Reprinted from Skin Cancer Foundation Journal Vol. XXX, 2012

Ready To Wear Sun Protection
Clothing Fits the Bill

PETER GIES, PHD, AND ALAN MCLENNAN, NZCS

What's the best way to protect yourself from the sun's harmful ultraviolet rays (UVR), given that we need to work, travel, and sometimes play outside? Clothing is the most basic and generally the best means of sun protection. Not all clothing is equal, however, and some of it isn't actually very good at protecting us. So, what makes a piece of clothing sun-safe?

MORE IS MORE

The sun damage done to every exposed part of your body is cumulative over your lifetime, continually adding to your risks of premature skin aging and skin cancer. So, to put it simply, the more skin you cover, the better. A long-sleeved shirt covers more skin than a T-shirt, especially if it has a high neckline or collar that shields the back of the neck; long pants cover more skin than shorts. A wide-brimmed hat protects more of the face than a baseball cap, and close-fitting wraparound sunglasses protect more of the area around the eyes than small lenses do. Cover up.

The sun damage done to every exposed part of your body is cumulative over your lifetime, continually adding to your risks of premature skin aging and skin cancer.

FABRIC FACTORS

Of course, you can have clothing over every square inch of your body, but if the sun goes right through it, it's not much use. Fabrics are made of tiny fibers woven or knitted together. Under a microscope, we can see lots of spaces between the fibers; UV can pass directly through these holes to reach the skin. The tighter the knit or weave, the smaller the holes and the less UV can get through. Twill, used to make tweeds or denim, is an example of a tightly woven fabric. Open weave fabrics provide much less protection. **[Figure 1, p.71]**

Fabrics can be made from many types of fibers, including cotton, wool, and nylon. Most fibers naturally absorb some UV radiation, and some have elastic threads that pull the fibers tightly together, reducing the spaces between the holes. Synthetic fibers such as polyester, lycra, nylon, and acrylic are more protective than bleached cottons, and shiny or lustrous semi-synthetic fabrics like rayon reflect more UV than do matte ones, such as linen, which tend to absorb rather than reflect UV. Finally, consider the fabric's weight and density — light, sheer silk gauze will provide far less UV protection than heavy cotton denim.[1,2,3]

COLOR COMPARISONS

Most of our clothing is dyed attractive or functional colors. Many dyes absorb UV, which helps reduce exposure. Darker colors tend to absorb more UV than lighter colors, including whites and pastels, but bright colors such as red can also substantially absorb UV rays.[3] The more vivid the color, the greater the protection; a bright yellow

UPF, a concept originally standardized in Australia in 1996, stands for ultraviolet protection factor, which quantifies how effectively a piece of clothing shields against the sun.

shirt is more protective than a pale one. But even a pale fabric can offer good protection if the weave, material, weight, etc. are effective at keeping out UV. And many white fabrics have "optical whitening agents," chemical compounds that strongly absorb UVR, especially UVA.[1,2]

UPF RATING

Though loosely evaluating fabric content, color, weight and weave by eye are helpful at sizing up UV protection, it is difficult to pinpoint just how protective a piece of clothing is simply by looking at it. Holding it up to the light helps show how much light passes through, but this isn't ideal, because the human eye sees visible light but not UV radiation.[2]

One solution is to choose garments with UPF labels. UPF, a concept originally standardized in Australia in 1996, stands for ultraviolet protection factor, which quantifies how effectively a piece of clothing shields against the sun.[4] The label means the fabric has been tested in a laboratory and consumers can be confident about the listed level of protection. It is based on the content, weight, color, and construction of the fabric, and indicates how much UV can penetrate the fabric. For instance, a shirt with a UPF of 50 allows just 1/50th of the sun's UV radiation to reach your skin. This would provide excellent sun protection, in contrast to a thin white cotton T-shirt, which has a UPF of about 5, which allows 1/5th of the sun's UV through — even more when wet. In studies done in Australia,

