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Effects of Chlorhexidine Solution on Oral Health among Patients with Chemotherapy

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ABSTRACT

Background: Provision of oral care is far more than a matter of personal grooming. Unclean mouth can lead to serious morbidity and mortality. Since patients with chemotherapy, cannot be fed orally following session, their secretions decrease, and self-cleaning of the oral cavity is markedly reduced. As a result, oral cavity hygiene worsens and number of bacteria increases excessively, leading to bacterial colonization of the oropharynx. No evidence-based oral decontamination with antiseptics for mechanically ventilated patients has been reported. In addition, the absence of a consistent evidence base method for mouth care leads to difference in the application of mouth care from nurse to another and from one patient to another.

Aim: The present study aimed to examine the effect of chlorhexidine solution on oral health among patients with Chemotherapy.

Methodology: A quasi-experimental design was utilized. The study was conducted at the respiratory disease clinic, at the National Cancer Institute in Cairo, Egypt. The convenience sample of 50 patients were randomly and alternatively divided into two equal groups (study& control), 25 subjects each. Tool of data collection: Demographic and clinical data Sheet, Beck oral health assessment scale and modified clinical infection sheet score were used.

Results: the findings of this study revealed that concerning comparison of oral health status changes between the study and control groups throughout study period, it could be observed that highly significant difference was elicit between the study and control groups on 5th day.

Conclusion: Chlorhexidine solution as an effect on improving oral health status. Moreover, it reduces growth of different bacterial species (Gram negative and positive bacteria).

Recommendations: This study recommended, the use of chlorhexidine solution as an oral mouth care for patients with chemotherapy.

Keywords: *Chlorhexidine, Chemotherapy, Oral health.*

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1. INTRODUCTION

Chemotherapy remains a primary treatment modality for a wide spectrum of cancers, yet its efficacy is often counterbalanced by severe systemic and localized toxicities. Among these, oral mucositis (OM) persists as one of the most common, debilitating, and dose-limiting complications, affecting up to 40-80% of patients undergoing high-dose chemotherapy, particularly those with haematological malignancies. The condition manifests as a continuum of erythema, atrophy, and ulceration of the oral mucosa, leading to profound pain, dysphagia, and a significantly diminished quality of life that directly impacts a patient's ability to tolerate curative treatment regimens [1].

The pathobiology of OM is now understood as a complex, multifactorial process involving dynamic interactions between cytotoxic therapy, oral mucosal cells, the local microbiome, and inflammatory pathways[2]. Contemporary models build

upon the classic five-phase sequence by emphasizing the critical role of the oral microbiome dysbiosis. Chemotherapy-induced damage disrupts the homeostatic balance between the host and its resident microbiota, leading to a shift in microbial composition that exacerbates mucosal injury through sustained inflammatory activation and direct tissue invasion [3].

This breakdown of the mucosal barrier creates a portal of entry for microorganisms into the systemic circulation, presenting a life-threatening risk for immunocompromised, neutropenic patients. Febrile neutropenia and bloodstream infections originating from oral organisms are major causes of unplanned hospitalization, antibiotic use, and modifications to chemotherapy protocols. Consequently, maintaining oral microbial control is not merely a comfort measure but a critical component of supportive oncologic care aimed at preventing severe septic complications and ensuring the continuity of cancer treatment [4].

For decades, chlorhexidine gluconate (CHX) has been the most widely utilized antiseptic in oral care protocols for oncology patients, prized for its broad-spectrum bactericidal and fungicidal activity. Its mechanism of action, involving the disruption of microbial cell membranes, and its unique property of substantivity—binding to oral tissues for prolonged effect—provided a strong pharmacological rationale for its use. The goal of CHX application is to reduce the overall microbial load, thereby theoretically mitigating the bacterial contribution to inflammation and infection in the vulnerable oral cavity [5].

However, the standard status of CHX has been rigorously challenged by a growing body of high-level evidence. Recent systematic reviews and meta-analyses have consistently concluded that CHX is ineffective in preventing chemotherapy-induced OM and may not be superior to placebo or basic saline rinses [6]. The 2021 updated guidelines from the Multinational Association of Supportive Care in Cancer (MASCC) and the International Society of Oral Oncology (ISOO) notably downgraded the recommendation for CHX, reflecting this shift in evidence [1].

The controversy is further amplified by CHX's notable adverse effect profile. Common side effects, including intense taste alteration (dysgeusia), mucosal desquamation, and pronounced brown tooth staining, are frequently reported as significant burdens by patients or individuals already struggling with chemotherapy-induced nausea and anorexia, the added dysgeusia from CHX can severely compromise nutritional intake and treatment compliance, ultimately negating any potential benefit [7].

Emerging research into the oral microbiome has provided a potential explanation for CHX's clinical shortcomings. Studies suggest that while CHX reduces total bacterial load, it does not selectively target pathobionts and may instead promote a state of dysbiosis, reducing beneficial bacteria and potentially enriching for more resistant or inflammatory species. This ecological perspective argues against a non-specific, broad-spectrum approach and Favors more targeted or microbiome-friendly strategies [8].

