

What's New in Energy Sources: A Review

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The demand for nonablative laser and light technologies has been increasing within the field of dermatology as patients seek treatment for a multitude of skin conditions that offer minimal downtime and reduced adverse effects. Investigators continuously are studying these energy systems to determine their efficacy and define their optimal parameters of use for treating a variety of cutaneous disorders. This review article covers 2 widely used light technologies (photodynamic therapy and intense pulsed light) and their application in the treatment of medical and cosmetic skin conditions such as cutaneous neoplasms, acne, chronic photodamage, and unwanted hair. Radiofrequency and infrared light, 2 newer energy sources that show promise in photorejuvenation, also are discussed.

The use of light, both with and without photosensitizing agents, is widely practiced by dermatologists to treat a multitude of skin conditions. This review article addresses the primary indications for photodynamic therapy (PDT), intense pulsed light (IPL), and other innovative energy sources, as well as newer uses of these evolving technologies.

PHOTODYNAMIC THERAPY

PDT involves the activation of a photosensitizer by light, which generates highly reactive oxygen intermediates. These intermediates irreversibly oxidize cellular components, leading to tissue damage and necrosis. Because of the accessibility of skin to light, PDT has become an attractive treatment option in the field of dermatology. The main classes of photosensitizers are porphyrin derivatives, chlorines, phthalocyanines, and porphycenes.¹ The most widely used

photosensitizing agents for the treatment of cutaneous diseases are hematoporphyrin derivatives such as porfimer sodium and protoporphyrin IX—inducing precursors such as 5-aminolevulinic acid (ALA) and methyl aminolevulinic acid (MAL), an ester derivative of ALA.²

The absorption spectrum of porphyrins exhibits a peak in the Soret band (360–400 nm), followed by 4 smaller peaks between 500 and 635 nm (Q bands). Tissue penetration is maximal at 630 to 635 nm, which corresponds to the weakest of the peaks. Lasers or incoherent light sources incorporating the blue and/or red spectra, which correspond to one or more Q bands while allowing for sufficient depth of penetration, are used most often in PDT.²

The conversion of ALA to the active photosensitizer protoporphyrin IX occurs in epidermal cells via enzymes in the heme biosynthetic pathway. This conversion takes place at higher rates in rapidly proliferating skin cells and serves as the basis for the application of PDT in the treatment of actinic keratoses (AKs) and other cutaneous neoplasms as well as inflammatory skin disorders.^{3,4}

Cutaneous Precancers and Malignancies

MAL in combination with red light (wavelength, 635 nm) is approved in Europe for the treatment of basal cell carcinoma (BCC) and actinic keratosis (AK). In the United States, 20% 5-aminolevulinic acid (Levulan® Kerastick®) in combination

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with blue light (wavelength, 417 nm) is approved for the treatment of AK. Numerous studies support the therapeutic application of PDT for AK and other conditions such as Bowen disease and squamous cell carcinoma (SCC), and several reports indicate efficacy of PDT for the treatment of cutaneous and subcutaneous metastases (eg, breast carcinoma), mycosis fungoides, and Kaposi sarcoma.¹

For superficial BCCs less than 4 cm in diameter, complete response rates following 1 to 3 treatments with topical PDT (ALA and an incoherent light source) range from 60% to 100%.^{1,2} Likely secondary to reduced penetration, tumors greater than 4 cm in diameter, as well as nodular and ulcerated BCCs, generally show a poorer response to topical PDT (10%–80%).¹

AK is a cutaneous disorder that is particularly responsive to PDT; reported clearance rates range from 71% to 100% after a single treatment with ALA or MAL and incoherent red or blue light.² In a study conducted by Ruiz-Rodriguez et al,⁵ 17 subjects with evidence of AKs and chronic actinic damage received 2 monthly treatments of ALA (4-hour incubation) and IPL (wavelength, 590–1200 nm; 615-nm cutoff filter). At 1-month and 3-month follow-up, resolution rates for AKs were 76.3% and 91%, respectively.

