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MEDICAL RESEARCH | NATIONAL INSTITUTE OF CANCER
PREVENTION AND RESEARCH

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Machine Learning for Health and Disease

Oral Cancer Screening in India: a feasibility study

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WARWICK
GLOBAL RESEARCH PRIORITIES
HFAITH

Our Team

- Department of Computer Science, University of Warwick
- National Institute of Cancer Prevention and Research (NICPR), Delhi
- Department of Oral Medicine and Radiology, KLES Institute of Dental Sciences, Bengaluru
- Department of Computational and Data Sciences, Indian Institute of Science, Bengaluru
- Biocon Foundation, Bengaluru
- School of Public Health, Post Graduate Institute of Medical Education and Research, Chandigarh

While the overarching goal is to bridge the gap between mathematical modelling and clinical problems in general, the program has these specific aims to:

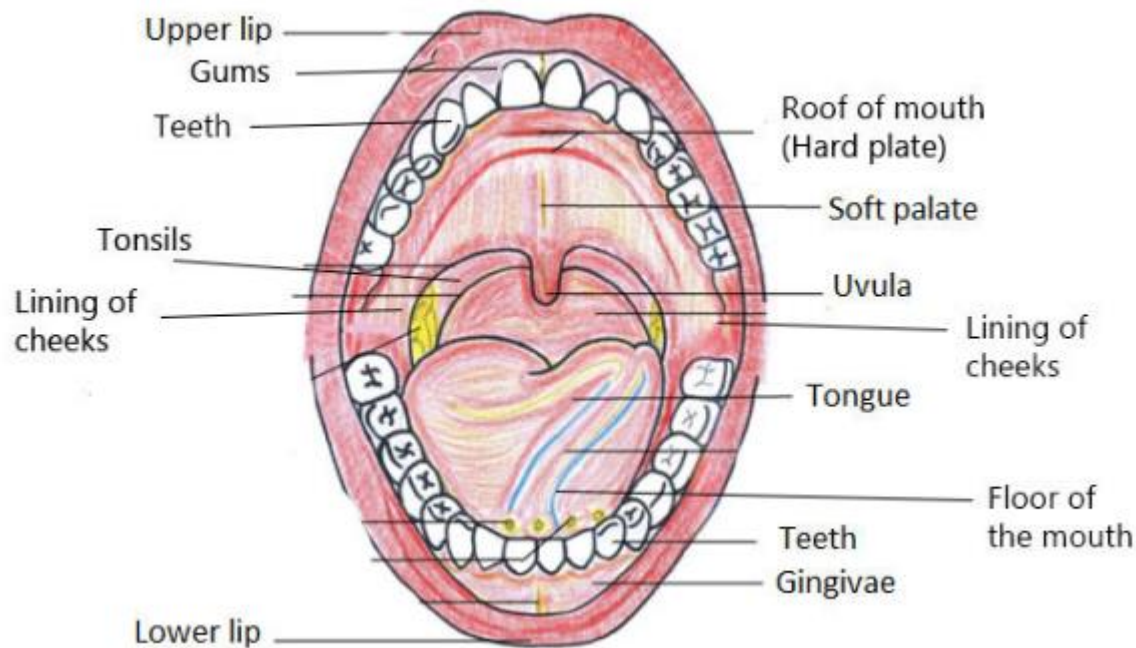
- 1. introduce people who are trained in machine learning (both theory and practice) to data-based problems in health care.*
- 2. introduce clinical practitioners with little ML background to tools that can be easily adapted to analyse their own data.*
- 3. have an open discussion between clinicians and mathematical modellers about the problems faced in bridging the gap between the communities.*
4. discuss the possibility of building public health databases as resources.
5. generate reference material, tutorials, videos and other resources to help clinicians understand and apply ML techniques in their work.

Want to cover:

- What is oral cancer
- How big a problem is it in India
- What are causes
- What can be done – screening
- Our feasibility study
- What can *you*, using Machine Learning, do to address this challenge?

What is oral cancer?

Cancer occurring in the tissues of oral cavity (begins at the lips and extends backwards to the front part of the tonsils) or oropharynx (part of the throat) is termed as oral cancer.