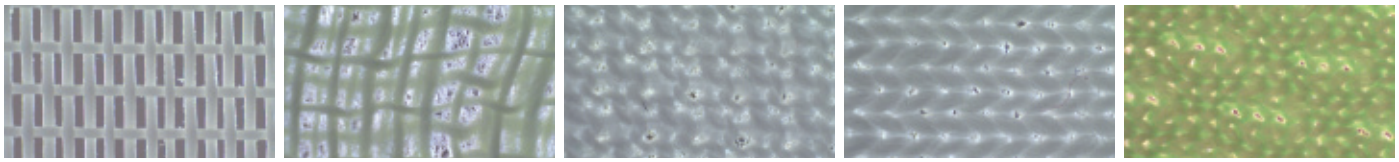

Figure 1: Five examples of real fabrics, all with different amounts of fiber or yarn per unit of surface area and providing different amounts of sun protection. The higher the UPF (ultraviolet protection factor), the greater the protection.

lycra/elastane fabrics were the most likely to have UPFs of 50 or higher, followed by nylon and polyester.[3] **[Figure 2]**

Today, systems for testing and determining UPF are similar around the world. In many countries, including the US, the ASTM International (formerly called the American Society for Testing and Materials) criteria for UPF assessment are used; UPF labels in the US often state that an item meets ASTM International standards.

Does all of this mean that everyone should specifically buy UPF-tested/UPF-labeled clothing, which most often carries a brand name? Is it so superior to everyday clothing that it is worth the extra expense and trouble to find? Not necessarily. Some items of clothing, such as denims and corduroys, are among the most sun-protective of all garments, UPF labels or not. However, a specially made high-UPF shirt, say, with long sleeves and a double layer of fabric at the shoulders — a high UV exposure area — might be constructed with a lightweight material that gives the wearer superior comfort and coolness as well as added sun safety. And the UPF label always adds a measure of certainty.

DO-IT-YOURSELF

As an alternative, consumers themselves can improve a piece of clothing's UPF. First, wash it. This generally makes the garment shrink slightly, closing up holes in the fabric that can let UV radiation in. Tests have also shown that you can wash in extra protection and raise the UPF with UV-filtering dyes and other additives.[1,2]

Here are some key tips for buying and staying sun-safe with clothing:

1. Buy garments that suit your purpose. You don't need a heavy work shirt for the beach, but a long-sleeved, tightly woven linen shirt can be both cool and sun-smart.

2. If you are buying elastic garments like leggings, make sure you purchase the right size — overstretching will lower the UPF rating.

3. Look for garments with a UPF of at least 30 so that you know you're getting effective sun protection.

4. Choose garments that cover more skin—there's no point in a high-UPF bikini. Instead, consider a rash guard or swim shirt. Made of lightweight, elastic materials like spandex, these athletic tops will cover your upper body without weighing you down. You can also have beach skirts or sarongs ready for when you leave the water.

5. Wash new garments made from cotton or cotton blends two or three times at least. This can often permanently raise the UPF rating due to shrinkage of the spaces between the fibers.

6. Select wide-brimmed hats (at least 3" in diameter) that shade your face, neck and ears.

7. When outdoors, seek out shaded areas under awnings or trees and minimize your time in the direct sun.

8. Be aware that UV light can bounce off surfaces such as water, snow and glass, hitting your skin twice and increasing the intensity of exposure.

9. Use UV-filtering sunglasses and sunscreen with a sun protection factor (SPF) of at least 15 for everyday incidental exposure and 30 or higher for extended exposure. Apply sunscreen on all exposed areas — clothing can't cover everything.[5]

Remember, sun-protective clothing doesn't have to be boring: it can be light and bright and fashionable and fun. And when chosen and used correctly, it's the best form of sun protection you can find. ■

DR. PETER GIES *is Senior Research Scientist, Ultraviolet Radiation Section, Non Ionizing Radiation Branch, Australian Radiation Protection and Nuclear Safety Agency. Key focuses for Dr. Gies are measurement of ultraviolet radiation (UVR), including solar UVR; hazard assessment of UVR sources; assessment of protective measures (sunglasses, hats, clothing, materials, car windows and sunscreens); and personal exposure studies of various population groups using polysulphone film dosimetry and time-stamped electronic UV dosimeters. Dr. Gies is a member of Standards Australia committees on Sunglasses and Fashion Spectacles, Sunscreens, Sun Protective Clothing, and Solaria. Formerly Chairman of the Commission Internationale d'Eclairage Technical Committee TC 6-29 "UV Protection and Clothing," he has authored more than 115 scientific publications.*

ALAN MCLENNAN *is Senior Technical Officer in the Ultraviolet Protection Factor Testing Service at the Australian Radiation Protection and Nuclear Safety Agency.*

References available on p.97.

