WHAT IS YOUR DIAGNOSIS?

Figure 1. Image credit: iStock.com/Gajus.

Editorial note: Welcome to the Journal of Investigative Dermatology (JID) Cells to Surgery Quiz. In this monthly online-only quiz, the first question (“What is your diagnosis?”) relates to the clinical image above, while additional questions concern the findings reported in a JID article by Miller et al (https://doi.org/10.1016/j.jid.2018.02.018).

Detailed answers and a list of relevant references are available following the Quiz Questions below.

QUIZ QUESTIONS

1. What is your diagnosis?
   a. Cellulitis
   b. Polymorphous light eruption (PMLE)
   c. Acute sunburn
   d. Allergic contact dermatitis (ACD)
   e. Drug-induced photoallergic reaction

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2. Regarding individuals who expose themselves to UV light for the cosmetic effect of a tan, which of the following is true?
   a. Chronic and repetitive exposure to UV light may result in tanning dependence or addiction, defined as the development of tolerance, withdrawal, and/or difficulty stopping the behavior despite negative consequences.
   b. Individuals who indoor tan are often not aware of the associated risk of skin cancer with this behavior.
   c. The risk of developing both melanoma and non-melanoma skin cancer increases with later age of initial exposure.
   d. There is no difference in rates of skin cancer screening between individuals who have a history of indoor tanning versus those who do not.
   e. The prevalence of indoor tanning among adults in the United States is increasing.

3. According to the cross-sectional study of addictive tanning behaviors and behavioral health conditions among adolescent high school students, Miller et al. found which of the following to be true?
   a. Tanning addiction is more prevalent in adolescents of higher socioeconomic status.
   b. Among diverse racial and ethnic groups, tanning addiction is most prevalent in those who identify as non-Hispanic white.
   c. The prevalence of tanning addiction is similar among male and female adolescents.
   d. No relationship exists between tanning addiction and problem substance use or behavioral health conditions.
   e. Adolescents who self-report OCD symptoms or marijuana abuse are at higher risk for tanning addiction.

See following pages for detailed answers.
DETAILED ANSWERS

1. What is your diagnosis?

Correct answer: c. Acute sunburn

Sunburn is an acute inflammatory reaction of the skin to ultraviolet (UV) light exposure (Young, 2006). Diagnosis is based on history of sun exposure and physical exam, which often shows blanching erythema in sun exposed regions. The severity, which is both dose and wavelength dependent, can range from mild to severe erythema with pain, edema, and/or blisters. Scaling, desquamation, and tanning can often show blanching erythema in sun-exposed regions. The diagnosis is based on history of sun exposure and physical exam (Young, 2006). Scaling, desquamation, and tanning are typically noted 4-7 days after the initial UV exposure. Histological markers of UVB exposure include “sunburn cells”, or apoptotic keratinocytes, and spongiosis with parakeratosis (Sheehan and Young, 2002).

UV wavelengths absorbed by the skin include ultraviolet A (UVA) (320-400 nm) and ultraviolet B (UVB) (280-320 nm) light (Baron and Suggs, 2014). At the cellular level, UV radiation induces DNA damage, reactive oxygen species generation, melanogenesis, and altered protein and gene expression. Acutely, these changes can induce skin erythema, pigmentation, and suppression of acquired immunity, while chronically, exposure can lead to carcinogenesis and skin aging (Young et al., 2017).

UV exposure damages cells primarily by inducing DNA injury in the skin. Chromophores in the skin absorb UV wavelengths, which can cause structural alterations in proteins and cause release of reactive oxygen species (Young et al., 2017). When DNA chromophores are excited, structural changes can be induced including cyclobutane pyrimidine dimers (CPDs). CPDs can induce DNA mutations (cytosine to thymine) and degradation of collagen, which are responsible for skin cancers and photoaging, respectively (Poon et al., 2015).