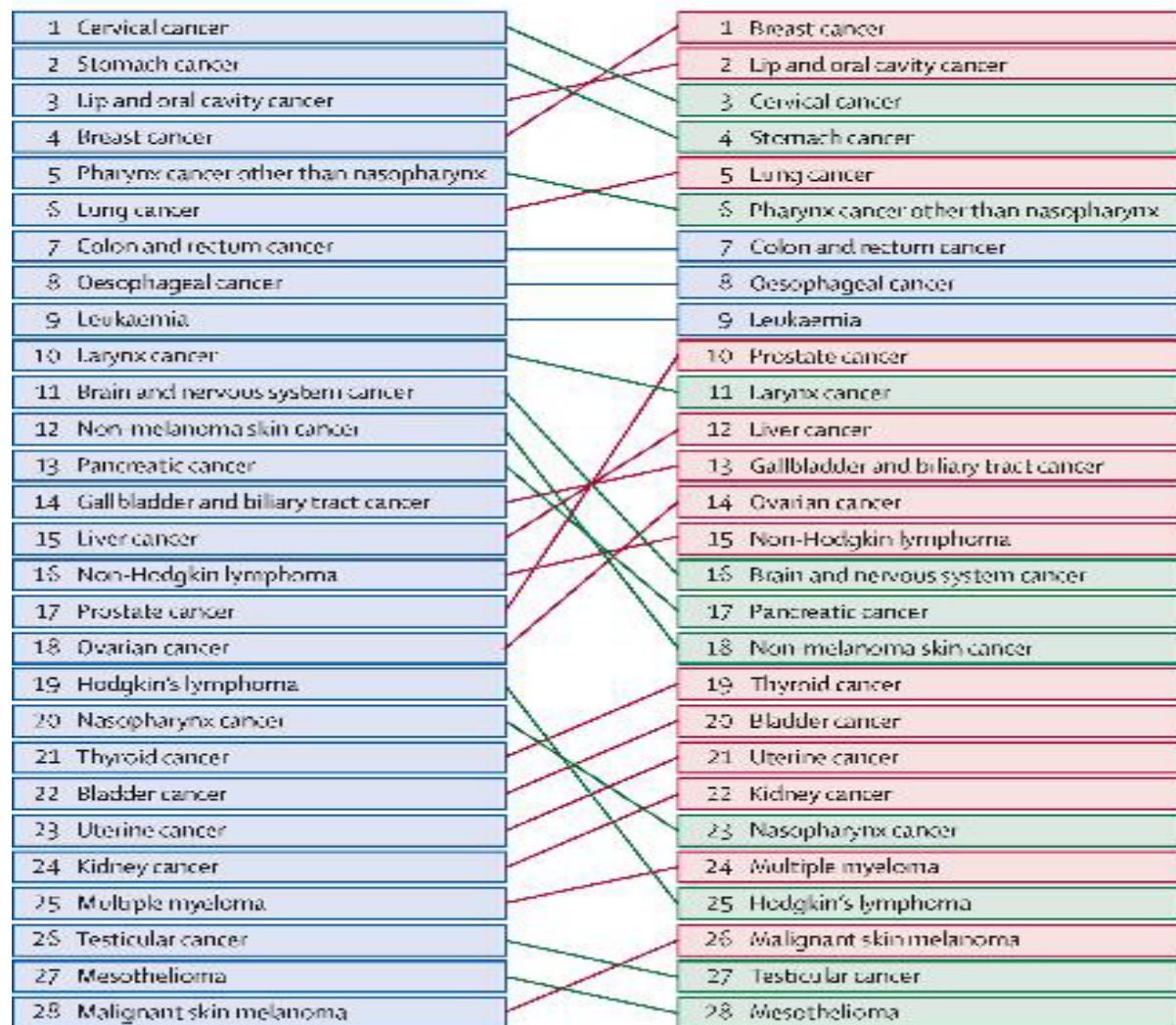




Change in incidence rate of different types of cancers in India, 1990–2016

Types of cancers, 1990

Types of cancers, 2016



- Cancer burden in India is increasing – second commonest cancer.

