

# Modern Electronic Devices: An Increasingly Common Cause of Skin Disorders in Consumers

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**The modern conveniences and enjoyment brought about by electronic devices bring with them some health concerns. In particular, personal electronic devices are responsible for rising cases of several skin disorders, including pressure, friction, contact dermatitis, and other physical dermatitis. The universal use of such devices, either for work or recreational purposes, will probably increase the occurrence of polymorphous skin manifestations over time. It is important for clinicians to consider electronics as potential sources of dermatological ailments, for proper patient management. We performed a literature review on skin disorders associated with the personal use of modern technology, including personal computers and laptops, personal computer accessories, mobile phones, tablets, video games, and consoles.**

With increasing use at work, home, and school, modern technology is increasingly involved in several dermatological conditions. These skin manifestations will probably increase over time with the use and pervasive popularity of electronic devices. Early recognition of the offending agent and its removal usually allow effective management.

We performed a literature review on cutaneous manifestations associated with the personal use of modern technology, including personal computers (PCs) and laptops, PC accessories, mobile phones, tablets, video games, and consoles.

A comprehensive search for articles in the PubMed database was conducted. Bibliographies of all included studies were also reviewed to find additional studies not included in previous research.

The key words used were as follows: *dermatitis, electronic devices, modern technology, contact dermatitis, cutaneous manifestations, PlayStation, PCs and laptops, PC-accessories* (such as *mouse and mouse pad, keyboard, and keyboard pad*), *mobile phones, tablets, video games, and console*. We included all types of articles.

Search results were categorized as follows: (1) video games; (2) PC, laptop, and computer accessories; and (3) mobile phones and tablets. For each category, we summarized the dermatological conditions related to the use of the device (Table 1).

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## Video Games–Related Dermatoses

Intensive video gaming has been associated with the occurrence of various cutaneous conditions arising from repeated trauma to the skin caused by the continuous use of video game controllers or by abnormal positions.<sup>5</sup> A recent survey has found that the average time spent playing video games in a sitting position is increasing<sup>59</sup>; this aspect is linked to conditions that are not really dermatological such as deep vein thrombosis and increased risk of thromboembolism.

Over the last few years, the release of a video game console with a motion sensitive control system (Nintendo Wii) has caused a new spectrum of video games–related pathology, not linked to immobility but to strong physical activity, especially in untrained or unfit people.

## PlayStation Thumb

PlayStation thumb is a repetitive strain injury, usually observed in children and young people, caused by continuous playing of PlayStation games. Repetitive strain injuries are conditions affecting the arms and hands due to repeated movements that damage tendons, nerves, muscles, and other soft body tissues.<sup>60</sup> Several jobs, sport activities, and the playing of musical instruments can lead to this kind of injury as well.

The first case of PlayStation thumb, described in 2004,<sup>61</sup> has been followed by other case reports and case series.<sup>1,60,62</sup>

Typically, PlayStation thumb manifests as pain and blisters located exactly on the site of recurrent pressure and friction with the controller of PlayStation, particularly on the thumbs and on the tips of the thumb, even though the involvement of other fingers, sometimes with nail alterations such as onycholysis, has also been reported.<sup>1,2</sup> Other possible associated symptoms include pain, stiffness, swelling, numbness, and tingling of the hands, wrists, elbows, shoulders, back, or neck. Dermoscopy on PlayStation thumb shows

