public health challenges of the 21st century (*Ali.et.al, 2011*). Further, new cases of breast cancer show an ever increasing incidence all over the world. Several prognostic factors have been identified which affect the outcomes of disease and treatment. Thus, the present study is mainly focused on the chance of remission of cancer in relation to three prognostic factors viz. Age, Node and Tumour size for the patients that are suffering from breast cancer.

The age of the patient is a well-defined prognosis factor for local recurrence. It is well established that patient age greater than 35 or 40 is associated with an increased frequency of local recurrence due to presence of various adverse pathologic features, such as lymph vascular invasion, grade 3 histology, ~~Losses of Estrogen Receptor (ER) and Progesterone Receptor (PR), presence of HER2 and presence of~~

extensive intra-ductal component (*Kollias.et.al, 1997*). Our study finds that there are 50.1 percent and 65.8 percent chance of remission of cancer for patients of age above 50 in case of breast cancer with below poverty line and above poverty line respectively. Thus, in agreement with previous studies, we can consider the higher age as good prognostic factor and younger age as poor prognostic factor in breast cancer.

Tumour size is considered to be the best measure of tumour behaviour in breast cancer. Patients with a primary tumour size of less than 1 cm exhibit a frequency of only 10 percent to 20 percent for nodal metastasis, such that the 10-year disease-free survival rate is about 90 percent (*Carter.et.al, 1989*). Since the American Joint Committee on Cancer (AJCC) has described tumour size less than or equal to 2 cm as T1, the present study has focused on this cut-off value of 2 cm as the determining prognostic factor in relation to tumour size. The chance of remission from cancer is 22.3 percent and 34.7 percent for BPL and APL patients respectively, if tumour size is greater than 2 cm.

Axillary lymph node status has been described as the second most important prognostic factor in relation to disease-free survival, as well as overall survival in breast cancer. 70 percent of node positive patients are likely to develop recurrence compared to only 20 percent to 30 percent of node-negative patients (*Veronesi.et.al, 1993*). Patients with 4 or more number of involved nodes have worse prognosis when compared to those with less than 4 nodes (*Fisher.et.al, 1993*). It is found from our study that there are 10.9 percent and 18.1 percent chances of remission of cancer, if the disease has metastasized to regional lymph nodes, with below poverty line and above poverty line respectively. Thus it can be concluded that the parameters viz. Tumour size and Node status, which measure the stage of the cancer patients are significant prognostic factors that help in predicting tumour behaviour and survival outcomes.

Conclusion

The present study has successfully brought out the relationship between specific prognostic factors and survival outcomes in breast cancer. The application of logistic regression model to the selected prognostic factors has revealed that a tumour size greater than 2 cm denotes a dismal prognosis, as does presence of axillary nodal involvement. Also, patient's age less than 50 years is associated with worse prognosis and poor overall survival.

List Of Abbreviations

Abbreviations	Meaning
cm	Centimetre
ER	Estrogen Receptor
PR	Progesterone Receptor
APL	Above Poverty Line
BPL	Below Poverty Line
LN	Lymph Nodes
p	Probability of remission of cancer
	Regression Coefficients
	Explanatory Variables
$\text{logit}(p)$	Logarithm of the odds, where p is the probability
B	, Regression Coefficients
S.E	Standard Error
Wald	Wald Statistic
d.f.	Degrees of freedom
Sig.	Significant
CI	Confidence Interval
@	Reference Category
Viz.	Namely
HER2	Human Epidermal Growth Factor Receptor 2
AJCC	American Joint Committee on Cancer
T1	Tumour size with 1 centimetre

Declarations

Ethics approval and consent to participate

The project was presented in front of Institutional Ethics Committee (IEC), Assam university, Silchar, Assam, India on 3rd April, 2019 (03/04/2019). The venue of the meeting was in the UGC-SAP conference Hall, Department of Life Science and Bioinformatics, Assam university, Silchar, Assam, India.

The Institutional Ethics Committee (IEC) had taken the decision that the project falls under exempted category as no participation of Human volunteer is directly involved and data will be collected from secondary sources.

The administration of the hospital (Cachar Cancer Hospital and Research Centre) had granted the permission to access and use the medical records for this particular study. The ethical committee decision report and permission letter of the hospital have been attached in the supplementary materials section through online process.

Consent for publication

“Not applicable”

Availability of data and material

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Competing interests

The authors declare that they have no competing interests.

Funding

“Not applicable”

Authors' contributions

The corresponding author of this paper is MD, who has analysed the data and interpreted the result as well as writing the whole manuscript.

DJB is the co-author of this manuscript and contributed himself as the supervisor as well as guardian of this project.

It has been declared that all authors have read and approved the manuscript.

Acknowledgements

The authors would like to take this opportunity of expressing their gratitude and acknowledging their indebtedness to the director of Cachar Cancer Hospital and Research Centre, Dr Ravi Kannan sir and the hospital staffs for the permission and providing the required dataset for this project.

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Supplementary Files

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- [RevisedDataset.xlsx](#)