- Rates of oral cancer vary between the States with the highest rates found in the north-east.

INDIA



Oral Cancer

- Oral cancer is the most common cancer in men (2016)
- Oral cancer is the second most common cancer in women
- Tongue cancer predominant type
- The mean age of oral cancer is 50 years

Survival rate (5-year)

- Present late usually stages III and IV (approx. 60-80%)
- 5-year survival for localised tongue cancers is 54% but 3% for advanced stages

Risk Factors

- **Tobacco** and ***smokeless tobacco**: around 80-90% of oral cancers are directly attributable to tobacco use

***smokeless tobacco** = not smoked or burned



Smokeless Tobacco Health Effects

Oral cancers

Oral wounds, ulcers,
and tumors

Destroyed oral tissue

Gum infection

Tooth discoloration

Enamel erosion

Shrinking gums

Tooth decays

Risk Factors

- **Tobacco** and smokeless tobacco: around 80-90% of oral cancers are directly attributable to tobacco use
- **Alcohol**
- Betel nut
- Human papillomavirus (HPV),



What can be done

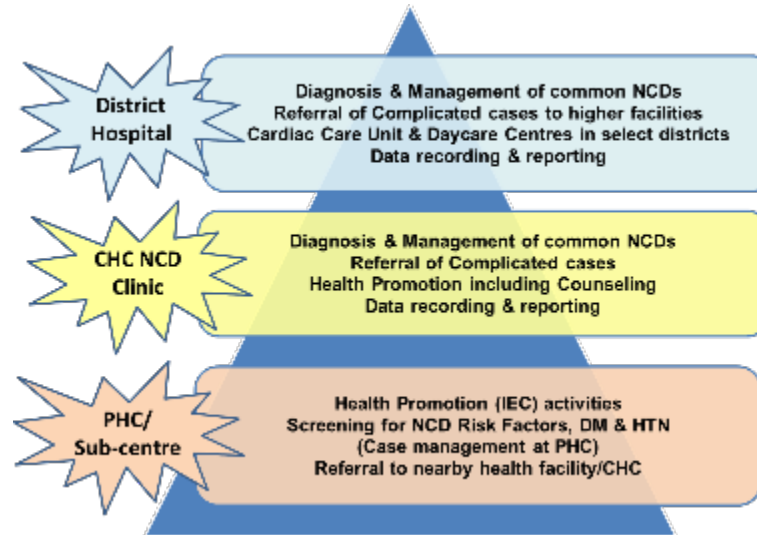
- Tackle the risk factors
- Screening:
 - previous trial in Kerala (Lancet 2005;365:1927)
 - non-medical graduates
 - bias – clustering analysis; blind outcomes; loss to follow-up

Policy Context

On February 1 2018, the Government of India launched an ambitious policy programme 'National Health Protection Mission', also known as Ayushman Bharat. This scheme has two pillars: strengthening primary healthcare and a health insurance scheme covering 40% of India's poorest population

The public healthcare infrastructure has been developed as a three-tier system:

- I Sub-centre (SC) serving population of 5,000/Primary Health Centre (PHC) serves 30,000 population.
- II Community health centre (CHC) serves 120,000 population .
- III District Hospital providing 24 hrs services



Services at different health care delivery system

The National Programme for the Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) was initially piloted in 100 districts and rolled out nationally.

Feasibility study

Thampi V, Hariprasad R, John A, et al. Feasibility of Training Community Health Workers in the Detection of Oral Cancer. *JAMA Netw Open*. 2022;5(1):e2144022. doi:10.1001/jamanetworkopen.2021.44022

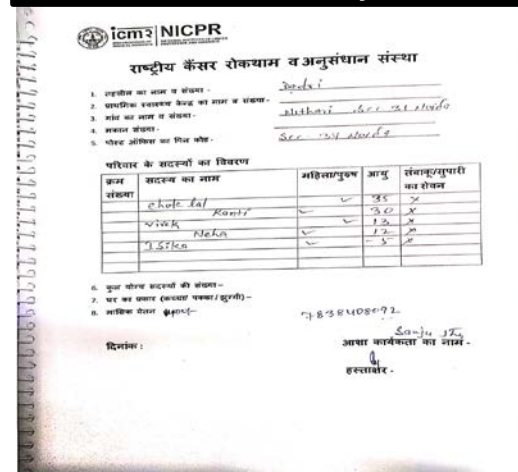
Research question

Can community health workers screen for oral potential malignant disease (OPMDs)?

