The pediatric dermatologist is equipped with several diagnostic and therapeutic tools that can be used in the office. The Wood’s lamp, introduced nearly a century ago, continues to be a safe, noninvasive diagnostic tool used today for diagnosing cutaneous infections, pigmentary disorders, and porphyrias. The pulsed dye laser is the treatment of choice for vascular lesions and has an expanding list of other applications, such as warts, which are extremely common in the pediatric population. Dermoscopy has emerged as an effective adjunctive tool in the in vivo examination of pigmented skin lesions and early diagnosis of cutaneous malignant melanoma. Other uses are also being explored including diagnosis of scabies. Future directions of technology in the pediatric dermatology office include implementation of electronic medical record systems and treatment of conditions such as molluscum, warts, and acne vulgaris with photodynamic therapy.

Wood’s Lamp

The Wood’s lamp (WL) was invented in 1903 by a Baltimore physicist, Robert W. Wood (1868-1955).1 It wasn’t until 1925 that this long-wave ultraviolet light was used in dermatology by Margarot and Deveze for the detection of fungal infection of hair.2 After more than 100 years the WL remains a small, simple, convenient, and affordable tool for the pediatric dermatologist. Because it is safe, painless, and noninvasive, the WL is particularly useful in a pediatric setting for the diagnosis of cutaneous infections, pigmentary disorders, and porphyrias.

Physics

WL, also called a black light, emits ultraviolet (UV) A radiation generated from a high-pressure mercury arc. The lamp contains a compound filter made of barium silicate with 9% nickel oxide, called the “Wood’s filter,” which blocks the passage of all light rays with the exception of a band between 320 and 400 nm (nm) with a peak at 365 nm. Tissue fluoresces when a molecule or pigment absorbs Wood’s UV light and emits radiation of a lower energy (ie, longer wavelength), which usually falls within the visible light spectrum (400-700 nm). When the emission of a lesion is enhanced above the normal colored background skin, it is termed enhancement. Normal skin fluoresces only faintly or not at all, mainly due to the normal skin constituents of elastin, aromatic...
amino acids, nicotinamide adenine dinucleotide (NAD) and precursors or products of melanin.3-5

Applications

Hypopigmentation and Depigmentation

Epidermal melanin is lacking in hypopigmented and depigmented lesions, allowing the use of WL to penetrate through to the dermal collagen, which autofluoresces or enhances a bright blue-white (see applications in Table 1).6-10 Some authors suggest that the enhancement seen in vitiligo is caused by a tetrahydrobiopterin byproduct generated in the vitiligo lesions. The margins of the lesion appear sharper under WL than ordinary room light because of the abrupt cut-off in emission of visible light at the spot’s border.6

In fair-skinned children, hypopigmented lesions can be difficult to detect. In such patients, WL is useful not only in making a diagnosis of vitiligo7 but in determining the location and extent of disease, which can be important in directing treatment. The efficacy of treatment can also be monitored with the WL through early demonstration of follicular repigmentation after oral photochemotherapy.11 WL has also been useful in identifying hypopigmented, ash-leaf, or lance-ovate shaped macules associated with tuberous sclerosis. Anecdotally, we have noted that hypopigmented mycosis fungoides also enhances or autofluoresces in a similar fashion to vitiligo, and WL is not useful for distinguishing these two entities.

Hyperpigmentation

In fair skin (not types IV and V), the depth of melanin in the skin can be determined by WL.12 Light in both the UV and visible range is strongly absorbed by this pigment. A region of heavily melanized epidermis absorbs most of the rays emitted from a Wood’s light, contrasting with the normal adjacent skin which emits light as usual. The contrast in dermal pigmentation, however, is not as pronounced13 because some of the autofluorescence of dermal collagen occurs both above and below the dermal melanin diminishing the amount of fluorescence returned to the eyes.6

Infections

Certain bacterial and fungal organisms produce pigment that fluoresces under WL, aiding in diagnosis of infection. For

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### Table 1 Wood’s Light Positive Diatheses