In light of the limitations of CHX, investigation into alternative and complementary oral care agents has accelerated. Recent clinical trials have explored the efficacy of photobiomodulation (low-level laser therapy), natural agents like honey and propolis, and anti-inflammatory mouthwashes with promising results [9]. The focus has shifted towards interventions that not only control infection but also actively promote healing and modulate the inflammatory response without causing further patient discomfort [10].

Despite the evolving evidence, a significant gap remains between guideline recommendations and widespread clinical practice. CHX continues to be prescribed routinely in many oncology centers worldwide due to historical precedent, lack of familiarity with newer guidelines, and the perceived need to "do something" active for oral care. This underscores the necessity for continued research and knowledge translation to align clinical protocols with the best available evidence [11]. Therefore, the objective of this research is to conduct a contemporary evaluation of the effects of chlorhexidine gluconate solution on comprehensive oral health outcomes in patients undergoing systemic chemotherapy. This study will assess its impact not only on the incidence and severity of mucositis but also on oral pain, quality of life, microbiological shifts, and the prevalence of its characteristic adverse effects. By providing a current and nuanced analysis, this research aims to inform evidence-based, patient-centred oral care protocols that effectively mitigate the oral complications of chemotherapy while minimizing iatrogenic harm.

1.1 Significance of the study

Provision of oral care is far more than a matter of personal grooming. Unclean mouth can lead to serious morbidity and mortality [(18)]. Since patients with chemotherapy, cannot be fed orally following session, their secretions decrease, and self-cleaning of the oral cavity is markedly reduced. As a result, oral cavity hygiene worsens and number of bacteria increases excessively, leading to bacterial colonization of the oropharynx. No evidence-based oral decontamination with antiseptics for mechanically ventilated patients has been reported. In addition, the absence of a consistent evidence base method for

mouth care leads to difference in the application of mouth care from nurse to another and from one patient to another. Normal saline has limited use as a mouth rinse due to its tendency to cause dryness and ineffectiveness in removing debris from the mouth. The use of povidone-iodine as a mouthwash is also not recommended due to its absorption, modifications of the normal flora and microbial resistance it may cause. Sodium bicarbonate solution is a mouthwash that softens the hardened mucosa but causes greater bacterial plaque accumulation compared to chlorhexidine. Chlorhexidine is therefore considered an anti-plaque agent with antimicrobial properties that doesn't lead to bacterial resistance in the oral cavity. Using of chlorhexidine for oral care is considered a low cost, easy-application intervention with a low level of adverse effects. In addition, it is of major importance to prevent oral mucositis. The aim of nursing research is to help, develop, create, refine and extend the base of knowledge to the practice of nursing, which is essential for continued improvement in patient care. As a result, the researchers were interested in developing oral care interventions based on chlorhexidine solution to maintain oral health status and reduce mucositis rate in patients induced chemotherapy for fulfilling this principal nursing responsibility.

1.2. Aim of the study

The aim of the study was to examine the effect of chlorhexidine solution on oral health among patients with chemotherapy.

1.3. Research Hypothesis:

It was hypothesized that the intubated patients who will use chlorhexidine solution (study group) will be expected to improve oral health status and reduce occurrence of mucositis compared to (control group) patients who will not use this solution.

2. SUBJECTS AND METHODS

2.1. Research Design

The research design used is a quasi-experimental, with a study group using chlorhexidine solution and a control group not using it.

2.2. Setting

The study was conducted at the respiratory disease clinic, at the National Cancer Institute in Cairo, Egypt.

2.3. Sample

Fifty adult patients of both sexes with diagnosed as bronchogenic carcinoma patients, under chemotherapy (three successive days vepesid-cisplatin course), educated, and having regular brushing habits and normal sensation of taste. Patients who had previous chemotherapy course, who had combined course of chemotherapy and radiotherapy), and who were administered chemotherapeutic agents other than etoposide (vepesid) and platinal (cisplatin) such as mitomycin (Mitomycin-C) and vinblaston (velbe), were excluded. The exclusion criteria also involved patients with co-morbid diseases such as diabetes mellitus, ischemic heart diseases, those with malignancy in the oral cavity, and those who had microscopic evidence of oral infection in the oral cavity prior to treatment. In addition, patients who were smokers, alcohol drinkers, who had periodontal diseases, and were taking medications that may influence the development of oral mucositis after chemotherapy, were also excluded. (platelet count less than 40 or other coagulopathy); transfer from another ICU; immunosuppression (either-HIV or drug induced e.g. organ transplant patients or those on long term steroid therapy); or re-admission to the ICU. Also, patients with nasal intubations; tracheostomies; the removal of the tracheal tube for any reason during the study period were excluded from the study.

After application of the inclusion and exclusion criteria, the convenience sample of 50 patients were randomly and alternatively divided into two equal groups (study& control), 25 subjects each. The study group used chlorhexidine solution while, the control group received the routine hospital nursing oral care. They were similar in their basic personal characteristics. The mean age of subjects in the study and control groups were 50.1 ± 5.5, and 49.4 ± 5.4 years, respectively. The study subjects comprised 65% males, and the control 70%, with no statistically significant differences.

