INTRODUCTION TO DERMOSCOPY

1 EPIDEMIOLOGY OF MELANOMA AND ITS RISK FACTORS (OVERVIEW)²⁻²

Cutaneous melanoma is a disease primarily of people of European origin. Age standardized incidence rates are highest in Australia and New Zealand (33/100 000), followed by North America (14), northern and western Europe (9) and southern Europe (6) (Figure 1). Relative to other adult cancers, melanoma occurs more frequently in young and middle-aged people. In high incidence countries, rates increase similarly in both sexes to middle age but then increase in males after 50 years (Figure 2).

Figure 1: Estimated age standardised incidence and mortality rates from melanoma²

Figure 2: Estimated age standardised incidence and mortality rates from melanoma²
1.1 RISK FACTORS

1.1.1 PHENOTYPIC

The most significant phenotypic risk factor for melanoma is a high number of common or atypical naevi. Light skin phototype/co-lour, freckling and red/red-blonde hair when adjusted for each other have relative risks (RR) of approximately 1.7 (unadjusted RR are tabled).

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Relative Risk (unadjusted for phenotype)</th>
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<tbody>
<tr>
<td>Common naevi (whole body)</td>
<td></td>
</tr>
<tr>
<td>0 - 15</td>
<td>1</td>
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<tr>
<td>16 - 40</td>
<td>1.5</td>
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<td>41 - 60</td>
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<td>61 - 80</td>
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<td>81 - 100</td>
<td>4.7</td>
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<tr>
<td>101 - 120</td>
<td>6.9</td>
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<td>Atypical Naevi</td>
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<tr>
<td>0</td>
<td>1</td>
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<td>1</td>
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<td>2</td>
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<td>4</td>
<td>4.4</td>
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<td>5</td>
<td>6.4</td>
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<tr>
<td>Hair Color</td>
<td></td>
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<tr>
<td>Dark</td>
<td>1</td>
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<tr>
<td>Red/Red Blonde</td>
<td>3.6</td>
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<tr>
<td>Blonde</td>
<td>2</td>
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<tr>
<td>Light Brown</td>
<td>1.6</td>
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<tr>
<td>Eye Color</td>
<td></td>
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<tr>
<td>Dark</td>
<td>1</td>
</tr>
<tr>
<td>Blue / Green / Hazel</td>
<td>1.5</td>
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<tr>
<td>Freckling</td>
<td></td>
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<tr>
<td>Low Density</td>
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<tr>
<td>High Density</td>
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<tr>
<td>Skin Phototype</td>
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<tr>
<td>Darkest category (Fitzpatrick IV)</td>
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<tr>
<td>Lightest Category</td>
<td>2.3</td>
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<tr>
<td>Skin Color</td>
<td></td>
</tr>
<tr>
<td>Dark</td>
<td>1</td>
</tr>
<tr>
<td>Light</td>
<td>2.3</td>
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</tbody>
</table>

1.1.2 GENETIC

The presence of one or more first degree family members with melanoma has a RR of 1.7. The hair and skin colour risk associations described above correlate in some respects to the low-penetrance MCIR variants seen in around 10% of people of European origin. Less commonly, in people carrying high-penetrance melanoma mutations found in classic familial melanoma (eg. CDKN2A, CDK4), melanoma lifetime risk can be extremely high (>80%) (Figure 3).

Figure 3: The most important phenotype for increased risk of melanoma is multiple common or atypical naevi.
1.1.3 ENVIRONMENTAL AND HISTORICAL

Sun exposure is the main environmental causative agent for melanoma. Increased relative risks for melanoma in European-derived populations living in areas of high ambient solar radiation (RR 1.8), high recreational sun exposure (RR 1.6), high number of sunburns (RR 1.6) and evidence of high levels of non-melanoma skin cancer, actinic keratoses, and solar elastosis (RR 1.9) all are consistent with this statement. Immunosuppressive therapy for organ transplantation (RR 2.3) is also a significant melanoma risk factor. Inconsistent or weak evidence associates PUVA or exposure to fluorescent lighting as possible risk factors. Finally, a previous personal history of melanoma significantly increases the risk of developing further primary melanoma (Figure 4).

