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Research Article

Impact of Oral Ice Cubes for Prevention of OM among Cancer Patients Receiving Chemotherapy: A Machine Learning Approach

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ABSTRACT

Oral Mucositis (OM) is a painful adversarial consequence of chemotherapy that affects the lining of the mouth and throat. The study goal is to investigate the efficiency of oral ice cubes on OM amongst cancer patients who receive chemotherapy with Machine Learning (ML) based predictive process. Quasi-investigational research was conducted for evaluating the efficacy of oral ice cubes on avoidance/minimization of OM among cancer patients receiving chemotherapy in V.S hospital in Chennai, India. Samples were selected by convenience sampling technique under quasi- investigational two groups namely pre-test and post-test research design. Among the total 60 samples, the first set of 30 samples in experimental group and next set of 30 samples in control group were selected. Before infusing chemotherapy, ice cubes were applied to the oral mucosa for 5 mins and 20 min post chemotherapy session. Observational checklist was assessed before and 7th day post intravenous chemotherapy to assess the clinical manifestations of OM. Naïve Bayes, support vector machine, and XGBoost are used to generate several predictive models. All the 't' values were statistically substancial, demonstrating that there is a substantial difference among the cancer patients undergoing chemotherapy. It depicts the oral ice cube application on the minimizing clinical manifestation of OM was effective among cancer patients post chemotherapy status. It is also reported that there were considerable variations found in the mean total scores and those who received oral ice cubes had minimal clinical manifestation of OM. It can be concluded that oral ice cube application reduced the level of clinical manifestation of OM induced by chemotherapy. Standing orders can be given to all nurses to apply ice cubes to all patients before 5 minutes who receive chemotherapy so that we can minimize or prevent OM in all cancer patients. The same can be included in health policy.

Keywords: OM, Chemotheraphy, Cancer patients, Machine learning, Oral ice cubes

1. INTRODUCTION

A most typical problem of cancer treatment is OM and as per the antineoplastic treatment modality, the incidence might differ. OM destroy mucosal lining of the mouth forming ulcer [1]. The prevalence of OM in patients experiencing Bone Marrow Transplantation (BMT) is high as 80% because of the heavy doses needed to accomplish myeloablation, while in cancer patients who receives traditional chemotherapy dose, the occurrence of OM differs between 20% to 40% [2]. In subjects undergoing ra-diotherapy without or with concomitant chemotherapy for neck and head malignancy, the occurrence of OM is above 90%. OM could considerably affect quality of life, nutri-tional status and oral hygiene.

For the patient who receives chemotherapy before BMT, OM has been testified to be the one devastating complication. Moderate to severe OM was related to transplant-related sepsis, death in the period of extreme

immunosuppression, and systemic life-threatening infections [3]. The severity of OM in patients with hematologic malignancy receiving BMT has been stated to be relevant to higher periods of demanding hospitalization time, the prevalence of infections, inpatient charges, and overall parenteral and narcotic therapy [4].

Many interventions were tested and tried for OM treatment and prevention. The International Society of Oral Oncology and Mucositis Study Group of the Multination-al Association for Supportive Care in Cancer (ISOO/MASCC) proposed medical practice guidelines for mucositis prevention and treatment. Oral cooling (Oral Cryotherapy (OC)) was popular for cost effective, easy intervention in the prevention of OM development and not likely to cause side effects [5]. The treatment includes placing ice (ice-cold water, or cubes) in the oral cavities during or before chemotherapy administration [6]. Further, OC may minimize the metabolism rate in the oral epithelium which contributes to minimizing the inflammation risk.

OC cools the patient's mouth in chemotherapy infusion utilizing popsicles, ice cubes, cool water, or ice-cream for reducing the danger of evolving chemotherapy-induced OM [1]. These intervention roles a vital play with respect to reducing bloodstream to mouth by narrowing the arteries and so diminishing the count of chemotherapy drugs which is penetrating the mucous membrane [7]. But the ice cream headache or cold neuralgia produced by OC can enhance the delivery of bone marrow stem cells to the human mind. OC is revealed to efficiently decrease the commonness and cruelty of OM in adults, getting 5FU-related therapy for solid cancer. It is evidence demonstrating that OC is decrease the commonness and cruelty in adults, who after-wards received high-dose melphalan-based chemotherapy preceding HCT [8]. An efficiency of OC for persons obtaining HCT. Thus, this systematic analysis purpose for determining if OC is effective to prevent severe OM and its effect on the onset of pain in patients who received HCT with haematological malignancy. So, the proper medical treatments are offered for managing chemotherapy induced OM in patients enduring HCT [9].

Severity of chemotherapy-induced OM is reduced by OC which is a low-risk intervention. The clients were tutored to keep the ice cubes in their mouths constantly and not to keep them stationary. OC was initiated 5 min before chemotherapy. Preventive measures directed toward etiology of OM are gaining importance.

Cryotherapy reduces the blood flow in oral mucosa by vasoconstriction and minimizes the amount of drug distributed to cells, hence decreasing the incidence of OM. Therefore, this article performs a study to measure the efficacy of plain ice cubes on OM amongst cancer patients receiving chemotherapy in V.S hospital.

2. MATERIALS AND METHODS

The present study was performed to assess the effectiveness of oral ice cubes in the prevention of OM among cancer affected individuals attending in-patient department at V.S hospital in Chennai. In this study, the research approach used is two groups of quantitative approaches, and convenience sampling method was used for selecting samples in both groups. To be precise, the present study was quasi-investigational in two groups of pre-and post-test study. Pre-test was conducted for all the samples that received their treatment and then post-test was carried out to de-fine the efficacy of treatment. The independent variable of the study is the application of ice cubes orally, and the dependent variable in the study was minimizing clinical manifestation of OM.