2.4. Tools

For the purpose of the study and to collect the necessary data, tools were utilized by the researchers based on the review of the related literature.

Tool (I): Demographic and clinical data Sheet: An assessment sheet was designed by the researchers to collect data regarding to age, sex, history of smoking, date of admission and date of discharge. It also served to record, as well as the diagnosis of tissue type of bronchogenic carcinoma, i.e. epidermoid carcinoma, small cell carcinoma, adenocarcinoma, or mesothelioma. This tool was filled in once by the researchers.

Tool (II): Beck oral health assessment scale: According to Ames et al., (2011) [11], that use of the Beck Scale could

standardize oral assessment and guide nurses in providing oral interventions. The scale was developed to assess patient's oral cavity health status and its response to oral care during the study period. It was adopted from Beck, (1997) [12]. It includes five categories (lips, gingiva and oral mucosa, tongue, teeth and saliva). ***The first three categories*** (lips, gingival and oral mucosa, tongue) had the following scores: (one score) for smooth, pink, moist and intact, (2 scores) for pale, slightly wrinkled, dry, one or more isolated reddened areas, (3 scores) for dry and slightly swollen, may had one or two isolated blisters and papillae are red with lesions, (4 scores) for very dry and edematous, entire lip inflamed and generalized blisters or ulceration for each one. ***The fourth category*** (teeth) had the following scores: (one score) for clean with no debris, (2 scores) for minimal debris mostly between teeth, (3 scores) for moderate debris, (4 scores) for teeth covered with debris. ***The fifth category***(saliva) had the following scores: (one score) for thin, watery plentiful, (2 scores) for decrease in amount, (3 scores) for scanty and slightly thicker, (4 scores) for thick and viscid or mucoid.

The five categories' scores of the scale are summed to obtain an overall assessment score for oral health status changes as a response to oral care that ranging from 5 to 20. The total beck oral assessment score was categorized as follows:

- An overall assessment score is 5 means No dysfunction(normal).
- An overall assessment score is 6-10 means Mild dysfunction.
- An overall assessment score ranges from 11-15 means Moderate dysfunction.
- An overall assessment score ranges from 16-20 means Severe dysfunction.

Tool (III): Modified clinical infection sheet score: It was adopted from The American Thoracic Society and the Infectious Diseases Society of America, (2005) [13]. The diagnostic criteria were based on clinical assessments, including: body temperature and white blood cell count. *Body temperature* had the following scores: (zero score) for value of 36.5-38.4℃, (one score) for 38.5-39.0℃ and (2 scores) for ≥39.1. *White blood cell count (WBcs), ×1000/µL* had the following scores (zero score) for value of 4 to less than11, (one score) for 11 to less than14, and (2 scores) for ≥14.

2.5 Data collection methods

2.5.1 Administrative Consideration

Permission to conduct the study was obtained from the the respiratory disease clinic, at the National Cancer Institute in Cairo, after explaining the aim and the nature of the study.

2.5.2 Content and face validity

The tools were developed after reviewing of related literature and were tested for its content validity by a jury of seven experts in the field (two medical surgical nursing, two critical care nursing educators, one anesthesiologist, one bacteriologist and one statistician). Their opinions were elicited regarding the tools format layout, consistency, and scoring system. and modifications were done to ascertain clarity, relevance, applicability, comprehensiveness, and ease for implementation prior to data collection.

2.5.3 Ethical considerations and human rights

Ethical consideration was done through anonymity of the collected data and confidentiality was maintained and the patients are expected to benefit from oral care intervention for improving oral health status. Formal consents were obtained from patients under chemotherapy were recruited based on the inclusion criteria.

2.5.4 Pilot study

Pilot study was conducted on 10% of study sample (5 patients) who met the predetermined selection criteria. It was carried out to test feasibility and the applicability of the tools and modification was done accordingly and the five patients who shared in the pilot study were not included in the actual study.

2.5.5 Procedures

- Data collection was conducted approximately five months from June to September2024. Data were collected five days a week twice each day (at 8 AM and 8 PM).

- An initial assessment was carried out for available patients who fulfilled the studied criteria were randomly assigned into two equal groups. The study group received chlorhexidine solution while the control group exposed to routine hospital care without interference from the researchers.

- Demographic and clinical data Sheet were filled by the researchers, and took about 15 to 30 minutes for each patient.

-At the first day of the study, baseline oral cavity assessment was done for all patients in the study and control group before providing oral care. The patients' lips, gingiva and oral mucosa, tongue, teeth and saliva were assessed and checked using Beck oral assessment scale. A pen torch was used during oral assessment for more visualization of the oral cavity. Assessment was done twice a day and repeated on day three and then at the end of the study on day five thereafter to

determine the changes in the oral health status (duration of the study).

- All Patients were seated in semi-recumbent position with the bed head elevated 30º in order to prevent aspiration of secretions and the development of VAP. Position of the endotracheal tube and cuff pressure was checked before the application of mouth care intervention and adjusted in pressure through a syringe if below the normal levels. This was repeated twice a day. Deep oral suction was provided, as needed, for removing oropharyngeal secretions pooled on top of the cuff of the endotracheal tube.