2 CLINICAL EXAMINATION OF PIGMENTED SKIN LESIONS USING THE CLINICAL ABCD(E) RULE

The clinical ABCD rule is primarily used for distinguishing naevi and lentigo from superficial spreading melanoma and lentigo maligna. The technique is clearly oversimplified since it may score many dysplastic nevi as melanoma, and may not adequately diagnose nodular or light coloured melanoma. By adding *Evolution* to the method the later lesions may be detected. Nevertheless, it may be used to screen lesions for dermoscopy examination when understanding these limitations. Using this approach you can examine with dermoscopy any lesion with one or more of the clinical features (Figures 5 – 8):

- **Asymmetry** of shape or pigmentation pattern
- **Border irregularity**: often described as a geographical edge
- **Colour variability**
- **Diameter** greater than 6mm
- **Evolution** as seen as any morphological change over time

Figure 5: These lentigo maligna have all of the ABCDs of melanoma.

Figure 6: Note the so-called “geographical edge” resembling the coastline of a map in these superficial spreading melanomas.
An Introduction to Dermoscopy

Additional clinical aids to melanoma diagnosis include the “Ugly Duckling sign” where a lesion is morphologically different to the majority of the patient’s skin lesions. Nevertheless, when examining a patient it should be encouraged to decrease your clinical “naked eye” suspicious threshold for melanoma and examine many lesions with dermoscopy. This is because dermoscopy has been shown to increase the sensitivity for the diagnosis of melanoma compared with clinical naked eye examination.

3 Dermoscopy

Dermoscopy (surface microscopy, epiluminescence microscopy, dermatoscopy) is an inexpensive technique that improves the diagnosis of a variety of benign and malignant skin lesions.

3.1 IMPROVEMENT FOR THE DIAGNOSIS OF PIGMENTED SKIN LESIONS

Dermoscopy has been shown to greatly enhance the clinical diagnosis of nearly all pigmented skin tumours. However, its main impact has been to improve the diagnostic accuracy of melanoma compared to naked eye examination.

In a recent meta-analysis performed exclusively in studies in a clinical setting (Figure 9), the diagnostic odds ratio (the best measure for diagnostic accuracy) for melanoma using dermoscopy was 15.6 times higher compared with naked eye examination. The overall estimate of sensitivity (percentage of melanomas correctly diagnosed) was higher for dermoscopy (90%) than for eye examination alone (71%). While there was no statistical evidence of a difference in specificity for melanoma (percentage of non-melanomas correctly diagnosed) between dermoscopy (90%) and eye examination (81%), a dramatic effect of dermoscopy on specificity is best examined by its effect on excision.
rates. In a randomized trial in a specialist setting of naked eye versus naked eye and dermoscopy examination there was a significant 42% reduction in patients referred to biopsy in the dermoscopy arm. This is consistent with the retrospective findings of a significant reduction of the benign/malignant ratio of excised melanocytic lesions in clinicians trained in the use of dermoscopy from 18:1 (pre-dermoscopy era) to 4:1 (post-dermoscopy era). In contrast, non-users of dermoscopy continued their diagnostic performance without improvement (from 12:1 to 14:1). More recently, in a clinical trial using the combination of dermoscopy and digital dermoscopy monitoring resulted in a dramatic reduction of 64% in the need for excisions or referrals of benign pigmented skin lesions by primary care physicians.

So the evidence is plentiful that dermoscopy decreases the need for biopsy in addition to improving the detection of melanoma compared with naked eye examination. This is perhaps best expressed by its corollary: that naked eye examination may miss detecting melanoma while also leading to needless excisions. The result of this evidence has lead to the following recommendation in the Clinical Practice Guidelines for the Management of Melanoma in Australia and New Zealand (2008) (Figure 10):

“Training and utilization of dermoscopy is recommended for clinicians routinely examining pigmented skin lesions” Grade A. Body of evidence can be trusted to guide practice.

The following figures (Figure 11) of three pigmented nodules as seen by naked eye examination illustrate the improved diagnostic accuracy when using dermoscopy. While all three have similar naked eye characteristics their dermoscopy features are remarkably different. The naevus on the left lacks the distinctive blue-white veil of the nodular melanoma seen centrally, while the widespread red-blue lacunes confirms the diagnosis of haemangioma on the right.

### 3.2 HISTORY, BASIC PRINCIPLES AND INSTRUMENTS USED

Initial studies on examining pigmented skin lesions with surface microscopes were published in a few articles between 1933-51 (Hinselmann and Goldman). The use of immersion oil at the skin surface was noted to be beneficial again in sporadic observations between 1970-81 (Mackie and Fritsch). Large, expensive and cumbersome microscopes were used to describe some of the diagnostic features of dermoscopy in the late 1980’s (Steiner). However, the development of inexpensive hand-held devices which were generally available around the beginning of the 1990’s allowed this technique to enter routine clinical practice (Figure 12).
Dermoscopy uses simple magnification (usually x10) with the addition of liquid on the skin (glass plate-liquid devices) or polarized filters within the instrument (cross-polarized devices) that removes the normal scattering of light at the stratum corneum. This combination of magnification and removal of scattered light results in the visualization of pigmented structures not seen with the naked eye (Figures 13-18).