A. Study Design and Sample Collection

The current research is performed to assess the effectiveness of oral ice cubes in the prevention of OM among cancer patients attending in-patient department at V.S hospital in Chennai. In this study, the research approach used is two groups of quantitative approaches, and convenience sampling method was used for selecting samples in both groups. To be precise, the present study was quasi- investigational two groups of pre-and post-test study. Pre-test was performed for all the samples that received their treatment and then post-test was carried out to define the efficacy of treatment. The independent variable of the study is the application of ice cubes orally, and the dependent variable in the study was minimizing clinical manifestation of OM. In this work, a total of 60 samples were included, among them, 30 samples were in study groups and 30 samples were in control groups by convenience sampling method. The sample selection was based on inclusion criteria like the patients receiving chemo-therapy who were willing to participate, who were above the age of 20 years and who were available during data collection. The exclusion criteria are the clients who were suffering from malignancies found in head and neck, who were undergoing radiation therapy, and who were critically ill. Two sections of the tool were used. It includes demographic characteristics namely gender, age, marital status, religion, education, family type, family income per month in rupees, site of cancer,

duration of illness, stage of cancer, cycle of chemotherapy, types of chemotherapy, chemotherapy drugs used along 5-flurouracil, frequency of mouth wash, personal habits and Observational Check List (OCL) and scoring key based on National Cancer Institute (NCI). The score of the nine categories in OCL is summed which includes ulceration and erythema in upper lips, lower lip, left cheek, right cheek, right ventral, lateral tongue, left ventral, floor of the mouth, lateral tongue, soft palate and hard palate. A total of 30 scores were used to assess the OM. Ulceration and erythema score is 0=no lesion, 1=<1cm2, 2=1-3 cm2, 3=3 cm2, score=no lesion, score 1-9 is mild, score 10-18 is moderate, score 19-30 is severe. Mouth pain was assessed by VAS. Ability to swallow score 0=normal, 1=only liquids, 2=only soft solid foods, 3=no foods or liquids. Before ice cubes were applied orally, OCL-NCI is used for assessment of oral ulceration and erythema, VAS for mouth pain and ability to swallow in both groups. Before infusing chemotherapy, ice cubes were exploited to the OM for 5 minutes and 20 minutes post session in the study group. Routine care was given to control group. Post-test assessment using OCL-NCI and VAS was done on day 7 along with handout about oral hygiene, and anti-cancerous diet to improve immune system of clients with cancer given to both groups to improve general well-being of cancer patients.

B. Statistical Analysis

The data was collected using an Observational Check List Of National Cancer Institute (OCL-NCI) and analyzed using frequency. Percentage distribution was assessed to find the pre-and post-test levels of clinical manifestation of OM amongst patients with cancer. Paired 't' value and unpaired 't' test were assessed to find out the efficacy of application of oral ice cubes in minimizing the clinical manifestation of OM prevention among patients who receive chemotherapy. Association of standard deviation, mean, and mean percentage of pre- and post test levels of clinical manifestations of OM amongst cancer patients was done based on the distribution of cases area wise. Chi-square values of relation between post-test levels of clinical manifestations of OM amongst cancer clients with their selected demographic variable were assessed.

C. Model Selection

1) XGBoost

XGBboost is an ensemble learning model that incorporates various weak techniques into a single strong model by iteratively boosting the weights of misclassified data points [10]. Gradient boosting machine is the implementation of XGBboost which is the better performing algorithm exploited for supervised learning. It is used for both regression and classification problems. An open-source gradient boosting library is extensively applied for regression and classification problems. XGBoost is known for its accuracy and speed, and it is especially efficient in managing large datasets with a large number of features. The library makes use of a regularized XGBboost architecture and exploits different approaches to avoid overfitting namely pruning and regularization. The unique feature of XGBoost is its capability to manage missing data and sup-port customized loss functions, making it flexible for variety of applications. Also, it supports parallel processing and is applied on different platforms, like distributed systems.

2) SVM

SVM is a supervised learning method which is used for classification and regression problems. A strong classifier is used to resolve linear problems [11]. Also, SVM supports kernel method to deal with non-linearity. Assuming a training dataset, the concept of SVM is that it constructs a line or a hyperplane that segregates the data point into classes. It is an effective ML method that could categorize data by finding the optimum boundary, called the hyperplane that splits the data point into distinct classes. In the presented method, all the data points are characterized as a vector in a high dimensional space, and the model finds the hyperplane that maximally splits the classes. Fig. 1 illustrates the structure of SVM hyperplane. The hyperplane can be determined by a bias term and set of weights, and the objective is to find the optimum set of weights and bias that reduces the classification error. SVM is especially efficient in cases where the data isn't linearly separable, as it uses a kernel function to convert the data into high dimensional space where it is more easily separable. Also, SVM deal with multiclass classification by using an integration of binary classifier.

