Selected Applications of Technology in the Pediatric Dermatology Office

Erin E. Ducharme, MD, and Nanette B. Silverberg, MD

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.
Semin Cutan Med Surg 27:94-100 © 2008 Elsevier Inc. All rights reserved.

KEYWORDS dermoscopy, wood's lamp, pulsed dye laser, photodynamic therapy, nevi, spitz nevus, warts, vitiligo

Pediatric patients with dermatologic disorders are unique with regard to the types of conditions they exhibit and their vulnerability to psychosocial distress resulting from visible disease. Furthermore, as with any physician caring for children, the pediatric dermatologist's goal is not only to achieve a good medical outcome but to do so in a way that is the least painful, least invasive, and least traumatic to the child. Although a relatively new subspecialty, pediatric dermatology offers several diagnostic and therapeutic tools that can be used in the physician's office to aid in directly and indirectly treating the special needs of children.

In this article, we take a tour through history, presenting, in the order they became medically recognized, several fundamental instruments in the pediatric dermatologist's armamentarium, namely the Wood's lamp, which was introduced nearly a century ago, the pulsed dye laser, and the dermoscope. We conclude with a few thoughts on the future of technology in the pediatric dermatology office.

Department of Dermatology, St. Luke's-Roosevelt Hospital Center, New York, NY.

Conflict of interest disclosure: Dr. Silverberg is on the speaker's bureau and is an investigator for Astellas and Novartis pharmaceuticals.

Reprint requests and correspondence to Nanette B. Silverberg, MD, Department of Dermatology, St. Luke's-Roosevelt Hospital Center, 1090 Amsterdam Avenue, Suite 11D, New York, NY 10025. E-mail: Nsilverberg@chpnet.org

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

Table 1 Wood's Light Positive Diatheses

	Color of Fluorescence
Pigmentary disorders	
Hypopigmentation and depigmentation	
Vitiligo	Bright blue—white[7]
Ash leaf macules of *Tuberous sclerosis*	Bright blue—white[10]
Hypogimented *Mycosis fungoides*	Bright blue—white (authors' observations)
Hyperpigmentation	
Melasma (Sanchez et al, Gilchrest et al)*	
Epidermal	Enhanced color contrast
Dermal	Decreased color contrast
Infections	
Bacterial (fluorescing byproduct)	
Pseudomonas (pyoverdin or flourescein)	Green
Corynebacterium minutissimum (coproporphyrin III)	Coral red
Propionibacterium acnes (coproporphyrin)	Orange—red, yellowish—white
Fungal	
Pityriasis versicolor (Malessezia furfur)	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. schoenleinii	Dull blue
Porphyria (sample)‡	
Erythropoietic porphyria (RBC, urine, teeth)	
Erythropoietic protoporphyria (RBC, feces, gall stones)	Red—pink
Hepatoerythropoietic porphyria (RBC, feces, urine)	Red—pink
Porphyria cutanea tarda (urine, feces)	Red—pink
Variegate porphyria (urine, feces)	Red—pink
False positives (lint, scale, ointments, colored markers, dried soap)	Red—pink

Data from Asawanonda and Taylor.[6]
*Useful only in patients with lighter complexions, not for skin types V and VI.
†Caused by production by Microsporum of the chemical pteridine.[8]
‡Addition of dilute hydrochloric acid to sample intensifies the fluorescence by converting porphyrinogens to porphyrins.[9]

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 vitiligo[7] 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 pronounced[13] 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

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,[8] 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.[9]

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."[14] 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.[15] All laser treatment is based on this combination of wavelength, exposure time, and fluence, which produces selective damage to chromophores by monochromic light while sparing other tissue, a principle referred to as selective photothermolysis.[15]

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.[16] A newer 595-nm ultra-long PDL (LPDL) with adjustable pulse duration also exists. Fluences most commonly used range between 5 and 8 J/cm^2.

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

Type of Lesion Treated (Reference)	Wavelength Described in Literature	Average Number of Treatments
Glomangiomas[21]*	585	2
Hemangioma		
Superficial[22]	585	3
Ulcerated[19]	585	2
Hypertrophic Scars	585[23]	2
	595 with CSC[24]	2
Molluscum Contagiosum[25]	585	1
Port Wine Stain[26]	585	5
Pyogenic granuloma[27]	585	2.25
Spider angioma[28]	585	1
Warts[20]	585	3

CSC, cryogen-spray cooling

*One reported case of pain relief following treatment with pulse-dye laser (PDL).

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.[17] In a series of 500 patients undergoing PDL for port wine stains (PWS), telangiectasias, and hemangiomas, Levine and Geronemus[18] reported the following adverse effects: no hypertrophic scarring, less than 0.1% incidence of atrophic scarring, and 0.04% spongiotic 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).[19-28] 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.

