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ORIGINAL ARTICLE

Holistic Approach for the Early Detection of Oral Cancer: A Comprehensive Training Module

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Abstract

Objectives Oral cancer is significantly high in India, and screening is an effective approach to downstage the disease. Educating Community Health Workers (CHWs) on early oral cancer detection is an effective step toward reducing the burden and serves as a first step toward facilitating the transfer of knowledge. Therefore, the purpose of this hands-on education was to equip CHWs with insight on the advanced diagnostics, preventive techniques, and innovations for the early detection of oral cancer.

Materials and Methods A total of 178 participants were trained in two groups: Group 1 received training for screening and primary prevention, while group 2 received training on updates in recent diagnostic adjuncts and innovations, AI-enabled point-of-care diagnostics, and essential patient care in management of Oral Potentially Malignant Disorders (OPMDs). Pre- and post-assessment questionnaires were used to evaluate the participants.

Results The knowledge assessment scores between the pre- and post-tests showed a statistically significant difference ($p < 0.001$), with rise in mean score of 3.99 from baseline. Six months following training, knowledge retention revealed a statistically significant difference ($p < 0.001$) in the participants' ability to recall the information.

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Conclusion A well-structured training module can create awareness, impart knowledge and upskill the CHWs for early detection of oral cancer. Retraining of CHWs is required for knowledge retention post-training.

Keywords Education · Oral cancer · Assessment · Community health workers · Detection · mHealth

Introduction

The burden of oral cancer is increasing in India, with 143,759 new cases and 79,979 deaths have been reported in 2022 and an age standardized incidence of 9.9%, while the mortality rate is 5.6% [1]. In addition, 30% of all cancers and one-third of all oral cancer cases worldwide occur in India [2]. Oral cancers are usually preceded by asymptomatic clinically evident oral lesions referred to as Oral Potentially Malignant Disorders (OPMDs) [3–6]. The 5-year survival rate for patients with early stage oral cancer is 82%, while the rate for patients with advanced-stage oral cancer is 27%. This indicates that early detection can increase the likelihood of survival [7, 8]. Consequently, community-based oral cancer screening has been shown to be one of the most successful ways to lower the burden of oral cancer. To mitigate the shortage of medical staff in areas with limited resources, it has been proposed that employing Community Health Workers (CHWs) as a bridge to fill the gap in human resources for health care has been proposed [8]. Therefore, training these CHWs is necessary and is a crucial tactic for lowering the incidence of oral cancer and updating cutting-edge ideas that may be applied in contemporary clinical practice.

Training modules on population-level screening of common malignancies, including oral cancer, have been established for medical officers and staff nurses by the National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) [9]. The Indian Council of Medical Research—National Institute of Cancer Prevention (ICMR NICPR)- ECHO conducted a virtual training module on oral cancer screening and tobacco cessation for CHWs across India and abroad (Libya), which has shown promising results in effectively sensitizing and training such personnel [10]. The Project ECHO used the virtual Hub and spoke model for telemedicine, which uses both in-person and online sessions, which facilitates learning among the rural CHWs. These educational initiatives aim to equip CHWs with the necessary knowledge and skills to recognize high-risk individuals for oral cancer. However, there are not enough offline training modules that make use of the available resource personnel in the regional zones to assist with community-based screenings for the early detection of oral cancer. Hence, the purpose of this educational initiative was to train the CHWs as a first step in disseminating knowledge about oral cancer prevention, recent advances, and innovations in diagnostics for early diagnosis.

To the best of our knowledge, this is the first in-person, hands-on training program of its kind. The extensive syllabus covers a wide range of topics related to oral cancer. The purpose of this module is to educate the participants on the importance of primary prevention and early detection and provides an update on the current advancements in diagnostics, AI-enabled point-of-care technology, telediagnosis, guidelines on the management of OPMDs and essential patient care, as well as impending breakthroughs.

