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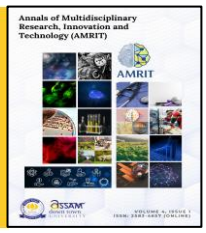

RESEARCH ARTICLE

CANCER PROGNOSTIC INDICATORS

Assessing Prognostic Indicators in Cancer: Insights into Survival Trends and Risk Stratification

Mrinal Deka [1]*

[1] Faculty of Science, Assam down town University, Panikhaiti, Guwahati, Assam 781026, India

*Corresponding author: Mrinal Deka, Email: *mrinal.deka@adtu.in*

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Abstract

This paper reports the prognostic factors (age, lymph node involvement, and tumour size) in patients with oral, lung, and breast cancer treated at Cachar Cancer Hospital and Research Centre, Silchar, Assam. Logistic regression analysis was performed to assess these factors' impact on recovery chances. Additionally, survival probabilities were compared using Nelson-Aalen and Kaplan-Meier estimators. The study reveals a significantly higher risk of cancer recurrence in patients over 50 years old, with lymph node involvement and larger tumour sizes. Non-parametric bootstrap analysis suggests that the Nelson-Aalen estimator provides more accurate survival probabilities. Furthermore, treatment comparisons indicate that combinations of surgery, radiotherapy, chemotherapy, and hormone therapy yield better survival rates compared to other therapies for breast, lung, and oral cancer.

Keywords: *Prognosis, Survival, Cancer, Logistic Regression, Bootstrap Analysis*

1. Introduction

Prognosis factors are considered prior knowledge about any disease before treatment. The concept is applied to 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 decide on treatment methods, as the preferred treatments for cancer are at a high cost. Thus, prior knowledge will benefit the common people in making clinical and health policy decisions through economic evaluations of cancer treatments. In this paper, age, node size and tumour sizes are considered as prognosis factors to observe the chance of returning the cancer to the patients that are suffering from three sites of cancer, viz. oral, lung and breast cancer. The patient's age is a well-defined prognosis factor for local recurrence caused by the presence of various adverse pathological features such as lymph vascular invasion, grade 3 histology, absence of Estrogen Receptor (ER) and Progesterone Receptor (PR), presence of HER2 and presence of extensive intraductal component [1]. Patients with primary tumours under 1 cm exhibit a frequency between 10-20 per cent nodal metastases only, a disease-free survival rate at 10 years of age is about 90 per cent then and therefore considered a cancer prognosis [2]. In addition to this, survival probabilities are computed for each site of cancer through Kaplan-Meier and Nelson-Aalen estimators and testing whether the two estimates differ significantly using bootstrap analysis.

2. Literature Review

Considering cancer risk factors to have utmost importance, various studies on cancer prognosis variables have been undertaken concurrently in recent years [3,4]. Research reveals that the knowledge of prognosis factors helps the general public in undertaking clinical and health policy choices, implicitly evaluating themselves on the economic implications of any cancer therapy [1]. A Comparative study was conducted in the year 2000 between those treated vs. those not treated with adjuvant cytotoxic therapy for breast cancer [5].

According to the study, young age has a negative prognostic effect in women diagnosed with low-risk disease who did not receive adjuvant cytotoxic treatment. Using the Markus Ionisation Chamber Detector, research computed the changes in Out-of-Field Dose related to radiation for various prognosis factors such as field size and depth of malignancy [6]. A study found that the effects of blood pooling, considering this as a prognostic factor, affect the levels of radioactivity measured in cancer tissues [7]. The 'Stage' of most cancers is an essential prognosis factor as the delay between the appearance of signs and symptoms and the patient's presentation to health care might lower the probability of healing [8].

However, the relationship between the prognosis factors and the socio-economic status of the family units has not been broadly studied in the above-mentioned research studies. The current study, under the limited domain of South Assam, tries to fill the gap in the literature available in this context.

3. Methods

The prognosis factors (Age, Node and Tumour size) are analyzed by logistic regression for the patients who are suffering from Oral, Lung and Breast cancer based on data collected from Cachar Cancer Hospital and Research Centre, located at Silchar town of Assam, India. Logistic regression is the chance of an event occurring in a model based on individual characteristics. Because the chance is mainly a ratio, that can be computed as

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

where p indicates the probability of an event, are the regression coefficients associated with the reference group and are the explanatory variables [9].