**TABLE 1. Technological Device, Related Diseases, and Localizations**

Technological Device	Dermatitis/Disease	Site
Video games	PlayStation thumb	Thumb/tip of the thumb; nail <sup>1,2</sup>
	PlayStation palmar hidradenitis	Palmar surfaces of the hands <sup>3</sup>
	Frictional hyperkeratosis; callus; knuckle pads	Right second distal, interphalangeal joint <sup>4</sup>
	Allergic CD	Fingers and palms <sup>5</sup>
	Nintendinitis	Extensor tendon of the thumb <sup>6</sup>
	Wiiitis	Shoulder tendon, carpal tunnel, Achilles tendon, patella <sup>7–13</sup>
PCs, laptops	e-Thrombosis	Lower legs <sup>14–17</sup>
	Computer palms	Palms <sup>18</sup>
	Mouse fingers	First and fifth fingertips <sup>19</sup>
	Mousing callus	Ulnar aspect of the wrist <sup>20</sup>
	Allergic CD	Fingers, palms, wrists, and forearms <sup>21–30</sup>
	EAI	Thighs, abdominal region, breast <sup>31–53</sup>
Cell phones	Screen dermatitis	Face, neck <sup>54</sup>
	Allergic CD	Facial dermatitis, preauricular, upper ear region bilaterally <sup>55–57</sup>
	Dermatitis related to abnormal cell phone use	Hands, forearms, breasts, lower abdomen <sup>58</sup>

CD, contact dermatitis; EAI, erythema ab igne.

typical hyperkeratosis and punctate hemorrhages.<sup>62</sup> More recently, a parallel-ridge pattern with “pebbles” on the ridges, observed on dermoscopy, has lead some authors to suggest the probably more appropriate term of “PlayStation fingertip” to describe this condition.<sup>2</sup>

### PlayStation Palmar Hidradenitis

To date, only 1 case of PlayStation palmar hidradenitis has been described in literature in a 12-year-old girl.<sup>3</sup> It was an acute, painful hand dermatitis characterized, on physical examination, by erythematous, firm and highly tender nodules on the palmar surfaces of the hands. The lesions appeared after she had started to play with a new video game on the PlayStation for several hours a day. The diagnosis of palmar eccrine hidradenitis was confirmed by histopathological examination showing neutrophilic infiltration of the eccrine sweat glands in the absence of infectious agents.<sup>3</sup>

### Frictional Hyperkeratosis (Callus)

The term *knuckle pad* refers to a fibrous hyperkeratotic plaque, usually round in shape, due to repetitive trauma. The first and only report of a knuckle pad induced by intensive video gaming was described in 2006 by Rushing et al.<sup>4</sup> They reported a single fibrotic lesion localized on the right second distal interphalangeal joint of a 13-year-old adolescent boy previously treated for a wart without improvement. Biopsy revealed hyperkeratosis, acanthosis, and increased vascularity and fibroblasts. This thickening of the skin was provoked both by anchoring the video game controller and by video gaming several hours a day. In children, knuckle pads can be idiopathic, inherited in association with an autosomal dominant disorder, but more frequently lesions can be acquired by repetitive actions that traumatize the skin. While the classical causes of knuckle pad are cracking or picking or chewing fingers,<sup>4</sup> playing video games may be an additional modern cause.

### Contact Dermatitis

Contact dermatitis (CD) caused by the use of video game controllers is uncommon and probably underreported.

A possible case of hand eczema caused by a video game controller (Sony PlayStation One) was described in a 34-year-old female<sup>1</sup>; for work-related reasons, she spent several hours a day playing with a Sony PlayStation One controller in her hands. Patch testing revealed positive reactions for nickel (+++) and cobalt (++). As the manufacturer did not provide the composition of the controller and chemical analysis of the scratched material from the controller was not performed, the diagnosis of allergic CD caused by a metallic part of the video game controller is not incontestable. However, a prompt resolution of the palmar eczema was observed when she stopped the contact with the electronic device. Certainly, the local environment, such as moist and warm conditions as well as sweating of the hands, may accelerate the occurrence of CD, especially by intensifying the penetration of allergens into the skin.