Figure 2: (A) Because they spend so much time in the sun, Australian lifeguards wear uniforms that have been tested and rated UPF 50+. Wide-brimmed hats and UV-filtering sunglasses are standard wear as well. **(B)** The importance of reducing UV exposure early in life is emphasized in Australia, so school uniforms generally provide excellent sun protection as well. *Images supplied courtesy of Queensland Health 2010.*

20 Dawson-Hughes B, Mithal A, Bonjour JP, et al. IOF position statement: vitamin D recommendation for older adults. *Osteoporos Int* 2010; 21:1151-4.
21 Gilchrest BA. Sun protection and vitamin D: three dimensions of obfuscation. *J Steriod Biochem Mol Biol* 2007; 103:655-63.
22 Holick MF. *The UV Advantage*. New York: iBooks Inc; 2004.
23 Wolpowitz D, Gilchrest BA. The vitamin D questions: how much do you need and how should you get it? *J Am Acad Dermatol* 2006; 54:301-17.
24 MacLaughlin JA, Anderson RR, Holick MF. Spectral character of sunlight modulates photosynthesis of previtamin D3 and its photoisomers in human skin. *Science* 1980; 216:1001-3.
25 Final report on carcinogens background document for broad-spectrum ultraviolet (UV) radiation and UVA, and UVB, and UVC December 13–14, 2000. National Toxicology Program. http://ntp.niehs.nih.gov/ntp/newhomeroc/roc10/uv.pdf. Accessed Feb. 2. 2012.
26 El Ghissassi F, Baan R, Straif K, et al. On Behalf of the WHO International Agency for Research on Cancer Monograph Working Group. A review of human carcinogens-part D: radiation. Lyon, France; 2009. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, vol. 100. http://monographs.iarc.fr/ENG/Monographs/vol100D/mono100D.pdf. Accessed Feb. 2, 2012.

REPELLING THE RAYS WHEN KIDS PLAY: A GUIDE FOR PARENTS (P.46)

1 Rigel DS. Cutaneous ultraviolet exposure and its relationship to the development of skin cancer. *J Am Acad Dermatol* 2008; 58(5 suppl 2): S129-S132.
2 Pleasance ED, Cheetham RK, Stephens PJ, et al. A comprehensive catalogue of somatic mutations from a human cancer genome. *Nature* 2009; 463:191-196.
3 Balk SJ and the American Academy of Pediatrics Council on Environmental Health and Section on Dermatology. Policy statement-ultraviolet radiation: a hazard to children and adolescents. *Pediatrics* 2011; 127(3):588-597.
4 Balk SJ and the American Academy of Pediatrics Council on Environmental Health and Section on Dermatology. Technical report-ultraviolet radiation: a hazard to children and adolescents. *Pediatrics* 2011; 127:e791-e817.
5 Lew RA, Sober AJ, Cook N, et al. Sun exposure habits in patients with cutaneous melanoma: a case study. *J Dermatol Surg Onc* 1983; 12:981-6.
6 Paller AS, Hawk JLM, Honig P, et al. New insights about infant and toddler skin: implications for sun protection. *Pediatrics* 2011; 128(1):92-102.
7 Ferrari A, Bono A, Baldi M, et al. Does melanoma behave differently in younger children than adults? A retrospective study of 33 cases of childhood melanoma from a single institution. *Pediatrics* 2005; 115(3):649-654.
8 Dusza SW, Halpern AC, Satagopan JM, et al. Prospective study of sunburn and sun behavior patterns during adolescence. *Pediatrics* 2012; 129(2):309-17.
9 Cokkinides V, Weinstock M, Glanz K, et al. Trends in sunburns, sun protection practices, and attitudes toward sun exposure protection and tanning among US adolescents, 1998-2004. *Pediatrics* 2006; 118(3):853-864.
10 Davis KJ, Cokkinides VE, Weinstock MA, et al. Summer sunburn and sun exposure among US youths ages 11 to 18: national prevalence and associated factors. *Pediatrics* 2002; 110(1 pt 1):27-35.
11 Robinson JK, Rademaker AW, Sylvester JA, Cook B. Summer sun exposure: knowledge, attitudes, and behaviors of Midwest adolescents. *Prev Med* 1997; 26(3):364-372.
12 Robinson JK, Rigel DS, Amonette RA. Trends in sun exposure knowledge, attitude and behaviors: 1986-1996. *J Am Acad Dermatol* 1997; 37(2 pt 1):179-186.
13 Schlumpf M, Kypkec K, Vöktd, CC, et al. Endocrine active UV filters: developmental toxicity and exposure through breast milk. *Chimia (Aaraw)* 2008; 62:345-351.
14 Calafat AM, Wong LY, Ye X, et al. Concentrations of the sunscreen agent benzophenone-3 in residents of the United States: national health and nutrition examination survey 2003-2004. *Environ Health Perspect* 2008; 116(7):893-897.