<table>
<thead>
<tr>
<th>Color of Fluorescence</th>
<th>Pigmentary disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypopigmentation and depigmentation</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Vitiligo | Bright blue—white
| Ash leaf macules of Tuberous sclerosis | Bright blue—white
| Hypopigmented Mycosis fungoides | Bright blue—white (authors’ observations)
| **Hyperpigmentation** | 
| Melasma (Sanchez et al, Gilchrest et al)* | Enhanced color contrast
| Epidermal | Decreased color contrast
| Dermal | 
| **Infections** | 
| Bacterial (fluorescing byproduct) | 
| Pseudomonas (pyoverdin or fluorescein) | Green
| Corynebacterium minutissimum (coproporphyrin III) | Coral red
| Propionibacterium acnes (coproporphyrin) | Orange—red, yellowish—white
| **Fungal** | 
| Pityriasis versicolor (Malessezia fursfur) | Yellowish—white, copper—orange
| Pityrosporum folliculitis | Bluish-white follicular
| Tinea capitis | 
| Microsporum audouinii† | Blue—green
| M. canis† | Blue—green
| M. ferrugineum† | Blue—green
| M. distortum† | Blue—green
| M. gypseum (some variants)† | Dull yellow
| T. schoenleini | Dull blue
| **Porphyria (sample)‡** | 
| Erythropoietic porphyria (RBC, urine, teeth) | Red—pink
| Erythrophoietic porphyrin fluoresce (RBC, feces, gall stones) | Red—pink
| Hepatoerythropoietic porphyria (RBC, feces, urine) | Red—pink
| Porphyria cutanea tarda (urine, feces) | Red—pink
| Variegated porphyria (urine, feces) | Red—pink
| False positives (lint, scale, ointments, colored markers, dried soap) | Red—pink

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*Useful only in patients with lighter complexions, not for skin types V and VI.
†Caused by production by Microsporum of the chemical pteridine.
‡Addition of dilute hydrochloric acid to sample intensifies the fluorescence by converting porphyrinogens to porphyrins.

Data from Asawanonda and Taylor.6
example, use of the WL can detect early *Pseudomonas* infection within burns. Erythrasma, caused by *Corynebacterium minutissimum*, is chronic cutaneous infection of the intertriginous areas, which can be identified with WL.

In the 1950s most tinea capitis in the United States was caused by zoophilic species of dermatophytes, which caused an infection that fluoresced with WL. Zoophilic and geophilic dermatophytes of the genus *Microsporum*, produce a pigment pteridine, which fluoresces under the UV lamp. Most of these organisms cause kerions, which are highly inflamed, boggy scalp lesions with overlying alopecia. WL is not as useful currently for this purpose because *Trichophyton* species, which are anthropophilic and do not fluoresce, are dominant in the United States. Despite the predominance of *Trichophyton* among tinea capitis cultures, checking for fluorescence of kerions is still helpful in deciding which antifungal to use for treatment, as fungal cultures take a number of weeks to grow the offending fungus.

**Porphyrias**

Excess porphyrins can be detected via the WL in the teeth, urine, stool samples, and red blood cells, depending on the porphyria variant. Adding an equal volume of 1.5 N HCl to the specimen accentuates the fluorescence by converting porphyrinogens to porphyrins.

**Pulsed Dye Laser**

In the 1980s, pioneering research performed by Anderson and Parrish led to development of the flashlamp pulsed-dye laser (PDL), "the first laser specially designed to treat cutaneous vascular lesions and the first laser to eliminate these lesions predictably without producing a scar." PDL achieves both efficacy and safety by (1) using a wavelength primarily absorbed by hemoglobin, (2) setting an appropriately short laser pulse to limit thermal diffusion away from hemoglobin into surrounding tissue, (3) administering sufficiently high energy density (fluence) to irreversibly damage the target, and (4) using dynamic cooling devices to reduce epidermal damage by the laser. All laser treatment is based on this combination of wavelength, exposure time, and fluence, which produces selective damage to chromophores by monochromatic light while sparing other tissue, a principle referred to as selective photothermolysis.

**Physics**

The PDL emits ultrashort pulses of monochromatic yellow light, the product of short pulses of white light from a flashlamp exciting the laser’s medium, rhodium dye. The original PDL emitted a wavelength of 577 nm (pulse duration 0.3 ms), corresponding with the third absorption peak of oxyhemoglobin, but was extended to 585 nm (0.45 ms) to achieve deeper tissue penetration while maintaining vascular selectivity. A newer 595-nm ultra-long PDL (LPDL) with adjustable pulse duration also exists. Fluences most commonly used range between 5 and 8 J/cm².

**Adverse Effects**

Although PDL is largely considered safe, complications do occur. The most common adverse effects are purpura and edema, which can arise during treatment and persist for 2 to 14 days, usually resolving without sequelae. Pain is also a frequent complaint. Erythema, blistering, and serous crusting have been observed. In a series of 500 patients undergoing PDL for port wine stains (PWS), telangiectasias, and hemangiomas, Levine and Geronemus reported the following adverse effects: no hypertrophic scarring, less than 0.1% incidence of atrophic scarring, and 0.04% spongiform dermatitis, 1% hyperpigmentation, and transient hypopigmentation. Pigmentary changes are more likely to occur in children with darker skin and, therefore, lower fluences may be needed in such patients.

