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ORIGINAL ARTICLE

Forecasting Breast Cancer Cases requiring Radiotherapy at a Teaching Hospital in Nepal

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ABSTRACT

Objective: The aim of this study was to determine the trends and to estimate the future load of patients with breast cancer requiring radiotherapy at Manipal Teaching Hospital, Pokhara, Nepal.

Materials and Methods: A retrospective study was carried out on the data collected from the treatment records of patients who were treated with radiotherapy at the department of Radiation Oncology at Manipal Teaching Hospital (MTH), Pokhara, between September 2000 and December 2008. Descriptive statistics and statistical modelling were used for the analysis and the forecasting of data.

Results: Seventy patients were found to have been treated with radiotherapy for breast cancer during the study period. The patients' mean age was 49.9 years (95% CI: 47.6, 52.3). Curative treatment was given to 80% and palliative treatment to the remaining 20% of the patients. Patients from the age group of 45-64 years were more likely to receive curative 76.2% radiotherapy. The compliance to treatment was 100% among the age group of 25-44 years and 90.5% among the group of 45-64 years, as compared to only 66% among patients older than 65 years. ($p = 0.03$). The number of patients receiving radiotherapy for breast cancer showed a pattern of increasing trend. Excluding the constant term from the equation, the cubic model was the best fitted with $R^2 = 0.95$, $p = 0.001$ for the forecasting of breast cancer cases. Using this model, the number of breast cancer cases treated with radiotherapy at the hospital by the year 2015 was estimated to be 194.

Conclusion: Breast cancer cases in Nepal show an increasing trend and treatment facilities are bound to be hard pressed in providing the necessary health care to the public. Nepal should adopt better strategies for the early detection of the disease and improvise on the resources required for the treatment of this malady.

Key Messages

1. Introduction

Breast cancer is the most common cancer and the leading cause of cancer deaths among women worldwide.

2. Discussion

a. Without the constant term, the equation of this model is $y = m_1 * x + m_2 * x^2 + m_3 * x^3$. This equation was the best fit equation in the forecasting of cancer cases from our data.

b. In many countries where the incidence of breast cancer is great enough to pose a public health problem, the government, medical professionals and the public may not recognize it's importance.

c. Considering the compliance to treatment, the age group of 25-44 years had 100% completion, the group of 45-64 years had 90.5% completion and the age group of 65-74 years had 66.7% completion.

3. Conclusion

In the near future, there might be a discrepancy between the necessity and the delivery of health care for breast cancer patients.

Key Words: Breast cancer, radiotherapy, future trend, incidence

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Introduction

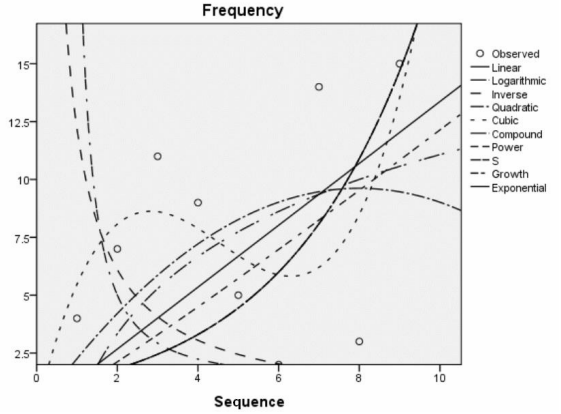
Breast cancer is the most common cancer and the leading cause of cancer deaths among women worldwide [1].Although the causes and the natural history of breast cancer remain unclear, epidemiological research has uncovered genetic, biological, environmental and lifestyle risk factors for the disease. Over the past several decades, the risk of breast cancer in developed countries has increased by one to two percent annually [2] .While the data for developing countries are limited, cancer registries suggest that age-standardized incidence rates are rising even more rapidly in low-incidence regions such as Africa and Asia [3]. Radiotherapy is an integral treatment component in the multimodal treatment approach for many patients with breast cancer. Perez and colleagues estimate that breast cancers constitute 25% of the patients visiting the radiotherapy OPD. Radiotherapy is used to reduce the loco-regional recurrence and the possible improvement in survival among these patients. Radiotherapy is also used with a palliative intent to achieve symptom relief. The aim of this study was to determine the trends and to estimate the future load of patients with breast cancer requiring radiotherapy at Manipal Teaching Hospital, Pokhara, Nepal.