SKIN CANCER AND THE GENDER GAP: WHY MORE MEN DIE FROM SKIN CANCER (P.51)

1 National Cancer Institute. SEER Stat Fact Sheets: Melanoma of the Skin. http://seer.cancer.gov/statfacts/html/melan.html. Accessed January 24, 2011.
2 American Cancer Society. Cancer Facts & Figures 2012. http://www.cancer.org/acs/groups/content/@epidemiologysurveilance/documents/document/acspc-031941.pdf. Accessed Feb. 8, 2012.
3 Jemal A, Siegel R, Ward E, et al. Cancer Statistics 2008. *CA-Cancer J Clin* 2008; 58(2):71-96.
4 Jemal A, Siegel R, Xu J, Ward E. Cancer statistics 2010. *CA-Cancer J Clin* 2010; 60 (5):277-300. Accessed November 1, 2010.
5 Ries LAG, Melbert D, Krapcho M, et al. (eds). SEER cancer statistics review, 1945-2005. Bethesda, MD: National Cancer Institute; Accessed January 24, 2010.
6 Sun Protection. Cancer Trends Progress Report - 2009/2010 Update. *National Cancer Institute*. Accessed November 1, 2010.
7 Armstrong BK, Kricker A. How much melanoma is caused by sun exposure? *Mel Res* 1993 December 3; (6):395-401.
8 U.S. Environmental Protection Agency. Health effects of overexposure to the sun. Updated July 1, 2010. Accessed January 25, 2011.
9 Godar DE, Urbach F, Gasparro FP, Van der Leun JC. UV doses of young adults. *Photochem Photobiol* 2003; 77(4):453-457.
10 Huang CL, Halpern AC. Management of the patient with melanoma. In: Rigel DS, Friedman RJ, Dzubow LM, Reintgen DS, Bystryn J-C, Marks R, eds. *Cancer of the Skin*. New York, NY: Elsevier Saunders; 2005:265-75.
11 Lee ET, O'Riordan D, Swetter SM, et al. Sun care advertising in popular U.S. magazines. *Am J Health Promot* 2006 May-Jun; 20(5):349-52.
12 Lowe JB, Ball J, Lynch BM, et al. Acceptability and feasibility of a community-based screening programme for melanoma in Australia. *Health Promot Int* 2004 Dec; 19(4):437-44. Epub 2004 Nov 1.

GROUNDBREAKING TREATMENTS FOR ADVANCED MELANOMA (P.54)

1. Atkins MB, Lotze MT, Dutcher JP, et al. High-dose recombinant interleukin 2 therapy for patients with metastatic melanoma: analysis of 270 patients treated between 1985 and 1993. *J Clin Oncol* 1999; 17:2105-16.
2. Hodi FS, O'Day SJ, McDermott DF, et al. Improved survival with ipilimumab in patients with metastatic melanoma. *N Engl J Med* 2010; 363:711-23.
3. Robert C, Thomas L, Bondarenko I, et al. Ipilimumab plus dacarbazine for previously untreated metastatic melanoma. *N Engl J Med* 2011; 364:2517-26.
4. Chapman PB, Hauschild A, Robert C, et al. Improved survival with vemurafenib in melanoma with BRAF V600E mutation. *N Engl J Med* 2011; 364:2507-16.
5. Sosman JA, Kim KB, Schuchter L, et al. Survival in BRAF V600-mutant advanced melanoma treated with vemurafenib. *N Engl J Med* 2012; 366:707-14.

