# Sunscreens
# Why, What , How?

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December 2022

- No relevant conflict of interest

- Advisory board member of :
- Penthrox
- Johnson & Johnson
- SanofiGenzyme
- Galderma

# Outlines

- To discuss different methods of sun protection
- To discuss different types of sunscreens
- To discuss current sunscreen controversies

# Sun rays

- The Sun emits  its energy as infrared, visible light  and UV
- Infrared is perceived as heat
- Visible light: solar radiation that is visible  at earth's surface
- UV is the most important modifiable risk factor for skin cancer

http://www.generationalenergy.com/images/window%20light%20spectrum%20pic.jpg

# Ultraviolet light

- Divided into three different bands:
- UVC is completely absorbed by earth atmosphere
- UVB is mostly absorbed :5% of UV  at earth surface
- UVA is less absorbed: 95% of  UV  at earth surface

https://qph.fs.quoracdn.net/main-qimg-82e6b5933740db4fb5a9332c7cbbfe4b-c

# UVA vs UVB

- UVB  intensity varies  according to time of the day , season and location
- UVA more constant without variations due to the time of day or year
- UVA passes through clouds
- UVB blocked by clouds

http://baydd.org/content/img

# UVA vs UVB

- UVA  has less energy but penetrates deeper into the skin

http://www.lightcontrolfilm.com/wp-content/uploads/image005-2.jpg

# UVA vs UVB: Sunburn

- Sunburn is caused by UV induced inflammation and apoptosis of skin cells
- Mostly mediated by UVB

Wikipedia

# UVA vs UVB : Tanning

- The process of the darkening of skin color mostly caused by UVB
- Damaged skin trying to make more melanin to protect against further damage
- Suntan can offer just  a SPF of 2  -3
- Safe tan is no tan

# UVA vs UVB :Aging

- Mostly mediated by UVA as penetrates deeper
- For 28 years, the trucker has had his left side exposed to UVA rays transmitted through his window – whereas his right side was covered and relatively unharmed
- Good example of  UVA passing through glass

NEJM April 2012
https://sawyer.com/wp-content/uploads/2013/12/tech-sun5.gif

# UVA vs UVB : Skin cancer

- Both Non melanoma skin cancers and melanoma are linked to sun exposure
- UV-A causes free radical production, resulting in oxidative damage
- UV-B induces DNA  mutation
- Both induce immunosuppression which reduces the body’s ability to destroy mutations

# Sun protection

- UV exposure can be avoided by :
- Shade/Avoidance
- Protective clothing
- Sunscreens

# Sun avoidance

- The most effective way but not very practical
- Avoid being out between 11 am and 3 pm as much as possible

# Shade

- Can be used as a UV protecting tool
- Blocks only the direct UV
- Reflected UV from surfaces like sand and water can reach skin
- Amount of indirect UV is proportional to the amount of visible sky from shade

https://i.pinimg.com/originals/a9/08/e2/a908e27d4109072baac61cc6ce85503c.jp
https://www.jnjvisioncare.ae/sites/default/files/public/uk/images/in_page/uv-rays-off-different-surfaces.jpgg

# Clothing

- Can be used as a measure of sun protection depending on how much light it passes
- A practical tip :hold the garment up to sun to see how much light shines through
- The tighter the weave of a fabric and the darker the colour the more the protection

https://www.skincancer.org/wp-content/uploads/Clothing_HeroImage-1024x682.jpg

# Clothing

- The efficiency of clothing to block UV is measured by UPF (UV Protection Factor)
- UPF indicates how much of the UV is passed through the fabric
- A fabric with UPF of 50 allows $1/50^{th}$=2% of the sun's UV to pass (98% block)
- A UPF rating of 5 : $1/5^{th}$ (20%) of UV  to pass through it

https://cdn.shopify.com/s/files/1/1019/3345/files/skin_aging_2.jpg?6223796670442067817

