Central Nervous System Infections in HIV-Infected Patients Hospitalized at King Chulalongkorn Memorial Hospital

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Background: *Central nervous system (CNS) infections are among one of the most common complications in HIV-infected patients. The present study aimed to determine the etiologies, clinical features, treatment, and outcomes of all CNS infections in HIV-infected patients.*

Material and Method: *A retrospective study was carried out in all adult HIV-infected patients with CNS infection who were hospitalized at King Chulalongkorn Memorial Hospital, Bangkok, Thailand, from January 1, 2007 to December 31, 2008. Medical records of the patients were identified by extensively searching the disease codes based on International Classification of Diseases-10, all microbiological data, and all histopathological data.*

Results: *One hundred forty eight patients were enrolled. There were 103 males (69.6%) with the mean age of 36.1 $\pm$ 8.9 years (range 15 to 75 years). Among 93 patients with available data, the median and percentage of CD4 cell count during hospitalization were 64.0 cells/microlitre and 6% (range 1-684 cells/microlitre and 1-57%). Among 106 patients with known HIV infection, 67 patients (63.2%) had received antiretroviral therapy with the mean duration of 1.6 $\pm$ 2.1 years. The most common CNS infection was cryptococcal meningitis (56 patients, 37.8%), followed by tuberculosis (53, 35.8%), toxoplasmosis (19, 12.8%), progressive multifocal leukoencephalopathy (6, 4.1%), varicella-zoster virus (VZV) meningitis (4, 2.7%), brain abscess (3, 2.1%), cytomegalovirus radiculomyelitis (2, 1.4%), pneumococcal meningitis (2, 1.4%), herpes simplex encephalitis, Epstein-Barr virus-related primary CNS lymphoma, and HIV-associated myelopathy (1 patient, each, 0.7%). Twenty-two patients died, accounting for the mortality rate of 14.9%. Of these 22 patients, tuberculous meningitis was the most common cause (9 patients, 16.9%), followed by cryptococcal meningitis (9, 16.1%), VZV encephalitis, Aspergillus brain abscess, herpes simplex encephalitis, and pneumococcal meningitis (1, 4.8% each).*

Conclusion: *To the authors' knowledge, this is the first comprehensive study in Thailand to investigate the etiologies, clinical manifestations, and outcomes of all CNS infections in AIDS patients. There are a high number of patients with tuberculosis and severe immunodeficiency in the present study. The authors' findings suggest an urgent need to actively search and treat most HIV-infected patients in the community before they become severely immunocompromised.*

Keywords: *Central nervous system infections, HIV, AIDS, Opportunistic infections, Toxoplasmosis, Cytomegalovirus, Cryptococcal meningitis*

J Med Assoc Thai 2011; 94 (5): 551-8
Full text. e-Journal: *http://www.mat.or.th/journal*

Central nervous system (CNS) opportunistic infections (OIs) are among one of the most common complications in patients with HIV infection, especially before the highly active antiretroviral therapy (HAART) era[1-8]. Approximately one-third of all patients with AIDS present with neurological complications mostly due to infections[1-7]. The sites of CNS involvement can be the brain, the spinal cord, the cranial nerves, the spinal nerve roots, and the meninge. The etiologies include infections, neoplasms and vasculopathy. Highly active antiretroviral therapy (HAART) is effective in the treatment of HIV infection and has been shown to improve survival of HIV-infected patients due to the decreased incidence of OIs and OI-associated neoplasms[9,10]. The incidence of many CNS OIs including cryptococcal meningitis, toxoplasmosis, progressive multifocal leukoencephalopathy (PML), and primary CNS lymphoma has decreased after the introduction of HAART. In addition, HAART has been shown to improve the number of CD4 cells, and restore

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the immune function[11]. The exaggerated immune response to an opportunistic pathogen or tumor antigen during this immune restoration called immune reconstitution syndrome may induce the clinical exacerbation of the OI[12,13]. Therefore, the spectrum and clinical manifestations of CNS OIs are different between before and after the HAART era.

In Thailand, there has been a wide use of HAART since 2002 when the Ministry of Public Health developed the national guidelines for management of HIV-infected patients[14]. The spectrum and clinical manifestations of CNS OIs may have been changed, compared to those before the HARRT era. The authors thus aimed to determine the occurrence, clinical manifestations and outcomes of CNS OIs in all HIV-infected patients hospitalized at King Chulalongkorn Memorial Hospital (KCMH), Bangkok, Thailand.