Materials and Methods

This hospital based study was conducted with the data available at the Department of Radiotherapy and Oncology, Manipal Teaching Hospital, Pokhara (MTH). Pokhara is a major town in the Western development region of Nepal and MTH is the only cancer treatment centre in this region. The data of breast cancer cases treated by external radiotherapy between September 2000 and December 2008 was collected from the department archives. The age of the patient, the date of presentation, the intent to treat (curative vs. palliative) and whether or not the patient completed the prescribed treatment, were recorded. The data was analysed using Excel 2003, R 2.8.0 Statistical Package for the Social Sciences (SPSS) for Windows Version 16.0 (SPSS Inc; Chicago, IL, USA) and the EPI Info 3.5.1 Windows Version. The chi-square test was used to examine the association between different variables. A p-value of < 0.05 (two-tailed) was used to establish statistical significance. The annual numbers of patients visiting the centre for radiotherapy was then plotted against the corresponding year in the x-axis. Curve fitting, also known as regression analysis, was used to find the "best fit" line or curve for a series of data points. Linear, Logarithmic, Inverse, Quadratic, Cubic, Compound, Power, Exponential and Growth models were chosen to fit to the obtained curve. The F-test was used for selecting the best fitting curve for the testing of hypothesis. *P*-value was taken as significant when < 0.05 (two-tailed). R^2 values > 0.80 were taken as significantly better for prediction [4]. Prior approval for the study was obtained from the institutional research ethical committee.

The decision regarding the selection of a suitable approach for prediction is governed by the relative performance of the models for monitoring and prediction. It should also adequately interpret the phenomenon under study. The cubic model selected here could closely fit curves for estimated and observed breast cancer cases [Table/Fig 1]. While

building models, the extremities (maximums and minimums) play a great role. If the points are scattered more, the curve tries to adjust with maximum number of observed points. The cubic model is a third degree polynomial, represented by the equation $y = m_0 + m_1 * x + m_2 * x^2 + m_3 * x^3$, where m_0 is the constant term and m_1, m_2, m_3 are coefficient terms [5,6]. Without the constant term, the equation of this model is $y = m_1 * x + m_2 * x^2 + m_3 * x^3$. This equation was the best fit equation in the forecasting of cancer cases from our data and the equation for predicting the total number of breast cancer cases receiving radiotherapy at our centre is $Y= 7.171X - 1.837X^2 + 0.134X^3$, where Y is the number of breast cancer cases presenting annually and X is the corresponding year (1=2000, 2=2001, 3=2002, 4=2003 and so on).



(Table/Fig 1) Fitted curves for observed breast cancer cases
(X-axis shows years; 1=2000, 2=2001, 3=2002, 4=2003 and so on, Y-axis shows number of cancer cases)

Results

A total of 70 breast cancer patients treated by radiotherapy in the aforementioned period were analyzed. The patients' ages ranged from 25 to 69 years, the mean age being 49.9 years (95% CI: 47.6, 52.3). [Table/Fig 2]depicts the annual numbers of patients with breast cancer receiving radiotherapy from the year 2000 onwards. The numbers of the cases had an increasing trend that reached a peak in 2006, showing a sharp decline in the years 2004, 2005 and in 2007 before recovering back in 2008.

