There were 2.1 million new HIV diagnoses worldwide in 2013. While the incidence across low- and middle-income countries has fallen by 30% since 2001, the incidence in the developed world appears to be increasing. Neurological disease is relatively common in patients with HIV infection, many of whom may have been previously undiagnosed. Host susceptibility to CNS infection, malignancy, and vascular disease (including aneurysms) is well described.

The neurological presentations in HIV-positive patients include neuropathy, myopathy, radiculopathy, myelopathy, and HIV-associated dementia, which have been covered in previous reviews. From a neurological perspective, the finding of a mass lesion on brain imaging or the development of hydrocephalus are the most common reasons for consultation. We discuss how the underlying diagnosis of HIV influences the approach to such a presentation, with a particular focus on decision making around biopsy.

The advent of combination antiretroviral therapy (cART) has given rise to new challenges in the care of HIV-positive individuals, including immune reconstitution inflammatory syndrome (IRIS). Of course, patients may also present with unrelated neurological pathology, and we highlight how health care professionals can reduce the risk of transmission within a surgical specialty.

While this review aims to guide neurosurgeons in the management of patients with HIV, it is important to emphasize that decisions should be made as part of a multidisciplinary team that includes HIV specialists, neurologists, microbiologists, and radiologists.
Conditions Associated With HIV

CNS Infection

The immunosuppressive effect of HIV was initially largely attributed to the viral-mediated destruction of memory CD4-positive T cells. The mechanism is now thought to be much more complex, with persistent immune suppression and chronic immune activation despite cART-associated viral suppression. HIV has also been shown to disrupt the blood-brain barrier, facilitating the entry of systemic organisms into the CNS.

HIV-related CNS infections manifest as meningitis, encephalitis, abscess, and malignancy, each of which is associated with high morbidity and mortality. In the context of HIV, the range of potential causative organisms has been broadened to include opportunistic pathogens. These infections typically occur when the CD4-positive counts are less than 200 cells/μl. The most important pathogens are Toxoplasma gondii, mycobacteria, Cryptococcus neoformans, Epstein-Barr virus (EBV), and John Cunningham (JC) virus.

Importantly, presentation may be atypical or affect more than 1 level of the nervous system. Multiple coexisting disease processes (with different pathogens) can occur in immunosuppressed individuals. Misdiagnosis is a particular risk if a CNS infection is falsely attributed to an organism that causes concurrent disease elsewhere, e.g., lung abscess.

Previous reviews cover in-depth the relevant aspects of presentation, diagnosis, management, and prognosis in tuberculous meningitis (TBM) and cryptococcal meningitis. Later, we discuss key concepts in the management of hydrocephalus related to these infections.

Primary CNS Lymphoma

Primary CNS lymphoma (PCNSL) represents 1% to 5% of all primary brain tumors. In HIV patients, PCNSL is associated with both immune suppression (typically CD4-positive counts < 100 cells/μl) and EBV infection, which is present in 75% to 100% of patients.

The diagnosis of AIDS confers up to a 3600-fold relative risk of developing PCNSL relative to the general population. In patients being treated with cART, the relative risk of developing PCNSL is approximately 80 times that of the normal population.

HIV-positive patients tend to be younger and are more commonly male. In a retrospective analysis comparing HIV-positive and -negative patients with PCNSL, HIV-positive individuals were more likely to present with seizures but less likely to present with hemiparesis. They were also more likely to have elevated serum lactate dehydrogenase levels. HIV-positive patients were found to have significantly lower complete remission rates and overall survival than their HIV-negative counterparts, even when correcting for performance status.

Within the HIV-positive PCNSL cohort, Karnofsky Performance Status at diagnosis and early cART were predictive of better outcome. Studies now report 3- and 5-year survival rates of 64% and 23%, respectively. This is in contrast to a median survival of 29 to 32 days prior to the introduction of antiretroviral treatment.

Since lymphoma can involve the spinal cord, meninges, and intraocular compartments, whole-spine MRI and ophthalmological examinations are recommended. Stereotactic brain biopsy remains the gold standard for diagnosis. In contrast to the immunocompetent population, a substantial minority of HIV-positive individuals (up to 35%) have Burkitt lymphoma.