A wide range of results has been reported with ALA-PDT for the treatment of Bowen disease, with clearance rates ranging from 30% to 100% after single or multiple (up to 10) treatments.¹ In a randomized phase 3 trial comparing ALA-PDT with topical 5-fluorouracil for the treatment of histologically proven Bowen disease in 40 subjects, complete response rates were 88% with PDT versus 67% with 5-fluorouracil.⁶ Similar to BCCs, superficial SCCs are more responsive than nodular SCCs to ALA-PDT, with reported complete clearance rates of 67% to 92% for superficial SCCs versus 0% to 67% for nodular SCCs.¹

The original clinical trials leading to US Food and Drug Administration approval of PDT for the treatment of cutaneous neoplasms such as AKs used ALA incubation times ranging from 14 to 18 hours prior to light exposure.³ Investigators are examining newer protocols that would shorten this incubation time to 1 to 4 hours, and some are attempting to shorten ALA incubation time to 15 minutes in an effort to increase patient convenience and tolerability while maintaining therapeutic efficacy.

Photoaging

Because many patients with AKs and cutaneous malignancies have other signs of chronic photodamage (eg, solar lentigines, rhytides, telangiectases, skin laxity), investigators have begun to examine the efficacy of PDT for photorejuvenation. A postulated mechanism by

which PDT may be beneficial in the treatment of chronic actinic damage is via increased photosensitizer conversion within hypermetabolic cells, such as melanocytes and fibroblasts, which leads to cellular damage and a subsequent decrease in pigmentary abnormalities and solar elastosis.⁷

Results of a retrospective review of 17 subjects treated with ALA and IPL reported a 55% improvement in telangiectases, a 48% improvement in pigmentary irregularities, and a 25% improvement in skin texture.⁸ However, minimal improvement in fine rhytides occurred following treatment.

In a study by Touma et al,⁹ 18 subjects with AKs and mild to moderate diffuse solar damage as measured by the Griffiths photonumeric scale¹⁰ received a single treatment of ALA (1- to 3-hour incubation) and blue light (peak output, 417±5 nm; fluence, 10 J/cm²). At 1-month follow-up, statistically significant improvements of 0.5 to 1.0 grades ($P<.001$) in skin quality and blended score of all parameters of photodamage were observed. More specifically, statistically significant improvements of a 0.7 grade in Griffiths score ($P<.006$), 1.2 grade in fine wrinkling ($P<.002$), 1.5 grade in sallowness ($P<.001$), and 1.1 grade in mottled pigmentation ($P=.05$, borderline significance) were observed. Additionally, in the 10 subjects seen at 5-month follow-up, further improvements in Griffiths score and sallowness were noted. Overall satisfaction was high, with 6% (1/17) of subjects rating their response to treatment as excellent, 76% (13/17) as good, and 18% (3/17) as fair.⁹

Results of a prospective study of 10 subjects treated 3 times at monthly intervals with short-contact full-face 20% ALA solution (incubation, 30–60 minutes) followed by IPL (wavelength, 500–1200 nm) reported an 85% response rate of targeted AKs at 1- and 3-month follow-up.¹¹ Additionally, 90% of subjects showed a greater than 75% overall improvement in chronic photodamage compared with baseline. Improvements in pigmentary alteration and facial erythema were seen in 90% and 50% of subjects, respectively.¹¹

Goldman et al¹² treated 32 subjects with multiple AKs and moderate actinic damage with short-contact (1-hour incubation) full-face ALA and blue light. At the end of the 6-month trial, 90% clearance of AKs was observed. Additionally, 72% of subjects also experienced improved skin texture and 59% experienced improved skin pigmentation.¹²