WATCH OUT FOR AGGRESSIVE PRECANCERS (P.61)

1 The Lewen Group, Inc. *The burden of skin diseases 2005*. The Society for Investigative Dermatology and The American Academy of Dermatology Association. 2005.
2 Lansbury L, Leonardi Bee J, Perkins W, Goodacre T, Tweed JA, Bath Hextall FJ. Interventions for non metastatic squamous cell carcinoma of the skin. *Cochrane Database of Systematic Reviews* 2010, Issue 4. Art. No.: CD007869. DOI: 10.1002/14651858.CD007869.pub2. http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0014651/. Accessed Feb. 21, 2012.
3 Rogers H. "Your new study of nonmelanoma skin cancers." Email to The Skin Cancer Foundation. April 1, 2010.
4 Criscione VD, Weinstock MA, Naylor MF, Luque C, Eide MJ, and Bingham SF. Actinic keratoses natural history and risk of malignant transformation in the Veterans Affairs Tropical Tretinoin Chemoprevention Trial. *Cancer* 2009; 115:2523-2530.
5 Goldberg LH, Joseph AK, Tschen JA. Proliferative actinic keratosis. *Int J Dermatol* 1994 May; 33(5):341-5.

PHOTODYNAMIC THERAPY: A NEW FRONTIER IN EARLY SKIN CANCER TREATMENT (P.63)

1 Raab O. Uber die wirkung, fluorescirender Stoffe auf infusorien. *Z Biol* 1900; 39: 524-546.
2 Tappeiner H von, Jodlbauer A. Uber die wirkung der photodynamischen (fluorescierenden) stoffe auf protozoen und enzyme. *Dtsch Arch Klin Med* 1903; 80:427–487.
3 Tope WD, Bhardwaj SS. Photodynamic therapy. In: Bolognia JL, Jorizzo JL, Rapini RP, editors. *Dermatology*. London: CV Mosby; 2008.
4 Morton CA, McKenna KE, Rhodes LE. Guidelines for topical photodynamic therapy: update. *Br J Dermatol* 2008; 159:1245–66.
5 Morton CA, Brown SB, Collins S, et al. Guidelines for topical photodynamic therapy; report of a workshop of the British Photodermatology group. *Br J Dermatol* 2002; 146:552-67.
6 Hongcharu W, Taylor CR, Chang Y, et al. Topical ALA-photodynamic therapy for the treatment of acne vulgaris. *J Invest Dermatol* 2000; 115:183–92.
7 Pollock B, Turner D, Stringer MR et al. Topical aminolaevulinic acid-photodynamic therapy for the treatment of acne vulgaris: a study of clinical efficacy and mechanism of action. *Br J Dermatol* 2004; 151:616–22.
8 Avram DK, Goldman MP. Effectiveness and safety of ALA-IPL in treating actinic keratoses and photodamage. *J Drugs Dermatol* 2004; 3 (Suppl.):S36–9.
9 Kalka K, Merk H, Mukhtar H. Photodynamic therapy in dermatology. *J Am Acad Dermatol* 2000; 42:389–413.
10 Ibbotson SH. Adverse effects of topical photodynamic therapy. *Photodermatol Photoimmunol Photomed* 2011; 27:116-30.