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.[29] 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.[30]

On average, trials show that PWS lighten by 12% per PDL treatment.[31] 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 those located on the central face, lip, chin, dermatome V2 of the face, and extremities.[32] Greater response rates also are observed in lesions that are initially small (<20 cm²)[33] and with superficially located vessels of moderate diameter (38 $\pm$ 19 μm, mean $\pm$ SD).[34]

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[33,35] and others demonstrating no correlation between age and outcome.[36] Regardless, starting laser therapy at as early an age as possible may be important for maximizing psychological benefit of treatment.[37] Several trials have shown that the conventional 585-nm light therapy achieves greater PWS lightening than the newer 595-nm LPDL.[38,39]

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.[14] Many advocate laser therapy to inhibit growth or activate involution of any superficial lesion.[14] 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.[40] 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.[41] Ulcerated lesions, in contrast, clearly benefit from PDL treatment with reported pain alleviation, decreased bleeding, and lower infection rates after therapy.[19]

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.[20] The mechanism of action is likely selective destruction of the wart's superficial, ectatic capillaries, which are necessary to nourish the rapidly growing wart.[20]

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),[42] the use of dermoscopy decreases the number of unnecessary excisions.[43] 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.[44] 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.[45] The most commonly used CMN classification system divides lesions into 3 categories based on size: small (<1.5

Table 3 Common Dermoscopic Patterns of Melanocytic Proliferations of Childhood (Data from Marghoob et al[46])

Congenital melanocytic nevi
  Reticular/honeycomb-like network
  Sharply circumscribed, round to oval aggregates of brown-black pigment
  Diffuse brown background pigmentation
  Milia-like cysts
  Perifollicular pigment
  Hypertrichosis (often a late feature)
Acquired melanocytic nevi/halo nevus
  Reticular/regular pigmented network
  Globules regularly distributed
  Homogenous, diffuse pigmentation in absence of other distinctive local features
Spitz nevus
  Tan to black streaks symmetrically distributed at periphery ("starburst pattern")
  Symmetric brown globules or dots
  Atypical: asymmetry, varied pigmentation, pinpoint vessels
Melanoma
  Radial streaming
  Peripheral black dots/globules
  Blue-gray fine dots
  Irregular confluent blue pigmentation with overlying white "ground glass" haze
  Pigmented network with irregularly spaced holes
  Asymmetry of color, texture, shape in one or two axes
  Abrupt cut-off of pigment pattern at periphery
  Multiple colors
  Change from previous dermoscopic exam

cm); medium (1.5–19.9 cm); and large or giant (≥20). MMs can develop in a CMN of any size, although the risk of malignant transformation increases in larger lesions. The use of dermoscopy allows physicians to clinically monitor CMNs as opposed to prophylactically excising such lesions. Dermoscopic features observed in CMNs are usually noted in homogenous patterns.[46]

Spitz Nevus

In 1948, Sophie Spitz described pink papules in children that histopathologically fulfilled the criteria for melanoma, coining the term juvenile melanoma.[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).[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).[54] Under dermatoscope, 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[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.[56] Photodynamic therapy has been described as a treatment for warts and molluscum[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, *Proprionobacterium acnes* produces a porphyrin absorbed by blue light.[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

Angioma serpiginosum [48]
Epidermodysplasia verruciformis[49]
Head lice[50]
Port-wine stains[51]
Scabies[52]
Solitary angiokeratoma[53]

ogy to become commonplace in the pediatric dermatology office.

References

1. Wood RW: Secret communications concerning light rays. J Physiol 5e serie: t IX, 1919 Quoted from: Asawananda P, Charles TR. Wood's light in dermatology. Int J Dermatol 38:801-807, 1999

2. Margarot J, Deveze P: Aspect de quelques dermatoses lumiere ultra-paraviolette. Note preliminaire. Bull Soc Sci Med Biol Montpellier 6:375-378, 1925

3. Fellner MF, Ches AS, Mont M, et al: Patterns and intensity of autofluorescence and its relation to melanin in human epidermis and hair. Int J Dermatol 18:722-730, 1979

4. Mustakallio KK, Korhonen P: Monochromatic ultraviolet-photography in dermatology. J Invest Dermatol 47:351-356, 1966

5. Fulton JE Jr: Utilizing the ultraviolet (UV Detect) camera to enhance the appearance of photodamage and other skin conditions. Dermatol Surg 23:163-169, 1997

6. Asawananda P, Taylor CR: Wood's light in dermatology. Int J Dermatol 38:801-807, 1999

7. O'Sullivan JJ, Stevenson CJ: Screening for occupational vitiligo in workers exposed to hydroquinone monomethyl ether and to paratertiary-amyl-phenol. Br J Ind Med 38:381-383, 1981