Sebaceous hyperplasia often is a presenting sign of photoaging and has been shown in one study to be responsive to treatment with ALA-PDT.¹³ Twelve subjects with sebaceous hyperplasia were randomized to receive ALA (30- to 60-minute incubation) and blue light (wavelength, 405–420 nm) or IPL (wavelength, 500–1200 nm) monthly

for 4 months. Clinical evaluation at 4 weeks and 12 weeks following the final treatment showed a greater than 50% reduction in sebaceous hyperplasia lesions for all subjects, with no recurrence during the study period.¹³

A recent split-face comparison study examined the photorejuvenation effects of 20% ALA and IPL versus IPL alone in 10 subjects and reported higher clinical improvement scores on the facial halves treated with combination ALA and IPL than the halves treated with IPL alone.¹⁴ Although larger comparative studies are needed, these preliminary results indicate that a cosmetic benefit may be derived from the addition of a photosensitizing agent versus light energy alone.

PDT with ALA (1- to 3-hour incubation) in conjunction with IPL or blue light is an effective noninvasive method of photorejuvenation; this treatment protocol has been shown to improve numerous visible signs of chronic actinic damage, including mottled pigmentation, telangiectasia, sebaceous hyperplasia, and overall skin texture.

Acne

The use of topical PDT in the treatment of acne is based in part on the observation that many patients report an improvement in their acne following sun exposure. It has been shown that *Propionibacterium acnes*, the organism implicated in the pathogenesis of inflammatory acne lesions, contains endogenous porphyrins (particularly coproporphyrin III) which may act as selective targets for visible light and lead to a photodynamic reaction and the subsequent destruction of the bacteria.¹⁵ The preferential accumulation of ALA in the pilosebaceous units provides a potential mechanism by which PDT is effective in the treatment of inflammatory acne lesions.⁷

In a randomized, open-controlled trial of 22 subjects, Hongcharu et al¹⁶ found a statistically significant ($P < .05$) reduction in inflammatory acne lesion counts for 10 weeks following a single treatment with ALA (3-hour incubation) and broadband light (wavelength, 550–700 nm; fluence, 150 J/cm²) and for at least 20 weeks following multiple ALA-PDT treatments. On histopathologic evaluation, sebaceous glands were found to be smaller and damaged, and decreased sebum excretion was maintained for 20 weeks.¹⁶

Results of a study by Gold et al¹⁷ reported an approximate 50% mean clearance rate of inflammatory acne lesions in 12 of 15 subjects treated with ALA (1-hour incubation) and IPL (wavelength, 430–1100 nm; fluence, 9 J/cm²) after 4 weekly treatments, a 68.5% rate at 4 weeks posttreatment, and a 71.8% rate at 12 weeks posttreatment.¹⁷

A study of 10 subjects with mild to moderate acne examined the effects of ALA-PDT (incubation, 3 hours; wavelength, 635 nm; fluence, 15 J/cm²) versus red light

from a diode laser alone (wavelength, 635 nm; fluence, 15 J/cm²), ALA alone (3-hour incubation), and an untreated control applied to each individual at random sites on the back.¹⁵ Study results found a statistically significant ($P < .001$) reduction in mean acne lesion counts (11.6 vs 3.6) after 3 weekly treatments with ALA-PDT. Although there also were reductions in mean lesion counts following light alone, ALA alone, and control, these were not statistically significant. No statistically significant difference in sebum excretion or in *P acnes* reduction was observed between the 4 sites.¹⁵

Although these and other studies support a role for PDT in the treatment of inflammatory acne vulgaris, the mechanisms by which PDT is effective and optimal therapeutic parameters (ie, number and timing of treatments, wavelength, and fluence) have not yet been determined. Initially, it was postulated that ALA-PDT was effective in the treatment of inflammatory acne lesions via reduction of sebum excretion and *P acnes* counts; however, the studies cited in this article provide conflicting data. Other possible mechanisms, such as reduction of follicular obstruction or damage to rather than destruction of *P acnes* within the pilosebaceous units, have been proposed.^{14,15}