Material and Method

Study design

All adult HIV-infected patients with CNS infection hospitalized at KCMH, Bangkok, Thailand between January 1, 2007 and December 31, 2008 were enrolled in the present study. The institutional review board approved the protocol.

Patients

Inclusion criteria included all adult patients older than 15 years of age who were hospitalized due to CNS infection. Medical records of these patients were retrospectively identified by extensively searching the disease codes based on International Classification of Diseases-10 (ICD-10), all microbiological data, and all histopathological data during the study period. All data including demography, clinical manifestations, microbiology, treatment, and outcomes were analyzed.

Statistic analysis

The SPSS software version 17.0 was used for the statistical analyses. The continuous variables were compared using the Student's t-test and the Chi-square or Fisher's exact test was used to compare the categorical variables. The variables, which were significantly different between the two groups analyzed by the univariate analysis, were then tested by the logistic regression model for the multivariate analysis. All p-values were two-tailed with those of less than 0.05 were considered statistically significant.

Results

Demographic characteristics

During the study period, there were one hundred forty eight patients [103 (69.6%) males] with the mean age of 36.1 $\pm$ 8.9 years (range 15 to 75 years) (Table 1). Thirty-three (22.3%) patients had underlying illnesses including chronic hepatitis C virus (HCV) infection (14 patients, 9.5%), chronic hepatitis B virus (HBV) infection (12, 8.1%), diabetes mellitus (4, 2.7%), hematologic diseases (4, 2.7%), cirrhosis (3, 2.02%), and cerebrovascular disease (2, 1.4%). One hundred eight (72.9%), 19 (12.8%) and 19 (12.8%) patients were categorized in the heterosexual, homosexual and intravenous drug use HIV risk groups, respectively. A diagnosis of HIV infection was made before and during this hospitalization in 106 (71.6%) and 42 (28.4%) patients, respectively. Among 106 patients with known HIV infection, 67 (63.2%) patients had received antiretroviral therapy with the mean duration of 1.6 $\pm$ 2.1 years. Among 93 patients with available data, the median absolute number and percentage of CD4 cell count during hospitalization were 64.0 cells/mL and 6% (range 1-684 cells/mL and 1-57%). Among 97 patients (65.5%) with previous opportunistic infections, there were 28 cryptococcosis (28.9%), 24 varicella-zoster virus (VZV) diseases (24.7%), 17 *Pneumocystis jirovecii* pneumonia (17.5%), 14 candidiasis (14.4%), three toxoplasmosis (3.1%), three cytomegalovirus (CMV) diseases (3.1%) and one mycobacterial infection (1.03%).

Clinical characteristics

Among 148 patients with CNS infection, the most common presenting neurological symptom was headache (97 patients, 65.5%), followed by altered consciousness (52, 35.1%), nausea/vomiting (52, 35.1%), weakness (35, 23.6%), seizures (32, 21.6%), diplopia (10, 6.8%), blurred vision (10, 6.8%), and numbness (8, 5.4%) (Table 2). The three most common extra-neurological symptoms were fever (86 patients, 58.1%), cough (16, 10.8%), and dyspnea (9, 6.1%). The most common neurological sign was neck stiffness (83 patients, 56.1%), followed by motor deficit (50, 33.8%), cranial nerve palsy (44, 29.7%), papilledema (26, 17.6%), and sensory deficit (16, 10.8%). In addition, the three most common extra-neurological signs included lymphadenopathy (70 patients, 47.3%), oral thrush (68, 45.9%), and oral hairy leukoplakia (53, 35.8%).