Methodology

- **Study participants:** Males & females aged above 30 years + Adult tobacco users <30 years registered in the house-hold survey-(Inclusion criteria)
- **Exclusion criteria:** Adult non tobacco users aged below 30 years
- **Sample size:** 1000 participants
- **Study duration:** 1 Year (1st Jan 2020-31st December 2020)
- **Study tool:** Household survey form and mobile application

House-hold survey form



icms NICPR
राष्ट्रीय केंसर रोकथाम व अनुसंधान संस्था

1. पदवीकृत का नाम व संकेत - Dr. S. K. Singh
 2. प्राथमिक स्वास्थ्य केंद्र का नाम व संकेत - Mukherjee Health Centre
 3. गांव का नाम व संकेत - Sec. 124, Alwar
 4. अक्षांश संकेत -
 5. पंचायत समिति का पिन कोड -

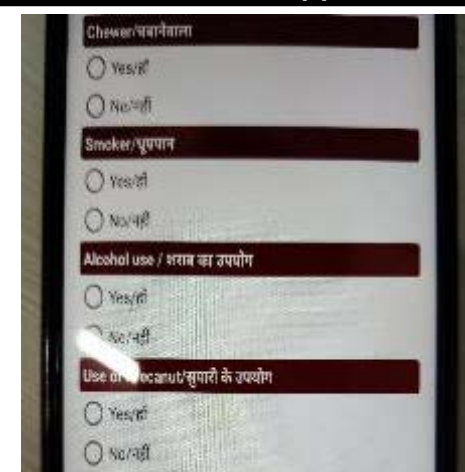
परिवार के सदस्यों का विवरण

क्रम संख्या	सदस्य का नाम	महिला/पुरुष	आयु	संलग्न/सुपारी का शेष
1	Rohit Lal	✓	35	X
2	Kanti	✓	30	X
3	Nikhil	✓	12	X
4	Neha	✓	12	X
5	Ashika	✓	5	X

1. कुल शेष सदस्यों की संख्या -
 2. घर का प्रकार (कच्चा/पक्का/दुपारी) -
 3. आर्थिक स्तर -

दिनांक: 27.08.2020
 अक्षर वाच्यता का नाम: Sanjay S.K.
 हस्ताक्षर: [Signature]

Mobile-app



Chewer/चबानेवाला
 Yes/हाँ
 No/नहीं

Smoker/सुपान
 Yes/हाँ
 No/नहीं

Alcohol use / शराब का उपयोग
 Yes/हाँ
 No/नहीं

Use of tobacco/सुपारी के उपयोग
 Yes/हाँ
 No/नहीं

Screening



NICPR clinic



Training of Community Health Workers

- 1-day hands-on training workshop for the 10 selected community health workers to:
 - (1) systematically enumerate households and individuals using a household form;
 - (2) interview the eligible individuals to elicit and record information on sociodemographic factors and tobacco and alcohol habits using the mobile application device;
 - (3) perform a systematic visual inspection of the mouth under adequate lighting and using 2 disposable wooden spatulas;
 - (4) identify any oral suspicious white and red lesions, trismus, and ulcers and growths suggestive of oral cancer, along with the referral criteria to the dental practitioner;
 - (5) photograph the oral cavity using the camera in the mobile phone.

A training manual provided descriptive/photographic documentation enabling identification of the different types of oral lesions.