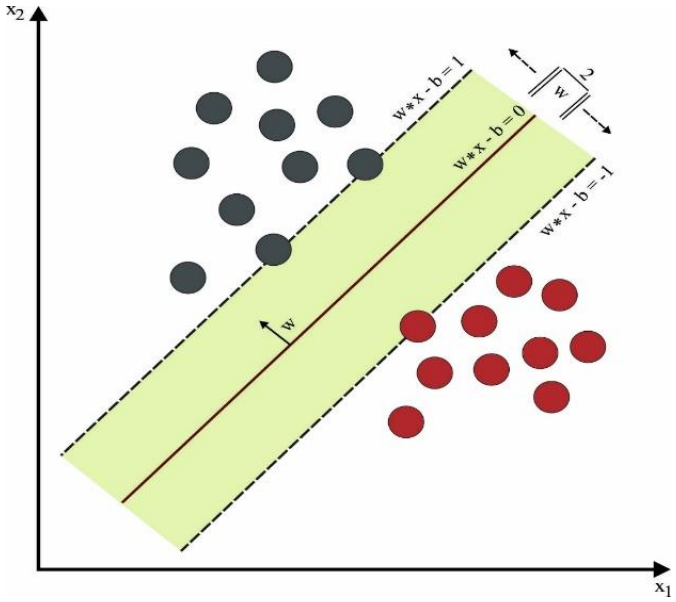

Figure 1. SVM hyperplane

3) NB Model

The NB classifier is a classification system based on Bayes' theorem that considers that each attribute was completely independent given the output class, named the conditional independence assumption. The major benefit of the NB classifiers is that it is easier to create without the necessity of complex iterative parameter estimation scheme [12]. Furthermore, NB classifier is strong to irrelevant attributes and noise. This technique was effectively employed in large number of sectors. The technique is named "naive" since it assumes that the feature of the input dataset is conditionally independent which implies the absence or presence of single feature doesn't affect the absence or presence of other features. This assumption enables the algorithm to evaluate the probability of a specific class given the input feature using the simplified form of Bayes' theorem. Fig. 2 demonstrates the structure of NB technique. The NB method is easier to implement and needs minimal training dataset, which makes it a common option for text classification tasks. It works well with high dimensional da-tasets and can manage continuous and categorical input variables.

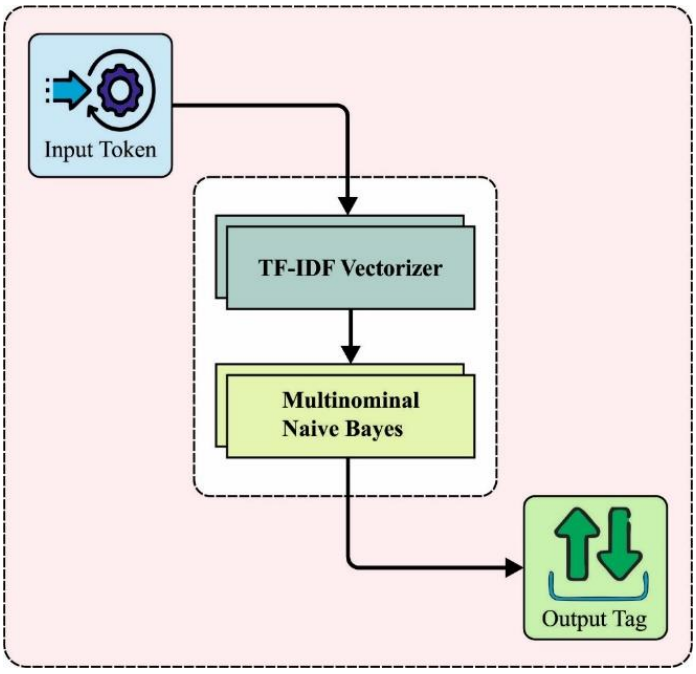

Figure 2. Structure of NB model

3. RESULTS

The percentage and frequency distribution of demographic variables amongst cancer patients receiving chemotherapy, their age, gender, marital status, religion, ed-ucation, family type, family income per month in rupees, site of cancer, duration of ill-ness, stage of cancer, cycle of chemotherapy, types of chemotherapy, chemotherapy drugs used along 5-flurouracil, frequency of mouth wash usage, personal habits were all assessed. Majority of cancer patients 13(43.33%)/14(46.67%) were amongst the age group of 41 - 50 years in study/control group and the both study and control group had 1(3.33%) in each of their groups who were the age group of 20 – 30 years in both groups.

Regarding the gender of cancer patients receiving chemotherapy, the majority 23(76.67%) were males, 7(23.33%) were females in both groups. With regard to marital status, the majority 27(90%) were married, and the least 1(3.33%) were divorcee in both groups. Regarding religion of cancer patients majority 22(73.33%)/ 21(70%) were Hindu in study/control groups, least 1(3.33%) were other religions in both groups. With regard to education majority of 11(36.67%) studied at secondary school level in study group,10(33.33%) had studied at higher secondary school level in control group, and the least 1(3.33%) was illiterate in both groups. With regard to family type 19(63.33%) / 20(66.67%) were living with nuclear family and 11(36.67%)/12(40%) were living with joint family in study/control groups. Regarding current occupation status majority 12(40%)/13(43.33%) were daily wage workers in study/control groups, least 6(20%) were self-employed in both groups.

With regard to family income for each month majority 13(43.33%) were getting more than Rs. 15 000 for each month in study group, 12(40%) were earning 5.000-10.000 in control groups, the least 5(16.67%)/7(23.33%) were earning Rs. 10.000 to 15.000 in study/control groups. Regarding the site of cancer, majority 15(50%) were having other types of cancer, and the least 3(10%) were having cervical cancer in both groups. With regard to duration of illness, majority 20(66.67%)/21(70%) were having illnesses for less than one year and 10(33.33%)/9(30%) were having illnesses for 1 year to 2 years in study/control groups. Regarding stage of cancer and cycle of chemotherapy, majority 23(76.67%) were having 1st stage and first cycle, and the least 7(23.33%) were having 2nd stage of cancer and taking second cycle of chemotherapy in both groups. Majority 30(100%) cancer patients were taking multi drug chemotherapy in both groups.