Historically, HIV-positive patients often presented with coexisting pathology and poor performance status. The mainstay of treatment was whole-brain radiotherapy, but this was complicated by cognitive dysfunction in 20% of patients. With early cART, patients can tolerate more aggressive treatment regimens with fewer complications. A multiagent, high-dose methotrexate chemotherapy regimen is offered, and whole-brain radiotherapy is reserved for relapse or to consolidate treatment effects.

Other therapeutic possibilities include autologous stem cell transplantation, rituximab, and intrathecal regimens (with better CNS penetration). However HIV-positive individuals are routinely excluded from randomized controlled trials due to poorer prognosis, so results cannot be generalized to this population.

Attempts to resect PCNSL lesions are discouraged, although there is some evidence that the accidental resection of a lymphomatous lesion that is later histologically identified may not be harmful.

Brain Metastases

As a result of cART, the incidence of AIDS-defining malignancies has fallen, but non–AIDS-defining malignancies are now emerging as an important cause of death in this population (13%). Although this is a consequence of improved treatment and longevity, it does appear that the risk of certain cancers, especially those with environmental risk factors, is increased in HIV-infected individuals.

Several of these malignancies have a propensity for brain metastasis, including Hodgkin disease (relative risk [RR] 77), melanoma (RR 5), lung cancer (RR 4), and renal cancer (RR 2). These figures were determined from age-, race-, smoking-, sex-adjusted data compared between 7893 HIV patients in Chicago and Illinois and the cancer registry between 1992 and 2002.

Progressive Multifocal Leuкоencephalopathy

CNS infection with JC virus leads to progressive multifocal leukoencephalopathy (PML) in the immunosuppressed state. The virus is endemic, with 60% to 80% of adults having antibodies to the JC virus. PML is characterized by progressive focal neurological deficit and cognitive decline. More specifically, the following features have been described in order of frequency: paresis or paralysis (67%), speech alteration (51%), ataxia (44%), cranial nerve palsies (31%), and visual loss (20%).

In contrast to other causes of intracranial mass lesions seen in patients with HIV, there are often no signs or symptoms of systemic infection or raised intracranial pressure. The virus attacks oligodendrocytes, resulting in demyelination predominantly within the cerebral hemispheres. The histological features of JC virus infection...
include demyelination, bizarre astrocytes, and enlarged oligodendrocyte nuclei.\textsuperscript{11}

A combination of a typical clinical presentation, suggestive MR imaging, and positive CSF polymerase chain reaction (PCR) analysis for JC virus—in the absence of a more likely diagnosis—is sufficient.\textsuperscript{31} When in doubt, a biopsy should be arranged as soon as possible.\textsuperscript{21}

Historically, prognosis was very poor, and with no focused treatment there was no emphasis on early diagnosis.\textsuperscript{44} However, improved survival and performance status have been demonstrated with the prompt commencement of cART, so early biopsy should be sought where indicated.\textsuperscript{11,102} Mirtazapine has been described as useful in the treatment of PML by preventing the further spread of the JC virus between oligodendrocytes.\textsuperscript{22} A recent follow-up study describes a 5-year survival rate of 75%, with two-thirds of patients being independent at the last follow-up.\textsuperscript{102} Poor prognostic indicators include infratentorial and brainstem lesions.\textsuperscript{9,102}

**IRIS**

IRIS of the CNS is a complication of cART that is characterized by neurological deterioration despite recovery of the immune system. IRIS involves new or exacerbated inflammation stimulated by antigens, which previously evoked little or no response during the immunodeficient state. In general, the diagnosis of IRIS is based on clinical findings; there is, as yet, no reliable surrogate marker.

As a consequence of IRIS, the patient may develop increased intracranial pressure, hydrocephalus, or herniation from vasogenic edema. Commencement of, or changes to, cART can result in the unmasking of the underlying disease (i.e., unmasking IRIS), or the worsening of known CNS disease despite immune reconstitution (i.e., paradoxical IRIS).\textsuperscript{47} Coexistent cryptococcal, PML, and tuberculous infections have been noted as particularly susceptible to IRIS with mean incidences of 19.5%, 16.7%, and 15.7%, respectively.\textsuperscript{48,62}

The faster the change from immune suppression to immune reconstitution, the higher the risk of mortality and neurological deficit. Low CD4-positive counts at the initiation of cART are associated with both an increased risk and severity of IRIS. High-dose glucocorticoids are used in short courses to dampen the immune response, thereby preventing immune-mediated damage to the CNS.\textsuperscript{24}