Among 148 patients, the most common CNS infection was cryptococcal meningitis (39 and

Table 1. Study population characteristics (148 patients)

Variable	Number (%)
Gender (men)	103 (69.6)
Age (mean ± SD) (year)	36.1 ± 8.9
Underlying illness	
Chronic HCV infection	14 (9.5)
Chronic HBV infection	12 (8.1)
Diabetes mellitus	4 (2.7)
Hematologic disease	4 (2.7)
Cirrhosis	3 (2.02)
Cerebrovascular disease	2 (1.4)
Others	6 (4.1)
HIV risk category	
Heterosexual risk	108 (72.9)
Homosexual risk	19 (12.8)
Intravenous drug use	19 (12.8)
Others	16 (10.8)
Diagnosis of HIV infection	
Known diagnosis	106 (71.6)
First diagnosis	42 (28.4)
Duration of HIV infection (median, range) (year)	3 (0.08-17)
Antiretroviral therapy among 106 patients with known HIV infection	
Current therapy	67 (63.2)
Duration (mean ± SD) (year)	1.6 ± 2.1
CD4 cell count during hospitalization (median, range)[1]	
Absolute number	64, 1-684 cells/μL
Percentage	6%, 1-57%
Previous opportunistic infection	
Cryptococcosis	28 (28.9)
Varicella-zoster infection	24 (24.7)
Pneumocystis jirovecii pneumonia	17 (17.5)
Candidiasis	14 (14.4)
Toxoplasmosis	3 (3.1)
Cytomegalovirus infection	3 (3.1)
Mycobacterial infection	1 (1.03)
Others	2 (1.6)

[1] Only 93 patients with available data
Data are shown in number and percentage of patients, unless otherwise indicated in some variables
SD = standard deviation; HCV = hepatitis C virus; HBV = hepatitis B virus

17 patients with definite and probable diagnosis, 37.8%), followed by tuberculosis both meningitis and disseminated infection (26 and 27 patients with definite and probable diagnosis, 35.8%), toxoplasmosis (19, 12.8%), JC virus-associated progressive multifocal leukoencephalopathy (PML) (6, 4.1%), VZV meningitis (4, 2.7%), brain abscess caused by *Staphylococcus aureus*, *Nocardia*, or *Aspergillus* (3, 2.1%), CMV radiculomyelitis (2, 1.4%), pneumococcal meningitis (2, 1.4%), herpes simplex virus (HSV) encephalitis, Epstein-Barr virus (EBV)-related primary CNS lymphoma, and HIV-associated myelopathy (1 patient, each, 0.7%) (Table 3). Some patients had more than one opportunistic infection and some had both CNS and extra-CNS infections.

Laboratory investigations

HIV infection

Among 148 patients, the median absolute number and percentage of CD4 cell count during hospitalization were 64.0 cells/microlitre and 6% (range 1-684 cells/microlitre and 1-57%) (Table 3). The patients

Table 2. Clinical characteristics of all 148 HIV-infected patients with central nervous system infection

Clinical characteristics	Number (%)
I. Symptoms	
Neurological symptoms	
Headache	97 (65.5)
Altered consciousness	52 (35.1)
Nausea/vomiting	52 (35.1)
Weakness	35 (23.6)
Seizures	32 (21.6)
Diplopia	10 (6.8)
Blurred vision	10 (6.8)
Numbness	8 (5.4)
Autonomic nervous system dysfunction	7 (4.7)
Ataxia	7 (4.7)
Extra-neurological symptoms	
Fever	86 (58.1)
Cough	16 (10.8)
Dyspnea	9 (6.1)
Chills	8 (5.4)
Diarrhea	8 (5.4)
Abdominal pain	4 (2.7)
Skin rash	4 (2.7)
Others	14 (9.5)
II. Signs	
Neurological signs	127 (85.8)
Neck stiffness	83 (56.1)
Motor deficit	50 (33.8)
Hemiparesis	25 (16.9)
Paraparesis	17 (11.5)
Monoparesis	5 (3.4)
Quadriparesis	3 (2.0)
Cranial nerve palsy	44 (29.7)
Papilledema	26 (17.6)
Sensory deficit	16 (10.8)
Cerebellar deficit	15 (10.1)
Autonomic nervous system deficit	5 (3.4)
Visual field defect	4 (2.7)
Others	25 (16.9)
Extra-neurological signs	
Lymphadenopathy	70 (47.3)
Oral thrush	68 (45.9)
Oral hairy leukoplakia	53 (35.8)
Hepatomegaly	38 (25.7)
Splenomegaly	10 (6.8)

with HIV-associated myelopathy had the lowest median absolute number and percentage of CD4 cell count (11 cells/mL, 2%), followed by those with EBV-related primary CNS lymphoma (20, 3%), PML (48, 4.5%), pneumococcal meningitis (50.5, 6%), VZV meningitis (55, 11.5%), toxoplasmosis (59, 6%), cryptococcal meningitis (82, 6%), tuberculosis (142, 9.5%), and brain abscess (180, 15%). Unfortunately, the data regarding plasma HIV RNA was not available in all patients.

