Neurology and the skin

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Many disorders affect both the nervous system and the skin. The complementary—and some would say—diametrically opposite—clinical methods of the dermatologist and the neurologist can in these circumstances reduce an otherwise dauntingly large differential into a more tractable, smaller list. Often triangulation with these and other clinical findings is sufficient for accurate diagnosis, but in other cases, serological or genetic data must be considered before diagnosis is secure.

We have purposely avoided traditional groupings such as phakomatoses, and immunological, infectious, or genetic diseases. Such distinctions are becoming increasingly obscure. Instead, we have organised the roughly 300 disorders with manifestations both in the skin and nervous system into clinically relevant groupings, as they may be first encountered by a practicing physician: neurocutaneous disorders associated with impaired immunity; stroke; neuropathy; meningitis or meningoencephalitis; vesicular lesions; ecchymoses, non-palpable purpura, and petechiae; cafe au lait spots; amyloidosis; rheumatoid arthritis; cutaneous vasculitis; photosensitivity; and melanoma. For disorders mentioned only in the tables, or not at all, the reader is referred to the encyclopaedic text of Fitzpatrick and more specialised compendia.

Neurocutaneous disorders of impaired immunity

AIDS

Eighty five per cent of those affected with AIDS have skin lesions, the most common of which are infectious, the result of impaired cell mediated immunity. Even such banal infections as verruca vulgaris and molluscum contagiosum are problematic. Both types of viral infection are resistant to therapy. Giant mollusca may disseminate over the body. Tinea corporis and recurrent bacterial infections, especially Staphylococcus aureus, may occur. The most common cutaneous manifestation, however, is recalcitrant seborrhoeic dermatitis, a chronic inflammation typically of the scalp and face, but which can also involve the intermammary region of the chest, groin, and axilla. It is thought to result from infection by Pityrosporum orbiculare, a saprophytic organism. Usually, it can be successfully suppressed by continued use of topical ketoconazole.

Herpes zoster is an AIDS defining event for those who test positive for infection with HIV.
OTHER NEUROCUTANEOUS DISORDERS WITH IMPAIRED IMMUNITY

Similar infections and tumours are common to other immunosuppression from a wide variety of causes such as chemotherapy, lymphoma, and in excess of 100 described heritable disorders in which the immune system is depressed, including severe combined immunodeficiency (Swiss or alymphocytic agammaglobulinaemia) with susceptibility to fungal and viral as well as pyogenic infections; the X-linked Wiskott-Aldrich syndrome of eczema and thrombocytopenia; Chediak-Higashi syndrome of partial albinism and neuropathy related to mutations of a beige-related lysosomal trafficking regulator encoded on chromosome 1q42; the Griscelli syndrome of partial albinism with silvery hair and progressive leukodystrophy, related to mutations of myosin 5 encoded on 15q21; ataxia telangiectasia; Bloom syndrome discussed below; and others.

Table 1 Neurocutaneous disorders associated with stroke

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Cutaneous Manifestations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amyloidosis VII</td>
<td>Cutis laxa</td>
</tr>
<tr>
<td>Behçet's disease</td>
<td>Erythema nodosum, genital and oral aphthous ulcers</td>
</tr>
<tr>
<td>Cerebral cavernous malformations</td>
<td>Rarely, angiomas</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>Necrobiosis lipoidica diabetorum, poorly healing ulcers</td>
</tr>
<tr>
<td>Endocarditis</td>
<td>Petechiae, Osler’s nodes, splinter haemorrhages</td>
</tr>
<tr>
<td>Fabry disease</td>
<td>Angiokeratoma—clusters of punctate dark red to blue black non-blanching macules or papules; symmetric, starting at the umbilicus and knees, then buttocks and scrotum</td>
</tr>
<tr>
<td>Haemolytic-uraemic syndrome</td>
<td>Erythematous necrotic skin lesions</td>
</tr>
<tr>
<td>Hereditary haemorrhagic telangieciasia</td>
<td>Telangiectasia</td>
</tr>
<tr>
<td>Homocystinuria</td>
<td>Sparse hair, malar flush, livedo reticulans, diffuse hypopigmentation</td>
</tr>
<tr>
<td>Hypercholesterolaemia</td>
<td>Xanthomas, xanthelasma</td>
</tr>
<tr>
<td>Progeria (Hutchinson-Gilford)</td>
<td>Aged skin, alopecia, generalised hypotrichosis, sparse or absent eyebrows, scleroderma-like, thin skin, midfacial cyanosis</td>
</tr>
<tr>
<td>Neurocutaneous angiomata</td>
<td>Large irregular haemangomas, angiomas</td>
</tr>
<tr>
<td>Pseudoxanthoma elasticum</td>
<td>Pseudoxanthoma, multiple papules, peau d’orange skin, angioid streaks, cutaneous calcification usually in blood vessels</td>
</tr>
<tr>
<td>Systemic lupus erythematosis</td>
<td>Photosensitivity, malar rash, telangiectasia, discoid lupus, patchy alopecia, mucosal ulcers, angioneurotic oedema, Raynaud’s phenomenon, subcutaneous nodules, palpable purpura, gangrene, erythema multiforme (rare)</td>
</tr>
<tr>
<td>Takayasu’s arteritis</td>
<td>Cutaneous necrotising venulitis—palpable purpura</td>
</tr>
<tr>
<td>Werner (Pangeria)</td>
<td>Scleroderma-like skin, greying hair and baldness, leg ulcers, progressive scalp alopecia, sparse body hair, telangiectasia, mottled pigmentation, loss of subcutaneous fat, subcutaneous calcification</td>
</tr>
</tbody>
</table>

Neurocutaneous disorders associated with stroke (table 1)

ANTIPHOSPHOLIPID SYNDROME

The antiphospholipid antibody syndrome is characterised by antibodies that are thought to induce hypercoagulability by neutralising anionic phospholipids on endothelial cells and platelets. These antibodies are most commonly seen in systemic lupus erythematosus but also as a primary abnormality. The most common antiphospholipid antibody of pathophysiological relevance is directed against epitopes localised to the cardiolipin 2 glycoprotein I complex. Other antibodies show specificity for prothrombin and annexin V. In some instances, antiphospholipid syndrome has been shown to be a familial trait. The two most common tests employed for detecting antiphospholipid antibodies are the anticardiolipin enzyme linked immunosorbent assay (ELISA) and a functional assay employing the Russell viper venom test (RVVT). The associated cutaneous manifestations are livedo reticulans, most commonly on the lower extremities (fig 2); acrocyanosis, a Raynaud’s-like phenomenon, and rarely, Degos malignant atrophic papulosis. The combination of livedo reticularis with multiple strokes resulting in dementia has been designated Sneddon’s syndrome. Antiphospholipid antibodies are associated with several neurological syndromes, most of which result from focal ischaemia.