In patients with a history of atopic dermatitis and intensive video gaming, the development of hand allergic CD should be suspected in the case of worsening of their eczema or loss of responsiveness to therapy. Nickel contained in a central “silver” button of the Xbox controller, positive tested by dimethylglyoxime (DMG spot test), was the cause of atopic dermatitis exacerbation due to a superimposed allergic CD in a 9-year-old atopic boy.<sup>63</sup>

### e-Thrombosis, Nintendinitis, and Wiiitis

Video game–related sport injury was first reported by Brasington<sup>6</sup> in 1990 as an inflammation of the extensor tendon of the thumb caused by fierce, repetitive pressures on the console’s button. The author coined the term *nintendinitis* for the phenomenon, from the name of the guilty interactive video game. While the first computer video games were sedentary, the currently available gaming devices consist in console, gaming unit, and interactive controller that require the player to mimic the motions of the games they are playing. One of the most common and popular

home video game entertainment systems, the Nintendo Wii, lets one play sports and other active games, such as soccer, bowling, baseball, tennis, boxing, running, golf, and fighting in one's own living room. Making movements similar to those of an athlete, players run the risk of developing extremity overuse syndrome, muscle soreness, or muscular tendinous stress and strain. In 2007, Bonis<sup>7</sup> invented the diagnosis of "wiiitis" to indicate all the possible Wii-related sport injuries. Even though we may expect to see video game-related injuries that mimic those common to traditional participation in these sports, the rate of injury may be even higher in the simulated sports, due to the lack of appropriate training and physical fitness.<sup>8</sup> After a Wii tennis match, several musculoskeletal injuries such as tendinitis of the shoulder, carpal tunnel syndrome, Achilles tendinitis, and patellar dislocation, in whatever age group, have been reported in literature.<sup>9–13</sup>

On the contrary, immobility due to a sitting position during playing video games may lead to circulatory disorders and venous thromboembolism.<sup>64–67</sup> In 2003, Beasley et al<sup>14</sup> first proposed the name "e-Thrombosis" for a case in which venous thromboembolism was related to prolonged immobility sitting in front of a computer, and further cases of thrombosis and thromboembolism caused by video games have recently been described in the literature.<sup>15–17</sup> "Gamer's thrombosis" mainly affects young people, but it may occur at any age, with higher risk for extreme gamers who spend at least 48 hours a week playing games.<sup>17</sup> Other factors related to prolonged gaming could be involved in the pathogenesis of thromboembolism, such as increased blood pressure and heart rate and mental stress, which have been hypothesized to induce a hypercoagulable state.<sup>68–70</sup>

## PC-Related Dermatoses

In recent years, the use of PCs has practically become universal, either for work or recreational purposes. As a consequence, health problems associated with both PC use and PC accessories are increasingly recognized.

Personal computer-related dermatoses can primarily be categorized in 4 groups of cutaneous pathologies: (1) various, friction-induced lesions resulting from PC overuse; (2) irritant and allergic CD from exposure to certain chemicals in PC mouses, keyboards, and wrist pads; (3) erythema ab igne (EAI); and (4) "screen dermatitis" from excessive exposure to visual display terminals (VDTs).

## Frictional Dermatitis

Several anatomical variants of friction dermatoses have been reported with different terms, these are as follows: *computer palms*, *mouse finger*, *mousedown callus*, *keyboard wrist pad*. Development of these disorders is related to prolonged periods of computer operation and other factors such as pressure, shear, moisture, and repetitive friction between the palms or fingers and keyboard, mouse, or mouse pad.

Computer palms corresponds, clinically speaking, to well-demarcated, erythematous patches, which cannot be blanched, with usually symmetric and asymptomatic telangiectases, occurring at sites of chronic pressure on the palms.<sup>18</sup> These lesions were described for the first time in 2 computer programmers who worked at a keyboard for many hours a day exerting pressure on the ulnar surfaces of the palms, compressed between the metacarpal bones and the work surface.<sup>18</sup> This occupational disorder corresponds to a stage 1 pressure ulcer due to reactive vessel engorgement and hemorrhage caused by a long-term pressure-induced ischemia, together with moisture and friction.

"Mouse fingers" is another frictional dermatosis, clinically different from computer palms. It typically affects the first and the fifth fingertips because only these fingers rub and move while handling the mouse. Mouse fingers consist of erythema, rhagades, and scaling induced by repetitive friction, pressure, and shear between the finger and the mouse pad.<sup>19</sup> As the kind of material the mouse pad is made of is not involved in the genesis of this dermatitis, mouse finger may also develop due to friction between the fingertips and the desk.