Opportunistic infections

Among 148 patients, the definite diagnosis could be made in 76 patients (51.4%) (Table 3). One hundred twenty one (81.7%) patients received at least one time of lumbar puncture for cerebrospinal fluid analysis, and 139 (93.9%) underwent either cranial computed tomogram (135 patients, 97.1%) or magnetic resonance imaging (33, 23.7%). Among 18 patients with polymerase chain reaction study in the cerebrospinal fluid specimen, the positive result was noted in five of seven (71.4%), three of three (100%), one of one (100%), one of two (50%) and one of five (20%) patients with tuberculous meningitis, VZV meningitis, HSV encephalitis, CMV radiculomyelitis and JC virus-associated PML, respectively. Eleven (7.4%) patients underwent either brain biopsy (9 patients, 81.8%) or necropsy (2, 18.2%). Among nine patients with brain biopsy, the definite diagnosis could be made in six (66.7%) patients. Among three patients with brain necropsy, the definite diagnosis was made in two (66.7%) patients.

Treatment and outcomes

Among 148 patients, the median length of hospital stay in all patients was 15 days (range 1 to 75 days) (Table 3). The patients with brain abscess had the longest median length of stay (42 days), followed by those with VZV meningitis (24 days), JC virus-associated PML and CMV radiculomyelitis (23 days, each), cryptococcal meningitis (18 days), tuberculosis and toxoplasmosis, and pneumococcal meningitis (12 days, each). Twenty-two patients died, accounting for the mortality rate of 14.9% (Table 3). Among these 22 patients, there were nine (16.9%), nine (16.1%), one (100%), one (50%), one (33.3%), and one (25%) deaths in patients with tuberculosis, cryptococcal meningitis, HSV encephalitis, pneumococcal meningitis, *Aspergillus* brain abscess and VZV meningitis, respectively.

Discussion

In Thailand, only one retrospective study in Chiang Mai University Hospital, North Thailand, has been performed to compare the prevalence of neurological complications in AIDS patients with HAART in the early HAART era (2003-2004) and without HAART in the pre-HAART (2002-2003) era[15].

Table 3. Central nervous system (CNS) infections in 148 HIV-infected patients

Infection	Category		Total	Median CD4 count (median percentage of CD4)	Median length of stay (day)	Mortality
	Definite	Probable				
Cryptococcal meningitis	39	17	56 (37.8)	82 (6.0)	18	9 (16.1)
Tuberculosis	26	27	53 (35.8)	142 (9.5)	12	9 (16.9)
Toxoplasmosis	0	19	19 (12.8)	59 (6.0)	12	0
PML	1	5	6 (4.1)	48 (4.5)	23	0
Varicella-zoster virus meningitis	3	1	4 (2.7)	55 (11.5)	24	1 (25.0)
Brain abscess[1]	3	0	3 (2.1)	180 (15.0)	42	1 (33.3)
Cytomegalovirus radiculomyelitis	1	1	2 (1.4)	NA	23	0
Pneumococcal meningitis	2	0	2 (1.4)	50.5 (6.0)	12	1 (50.0)
Herpes simplex virus encephalitis	1	0	1 (0.7)	NA	2	1 (100)
Epstein-Barr virus-related primary CNS lymphoma	0	1	1 (0.7)	20 (3.0)	5	0
HIV-associated myelopathy	0	1	1 (0.7)	11 (2.0)	4	0
Total	76 (51.4)	72 (48.6)	148 (100)	64 (6.0)	15	22 (14.9)

[1] Brain abscess caused by *Staphylococcus aureus*, *Nocardia*, and *Aspergillus* (1 patient, each)
Data are shown in number and percentage (in parenthesis) of patients, unless otherwise indicated in some variables
PML = progressive multifocal leukoencephalopathy; NA = not available

There has been a wide use of HAART since 2002 when the Ministry of Public Health of Thailand developed the national guidelines for management of HIV-infected patients[14]. The present study is the first comprehensive study in Thailand to investigate the etiologies, clinical manifestations, and treatment outcomes of all CNS infections in HIV-infected patients with and without HAART by extensively searching the diseases based on ICD-10, all microbiological data, and all histopathological data after the implementation of the national guidelines for eight years.