**Dynamic Cooling Device**

The use of a dynamic cooling device, which cools the epidermis with a nontoxic cryogen spray during laser treatment, permits delivery of increased fluence to the lesion without damaging the surrounding epidermis and dermis. Of particular value in the pediatric setting, where pain-thresholds are notoriously low, cooling has the added benefit of being analgesic as well as reducing the intensity and duration of post-treatment purpura. Topical lidocaine preparations used before the procedure may also aid in analgesia, but may only be applied to limited body surface areas.

**Applications**

Although the PDL is largely recognized as a vascular laser, its application continues to be expanded into other pediatric dermatologic conditions (Table 2). Because of space limitations in this article, only a brief review of usage of the pulsed dye laser for therapy of port wine stains, hemangiomas and warts will be addressed.

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**Table 2 Applications of Pulsed Dye Laser in the Pediatric Dermatology Office**

<table>
<thead>
<tr>
<th>Type of Lesion Treated (Reference)</th>
<th>Wavelength Described in Literature</th>
<th>Average Number of Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glomangiomas*&lt;sup&gt;21&lt;/sup&gt;</td>
<td>585</td>
<td>2</td>
</tr>
<tr>
<td>Hemangioma</td>
<td>585</td>
<td>3</td>
</tr>
<tr>
<td>Ulcerated&lt;sup&gt;19&lt;/sup&gt;</td>
<td>585</td>
<td>2</td>
</tr>
<tr>
<td>Hypertrophic Scars&lt;sup&gt;23&lt;/sup&gt;</td>
<td>595 with CSC&lt;sup&gt;24&lt;/sup&gt;</td>
<td>2</td>
</tr>
<tr>
<td>Molluscum Contagiosum&lt;sup&gt;25&lt;/sup&gt;</td>
<td>585</td>
<td>1</td>
</tr>
<tr>
<td>Port Wine Stain&lt;sup&gt;26&lt;/sup&gt;</td>
<td>585</td>
<td>5</td>
</tr>
<tr>
<td>Pyogenic granuloma&lt;sup&gt;27&lt;/sup&gt;</td>
<td>585</td>
<td>2.25</td>
</tr>
<tr>
<td>Spider angioma&lt;sup&gt;28&lt;/sup&gt;</td>
<td>585</td>
<td>1</td>
</tr>
<tr>
<td>Warts&lt;sup&gt;20&lt;/sup&gt;</td>
<td>585</td>
<td>3</td>
</tr>
</tbody>
</table>

*CSC, cryogen-spray cooling
One reported case of pain relief following treatment with pulse-dye laser (PDL).
Port Wine Stain

PDL is the treatment of choice for PWS. A PWS is a congenital malformation of the superficial dermal blood vessels, usually postcapillary venules, occurring in 0.3% of newborns. The stains originate as pink macules. Because of progressively abnormal blood flow, the vessels enlarge with age, causing these lesions to become progressively thicker and darker with time. They can occur anywhere on the body; however, the face is associated with the greatest psychosocial distress, often making medical treatment of the lesions necessary.

On average, trials show that PWS lighten by 12% per PDL treatment. However, individual response rates depend on several variables, including anatomic location, initial stain size, depth, and vessel diameter. Better results are achieved in stains on the forehead, lateral face, neck, and trunk than on the face. They can occur anywhere on the body; however, the face is associated with the greatest psychosocial distress, often making medical treatment of the lesions necessary.

It is unclear whether the patient’s age at treatment influences degree of lightening, with the authors of some trials reporting improved responses in younger children and others demonstrating no correlation between age and outcome. Regardless, starting laser therapy at as early an age as possible may be important for maximizing psychological benefit of treatment. Several trials have shown that the conventional 585-nm light therapy achieves greater PWS lightening than the newer 595-nm LPDL.

Hemangiomas

A hemangioma is a benign endothelial tumor occurring in 10-12% of all children by 1 year of age, one-third of which are visible at birth as a faint bluish macule. The lesion enlarges rapidly, reaching stabilization usually at the end of the first year of life and then in most cases begins to spontaneously involute over the ensuing years. As with other lesions perceived to affect appearance, hemangiomas can cause psychological distress in both child and parent.