FABRY’S DISEASE

Fabry’s disease is an X-linked multisystem disorder resulting from deficiency of ceramide trihexosidase (also known as α-galactosidase) and resultant vascular deposition of lipid. Affected males are easily recognised by a purpuric skin rash for which the disorder was given its other name, angiokeratoma diffusum universalis. There is a characteristic whorl-like corneal dystrophy of similar severity in heterozygotes as in hemizygous males, but affected females almost never have the characteristic skin rash. Without the rash, the diagnosis is often overlooked. The cutaneous manifestations of Fabry’s disease are characterised by discrete angiokeratomas most prevalent between the knees and nipples.
In addition to a painful small fibre neuropathy with autonomic involvement and abdominal crises, the early syndrome includes small infarctions in the retina and kidney that had previously led to death by the third decade. However, renal transplantation has permitted survival to a later stage of multiple infarctions of the CNS. Although women tend to survive longer than affected men, clinical involvement can be very severe, including debilitating autonomic neuropathy, renal failure, cardiomyopathy, and involvement of the CNS.

Angiokeratomas can also be found in association with other heritable disorders.3

**DIABETES MELLITUS: METABOLIC ENCEPHALOPATHY, NEUROPATHY, RETINOPATHY, AND STROKE**

Diabetes is arguably the most common neurological disorder in the developed world. The cutaneous manifestations of diabetes mellitus include necrobiosis lipoidica diabeticorum and a non-specific diabetic dermopathy. The last is characterised by reddish brown macules most commonly over the extensor surfaces of the lower extremities. The more characteristic lesion, however, is necrobiosis lipoidica diabetorum. This lesion, although not absolutely specific, generally occurs in patients with longstanding diabetes mellitus. Lesions consist of sharply demarcated, yellowish-brown plaques located most characteristically over the anterior surface of the lower legs (fig 3). A peculiar yellowish hue is characteristic, as well as the presence of telangiectasia. Ulceration of this lesion may occur.

**Neurocutaneous disorders with neuropathy (table 2)**

**LEPROSY**

In addition to diabetes mellitus, there are many neurocutaneous disorders associated with neuropathy. Although largely sparing developed nations, leprosy is perhaps the most common neurocutaneous disorder and peripheral neuropathy in the world. Vulnerability to infection with *Mycobacterium leprae* appears, in part, to be determined genetically.14 It had consistently affected some 10 to 12 million people until the introduction of multidrug therapy in the mid-1980s. By 1991 this number had dropped to about 5.5 million, including some 2 to 3 million who were seriously deformed.15 The characteristic abnormality is a hypaesthetic mononeuropathy multiplex, with palpably thickened nerves, beginning with burning or shooting nerve pain and progressing to complete anaesthesia in affected areas, comparable with that resulting from syringomyelia or completed nerve transection. There is invariably a non-necrotising lymphocytic angiitis of the
neurological disorders. Patchy demyelination of the CNS can mimic roughly some common neurological diseases, including stroke, have suggested associations, none of which have been established.

In chronically affected patients there can also be a non-vasculitic mononeuropathy multiplex, perhaps mechanistically identical to the acute form. Some untreated patients develop an indolent, indistinct diffuse encephalopathy. This nondescript chronic syndrome has become seriously over-diagnosed, in part because of the problems inherent in serological diagnosis of an immunologically complex spirochete, endemic in some areas and rare in others. Inappropriate diagnosis may well contribute to the belief that there is a subgroup of patients with chronic Lyme disease unusually refractory to antibiotic treatment, in contradistinction to the responsiveness of classic neuroborreliosis.

Difficulties with serological diagnosis abound.

**Neurocutaneous disorders with meningitis or meningoencephalitis**

In addition to Lyme disease, there is a wide variety of neurocutaneous disorders associated with inflammation of the meninges, often with associated cranial or peripheral neuropathies. Dermatological findings are particularly helpful in diagnosing aseptic meningitis or those associated with indolent organisms.

**Behçet’s syndrome**

This is an inflammatory dermatosis of unknown aetiology. There is a high prevalence of Behçet’s syndrome in people from the Mediterranean, Middle East, China, and Japan. There is an increased frequency of HLA-B5 (Bw51 split) in affected people. There is evidence that the primary association with Behçet’s syndrome is not in the HLA-B1 gene itself, but in the newly discovered MICA gene.

**LYME DISEASE**

Lyme disease (erythema chronicum migrans) is a chronic inflammatory disease caused by the spirochete *Borrelia burgdorferi*. It is transmitted by a tick bite (*Ixodes dammini*). No genetic vulnerability loci have been identified. About 85% of patients develop a very peculiar, distinctive, cutaneous inflammatory reaction at the site of the tick bite. Initially there is an inflammatory papule, which over a period of weeks spreads centrifugally. Central clearing occurs but a haemorrhagic, papular, vesicular lesion may remain at the site of the tick bite. Multiple lesions of erythema chronicum migrans occur if the disease process is untreated.

*Borrelia burgdorferi* affects the joints, the heart, and the nervous system. The typical presentation is of a painful patchy mononeuritis multiplex in association with mild lymphocytic meningitis. The mononeuritis can take the form of cranial neuropathies, particularly of the facial nerve, or a painful radiculopathy, or brachial or lumbar plexitis. Less often, there can be a myositis. Involvement of the CNS can mimic roughly some common neurological disorders. Patchy demyelination sometimes suggests an atypical distribution of multiple sclerosis. Myelopathy with radiculopathies has crudely approximated motor neuron disease in some patients. Such rare occurrences as well as incidental seropositivity in patients affected with these common diseases, including stroke, have suggested associations, none of which have been established.

In chronically affected patients there can also be a non-vasculitic mononeuropathy multiplex, perhaps mechanistically identical to the acute form. Some untreated patients develop an indolent, indistinct diffuse encephalopathy. This nondescript chronic syndrome has become seriously over-diagnosed, in part because of the problems inherent in serological diagnosis of an immunologically complex spirochete, endemic in some areas and rare in others. Inappropriate diagnosis may well contribute to the belief that there is a subgroup of patients with chronic Lyme disease unusually refractory to antibiotic treatment, in contradistinction to the responsiveness of classic neuroborreliosis.

Difficulties with serological diagnosis abound.