(Table/Fig 2) Annual numbers of patients with Breast cancer receiving radiotherapy (in percentage)

Year	Breast	Confidence Interval	Age	
			Mean	SD
2000	5.7	1.6-14.0	54.75	10.50
2001	10.0	4.1-19.5	45.71	9.93
2002	15.7	8.1-26.4	50	9.52
2003	12.9	6.1-23.0	54.44	10.41
2004	7.1	2.4-15.9	50	7.31
2005	2.9	0.3- 9.9	51	4.24
2006	20.0	11.4-31.3	49.21	10.48
2007	4.3	0.9-12.0	40	3
2008	21.4	12.5-32.9	50.4	10.28

[Table/Fig 3] displays compliance to treatment in various age categories. It can be noted that the younger age group of 25-44 years had 100% compliance to treatment, while the age groups of 45-64 and 65-74 years had a 90.5 and a 66.7% completion rate, respectively. The difference was found to be statistically significant (p = 0.03). [Table/Fig 4] shows the age group and the intent to treat. Patients from the age group of 25-44 years were more likely to receive curative radiotherapy (86.4%), while the patients between 45 and 64 years of age were more likely to receive palliative radiotherapy.

(Table/Fig 3) Age group vs. completion of treatment [n (%)]

Age group	Treatment		TOTAL
	Not Completed	Completed	
25-44	0(0)	22(100)	22(100)
45-64	4(9.5)	38(90.5)	42(100)
65-74	2(33.3)	4(66.7)	6(100)
TOTAL	6(8.6)	64(91.4)	70(100)

(Table/Fig 4) Age group and intent to treat

Age group	Palliative	Curative	TOTAL
25-44	3(13.6)	19(86.4)	22
45-64	10(23.8)	32(76.2)	42
65-74	1(16.7)	5(83.3)	6
TOTAL	14(20.0)	56(80.0)	70

The data were modelled using the curve fitting method. [Table/Fig 5] depicts the model summary and the parameter estimates including the constant term for different models. When the constant term was included, the p values were >0.05 in all the models and none of the models were best fitted. After excluding the constant term, all curves (except for inverse curve) fitted well with the data. [Table/Fig 6] displays the model summary and the parameter estimates excluding the constant term for different models and (Table/Fig 1) shows the fitted curves for observed breast cancer cases. However, with the highest R^2 value, the cubic model is the best fit, with $R^2 =$

0.83, p = 0.001 and shape of the curve also conforming well to the observed data, as compared to other curves.

(Table/Fig 5) Model Summary and Parameter Estimates including the constant term for different models

Equation	Model Summary	
	R Square	p-value
Linear	0.088	0.438
Logarithmic	0.083	0.451
Inverse	0.087	0.440
Quadratic	0.114	0.694
Cubic	0.351	0.503
Compound	0.012	0.775
Power	0.016	0.746
S	0.031	0.652
Growth	0.012	0.775
Exponential	0.012	0.775

(Table/Fig 6) Model Summary and Parameter Estimates excluding the constant term for different models

Equation	Model Summary	
	R Square	p-value
Linear	0.702	0.002
Logarithmic	0.712	0.002
Inverse	0.316	0.091
Quadratic	0.731	0.010
Cubic	0.833	0.010
Compound	0.729	0.002
Power	0.754	0.001
S	0.458	0.032
Growth	0.729	0.002
Exponential	0.729	0.002

[Table/Fig 7] depicts the observed number of cases until 2008 and the estimated number of cases along with confidence intervals up to 2015. The observed and the estimated number of cases have a fair degree of coincidence up to 2008. This model can thus be considered to be able to project the data with reasonable precision. The projected numbers of breast cancer patients visiting the centre for radiotherapy using this model hint at an increasing trend from 2009 onwards. One hundred and ninety four patients are expected to visit the centre for radiotherapy for breast cancer by the year 2015.