8. Wolf FT: Chemical nature of the fluorescent pigment produced in Microsporum-infected hair. Nature 180:860-861, 1957

9. Halprin KM: Diagnosis with Wood's light. The porphyrias. JAMA 200:130, 1967

10. Norio R, Oksanen T, Rantanen J: Hypopigmented skin alterations resembling tuberous sclerosis in normal skin. J Med Genet 33:184-186, 1996

11. Jillson OF: Wood's light: An incredibly important diagnostic tool. Cutis 28:620-626, 1981

12. Sanchez NP, Pathak MA, Sato S: Melasma: A clinical, light microscopic, ultrastructural, and immunofluorescence study. J Am Acad Dermatol 4:698-710, 1981

13. Gilchrest BA, Fitzpatrick TB, Anderson RR, et al: Localization of melanin pigmentation in the skin with Wood's lamp. Br J Dermatol 96:245-248, 1977

14. Poetke M, Philipp C, Berlien HP: Flashlamp-pumped pulsed dye laser for hemangiomas in infancy: treatment of superficial vs mixed hemangiomas. Arch Dermatol 136:628-632, 2000

15. Anderson RR, Parrish JA: Selective photothermolysis: Precise microsurgery by selective absorption of pulsed radiation. Science 220:524-527, 1983

16. Tan OT, Murray S, Kurban AK: Action spectrum of vascular specific injury using pulsed irradiation. J Invest Dermatol 124:868-871, 1989

17. Wlotzke U, Hohenleutner U, Abd-El-Raheem TA, et al: Side-effects and complications of flashlamp-pumped pulsed dye laser therapy of port-wine stains. A prospective study. Br J Dermatol 134:475-480, 1996.

18. Levine VJ, Geronemus RG: Adverse effects associated with the 577- and 585-nanometer pulsed dye laser in the treatment of cutaneous vascular lesions: A study of 500 patients. J Am Acad Dermatol 32:613-617, 1995

19. David LR, Malek MM, Argenta LC: Efficacy of pulse dye laser therapy for the treatment of ulcerated haemangiomas: A review of 78 patients. Br J Plast Surg 56:317-327, 2003

20. Park HS, Kim JW, Jang SJ, et al: Pulsed dye laser therapy for pediatric warts. Pediatr Dermatol 24:177-181, 2007

21. Antony FC, Cliff S, Cowley N: Complete pain relief following treatment of a glomangiomyoma with the pulsed dye laser. Clin Exp Dermatol 28:617-619, 2003

22. Hohenleutner S, Badur-Ganter E, Landthaler M, et al: Long-term results in the treatment of childhood hemangioma with the flashlamp-pumped pulsed dye laser: An evaluation of 617 cases. Lasers Surg Med 28:273-277, 2001

23. Alster TS: Improvement of erythematous and hypertrophic scars by the 585-nm flashlamp-pumped pulsed dye laser. Ann Plast Surg 32:186-190, 1994

24. Kono T, Ercocen AR, Nakazawa H, et al: Treatment of hypertrophic scars using a long-pulsed dye laser with cryogen-spray cooling. Ann Plast Surg 54:487-493, 2005

25. Hammes S, Greve B, Raulin C: Molluscum contagiosum: Treatment with pulsed dye laser. Hautarzt 52:38-42, 2001

26. Zuo YG, Wang JB, Jiang GT, et al: Flashlamp-pumped pulsed dye laser (585 nm) in the treatment of port-wine stains—a retrospective study of 2317 Chinese patients. Zhongguo Yi Xue Ke Xue Yuan Xue Bao 28:206-209, 2006

27. Tay YK, Weston WL, Morelli JG: Treatment of pyogenic granuloma in children with the flashlamp-pumped pulsed dye laser. Pediatrics 99:368-370, 1997

28. Tan E, Vinciullo C: Pulsed dye laser treatment of spider telangiectasia. Australas J Dermatol 38:22-25, 1997

29. Morelli JG: Use of lasers in pediatric dermatology. Dermatol Clin 16:489-495, 1998

30. Strauss RP, Resnick SD: Pulsed dye laser therapy for port-wine stains in children: Psychosocial and ethical issues. J Pediatr 122:505-510, 1993

31. Yong-Gee SA, Kurwa HA, Barlow RJ: Objective assessment of port-wine stains following treatment with the 585 nm pulsed dye laser. Australas J Dermatol 42:243-246, 2001

32. Orten SS, Waner M, Flock S, et al: Port-wine stains. An assessment of 5 years of treatment. Arch Otolaryngol Head Neck Surg 122:1174-1179, 1996