House-hold listing is done systematically by the CHW's using house-hold listing forms and eligible participants are screened



Mobile application device was used to record information on socio-demographic, tobacco and alcohol habits of eligible participants. Oral exam was done by the CHW's and 4 photographs of the oral cavity were captured using the mobile app



The information collection by the CHWs in the mobile application syncs to the ICMR-NICPR data Server once it is connected online



Participants screened by the CHW's in the community based oral cancer screening are referred to the Indian Council of Medical Research -National Institute of Cancer Prevention and Research (NICPR)- Health promotion Clinic (HPC)



Rescreening of all participants by the dentists at NICPR-HPC by Oral visual examination where tobacco history and alcohol history are taken and entered in the NICPR portal



Behavioral counselling, Nicotine replacement & pharmacological therapy done at Tobacco Cessation Clinic (TCC)



Capturing of high quality images of the oral lesions using DSLR camera by the dentists



All the data gets compiled into the NICPR Data server and finally inter-rater agreement is calculated between the positive & negative findings between CHWs and the dentists

Materials and consumables

1. A kit was provided to the community health workers(CHWs) containing a

- *Tongue depressors*
- *Mouth mask*
- *Disposable gloves*
- *Torch*
- *Red garbage bags*
- *Hand sanitizer*
- *Mobile phones for data entry*
- *A manual for identification of oral lesions*
- *Consent forms*



2. A high resolution camera for clicking the photographs of the oral cavity at the NICPR clinic

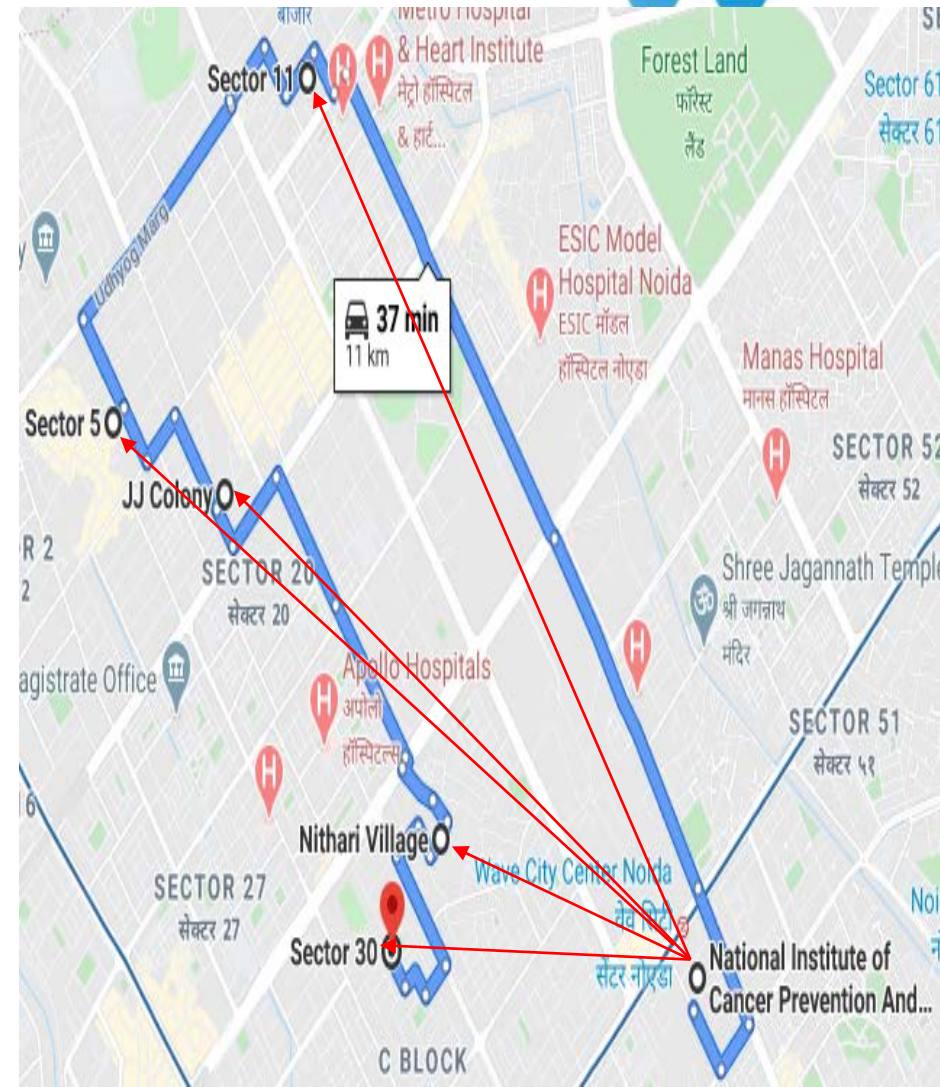
3. Medicines for the patients detected with any oral potentially malignant disorders (OPMDs)



- **Study location** : Five selected semi-urban and rural areas in Noida ,Uttar Pradesh.