Methodology

Study Settings and Study Population

This comprehensive, interactive, educational training module on oral cancer was organized in association with the Mazumdar Shaw Medical Foundation (MSMF), the Biocon Foundation, and the KLE Society's Institute of Dental Sciences (KLESIDS), in Bengaluru. A total of ($n = 178$) participants were divided into two groups. Group 1 consisted of ($n = 101$) low-skilled personnel such as ASHAs, CHWs with elementary and secondary level education and nonprofessional's who were trained in oral cancer prevention at the primary level, and Group 2 consisted of ($n = 77$) participants with backgrounds in technology and health, who received specialized training on the recent advances, and updates on innovations for the early detection of oral cancer. The primary prevention of oral cancer included education and awareness of the burden of oral cancer, an orientation toward risk habits, the importance of screening and early detection and hands-on for technology-assisted screening. Group 1

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participants had no prior registration, while participants in Group 2 had to enroll in advance for the five-day training program. These training sessions were planned and scheduled by the program coordinators once a month, taking into consideration the availability of camp dates and resource personnel from two institution (MSMF and KLESIDS) centers. The duration of the study ranged from January 2022 to December 2023.

This workshop was self-directed, and those interested voluntarily enrolled themselves to receive training in advance hand. The syllabus covered a wide range of topics pertaining to early diagnosis and updates on oral cancer (Table 1). Table 2 lists-out the learning objectives of this training. Focused training was conducted in batches; each batch constituted of five to seven members, and small batches ensured person-to-person attention and efficient hands-on training. Accredited Social Health Activist (ASHA) workers, CHWs, general dentists, physicians, medical biotechnology, undergraduate and graduate students, Masters of Social Work, Masters of Science, PhD scholars, and faculty members

Table 1 Schedule of oral cancer control program

Schedule	Topic of didactic
■ Day 1	■ Pre-test for knowledge assessment ■ Orientation and introduction to oral cancer control program ■ Training for early detection of oral cancer ■ Conventional oral visual examination ■ Training and hands-on for technology assisted screening (mHealth-based screening) ■ Demonstration of white light imaging and Autofluorescence imaging ■ Demonstration for telediagnosis ■ Demonstration of AI models
■ Day 2	■ mHealth-based screening at primary healthcare centers
■ Day 3	■ Field visit ■ mHealth-based screening at organized screening camps/ house-to-house screening
■ Day 4	■ Introductory session to PoC imaging systems and cytology techniques ■ Demonstration on AI-enabled PoC diagnosis with AI scores ■ Demonstration of conventional cytology and molecular cytology ■ Training for interpretation of cytology images and demonstration of image analysis ■ Demonstration of Oral epithelial cell segmentation from fluorescent multichannel cytology images using deep learning ■ Demonstration of CD44/SNA-1 integrated cytopathology for delineation of high grade dysplastic and neoplastic oral lesions
■ Day 5	■ Overview on adjunct diagnostic aids for early detection of Oral cancer ■ Hands-on training for use of PoC diagnostic tools ■ Imaging ■ Cytology ■ Slide interpretation of oral epithelial dysplasia and oral cancer ■ Recent updates on consensus guidelines in management of OPMDs ■ Demonstration for image analysis (WLI and AFI) using ImageJ software ■ Basic statistical analysis ■ Post-test ■ Program feed-back and conclusion

[a]*AI*, Artificial intelligence; [b]*OPMDs*, Oral potentially malignant disorders; [c]*WLI*, White light imaging; [d]*AFI*, Autofluorescence imaging; [e]*PoC*, Point-of-care

Table 2 Learning objectives of oral cancer control program

1. To describe the importance of early detection of Oral cancer
2. To explain the various adjunct diagnostic aids in early detection of Oral cancer
3. To participate in the field visit for screening of Oral cancer
4. To demonstrate AI models and Point-of-care diagnostic tools (Autofluorescence Imaging and Cytology)
5. To describe recent updates on management of OPMDs
6. To demonstrate telediagnosis in identification of oral lesions (Normal/normal variations/Benign/ OPMDs/Oral Cancer)
7. To interpret slides of oral epithelial dysplasia and oral cancer
8. To interpret data and discuss the basics in statistics
9. To compute and illustrate the basics in image analysis and data analysis

from various institutions were among those who voluntarily expressed interest in oral cancer and enrolled in the program.

A questionnaire-based pre-test was conducted to assess the participants' knowledge and awareness on oral cancer prior to the training. The test was conducted in vernacular language (Kannada) for low-skilled personnel. The Cronbach's alpha value was determined, and the content validity (Eigenvalue) of the questionnaires was assessed. In our earlier study [11], the details of the structured questionnaire were discussed. The participants were trained by oral pathologists and specialists in Oral Medicine.