**PML-IRIS**

The initiation of cART, or a regimen change, results in improved immune surveillance and may lead to IRIS with a time of onset between days and months. Any deterioration in the clinical condition may suggest PML-IRIS, but seizures are a particular feature. The demonstration of new contrast enhancement on MRI would support a clinical diagnosis of IRIS in PML patients; gadolinium enhancement on MRI occurred in 44.4% of cases with PML-IRIS versus 5.1% with PML alone.\textsuperscript{37} This, however, is not sensitive for milder PML-IRIS inflammation.\textsuperscript{24} A diagnosis of PML-IRIS can be made at stereotactic biopsy by using the ratio of CD8-positive cells to JC virus–infected cells, which is 70 times higher in PML-IRIS versus PML alone. The outcome of PML-IRIS is entirely dependent on severity at presentation. Corticosteroids, often at high doses, are required alongside ongoing effective cART.\textsuperscript{24}

**Cryptococcal IRIS**

The outcome of cryptococcal meningitis or cryptococcoma significantly worsens with the development of cryptococcal IRIS. More than 20% of all deaths of patients with HIV and cryptococcal disease are attributed to IRIS.\textsuperscript{60} In fact, delaying cART for 5 weeks after the commencement of cryptococcal treatment has been shown to improve survival.\textsuperscript{14} Testing for cryptococcal disease in severely immunocompromised patients prior to the commencement of cART is recommended.\textsuperscript{24} The cryptococcal polysaccharide capsule is a potent antigen that drives the immune response, so in addition to antifungal treatment, repeated large-volume lumbar puncture is recommended to reduce its concentration. High-dose corticosteroids may also be indicated.\textsuperscript{24}

**Tuberculosis-Associated IRIS (TB-IRIS)**

The median time to developing tuberculosis-associated IRIS (TB-IRIS) is 14 days after starting cART, but it can be more than 3 months.\textsuperscript{5} Mortality from TB-IRIS is as high as 30% at 9 months.\textsuperscript{5} The ideal delay between initiating treatment for TBM and starting cART is unknown. A randomized controlled trial comparing a 7-day delay with an 8-week delay found no difference in outcome. South African treatment guidelines recommend 2 to 8 weeks of antitubercular treatment before the commencement of cART, depending on the CD4-positive count.\textsuperscript{52} High-dose corticosteroids are routinely given for TBM-IRIS (1.5 mg prednisolone/kg/day) for 4 weeks before tapering over a further 2 to 4 months. cART should only be temporarily discontinued when a severe neurological deficit or reduced conscious level persists despite high-dose steroid therapy.\textsuperscript{5}

The case for empirical corticosteroid and antitubercular medication in TBM, while proven in the HIV-negative population, is not confirmed for the adult HIV-positive population.\textsuperscript{53} When used for the treatment of TBM, they do not seem to provide protection against IRIS.\textsuperscript{5}

IRIS may also be associated with other mycobacterial infections, including *Mycobacterium avium intracellulare* (Fig. 1).

**CD8-Positive T-Cell Encephalitis**

CD8-positive T-cell encephalitis is a distinct disease entity from IRIS where cART-induced immune recovery can itself damage the brain in the absence of opportunistic CNS infection.\textsuperscript{62} Corticosteroids have been reported as effective in the management of CD8-positive T-cell encephalitis.\textsuperscript{50}

**Investigation of CNS Pathology in Patients With HIV**

**Imaging**

Imaging plays a pivotal role in the clinical assessment of HIV-positive patients, who may present with a range of symptoms, including confusion, seizures, and sensory or motor neurological deficits. CT is widely used at acute presentation in the emergency department to exclude...
acute intracranial hemorrhage, space-occupying lesions, or hydrocephalus. The value of MRI is increasingly recognized due to the often nonspecific appearances, even on postcontrast CT, of small lesions, brainstem or cerebellar pathology, and multifocal lesions.23

Mass lesions in HIV-positive patients may have an atypical appearance, and a diagnosis cannot be made based on imaging alone. There are, however, a number of characteristic radiological features that may be instructive.

Toxoplasmosis has a predilection for the basal ganglia, corticomedullary junction, thalamus, and cerebellum (Fig. 2). On CT, lesions are ill-defined, hypodense, and associated with vasogenic edema. They appear hypointense on both T1- and T2-weighted MRI. The administration of intravenous contrast with either modality produces a typical target enhancement.