**BEHÇET’S DISEASE: MENINGOEENCEPHALITIS AND SINUS THROMBOSIS**

This is an inflammatory dermatosis of unknown aetiology. There is a high prevalence of Behçet’s syndrome in people from the Mediterranean, Middle East, China, and Japan. There is an increased frequency of HLA-B5 (Bw51 split) in affected people. There is evidence that the primary association with Behçet’s syndrome is not in the HLA-B1 gene itself, but with the newly discovered MICA gene.

Behçet’s syndrome is characterised by recurrent aphthous stomatitis, genital ulcers, uveitis, erythema nodosum, and thrombophlebitis. Recurrent aphthous stomatitis occurs in 98% of patients with Behçet’s syndrome and is often the initial manifestation. As many as 90% of patients with Behçet’s syndrome have a relapsing iridocyclitis, anterior and posterior uveitis, or retinal vasculitis. Optic atrophy may occur and blindness may result. Pathergy (the development of postulation at the site of trauma) is a characteristic feature. Vesicles, pustules, folliculitis, pyoderma, and acneiform eruptions, as well as necrotising vasculitis have also been described.

Neurological manifestations are the least frequent but most feared aspect of this disorder, affecting 2.2% of those in a recently reported series. Most often, this takes the form of a recurrent or chronic aseptic meningitis. In about 10% of patients there is a meningoencephalitis or meningomyelitis, which may respond to early and aggressive treatment with steroids, immunosuppressive drugs, and colchicine. There is a high incidence of dural sinus
thrombosis, affecting about 25% of all those with Behçet’s syndrome. Psychiatric disturbances and isolated trigeminal neuralgia have also been described.

SARCOIDOSIS: CRANIAL NEUROPATHIES AND ASEPTIC MENINGITIS
Sarcoidosis is a chronic granulomatous disease of unknown aetiology. Some 20% to 35% of patients with systemic sarcoidosis have cutaneous disease. The cutaneous features include skin coloured papules, nodules, and annular lesions. The annular lesions are most common in people of African descent. In addition to being skin coloured, the lesions of sarcoidosis may be brownish red or violaceous. They are often detected on the face, especially around the nostrils. On occasion, they may become confluent, forming erythematous plaques.

The angiolupoid form of sarcoidosis is a rare cutaneous lesion occurring most often in women. These lesions are soft, well demarcated, orange-red or reddish brown, with a livid hue secondary to prominent telangiectasia. Lupus pernio is characterised by large, bluish red, dusty, violaceous infiltrated nodules and plaques, which generally appear on the cheeks, ears, fingers, and nose. On rare occasions, sarcoidosis may present as an erythodermic lesion characterised by red scaling patches extending and merging into brownish red, confluent areas. Ulceration is rare, but most commonly seen in those of African descent.

Clinically recognisable disease of the nervous system occurs in 5% to 10% of patients with sarcoidosis. In half of these patients, neurological signs were the presenting feature. The most common findings were cranial neuropathies, chiefly of the facial nerve. Also encountered were parenchymatous lesions of the nervous system including the hypothalamus, hydrocephalus, peripheral neuropathy, and myopathy.

SYMPHILIS
After a period of diminishing prevalence, there has been a 10-fold rise in the incidence of primary and secondary syphilis, some 20/100 000 in the United States and 360/100 000 in parts of Africa. Inflammatory CSF is found in 10%-20% of those with primary syphilis, 30% to 70% of cases of secondary syphilis (2–4 months after infection), and falling to 10%-30% of cases of latent syphilis. In these early stages mild meningism can be associated with cranial nerve involvement, particularly of the optic, facial, and acoustic nerves.

The cutaneous manifestations of syphilis characteristically are initiated by a primary chancre most commonly on the genitalia, but sometimes on the lips or in the throat. This is a painless, indurated, rubbery lesion generally occurring within 2 weeks of infection (fig 4). It is also characterised by painless swelling of the draining lymph node (bubo). Serological testing (Venereal Disease Research Laboratory test) may be negative during the early phase, but invariably becomes positive within 1 month of infection. The fluorescent Treponema antibody test, however, is generally positive within 2.5 weeks of the onset of infection. The primary chancre may go untreated or unrecognised (most common in women with a cervical primary chancre) allowing the secondary phase of syphilis to occur. This can occur while the primary chancre is still present. It is characterised by mucous membrane patches and a patchy alopecia, as well as copper coloured lesions on the palms and soles (fig 5).

In adults, it is only during the early meningeal phases of the illness that cutaneous abnormalities are present. About 10% of those with early syphilitic meningitis have a rash. Cutaneous abnormalities resolve by the time of the later stages of neurosyphilis: meningovascular, which peaks after 4 to 7 years; general paresis, 10–15 years; and tabes dorsalis, 15–25 years. There is considerable overlap in the times of incidence. Cutaneous nodules or plaques of late syphilis are distinctly rare.

Prenatal syphilis is lethal in utero or shortly after birth in about half the cases. Early prenatal syphilis, with manifestations occurring before the age of 2, corresponds to secondary syphilis, whereas the signs of late prenatal syphilis do not appear until after the age of 2, rarely as late as 30. Half of early cases have cutaneous manifestations, typically copper red macules and papules on the palms, soles, and perineum. Fissures of the lips or anus “rhagades” affect 75% of affected infants. Less
often, there are bullae or a bright red nasal discharge “snuffles”. As in secondary syphilis of adults, meningoencephalitis is the most common neurological presentation. Neurologists must be wary of the “pseudoparalysis of Parrot”—failure to move a limb because of a painful osteochondritis at the epiphysis of a long bone.

OTHER NEUROCUTANEOUS DISORDERS WITH MENINGITIS OR MENINGOENCEPHALITIS
In addition to Behçet's disease and neurosarcoïdosis, aseptic meningitis with uveitis can occur in infantile multisystem inflammatory disease and in the rare Vogt-Koyanagi-Harada syndrome. In the last, a prodromal meningoencephalitis precedes uveitis and the final phase with the characteristic dermatological findings of alopecia, poliosis, and leukoderma with symmetric patches of vitiligo involving the head, neck, shoulders, and eyelids. There is a large differential for meningitis or meningoencephalitis with cutaneous manifestations (table 3).

Neurocutaneous disorders with vesicular lesions
HERPES VARICELLA ZOSTER
The varicella zoster virus causes two distinct syndromes: a primary infection (chickenpox) and a recurrent infection (shingles) after reactivation of virus that has lain dormant in the nerves for years after the primary infection. The most common nervous system complication of primary infection is a self-limiting cerebellar ataxia and aseptic meningitis, which typically occurs around 21 days after the eruption of cutaneous vesicles. About 0.1% to 0.2% of infected children develop encephalitis. About 2% of patients with childhood chickenpox will reactivate the virus to develop shingles, usually in the 6th through to the 8th decade. Excruciating dermatomal pain, typically in the thoracic or high lumbar dermatomes precedes by 2–3 days the development of a maculopapular rash that quickly matures into a vesicular eruption that may take 2–4 weeks to resolve completely. Postherpetic neuralgia, usually in the 6th through to the 8th dermatome, is a frequent complication. Classic neurologic syndromes: a primary infection (chickenpox) and a recurrent infection (shingles) after reactivation of virus that has lain dormant in the nerves for years after the primary infection.