Chronic UV exposure is a well known risk factor for development of many types of skin cancer, including non-melanoma skin cancers (NMSCs), melanoma, and Merkel cell carcinoma (MCC) (Savoye et al., 2018). The incidence of NMSC is directly correlated with proximity to the equator, where UV energy is the strongest (Rigal, 2008). While the risk of developing NMSC is strongly related to cumulative UV exposure, risk of developing melanoma appears to be more dependent on acute intermittent UV exposure (Rigal, 2008). MCC incidence is correlated with annual exposure to UVB radiation and tends to occur on sun exposed areas of skin, such as the head and neck (Grabowski et al., 2008). There are many strategies to reduce UV exposure, including sun-protective behaviors, sunscreen use, and tanning bed avoidance.

Discussion of incorrect answers:

a. Cellulitis

Cellulitis is a bacterial skin infection, diagnosed primarily by history and physical exam (Raff and Kroshinsky, 2016). The clinical presentation is characterized by a poorly demarcated area of erythema with associated warmth, swelling, and pain. The infection most commonly is unilateral on the lower extremities, and the presence of fever is variable. There can also be associated bulla and lymphangitis depending on the extent and severity (Raff and Kroshinsky, 2016). Histologic features include neutrophilic infiltrate surrounding blood vessels with dermal edema. Bacterial cultures obtained by needle aspiration or punch biopsy are often negative (Chira and Miller, 2010). In immunocompetent adults, the most common perpetrators are *Streptococcus pyogenes* and *Staphylococcus aureus* (Stevens et al., 2014).

b. Polymorphous light eruption (PMLE)

PMLE is the most common immunologically mediated photodermatosis, with highest prevalence in women in the 3rd-4th decade in temperate climates (Gambichler et al., 2009). The rash often presents hours after sun exposure with severe pruritus and development of erythematous papules coalescing into plaques in sun exposed regions; however, the exact morphology can vary widely. Characteristically the rash first presents with sun exposure in the beginning of spring/summer, can occur repeatedly, and decreases in frequency with repeated exposure, a term known as “hardening” (Gruber-Wackernagel et al., 2014). Histopathologic analysis reveals dermal edema with a lymphohistocytic infiltrate surrounding blood vessels and adnexa and occasional dyskeratotic cells. The pathogenesis of PMLE is thought to be secondary to a delayed hypersensitivity reaction to an unknown UV-induced antigen (Gambichler et al., 2009).

d. Allergic contact dermatitis (ACD)

ACD is caused by direct contact of the skin with a previously exposed allergen, resulting in a Type IV delayed hypersensitivity reaction (Fonacier and Sher, 2014). The clinical presentation of ACD is characterized by formation of erythematous, pruritic plaques with accompanying vesicles and bulla in severe cases. Chronically, the rash can become thickened and lichenified with overlying excoriations and possible impetiginization. (Tan et al., 2014). Classic histologic features include extensive spongiosis with potentially intraepidermal vesicles, perivascular lymphocytic infiltrate, and eosinophils.

e. Drug-induced photoallergic reaction

Drug-induced photosensitivity reactions include both phototoxic and photoallergic subtypes. Drug-induced
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photoallergy is a delayed hypersensitivity reaction to a protein in the skin that binds with a drug in the presence of UV light (Khandpur et al., 2017). The rash often develops 24 hours after exposure to the sun in photo-distributed areas, but the rash can spread beyond these borders (Monteiro et al., 2016). The clinical presentation can be similar to allergic contact dermatitis, with possible erythema, scaling, pruritus, and vesicles. The most frequent types of responsible agents are topical, including sunscreens, fragrances, plant derivatives, and nonsteroidal anti-inflammatory drugs (Monteiro et al., 2016).

2. Regarding individuals who expose themselves to UV light for the cosmetic effect of a tan, which of the following is true?

Correct answer: a. Chronic and repetitive exposure to UV light may result in tanning dependence or addiction, defined as the development of tolerance, withdrawal, and/or difficulty stopping the behavior despite negative consequences.