OTHER CONDITIONS RESPONSIVE TO PDT

In a small prospective study of MAL (4-hour incubation) and red light (wavelength, 632 nm; fluence, 37 J/cm²) therapy, clinical remission of papulopustular rosacea ranging from 3 to 9 months was observed in 3 of 4 subjects following 2 treatments.⁴ In another study, 75% to 100% improvement rates were reported for up to 3 months following treatment of hidradenitis suppurativa in 4 patients with short-contact (30 minutes to 1 hour) ALA and blue light.¹⁸ Prior to this, the successful treatment of 2 patients with recalcitrant familial benign pemphigus (Hailey-Hailey disease) was reported with ALA (4-hour incubation) and an incoherent light source (wavelength, 590–700 nm). Following 2 treatments (2 months apart), both patients achieved clinical remission for 19 and 25 months, respectively.¹⁹

ADVERSE EFFECTS OF PDT

The most common adverse effects of PDT are stinging or burning during treatment and the development of urticated erythematous plaques immediately following treatment that last an average of 1 to 2 hours.¹⁵ Moderate to severe phototoxic reactions consisting of erythema, edema, and crusting may occur, usually one day following PDT treatment; these conditions generally heal spontaneously within 2 to 8 weeks.²⁰ PDT also may induce postinflammatory hypopigmentation and hyperpigmentation; however, these

pigmentary changes tend to resolve within several months following treatment.²⁰

Of some concern is the use of PDT for cosmetic applications in which generated reactive oxygen species in theory may be carcinogenic. Few current protocols use scavenger systems to attempt to reduce this potential risk. This concern is tempered by the relative specificity of the applied photosensitizer to rapidly dividing cells such as those involved in cutaneous neoplasms and inflammatory conditions, which may be more common in photodamaged skin. Additionally, it is well established that PDT works as a result of damage induced by generated reactive oxygen species, the efficacy of which may be hindered by the concurrent use of scavenger systems. The literature contains no reports of cutaneous malignancies related to PDT treatment. With further widespread use and long-term follow-up of patients receiving PDT, more definitive data on the carcinogenic risk of PDT will become available.

INTENSE PULSED LIGHT

IPL systems differ from laser technology in that they emit noncoherent light in a broad wavelength spectrum (515–1200 nm). Both IPL and laser systems are effective for treating cutaneous disorders via the well-described principle of *selective photothermolysis* whereby different cutaneous and subcutaneous target structures display specific absorption peaks. Hemoglobin absorbs light energy primarily at a wavelength of 580 nm, whereas melanin absorbs the entire visible range (400–750 nm). Longer wavelengths within the visible spectrum also provide deeper penetration. Thus, wavelengths also may be adjusted to the depths of target structures such as vessels, hair follicles, and pigmented lesions.²¹

Photoaging

The precise mechanism of action of IPL in the repair of photodamage is unclear. It has been proposed that IPL systems cause small vessel coagulation, epidermal necrosis limited to sites of hyperpigmentation, and heating of the upper dermis to stimulate a wound-healing response and deposition of new collagen.²²

Twenty-three female subjects with photodamage and/or rosacea were treated with IPL (EsteLux® Pulsed Light System) using double-stacked pulses and fluences of 24 J/cm² or 30 J/cm².²³ Decreases in clinical grades (mild, moderate, or severe) of skin roughness, hyperpigmentation/solar lentigines, and telangiectases/erythema were noted at baseline and 1 month after 3 treatments. A diminution in pore size also was noted following IPL. This finding was attributed as likely being secondary to a smoothing of the ostium of the follicular infundibulum.²³