ECCHYMOSES, PURPURA, AND PETECHIAE
Ecchymoses, petechiae, and purpura result from extravasation of blood into the skin or subcutaneous tissues. Such bleeding can occur after significant trauma in people who are otherwise well. However, subcutaneous haemorrhages occurring after trivial trauma indicate either a coagulopathy or disorder of platelets or blood vessels. All of these may concurrently affect the nervous system, platelet disorders perhaps less so than the others.

CHILD ABUSE: THE SHAKEN BABY SYNDROME
Physical abuse—delivered either by a frustrated caregiver trying to stop an infant's crying, or by someone deliberating trying to inflict harm—is the leading cause of serious head injury in infants, accounting for 95% of serious intracranial injuries. Intracranial pathology may occur in the setting of bone fractures and the mucocutaneous manifestations described above. However, the “shaken baby syndrome” can occur in the absence of skeletal or cutaneous manifestations of trauma. Infants present comatose or convulsing with retinal haemorrhages and anaemia from intracranial extravasation of blood into the subdural or subarachnoid space. The clinical triad of the “tin ear syndrome”: unilateral ear bruising, ipsilateral cerebellar oedema, and retinal haemorrhage is said to be pathognomonic, but bilateral subdural haematomas are seen most often. In more severe cases there may be lacerations or other intraparenchymal brain lesions. Up to 60% of children either succumb or become profoundly mentally retarded, blind, or tetraparetic with residual encephalomalacia, porencephalic cysts, and chronic subdural fluid collections. Less often rhabdomyolysis and myoglobinuric renal failure ensue.

The differential diagnosis for the neurocutaneous manifestations includes haemophilia and vitamin K deficiency of infancy. Multiple bone fractures after trivial trauma can occur in osteogenesis imperfecta type 3 or 4 (resulting from mutations in the genes encoding collagen 1A or 2A) Wormian bones in these disorders can simulate the multiple skull fractures which are now considered almost pathognomonic for child abuse. Careful radiographic examination of bones usually permits distinction of osteogenesis imperfecta from child abuse.

THROMBOTIC THROMBOCYTOPENIC PURPURA
Thrombotic thrombocytopenic purpura is a rare acute or subacute disease that chiefly affects young women, sometimes in association with systemic lupus erythematosus, Sjögren's disease, or scleroderma. Petechiae are less frequent than in the unrelated disorder, idiopathic thrombocytopenic purpura, in which there is no involvement of the nervous system. Jaundice can result from the severe haemolysis that is a hallmark of this disease. A severe encephalopathy with seizures, focal deficits, and coma occur in about 90% of patients that succumb to the disease, usually as a result of cerebral or renal involvement. However, patients successfully treated with plasmapheresis will go on to complete neurological recovery.
### Table 3 Meningitis or meningoencephalitis with cutaneous manifestations

