LUMORA SCAN

A real-time point of care device for non-invasive & non-contact, fast screening and diagnosis of oral cancerous epithelia.

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(User Manual)

Abstract

This manual provides comprehensive guidelines for the operation of **Lumora Scan** - A real-time point of care device for non-invasive & non-contact, fast screening and diagnosis of oral cancerous epithelia. This manual details the system's components, setup procedures, and operational protocols to assist oncological surgeons and clinical staff in optimizing fluorescence-based multi modal oral squamous cell carcinoma (OSCC) screening and diagnosis. Key sections include introduction to the technique, theoretical description device detailing, step-by-step usage instructions. This device can be used for non-invasive and non-contact, rapid screening and diagnosis of OSCC at an early stage using auto fluorescence (AF) and fluorescence (FL) imaging & spectroscopy.

Introduction

Oral cancer conventionally deals with squamous cell carcinoma of the oral cavity, lip, and oropharynx. In oral cancer diagnosis, the most important predictor of malignant growth in pre-malignant lesions is the presence of epithelial dysplasia. If early diagnosis is done and a premalignant lesion is detected at the initial stage and treated therewith, then it may not lead to cancer. Thus, the early screening of oral cancer requires the use of effective tools and techniques. A number of non-invasive diagnostic techniques have been developed that aid in fast and rapid cancer screening; these include light-based techniques such as auto-fluorescence and fluorescence imaging, auto-fluorescence and fluorescence spectroscopy, etc. This chapter describes the various diagnostic techniques available for screening cancerous and precancerous lesions.

The conventional oral examination of oral cancer patients is conducted under white light illumination. It may be useful in visual cancer screening for a few locations, such as inspection of lesions on the skin, but it is not very useful in other conditions. The conventional method helps detect oral lesions, but it does not entirely hold the potential of detecting premalignant lesions. As benign and malignant lesions are not always evident enough, a conventional oral examination carried out by a clinician cannot predict the actual biological behavior of these lesions.

There are many difficulties associated with conventional oral screening; for example, many of the general population has oral abnormalities, but most of these lesions are benign. Furthermore, oral malignancy is characterized by a red or white patch or a persistent ulcer. However, only a small percentage of these white patches or leukoplakia are malignant. Conventional oral examination does not help differentiate between malignant and non- malignant plaques. In addition to this, conventional oral examination is unable to distinguish between normal and precancerous lesions as precancerous lesions as they appear normal clinically. Histopathology of these lesions and the classification of epithelial dysplasia acts as the gold standard for precancerous lesion evaluation.

There are several imaging modalities that clinicians and doctors use for cancer screening. These cancer screening modalities encompass Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), ultrasound examination, endoscopic evaluations, and, in specific instances, mammography and X-ray procedure. CT combines X-ray imaging and computational algorithms to produce 3D images of the body and provides information about abnormalities, including tumor identification and metastasis detection.

Histopathology encompasses the study of processed tissue, explicitly focusing on examining diseased tissue under a microscope; when investigating normal tissue, this field is termed histology. Tissues consist of various cells organized to perform distinct functions in the human body, differentiated based on characteristics such as color, shape, size, structure, and the ratio of nucleus to cytoplasm. Pathologists utilize stained sections using hematoxylin and eosin (H&E) for identification, a process that remains the gold standard. This process allows for the examination of microscopic and structural alterations within diseased tissue. Moreover, histopathology is a critical tool for cancer detection and diagnosis, evaluating cellular features like cell size, shape, nucleus characteristics, and spatial distribution. However, this method involves taking a tissue sample (biopsy) from the patient, and the confirmation of cancer typically takes around 8 to 10 days.

Introducing Lumora Scan, AI powered, non-invasive, non-contact, rapid cancer screening and diagnostics kit that runs on advanced photonics techniques like auto-fluorescence and fluorescence imaging and spectroscopy.