Bitter²⁴ examined the effects of nonablative treatment of photodamage and rhytides in a study using full-face IPL (VascuLight™) in 49 subjects. Using wavelength cutoff filters of 550 or 570 nm, double- or triple-stacked pulses at fluences ranging from 30 to 50 J/cm² were administered for 4 to 6 sessions at 3-week intervals. Subjects reported a 50% or greater improvement in skin smoothness (72%), telangiectasia (70%), erythema (59%), and fine wrinkles (46%). Additionally, more than 60% of patients reported at least a 50% improvement in flushing and pore size. Overall improvement in skin appearance by self-evaluation was rated as 50% or greater in 75% of the treated subjects.²⁴

Weiss et al²⁵ performed a retrospective analysis of 80 subjects treated with IPL (median of 3 treatments) for actinic damage at various anatomic sites. Results were obtained at 4-year follow-up as measured by photographs and patient self-assessments. Improvements in skin texture, telangiectasia, and pigmentation were reported in 83%, 82%, and 79% of subjects, respectively. Facial skin was more responsive to IPL therapy than skin of the chest and neck.²⁵

In a study evaluating the efficacy of IPL for photorejuvenation in Asian populations, 97 subjects were treated with VascuLight (fluence range, 28–32 J/cm²) for a maximum of 6 sessions.²⁶ More than 65% of subjects rated improvement in skin texture as good or excellent.^{26,27} In a study of 30 subjects treated with IPL for photoaging, all subjects demonstrated some improvement but none showed complete resolution of rhytides.^{27,28}

Hernandez-Perez and Ibieta²⁹ conducted a prospective study of 5 women with Fitzpatrick skin types III to IV treated with full-face IPL (VascuLight Plus) bimonthly for 5 sessions. Posttreatment skin biopsy results showed overall microscopic improvement in all examined epidermal parameters (ie, atrophy, horny plugging, loss of polarity, basal cell liquefaction, and rete ridge flattening). Dermal damage also improved as indicated by a decrease in histopathologic evidence of elastosis, edema, telangiectasia, and inflammation.²⁹

IPL is an effective modality in photorejuvenation, improving multiple clinical signs of photodamage including fine rhytides, telangiectasia, erythema, pigmentary changes, and overall skin texture. Additionally, as evidenced by several of the studies cited in this article, overall patient satisfaction following IPL therapy is high.

Photoepilation

One suggested mechanism of action for IPL in the treatment of unwanted hair is that of *thermokinetic selectivity*[™] whereby thermal damage is concentrated in the follicular papilla, germinative cell layer, and bulge at the preserved hair follicles, which leads to interruption of normal hair growth. Other studies postulate that damage to the hair follicle and shaft

specifically during the anagen phase (secondary to increased melanization during that phase) results in sustained interference in the normal hair growth cycle.^{21,30}

Sadick et al³⁰ used an IPL system (EpiLight[®]) with broad-spectrum radiation (wavelength, 550–1200 nm) for photoepilation of various anatomic sites in 34 subjects with Fitzpatrick skin types II to V. A series of 2 to 5 mini pulses was administered at fluences of 34 to 42 J/cm² for 3 or more treatments at monthly intervals. The mean hair removal efficiency, which is the percentage of the number of hairs present compared with baseline, was 76% (“excellent”) after a mean of 3.7 treatments. A subgroup of subjects seen at 30-month follow-up continued to show improvement, with a mean hair removal efficiency of 92% ± 12%.³⁰

Similarly, a multicenter study of 40 subjects treated with IPL (PhotoDerm[®] VL) for unwanted facial hair revealed a mean reduction of 76.6% over a 3-month follow-up period after an average of 6 sessions (mean wavelength, 585 nm; average fluence, 38.7 J/cm²).^{21,30} Another study examined the efficacy of a second-generation broad-spectrum IPL system (Ellipse Relax Light) in 10 female subjects with Fitzpatrick skin types II to IV for hair removal in the groin region administered as 4 monthly treatments (wavelength, 600–950 nm; mean fluence, 18.3 J/cm²). Mean hair removal efficiencies were reported as 74.7% and 80.2% at 4-month and 8-month follow-up, respectively.^{21,31}

The studies cited in this article demonstrated good results with IPL for the treatment of unwanted hair. Most studies report an average 75% reduction in hair after relatively few treatments (3–6 sessions) and sustained results at 3 to 30 month follow-up visits.

