MDG November 5, 2014 Forum
In Vivo Optical Cancer Detection
In Vivo Optical Cancer Detection

In Vivo Cancer Research

In Vivo Surgical Margin Assessment

In Vivo Diagnostics

In Vivo Post-Therapy Surveillance

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Background
Cancer Rates - U.S. Males


*Per 100,000, age adjusted to the 2000 US standard population.

Note: Due to changes in ICD coding, numerator information has changed over time. Rates for cancer of the liver, lung and bronchus, and colon and rectum are affected by these coding changes.


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Cancer Rates - U.S. Females


*Per 100,000, age adjusted to the 2000 US standard population. †Uterus cancer death rates are for uterine cervix and uterine corpus combined.

Note: Due to changes in ICD coding, numerator information has changed over time. Rates for cancer of the lung and bronchus, colon and rectum, and ovary are affected by these coding changes.

Cancer

- 8.2 million deaths worldwide in 2012
- Leading cause of death worldwide, lung cancer most common since 1985
- > 100 types, depending on tissue/cell of origin
- At least 1/3 preventable via early diagnosis/treatment → focus on early detection before metastasis has occurred

Source: http://www.cancersupportcommunity.org/
Clinical Cancer Assessment/Management

- Morphological
- Structural
- Metabolic
- Functional

Cancer Detection & Management Strategies - Breast Cancer

Non-Optical
- Palpation/CBE
- Mamography
- Ultrasound

Optical
- Thermography
- Tomography (both still in research stage)

Collection:
- FNA
- Lavage

Analysis:
- Cytology
- Histopathology
- Spectroscopy

Assessments (Margin Detection):
- Spectroscopy
- Molecular probes

Therapies:
- Surgery
- Radiation
- Chemotheray

Screening → Diagnosis & Staging → Treatment & Monitoring → Follow-up
Optical Cancer Detection
“Optical Biopsy”

Advantages:

- Non-invasive / Non-ionizing
- Less risk of spreading biopsied malignant cells
- Nearly unlimited sampling
- High diagnostic accuracies
- High resolution
- Instant results
- No samples to be lost or mishandled

Light Interaction with Tissue

- Diffuse Reflectance
- Raman
- Fluorescence

Absorbed
Scattered

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Clinical Techniques for Optical Cancer Detection *In Vivo*

- **White Light Imaging/Endoscopy (WLE)**
- **Optical Coherence Tomography (OCT)**
- **Chromoendoscopy/CVC/Multispectral Imaging**
  - Olympus Narrow Band Imaging (NBI)
  - Fujinon Intelligent Color Enhancement (FICE)
  - Pentax iScan
- **Confocal Laser Endoscopy**
  - tissue reflectance or fluorescence (IV dye)
- **Fluorescence**
- **Elastic Scattering / Diffuse Reflectance**
- **Cherenkov Luminescence Imaging**
- **Lesion Morphology**
- **Polarization methods and/or extrinsic contrast agents can be used with some of the above methodologies to enhance detection**

Standard Endoscopy:
Once Revolutionary, But Now Not Good Enough

- Endoscopy
  - Has technical & clinical limitations

- New optical techniques provide new information related to:
  - Tissue differentiation (Identification)
  - Morphology/Orientation
  - Stability
  - Molecular markers
  - 3D volume of lesion
  - Blood Flow/Oxygen Saturation
  - Tissue Mechanics
  - Targeted probes can further increase contrast, specificity, and signal
Clinical Techniques for Optical Cancer Detection *In Vivo*

- “Cancer Field Effect”
Challenges & Limitations
Challenges & Limitations

- Regulatory
- IP
- Funding
- Reimbursement
- Turf wars
- Cultural
Challenges & Limitations -- Technical

- Limited tissue penetration
- Blood absorbs light
- Different skin types

Lead to:

- Inadequate specificity
- Poor margin discrimination
Approved Devices
Some FDA Approved OCD Devices

NinePoint Medical
Nvision VLE for esophageal screening

MelaFind
hyperspectral imager for skin lesions

VelScope
intraoral cancer screening

SpectraScience
Luma scanner for cervical dancer
Looking Ahead
Promising Technologies

Tissue structure
- OCT
- Photoacoustic Imaging
- SHG/THG

Functional
- Diffuse Optical Tomography/Spectroscopy

Cellular structure
- Endocytoscopy

Metabolic
- Raman Spectroscopy

Neovascularization
- Laser Speckle Imaging

Molecular
- NIR Fluourescence
Technology Trends

- Smaller image sensors
- Smaller optical/scanning components
- Better detectors
- Greater signal processing power
- Molecular probes
International Approval and FDA Pipeline

Caliber I.D. VivaScope 1500 for skin cancer screening

Photoacoustic microscopy (PAM), Washington Univ.

LuViva cervical cancer screening

Guided Therapeutics LuViva cervical cancer screening

Imaging Diagnostic Systems, Inc (IDSI) Computed Tomography Laser Mammography

Lihong Wang's research is dedicated to the development of novel imaging technologies. The photoacoustic microscopy image shows a melanoma tumor. Such an imaging capability is expected to play an important role in both preclinical and clinical applications.
end