PDL therapy is effective only in superficially located hemangiomas, although most hemangiomas eventually regress, calling into the question the sagaciousness of treatment (which has its own risks). A total of 15% of untreated children are left with residual skin changes such as atrophic scarring, pigmentary changes, and telangiectasias. Many advocate laser therapy to inhibit growth or activate involution of any superficial lesion. However, the only randomized controlled study that examined early PDL treatment revealed no useful benefit of early laser therapy in uncomplicated hemangiomas over a wait-and-see policy. In fact, the study reported that treated lesions were at an increased risk of skin atrophy and hypopigmentation. Recently, the LPDL with cryogen skin cooling demonstrated greater effectiveness and superior safety over PDL in uncomplicated, early lesions. Ulcerated lesions, in contrast, clearly benefit from PDL treatment with reported pain alleviation, decreased bleeding, and lower infection rates after therapy.

Warts

Warts are a common, hard-to-treat dermatologic disease that occurs in up to 20% of children. Although not first-line therapy, PDL has been shown to be a safe, relatively effective additional treatment modality for viral warts in children. The mechanism of action is likely selective destruction of the wart’s superficial, ectatic capillaries, which are necessary to nourish the rapidly growing wart.

Dermoscopy

During the last 10 years, dermoscopy, also termed epiluminescence microscopy or skin surface microscopy, has emerged as a valuable tool in the in vivo evaluation of pigmented skin lesions (PSLs). By increasing the sensitivity, specificity, and accuracy of clinical diagnosis of early malignant melanomas (MMs), the use of dermoscopy decreases the number of unnecessary excisions. This noninvasive technique is particularly useful in pediatric patients who can become anxious about painful procedures and refuse biopsy.

Technique

Because of dissimilar optical densities and refractive indices the reflection, dispersion and absorption of light by the stratum corneum differs from that of the surrounding air. Visible light is mainly reflected by the skin’s surface consequently obscuring visualization of underlying structures. The skin can be flattened with a glass slide to provide an even surface, which can be enhanced with oil. Optical magnification enables the observer to examine the dermal-epidermal and dermal structures.

Instruments

Hand-held devices are inexpensive and easy to use with typically 10-fold magnification power. These instruments are battery powered and use halogen lamps or light-emitting diodes as a light source. Newer instruments use polarizing filters for glare reduction, which eliminates the need for skin contact and immersion liquids, allowing a quicker, more convenient examination. Some hand-held models are equipped with adaptors that attach to standard or digital cameras allowing images to be captured. Others allow stereomicroscopy, a form of binocular inspection with higher magnification capability that produces high optical quality, three-dimensional visualization. Electronic dermatoscopes include a high-resolution video probe that transmits images to a color monitor or onto a computer.

Applications

Congenital Melanocytic Nevus

Congenital melanocytic nevi (CMN; Table 3) result from the proliferation of benign melanocytes in the dermis, epidermis, or both. Most CMNs are present at birth but may develop pigmentation as late as 6 months of age. These lesions are termed nevus tardive. CMN occur in 1-6% of the population. The most commonly used CMN classification system divides lesions into 3 categories based on size: small (<1.5 cm), medium (1.5-7.5 cm), and large (≥7.5 cm).
Table 3  Common Dermoscopic Patterns of Melanocytic Proliferations of Childhood (Data from Marghoob et al)\textsuperscript{46}

<table>
<thead>
<tr>
<th>Congenital melanocytic nevi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reticular/honeycomb-like network</td>
</tr>
<tr>
<td>Sharply circumscribed, round to oval aggregates of brown-black pigment</td>
</tr>
<tr>
<td>Diffuse brown background pigmentation</td>
</tr>
<tr>
<td>Milia-like cysts</td>
</tr>
<tr>
<td>Perifollicular pigment</td>
</tr>
<tr>
<td>Hypertrichosis (often a late feature)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acquired melanocytic nevi/halo nevus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reticular/regular pigmented network</td>
</tr>
<tr>
<td>Globules regularly distributed</td>
</tr>
<tr>
<td>Homogenous, diffuse pigmentation in absence of other distinctive local features</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spitz nevus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tan to black streaks symmetrically distributed at periphery (&quot;starburst pattern&quot;)</td>
</tr>
<tr>
<td>Symmetric brown globules or dots</td>
</tr>
<tr>
<td>Atypical: asymmetry, varied pigmentation, pinpoint vessels</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Melanoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial streaming</td>
</tr>
<tr>
<td>Peripheral black dots/globules</td>
</tr>
<tr>
<td>Blue-gray fine dots</td>
</tr>
<tr>
<td>Irregular confluent blue pigmentation with overlying white &quot;ground glass&quot; haze</td>
</tr>
<tr>
<td>Pigmented network with irregularly spaced holes</td>
</tr>
<tr>
<td>Asymmetry of color, texture, shape in one or two axes</td>
</tr>
<tr>
<td>Abrupt cut-off of pigment pattern at periphery</td>
</tr>
<tr>
<td>Multiple colors</td>
</tr>
<tr>
<td>Change from previous dermoscopic exam</td>
</tr>
</tbody>
</table>