Experimental Setup

This compact, portable oral cancer screening solution combines a smartphone-based multispectral imaging device and a precision spectroscopy system to deliver early, non-invasive detection at the point of care. The imaging unit features three integrated LEDs (365nm, 405nm, 450nm) with specific filters long pass and band pass, powered by a rechargeable 12.8V lithium-ion battery, all enclosed in a durable 3D-printed plastic housing. Complementing this is a multispectral spectroscopy system using three narrow-band lasers, a high-resolution spectrometer, and a Y-shaped optical fiber probe designed for safe intraoral scanning. Both units include LED/LCD displays, rechargeable power systems, and are neatly packed in a high-grade plastic case—making them ideal for use in clinical, rural, or outreach settings with AI-enabled diagnostic support.

- Smartphone with multispectral imaging attachment
- 3 LED light sources
- Multispectral filters (Filter cassette with position 1, 2, 3)
- Y-shaped fiber-optic probe
- Laser source box with 3 lasers
- Spectrometer
- Sterile disposable probe tube
- Cyto-brush (for dye application)
- Fluorescein dye (topical)
- Computer with Linux OS (optional for spectrometer interface)
- Diagnostic software (image and spectral analysis application)

Steps and Procedures

A. Smartphone-Based Multispectral Imaging Procedure:

a. Ask patients to close their eyes.
b. Switch on the smartphone and insert filter side 1.
c. Focus and capture image with LED1 on, then switch it off. Repeat for LED2.
d. Flip the cassette to filter side 2.
e. Focus and capture the image with LED3, then switch it off.
f. Transfer all three images to the diagnostic software.

B. Multispectral Spectroscopy Procedure:

a. Connect:
    i. One fiber arm (labeled "laser") to the light source box.
    ii. Second arm (labeled "spectrometer") to the spectrometer.
b. Turn on the spectrometer (wait 10 seconds).
c. Insert sterilized tube into probe and hold it securely.
d. Set filter to position 1.
e. Switch on Laser 1 and maintain probe 4–5 mm from the lesion.
f. Record spectrum (10 seconds) and switch off Laser 1.
g. Change filter to position 2, repeat with Laser 2.
h. Change filter to position 3, repeat with Laser 3.
i. Extract spectral data and send it to software.
j. (Optional) Connect spectrometer to computer via USB.

k. (Optional) Use Laser 3 for fluorescence spectroscopy with fluorescein dye.

l. Apply fluorescein dye topically using cyto-brush or rinse.

m. Capture fluorescence image and spectrum.

n. Store data for analysis.

C. Software Operation Procedure:

a. Launch Linux-based diagnostic software.

b. Go to the Patient Registration tab – fill details.

c. Download 3 images and 4 spectra from the device.

d. Upload in Image Analysis tab under:

i. Fluorescence

ii. Autofluorescence

e. Calculate image-based parameters.

f. Plot spectral peaks and fluorescence red shift.

g. Use Report Tab to run ML models on data.

h. Click Generate Report to export diagnostic summary as PDF.

Appendix A - Acceptance Criteria

- **Imaging:**
  - Clear, focused multispectral images under each LED filter.
  - Proper illumination and no overexposure.

- **Spectroscopy:**
  - Clean, distinguishable spectral peaks for each laser.
  - No noise/interference due to improper probe handling.
  - Correct spatial alignment and distance from tissue.

- **Software:**
  - All images and spectra were successfully uploaded.
  - No errors during processing.
  - Diagnosis generated using AI models.
  - PDF report includes all results (image metrics, spectral plots, ML outcome).

- **Patient Safety:**
  - No direct contact between probe and tissue.
  - Eyes closed during imaging.
  - Fluorescein dye used topically only with sterile protocol.

Conclusion

Lumora Scan is a transformative advancement in non-invasive oral cancer diagnostics, combining the power of advanced photonics and AI to enable rapid, real-time screening at the point of care. By following the outlined setup, operational procedures, and safety protocols, clinicians can ensure accurate, efficient, and patient-friendly diagnosis of oral squamous cell carcinoma. This manual aims to equip healthcare professionals with the necessary guidance to integrate Lumora Scan effectively into clinical workflows, thereby accelerating early detection and improving patient outcomes.