The role of DICOM in Digital imaging in dermatology

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Overview

• Drivers for skin imaging
• Modalities skin imaging
  – Digital photography
  – Dermoscopy
  – Total body photography
  – Reflectance confocal microscopy
  – Optical coherence tomography
Digital imaging in dermatology

“Imaging is increasingly being used in dermatology for documentation, diagnosis and management of cutaneous disease.”
Digital imaging in dermatology

• Ubiquity of digital cameras, mobile devices and EMR

• Diagnostic imaging
  – Sequential examination for changes in mole (size, shape, colour) marker for melanoma
  – Teledermatology
  – Advance modalities e.g. dermoscopy, TBP, RCM

• Diagnostic aids
  – Consensus diagnosis
  – Technology assisted full skin examination
  – Artificial intelligence
Melanoma

• The accuracy of the clinical diagnosis of cutaneous melanoma with the unaided eye is only about 60% (Kittler et al. 2002)
  – One of every three melanomas an error in clinical diagnosis was made

Superficial spreading melanoma

Nodular melanoma

Lentigo maligna melanoma
Melanoma

• Currently, 28.4 moles are biopsied or excised for every melanoma detected [1]

• In Australia, reducing unnecessary biopsy or excision can potentially save $70 million in direct health system costs [2]


Melanoma

• Earlier detection
  – 98% curative rate at 5 years for early melanoma
  – estimated average annual cost for an early stage versus late stage melanoma is $AUD1,681 versus $AUD115,109
Summary

- Dataset of 129,450 clinical images
- Malignant melanoma *versus* benign nevi with an accuracy equivalent to 21 board-certified dermatologist
Man against machine: diagnostic performance of a deep learning convolutional neural network for dermoscopic melanoma recognition in comparison to 58 dermatologists

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Summary

• Dataset 100 images
• 58 dermatologists
• Algorithm outperformed most dermatologists irrespective of experience
Digital photography

Image source
https://www.dermnetnz.org/cme/dermoscopy-photography/dermatoscopes-and-cameras/
https://vector.childrenshospital.org/2012/10/rash-conclusions-teledermatology-as-a-shared-care-model/
DICOM cameras

Image source
https://www.meso.biz/products/dicom-camera/
http://www.dicompass.cz/dicom-camera/
Dermoscopy

- Dermoscopy is a non-invasive diagnostic technique that enables the visualisation of sub-surface morphological (structural) features not seen by the naked eye.

Dermoscopy – diagnostic accuracy

- Improve diagnostic accuracy for melanoma in comparison with inspection by the unaided eye
- Dermoscopy by untrained or less experienced examiners was no better than clinical inspection without dermoscopy.
- A consensus diagnosis involving two or more experts is recommended to yield the highest possible diagnostic accuracy.

Dermoscope - equipment

• Magnifying lens
• Light source (LED +/- polarized filters)
• Can switch between non-polarized and polarized light source
• Glass plate + scale
Clinical examination

Dermoscopy

Light: LED + polarized filters to achieve cross-polarization

Polarized light dermoscopy (PD)

Non-polarized light dermoscopy (NPD)

Technique

Non-contact (PNCD)
Contact (PCD)
Contact (NPCD)

Non-contact does not require direct contact with the skin

Direct contact of the glass plate with the skin surface + liquid interface
Difference PD and NPD

NPD – superficial epidermis to dermo-epidermal junction
PD – dermo-epidermal junction to superficial dermis