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Cutaneous</th>
<th>Neurological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams-Oliver aplasia cutis congenita type III</td>
<td>Scalp defect at the vertex, hypoplastic nails, tortuous scalp veins, cutis marmorata telangiectatica, haemangioma</td>
<td>Acute bacterial meningitis from skull defect</td>
</tr>
<tr>
<td>AIDS</td>
<td>Seborrhoea, herpes zoster, tinea corporis, <em>S Aureus</em>, molluscum contagiosum, Kaposi sarcoma, cryptococcosis</td>
<td>Transient meningoencephalitis during seroconversion</td>
</tr>
<tr>
<td>Amyloidosis V (Meretoja)</td>
<td>Cutis laxa</td>
<td>Cranial and peripheral neuropathies</td>
</tr>
<tr>
<td>Behçet’s disease</td>
<td>Erythema nodosum, genital and oral aphthous ulcers (not as painful as recurrent aphthae) 1-5 ulcers &lt;10 mm, 4-14 days duration, papules, purpuria, pustules, dermatographia, pyoderm</td>
<td>Chronic or recurrent meningitis, meningoencephalitis, dural sinus thrombosis</td>
</tr>
<tr>
<td>Blastomycosis</td>
<td>Hyperplastic granulomatous microabscesses</td>
<td>Very rarely; chronic meningitis or cerebral abscess</td>
</tr>
<tr>
<td>Bril-Ziner epidemic typhus</td>
<td>Macular rash</td>
<td>Meningoencephalitis</td>
</tr>
<tr>
<td>Chagas disease</td>
<td>Romana’s sign, inflammation of lacrimal glands, erythema multiforme</td>
<td>Encephalitis</td>
</tr>
<tr>
<td>Coccidiomycosis</td>
<td>Erythema nodosum, draining sinus, subcutaneous cellulitis</td>
<td>Meningitis common; sometimes from parameningeal focus in vertebral osteomyelitis</td>
</tr>
<tr>
<td>Cryptococcosis</td>
<td>Macules and nodules in only 10-15% of affected individuals</td>
<td>Chronic meningitis</td>
</tr>
<tr>
<td>Haemophilus influenza</td>
<td>Typically single indurated area on face, neck, upper chest, or arm</td>
<td>Acute purulent meningitis</td>
</tr>
<tr>
<td>Histiocytic reticulosis (autosomal recessive)</td>
<td>Purpura, jaundice, erythrodema</td>
<td>Chronic aseptic meningitis, neuropathy</td>
</tr>
<tr>
<td>Infantile multisystem inflammatory disease</td>
<td>Evanescent rash, uveitis</td>
<td>Papilledema, optic atrophy, mental retardation, aseptic meningitis</td>
</tr>
<tr>
<td>Leptospirosis</td>
<td>Scleral conjunctival injection; maculopapular rash of trunk in 50% of cases, jaundice</td>
<td>Subacute meningitis</td>
</tr>
<tr>
<td>Leukaemia</td>
<td>Erythema nodosum, Sweet’s syndrome (acute febrile neutrophilic dermatosis) — painful raised red plaques commonly on face and extremities</td>
<td>Meningeal leukaemia is common form of relapse, especially in all</td>
</tr>
<tr>
<td>Listeria</td>
<td>Generalised erythematous papules or petechiae in infants; veterinarians with tender red papules of hands</td>
<td>Subacute meningitis</td>
</tr>
<tr>
<td>Lyme borreliosis</td>
<td>Target lesion</td>
<td>Early aseptic meningitis, polyneuropathy, delayed demyelinating disease</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>Erythema nodosum</td>
<td>Subacute meningitis, cerebral or vertebral metastasis</td>
</tr>
<tr>
<td>Lymphoma, cutaneous (T cell)</td>
<td>Scaly erythematous patches, leonine facies, poikiloderma, hypopigmented and hyperpigmented patches with atrophy and telangiectasia</td>
<td>Subacute meningitis, vertebral metastases</td>
</tr>
<tr>
<td>Meningococcaemia</td>
<td>Typically small and irregular petechiae with smudged appearance, usually on extremities and trunk; initially can mimic a viral exanthem</td>
<td>Fulminant meningitis</td>
</tr>
<tr>
<td>Murine typhus</td>
<td>Auxiliary rash, macular rash of upper abdomen, shoulders, chest</td>
<td>Headache, encephalopathy, and nuchal rigidity without meningitis</td>
</tr>
<tr>
<td>Neurocutaneous melanosis</td>
<td>Melanosis; large multiple pigmented skin nevi (&gt; 20 cm), no malignant melanoma other than CNS; primary CNS melanoma in over 50% of cases</td>
<td>Meningeal enhancement secondary to melanosis of pia-arachnoid; cranial nerve palsies, Dandy Walker malformation, suprasellar calcification;</td>
</tr>
<tr>
<td>Rickettsios, familial histiocytic</td>
<td>Purpura, jaundice, erythrodema</td>
<td>Chronic meningitis, peripheral neuropathy</td>
</tr>
<tr>
<td>Rocky mountain spotted fever</td>
<td>Characteristically progressing rash begins (1) on the fourth day of fever with pink macules on wrists, ankles, forearms; (2) after 6 to 18 hours, on palms and soles, then centrally (3) after 1-3 days deep red macules; (4) after 2-4 days, non-blanching petechiae</td>
<td>Vasculitic meningoencephalitis, choreoathetosis, deafness, hemiplegia</td>
</tr>
<tr>
<td>Sarcoidosis</td>
<td>Dry skin, hypohidrosis, decreased sweating, cicatricial alopecia; acute: erythema nodosum, vesicles, maculopapular rash; chronic: lupus pernio, plaques, scars, keloids</td>
<td>Chronic meningitis with cranial neuropathies, distal neuropathy and proximal myopathy; leukopothy; hypothyamic involvement</td>
</tr>
<tr>
<td>Sjögren’s syndrome</td>
<td>Purpura, Raynaud’s phenomenon, keratoconjunctivitis, oral ulceration, sicca syndrome, arthritis</td>
<td>Aseptic meningitis, dorsal ganglioneuropathy with sensory ataxia, dural sinus thrombosis</td>
</tr>
<tr>
<td>Syphilis</td>
<td>Primary: chancres; secondary maculopapular non-pruritic scaling rash (acral), hair: patchy alopecia, condyloma lata, mucous patches, erythema multiforme, hyperpigmentation on healing; split papules, palm and sole lesions</td>
<td>Aseptic meningitis in secondary phase; late meningoencephalitis; syphilis; tuberculosis;</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>Cutaneous tuberculosis is rare; primary tuberculosis chancres; warty tuberculosis verrucosa cutis from re-infection, postprimary lupus vulgaris, scrofuloderma, erythema nodosum, erythema multiforme</td>
<td>Chronic meningitis; Pott’s disease of vertebrae; CNS tuberculosis</td>
</tr>
<tr>
<td>Varicella-zoster (chickenpox)</td>
<td>Vesicles with oral lesions</td>
<td>Meningitis with cerebellar ataxia</td>
</tr>
<tr>
<td>Vogt-Koyanagi-Harada</td>
<td>Vitiligo type macules, poliosis and alopecia in convalescent phase</td>
<td>Meningoencephalitis in first phase of illness, preceding uveitis</td>
</tr>
<tr>
<td>Yersinia pestis (bubonic plague)</td>
<td>Erythema multiforme, bubos then petechiae and ecchymoses</td>
<td>Meningitis can complicate all three types: bubonic, bubonic-Septicaemic, pulmonary</td>
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**Cafe au lait spots**

**NEUROFIBROMATOSIS TYPE 1**

Neurofibromatosis is the most common single gene disorder to affect the nervous system, affecting about 1/3500 people. The NIH consensus criteria for the diagnosis of neurofibromatosis type 1 (von Recklinghausen’s neurofibromatosis) require at least two of the following: (1) the presence of six or more cafe au lait macules with a diameter of 5.0 mm in children younger than 6 years and >15 mm in older people (fig 6); (2) two or more neurofibromas of any type or one plexiform neurofibroma; (3) axillary or inguinal region freckling; (4) optic pathway glioma; (5) two or more Lisch nodules (whitish tumours of the iris); (6) dysplasia of the sphenoid bone or thinning of the cortex of long bones with or without pseudarthrosis; and (7) a first degree relative exhibiting these changes.

Among the most pressing management issues in neurofibromatosis type 1 are those pertaining to tumours, usually histologically benign. Neurological involvement most often results from benign neurofibromas arising in the root entry zone, causing radiculopathy or compression of the spinal cord. Plexiform neurofibromas, which can be
Neurofibromatosis type 1 is caused by mutations in the NF1 gene. The gene is located on chromosome 17 and encodes a protein called neurofibromin. This protein is involved in the regulation of the GTPase activity of Ras, which is a key protein in cell signaling. Mutations in NF1 result in reduced or absent expression of neurofibromin. This leads to uncontrolled cell growth, which is the basis for the development of tumors in neurofibromatosis type 1.

The hallmark of neurofibromatosis type 1 is the presence of multiple skin lesions known as cafe au lait spots. These are large, flat, yellow-brown patches that are usually present from birth. Other signs of neurofibromatosis type 1 include freckling in the armpit and groin areas, growths on the skin called neurofibromas, and abnormal bone development.

Neurofibromatosis type 2 is a different genetic disorder that affects the nervous system. It is caused by mutations in the NF2 gene, which is located on chromosome 22. The NF2 gene encodes a protein called merlin. Mutations in NF2 result in reduced or absent expression of merlin, which leads to uncontrolled cell growth, similar to what occurs in neurofibromatosis type 1.

The hallmark of neurofibromatosis type 2 is the presence of bilateral vestibular schwannomas, which are benign tumors that grow on the nerves that connect the inner ear to the brain. Other signs of neurofibromatosis type 2 include growths on the skin called schwannomas, hearing loss, and visual disturbances.