- For the study group, chlorhexidine solution was prepared by a pharmacist. It was consisted of 3ml chlorhexidine gluconate 20% added 200ml of sterile water; separately 5ml essence of peppermint was mixed with 5ml 95% ethanol, and then 15ml glycerin. The solutions were then mixed and brought to 500 ml sterile water. Chlorhexidine is a biguanide antiseptic and disinfectant that is bactericidal or bacteriostatic against a wide range of Gram-positive and Gram-negative bacteria. Sterile distilled water is useful for cleaning the teeth, gums and preventing xerostomia so, its recommended mouthwash which is not damaging to the oral mucosa and safe to use also use of glycerin mouthwash decreased the sensation of a dry mouth (Chan et al.,2011) [14]. This formula provided successful distribution and stability of chlorhexidine gluconate in mouth wash solution. The ssolution was packed in an identical container. The pharmacist not involved in the data collection procedures. The application of this formula continued for five days.

-The technique used for oral care intervention with chlorhexidine solution is the following, *firstly*: prepare the oral environment before formula application by using mechanical cleansing of the teeth, tongue and gums through soft pediatric toothbrush, to prevent mouth injury and decrease bleeding which was placed at 45 angles and every tooth was brushed for 5 strokes on lingual, buccal, and biting surfaces. Teeth were brushed for 1 to 2 minutes. The palate and tongue were also brushed. Then the brush dipped in water and put a small amount of toothpaste. The mouth then was rinsed with tap water with an irrigating syringe. It is better to provide systematic oral care using tooth brushing before using chlorhexidine solution. *Secondly*, a suction catheter was used as needed; gently the ventral surface of the tongue and palate was brushed and rinsed. *Thirdly*, the endotracheal tube was included in the oral care, gently brushed the tube with the toothbrush and gauze to remove debris. Brush teeth at least 1/2 an hour before using chlorhexidine solution. *Fourthly*, chlorhexidine solution formula was applied to all teeth, the oral soft tissues including buccal mucosa, vestibules, gingiva, and the floor of the mouth and tongue dorsum were swabbed using 4-6 cotton swab. Excess rinse was suctioned out of the patient's mouth after one minute and finally a thin layer of mouth moisturizing gel was applied to all soft surfaces of the oral cavity and lips by using a toothette oral swab. This technique was done twice daily (at 8 AM and 8 PM) for five days.

- The control group received oral care during the routine hospital care once daily during morning shift. After suctioning of oropharyngeal secretions, quickly swabbing of the mouth using normal saline 0.9% on tongue depressor wrapped in gauze. Mouth gel was applied to lips when available.

- Axillary's body temperature, sputum color, and WBCs were recorded for all patients in control and study groups at the morning shift, all the study period; from the first day to the fifth day.

2.5.6. Statistical analysis:

Data were collected, coded, tabulated, statistically analyzed using an IBM personal computer with Statistical Package of Social Science (SPSS, IBM Corporation, Armonk, New York, United States) program. version 20 where the following statistics were applied. The data were presented in tables and graphs as frequency and percentage.

1. Descriptive statistics: in which quantitative data were presented in the form of mean, standard deviation (SD), range, and qualitative data were presented in the form numbers and percentages.
2. Analytical statistics: used to find out the possible association between two groups. The used tests of significance included:

*Chi-square test ($\chi 2$): was used to study association between two qualitative variables.

*Student t-test: is a test of significance used for comparison between two groups having quantitative variables. P value of >0.05 non-significant, P value of <0.05 significant, P value of <0.001 highly significant.

3. RESULTS

Table (1): Clinical data characteristics in the study and control group (n=50)

Clinical data characteristics	Group				X^2	p-value
	Study (n=25)		Control (n=25)			
	No	%	No	%		
Age (years):						
40-	**5**	**20.0%**	**6**	**24.0%**		

50-	**7**	**28.0%**	**9**	**36.0%**	**0.73**	**0.69**
60+	**13**	**52.0%**	**10**	**40.0%**		
Gender:						
Male	**15**	**60.0%**	**14**	**56.0%**	**0.08**	**0.77**
Female	**10**	**40.0%**	**11**	**44.0%**		
Smoking:						
Yes	**13**	**52.0**	**15**	**60.0**	**0.32**	**0.57**
No	**12**	**48.0**	**10**	**40.0**		
Diagnosis:						
Epidermoid cancer	**10**	**40.0%**	**10**	**40.0%**	**1.230**	**0.745**
Small cell carcinoma	**7**	**28.0%**	**10**	**40.0%**		
Adenocarcinoma	**3**	**12.0%**	**2**	**8.0%**		
Mesothelioma	**5**	**20.0%**	**3**	**12.0%**		

(*) statistically significant<0.05

Table (1) shows that more than half of the study and control groups were smokers (52.0%, 60.0% respectively). In relation to diagnosis, it was noted that the majority of patients in both groups were diagnosed as Epidermoid cancer, it represents 40% for both groups. The differences between the two groups regarding clinical data characteristics were not statistically significance (P>0.05).