**Figure 13:** The schematic diagram shows the optics of skin following naked eye examination. In this situation most light is reflected from the stratum corneum allowing less detail of underlying structures. From Atlas of Dermoscopy. Marghoob et al. Taylor and Francis, 2005.  
[click to see larger image]

**Figure 14:** With dermoscopy using liquid at the skin surface the amount of reflected light is much diminished, allowing greater penetration of deeper layers of the skin. From Atlas of Dermoscopy. Marghoob et al. Taylor and Francis, 2005.  
[click to see larger image]

**Figure 15:** An alternative to using liquid at the surface of the skin to reduce scattered light is to use polarized filters both beyond the light source and at the eye piece. From Atlas of Dermoscopy. Marghoob et al. Taylor and Francis, 2005.  
[click to see larger image]
Hence, the terminology in dermoscopy is completely different to that used for describing a lesion using naked eye examination, since the vast majority of features seen with dermoscopy, e.g. pigment network, globules, dots, blue-white veil and the various vascular morphologies, are not seen with the naked eye.

It should be emphasised that dermoscopy using non-glass plate polarizing filtered devices can be significantly different to those of liquid-glass plate devices\(^1\). In the former, structures such as milia-like cysts, crypts (comedo-like openings), multiple blue-grey dots and blue-white veil may not be visualized. In contrast, compression using glass plate devices may decrease the visualization of vessels and white streaks. In regards to liquid-glass plate devices, the more recent models using greater illumination with LED light sources has improved the range of colours and structures detected. 70% ethanol used as a liquid provides superior visualization in addition to antisepsis between patients (Figures 19-21).
An understanding of the histology of the skin will help understand the morphological features seen under dermoscopy. For example, the pigment network found in some melanocytic lesions (as illustrated in the following schematic figure) is due to an increased vertical density of melanin pigment down the epidermal rete ridges (forming the grids/cords of the network) compared with the relative low vertical density seen overlying the dermal papillae (forming the holes of the network). Within the epidermis melanin pigment can be found within melanocytes, neighbouring keratinocytes from transfer of melanin from these melanocytes, or nevus cells. Indeed, in many pigmented lesions the majority of epidermal melanin may be found in basal or supra-basal keratinocytes (Figure 22).

Hence differences in the size and spacing of the dermal papillae and rete ridges of the skin will lead to different appearances of the pigment network as illustrated below (Figures 23 & 24).
An Introduction to Dermoscopy

Using dermoscopy the colour of the skin depends upon two pigments, melanin and haemoglobin. The latter appears as red or blue depending upon oxygenation and depth of the vessels within the skin. While melanin is a dark brown to black pigment in nature, its colour, when visualized with dermoscopy, depends upon its location in the skin (Figure 25). When at the surface melanin appears as black, mid epidermis dark brown, dermoepidermal junction tan, upper dermis grey and mid dermis blue. The colour difference is explained by the Tyndall effect, in which short-wavelength visible light (blue) is dispersed and reflected more than long-wavelength light (red).\(^{12}\)

An example of the importance of seeing a variety of colours in dermoscopy is for the diagnosis of invasive melanoma. Invasive melanoma has increased vasculature (hence red is seen) compared to most benign naevi. Additionally, unlike in the majority of benign compound naevi, melanoma cells containing melanin can be found in the upper layers of the epidermis (pagetoid spread) giving dark brown and black colour. In addition, in contrast to naevus cells, melanoma cells when found in the dermis often retain melanin pigment, giving grey and blue colour (Figure 26).

### 3.3 Key Learning Points

- The most significant phenotypic risk factor for melanoma is a high number of common or atypical naevi. Light skin phenotype/colour, freckling and red/red-blonde hair when adjusted for each are lower but significant phenotypic risk factors.
The presence of personal history of melanoma, one or more first degree family members with melanoma, high recreational sun exposure, high number of sunburns, and evidence of high levels of non-melanoma skin cancer or actinic keratoses all are significant risk factors for melanoma.