Many theories have been proposed to explain the increase in intentional tanning behaviors over the past century, including more sun-exposing clothing styles, increased outdoor leisure activities, and the discovery of the therapeutic qualities of UV light for disorders such as psoriasis and vitamin D deficiencies (Chang et al., 2014). However, indoor tanning before the age of 35 is associated with a 60% increase in melanoma risk (Boniol et al., 2012). Studies have also shown that appearance oriented individuals are more likely to engage in both indoor tanning and outdoor sunbathing (Gillen and Markey, 2012). For adolescents in particular, positive parental attitude towards indoor tanning is a strong positive predictive factor for tanning bed use (Feng et al., 2018).

In addition to its damaging effects on DNA and proteins and cancer causing potential in the skin, UV light induces pro-opiomelanocortin (POMC) synthesis in keratinocytes, which is converted to melanocyte-stimulating hormone. This molecular series of events is the basis for tanning of the skin (Yamamoto et al., 2015). In animal models, UV light induces production of a peptide derived from POMC, β-endorphin (Fell et al., 2014). Chronically, UV exposure can increase pain tolerance, induce withdrawal symptoms in its absence, and simulate physiologic dependence seen with opioids (Kaur et al., 2006).

Tanning addiction (also referred to as tanning dependence) is a disorder characterized by a physical and psychological dependence on the use of indoor UV tanning beds or outdoor sunbathing (Heckman et al., 2014). Prior studies have demonstrated that higher scores on the Tanning Pathology Scale (TAPS), a method to assess tanning dependence, correlate with longer tanning session lengths and difficulty affording indoor tanning bills (Heckman et al., 2015).

There is yet to be consensus on whether tanning addiction is a unique mental disorder, or how to most accurately assess tanning behaviors in patients (Petry et al., 2018). The modified Cut-down, Annoyed, Guilty, Eye-opener (mCAGE) scale, traditionally used to assess alcohol abuse, has recently been adapted and validated as a measure for tanning addiction (Heckman et al., 2014).

Discussion of incorrect answers:

b. Individuals who indoor tan are often not aware of the associated risk of skin cancer with this behavior. The majority of past and current tanners are aware of the associated cancer risk with tanning beds (93% and 91%, respectively) (Knight et al., 2002). Even with this knowledge, indoor tanning is still a common practice estimated to be near 28 million annually (Chang et al., 2014), suggesting that for individuals who tan, the perceived benefits of tanning and other factors outweigh the known risks (Nolan and Feldman, 2009). Indoor tanning alone is estimated to account for up to 452,796 cases of NMSC and 11,374 cases of melanoma annually (Wehner et al., 2014).

c. The risk of developing both melanoma and non-melanoma skin cancer increases with later age of initial exposure. The risk of both NMSC and melanoma is highest in those exposed to indoor tanning early in life (Boniol et al., 2012, Wehner et al., 2012). A recent meta-analysis estimated that approximately 19% of adolescents and 55% of college aged students have been exposed to indoor tanning. The incidence of indoor tanning is rising, raising concern that rates of both melanoma and NMSC may continue to rise in the future (Wehner et al., 2014).

d. There is no difference in rates of skin cancer screening between individuals who have a history of indoor tanning versus those who do not. A recent investigation of the prevalence of skin cancer screening among both indoor tanners and non-tanners found that skin cancer screening rates are higher in individuals who have a history of indoor tanning (30.18% vs 19.52%, respectively) (Heckman et al., 2018). However, participants who reported use of low SPF sunscreen (SPF 1-14) were less likely to be screened for skin cancers than those who reported use of high SPF sunscreen (SPF > 50), representing a group that may be more likely to develop skin cancers and go unscreened (Heckman et al., 2018).

e. The prevalence of indoor tanning among adults in the United States is increasing. From 2010 to 2015, rates of indoor tanning among US adults decreased from approximately 11.7 million to 7.8 million, possibly due to a combination of improved safety measures, increased knowledge of risks, and national and
state policies restricting tanning bed accessibility (Guy et al., 2017). Overall, it is still estimated that approximately 20.4% of non-Hispanic white females engage in indoor tanning annually, while the prevalence of outdoor tanning is more difficult to assess (Guy et al., 2017, Miller et al., 2018).