Areas were selected based on the following criteria

- 1.Community health workers were performing well from these areas
- 2.Accessibility on bringing the participants to NICPR



Health awareness event



Results

Screening commenced on **1st January 2020** and was halted due to Covid -19 lockdown on **20th March – 31 May 2020**

1200 approached with 98% uptake

182 (M:54%; F:46%) nonparticipation:

Main reasons - 'being healthy' and 'lack of time'



Table 1. Substance Use History Among the Population Screened by Community Health Workers and Dentists

Substance use	Sex	Age group, No. (%), y							Total
		0-19	20-29	30-39	40-49	50-59	60-69	≥70	
No. (%)		17	175	338	324	99	53	12	1018
No use	Male	1 (1.5)	12 (17.6)	21 (17.6)	27 (39.7)	3 (4.4)	4 (3.8)	0	68 (6.7)
	Female	0	9 (2.7)	150 (44.9)	133 (39.8)	25 (7.5)	14 (4.2)	3 (0.9)	334 (32.8)
Smoking only	Male	6 (2.7)	63 (28.8)	52 (23.7)	50 (22.8)	26 (11.9)	17 (7.8)	5 (2.3)	219 (21.5)
	Female	0	4 (19)	0	7 (33.3)	7 (33.3)	3 (14.2)	0	21 (2.1)
Smokeless tobacco (SLT) users	Male	13 (3.8)	81 (23.8)	103 (30.2)	98 (28.7)	32 (9.4)	13 (3.8)	1 (0.3)	341 (33.5)
	Female	1 (0.8)	33 (26)	34 (26.8)	39 (30.7)	10 (5.5)	7 (5.5)	3 (2.4)	127 (12.5)
Areca nut ^a	Male	1 (3.1)	6 (18.8)	9 (28.1)	11 (34.3)	2 (6.3)	3 (9.4)	0	32 (3.1)
	Female	0	3 (16.7)	10 (55.6)	3 (16.7)	1 (5.6)	1 (5.6)	0	18 (1.8)
Dual use (smoking and SLT users)	Male	4 (3.5)	29 (25.4)	33 (28.9)	33 (28.9)	8 (7)	7 (6.1)	0	114 (11.4)
	Female	0	1 (33.3)	0	2 (66.7)	0	0	0	3 (0.3)
Smoking and alcohol	Male	3 (3.1)	27 (27.8)	25 (25.8)	25 (25.8)	12 (12.4)	4 (4.1)	1 (1)	97 (9.7)
	Female	0	0	0	0	1 (100)	0	0	1 (0.09)
Smokeless tobacco use and alcohol users	Male	5 (3.6)	38 (27.5)	44 (31.9)	36 (26.1)	10 (7.2)	5 (3.6)	0	138 (13.6)
	Female	0	0	0	3 (100)	0	0	0	3 (0.3)

^a Areca nut, commonly known as betel nut.

Table 2. Findings on Participants Referred to Dentists

Visual findings	No. (%)		
	Men	Women	Total
No.	526 (51.7)	492 (48.3)	1018
White patch lesions			
Leukoplakia	129 (24.5)	19 (3.9)	148 (14.5)
Oral lichen planus	4 (0.8)	5 (1.0)	9 (0.9)
Red patch lesions			
Erthyroplakia	1 (0.2)	0	1 (0.09)
Ulcer			
Recurrent aphthous ulcer	30 (5.7)	18 (3.7)	48 (4.7)
Growth mass			
Malignant	23 (4.4)	4 (0.8)	27 (2.7)
Other			
Oral submucous fibrosis	57 (10.8)	22 (4.5)	79 (7.8)
Tobacco pouch keratosis	74 (14.1)	7 (1.4)	81 (8.0)
Lichenoid lesion	2 (0.4)	4 (0.8)	6 (0.6)
Mixed lesions			
Leukoplakia + tobacco pouch keratosis	2 (0.4)	0	2 (0.2)
Oral submucous fibrosis + tobacco pouch keratosis	2 (0.4)	0	2 (0.2)
Normal	202 (38.4)	413 (83.9)	615 (60.4)

eTable 2. Distribution and agreement by type of individual findings on oral visual inspection by CHWs and dentists