Dermoscopy improves the diagnosis of pigmented skin lesions compared to naked eye examination. Dermoscopy has also been shown to reduce the benign: malignant ratio of excised melanocytic lesions and reduce the number of patients referred for biopsy.

Using cross-polarized surface microscopes structures such as milia-like cysts, crypts (comedo-like openings), multiple blue-grey dots and blue-white veil may not be visualized. In contrast, compression using liquid-glass plate devices may decrease the visualization of vessels and white streaks.

### References


Figure 3: The most important phenotype for increased risk of melanoma is multiple common or atypical naevi.

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Figure 4: The presence of non-melanoma skin cancer or actinic keratoses approximately doubles the risk of developing primary melanoma.

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Figure 5: These lentigo maligna have all of the ABCDs of melanoma.
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Figure 6: Note the so-called “geographical edge” resembling the coastline of a map in these superficial spreading melanomas.

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Figure 7: Without the ulceration seen here these nodular melanomas would only have the “D” feature. For the clinical diagnosis of nodular melanoma it is useful to use the “EFG rule” of Elevation, Firm to palpation and Growth (progressively over more than a month).
Figure 8: Dysplastic naevi often have one or more of the ABCDs of melanoma.

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Figure 9: Summary receiver operator curve comparing dermoscopy and naked eye examination for the diagnosis of melanoma in studies exclusively performed in the clinical setting. The greater the area under the curve the greater the diagnostic accuracy. (From Vestergaard et al. Br J Dermatol 2008.)

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Figure 12: Early glass plate-liquid (left) and non-compressive cross-polarized devices (right).
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Figure 13: The schematic diagram shows the optics of skin following naked eye examination. In this situation most light is reflected from the stratum corneum allowing less detail of underlying structures. From Atlas of Dermoscopy. Marghoob et al. Taylor and Francis, 2005.
(click to return)
Figure 14: With dermoscopy using liquid at the skin surface the amount of reflected light is much diminished, allowing greater penetration of deeper layers of the skin. From Atlas of Dermoscopy. Marghoob et al. Taylor and Francis, 2005.

(click to return)
Figure 15: An alternative to using liquid at the surface of the skin to reduce scattered light is to use polarized filters both beyond the light source and at the eye piece. From Atlas of Dermoscopy. Marghoob et al. Taylor and Francis, 2005.

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Figure 16: Normally light is scattered at the stratum corneum making visualization of subsurface structures more difficult (left). The addition of a liquid approaching the optical density of the stratum corneum removes this scattering of light and allows more detailed view of the pigmented structures below its surface (right).

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Figure 17: Naked eye (left) versus dermoscopy examination (right) showing the improved visualization of structures seen with dermoscopy (red-blue lacunes). There are over 100 defined dermoscopy features in the literature, with the majority not visualized with naked eye examination.
Figure 18: Dermoscopy examination (right) again displays features (pigmented crypts and additional colours, non-pigmented milia-like cysts and vascular) not visualized with the naked eye examination (left).

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Figure 19: Note the blue-white veil seen using the glass plate-liquid device (left) is not visualized using the cross-polarized device (right). Melanin also appears darker using the cross-polarized device.

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Figure 20: In this seborrheic keratosis the milia-like cysts and crypts (comedo-like openings) seen using the glass plate-liquid device (left) are nearly completely lost and not seen with the cross-polarized device (right).
Figure 21: Glass plate devices may compress vessels (left). In contrast non-compression cross-polarized devices allow greater visualization of vessel structures (right). However, currently vessel morphology has been described in the literature using the former devices, making assessment of vessels using cross-polarized devices problematic.
Figure 23: Wide pigment network. In this naevus the holes of the network have a wide diameter due to the relatively wide diameter of the dermal papillae (arrow). Note the majority of the melanin pigment found in this and many other melanocytic derived lesions are found in basal keratinocytes and melanocytes rather than in the naevus cells. From Menzies et al. Dermoscopy. An Atlas 3rd Edn. McGraw-Hill Book Co. 2009.

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Figure 24: Narrow pigment network. Here the width of the dermal papillae are relatively narrow leading small holes in the network. From Menzies et al. Dermoscopy. An Atlas 3rd Edn. McGraw-Hill Book Co. 2009. (click to return)
(click to return)
Figure 26: In this invasive melanoma a greater range of colours are seen with dermoscopy compared with naked eye examination (top). See also figures in 3.1. From Menzies et al. Dermoscopy. An Atlas 3rd Edn. McGraw-Hill Book Co. 2009.

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