Due to the prolonged use of a computer mouse, several cases of asymptomatic, frictional, lichenified dermatosis localized on the ulnar aspect of the wrist, in correspondence of the pisiform prominence of the carpal bone, are described in literature with the term of "mousing callus"<sup>20</sup> or more simply "mouse-related dermatosis."<sup>54,71</sup> The same lesions have also been attributed to the keyboard.<sup>21</sup> The development of these lichenified lesions, most commonly seen over bony prominences, corresponds to a protective response to friction, characterized by an increased turnover in epidermal cells and the accumulation of thickened collagen bundles in the papillary dermis.

## Allergic CD

Allergic CD secondary to PC or laptop and their accessories, such as the mouse, mouse pads, and keyboard wrist rests, have been frequently reported.

Nickel is the main allergen responsible for allergic CD induced by laptop computers and iPad use in both adults and children.<sup>22–24</sup> It can be found in and released from metallic parts of the top and bottom surfaces of these devices, especially when laptop finishes are rubbed off. Paradoxically, even laptop finishes may be a source of nickel release.<sup>25</sup> The presence of nickel has also been demonstrated in the metallic parts of computer mouses with the DMG spot test.<sup>22</sup>

Capon et al first described 2 cases of allergic CD to a computer mouse in which patch testing revealed a positive reaction to diethyl phthalate and dimethyl phthalate, chemicals that were present in the plastics of the accessory.<sup>26</sup> Resorcinol monobenzoate, a UV absorber in plastics, caused a further case of CD due to computer mouse.<sup>27</sup>

A mouse pad as well has been seen to be the cause of CD due to diphenylthiourea, 2,6-di-tert-butyl-4-cresol, and zinc dibutyl-dithiocarbamate in neoprene rubber.<sup>28</sup>



**Figure 1.** Erythema ab igne of the left thigh caused by laptop.

In the literature, 3 further reports of allergic CD induced by mixed dialkyl thioureas, thiurams, and mercaptans in keyboard wrist rest pads have been reported.<sup>21,29,30</sup>

### Erythema Ab Igne

Erythema ab igne (EAI) is a well-known adverse effect of repeated long-term exposure to mild heat in the range 43°C to 47°C, which is insufficient to cause a burn.<sup>72</sup>

Clinically, EAI is typically characterized by the presence on the skin of an asymptomatic, fixed, nontender, brownish-red livedoid, reticulate patch, which is variable in shape and width (Figs. 1, 2).

Histopathologic changes include hyperkeratosis, interface dermatitis, epidermal atrophy with apoptotic keratinocytes, and melanin incontinence. Erythema ab igne could histologically resemble actinic keratosis and, therefore, has been termed *thermal keratosis*.<sup>73</sup> Chronic changes may lead to squamous cell carcinoma or, exceptionally, to Merkel cell carcinoma.<sup>74</sup> The latency of developing malignant tumors seems to be long and can reach 30 years or more.<sup>75</sup>

Historically, this condition has been seen on the legs and inner thighs of elderly women who sit close to heaters, fires, or stoves. It has become less common because of the increased use of central heating. Erythema ab igne can also appear on the lumbar region in patients who apply hot water bottles or heating pads for chronic backache or on different sites exposed to heat sources for professional purposes.<sup>72</sup> If exposure is discontinued, EAI normally resolves with mild residual pigmentation.

In our survey of the literature, 23 reports of laptop-induced EAI have been reported to date since the first publication in 2004 (Table 2), and a further unpublished case in a 24-year-old woman is shown in Figure 1. Thirteen patients were women

(54.2%) and 11 men (45.8%) with an average age of 25 years at diagnosis (range, 9–50 years). Seventeen patients (70.8%) were white, 2 (8.3%) Asian, 2 (8.3%) Indians, 1 (4.2%) black, and in 2 (8.3%) cases, the race was not reported. Duration of laptop exposure ranged from 2 weeks to 2 years. Most cases of laptop-induced EAI occurred on the thighs (79.2%); other sites involved were the abdominal region (16.6%) and breast (4.2%).