Typical cryptococcal infiltration of the CNS can be seen as dilated perivascular Virchow-Robin spaces. Although visible on T2-weighted imaging in its advanced form, subtle cases may only appear on postcontrast MRI studies.59 Interestingly, HIV-positive serology is associated with a higher proportion of normal brain images relative to HIV-negative cases (44% vs 13%; p = 0.003).49

PCNSL may have a similar appearance to toxoplasmosis, with solitary or multiple lesions. While generally enhancing, this is not necessarily the case in HIV-positive patients. Lesions are supratentorial in 90% of cases, localizing to the periventricular white matter and basal ganglia, and may be associated with hemorrhage and necrosis. FDG (18F-fluorodeoxyglucose) PET and 201Tl (thallium-201) SPECT are alternative imaging modalities that can be used to help differentiate lymphoma from toxoplasmosis lesions, based on the rationale that lymphoma has a higher metabolic rate relative to nonmalignant tissue.52,93 However, MRI remains the principal modality for PCNSL diagnosis. Increased cellular density and reduced vascularity distinguish PCNSL from other CNS malignancies, and this can be seen using diffusion-weighted and perfusion MRI studies.73

The typical PML lesions are diffuse, bilateral but
asymmetric, and not associated with mass effect (see Fig. 3). Occasionally PML may be unifocal at presentation.\textsuperscript{10,23} Lesions seldom enhance. They appear as hyperintense focal or more diffuse abnormalities on T2-weighted MRI or FLAIR imaging and are usually seen in the subcortical or periventricular white matter.

When imaging suggests both meningitis and parenchymal brain lesions, \textit{Mycobacterium tuberculosis} is a likely causative organism, and diagnostic certainty increases if pulmonary tuberculosis is also present.\textsuperscript{68} In TBM, CT scanning with contrast typically demonstrates basal enhancement, but this may be less obvious in HIV-infected individuals.\textsuperscript{43}

While PCNSL, PML, and cryptococcal and tubercular CNS pathologies have characteristic features, radiological diagnosis alone is not adequate for diagnosis in HIV-positive individuals.

Cerebrospinal Fluid

Importantly, the initial CSF examination results may be normal in patients with HIV-related neurological disease as a consequence of immunosuppression.\textsuperscript{57} Specific tests are available\textsuperscript{15,31} and, while they have limitations, are useful in certain circumstances.

Confidence surrounding a diagnosis of PCNSL can be supported by the detection of EBV DNA in CSF, but this cannot confirm the disease (positive predictive value [PPV] 29\%-50\%).\textsuperscript{38} Experimental techniques now exist for identifying the biomarkers cytokine CXCL13 (a mediator of B-cell migration) and interleukin-10, which are 50 times higher in patients with PCNSL than in healthy controls.\textsuperscript{79} PPV was 95\% with a negative predictive value of 88\% for the diagnosis of CNS lymphoma. Tests of this type may provide an alternative to biopsy in the future.\textsuperscript{78}

The CSF detection of JC virus DNA is not adequately sensitive for PML in the post-cART era.\textsuperscript{58} Historically, sensitivity was high (90\%), but with a low PPV. Sensitivity is now lower (57\%), but PPV has risen to 100\%.\textsuperscript{39}

Prior to taking CSF samples, one must note that when a compressive mass lesion has been identified, lumbar puncture (LP) is not advised due to low yield (16\%)\textsuperscript{38} and the potential risk of herniation.\textsuperscript{80}

Brain Biopsy

Obtaining a positive microbiological culture or tissue diagnosis is a priority in the management of HIV-related CNS disease. Notably, one series of HIV-positive patients with cerebral mass lesions reported that the diagnosis and management were changed following biopsy in one-third of cases.\textsuperscript{34}

Indications

The leading causes of cerebral mass lesions in HIV-infected individuals worldwide are toxoplasmosis, PCNSL, PML, tuberculosis, and cryptococcal abscess. Toxoplasmosis is responsible for over 70\% of these lesions, and 90\% of patients show improvement within 14 days of commencing treatment (median 5 days).\textsuperscript{55} Management algorithms (as summarized in Fig. 4) therefore recommend a 14-day trial of empirical anti-toxoplasmosis therapy, following which nonresponders should proceed to biopsy.\textsuperscript{57,77}

This avoids unnecessary biopsy for a significant proportion of patients.