(Table/Fig 7) Observed and estimated Breast cancer cases

Year	Observed	Estimated	Lower	Upper
2000	4	5	--	17
2001	7	8	--	21
2002	11	9	--	21
2003	9	8	--	20
2004	5	7	--	19
2005	2	6	--	18
2006	14	6	--	19
2007	3	8	--	21
2008	15	14	--	28
2009		22	--	46
2010		35	--	75
2011		53	--	117
2012		77	--	174
2013		108	--	247
2014		147	--	337
2015		194	--	447

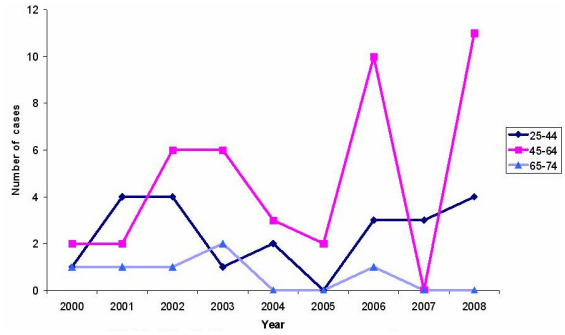
Discussion

The cancer prevalence rate in Nepal is unknown due to the lack of a population based national cancer registry. However, every year, at least 17,000 new cancer cases are estimated and the figure is expected to go up considerably in the future [1]. The increasing rates of newly diagnosed cases of breast cancer in developing countries are bound to put a stress on their limited resources available for treatment. Moreover, establishing a radiotherapy centre is a very expensive undertaking. Nepal has only 4 centres which are equipped to treat patients with radiotherapy, to date. In our study, using the curve fitting method, we tried to estimate the number of breast cancer cases that are expected to undergo radiotherapy in this region of Nepal in the near future.

As seen in the [Table/Fig 6], from the year 2009 onwards, the cases show an increasing trend. From (Table/Fig 1) it is clear that breast cancer patients from the age group of 45-64 years presented the most to our department. In many countries where the incidence of breast cancer is great enough to pose a public health problem, the government, medical professionals, and the public may not recognize its importance. Advocacy directed to government officials and policy makers can place breast cancer on the national agenda, encourage the development of systematic health policies and service protocols and increase women's access to the detection and treatment services[7]. From this study, it was found that 17% of patients in the age group of 65-74 years, 24% patients in the age group of 45-64 years and 14% patients in the age group

of 25-44 years were not likely to receive curative radiotherapy. In other studies, elderly patients have been observed to be more likely to receive palliative rather than curative radiotherapy [8]. Considering the compliance to treatment, the age group of 25-44 years had 100% completion, the age group of 45-64 years had 90.5 completion and the age group of 65-74 years had 66.7% completion. There is a statistical relationship between the age group and completion (p = 0.03) in breast cancer radiotherapy treatment. The issue of patient access is a significant factor in many published reports that consider the development of radiation oncology services [9],[10],[11],[12],[13].

Using the curve fitting method, we estimated the number and the trend of breast cancer cases which had to receive radiotherapy at MTH from the years 2002 to 2015. The cubic model provided closely fitted curves for estimated and observed cancer cases [Table/Fig 1]. While building models, the extremities (maximums and minimums) play a great role. If the points are scattered more, the curve tries to adjust with maximum number of observed points. Therefore, it might give over-and under-estimation inevitably, but that is not the case in all the situations. A sudden annual decrease and increase in the trend is possible, as the curve cannot exactly connect these data points because of its shape. For adjusting the over-and under-estimation, the model gave wide confidence intervals in the cases of some years [Table/Fig 7]. In our study, the future annual estimated breast cancer-cases [Table/Fig 6] showed an increasing trend of the disease after the year 2010. Such an increase might be convincing as the cancer incidence in developing countries is expected to rise principally due to the possible decline of mortality from infectious diseases, population growth and increasing life expectancy[14]. Our study hereby establishes the applicability of statistical modelling in predicting the cancer incidence in the Nepalese context. [Table/Fig 8]



(Table/Fig 8) Year wise cancer cases of age groups.

Conclusion

Considering that the projections of our hospital data show a continuously increasing trend, it can be appreciated that breast cancer is on rise in Nepal. Thus, in the near future, there might be a discrepancy between the necessity and the delivery of health care for these patients. The Nepal Government must now be geared up to promote better strategies for health promotion, prevention, the earlier diagnosis and the treatment of breast cancer cases in the coming years.

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