Description of Training Sessions

Prior to the commencement of the module the participants were assessed for their inherent knowledge and baseline understanding on the topic through pre-test questionnaires. A questionnaire-based pre-test was conducted was also translated into the vernacular language (Kannada) for low-skilled personnel. The pre-test was projected as a PowerPoint presentation with multiple choice questions and intraoral clinical images of both normal/normal variations and oral lesions. The participant details (name, age, gender, educational qualification, years of experience, institution/work area) were collected on the day one of the training program. An expert (Oral Medicine Specialist) provided an overview of the training program, which was initiated with an orientation session on oral cancer burden, etiology, risk habits, importance of screening and early detection. The presentation also gave an insight into the reasons for delayed diagnosis and treatment, prognosis and mortality. The significance of technology-assisted screening (mHealth), Electronic Medical Records (EMR), Artificial Intelligence (AI) models, surveillance, and self-mouth examination was explained.

An expert trained the participants for conventional oral visual examination in the clinical chair-side settings. They were instructed to systematically examine all subsites of the oral cavity including the gingiva, labial and buccal mucosa, lips, vestibules, tonsillar region, hard and soft palate, tongue-dorsal, ventral, and lateral surfaces, floor of mouth, and retromolar area and were educated on the early presentation of OPMDs/oral cancer. Consequently, the participants were demonstrated for technology-assisted screening and AI-enabled point-of-care diagnostics using dual mode (WLI and AFI) and dual view (which captures images in wide view and narrow field of view) tools. A smartphone-based screen with a customized application that provides a platform to record patient demographics, habit history, and images of the oral cavity was captured and uploaded for remote consultation. The telemedicine module was demonstrated with telediagnosis. The participants screened the patients using these tools in a hospital-based setting.

The following two days included field visits involving house-to-house screening, which was coordinated by ASHAs, and opportunistic screening at primary healthcare centers (PHCs). Both screenings were included as a part of the training module to understand the patients' attitudes and willingness to participate. Participants were screened using mobile phones in the field and at the PHC. The field visit and house-to-house screening are positioned considerably far from the city area to help the participants understand the public's difficulties in health.

On the fourth day of training, the participants were trained with novel and advanced innovative adjunct diagnostic aids for early oral cancer detection. An introductory session as well as hands-on training for imaging and cytology techniques and how automation can be used to detect the high-risk populations was elucidated. The primary challenge surrounding oral cancer in our nation is the failure to achieve early diagnosis due to multiple factors. In this context, the participants were informed of the clinical imperative required to overcome this obstacle and to outline potential implementation strategies applicable to primary and tertiary healthcare centers. Our previous study related to the early detection of oral cancer, such as real-world validation, challenges faced in the process, steps made to improve sensitivity and specificity, and the device's effectiveness of the device as a proof-of-concept system, was explained [8].

Oral cytology as a diagnostic adjunct, using specific markers and establishing their clinical relevance as a significant step toward developing a pathology-equivalent, point-of-care (PoC) diagnostic tool formed a part of the next session. The introductory session in the training program focussed on the relevance of the molecular markers like CD44/SNA-1, and the integration of clinical parameters with automated image analysis, which in our prior study demonstarted an 85-90% increseae in efficacy [12]. As a part of the cytology demonstration, brush biopsy samples were collected from patients who were clinically/histologically diagnosed with oral cancer/OPMD via SurePath (BD Biosciences; Catalog No: 491253).

The last day of the session incorporated the basics of image interpretation and demonstrated image analysis. The orientation of the participants for histopathological features to clinical correlation was explained by oral pathologists. Slide interpretation of oral epithelial dysplasia, carcinoma in situ and oral cancer was explained in sequence. Subsequently, the imaging devices were demonstrated providing an explanation of their parts, detailing how the accompanying application is utilized, and elucidating the process by which AI scores are generated for imaging. Following this, a laboratory visit was arranged for the demonstration.

The knowledge level of the participants was tracked before the training and immediately after, and 6 months later for knowledge retention. Feed-back was obtained from all

the participants for evaluation of each session and overall program. The sessions were concluded with the distribution of certificates. The scores obtained from the pre- and post-test were tabulated and analyzed. The paired t test was applied to determine the increase in the knowledge level of the participants after the training, and ANOVA was used for knowledge retention, descriptive statistics for session and the program evaluation.