Majority 24(80%) cancer patients were taking cisplatin/carboplatin, the least 6(20%) were taking methotrexate in both groups. Majority of 28(93.33%)/27(90%) mouthwash every time after eating in study/control groups, and the least 2(6.67%)/3(10%) were doing mouth twice a day in study/control groups. Regarding personal habits, majority of 14(46.67%) cancer patients were having none of the personal habits, least 1(3.33%) had tobacco habits in both groups. In the pre-test, majority 23(76.7%) of cancer patients in the study group had no lesions 7(23.3%) had mild lesions, none of them had moderated or severe levels of lesions and a majority of 29(96.7%) had mild level of ulceration in the post test group, 1(3.33%) had moderate lesions, and few had severe lesions in the study group. Majority of 23(76.7%) cancer patients in the control group had no lesions and 7 (23.3%) had mild levels of lesions, none of them had moderate or severe levels of lesions.

A majority of 28(93.3%) had moderate ulceration in the post test group as shown in Table 1. In the pre-test, majority 23(76.7%) of cancer patients in the study group had no erythema and 7(23.3%) had mild erythema, none of them had moderated or severe levels of erythema and a majority of 29(96.7%) had mild level of erythema in the post test group, 1(3.33%) had moderate erythema levels, and few had severe erythema in the study group. Majority of 23(76.7%) cancer patients in the control group had no erythema and 7 (23.3%) had mild levels of erythema, none of them had moderate or severe levels of erythema. In the post test, majority of 28(93.3%) had erythema of moderate levels as shown in Table 1.

In the pre-test, almost 30(100%) of cancer patients in the study group had normal levels of mouth pain and none developed mild, moderate or severe levels of mouth pain. In the post test, a majority of 20(66.67%) had mild levels of mouth pain, and 10(33.33%) had moderate levels of mouth pain. In the control group, almost all 30(100%) cancer patients in the pre-test had normal levels of mouth pain and in the post test, majority 23(76.67%) had moderate levels of mouth pain Table 1. In the pre-test, almost 30(100%) of cancer patients in the study group had normal levels of swallowing and none of them developed mild, moderate or severe levels of swallowing difficulty in the post test majority 20(66.67%) had mild levels of swallowing difficulty, 10(33.33%) had moderate level of swallowing difficulty. In the control group, almost all 30(100%) cancer patients in the pre-test had normal levels of swallowing and in the post test, majority 23(76.67%) had moderate levels of swallowing difficulty in Table 1. In the study group, the pre-

test the mean score of ulceration was 0.40 with S.D 0.81, erythema 0.63 with S.D 1.19, mouth pain 0.00 with S.D 0.00.and ability to swallow, 0.00 with S.D 0.00 and the post-test mean level ulceration was 8.30 with S.D 0.88, erythema 8.03 with S.D 0.19, mouth pain 2.00 with S.D 0.69 and ability to swallow 1.33 with S.D 0.48. The evaluated paired 't' value of t=34.85(ulceration), 26.62(erythema), 15.76(mouth pain) and 15.23(ability to swallow) was found to be greatly substantial at p<0.001 level which demonstrates that their is a great difference in the level of clinical manifestation of ulceration, erythema, mouth pain and ability to swallow scores among the cancer patients undergoing chemotherapy in the study.

TABLE I. Assessment of pre-test and post-test levels of clinical manifestation of OM amid the study and control group. (Level of ulceration, erythema, mouth pain. ability to swallow)

N=60(30+30)

Group	**Level of Ulceration**	**No Lesion**		**Mild**		**Moderate**		**Severe**	
		No	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Study	Pre-test	23	76.7	7	23.3	0	0	0	0
	Post test	0	0	29	96.7	1	3.33	0	0
Control	Pre-test	23	76.7	7	23.3	0	0	0	0
	Post test	0	0	0	0	28	93.3	2	6.67
	Level of Erythema								
Study	Pre-test	23	76.7	7	23.3	0	0	0	0
	Post test	0	0	29	96.7	1	3.33	0	0
Control	Pre-test	23	76.7	7	23.3	0	0	0	0
	Post test	0	0	2	6.7	27	90.0	1	3.3
	Level of Mouth pain								
Study	Pre-test	30	100.0	0	0	0	0	0	0
	Post test	0	0	20	66.67	10	33.33	0	0
Control	Pre-test	3	100.0	0	0	0	0	0	0
	Post test	0	0	4	13.33	23	76.67	3	10.0
	Level of Ability to swallow								
Study	Pre-test	30	100.0	0	0	0	0	0	0
	Post test	0	0	20	66.67	10	33.33	0	0
Control	Pre-test	30	100.0	0	0	0	0	0	0
	Post test	0	0	4	13.33	23	76.67	3	10