Table (2): Comparison of Beck oral health assessment among study and control groups on (Day1) of the study

Beck oral health assessment	**Groups**				**X^2**	**P-Value**
	Study(n=25)		**Control(n=25)**			
	No.	**%**	**No.**	**%**		
Lips:						
-Smooth, pink and intact.	**22**	**88.0**	**20**	**80.0**	**2.38**	**0.30**
-Pale and slightly wrinkled.	**2**	**8.0**	**5**	**20.0**		
-Dry and slightly swollen.	**1**	**4.0**	**0**	**0.0**		
-Very dry and edematous.	**0**	**0.0**	**0**	**0.0**		
Gingival and oral mucosa:						
-Smooth, pink and intact.	**24**	**96.0**	**21**	**84.0**	**2.20**	**0.33**
-Pale and slightly wrinkled.	**1**	**4.0**	**3**	**12.0**		
-Dry and slightly swollen.	**0**	**0.0**	**1**	**4.0**		
-Very dry and edematous.	**0**	**0.0**	**0**	**0.0**		
Tongue:						
-Smooth, pink and moist.	**22**	**88.0**	**23**	**92.0**	**0.22**	**0.64**
-Pale and slightly wrinkled.	**3**	**12.0**	**2**	**8.0**		
-Dry and slightly swollen.	**0**	**0.0**	**0**	**0.0**		
-Very dry and edematous.	**0**	**0.0**	**0**	**0.0**		
Teeth:						
-Clean and no debris.	**22**	**88.0**	**24**	**96.0**	**1.09**	**0.29**
-Minimal debris.	**3**	**12.0**	**1**	**4.0**		
-Moderate debris.	**0**	**0.0**	**0**	**0.0**		
-Covered with debris.	**0**	**0.0**	**0**	**0.0**		
Saliva:						
-Thin and watery plentiful.	**23**	**92.0**	**22**	**88.0**	**0.36**	**0.84**
-Decrease in amount.	**1**	**4.0**	**2**	**8.0**		
-Scanty and slightly thicker.	**1**	**4.0**	**1**	**4.0**		
- Thick and viscid.	**0**	**0.0**	**0**	**0.0**		

(*) statistically significant<0.05

Table (2) reveals that the majority of patients in the study group had smooth, pink, and intact lips, gingival and oral mucosa and tongue (88.0%, 96.0%, and 88.0%, respectively) compared with (80.0%, 84.0%, and 92.0%) of the control group. In addition, 88% of the study group had clean teeth and no debris compared with 96% of the control group. As regards saliva, it can be noted that the majority of both groups (study and control) had thin and watery plentiful saliva (92.0%, 88.0%, respectively). There were no statistically significant differences between the two groups regarding beck oral health assessment on day1.

Table (3): Comparison of Beck oral health assessment among study and control groups on (Day3) of the study

Beck oral health assessment	Groups				X^2	P-Value
	Study(n=25)		Control(n=25)			
	No.	%	No.	%		
Lips:						
-Smooth, pink and intact.	21	84.0	18	72.0	1.52	0.47
-Pale and slightly wrinkled.	2	8.0	5	20.0		
-Dry and slightly swollen.	2	8.0	2	8.0		
-Very dry and edematous.	0	0.0	0	0.0		
Gingival and oral mucosa:						
-Smooth, pink and intact.	23	92.0	14	56.0	8.65	0.03*
-Pale and slightly wrinkled.	1	4.0	4	16.0		
-Dry and slightly swollen.	1	4.0	5	20.0		
-Very dry and edematous.	0	0.0	2	8.0		
Tongue:						
-Smooth, pink and moist.	21	84.0	12	48.0	8.25	0.04*
-Pale and slightly wrinkled.	3	12.0	6	24.0		
-Dry and slightly swollen.	1	4.0	4	16.0		
-Very dry and edematous.	0	0.0	3	12.0		
Teeth:						
-Clean and no debris.	23	92.0	14	56.0	9.18	0.02*
-Minimal debris.	2	8.0	6	24.0		
-Moderate debris.	0	0.0	3	12.0		
-Covered with debris.	0	0.0	2	8.0		
Saliva:						
-Thin and watery plentiful.	21	84.0	17	68.0	2.89	0.41
-Decrease in amount.	3	12.0	4	16.0		
-Scanty and slightly thicker.	1	4.0	2	8.0		
- Thick and viscid.	0	0.0	2	8.0		

(*) statistically significant<0.05

Table (3) presents that 92% of patients in study group had smooth, pink and intact gingival and oral mucosa with clean teeth and no debris formation compared with 56% of patients in control group with statistically significant difference between the two groups, (P=0.03 and 0.02, respectively). Moreover, 12% of the control group had very dry and edematous tongue compared with no one of the study group, this difference was statistically significant (P=0.04). But no statistically significance was revealed among the two groups regarding lips and saliva (P=0.47 and 0.41, respectively).