THE BATTLE AGAINST SKIN CANCER: NEWS FROM THE EASTERN FRONT (P.67)

1 Ferlay J, Shin HR, Bray C, Forman D, Mathers C, Parkin DM. Globocan 2008 v1.2, Cancer Incidence and Mortality Worldwide: IARC CancerBase No. 10 [internet]. In: International Agency for Research on Cancer; 2010.
2 American Cancer Society. Melanoma skin cancer overview. http://www.cancer.org/acs/groups/cid/documents/webcontent/003063-pdf.pdf. Updated Jan. 23, 2012. Accessed Feb. 22, 2012.
3 Garbe C, Leiter U. Melanoma epidemiology and trends. *Clin Dermatol* 2009; 27(1):3-9.
4 Baumert J, Schmidt M, Giehl KA, et al. Time tends in tumour thickness vary in subgroups; analysis of 6475 patients by age, tumour site and melanoma subtype. *Mel Res* 2009; 19:24-30.
5 Downing A, Yu XQ, Newton-Bishop J, et al. Trends in prognostic factors and survival from cutaneous melanoma in Yorkshire, UK and New South Wales, Australia between 1993 and 2003. *Int J Cancer* 2008; 123:861-6.
6 Sant M, Allemani C, Santaquilani M, Knijn A, Marchesi F, Capocaccia R. EUROCARE-4. Survival of cancer patients diagnosed in 1995-1999. Results and commentary. *Eur J Cancer* 2009; 45(6):931-91.
7 Marmol VD, Forsea A. Euromelanoma: present challenges and future perspectives at 10th anniversary. In: 1st Conference on UV effects and skin cancer prevention; Copenhagen; 2011.
8 Lew RA, Sober AJ, Cook N, Marvell R, Fitzpatrick TB. Sun exposure habits in patients with cutaneous melanoma: a case study. *J Dermatol Surg Onc* 1983; 12:981-6.
9 Pfahlberg A, Kolmel KF, Gefeller O. Timing of excessive ultraviolet radiation and melanoma: epidemiology does not support the existence of a critical period of high susceptibility to solar ultraviolet radiation-induced melanoma. *Brit J Dermatol* March 2001; 144:3:471.
10 Aneja S, Aneja S, Bordeaux JS. Association of increased dermatologist density with lower melanoma mortality. *Arch Dermatol* 2012; 148(2):174-178. doi:10.1001/archdermatol.2011.345
11 Euromelanoma. Fact sheet: the Euromelanoma day. http://www.euromelanoma.org/upload/belgium/presse/01-Euromelanoma-Day-countries.pdf. Accessed Feb. 23, 2012.
12 Commission of the European Communities. The European Economic and Social Committee of the Regions on Action against Cancer. Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions on actions against cancer: European partnership. Brussels: Commission of European Communities; 2009. http://ec.europa.eu/health/ph _ information/dissemination/diseases/docs/com _ 2009 _ 291.en.pdf. Accessed Feb. 22, 2012.
13 Doré JF, Kunseler E, Pirard P, Zeeb H. Policies to reduce the excessive exposure of children to ultraviolet radiation. ENHIS fact sheet No. 4.8. Copenhagen: World Health Organization Regional Office for Europe, 2007. http://www.euro.who.int/ _ _ data/assets/pdf _ file/0008/97451/4.8.pdf. Accessed Feb. 22, 2012.
14 Colijn M, van Wilgenburg E, Weijland JW. Joint action on sunbeds 2008-2009. Product Safety Enforcement Forum of Europe. European Commission, Health and Consumer Protection Directorate-General; 2009. http://ec.europa.eu/consumers/citizen/my _ safety/sunbeds/sunbeds _ report _ 2008-2009 _ en.pdf. Accessed Feb. 22, 2012.

READY TO WEAR SUN PROTECTION: CLOTHING FITS THE BILL (P.70)

1 CIE (International Commission on Illumination) Technical report. UV protection and clothing. CIE 172:2006 CIE Central Bureau, Vienna, Austria, 2006.
2 Osterwalder U, Schlenker W, Rohwer H, et al. Facts and fiction on ultraviolet protection by clothing. *Radiat Prot Dosimetry* 2000; 91(1):255–259.
3 Gies P. Photoprotection by clothing. *Photodermatol Photoimmunol Photomed* 2007; 23:264-274.
4 Standards Australia/Standards New Zealand. Sun protective clothing—evaluation and classification. AS/NZS 4399. 1996; Standards Australia, Sydney and Standards New Zealand, Wellington.
5 Diffey BL. Sunscreens: expectation and realization. *Photodermatol Photoimmunol Photomed* 2009; 25:233-236.