# Hat

- Should protects face, back of the neck, eyes and ears
- Broad-brimmed, bucket or legionnaire hats are the best
- Baseball or peaked caps and sun visors not recommended

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTUiK5GHmAN8_3zzOLMRUIPOfBi9Ajvy7oXnOnTqe7iQ8LA5vLr&s

https://cdn11.bigcommerce.com/s-g4ufd5e/images/stencil/500x500/products/431/1343/Sun-busters-girls-uv-legionnaire-hat-tangelo__13640.1522315667.jpg?c=2&imbypass=on

https://jamanetwork.com/journals/jama/fullarticle/2383280

# Sun glasses

- UV exposure : Photokeratitis, cataracts,  macular degeneration, pterygium
- Sunglasses should block both UVA and UVB rays
- Look for UV400  :means that the glasses absorb  UV up  to 400 nanometers
- Wraparound-style frames

# Sun protection : Sunscreens

- First developed for soldiers in WWII to block sunburn causing ray
- Form a coating on the surface of skin that “filters out” UV
- Two main groups of sunscreen

https://www.solaveil.com/mediaassets/images/solaveil/organic-sunscreen.jpg?h=532&la=en-GB&w=753&hash=F369316ACD4F00EB45F880E0E41744CC81F55F79

# Organic (Chemical sunscreens )

- Here, the term ‘organic’ means that the chemicals primarily contain carbon
- Organic substances that absorb UVB and /or UVA and change it to heat
- Different kinds of molecules have different ranges of absorption
- Used in combination because no single one provides sufficient protection

https://49ylquvj9d1n24l11tphxbuc-wpengine.netdna-ssl.com/wp-content/uploads/2018/03/chemical-vs-physical-sunscreens_small-min.png

# Inorganic or physical sunscreen

- Usually formulated with mineral compounds such as  Titanium dioxide and zinc oxide
- Reflects  and scatter both UVA and UVB

http://tizofusion.com/wp-content/uploads/2017/12/chemical_physical-sunscreen-chart.jpg

# Inorganic or physical sunscreen

- Titanium dioxide and zinc oxide molecules clump together to make big particles
- Whitening effects of regular mineral sunscreen can be problematic
- Improved by Nano particles (smaller than 100 nm)

# Sunscreen: How much to use?

- Two milligrams of sunscreen per square centimeter of skin
- It takes 35 gr per application to cover properly an adult body surface area
- **Apply sunscreen generously**

https://www.cancercouncil.com.au/wp-content/uploads/2018/01/Sunscreen-amount.png

# Sunscreen efficacy : SPF

- SPF measures a sunscreen ability to filter UVB
- Protected versus  unprotected skin  are exposed to simulated sunlight
- SPF is a measure of how much UVB is required to produce sunburn on protected skin (2 mg/cm2 sunscreen) relative to unprotected skin

A sunscreen with an SPF 15 allows one to get exposed to 15 times more UV radiation than would normally be possible without getting sunburn.

https://www.derma-tronnier.de/sites/default/files/styles/detail_retina/public/page/_mg_5445.jpg?itok=9VcX-BKo

# SPF

- The larger the SPF value, the greater the sunburn protection
- We usually suggest an SPF of at least 30
- No sunscreen can filter out 100% of the sun's UVB rays
- Is there any point to use high SPF  sunscreens?

https://vvazw1o18pf4bhdd434btzh7-wpengine.netdna-ssl.com/wp-content/uploads/2015/07/uv-block.jpg

# Sunscreen efficacy : SPF

- The SPF claimed comes with the amount used when testing
- Most people only apply 25-50% of that
- SPF decreases with inadequate use
- Higher SPF sunscreens may compensate for common underapplication

https://www.badgerbalm.com/blog/wp-content/uploads/2015/07/Applying-Mineral-Sunscreen1.jpg

# Sunscreen efficacy : UVA

- UVA is also harmful
- A good sunscreens should protect from UVA too
- The SPF is not related to protection against UVA-induced damage
- UVA protection factor measurement is complicated
- Look for Broad Spectrum or UVA label