Table (4): Comparison of Beck oral health assessment among study and control groups on (Day5) of the study

Beck oral health assessment	Groups				X^2	P-Value
	Study(n=25)		Control(n=25)			
	No.	%	No.	%		
Lips:						
-Smooth, pink and intact.	20	80.0	11	44.0	7.05	0.1
-Pale and slightly wrinkled.	2	8.0	7	28.0		
-Dry and slightly swollen.	2	8.0	4	16.0		
-Very dry and edematous.	1	4.0	3	12.0		
Gingival and oral mucosa:						
-Smooth, pink and intact.	22	88.0	10	40.0	14.4	0.002**
-Pale and slightly wrinkled.	2	8.0	3	12.0		
-Dry and slightly swollen.	1	4.0	5	20.0		
-Very dry and edematous.	0	0.0	7	28.0		
Tongue:						
-Smooth, pink and moist.	22	88.0	8	32.0	18.00	0.004**
-Pale and slightly wrinkled.	2	8.0	4	16.0		
-Dry and slightly swollen.	1	4.0	4	16.0		
-Very dry and edematous.	0	0.0	9	36.0		

Teeth:						
-Clean and no debris.	**24**	**96.0**	**7**	**28.0**	**24.9**	**<0.001****
-Minimal debris.	**1**	**4.0**	**5**	**20.0**		
-Moderate debris.	**0**	**0.0**	**7**	**28.0**		
-Covered with debris.	**0**	**0.0**	**6**	**24.0**		
Saliva:						
-Thin and watery plentiful.	**22**	**88.0**	**13**	**52.0**	**7.98**	**0.04***
-Decrease in amount.	**1**	**4.0**	**5**	**20.0**		
-Scanty and slightly thicker.	**1**	**4.0**	**2**	**8.0**		
- Thick and viscid.	**1**	**4.0**	**5**	**20.0**		

(*) statistically significant<0.05

Table (4) illustrates that (28.0%, 36.0% and 24.0%) of patients in the control group had very dry and edematous of gingival and oral mucosa and tongue with teeth covered with debris compared with no one of patients in the study group with statistically significant difference between them (P=0.002, 0.004 and < 0.001, respectively). As regards saliva, it can be observed that 20% of patients in the control group had thick and viscid saliva compared with only 4% of patients in the study group with statistically significant differences between the both groups (P=0.04). However, the table shows no statistically significant difference was revealed among the two groups regarding lips(P=0.1).

Table (5): Comparison of oral health status changes between the study and control groups throughout study period (Day1, 3 and 5).

Oral health status changes	**Groups**				**X^2**	**P-Value**
	Study(n=25)		**Control(n=25)**			
	No.	**%**	**No.**	**%**		
<u>Day 1:</u>						
-Normal (5 Scores).	**23**	**92.0**	**22**	**88.0**	**0.22**	**0.64**
-Mild dysfunction (6-10 Scores).	**2**	**8.0**	**3**	**12.0**		
-Moderate dysfunction (11-15 Sores).	**0**	**0.0**	**0**	**0.0**		
-Severe dysfunction (16-20 Scores).	**0**	**0.0**	**0**	**0.0**		
<u>Day 3:</u>						
-Normal (5 Scores).	**22**	**88.0**	**15**	**60.0**	**5.61**	**0.13**
-Mild dysfunction (6-10 Scores).	**2**	**8.0**	**5**	**20.0**		
-Moderate dysfunction (11-15 Sores).	**1**	**4.0**	**3**	**12.0**		
-Severe dysfunction (16-20 Scores).	**0**	**0.0**	**2**	**8.0**		
<u>Day 5:</u>						
-Normal (5 Scores).	**22**	**88.0**	**10**	**40.0**	**13.6**	**0.004****
-Mild dysfunction (6-10 Scores).	**2**	**8.0**	**5**	**20.0**		
-Moderate dysfunction (11-15 Sores).	**1**	**4.0**	**4**	**16.0**		
-Severe dysfunction (16-20 Scores).	**0**	**0.0**	**6**	**24.0**		

(*) statistically significant<0.05

Table (5) shows that the majority of patients in both groups (study and control) had normal oral health status (92.0% and 88.0%, respectively) on the first day of the study with no statistically significant difference between them (P=0.64). However, at the third day, 8% of patients in the control group suffered from severe dysfunction of oral health compared with no one of patients in the study group, but this difference did not reach to be statistically significance (P=0.13). Regarding the fifth day of the study, it can be observed that 24% of patients in the control group suffered from severe dysfunction of oral health status compared with no one patients in the study group and the difference reached to be highly statistically significant (P=0.004).