CHW findings		Dentists findings			Kappa
		Positive	Negative	Total	
White patch	Positive	150	6	156	0.9
	Negative	7	855	862	
	Total	157	912	1018	
Red patch	Positive	1	2	3	1.0
	Negative	0	1015	1015	
	Total	1	1017	1018	
Growth mass	Positive	27	2	29	1.0
	Negative	0	989	989	
	Total	27	991	1018	
Ulcer	Positive	46	2	48	0.9
	Negative	2	968	970	
	Total	48	970	1018	
Others	Positive	180	1	181	0.9
	Negative	2	825	827	
	Total	182	826	1018	

eTable 1. Identification of the oral lesion by CHWs and dentists in the screened population

TOTAL	Dentists' findings			Total
	Positive	Negative		
CHW findings	Positive	321	9	330
	Negative	11	677	688
	Total	332	686	1018

Statistic	Value (95% CI)
Sensitivity	96.69% (94.15 to 98.33%)
Specificity	98.69% (97.52 to 99.40%)
Positive Likelihood Ratio	73.70 (38.50 to 141.08)
Negative Likelihood Ratio	0.03 (0.02 to 0.06)
Disease prevalence (*)	32.41%
Positive Predictive Value (*)	97.20% (94.77 to 98.52%)
Negative Predictive Value (*)	98.44% (97.25 to 99.12%)
Accuracy (*)	98.29% (97.29 to 98.99%)

(*) These values are dependent on disease prevalence

Smokers referred to tobacco cessation clinic

27 oral cancers (2.7%) detected

Photographs of the oral lesions captured during the study



Leukoplakia



Oral sub mucous fibrosis



Tobacco pouch keratosis



Chemical burns



Squamous cell carcinoma



Aphthous ulcer

1.Challenge: Non- availability of male participants

SOLUTION:

- 1.Home visits on Sundays
- 2.Setting up of health promotion clinic on the first Sunday of the month
3. Sarpanch/Panchayat raj institutions (PRI) from the community were contacted



Home visits



Screening of patients

2. Challenge: Health Seeking behavior

- SOLUTION:

Initially, some of the participants refused to take part in the study as many claimed that they were healthy. Therefore, rigorous awareness & community mobilization was carried out by community health workers.