OTHER CONDITIONS RESPONSIVE TO IPL

IPL has been reported to be effective in treating a variety of other skin disorders including capillary and venous malformations, essential telangiectasia, and poikiloderma of Civatte.²¹ In one study, 4 subjects with rosacea-associated erythema and telangiectasia were treated with IPL (PhotoDerm VL) using a 515-nm filter, 3-ms pulse duration, and 22 to 25 J/cm² fluence range for 5 sessions at 3-week intervals.³² Scanning laser Doppler images showed an average 30% decrease in blood flow following IPL therapy. Results of photographic evaluation and computer-generated image analysis demonstrated a 29% and 21% decrease in telangiectasia and erythema intensity, respectively.³²

IPL has been reported to be effective in the treatment of late-stage striae distensae of the abdomen. In a prospective study of 15 subjects with Fitzpatrick skin types III to IV, IPL was administered bimonthly for 5 sessions.³³ Study results

found a decrease in the average number of striae from 7.80 to 6.26 per patient. Histopathologic analysis from punch biopsy specimens of striae pretreatment and posttreatment showed an overall decrease in epidermal atrophy, elastosis, edema, inflammation, and dermal collagen damage.³³

Results from a recent pilot study found that IPL was equally as effective as the long-pulsed pulsed dye laser in improving the appearance (mean improvement range, 65%–80% after 2 treatments with either IPL or long-pulsed pulsed dye laser) of 15 hypertrophic surgical scars.³⁴ The incidence of posttreatment purpura also was lower with IPL; however, patients reported more discomfort with IPL compared with long-pulsed pulsed dye laser.³⁴

ADVERSE EFFECTS OF IPL

Patients receiving IPL may experience sensations of warmth, burning, or pain during treatment; however, with the use of cooling devices, topical anesthesia typically is unnecessary.^{21,23} The most common side effect of IPL is mild transient erythema that lasts 2 to 48 hours and that occasionally is accompanied by edema of the treated areas.²¹ Temporary darkening of lentigines frequently has been reported with IPL treatment.²³ There also have been reports of transient purpura, crusting, and pigmentary alterations following IPL treatment; this reaction usually occurs in patients with darker or tanned skin or in patients treated for hypertrichosis.²¹ Additionally, a rare paradoxical effect of increased hair growth at sites treated with IPL epilation has been described.³⁵

OTHER ENERGY SOURCES

Newer energy sources recently have been introduced for the treatment of rhytides, photodamage, photorejuvenation, and face lifting. Radiofrequency sources deliver radiofrequency electrical energy to rapidly heat deep structures and produce rapid dermal collagen remodeling effects, as well to produce what is thought to be immediate tissue tightening.³⁶ Radiofrequency energy is delivered as a current of ions that interacts with tissue to produce thermal effects. It is thought that selective heating and tightening of fibrous treads that run through fat is responsible for the visible contouring changes observed clinically following radiofrequency treatment.³⁷ The major advantage of radiofrequency technology over light-based systems is that it does not rely on the interdependence of treatment efficacy and levels of a targeted chromophore. Thus, radiofrequency extends the use of energy sources to a greater range of skin types.

Radiofrequency technology is available in monopolar and bipolar energy delivery. Most available systems are monopolar, such as the popular ThermoCool[™] system. Recent reviews have addressed the use of ThermoCool for cosmetic applications.^{34,35} This system delivers 6 Hz of

alternating current radiofrequency energy to the skin via a thin capacitive membrane that distributes energy over the volume of tissue in the treatment area, which leads to heating of tissue through its resistance to the flow of electrical current. Cryogen spray built into the unit protects the epidermis from thermal damage.