Results

Baseline Characteristics of the Participants

Of the 178 participants in total, 58% ($n=102$) were female and 42% ($n=76$) were male. The participants' ages ranged from 20 to 43 years old. A total of 39% ($n=70$) of them had a medical background, with the majority being from general dentistry, medicine, ayurveda, or nursing. Undergraduate students from a variety of disciplines (such as engineering, biotechnology, yoga, bachelor in arts and commerce) made up 34% ($n=61$), followed by secondary school graduates (14%, $n=23$), preuniversity graduates (8%, $n=15$), postgraduate students (3%, $n=05$), and elementary school graduates (2%, $n=03$). The competency of these participants varied diversely. Out of the total number of participants ($n=178$), 60% ($n=107$) individuals in group 1 were trained for primary level prevention, while the remaining 40% of the participants ($n=71$) in group 2 received five days of intensive training.

Knowledge Assessment Post-Training

Of the total participants ($n=178$) who appeared for pre-evaluation questionnaires 95% ($n=170$) completed the post-evaluation questionnaires, while 5% ($n=8$) did not. The mean scores were 22.52 and 26.71 for the pre-test and post-test evaluations, respectively, with a rise in the score to 3.99 at the time of post evaluation. Table 2 illustrates the statistically significant difference ($p<0.001$) in the knowledge assessment scores between the pre- and post-tests according to the paired t test. Sixteen percent (n = 28) answered all questions correctly post-training, 33% ($n=59$) scored more than 90%, 45% ($n=80$) between 65 and 80%, and 6% ($n=11$) less than 65%. There was a strong positive correlation ($r=0.66$) between the pre- and post-test results for the quantitative variables (Table 3). After six months of training, a subgroup of the individuals ($n=26$) had their post-knowledge retention assessed. ANOVA revealed a statistically significant difference ($p<0.001$) in the knowledge assessment regarding the participants' recall of information (Table 4).

Table 3 Knowledge assessment post-training

	Pre-test score	Post-test score
Mean	22.53	26.51
Variance	14.89	18.75
Observations	170	170
Pearson correlation	0.6671	
df	168	
std dev	3.8570027	4.3176234
std error	0.295818	0.3311466
Paired t test	$^{*}4.1\times10^{-34}$	

Feedback Evaluation for Session and Overall Program Evaluation

Overall and at each session, the program was evaluated using a three-point scale. The visit to the MSMF for the demonstration of AI-enabled point-of-care diagnostics with AI scores, cytology techniques, molecular cytology, and oral epithelial cell segmentation using deep learning was deemed very useful by 100% of the participants. This was followed by 95% ($n=57$) who found the demonstration of autofluorescence imaging (AFI) and AI-enabled point-of-care diagnostics to be very helpful. Over 28% ($n=14$) of participants thought that PHC screening and house-to-house visits were useful. Most participants rated the program's overall organization, ambiance, and relevancy as outstanding. The majority of them were not happy about the distance to the screening subsites (Table 5).

Discussion

Cancer prevention or early detection has not been addressed in detail in the curriculum of medical courses or paramedical courses in India [13]. To reduce the burden of cancer in India, the Ministry of Health and Family Welfare (MoHFW) of the Government of India (GoI) launched the operational framework in August 2016 for the Management of Common Cancers in India, which consisted of screening and early detection of three preventable cancers of oral, breast, and cervical cancer [14]. Therefore, the existing CHWs offered cancer screening services to the community. Training the public sector workforce and leveraging with technology assisted screening is the way forward to downstage cancer [13]. The oral cavity is easily accessible for physical examination, and oral lesions can be detected at an early stage. Several studies [15-19] have proved that the trained CHWs can be utilized for screening of oral cancer effectively. In this context, this educational program was initiated to empower CHWs with knowledge,

Table 4 Assessment for knowledge retention following six months post-training

Source of variation	SS	df	MS	F	*P* value	*F* crit
Rows	627.385	25	25.09538	2.648052	*0.001682264	1.72734
Columns	711.487	2	355.7436	37.53788	*1.10897E^{-10}	3.18261
Error	473.846	50	9.476923			

[a]*SS*, sum of squares, [b]*df*, Degree of freedom, [c]*MS*, Mean squares, [d]*F*, F ratio; [e]*F*, crit; *F*, critical