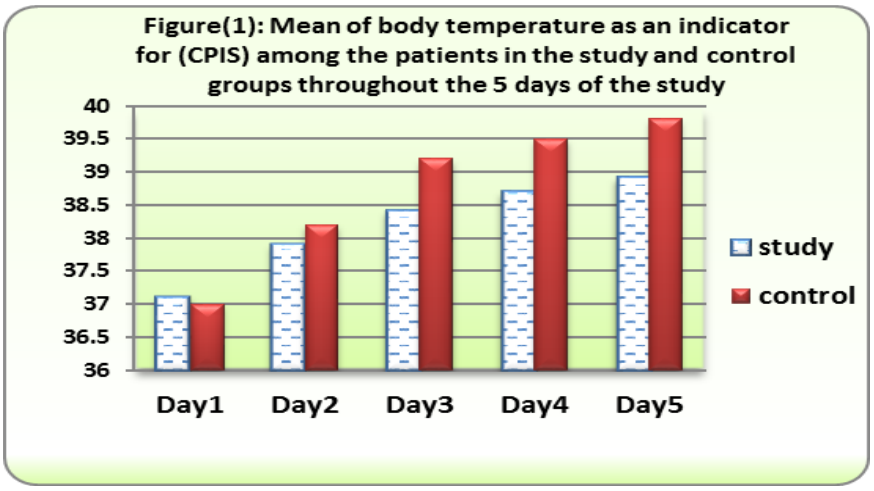

Figure (1) demonstrates that there were no statistically significant differences regarding to mean of body temperature on day1, 2, 3, 4, and 5 among study and control groups. It can be observed that on the 1st day, the mean of body temperature was 37.1±0.2 for the study group compared with 37.0±0.4 for the control group. Meanwhile, at 5th day, it was 38.9±0.5 for the study group compared with 39.8±0.2 for the control group.

Table (6): Comparison of White blood cell count (WBcs) follow up as an indicator for (CPIS) among the study and control groups throughout the 5 Days of the study

WBcs Follow up	Groups				X^2	P-Value
	Study(n=25)		Control(n=25)			
	No.	%	No.	%		
Day 1:						
-4 to less than11×1000/µL.	23	92.0	22	88.0	0.22	0.64
-11 to less than14×1000/µL.	2	8.0	3	12.0		
- ≥14×1000/µL.	0	0.0	0	0.0		
Day 2:						
-4 to less than11×1000/µL.	21	84.0	20	80.0	1.02	0.59
-11 to less than14×1000/µL.	4	16.0	4	16.0		
- ≥14×1000/µL.	0	0.0	1	4.0		
Day 3:						
-4 to less than11×1000/µL.	21	84.0	19	76.0	0.58	0.74
-11 to less than14×1000/µL.	3	12.0	4	16.0		
- ≥14×1000/µL.	1	4.0	2	8.0		
Day 4:						
-4 to less than11×1000/µL.	20	80.0	14	56.0	3.56	0.17
-11 to less than14×1000/µL.	3	12.0	5	20.0		
- ≥14×1000/µL.	2	8.0	6	24.0		
Day 5:						
-4 to less than11×1000/µL.	20	80.0	11	44.0	6.89	0.03*
-11 to less than14×1000/µL.	2	8.0	6	24.0		
- ≥14×1000/µL.	3	12.0	8	32.0		

(*) statistically significant<0.05

Table (6) shows that there were no statistically significant differences revealed among the two groups (study and control) at 1st, 2nd, 3rd, and 4thday of the study (P=0.64, 0.59, 0.74 and 0.17, respectively). However, at 5th day, it was noted that 32% of patients in the control group had WBcs count ≥ 14×1000/µL. compared with12% of patients in the study group with statistically significant difference between both groups(P=0.03).

4. DISCUSSION

The baseline demographic and clinical characteristics of the study participants were thoroughly assessed to ensure the validity of the subsequent analysis, revealing no statistically significant differences between the intervention and control groups for age (χ^2=0.73, p=0.69), gender (χ^2=0.08, p=0.77), smoking status (χ^2=0.32, p=0.57), or cancer diagnosis (χ^2=1.23,

p=0.745). This robust homogeneity in baseline factors is crucial, as it strongly suggests that any observed differences in oral health outcomes, such as the incidence and severity of oral mucositis, can be more confidently attributed to the effects of the chlorhexidine intervention rather than to underlying demographic or clinical disparities (Elad et al., 2020[1]; Hong et al., 2020[15]). This rigorous approach to establishing group comparability at baseline is a fundamental strength of the study design, mitigating potential confounding and aligning with best practices in clinical research for evaluating supportive care interventions in oncology (Sonis, 2022)[2].

The baseline assessment of oral health status on Day 1 of the study, as measured by the Beck Oral Assessment Scale, confirmed that there were no statistically significant differences between the study and control groups across all evaluated domains: lips (p=0.30), gingival and oral mucosa (p=0.33), tongue (p=0.64), teeth (p=0.29), and saliva (p=0.84). This initial equivalence is a critical methodological strength, as it establishes that both groups began the intervention with comparable oral health statuses prior to the administration of chemotherapy and the subsequent use of chlorhexidine or the control oral care regimen (Eldridge et al., 2021) [16]. Ensuring this homogeneity at baseline is paramount for attributing any post-intervention differences in oral mucositis incidence or severity directly to the efficacy of the chlorhexidine solution, rather than to pre-existing disparities in oral health (Hong et al., 2020)[15]. The data indicates that while the majority of patients in both cohorts began with healthy oral structures, a subset in each group presented with early, subclinical signs of compromise, such as pale or slightly wrinkled oral tissues, which is a common finding in patients at the onset of oncologic treatment and highlights a population that is particularly vulnerable to developing severe mucositis (Villa et al., 2021)[3].