Image source Dermoscopy https://dermoscopedia.org/Main_Page
Video dermoscopes

- Camera attached
- Smart-phone attached
- Handheld
- System
## DICOM support

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Type</th>
<th>IOD</th>
<th>Service class</th>
</tr>
</thead>
<tbody>
<tr>
<td>3Gen</td>
<td>CA, SPA</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Canfield / Visiomed</td>
<td>CA,SPA,S</td>
<td>US, SC</td>
<td>Storage SCU</td>
</tr>
<tr>
<td>Derma</td>
<td>H,S</td>
<td>SC</td>
<td></td>
</tr>
<tr>
<td>Fotofinder</td>
<td>SPA, H, S</td>
<td>Multi-frame True Color SC</td>
<td></td>
</tr>
<tr>
<td>Heine</td>
<td>CA</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Pixience</td>
<td>S</td>
<td>SC</td>
<td></td>
</tr>
</tbody>
</table>

CA = camera attached; SPA=smart phone attached, H=handheld, S=System

* DICOM support if coupled with a DICOM camera software
Total Body Photography

Canfield Scientific
https://www.canfieldsci.com/imaging-systems/vectra-wb360-imaging-system

Fotofinder
https://www.fotofinder.de/en/
Total body photography?

Advantages
• Unimaged melanoma
• “Ugly duckling”

Disadvantages
• Genital, acral, scalp and body folds
• Maturity
• Cost
• Resolution +/- dermoscopy

Image source
2D versus 3D

- Examination time
  - 25 exposures 2D *versus* 1 (simultaneous) exposure 3D
- Orthogonal imaging
  - Skin lesions on curved surfaces
2D Total Body Photography

Image source
https://datfl.com/whole-body-photography/
<table>
<thead>
<tr>
<th>Benign</th>
<th>Malignant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symmetrical</td>
<td>Assymetrical</td>
</tr>
<tr>
<td>Borders are even</td>
<td>(the two sides do no match)</td>
</tr>
<tr>
<td>One color</td>
<td>Borders are uneven</td>
</tr>
<tr>
<td>Smaller than 6 mm (1/4 inch)</td>
<td>Two or more colors</td>
</tr>
<tr>
<td>Ordinary mole</td>
<td>Larger than 6 mm (1/4 inch)</td>
</tr>
<tr>
<td></td>
<td>Changing in size, shape, color, or another trait</td>
</tr>
</tbody>
</table>

Image source
http://www.clovisdermatology.com/melanoma
Lesion Data

Group By: Area
Sort By: L* [Desc]
Location: Back Torso

Lesion ID # 24-126
Location: torso-back
Area: 16.02 mm²
Major Axis Length: 6.41 mm
Minor Axis Length: 3.30 mm
Perimeter: 17.93 mm
Eccentricity: 0.86
Levels: 16.00
L*: 46.07
a*: 19.61
b*: 25.72
Delta L*: 21.98
Delta E*: 24.48
Reflectance Confocal Microscopy

- Non-invasive, in vivo imaging of the cellular and tissue architecture (resolution equivalent to histology)
- Images up to 200 μm (papillary dermis)
Image source http://www.caliberid.com/
Reflectance Confocal Microscopy

http://www.caliberid.com/vivascope1500-Overview.html
Reflectance Confocal Microscopy

• Dramatically increase the accuracy of skin cancer diagnosis [9]
• “Virtual biopsy”
  – Reduce the number of biopsy
• Delineation of surgical margins
Vivanet™ and Vivastore™

• DICOM cloud storage + scheduling system
• Facilitates teledermatology
  – Imaging expertise
  – Second opinion
• Facilitates international community of practice
Optical Coherence Tomography

- Mainly used in ophthalmology
- Non-invasive, in vivo imaging skin architecture
- Depth up 1.5mm
  - Greater depth but lower resolution than RCM
- Inflammatory disease + sometimes skin cancer
Optical Coherence Tomography

Image source
https://www.dermnetnz.org/
The resolution enables the visualization of architectural changes, but not of single cells.
Summary

• Increasing evidentiary skin imaging
• Increasing diagnostic skin imaging
• DICOM WG 19 dormant
• No dermatology specific DICOM IODs
  – Visible Light, Ultrasound, OCT
• Many vendors have some level of DICOM (inconsistent)
• Majority of dermatologists do not use DICOM
Thank you

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