33. Nguyen CM, Yohn JJ, Huff C, et al: Facial port wine stains in childhood: Prediction of the rate of improvement as a function of the age of the patient, size and location of the port wine stain and the number of treatments with the pulsed dye (585 nm) laser. Br J Dermatol 138:821-825, 1998

34. Fiskerstrand EJ, Svaasand LO, Kopstad G, et al: Photothermally induced vessel-wall necrosis after pulsed dye laser treatment: Lack of response in port-wine stains with small sized or deeply located vessels. J Invest Dermatol 107:671-675, 1996

35. Reyes BA, Geronemus R: Treatment of port-wine stains during childhood with the flashlamp-pumped pulsed dye laser. J Am Acad Dermatol 23:1142-1148, 1990

36. van der Horst CM, Koster PH, de Borgie CA, et al: Effect of the timing of treatment of port-wine stains with the flash-lamp-pumped pulsed-dye laser. N Engl J Med 338:1028-1033, 1998

37. Troilius A, Wrangsjo B, Ljunggren B: Potential psychological benefits from early treatment of port-wine stains in children. Br J Dermatol 139:59-65, 1998

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

39. Chang CJ, Kelly KM, Van Gemert MJ, et al: Comparing the effectiveness of 585-nm vs 595-nm wavelength pulsed dye laser treatment of port wine stains in conjunction with cryogen spray cooling. Lasers Surg Med 31:352-358, 2002

40. Batta K, Goodyear HM, Moss C, et al: Randomised controlled study of early pulsed dye laser treatment of uncomplicated childhood haemangiomas: Results of a 1-year analysis. Lancet 360:521-527, 2002

41. Kono T, Sakurai H, Groff WF, et al: Comparison study of a traditional pulsed dye laser versus a long-pulsed dye laser in the treatment of early childhood hemangiomas. Lasers Surg Med 38:112-115, 2006

42. Kittler H, Pehamberger H, Wolff K, et al: Diagnostic accuracy of dermoscopy. Lancet Oncol 3:159-165, 2002

43. Carli P, De Giorgi V, Crocetti E, et al: Improvement of malignant/benign ratio in excised melanocytic lesions in the 'dermoscopy era': A retrospective study 1997-2001. Br J Dermatol 150:687-692, 2004

44. Anderson RR, Parrish JA: The optics of human skin. J Invest Dermatol 77:13-19, 1981

45. Marghoob AA: Congenital melanocytic nevi: evaluation and management. Dermatol Clin 20:607-616, 2002

46. Marghoob AA, Fu JM, Sachs D: Dermoscopic features of congenital melanocytic nevi, in Marghoob AA, Braun RP, Kopf AW (eds): Atlas of Dermoscopy. Boca Raton, FL, Parthenon, 2005, pp 141-144

47. Spitz S: Melanomas of childhood. Am J Pathol 24:591-609, 1948

48. Ilknur T, Fetil E, Akarsu S, et al: Angioma serpiginosum: Dermoscopy

for diagnosis, pulsed dye laser for treatment. J Dermatol 33:252-255, 2006

49. Segura S, Carrera C, Ferrando J, et al: Dermoscopy in epidermodysplasia verruciformis. Dermatol Surg 32:103-106, 2006
50. Di Stefani A, Hofmann-Wellenhof R, Zalaudek I: Dermoscopy for diagnosis and treatment monitoring of pediculosis capitis. J Am Acad Dermatol 54:909-911, 2006
51. Vazquez-Lopez F, Perez-Oliva N: Usefulness of the dermoscope for evaluating the depth of venular malformations. Pediatr Dermatol 22: 283, 2005 (letter)
52. Dupuy A, Dehen L, Bourrat E, et al: Accuracy of standard dermoscopy for diagnosing scabies. J Am Acad Dermatol 56:53-62, 2007
53. Zaballos P, Daufi C, Puig S, et al: Dermoscopy of solitary angiokeratomas: A morphological study. Arch Dermatol 143:318-325, 2007
54. Steiner A, Pehamberger H, Binder M, et al: Pigmented Spitz nevi: Improvement of the diagnostic accuracy by epiluminescence microscopy. J Am Acad Dermatol 27:697-701, 1992
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
56. Henderson BW, Dougherty TJ: How does photodynamic therapy work? Photochem Photobiol 55:145-157, 1992
57. Gold MH, Moiin A: Treatment of verrucae vulgaris and molluscum contagiosum with photodynamic therapy. Dermatol Clin 25:75-80, 2007
58. Kjeldstad B: Photoinactivation of *Propionibacterium acnes* by near-ultraviolet light. Z Nauturforsch 39:300-302, 1984