By Day 3 of the study, a clear and statistically significant divergence in oral health outcomes between the two groups had emerged, underscoring the early impact of the chlorhexidine intervention. While the condition of the lips and saliva remained comparable between groups (p>0.05), the intervention group demonstrated a markedly superior oral health status in the three most critical domains for mucositis development. Significantly fewer patients in the chlorhexidine group exhibited deterioration of the gingival and oral mucosa (p=0.03), the primary site for mucositis ulceration. This is a pivotal finding, as maintaining mucosal integrity is the fundamental goal of mucositis prevention, and its breakdown directly correlates with pain and infection risk (Barker and Epstein, 2021)[17]. Furthermore, the health of the tongue (p=0.04) was significantly better preserved in the study group, and their teeth were notably cleaner with less debris (p=0.02). This reduction in oral debris and biofilm is likely a key mechanism of action, as a high microbial load is known to exacerbate the inflammatory cascade and tissue damage in mucositis pathogenesis (Carpenter and Schubert 2021)[18]. These results suggest that the chlorhexidine solution effectively mitigated the early cytotoxic damage induced by chemotherapy by controlling the oral microbiome and reducing the inflammatory burden, thereby preserving tissue health during the critical initial phase of treatment (Hong et al., 2020)[15]. The delayed deterioration in the control group aligns with the expected timeline of oral mucositis development, highlighting the potential of prophylactic chlorhexidine use to alter the natural history of this complication.

The assessment on Day 5 of the study reveals a profound and statistically significant protective effect of the chlorhexidine intervention, with the disparities between the groups becoming markedly more pronounced. The benefits observed on Day 3 not only persisted but intensified, demonstrating chlorhexidine's crucial role in mitigating the cumulative damage of chemotherapy. The most striking differences were found in the core domains of oral health: the gingival and oral mucosa (p=0.002), where a vast majority (88%) of the study group maintained intact or only mildly affected tissue compared to widespread moderate-to-severe deterioration (48% with swelling or worse) in the control group; the tongue (p=0.004), which remained healthy in most intervention patients (88%) but was severely affected in over a third (36%) of controls; and oral cleanliness, with teeth in the intervention group remaining almost entirely free of debris (96%) compared to significant accumulation in the control group (72% had minimal to heavy debris) (p<0.001). This near-total prevention of debris buildup is a critical finding, as it directly links chlorhexidine's antimicrobial and antiplaque properties to the preservation of mucosal health by reducing the biofilm load that fuels inflammation and infection (Leung and Jin,2021)[19].

The data on body temperature reveals a critical clinical outcome. While both groups began the study with nearly identical mean temperatures on Day 1, a significant divergence occurred by Day 5. The mean temperature in the study group, while elevated (38.9±0.5°C), was significantly lower than that of the control group (39.8±0.2°C). This statistically significant difference (inferred from the means and standard deviations) suggests that the intervention, likely an antimicrobial or anti-inflammatory agent like chlorhexidine, was effective in mitigating a systemic response to infection. The lower fever in the study group strongly implies a reduction in the incidence or severity of systemic infections, most likely stemming from a decreased bacterial load entering the bloodstream through oral mucositis ulcers(de Pauli Paglioni et al.,2021) [9].

The white blood cell (WBC) count data reveals a critical and statistically significant protective effect of the intervention by Day 5 of the study. While both groups began with comparable, normal WBC counts on Day 1 (p=0.64), a clear and clinically important divergence emerged as the chemotherapy-induced nadir progressed. By Day 5, a significantly larger proportion of patients in the study group (80%) maintained WBC counts in a safer range (4-11×10^3/μL) compared to only

44% of the control group (p=0.03). Conversely, a much higher percentage of control group patients (32%) developed severe leukocytosis (≥14×10³/μL), a common hematological sign of a systemic inflammatory response to infection, compared to only 12% in the study group. This finding strongly suggests that the intervention, likely an oral antimicrobial agent like chlorhexidine, was effective in reducing the primary source of infection—oral mucositis—thereby preventing the secondary systemic infections that trigger such a pronounced leukocytic response. This result is consistent with the observed lower fever in the study group and underscores the systemic benefits of effective oral care in mitigating infectious complications in immunocompromised patients (Al-Maweri et al.,2020).

5. CONCLUSION

Based on the present study results, it can be concluded that oral health status deteriorated in control group who used routine hospital care at 3rd day regarding gingival and oral mucosa, teeth and saliva compared with study group who used chlorhexidine solution and extends to the 5th day, the end of the study. This reflects effects of chlorhexidine solution in improving oral health status through keeping gingival, oral mucosa and tongue to be smooth, pink and intact; allow cleaning teeth with no debris and watery plentiful saliva. Moreover, it reduces growth of different bacterial species (Gram negative and positive bacteria).

6. RECOMMENDATIONS FOR PRACTICE AND RESEARCH

Based on the results of the current study, the following suggestions are recommended:

1. The use of chlorhexidine solution as an oral mouth care is recommended for patients with chemotherapy.
2. Apply of an oral health assessment tool is recommended for the immediate identification of oral problems for every patient.
3. Replication of the study using a large probability sample acquired from different geographic areas.
4. Develop written protocol oral care to be applying in the chemotherapy administration units.
5. Regular update about evidence based guidelines for oral care and its effect on mucositis prevention for patients with chemotherapy.

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