Both neurofibromatosis type 1 and type 2 can be inherited in an autosomal dominant pattern, which means that an affected individual has a 50% chance of passing the disorder on to their children. However, the severity and expression of the symptoms can vary significantly from one individual to another. In some cases, the disorder may be sporadic, meaning that it occurs without a family history.

Diagnosis of neurofibromatosis type 1 and type 2 is usually based on the presence of specific clinical features and a family history of the disorder. Imaging studies, such as MRI or CT scans, are often used to confirm the diagnosis and monitor the growth of tumors. Genetic testing can also be used to confirm the diagnosis and identify individuals at risk for the disorder.
Neurology and the skin

incorrect.3

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Cafe au lait spots are also seen in other neuro-
cutaneous tumour syndromes, which can be easily distinguished both clinically and genet-
ically. In tuberous sclerosis the distinguishing cutaneous manifestations are not cafe au lait spots but adenoma sebaceum, periungual angiokeratomas, Shagreen patches (fig 7), and hypopigmented ash leaf spots, best appreciated under Wood’s ultraviolet lamp.3 The neurological manifestations vary from severe mental retardation and infantile spasms to normal intelligence. Cardiac and olfactory hamartomas are characteristic of severely affected infants. Large hamartomas called tubers are often found on neuroimaging and can only be distinguished from astrocytomas, also associated with tuberous sclerosis, by serial scanning. The characteristic tumours are ganglioneuromas that give a candle guttering appearance to the ventricular wall. Other associated lesions are ependymomas, Wilms’ tumour, retinal phakomas, clinically silent renal cysts, and angiolipomas, as well as, less often, renal cell carcinoma.3 4 5 This autosomal dominant disorder is genetically heterogeneous: tuberous sclerosis I is caused by mutations of the hamartin gene on chromosome 9q34, and tuberous sclerosis II, with a higher risk of mental retardation, by mutations of the tuberin gene on chromosome 16p13.3.3 5 65

CAFE AU LAIT SPOTS BUT NOT TUMOURS

Cafe au lait spots are characteristic of McCune Albright polyostotic fibrous dysplasia. Although it was commonly understood that the rough border of these cutaneous lesions distinguished them from the smoother contour seen in neurofibromatosis, this does not permit the reliable distinction afforded by the rest of the syndrome.3 77 The osseous and endocrine abnormalities result from somatic mosaicism for constitutively lethal mutations the GNAS1 gene (guanine nucleotide binding protein, a-stimulating activity polypeptide 1), that encodes a GTP binding subunit of adenylate cyclase. Neurological manifestations are limited to brainstem compression and syringomyelia resulting from severe basal invagination.74

Cafe au lait spots are associated with mental retardation in several clinically distinguishable syndromes: the rare Westerhof syndrome in which growth retardation is associated with congenital hypopigmented and hyperpigmented patches,7 as well as in children with ring 14 and ring 17 chromosomal anomalies. Microcephaly but usually normal intelligence are typical of Russell-Silver dwarfi,

smallest café au lait spots have been seen in Turcot’s syndrome,1 72 a rare autosomal dominant syn-
drome of brain tumours, usually medulloblas-
tomas, colon cancer associated with polyposi-
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NEUROLOGICAL DISORDERS ASSOCIATED WITH CAFE AU LAIT SPOTS BUT NOT TUMOURS

Very large, unilateral and segmental cafe au lait spots are characteristic of McCune Albright polyostotic fibrous dysplasia. Although it was commonly understood that the rough border of these cutaneous lesions distinguished them from the smoother contour seen in neurofibromatosis, this does not permit the reliable distinction afforded by the rest of the syndrome.3 77 The osseous and endocrine abnormalities result from somatic mosaicism for constitutively lethal mutations the GNAS1 gene (guanine nucleotide binding protein, a-stimulating activity polypeptide 1), that encodes a GTP binding subunit of adenylate cyclase. Neurological manifestations are limited to brainstem compression and syringomyelia resulting from severe basal invagination.74

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Finally, it is important to remember that autosomal dominant transmission of cafe au lait spots can be seen in the absence of other abnormalities.3 Some,7 although not all77 such cases result from mutation in the neurofibromin gene.

Amyloidosis

Amyloidosis refers to extracellular deposition of insoluble protein fibrils. The pattern of cutaneous, neurological, or visceral involvement is to some extent related to the type of protein that is being deposited.78 Slightly raised

Facial telangiectasias are also typical in Bloom syndrome,3 45 in which susceptibility to infec-

tions and neoplasia result from mutations in DNA ligase 1 encoded on chromosome 15q26.1. There is dolichocephaly and light sensitivity, with mild learning disability as the only neurological manifestation. Leukaemia is a fatal complication of the genetically hete-

geneous Fanconi syndrome.3 45 in which mental retardation is associated with microcephaly, deafness, thumb anomalies, and pancytopenia. Rarely, cafe au lait spots as well as hypopigmented patches are seen in the von Hippel-Lindau syndrome: autosomal dominant retinal angiomas; hemangioblastomas of the cerebellum and spinal cord; renal and pancreatic cysts and carcinomas; as well as pheochromocytomas.3 79 81 However, cutaneous manifestations are decidedly rare in this common autosomal dominant disorder that results from mutations in a gene on chromosome 3p26-p25. This gene encodes a novel tumour suppressor protein that both regulates exit from the cell cycle and the expression of several hypoxia-inducible genes, including vas-
cular endothelial growth factor.3 More often, cafe au lait spots have been seen in Turcot’s syndrome,1 72 a rare autosomal dominant syn-
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OTHER NEUCUTANEOUS SYNDROMES ASSOCIATED WITH CAFE AU LAIT SPOTS AND TUMOURS

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Cafe au lait spots are sometimes found in some of the many autosomal recessive neurocutaneous disorders associated with defective DNA repair. Some early compendia had associated ataxia telangiectasia with cafe au lait spots.66 However, the association is not with the classic disorder but with what had been called ataxia telangiectasia variant VI. This genetically distinct disorder is now known as the Nijmegen breakage syndrome of microcephaly with (usually) normal intelligence, immunode-
ficiency, and lymphoreticular malignancies.3 67 Facial telangiectasias are also typical in Bloom syndrome,3 45 in which susceptibility to infec-
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Figure 7 Shagreen patch over the back of a patient with tuberous sclerosis. This is a hamartoma resulting from subependymal fibrosis.
cutaneous papules clustered in skin folds of the axilla or perineum are characteristic of amyloidosis (AL type), resulting from deposition of fragments of immunoglobulin light chains. There is a painful small fibre peripheral neuropathy, with prominent autonomic involvement. A similar small fibre neuropathy in the absence of cutaneous lesions is associated with autosomal dominant mutations of the transthyretin gene.80

In familial amyloidosis type VII cutis laxa is associated with an episodic encephalopathy and amyloid deposition in leptomeningeal and retinal blood vessels.89 In amyloidosis type V, cutis laxa and lattice corneal dystrophy are associated with multiple cranial neuropathies, but not autonomic dysfunction.82 Erythelasma-like erythema and benign recurrent meningitis similar to Mollaret's83 are the neurocutaneous features of familial Mediterranean fever, associated with mutations in the pyrin gene44 an autosomal dominant disorder that leads to amyloid deposition in the kidneys.

