Phototherapy

Rebecca Bialas, MD, MPH

Phototherapy Modality	Peak Wavelength (nm)	Mechanism of Action	Uses	Dosing	Adverse Effects	Notes
Excimer Laser	308	UV light absorbed by chromophores (nuclear DNA) → forms DNA photoproducts like **pyrimidine dimer**s, decreased cellular proliferation, T cell apoptosis, suppression of LHC	Recalcitrant psoriatic lesions, especially those on palms, soles, knees, elbows	Use high multiple of MED (4-6 times MED) to treat lesions only. Fewer treatments required than NB-UVB	Theoretically less risk of carcinogenesis as only lesional skin treated.	Expensive, spot size 2 cm2
Narrowband UVB	311-313		Psoriasis, especially guttate; CTCL: patch > plaque; Vitiligo (as effective as PUVA with fewer side effects and better color match); Atopic dermatitis (UVA/UVB combo); Pruritus – hepatic, idiopathic	**Dosed in mJ/cm2** Determine MED, initial dose = 70% of MED. Increase by 20-40% per visit with goal of minimally perceptible erythema after treatment. Hold for painful erythema +/- bullae; continue until clear. Consider maintenance x 2 mo.	**Erythema** after 4-6 hrs, peaks at 12-24 hrs; xerosis; increased frequency of HSV infections; **photoaging**; **carcinogenesis** (no studies but in general carcinogenic potential lower than with PUVA)	Safe in pregnant women and children
UVA 1	340-400	T cell apoptosis, decreased number of LHC and mast cells in dermis; increased collagenase expression; Able to penetrate more deeply to dermal structures including vessels	MF, atopic dermatitis, cutaneous mastocytosis, localized scleroderma, acute and chronic sclerodermoid GVHD	Determine MED for UVA1, start dose at MED. Subsequent protocols vary. One treatment cycle per year consisting of 10-15 exposures total	Delayed erythema, photoaging, carcinogenesis	Use for diseases with periods of severe, acute flares
Psoralen + UVA (PUVA)	352	Psoralen intercalates into DNA and excitation by UVA → **pyrimidine cross-linking, ROS**; therapeutic effect speculative – decreases cellular proliferation, T cell apoptosis, suppression of LHC, stimulation of melanocytes	Psoriasis, vitiligo, CTCL (MF stages IA-IIA), AD (high recurrence), generalized LP, acute & chronic GVHD, (lichenoid and local sclerodermoid variants), urticaria pigmentosa, PLEVA/PLC, LyP, generalized GA, localized scleroderma and pansclerotic morphea; as hardening in PMLE and solar urticaria	**Dosed in J/cm2** Oral PUVA: **8-MOP 0.4-0.6 mg/kg PO 1-2 hrs (peak plasma conc at 1.5 hrs)** before exposure (5-MOP 1.2-1.5 mg/kg). Initial dose based on Fitzpatrick skin type and increases by 0.5 J/cm2 intervals from 0.5 J/cm2 in Type I to 3.0 J/cm2 in Type VI. 2-4 treatments per week, increase dose by 30%, dose adjustments at least 72 hrs apart. No minimally perceptible erythema required for success.	**Ocular toxicity**: psoralen in lens for up to 12h after ingestion; avoid sun exposure for 24h after PUVA treatment. **Erythema** after 24-36 hrs, peaks at 48-96 hrs; diffuse hyperpigmentation; **PUVA lentigines**; n/v with 8-MOP > 5-MOP; stinging/pruritus; **photoaging**; **carcinogenesis** (SCC, no definitive studies for BCC or melanoma)	Bath and topical PUVA also available **Safe in HIV** In psoriasis, can combine with topicals, retinoids, but NOT CSA – increased risk skin carcinogenesis Contraindicated in pregnancy (cat C) and children < 12 (lens more permeable)
Extracorporeal Photochemotherapy	320-400 (UVA range)	Blood collected, WBCs separated from RBCs, plasma; 8-MOP added to WBCs, exposed to UVA light, cells re-infused with RBCs and plasma; MOA unclear, possibly induces immune response against malignant cells and apoptosis of autoreactive T cells	CTCL (erythrodermic), Sezary syndrome, autoimmune dermatoses (PV, PF, EBA, scleroderma), GVHD	WBCs exposed to UVA irradiation at 2 J/cm2. Repeated on 2 successive days; 2 day cycle repeated monthly	Nausea if 8-MOP ingested PO; hypotension and vasovagal reflex due to fluid shifts in treatment	

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Phototherapy (cont.)

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Blue Light Photodynamic Therapy	410 (Soret band)	Topical 5-ALA or MAL metabolized to **protoporphyrin IX** (higher amounts found in tumor cells); with exposure to red or blue light, ROS generated and locally destroy intercellular structures **(in ALA, porphyrins localize to mitochondria)** → cell apotosis or necrosis Blue light: Blu-U device Red light: Aktilite device	Non-hypertrophic AK, acne (red light), photoaging, superficial BCC, SCCis when surgery not optimal	Degrease skin with acetone scrub. Apply ALA to entire tx area, incubate 1-2 hrs. Expose to blue light to 10 J/cm2. Retreat at 4-8 wks if needed.	Excessive phototoxic reaction Hyperpigmentation at treated sites (resolves with time)	Sunscreen with physical blocker for next 48 hours MAL is more lipophilic than ALA, allowing deeper tissue penetration Cream preparation contains peanut and almond oils Pregnancy: cat. C
Red Light Photodynamic Therapy	635			Degrease skin with acetone scrub. Apply MAL to individual lesions under occlusion, incubate 3 hrs, and expose to red light to 37 J/cm2. Retreat in 7 days if needed.		

References:

Bolognia JL, Jorizzo JL, Schaffer JV. Dermatology, 3rd edition. Elsevier, 2012.

Wolverton SE. Comprehensive Dermatologic Drug Therapy, 3rd edition. Elsevier, 2013.

Abbreviations used:

ROS = reactive oxygen species
8-MOP = 8-methoxypsoralen
5-MOP = 5-methoxypsoralen
TMP = 4,5,8-trimethylpsoralen
CTCL = cutantous T-cell lymphoma
LHC = Langerhans cell
5-ALA = 5-aminolevulinic acid
MAL = methyl aminolevulinate
CSA = cyclosporine A
MED = minimal erythema dose
LyP = lymphomatoid papulosis
GA = granuloma annulare
PMLE = polymorphic light eruption
PV = pemphigus vulgaris
PF = pemphigus folicaeus
EBA = epidermolysis bullosa acquisita
GVHD = graft-vs-host disease