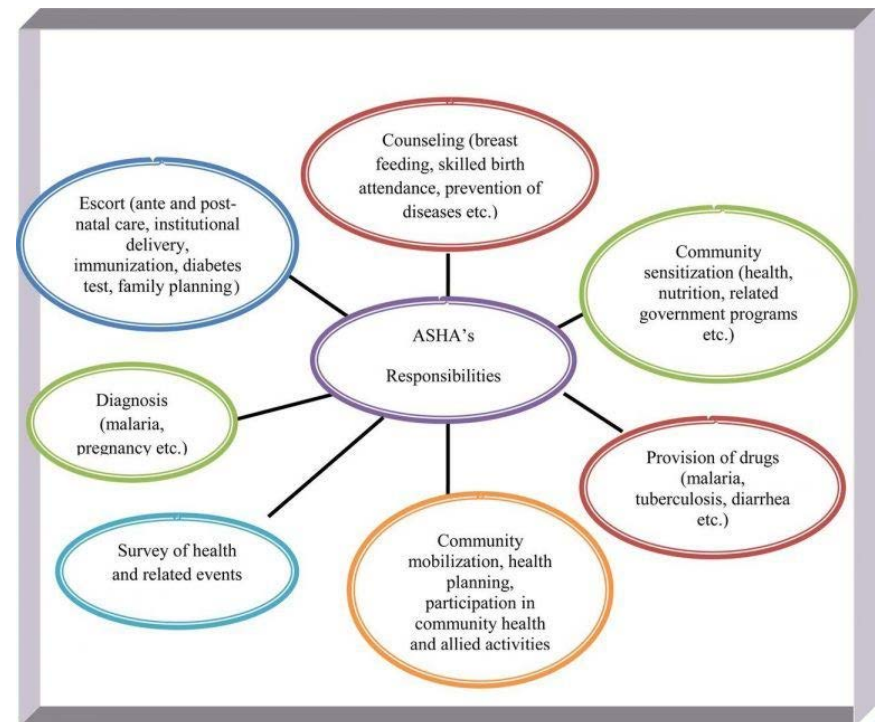


Community Awareness on Cancer by ASHA worker

3. Challenge: Overburdened Community health workers(CHWs)

- SOLUTION:

CHWs were involved in various health programs like Maternal & Child health, Tuberculosis program, and to help with the cancer program, the incentives of the Community health workers(CHW) were increased



4. Challenge: Loss to follow -up

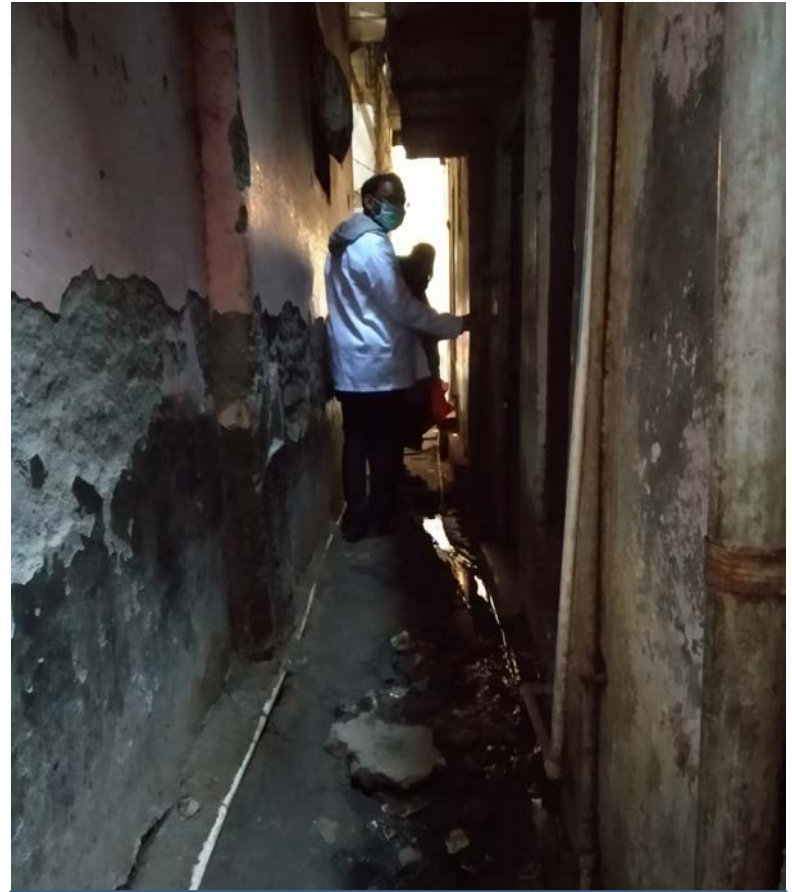
- SOLUTION:
 1. Tracking the patients through phone – calls
 2. Setting up a mobile oral cancer screening camp



Screening of patients during home visits

5. Challenge: Congested houses

- **SOLUTION:**
Localities with congested houses were identified, mapped and visited thoroughly.



Home visits through congested space

WAY FORWARD

Train rest of the community health workers on Oral Cancer Screening

Ensure that all beneficiaries who have been screened at the community are getting screened at NICPR as well

Management of suspected oral lesions and regular follow up for tobacco users

Expedite the process of Oral screening by Community health workers

Establish dataset of photographs for analyses by screening more population

And Use Machine Learning to develop algorithms for use within the community



**THANK YOU
and any questions?**