Spitz Nevus

In 1948, Sophie Spitz described pink papules in children that histopathologically fulfilled the criteria for melanoma, coined the term juvenile melanoma.\textsuperscript{47} Ultimately renamed for the woman who first reported them, the Spitz nevus (SN) is composed of spindle and epithelioid nevus cells and usually presents as a solitary lesion on the lower extremities or the face (Table 4).\textsuperscript{48-53} Although classically described as pink–red resulting from a lack of melanin, tan, brown, and black pigmented SN are also common. These benign lesions require correct identification to avoid the extensive surgical intervention that would follow a misdiagnosis as MM. One study reported that using dermoscopic criteria to examine 54 SN increased the accuracy of diagnosing pigmented SN from 56% (clinical) to 93% (dermoscopic).\textsuperscript{54} Under dermoscope, the majority of SN exhibit a symmetrical starburst pattern. Some SN exhibit atypical features such as asymmetry and irregular pigmentation making differentiation from MM difficult to impossible without excision.

Future Technology

Two types of technology promise to become commonplace in the pediatric dermatology office. First, according to an Executive Order\textsuperscript{55} issued by the President, beginning January 1, 2007, all federal agencies providing medical care and all agencies paying other providers for medical care (including Medicare), “... shall utilize, where available, health information technology systems and products that meet recognized interoperability standards.” Electronic Medical Records will require specific features for the pediatric dermatology office. Of course, security will be paramount in addition to compatibility with writing tablets and billing software. In addition, specific templates for the major diagnoses seen in the pediatric dermatology office will be needed, namely atopic dermatitis, acne vulgaris, warts, molluscum, and vascular birthmarks. Ideally, educational handouts would be generated on completion of therapeutic plan, which would summarize skin care, products recommended over the counter, prescription product usage and environmental alterations such as humidifiers. Unfortunately, such software does not currently exist.

Photodynamic therapy is another emerging technology for the pediatric dermatology office. Photodynamic therapy is a therapy in which a porphyrin is applied to the skin, which is generally selectively absorbed by skin with rapid turnover, such as skin cancers or warts. An external light source is radiated on the skin, is selectively absorbed by the porphyrin laden tissue, converting the radiant energy into a zone of thermal destruction.\textsuperscript{56} Photodynamic therapy has been described as a treatment for warts and molluscum\textsuperscript{57} but is accompanied by tremendous pain and limited reimbursement for the porphyrin application (usually ALA-PDT). Photodynamic therapy has also been used for treatment of acne vulgaris as the contributory bacteria, \textit{Propionibacterium acnes} produces a porphyrin absorbed by blue light.\textsuperscript{58} As this technology advances, usage in the pediatric dermatology office is likely to become more commonplace.

Conclusion

Technological advances of the last century have allowed pediatric dermatologists to more effectively diagnose and treat childhood and adolescent skin disease. In the current century, we can expect to see further usage of medical technol-

Table 4  Other Pediatric Uses of Dermoscopy

<table>
<thead>
<tr>
<th>Angioma serpiginosum \textsuperscript{48}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidermodysplasia verruciformis\textsuperscript{49}</td>
</tr>
<tr>
<td>Head lice\textsuperscript{50}</td>
</tr>
<tr>
<td>Port-wine stains\textsuperscript{51}</td>
</tr>
<tr>
<td>Scabies\textsuperscript{52}</td>
</tr>
<tr>
<td>Solitary angiookeratoma\textsuperscript{53}</td>
</tr>
</tbody>
</table>
ogy to become commonplace in the pediatric dermatology office.

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38. Greve B, Raulin C: Prospective study of port wine stain treatment with dye laser. Comparison of two wavelengths (585 nm vs. 595 nm) and two pulse durations (0.5 milliseconds vs. 20 milliseconds). Lasers Surg Med 34:168-173, 2004


55. Bush GW: Promoting Quality and Efficient Health Care in Federal Government Administered or Sponsored Health Care Programs. Executive Order 13410 of the President of the United States, August 22, 2006