In the control group pre-test, the mean score of ulceration was 0.53 with S.D 1.04, erythema 0.63 with S.D 1.22, mouth pain 0.00 with S.D 0.00 and ability to swallow,0.00 with S.D 0.00 and the post-test mean score ulceration was 15.30 with S.D 2.57, erythema 13.17 with S.D 2.84, mouth pain 5.93 with S.D 1.41 and ability to swallow 1.97 with S.D 0.49. The estimated paired 't' value of 29.01 (ulceration), 23.31(erythema), 23.00 (mouth pain) and 21.97 (ability to swallow) was showed to be greatly substancial at p<0.001 level which precisely exhibits that there is a great difference in the level of clinical manifestation of ulceration, erythema, mouth pain and ability to swallow scores among the cancer patients undergoing chemotherapy in the study group in Ta-ble 2. In the study, the post-test mean score of ulceration was 8.30 with S. D 0.88, erythema 8.03 with S.D 0.96, mouth pain 2.00 with S.D 0.69 and ability to swallow, 1.33 with S.D 0.48, and in the control group, the mean score of ulceration was 15.30 with S. D 2.57, erythema 13.17 with S.D 2.84, mouth pain 5.93 with S.D 1.41, ability to swallow 1.97 with S.D 0.49 The evaluated unpaired 't' value of t= 14.09 (ulceration), 9.37 (erythema),13.68(mouth pain),5.05 (ability to swallow) was showed

to be statically greatly substantial at p<0.001 level which clearly illustrate that there is a great difference in the post test ulceration, erythema, mouth pain and ability to swallow scores between the study and control group after the application of plain ice cubes to minimize OM among the cancer patients undergoing chemotherapy in the study group. No variable of the demographic demonstrated any statistically substantial relationship with the post-test ulceration level in the study group in Table 3.

TABLE II. Relation of pre-test and post-test clinical manifestation scores of OM among cancer patients in the study and control groups. (Level of ulceration, erythema, mouth main. ability to swallow) N=60(30+30)

Group	Level of Ulceration	Mean	S.D	Paired 't' Value
Study	Pre-test	0.40	0.81	t=34.852***
	Post test	8.30	0.88	*P*=0. 000. S
Control	Pre-test	0.53	1.04	t=29.013***
	Post test	15.30	2.57	*P*=0. 000. S
	Level of Erythema			
Study	Pre-test	0.63	1.19	t=26.626***
	Post test	8.03	0.19	*P*=0. 000. S
Control	Pre-test	0.63	1.22	t=23.312***
	Post test	13.17	2.84	*P*=0. 000. S
	Level of Mouth pain			
Study	Pre-test	0.00	0.00	t=15.766***
	Post test	2.00	0.69	*P*=0. 000. S
Control	Pre-test	0.00	0.00	t=23.006***
	Post test	5.93	1.41	*P*=0. 000. S
	Level of Ability to swallow			
Study	Pre-test	0.00	0.00	t=15.232***
	Post test	1.33	0.48	*P*=0. 000. S
Control	Pre-test	0.00	0.00	t=21.977***
	Post test	1.97	0.49	*P*=0. 000. S

***p<0.001. S-Significant

TABLE III. Association of post- test level of clinical manifestation of OM among cancer patients in the study and control group.

N=30

Demographic Variables	Mild		Moderate		Chi-Square Value
	No	%	No	%	
Age					χ^2=1.353
20-30 years	1	3.3	0	0	d.f=3
31-40 years	7	23.3	0	0	*P*=0.717
41-50 years	15	40.0	1	3.3	N. S
>51 years	9	30.0	0	0	
Gender					χ^2=3.399
Male	23	76.7	0	0	d.f=1
Female	6	20.0	1	3.3	*P*=0.065

Transgender					N. S
Marital Status					χ^2=0.115
Marital	26	86.7	1	3.3	d.f=2
Unmarried	2	6.7	0	0	*P*=0.944
Divorce	1	3.3	0	0	N. S
Widow/widower	-	-	-	-	
Religion					χ^2=0.376
Hindu	21	70.0	1	3.3	d.f=3
Christian	4	13.3	0	0	*P*=0.945
Muslim	3	10.0	0	0	N. S
Others	1	3.3	0	0	
Education					χ^2=1.787
Illiterate	1	3.3	0	0	d.f=4
Primary	2	6.7	0	0	*P*=0.775
Secondary	10	33.3	1	3.3	N. S
Higher Secondary	9	30.0	0	0	
Graduates/Postgraduates					
Family type					χ^2=0.599
Nuclear	18	60.0	1	3.3	d.f=1
Joint	11	36.0	0	0	*P*=0.439
Broken family	-	-	-	-	N. S
Extended family	-	-	-	-	
Current occupation status					χ^2=4.138
Unemployed	-	-	-	-	d.f=2
Daily wages worker	12	40.0	0	0	*P*=0.126
					N. S
Stage of cancer					χ^2=3.399
1st stage	23	76.7	0	0	d. f=1
2nd stage	6	20.0	1	3.3	*P*=0.065
					N. S
Cycle of chemotherapy					χ^2=0.315
First cycle	23	73.3	1	3.3	d. f=1
Second cycle	7	23.3	0	0	*P*=0.575
					N. S
Types of chemotherapy					
Single drug chemotherapy	29	96.7	1	3.3	
Multi drug chemotherapy	-	-	-	-	
Chemotherapy drugs used along 5- Fluorouracil					χ^2=0.259 d. f=1
None	-	-	-	-	*P*=0.611
Cisplatin/Carboplatin	23	76.7	1	3.3	N. S
Methotrexate	6	20.0	0	0	
Frequency of mouthwash					χ^2=0.074
None	-	-	-	-	d. f=1
Once a day	-	-	-	-	*P*=0.786
Twice a day	2	6.7	0	0	N. S
Every time after eating	27	90.0	1	33	
Personal habits					χ^2=6.724
Smoking	3	10.0	1	3.3	d. f=3
Alcohol	11	36.7	0	0	*P*=0.081
Tobacco use	1	3.3	0	0	N. S
None	14	46.7	0	0	

N.S- Not Significant

In Table 4, the overall result analysis of different ML models is given. The results are examined under training set and test set.