Rheumatoid arthritis
The characteristic cutaneous findings in rheumatoid arthritis are subcutaneous nodules. In some patients there may be painful intracutaneous papules of the finger pulp, bright red “liver palps”, or a vivid washable yellow discoloration of the skin from inspissated sweat. Rheumatoid nodules characteristically occur at sites of trauma: extensor surfaces of forearms, ears, and posterior scalp.

The most serious neurological complication commonly encountered in rheumatoid arthritis is a high cervical myelopathy, most often attributed to horizontal atlantoaxial instability, but recently discovered to be as frequent in those who had systemic features overlapping with those of Sjögren’s syndrome or systemic lupus erythematosus. An unusual form of localised scleroderma is seen in the Parry-Romberg syndrome of progressive hemiatrophy of the face with contralateral focal epilepsy and trigeminal neuralgia.89

Palpable purpura: cutaneous vasculitis
Raynaud’s phenomenon is also the most common cutaneous manifestation of Sjögren’s syndrome, a very heterogeneous rheumatic disease associated with characteristic dryness of the eyes and mouth. This common disease affects 3% to 5% of elderly women, some 30% of whom have anti-La(SS-B) or anti-Ro(SS-a) antibodies. Peripheral neuropathy occurs in about 10% of those with Sjögren’s syndrome. The most distinctive neurological manifestation of Sjögren’s syndrome is a sensory ataxia associated with lymphocytic infiltration of the dorsal root ganglia.84 Other neurological manifestations have been attributed to Sjögren’s syndrome but the strength of these associations has yet to be determined.85–87 There is cutaneous vasculitis manifesting either as palpable purpura of the lower extremities or urticaria-like vasculitic lesions in as many as 25% of anti-Ro(SS-a) antibody positive patients with Sjögren’s syndrome. Palpable purpura, the hallmark of cutaneous vasculitis can also be seen in other vasculitides including polyarteritis nodosa, Henoch-Schönlein purpura, essential cryoglobulinemia, some cases of giant cell arteritis, and Churg-Strauss allergic granulomatosis,88 as well as the autosomal dominant syndrome of retinal vasculopathy with cerebral leukodystrophy.89

Photosensitivity
Exaggerated sensitivity of the skin to sunlight is a feature of several neurocutaneous disorders of diffuse aetiology: two autoimmune disorders, systemic lupus erythematosus and dermatomyositis; nutritional deficiency of niacin; as well as several heritable disorders of intermediary metabolism or DNA repair.

Scleroderma
The defining cutaneous abnormality of progressive systemic sclerosis is sclerodactyly, but all patients also have Raynaud’s phenomenon. About two thirds have proximal scleroderma, telangiectasias, or digital pitting scars of the fingers. About half exhibit calcinosis. Although scleroderma is thought to be the least likely of the connective tissue disorders to be associated with neurological dysfunction, a systematic survey found the frequency of both peripheral and CNS involvement in scleroderma to be comparable with that in systemic lupus erythematosus and Sjögren’s syndrome, although the types of pathology differ.89 In that survey one third of patients with scleroderma had peripheral involvement, including trigeminal neuralgia and brachial plexopathy. Most CNS pathology in patients with scleroderma occurred in those who had systemic features overlapping with those of Sjögren’s syndrome or systemic lupus erythematosus.

Systemic lupus erythematosus is a chronic relapsing and remitting multisystem inflammatory disorder thought to result from impaired control of autoimmunity. The genetics of lupus is complex, susceptibility being associated with certain HLA class II alleles; homozygosity for deficiency of several complement genes as well as a demonstrated but uncharacterised susceptibility locus on chromosome 1.90 Photosensitivity is the most common cutaneous manifestation of systemic lupus erythematosus, usually manifested as a malar rash. Less often there is a discoid rash and oral ulceration. Neurological complications are frequent and diverse in systemic lupus erythematosus, affecting 70% of those with the disease.90 Events that predominate in the CNS. This may in part be an artefact of disease definition. Psychosis and seizures are each elements of the American

cutaneous vasculitis.
Rheumatological Association’s diagnostic scheme, whereas polymyopathy and myositis are not. A diffuse encephalopathy is a frequent manifestation, as is optic neuropathy. The initial presentation if systemic lupus erythematosus is often a psychosis that develops months before other aspects of the disorder. Both large and small vessel strokes occur, either as a manifestation of vasculitis, embolisation from Libman-Sachs endocarditis, or secondary to a coagulopathy. There may be an associated antiphospholipid syndrome, as described above. Distal axonal neuropathy, mononeuropathies, multiplex, myopathy, and myasthenia gravis occur less often.

DERMATOMYOSITIS

Dermatomyositis is a distinctive disorder in which myositis and dermatitis usually coexist, but both are sufficiently distinctive to permit accurate diagnosis in the absence of the other. The characteristic dermatological manifestation is photosensitivity. In addition to the characteristic heliotrope rash of the eyelids, a photosensitive erythematous rash often develops over sun exposed areas: malar, the “shawl” of the neck and shoulders, and the exposed anterior “V” of the chest. Unlike in systemic lupus erythematosus, there is a tendency for the eczematous rash to localise over knuckles, malleoli, and other joints (fig 8). In about two thirds of paediatric cases, there is also subcutaneous calcification. There can also be peri-orbital and perioral oedema and cicatricial alopecia. Sometimes the characteristic cutaneous photosensitivity occurs in the absence of myositis.97

Contrary to popular thinking, dermatomyositis is not “polymyositis with a rash.” Both disorders are rare with a combined annual incidence of 1/100 000. Although a subacute or insidious steroid responsive proximal myopathy is common to both, dermatomyositis is distinct from polymyositis. Histologically, dermatomyositis is a vasculitis, with perimysial and perivascular infiltration by CD4+ T cells and B cells, unlike the endomysial infiltration by CD8+ T cells and macrophages typical of polymyositis.98 99 Furthermore, each disease is associated with a characteristic HLA genotype and a different spectrum of autoantibodies.100 Both disorders can be part of overlap mixed connective tissue disorders, but an increased frequency of malignancy is a feature of dermatomyositis, particularly of adult onset. Among the more striking is a 16-fold to 32-fold increase in the rate of ovarian cancer.101