However, biopsy should not be delayed in patients with negative toxoplasma serology, which has a 98.8\% negative predictive value.\textsuperscript{77} False-negative results occur rarely: when immune suppression is severe or in cases of primary infection.\textsuperscript{57} Tissue diagnosis should also be expedited if the history or imaging is highly atypical of toxoplasmosis, or if neurological deterioration occurs during treatment.

Relative contraindications to this “delayed biopsy” approach include symptomatic mass effect, the proximity of the mass to eloquent tissue or ventricles, advanced HIV disease, and cases in which patients who have been on prophylactic sulfa drugs for \textit{Pneumocystis jirovecii} prior to presentation, as these also reduce the likelihood of toxoplasma reactivation.\textsuperscript{77}

Management must be modified to reflect the higher incidence of other infectious CNS lesions,\textsuperscript{60,82,98} such as Chagas disease and tuberculosis in other countries (Table 1). The time frame for reassessment of the clinical condition and imaging in response to empirical treatment in these cases should be made on an individual basis and in close liaison with neurology and infectious disease colleagues.

Patients with HIV-positive serology have an increased propensity to multiple brain abscesses: 19\% relative to 7\% in the HIV-negative population.\textsuperscript{65} They are also at increased risk of polymicrobial infection, with 18\% culturing at least 3 organisms relative to 3\% in the immune-competent population.\textsuperscript{65} A biopsy series from the United States found multiple pathologies at a single location in 16 of 260 (6\%) of stereotactic biopsies.\textsuperscript{34}

Finally, it is important to note that large biopsy series are no longer possible due to the low number of untreated HIV patients. However, the incidences of PML-IRIS, CD8-positive encephalitis, and TB-IRIS appear to be increasing, while those of lymphoma, tuberculoma, cryptococcoma, and toxoplasma lesions are reportedly decreasing.

Procedural Complications

The major complications of biopsy are hemorrhage, in-
fection, and death. There is also a risk that the sample obtained is nondiagnostic. Interestingly, the rate of successful biopsy has increased from 91% (179 of 196 biopsies) to 96% (48 of 50 biopsies) since the introduction of cART. Both technological advancement and changes in the predominant pathologies may explain this improvement. Other series report diagnostic yields of 88% to 98%. The success rate of repeat biopsy has been reported as 100%. A series showed that mortality following stereotactic biopsy was equal in HIV-positive and -negative patients (5 of 218 [2%] vs 3 of 188 [2%], respectively), with all procedures performed by the same surgeon. HIV-positive patients undergoing biopsy have marginally higher hemorrhage rates of 3% to 12%. A case-control study found focal CNS lesions, coagulopathy, hepatitis C status, and alcohol and drug misuse to be associated with this increased hemorrhage risk, whereas cART was not associated.30

While it was initially argued that fresh-frozen plasma, platelets, and desmopressin should be given empirically to all HIV-positive patients both pre- and postbiopsy, selective correction of coagulopathy achieved a similarly low hemorrhage rate (5.3%) in a large series. Rosenow and Hirschfeld reported that symptomatic bleeds were higher when the platelet counts were less than 100,000 platelets/ml and recommended replacement preprocedures when the counts were below this level.

In summary, biopsy complication rates in HIV-positive patients with mass lesions mirror those of HIV-negative status, provided correction is made for coagulopathy and thrombocytopenia. Neither biopsy series reported seeding of infection, but the proportion of infective lesions sampled was also lower than that seen in less-developed countries. Corticosteroids

In HIV, corticosteroids should be withheld until a biop-


CSF Diversion

Patients with HIV may present with obstructive hydrocephalus as a result of mass lesions such as a tuberculoma or toxoplasmosis. Alternatively, HIV may be complicated by communicating hydrocephalus due to cryptococcal meningitis or TBM.

Obstructive hydrocephalus secondary to toxoplasmosis can be successfully managed medically. However, select cases, such as those with posterior fossa mass lesions, may require temporary CSF diversion while awaiting treatment response.

Cryptococcal Meningitis

In patients with communicating hydrocephalus secondary to cryptococcal meningitis and an opening pressure greater than 25 cm H₂O, daily LP should be performed for up to 1 week. Medical therapies, including mannitol, corticosteroids, and acetazolamide, have not been shown to be effective.