When reported, the cessation of laptop use on the site involved produced a progressive disappearance of the lesion, with only residual hyperpigmentation in 1 case. The time of resolution ranged from 2 to 5 months.

### Screen Dermatitis

Skin complaints in people exposed to visual display terminals have been reported since the late 1970s. As a reaction to chronic exposure to VDTs from computer monitor screens, patients develop a rosacea-like dermatitis characterized by erythema, edema, papules, or pustules, while subjective symptoms include itching, pain, and smarting.<sup>54</sup> Some patients present with only subjective symptoms and no visible skin disease. Rarely, central nervous system symptoms are reported, that is, dizziness, tiredness, headache, and slurred speech.<sup>76</sup>

The precise underlying etiology of this constellation of symptoms remains unclear and has been a topic of much investigation. Berg et al<sup>77</sup> demonstrated that the majority of these patients had a predisposed sensitive skin: they are so-called stingers, reacting with stinging or itching when lactic acid (5%) is applied to the cheek.

Gangi and Johansson<sup>76</sup> demonstrated that the clinical manifestations and histochemical changes were strikingly similar to skin damage from UV light and ionizing radiation. Most striking was the increased number of mast cells containing histamine in the skin affected by screen dermatitis. Histamine is released when mast cells are exposed to UV light and may also account for symptoms of itching, pain, edema, and erythema in screen dermatitis. Furthermore, Langerhans cells in the epidermis were significantly decreased or virtually absent both in screen dermatitis and in skin damaged by UV light or ionizing radiation.<sup>76</sup> On the other hand,



**Figure 2.** Erythema ab igne of the abdomen caused by laptop.

**TABLE 2. Reported Cases of EAI Induced by Laptop Use**

Author	Age, y	Sex	Race	Duration of Exposure, mo	Location
Bilic et al, <sup>31</sup> 2004	50	M	White	0.50	Left anterior thigh
Jagtman, <sup>32</sup> 2004	48	F	White	NR	Both thighs (>right)
Maalouf et al, <sup>33</sup> 2006	17	F	NR	12	Both thighs (>left)
Mohr et al, <sup>34</sup> 2007	26	F	Asiatic	2	Right anterior thigh
Levinbook et al, <sup>35</sup> 2007	40	F	White	NR	Thighs bilaterally
Bachmeyer et al, <sup>36</sup> 2009	26	M	White	NR	Right anterior thigh
Fite and Bouscarat, <sup>37</sup> 2009	25	F	Asiatic	6	Both thighs (>left)
Botten et al, <sup>38</sup> 2010	20	F	White	2	Thighs bilaterally
Arnold and Itin, <sup>39</sup> 2010	12	M	White	Several months	Left thigh
Andersen, <sup>40</sup> 2010	15	M	White	Several months	Both thighs (> left)
Corazza et al, <sup>41</sup> 2010	29	F	White	Few months	Left anterior thigh
Karlsson and Linde, <sup>42</sup> 2010	9	M	White	NR	Left thigh
Küçüktaş et al, <sup>43</sup> 2010	21	M	White	3	Left thigh
Giraldi et al, <sup>44</sup> 2011	12	F	White	8	Both thighs (>right)
Boffa, <sup>45</sup> 2011	18	F	White	3	Left breast
Karolak and Jonkman, <sup>46</sup> 2012	15	M	White	NR	Paraumbilical
Fu and Vender, <sup>47</sup> 2012	16	M	NR	NR	Left anterior thigh
Riahi and Cohen, <sup>48</sup> 2012	21	F	Black	24	Both thighs (>left)
Nayak et al, <sup>49</sup> 2012	20	M	Indian	24	Abdomen
Gauglitz et al, <sup>50</sup> 2013	36	F	White	18	Thighs bilaterally
Kesty and Feldman, <sup>51</sup> 2014	49	F	White	24	Posterior upper legs and buttocks
Marchal et al, <sup>52</sup> 2014	11	M	White	1.5	Thighs bilaterally
Manoharan, <sup>53</sup> 2015	40	M	Indian	2	Abdomen
Corazza et al, unpublished (Fig. 2)	24	F	White	6	Abdomen