TABLE IV. Classification outcome of different ML techniques

Dataset	Indicator	MLR	KNN	DT	Naïve Bayes	XGBoost	SVM
Training set	MAE	4.165	4.518	5.909	3.801	3.433	3.051
	MSE	37.746	30.492	32.515	26.687	24.023	19.522
	R^2	0.572	0.718	0.549	0.773	0.812	0.867
Test set	MAE	6.075	2.872	4.934	2.656	2.083	1.877
	MSE	36.199	36.911	36.504	33.434	29.784	27.660
	R^2	0.592	0.472	0.450	0.614	0.656	0.716

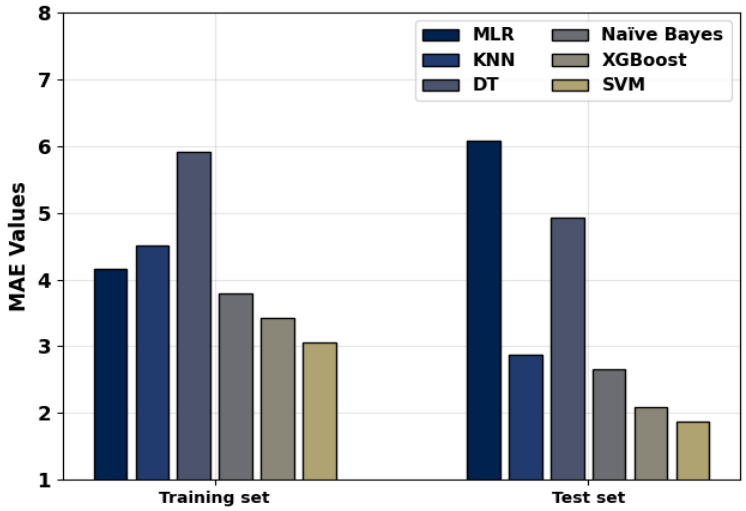

Figure 3. MAE analysis of distinct ML techniques under training and testing sets

Fig. 3 shows the MAE results of the ML models on the training and test sets. The results indicate that MLR, KNN, and DT models have shown higher MAE values. Though the NB and XGBoost models obtain slightly decreasing mAE values, the SVM model reaches least MAE values. For instance, on training set, the SVM model attains lower MAE of 3.051 whereas the MLR, KNN, DT, NB, and XGBoost models obtain in-creasing MAE of 4.165, 4.518, 5.909, 3.801, and 3.433 respectively. Besides, on testing set, the SVM approach attains lesser MAE of 1.877 whereas the MLR, KNN, DT, NB, and XGBoost techniques acquire maximal MAE of 6.075, 2.872, 4.934, 2.656, and 2.083 respectively.

Fig. 4 displays the MSE results of the ML techniques on the training and test sets. The outcomes stated that MLR, KNN, and DT models have shown higher MSE values. Though the NB and XGBoost techniques obtain slightly decreasing MSE values, the SVM model reaches least MSE values. For instance, on training set, the SVM system attains minimal MSE of 19.522 whereas the MLR, KNN, DT, NB, and XGBoost techniques obtain increasing MSE of 37.746, 30.492, 32.515, 26.687, and 24.023 correspondingly. Moreover, on testing set, the SVM approaches attains reduced MSE of 27.660 whereas the MLR, KNN, DT, NB, and XGBoost techniques obtain increasing MSE of 36.199, 36.911, 36.504, 33.434, and 29.784 correspondingly.

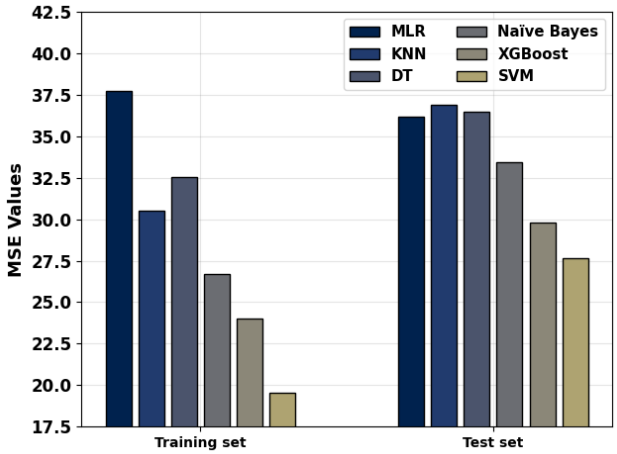

Figure 4. MSE analysis of distinct ML techniques under training and testing sets

Finally, the R^2 analysis of the different ML models is presented in Fig. 5. The results indicate the effectual performance of the NB, XGBoost, and SVM models. Partic-ularly, the SVM model gains effectual performance with maximum R^2 values of 0.867 and 0.716 under training and testing sets respectively.