# Broad spectrum label vs SPF

- Broad spectrum label is just a pass or fail  mark
- It does not quantify the UVA protection
- As SPF increases, the UVA protection is not necessarily increasing
- So be careful when using high SPF sunscreen
- High-SPF products may encourage staying in the sun longer with a false sense of security
- You wont burn but you get overexposed to harmful UVA

# Sunscreen : when to use?

- Cloudy days vs sunny days?
- Winter  vs summer?
- UVB  intensity varies  according to time of the day, season and location
- UVA more constant without variations due to the time of day or year
- UVA passes through clouds / UVB partly  blocked by clouds
- Sun protection should be practiced all day if the endpoint is to prevent skin cancer and aging

# Should I use sunscreen when indoor ?

- If windows present :
- Yes as UVA passes through
- If no window ?

- Incandescent bulbs have little to no UV irradiance
- LED does not emit UV
- Halogen lamp usually ok as they are doped or have glass shield
- Fluorescent lamps may increase lifetime UV exposure based on distance from skin.
- Long fluorescent tube safer than compact fluorescent tube
- As long as there is at least 30 cm distance with the light the risk should be very low
- Acrylic or plastic diffusers

https://bchsgroup.com/wp-content/uploads/2018/01/bulbs.png

# Sunscreen : Application frequency

- General recommendation: reapply sunscreen every 2-3 hours
- Recent experimental studies have shown that sunscreen remains on the skin at the desired SPF for as long as 8 hours after a single application
- If the appropriate amount is initially used, reapplication is necessary only after activities that remove the sunscreen
- Reapplication can compensate for initial underapplication

# How Long Before Exposure Should Sunscreen Be Applied?

- 15 to 30 minutes ?
- No data to suggest that there is a delay in sunscreen efficacy
- It seems sunscreen offered immediate protection when applied
- Reasonable to wait 15-30 minutes before water exposure to ensure water resistance

# Water proof or water resistant?

- There is no waterproof or sweatproof sunscreen
- Sunscreen efficacy decreases in the water or with sweating.
- Sunscreens can be labeled water/sweat resistant or very resistant if they last up to 40 minutes or 80 minutes, respectively, in the water

# Do people of color need sunscreen?

- The average SPF of black skin is 13.4 as compared with white skin, which is 3.4

- Much less than recommended

# Are sunscreen safe?

- Sunscreen initially approved as OTC before the modern era of drug evaluation (1978**).** The original FDA monograph listed 16 approved UV filters

- Despite decades of use, their systemic absorption has not been studied thoroughly
- Over time several studies showed chemical sunscreens have :

- Photoallergic potential
- Systemic absorption
- Endocrine effects
- Environmental impact

# Are sunscreen safe?

- Sunscreens regulation needed to be updated with the latest scientific standards
- 2019 :FDA announced  new proposed sunscreen guidelines for those 16 UV filters
- GRASE “Generally Recognized as Safe and Effective” just for titanium dioxide and zinc oxide as no systemic absorption
- Not GRASE for PABA and trolamine Dioxide
- 12 other chemical sunscreen agents need more data to be labeled as GRASE

JAMA | Preliminary Communication

# Effect of Sunscreen Application Under Maximal Use Conditions on Plasma Concentration of Sunscreen Active Ingredients

## A Randomized Clinical Trial

- A pilot study by FDA/ JAMA May 2019
- 24 adults divided in 4 groups
- Each group used a different sunscreen (2 mg/cm$^2$) 4 times a day to 75% of body surface area (maximal use conditions)
- Each sunscreen had : avobenzone ,oxybenzone ,octocrylene ,and ecamsule
- All participant had  high blood level of all 4 active ingredient exceeding the FDA threshold for safety testing (plasma concentration >0.05 ng/mL) after 1 day