Now, non-parametric bootstrap analysis is applied to test whether the two estimates differ significantly. It is a resampling technique with replacement to estimate the statistics of a population. The purpose of using this analysis is that it is a powerful statistical tool and more convenient to quantify the uncertainty associated with a given estimator or statistical learning method. As the technique is a random sampling method with replacement, there is an equal chance of being chosen as a sampling unit in the sample. In addition to this, the number of repetitions can be managed intentionally, which reduces the chance of increasing the error term in the model [10].

4. Results

In this present study, prognostic factors (Age, Node and Tumour size) are analysed by logistic regression for the patients who are suffering from oral, lung and breast cancer based on data collected from Cachar Cancer Hospital and Research Centre. The purpose of applying a logistic regression model is to observe the probability of returning the cancer in the presence of these prognostic factors. In addition to this, the survival probabilities obtained from Kaplan-Meier and Nelson-Aalen estimators are also compared for the above-mentioned sites of cancer by applying non-parametric bootstrap analysis. The dataset is classified on the basis of poverty lines (BPL and APL), as the preference for treatments for cancer is at a high cost. Thus, it is dependent on the patients' standard of living. We consider our null hypothesis that the test statistics are not statistically significant for both estimators.

Table 1: Analysis of logistic regression for different prognosis factors.

Breast Cancer				
Variables	Sig.	Odds Ratio	95 % CI	
			Lower	Upper
Age > 50	0.023	1.501	1.098	3.432
Cancer spread to Lymph Node	0.027	1.109	1.088	4.016
Tumour size > 2 cm	0.007	1.223	1.271	4.654
Constant	.0130	1.480	-	-
Lung Cancer				
Variables	Sig.	Odds Ratio	95 % CI	
			Lower	Upper
Age > 50	0.004	1.658	1.384	5.817
Cancer spread to the Lymph Node	0.042	1.181	1.041	5.864
Tumour size > 2 cm	0.019	1.347	1.236	3.877
Constant	0.000	0.091	-	-
Oral Cancer				
Variables	Sig.	Odds Ratio	95 % CI	
			Lower	Upper
Age > 50	0.030	1.705	1.086	3.062
Cancer spread to Lymph Node	0.038	1.250	1.040	3.790
Tumour size > 2 cm	0.057	1.287	0.997	3.079
Constant	0.012	0.375	-	-

It has been observed that there is a 50%, 65% and 70% higher risk of coming back cancer and less favourable prognosis for the patients who are over 50 years of age in case of breast, lung and oral cancer, respectively. If the cancer is spread to lymph nodes, it has a 10%, 18% and 25% higher risk of returning cancer than not spread to lymph nodes for breast, lung and oral cancer. It is also obtained that the risk of coming back cancer is 22%, 34% and 28%

for breast, lung and oral cancer, if the tumour size is greater than 2 cm.

Now, non-parametric bootstrap analysis is performed for the comparisons of two estimates that differ significantly. A total of 1000 new samples have been drawn by a random sampling technique with replacement during the bootstrap analysis, and as a result, we have obtained that the p value is less than 0.05 for each of the three test statistics (absolute mean difference, absolute median difference and MSE). Thus, we may conclude that the test statistics are statistically significant for both the estimates, viz. Kaplan-Meier and Nelson Aalen estimates and thus differ significantly for both the poverty line as well as three sites of cancer. In other words, we may conclude that Nelson Aalen gives higher survival probabilities as compared to the Kaplan-Meier estimator.

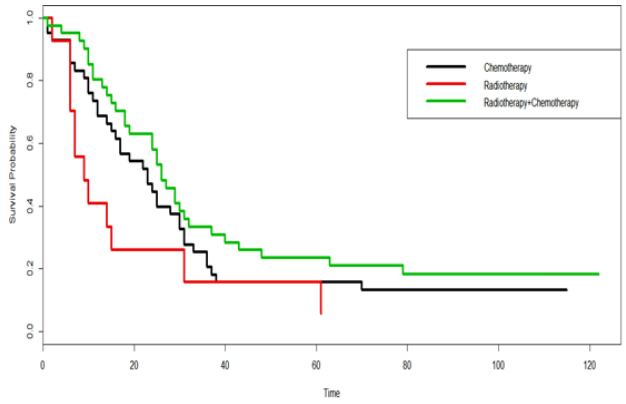

Figure 1: Survival curves for different treatment methods for breast cancer.