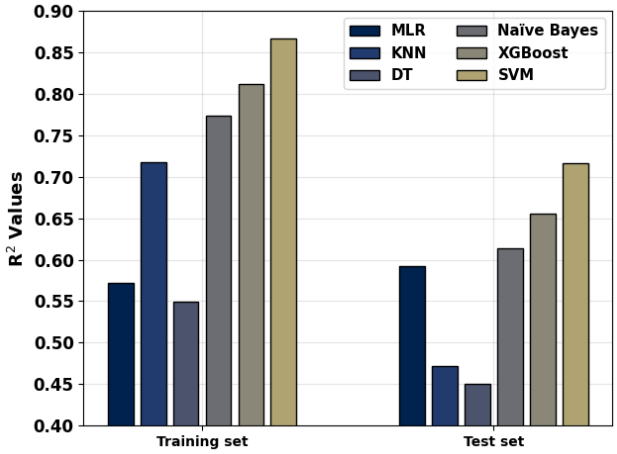

Figure 5. R^2 analysis of distinct ML techniques under training and testing sets

4. DISCUSSION

OM is the negative effect of chemotherapy that frequently exacerbate the patient health receiving chemotherapy, along with increasing financial expense. OM might result from systemic chemotherapy by cytotoxic drugs. It affects around 60%-100% of patients receiving chemotherapy. Almost all clients receiving chemotherapy will grow OM. The severity and frequency of OM rely on the dose, type, and duration of chemo-therapy utilized. OM in oncologic patients is the most undesired event of the chemo-therapeutic treatments. In this chapter, the study results are discussed with reference to the hypotheses and objectives. The study findings showed that in both groups 23(76.67%) of the patients were male and 27(90%) of the patients were married. Major number of the patients in the study group 20(66.67%) patients were suffering from cancer for less than 1 year and in the control group, 21(70%) patients were less than 1 year. In the study group, 23(23.33%) were in 1st stage of cancer and in the control group, 23(76.67%) were in 1st stage of cancer. In this study, 24(80%) patients were receiving cisplatin/carboplatin drugs and in the control groups, 24(80%) patients were cisplatin/carboplatin drugs.

The first goal is to evaluate the level of OM among patients undergoing chemo-therapy before and after the application of oral ice cubes in both groups. Frequency and percentages distribution was assessed to find the pre- and post- test levels of OM among cancer patients in the study and control group. In the post test majority of 29(96.7%) had mild levels of ulceration, 1(3.33%) had moderate levels of lesion, and few had severe lesions in the study group. There is no evidence of severe lesions on the 7th day of post oral ice cube application. In the post test,

none of them had mild levels of ulceration, 28(93.3%) had moderate levels of lesions 2(6.67%) had severe lesions in the control group.

This present study result shows that there is evidence of severe lesions seen in patients with cancer who receive chemotherapy due to non-application of ice cubes while receiving chemotherapy infusion in control group. In the post test, majority of 29(96.7%) had mild levels of erythema, 1(3.33%) had moderate levels of erythema, and few had severe erythema the study group. There is no evidence of severe erythema on the 7th day of post oral ice cube application. In the post test, none of them had mild level of erythema 27(90%) had moderate level of erythema 1(3.3%) had severe erythema in the control group. This present study result demonstrates that there is evidence of severe erythema seen in patients with cancer who receive chemotherapy due to non-application of ice cubes in control group. In the post test majority of 20(66.67%) had mild levels of mouth pain, 10(33.33%) had moderate levels of mouth pain, and few had severe mouth pain. There is no evidence of severe mouth pain on the 7th day of post oral ice cube application. In the post-test 4(13.33%) had mild levels of mouth pain, 23(76.67%) had moderate levels of mouth pain, 3(10%) had severe mouth pain in the control group. This present study result exhibits that there is evidence of severe mouth pain seen in patients with cancer who receive chemotherapy due to non-application of ice cubes.

In the post test, majority of 20(66.67%) had mild levels of swallowing difficulty, 10(33.33%) had moderate levels of swallowing difficulty, and none of them had severe swallowing difficulty in the study group. There is no evidence of severe swallowing difficulty on the 7th day of post oral ice cube application. In the post-test 4(13.33%) had mild level of swallowing difficulty, 23(76.67%) had moderate level of swallowing difficulty, and 3(10%) had severe mouth pain in the control group. This present study result shows that there is evidence of severe mouth pain seen in patients with cancer who receive chemotherapy due to non-application of ice cubes. Present study result seems that application of ice cubes minimizes clinical manifestation of OM. There is a substancial minimization in the post test score of chemotherapy induced OM after application of the plain ice cubes in the study group.

Cryotherapy hypothesized that topical management of ice chips to the oral cavity in chemotherapy management resulted in diminished delivery of the chemotherapeutic agents to the OM. These effects are apparently facilitated via local vasoconstriction and minimized blood flow. Many researches have illustrated that cryotherapy de-creases the OM severity among patients undergoing chemotherapy. The Multinational Association for Supportive Care in Cancer and International Society of Oral Oncology (MASCC/ISOO) guideline recommends the usage of cryotherapy to decrease OM in patients undergoing bolus doses of 5-fluorouracil, methotrexate and melphalan. Ice chips are placed in the mouth, beginning five minutes beforehand administration of chemotherapy and replenished as desired for up to thirty minutes. Cryotherapy is used for short bolus chemotherapeutic infusion. The second aim is to determine the efficacy of plain ice cubes on OM amongst patients in study group.