JAMA | Original Investigation

# Effect of Sunscreen Application on Plasma Concentration of Sunscreen Active Ingredients

## A Randomized Clinical Trial

- Again an FDA conducted study / JAMA Jan 2020
- Randomized clinical trial in 48 patients divided in 4 groups each using a different sunscreen
- Each sunscreen had 6 common chemical sunscreen ingredients :avobenzone, oxybenzone, octocrylene,homosalate, octisalate, and octinoxate
- The participants applied sunscreen to 75% body surface area once on day 1, followed by maximal use (application 4 times a day) on days 2 through 4
- All 6 sunscreens achieved plasma concentrations above the FDA threshold for waiving additional safety studies after a single application

# What does it mean?

- FDA has not deemed the chemical sunscreen unsafe
- FDA is asking manufacturers for more data:
- Whether and to what extent, the chemical sunscreens are  absorbed into the body
- Whether absorbing sunscreen would increase the risk for cancer, birth defects…

# What should be recommended?

- Patient can be assured to  continue using the same sunscreens currently using
- If concerned can switch to physical sunscreens

# Sunscreen and kids

- No sunscreen before 6 months of age as potential risks of absorption

- Photoprotection should be based largely on behavioural modification

# Which form of sunscreen ?

- New FDA  proposed rules:
- Oils, lotions, creams, gels, pastes, ointments, and sticks : OK
- Spray sunscreens are Ok  as long as they pass inhalation particle size & flammability testing.
- Further data needed for powders, wipes, body washes, and shampoos to be deemed GRASE.

# Nano sunscreen safety

- Nano particle don’t penetrate  through the skin
- Could be toxic if inhaled as lungs are not able to clear them
- Nano particle may generate free radicles upon exposure to UV
- As nanoparticle just stay at surface of the skin the risk of free radicals affecting cells beyond the desquamating  dead skin cells is exceedingly low

# Sunscreen and coral reef

- Coral reefs are colonies of tiny animals found in marine waters
- When under stress Corals “bleach,” meaning turning  white
- It seems two sunscreen agents oxybenzone and octinoxate can hurt corals
- Hawaii initiated the first ban of these two sunscreens
- Key West, Florida, US Virgin Islands, Palau, Bonaire, and the nature reserve areas in Mexico are following

https://media.fromthegrapevine.com/assets/images/2015/6/Colorful%20coral%20reef.jpg.824x0_q71_crop-scale.jpg

# Sunshine vitamin

- Major source of vitamin D
- UVB is absorbed by 7-dehydrocholesterol in the skin
- D3 is metabolized  in the liver and kidneys into 25-hydroxyvitamin D and 1,25-dihydroxyvitamin D respectively

http://www.doctortomah.com/dr-tomah-articles/the-sunshine-vitamin

# Could we depend on sun to have enough Vit D?

- Our ancestors did.

- They had different work schedule, different clothing and were not aware of risk of skin cancer

- Life expectancy was less than 40 years of age; long-term photodamage was not a concern

# Could we depend on sun to have enough Vit D?

- In higher latitudes, early morning and late afternoon and during the winter months the amount of UVB reaching the earth is reduced

- Therefore very little or no vitamin $D_3$ production

- Forget about making Vitamin D between October till March by exposing yourself to sun  (vitamin D winter)

# Could we depend on sun to have enough Vit D?

- **Sensible sun exposure during summer?**
- Yes you will make vitamin D
- Probably a few minutes  with forearms, hands or lower legs uncovered in midday sun
- CDA and AAD don’t  not encourage intentional sun exposure as a source of vitamin D
- There is no safe level of exposure even if you don’t burn

# To take home messages

- Sunscreen is just one of the measures of sun protection
- FDA is investigating chemical sunscreens
- However they still can be used s as before
- Mineral sunscreen can be used for children and concerned people
- Sun exposure can not be trusted as a safe and reliable source of vitamin D
- Be out ,enjoy the sun but be sun smart by using shade ,clothing and sunscreen


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