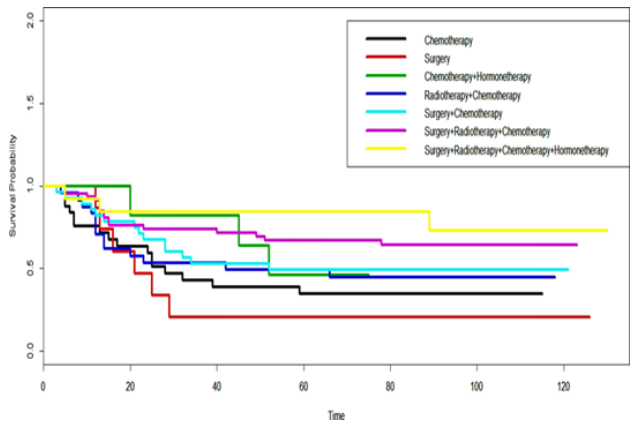

Figure 2: Survival curves for different treatment methods for lung cancer.

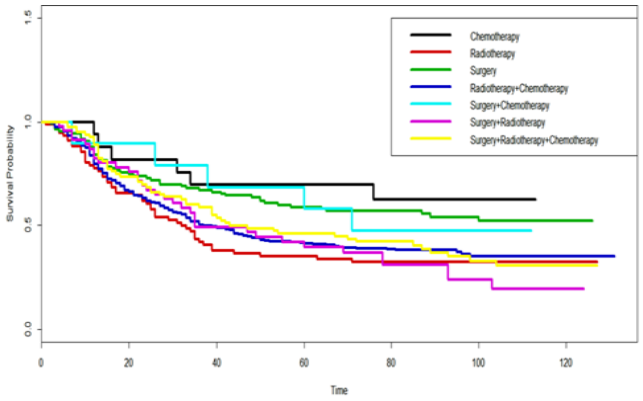

Figure 3: Survival curves for different treatment methods for oral cancer.

We obtain that combination of (Surgery, Radiotherapy, Chemotherapy and Hormonotherapy), combination of (Radiotherapy and Chemotherapy) and the Chemotherapy, have the higher probability of survival than the other therapies in case of breast, lung and oral cancer respectively by applying Nelson Aalen estimator survival curve for the different treatment techniques instead of Kaplan-Meier estimator.

5. Discussion

Prevention of cancer is one of the most significant public health challenges of the 21st century, with the growing global burden. Further, a matter of serious concern is that the new cases of oral, lung and breast cancer are growing day by day all over the world. Thus, the study is mainly focused on the analysis of prognosis factors (Age, Node and Tumour size) by logistic regression and computation of survival probabilities obtained from Kaplan Meier and Nelson Aalen estimates for the patients that are suffering from above mentioned sites of cancer, based on data collected from Cachar Cancer Hospital and Research Centre, located at Silchar town of Assam. The purpose of applying a logistic regression model is to observe the probability of returning the cancer in the presence of these prognostic factors.

In addition to this, the survival probabilities are also compared for the above-mentioned sites of cancer using non-parametric bootstrap analysis. In this study, only three prognosis factors are considered to get an idea of how cancer will effect the body and how it will respond to the therapies. In future, we can increase the prognostic factors in our study, which will give a better result for the cancer patients. Non-Parametric Bootstrap Analysis is applied for the comparison of two estimators, viz. Kaplan-Meier and Nelson-Aalen estimator. Thus, there is an opportunity to do research with Parametric Bootstrap Analysis so that one can draw the samples from the known distribution instead of drawing from the original to simulate the dataset. Thus, it will give a more reliable estimate for the test statistics as compared to Non-Parametric Bootstrap Analysis.

6. Conclusion

Growing cases of oral, lung, and breast cancer are a serious concern all over the world. The present study focused on the

analysis of prognostic factors (Age, Node, and Tumour size) of these cancers by using logistic regression and computation of survival probabilities. The purpose of applying a logistic regression model was to observe the probability of returning the cancer in the presence of these prognostic factors. The survival probabilities are also compared for the above-mentioned cancer sites using non-parametric bootstrap analysis. In this study, the three prognostic factors were considered to get an idea of how the cancer will effect the body, and how it will respond to therapies.

Conflict of Interest

The authors declared no conflict of interest related to this article.

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