Paired ‘t’ test value was assessed to find the efficacy of oral ice cube application in minimizing the clinical manifestation of OM among cancer patients who receive chemotherapy. The paired ‘t’ value for ulceration were 34.85 in study group, 29.01 in control group, for erythema 26.62 in study group, 23.31 in control group, for mouth pain 15.76 in study group, 23.00 in control group, ability to swallow 15.23 in study group, 21.97 in control group. Present study all the ‘t’ values were demonstrated to be greatly substantial at $p<0.001$ level which reveals that there is a great difference in the level of clinical manifestation of OM scores among the cancer patients undergoing chemotherapy in the study group. The third objective is to compare the post-test OM score among study and control groups. Unpaired ‘t’ test value was assessed to find the effectiveness of oral ice cube application in minimizing the clinical manifestation of OM among cancer patients who receive chemotherapy in study and control groups. The unpaired ‘t’ value for ulceration was 14.09, for erythema 9.37, for mouth pain 13.68, and for ability to swallow 5.05. All unpaired ‘t’ value was shown to be greatly substantial at $p<0.001$ level which reveals that there is a great difference among the study and control group in the post test scores after the application of plain ice cubes to minimize OM among the cancer patients undergoing chemotherapy in the study group. It seems that the oral ice cube application is effective in minimizing clinical manifestation of OM among cancer patients who receive chemotherapy. There is a great difference in the post test mucositis score of chemotherapy induced OM among cancer patients in study and control groups. Hence, this hypothesis is accepted. OC is effective for pre-venting OM in adults getting fluorouracil-base chemotherapy for solid cancers. The efficacy of OC was illustrated in seven studies, where the severity and incidence of OM were demonstrated to be considerably (p value <0.05) lesser in the treatment group than control group. Typically, OC includes holding ice chips in the mouth 5 min before chemotherapy and continuing for thirty minutes.

The fourth objective is to relate the effectiveness of plain ice cubes with the selected demographical variables of study group. Chi-square was evaluated for finding the relationship between the posttest levels of clinical manifestation of OM among cancer patients who receive chemotherapy with their selected variable in Table 3. It exhibits that no demographical variables demonstrated any substantial relationship with the post- test level of ulceration in the study group. There is a significant association between the mucositis score and selected demographical variables in the study. Hence, this hypothesis is rejected. Our results contrast with the result of effectiveness of oral ice cube application on prevention of OM amongst cancer patients who receive chemotherapy. The study selected was pre-experimental one group pre-test study. Thirty in-patients who receive chemotherapy (5-fluorouracil and methotrexate) were taken as the samples in convenience sampling method. Oral Assessment Guide (OAG) was used prior to and on 7th day of post-intravenous chemotherapy to assess the level of OM. In pre-test, 100% of the cancer patients were healthy OM. In the post-test. 73.3% of cancer patients were with healthy OM and 26.5% were with moderate OM. The paired 't' value was 3.3 for healthy OM and 2.17 for moderate OM. There was no evidence of severe mucositis.

All the 't' values are higher than table value of 2.05. It seems that there is significant efficacy of oral ice cubes in prevention of OM among cancer patients receiving chemotherapy. Chi-square shows that there was a significant relation (p=>0.05) found among the post-test scores OAG and demographic variables such as frequency of check-ups. According to Oral Cancer Foundation.org. It leads to different problems, involving pain, nutritional problems because of the incapability to eat, and high risk of infection because of open sores in the mucosa. It could be dose-limiting (viz., require a reduction in succeeding chemotherapy dose) and has significant effects on the quality of life. Factors that can make it worse if it does occur or that increases the probability of growing OM, include habit of tobacco chewing, and poor oral hygiene. This re-search's strong point was that an ice cube applied an individualized approach for cancer patients who are receiving chemotherapy with in-person interactions. This facilitated the investigator in meeting the cancer patients and give patient centered interactions and resolutions for the cancer patients to prevent or minimize OM induced by chemotherapy. This was imitated in the study outcomes on level of clinical manifestation of OM. India has reported over 40 lakh cancer case studies and 22.54 lakh deaths occurred between 2018 to 2020 as reported by the government to the Lok Sabha on Fri-day.

OM is a commonly seen complication of cancer therapy. Around 40% of the cases on conventional chemotherapy may develop OM Chemotherapy-induced OM is a self-limiting condition. OM restricts oral intake, causes pain, often contributes to interruption of therapy, might increase the usage of narcotics and antibiotics, might rises the overall cost of treatment and extend the length of hospitalization. It is a greatly threatening problem ahead and are surmounting bottlenecks and medical system blocks to minimize or prevention of OM and improve standards of living. In the pre-sent study, with ice cubes application shows substantial differences at $p<0.001$ and proved that ice cubes application before 5 min of initiation of chemotherapy and 20 min post the session minimized the clinical manifestation of OM in study group more than the control group.

5. CONCLUSION

The chemotherapeutic treatment of cancer patients triggers the onset of OM in the tongue, lips, labial mucosa, buccal mucosa or palate, and gums area affecting the qual-ity and quantity of saliva and impairing swallowing function. Those changes might cause imbalance in the normal functioning of the stomatognathic system, thus impair-ing patients' health and standards of living, and harming the course of cancer treatment. This study shows that the application of oral ice cubes has a significant contribution to the protection of oral health by minimizing the clinical manifestations of OM. It is a greatly threatening problems ahead and are surmounting bottlenecks and medical system blocks to minimize or prevention of OM and increase standards of living. In the present study, with ice cubes application shows substantial differences at $p<0.001$ and proved that ice cubes application before 5 min of initiation of chemotherapy and 20 min post the session minimized the clinical manifestation of OM in study group more than the control group.

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