Table 5 Session and overall program evaluation

Session evaluation					
Sl No	Task	Not useful	Moderately useful	Very useful	Total
1	Pre- and post-training assignment	0	5	66	71
2	Demonstration of AFI and cytology	0	3	68	71
3	Visit to PHC/field training	0	12	59	71
4	Visit to MSMF	0	0	71	71
5	Visit to house-to-house screening	0	14	57	71
6	Training on AI/technological aspects	0	3	68	71
7	Training in statistics	0	12	59	71
Overall program evaluation					
Sl No	Task	Excellent	Good	Poor	total
1	Overall structure of the program	64	7	0	71
2	Ambience of training	63	8	0	71
3	Time schedule and travel	37	34	6	71
4	Relevance of the program	24	10	0	71

[a]*AFI*, Autofluorescence Imaging; [b]*PHC*, Primary healthcare center; [c]*AI*, Artificial Intelligence

awareness, and technology-assisted screening for the early detection and prevention of oral cancer.

Education for cancer for dental professionals across the Asian countries (EDUCAN) [20] and Omnicuris are other online-platforms for oral cancer Nationwide in addition to the project ECHO to train dental professional. These platforms are online and target only the dental professionals. Unlike ours, everyone who participated in our training program received offline training tailored to their level of competency. Professionals with a foundation in technology and health received advanced training, while low-skilled individuals were trained for early detection and primary prevention. Our hands-on training empowers CHWs with technology-assisted screening and AI-enabled point-of-care diagnostics. Furthermore, the training focused a strong emphasis on field screening and screening at Primary Healthcare centers (PHCs) in order to help participants comprehend the difficulties associated with field screening as well as patient attitudes in hospital-based and house-to-house screening scenarios. Moreover, our workshop used an interdisciplinary approach to equip persons with advanced competency in molecular markers, artificial intelligence-enabled point-of-care diagnostics, the latest adjunct diagnostic modalities, and guideline management and surveillance of OPMDs.

This oral cancer control program was conducted to train all participants for early detection, prevention and to provide an insight on the latest updates in oral cancer research. Pre- and post-tests were conducted to assess the knowledge gain among the participants. Our study demonstrated an improvement in knowledge of the participants post-training. There was an attrition rate of 5% for the post-test evaluation, which could be attributed to participants missing the test owing to personal emergencies or health issues. A study conducted at the tribal primary healthcare facility of Gumballi evaluated the knowledge level of CHWs following ECHO training in oral, cervical, and breast cancer screening, and it revealed an improvement in knowledge level. [21]. This study revealed a marked improvement in knowledge level score from an average of 6.3 to 13.7 on a 15-point scale. This study has used a virtual training platform such as ECHO, which trains CHWs every two weeks for six months in order to retain the knowledge. This highlights how important it is for CHWs to receive retraining to retain their knowledge. Although our study showed a significant difference in knowledge level post-training, our training module was a one-on-one, offline training module, it required frequent re-training for knowledge retention. In this context, knowledge retention six months post-training was assessed and a statistically significant difference ($p < 0.001$) in the knowledge assessment

regarding the participants' recall of information was found. Not all participants were evaluated for knowledge retention as it was not feasible for participants to travel from distant places, and they were engaged with other commitments. Only 26 participants were evaluated for knowledge retention with a mean rise in post-test score of 6.5. A possible explanation could be that these CHWs are constantly engaged in screenings and were monitored remotely on a bi-weekly basis, which emphasizes the need for retraining.

Feed-back was obtained from the participants who attended the five-day hands-on training module. The majority of them found it was very useful to learn AI-enabled PoC diagnosis, demonstration of conventional cytology and molecular cytology, interpretation of cytology images and demonstration of image analysis, demonstration of oral epithelial cell segmentation. This finding suggests the use of technology aided screening and use of PoC innovations. The majority expressed dissatisfaction with the lengthy travel time to the screening site and the heavy traffic during field screenings. However, focused in-person training may not be a scalable model. Overall, the program was found to be useful by most of the participants.

Conclusion

A well-structured training module is essential for the success of oral cancer screening and early detection programs. Evaluation of knowledge acquired at the end of the program in order to qualify as a screener and a hybrid model of online training that is followed by an in-person, hands-on course is recommended. With the development of technology, the end user should be aware of the feasibility, adaptability and limitations of these techniques.

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