3. According to the cross-sectional study of addictive tanning behaviors and behavioral health conditions among adolescent high school students, Miller et al. found which of the following to be true?

Correct answer: e. Adolescents who self-report OCD symptoms or marijuana abuse are at higher risk for tanning addiction.

Miller et al. evaluated a cross-sectional cohort of adolescent high school students for the prevalence of addictive tanning behaviors and correlation with problem substance use and psychological symptoms (Miller et al., 2018). Tanning addiction was defined as meeting two or more mCAGE criteria, a validated tool to measure problematic tanning behavior (Heckman et al., 2014). Survey questions about tanning behaviors did not differentiate between indoor tanning bed use versus outdoor sunbathing. Past 30-day substance use and behavior consistent with substance abuse were assessed for substances smoking, vaping, alcohol, and marijuana. Psychological symptoms were also assessed for depression, generalized anxiety, social phobia, OCD, bipolar disorder, and ADHD (Miller et al., 2018).

Overall, 185 (7.02%) of 2,637 adolescents met criteria for tanning addiction. In unadjusted models, tanning addiction was positively correlated with past 30-day use of smoking, alcohol, and marijuana, alcohol and marijuana substance abuse, and symptoms of depression, panic disorder, social phobia, OCD, and bipolar disorder. After a multivariable regression model was conducted to control for all covariates and comorbidities, including significant covariates, psychological and substance use variables, only marijuana abuse and OCD symptoms remained at higher risk for tanning addiction. Adolescents who met criteria for marijuana abuse or OCD symptoms were 2.06 (95% CI 1.03-4.09) and 2.54 (95% CI 1.73-3.72) times more likely to have co-existing tanning addiction, respectively (Miller et al., 2018). This relationship between OCD and excessive tanning has also been demonstrated among college students (Ashrafioun and Bonar, 2014).

Discussion of incorrect answers:

a. Tanning addiction is more prevalent in adolescents of higher socioeconomic status.

Using eligibility for free or reduced price lunch as a proxy for socioeconomic status, there was not a significant difference in tanning addiction prevalence between higher and lower socioeconomic status (Miller et al., 2018). Lower socioeconomic status is associated with a lower likelihood of obtaining skin cancer screening in both indoor tanners and non-tanners (Heckman et al., 2018), making this demographic especially important to follow.

b. Among diverse racial and ethnic groups, tanning addiction is most prevalent in those who identify as non-Hispanic white.

Among diverse ethnic and racial groups, Native Hawaiian/Pacific Islanders reported the absolute highest rates of tanning addiction, at 10.53%. Non-Hispanic white and Hispanic adolescents had the second highest rates of tanning addiction, at 7.91% and 7.57%, respectively (Miller et al., 2018). Previous studies have determined that non-Hispanic white women represent the largest demographic among indoor tanners (Guy et al., 2017); however, this study demonstrates that the risk for tanning addiction spans across many ethnicities and races.

c. The prevalence of tanning addiction is similar among male and female adolescents.

Tanning addiction was significantly more prevalent in females (8.62%) compared to males (5.10%) (Miller et al., 2018). This trend has been confirmed by prior studies on rates of tanning addiction in males and females, both for indoor tanning and outdoor sunbathing (Ashrafioun and Bonar, 2014, Gillen and Markey, 2012).

d. No relationship exists between tanning addiction and problem substance use or behavioral health conditions.

Miller et al. found adolescents who reported OCD symptoms and marijuana problem abuse to be at higher risk of tanning addiction. Furthermore, linear regression models demonstrated that for each additional psychological symptom and problem substance, the probability of comorbid tanning addiction increased by 30% and 67%, respectively (Miller et al., 2018). Current treatment approaches for problem tanning behavior primarily aim to counsel and educate patients; however, given the association of tanning addiction with other behavioral comorbidities, future directions may aim to incorporate cognitive and behavioral based interventions (Stapleton et al., 2017).

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