Persistently elevated intracranial pressure is the most accurate predictor of poor prognosis, and reduced admission-to-CSF-diversion time is associated with lower mortality rates. If repeated LP fails to normalize the intracranial pressure, then a ventriculoperitoneal (VP) shunt should be inserted. Direct VP shunting (without an LP trial) is indicated for patients presenting with seizures, reduced conscious level, or cranial nerve palsies.

VP shunting is the preferred method for CSF diversion, but the ventricles may be difficult to cannulate as they are frequently noncompliant and small. In such cases, lumbar or lumbo-peritoneal shunts can be used in adults as an alternative method for CSF diversion.

TBM

Communicating hydrocephalus is frequently managed medically, with LP if required. VP shunting is reserved for patients who present with a low level of consciousness, subsequently deteriorate, or do not show signs of clinical improvement within 1 week of therapy. However, in non-communicating hydrocephalus, early VP shunt placement is recommended.

Patients with HIV infection generally present with higher grade TBM, which has a very poor prognosis. Some authors, therefore, are hesitant about early shunting and instead advocate a 48-hour trial of external ventriculostomy or lumbar drainage in order to assess the response. However, in a case series of patients with Vellore Grade IV TBM, 18% of the group who had not responded to external ventriculostomy did well following VP shunting. Thus external ventriculostomy should only be reserved for patients who are not fit for shunt surgery, regardless of HIV coinfection or TBM disease grade.

Complications

Tuberculosis or cryptococcal disease of the abdomen has not been described as a consequence of VP shunt obstruction where appropriate antibiotics or antifungals had been commenced. The risk of VP shunt obstruction is increased 4-fold in TBM when the CSF protein concentration is greater than 200 mg/dl. In cryptococcal meningitis, HIV-positive patients may have some protection from shunt obstruction, as the CSF protein concentration has been shown to be lower compared with HIV-negative individuals (mean 88 vs 149 mg/dl, respectively; p = 0.01).

Public and Occupational Health Considerations

HIV Testing

Suspicion of HIV should arise when patients who are not known to be HIV positive present with atypical lesions. Of those living with HIV in the United Kingdom, approximately 25% are unaware of their diagnosis. Disease prevalence for specific populations can be estimated and may inform the clinician of those at greatest risk. For example, high HIV disease prevalence is seen in men who have sex with men in London (80 per 1000 persons), whereas widows and married women have a higher HIV prevalence over never-married women in sub-Saharan Africa. However, the misdiagnosis of neurological conditions has been described in cases in which HIV testing has been withheld from individuals who were perceived to be at low risk. Therefore, HIV testing should be performed in all cases in which the neurosurgical presentation is suggestive. Patients should always be informed that HIV testing will be performed, and they are entitled to refuse. No formal written consent should be required.

TABLE 1. Biopsy diagnoses showing regional variation

<table>
<thead>
<tr>
<th>Country</th>
<th>Sample Size</th>
<th>PML</th>
<th>PCNSL</th>
<th>Toxoplasmosis</th>
<th>Abscess, %</th>
<th>Other, %</th>
<th>No diagnosis, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>83</td>
<td>29%</td>
<td>23%</td>
<td>16%</td>
<td>12*</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>US</td>
<td>246</td>
<td>19%</td>
<td>53%</td>
<td>8%</td>
<td>?†</td>
<td>13†</td>
<td>7</td>
</tr>
<tr>
<td>US</td>
<td>243</td>
<td>30%</td>
<td>33%</td>
<td>16%</td>
<td>4</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Italy</td>
<td>158</td>
<td>17%</td>
<td>51%</td>
<td>6%</td>
<td>4</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>South Africa</td>
<td>38</td>
<td>0%</td>
<td>0%</td>
<td>39%</td>
<td>16</td>
<td>37‡</td>
<td>8</td>
</tr>
</tbody>
</table>

* Four patients had tuberculoma, 3 had nocardiosis, 2 had Chagas disease, and 1 had histoplasmosis.
† The authors do not provide a breakdown of “other diagnoses” therefore, the number of brain abscesses is unknown.
‡ Four patients had tuberculoma, 7 had encephalitis, 2 had cryptococcoma plus toxoplasmosis, and 1 had an infarction.
Risk of HIV Transmission Associated With Surgery

Sharps injuries are a potential route for HIV transmission during a neurosurgical admission. These may occur on the wards or in the operating room (with only 20% attributed to the operating room in the United Kingdom). A range of techniques exist to minimize the risk of sharps injuries, including a “no touch” suturing technique, use of a neutral zone for the passing of sharps, use of needle safety devices, and the use of blunt needles for fascial and muscle closure.