M, male; F, female; NR, not reported.

levels of some neuropeptides were determined, and although several differences were found compared with normal skin, no single marker could distinguish between healthy skin and screen dermatitis.<sup>78</sup> Moreover, it is unclear if VDTs leak electric or magnetic fields that affect our cells. In keeping with these findings are the conclusions of a case-referent study, stating that screen dermatitis is probably the result of nonspecific or irritant factors in subjects with sensitive skin.<sup>79</sup>

### Cell Phone-Related Dermatoses

In the 2000s, cell phone dermatitis emerged as a problem (Figs. 3, 4). The pioneer case was described in 2000 in Italy, when Pazzaglia

et al<sup>55</sup> reported 2 patients with persistent facial dermatitis; patch tests showed positive reaction to 5% nickel sulfate.

In 2002, Japanese authors described 3 cases of preauricular eczema in young subjects allergic to 0.5% potassium dichromate<sup>56</sup>; further cases have been reported.<sup>57</sup> However, in these cases, chemical analysis was not performed to ascertain the presence and the amount of chromium in the devices. Allergic CD to chromium and especially to cobalt is currently uncommon.

In 2008, an American study investigated the frequency of response to DMG spot test on 22 models of cell phones, 45.5% of them gave positive reactions.<sup>80</sup>

In the same year, a comprehensive study investigated the frequency of positive DMG spot test on cell phones sold on the



**Figure 3.** Cell phone dermatitis in a nickel sensitized boy.



**Figure 4.** Cell phone dermatitis in a nickel sensitized woman.

Danish market. A positive DMG spot test (indicating nickel release  $> 0.5 \mu\text{g}/\text{cm}^2$  per week) was found in 8 of 41 cell phones.<sup>81</sup> This study determined an important change in regulatory law, so the EU Nickel Directive was extended in January 2009 to cell phones.<sup>82</sup>

However, successive studies were able to demonstrate an excess of nickel release from cell phones currently on sale on the international market.<sup>83,84</sup> Up to date, nickel remains the most common cause of contact allergy to cell phone materials.<sup>85</sup>

Recently, a comprehensive review of about 21 reports of cell phone dermatitis highlighted the variety of clinical features (eczema, lichenification, scaling) and sites (face, hands, forearms, breasts, lower abdomen) related to abnormal cell phone use.<sup>58</sup>

Cell phone gadgets and accessories can also be responsible for CD. Williams et al<sup>86</sup> in 2012 reported a CD due to a silicone mobile phone cover where patch test revealed positive reaction to tricresyl phosphate, phenol formaldehyde, PTBC (*p*-ter-butyl-catechol), wool alcohols, and Amerchol L101. However, as the authors could not obtain clear information by manufacturers of the silicone covers, the relevance of these plasticizers remained speculative. Furthermore, the previous application of emollient creams containing wool wax alcohols and Amerchol L101 (a commercial product containing wool alcohols) could have played a substantial role in inducing or worsening the dermatitis. In 2011, we described an ACD of the upper ear region bilaterally due to the frequent use of a cell phone headset (3-4 h/d) with a positive reaction to thiuram mix 1% and mercaptobenzothiazole 1%.<sup>87</sup>

A recent report has described a generalized dermatitis in an 11-year-old atopic patient who spent a lot of time playing with a first-generation iPad, proven positive to the DMG nickel spot test.<sup>23</sup> Even if it remains questionable that a weak nickel sensitization (1+ at 96 hours) may cause a generalized dermatitis by contact with an iPad, the authors emphasize the causative role of nickel due to an increased use of electronic mobile devices in the pediatric population.

## CONCLUSIONS

Modern technologies are increasingly becoming new sources of dermatological concern causing either new disorders or reappearance

of traditional dermatological conditions. Both chemical and physical injuries related to the constant and repetitive use in everyday life of electronic devices may be responsible for skin disorders in adults and children. Recognizing and removing these emerging offending agents is the most effective intervention and can prevent misdiagnoses and long-term unnecessary treatments.

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