PORPHYRIA

Heritable disorders of porphyrin metabolism are clinically divisible into two general types: the cutaneous porphyrias, most of which have no neurological involvement, and the hepatic porphyrias, most of which have no cutaneous involvement. The hallmarks of hepatic porphyrias are metabolic crises with delirium, abdominal pain, and sometimes an axonal neuropathy, the rapid evolution of which can clinically simulate Guillain-Barré syndrome.1 Only two of the porphyrias exhibit both cutaneous and neurological features. Variegate (South African) porphyria typically results in severe photosensitivity with bullae, scars, erosions, and leather-like thickening of sun exposed skin. Infrequently, photosensitivity with some blistering is found in coproporphyria. In both of these disorders, neurological crises are triggered by a wide variety of drugs including barbiturates, carbamazepine, valproic acid, and ergot alkaloids.102

PELLAGRA AND HERITABLE NEUROCUTANEOUS DISORDERS WITH SIMILAR RASH

Pellagra is a chronic wasting neurocutaneous disorder characterised by dermatitis, dementia, and diarrhoea. It results from niacin (a B vitamin that can be synthesised from large quantities of dietary tryptophan) deficiency. Both niacin and tryptophan are in short supply in maize. The rash is characteristically symmetric, hyperkeratotic, hyperpigmented, and desquamated in sun exposed areas.103 A similar rash occurs intermittently during bouts of metabolic encephalopathy in two distinct autosomal recessive disorders: Hartnup disease, a mild disorder resulting from altered transport of tryptophan and other neutral amino acids that affects some 1/14 000 people with emotional instability and intermittent ataxia that occasionally progresses to stupor, and hydroxykynureninuria a very rare, severe affliction of tryptophan metabolism in which episodic metabolic crises are superimposed on a congenital encephalopathy with marked hypertonia and deafness. A pellagra-like rash can also occur in the carcinoid syndrome, in which tryptophan is catabolised at abnormally high rates.

XERODERMA PIGMENTOSUM AND OTHER DISORDERS OF DNA REPAIR

Xeroderma pigmentosum is a rare condition affecting about 1/100 000 people. However, the insights provided by this and related autosomal recessive neurocutaneous syndromes make their heuristic value greater than their frequency. The hallmark of xeroderma pigmentosum is extreme sensitivity to sunlight with progressive atrophy of the skin, irregular
pigmentation, telangiectasias, keratoacanthomas, actinic keratosis, and high onset of skin cancer, including melanoma, basal cell, and squamous cell carcinomas. It is genetically heterogeneous, as was originally suspected from complementation studies of DNA repair with fibroblasts from affected patients. Patients in some complementation groups, although not others, have progressive degeneration of the nervous system: characteristically spastic ataxia, often associated with microcephaly, peripheral neuropathy, dementia, choreoathetosis and sensorineural deafness. Some of these patients had previously been described as having the De Sanctis-Cacchione syndrome, a term that has outlived its usefulness and is best abandoned. One form of xeroderma pigmentosum (complementation group G) is allelic with phenotypically distinct Cockayne syndrome, characterised by a triad of precocious senility beginning in infancy, salt and pepper retinopathy with optic atrophy and sensorineural deafness, as well as photosensitive dermatitis. Neurological deficits in Cockayne syndrome include dementia, peripheral neuropathy as well as ataxia. Cockayne syndrome is itself genetically heterogeneous. Other complementation groups of xeroderma pigmentosum (B and D) are allelic with trichothiodystrophy, a syndrome with brittle hair and nails, as well as photosensitive ichthyotic skin and mental retardation. However, photosensitivity is not a feature of all neurocutaneous disorders associated with defects in DNA repair. In ataxia telangiectasia, cutaneous findings are limited to the diagnostic oculocutaneous telangiectasias that appear after the development of oculomotor apraxia and ataxia. Severe progressive neurodegeneration leads to choreoathetosis and peripheral neuropathy. Neurodegeneration only occurs in homozygotes for mutations in the ATM gene on chromosome 11q22.3, which encodes a DNA binding protein kinase. Both heterozygotes and homozygotes for ATM mutations are unusually sensitive to ionising radiation, a clinically relevant problem given the high incidence of lymphoma in homozygotes, and breast cancer in heterozygotes.

Melanoma

Of the three major types of skin tumour—basal cell carcinoma, squamous cell carcinoma, and melanoma—only the last typically involves the nervous system by metastases. There has been a dramatic 300% increase in the incidence of melanoma over the past 40 years, resulting in over 6700 deaths annually in the United States. If allowed to grow vertically, melanoma has a high rate of metastasis, initially to regional lymph nodes, and then by haematogenous spread to lung, liver, bone, and brain. Brain metastases from malignant melanoma usually are multiple, unlike the solitary metastases typical of colon, breast, or renal cancer.

Excessive exposure to sunlight is clearly the strongest aetiological factor, but genetic predisposition has been found. In addition to the increased (but not exclusive) vulnerability of fair skinned people, there is evidence for other genetic susceptibility factors. Primary tumours of the CNS are seen in increased frequency in family members of patients with cutaneous melanoma. The melanoma-astrocytoma syndrome segregates as an autosomal dominant trait. Melanomas are also seen in association with more complex neurocutaneous syndromes, such as xeroderma pigmentosum. In the rare neurocutaneous melanosis syndrome malignant transformation of a hypermelanotic leptomeninges leads to death in childhood.

Summary

As knowledge of pathophysiology grows, so does the refinement of diagnoses. Sometimes increased knowledge permits consolidation and unification. Unfortunately, at our present level of understanding, it usually demands proliferation of diagnostic categories. As tedious as this diagnostic splintering may seem, such is the price currently exacted of both the investigator and the clinician who seek to optimise management.

Increased diagnostic refinement often requires inquiry into matters outside the bounds of one’s specialty. Most often we turn to the radiologist or to the laboratory to narrow the differential diagnosis generated from the history and neurological examination. As we have shown, a useful intermediate step is extension of the physical examination to organs such as the skin, which are not the traditional preserve of the neurologist. That any text could confer the sophistication required for expert dermatological diagnosis is an unrealistic expectation. However, we hope that this review will encourage careful examination of the skin, hair, and nails by the neurological practitioner, with consideration of referral to a dermatologist when greater expertise is required.

6 Moore PM, Richardson B. Neurology of the vasculitides and connective tissue diseases. J Neurol Neurosurg Psychiatry 1998;65:10–22.