In one study, 86 subjects aged 35 to 70 years with a wide range of skin phototypes were treated once with the ThermoCool system for periorbital rhytides and skin laxity; 83.2% (99/119) of treated periorbital areas evaluated at 2, 4, and 6 months posttreatment showed at least 1 level of improvement, as measured by the Fitzpatrick wrinkle classification scheme.³⁸

Further studies must be conducted to quantify the effectiveness of the ThermoCool system for skin tightening. In a split-face trial, 10 subjects were treated on the left side of the face and were followed to measure the extent of improvement in the superior palpebral crease, brow position, angle of the eyebrow, and jowl surface area.³⁹ All subjects showed significant improvement ($P < .001$). Specifically, a mean 1.9-mm elevation in the superior palpebral crease, 4.0-mm elevation in the brow position, and 22.6% decrease in the jowl surface area on the left (treated) side was observed. In contrast, no changes were observed on the right (untreated) side.

The efficacy of ThermoCool for the treatment of acne scarring also has been examined. Twenty-two subjects aged 16 to 28 years with moderate to severe acne scarring and cystic active acne received either 1 or 2 treatments (average fluence, 72 J/cm²) with the ThermoCool device. Eighty-two percent of subjects (18/22) had an excellent response to treatment; 9% (2/22) had a modest response; and 9% (2/22) had no response.⁴⁰

The application of radiofrequency to skin resurfacing also has shown favorable results. The Visage System™ uses monopolar radiofrequency in a process coined "coblation" (short for cold ablation) of unwanted epidermal structures in a resurfacing fashion. A study of 95 subjects with mild to severe photodamage were treated with up to 2 passes for class I rhytides (Fitzpatrick wrinkle classification) and up to 3 passes for class II and III rhytides at power settings of 125 to 139 V on the radiofrequency resurfacing system.⁴¹ Results showed an improvement in rhytides that correlated with the use of higher power settings and number of passes. The degree of improvement in this study was noted to correlate with the severity of baseline rhytides. Within 7 days, 90% of the treated areas were reepithelialized; adverse effects included transient postinflammatory hyperpigmentation in 26% of periorbital sites and 4% of perioral sites.⁴¹

Several other newer systems have combined radiofrequency with light sources for cosmetic applications. The

main advantage that these hybrid units offer is the ability to select reduced fluences for the optical source that is safe for all skin phototypes, while compensating for the reduced optical or laser energy can be achieved with electrical radiofrequency energy. Examples of such systems include the Aurora™ DS, which combines IPL with radiofrequency for the removal of unwanted hair, and the Polaris™ LV, which combines a bipolar radiofrequency source with a 900-nm diode laser for the treatment of leg veins. Many other units are available for the treatment of unwanted hair, telangiectases of the lower legs, rhytides, and photodamage. Given the success in clinical trials of existing modalities, it is likely that several new hybrid systems will become available with enhanced safety profiles.

Similar to the development of IPL systems in which filters are used to select particular visible band widths of light for clinical applications (particularly cosmetic), newer infrared sources that are noncoherent in the infrared range also have been developed. Most notable is the Titan™ infrared light device, which emits light in the 1100- to 1800-nm wavelength range. This device is used predominantly for skin tightening and facial contouring, with the main advantage of being significantly less painful than other devices used for similar applications. Immediate posttreatment erythema is minimal.⁴²

CONCLUSION

Energy sources may be applied to a multitude of skin conditions, both medical and cosmetic. PDT and IPL are effective for the treatment of many of the visible signs of chronic photodamage (particularly mottled pigmentation, telangiectasia, sebaceous hyperplasia, and rough skin texture) without significant adverse effects. Although these technologies have not demonstrated great success in the reduction of rhytides, newer energy sources such as radiofrequency systems show promise for the improvement of wrinkles and overall skin laxity. Other common skin conditions such as acne, rosacea, and unwanted hair also are highly amenable to nonablative light therapies.

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