When the HIV status of a patient is known, additional practices are commonly employed. These include highlighting the potential risk during the surgical briefing, minimizing the number of operating surgeons and trainees, wearing eye protection, and double gloving with indicator gloves. Demonstrating the reduced risk of viral transmission consequent to these preventative measures is near impossible, but studies using models that assess glove damage, awareness of glove damage, and reported sharps injuries are generally supportive of these safety measures.

The risk of acquiring HIV infection following a needle stick injury from a known HIV positive patient is approximately 0.3%. The following are associated with an increased risk of HIV transmission: emergency surgery, deep injury, vascular breach, large volume of transferred blood, and injury caused by a hollow needle. In theory, any exposure that involves a breach of the skin could transmit infection, though many clinicians consider drawing blood exposure that involves a breach of the skin could transmit infection with an estimated risk of 0.09%. Other blood-borne viruses, such as hepatitis B and C, are associated with higher transmission rates (up to 30% and 3% respectively), and testing for these is also indicated following exposure.

Response to a Sharps Injury

Following a sharps injury, the trauma site should immediately be held under running water and washed with soap or mild disinfectant such as chlorhexidine gluconate. The hospital’s occupational health department should be informed at the first opportunity. When the HIV status of the patient is unknown, the patient should be approached and counseled for testing, but not by the injured party. If this is not possible, or if the patient refuses testing, the risk of transmission may be estimated based on the known prevalence within his or her demographic.

If the patient is known to be positive for HIV, or his or her status is unknown but considered high risk and the exposure significant, then PEP should be started within 1 hour and no later than 72 hours after injury. This has been shown to significantly reduce the risk of HIV seroconversion in the injured party (OR 0.19; [95% CI 0.06–0.52]).

Point-of-care testing can be performed using a mouth swab or finger-prick test, with the results available within minutes and a sensitivity approaching 100%. However, PEP should not be delayed while waiting for test results and should be continued for 28 days as tolerated. There may be adverse effects associated with PEP, although these vary according to the regimen used.

Following significant exposure, HIV testing should occur at baseline, 6 weeks, 12 weeks, and 6 months after exposure with pre- and posttest counseling. Legislation in the United Kingdom has recently changed to allow surgeons who test positive for HIV to carry out surgical procedures as long as they adhere to antiretroviral treatment and have an undetectable viral load.

Conclusions

The spectrum of possible CNS pathologies in HIV-positive individuals is broad. A definitive diagnosis can rarely be established on the basis of imaging and CSF tests alone yet is crucial to determining further management for hydrocephalus and guiding the timing of cART initiation. Established protocols for the management of mass lesions in an HIV-positive individual may advocate an initial trial for the treatment of toxoplasmosis. Neurosurgeons must be aware that in an HIV-positive individual with brain abscess, multiple microorganisms may concurrently be responsible. Corticosteroids should be avoided, if at all possible, prior to obtaining a diagnosis.

HIV infection should be considered, and testing offered, for all patients who present with suggestive CNS pathology. There is a small risk of HIV transmission from sharps injuries, and appropriate safety measures should be employed when undertaking surgery or more minor procedures. In the event of injury, the local occupational health services should be notified, and protocol should be followed to ensure prompt commencement of PEP where indicated.

HIV remains an important problem in both developed and developing countries. In cases of HIV-related CNS disease, neurosurgical involvement may be sought in order to obtain the diagnosis and manage complications, most notably hydrocephalus. Neurosurgeons should be aware of the range of possible pathologies, the limitations of imaging techniques in their diagnosis, and the need for a tailored approach to their management.

References


References
79. Saverdekar A, Chatterji D, Singh S, Mohindra S, Gupta S,
87. Skiest DJ, Crosby C: Survival is prolonged by highly active antiretroviral therapy in AIDS patients with primary central nervous system lymphoma. AIDS 17:1787–1793, 2003

Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Correspondence
Hugh Sims-Williams, Sheffield Centre for Neurosurgery, Sheffield Teaching Hospitals NHS Trust, Royal Hallamshire Hospital, Glossop Road, Sheffield S10 2JF, United Kingdom. email: simswilliams@doctors.org.uk.