In the present study, there were approximately one-fourth of the patients with a new diagnosis of HIV infection during this hospitalization, and only two-thirds of the patients with known HIV infection had received antiretroviral therapy with the mean duration of approximately two years and the median number of CD4 cell count of approximately 60 cells/mL. In the present study, the common CNS infections included cryptococcal meningitis, tuberculosis both disseminated infection and meningitis, toxoplasmosis, and PML, which differ from those described in other studies in tuberculosis-nonendemic countries. The incidence of cryptococcal meningitis, primary CNS lymphoma, and toxoplasmosis in the Multicenter AIDS Cohort Study has decreased significantly since the introduction of HAART in 1996[16]. A study in homosexual men has shown the decreased incidence rates of toxoplasmosis and PML between 1992 and 1996[17]. A recent cohort study in American patients between 1994 and 2007 described the declining incidence of OIs, and the most common AIDS-defining illnesses were esophageal candidiasis, *Pneumocystis jirovecii* pneumonia, cervical cancer and *Mycobacterium avium* complex infection[18]. In conclusion, in developed countries, the incidence of CNS OIs including cryptococcal meningitis, toxoplasmosis, PML, and primary CNS lymphoma have decreased since the introduction of HAART[19]. In Thailand, there are a handful studies of OIs in HIV-infected patients both in the pre-HAART and HAART periods. A study in adult patients hospitalized at Bamrasnaradura Infectious Disease Hospital, Bangkok, in the pre-HAART period between 1993 and 1996, has shown that the most common OIs were extrapulmonary cryptococcosis, tuberculosis and *Pneumocystis jirovecii* pneumonia[20]. A national study by the Ministry of Public Health between 1994 and 1998 has shown that the five most common AIDS-defining illnesses were tuberculosis, *Pneumocystis jirovecii* pneumonia, cryptococcosis, esophageal candidiasis, and bacterial pneumonia[21]. Another study in Siriraj Hospital, Bangkok, in the early HAART period in 2002, reported that the most common OIs in hospitalized

patients were tuberculosis, *Pneumocystis jirovecii* pneumonia and cryptococcosis. In that study, only 7.7% of the patients had received antiretroviral therapy before hospitalization[22]. A recent study in Chiang Mai University Hospital, North Thailand, reported that the incidence of PML, toxoplasmosis, and cryptococcal meningitis has decreased, whereas the incidence of stroke and primary CNS lymphoma has increased since the introduction of HAART in 2003[15]. Surprisingly, there were no patients with CNS tuberculosis in this study, probably due to the differences in inclusion criteria, the study period and geographic distribution of OIs.

The mortality rate in the present study was approximately 15%. Tuberculosis and cryptococcal meningitis were the two most common causes of death, contributing to more than 80% of the patients. The mortality of HIV-infected patients with cryptococcal meningitis varied from 10% to 50%. The poor outcome is mainly due to inappropriate management of increased intracranial pressure, no availability of effective antifungal agents and late presentation of most patients[23]. In the present study, the mortality was approximately 17%, which was consistent with that observed in a previous study in KCMH[24]. In Thailand, the average mortality of cryptococcal meningitis varies from 10% to 30%[23]. The mortality of HIV-infected patients with tuberculosis can be up to 50% especially within two months after treatment[25,26]. A retrospective study in Thailand reported the short-term mortality rate of HIV-infected patients with tuberculosis was approximately 45%[27]. A recent study in Ubon-ratchathani, Northeast Thailand, demonstrated that the mortality of tuberculosis was reduced from 43% to 7% in HIV-infected patients without and with HAART[26].

The limitations of the present study are mainly from the retrospective nature and incomplete clinical data from unavailable medical records. Despite these limitations, to the authors' knowledge the present study is the first comprehensive study in Thailand to investigate the etiologies, clinical manifestations and outcomes of all CNS infections in AIDS patients.

In conclusion, in KCMH, there is still a high number of HIV-infected patients with severe immunodeficiency who presented with neurological AIDS-defining illness. The profile of infections is comparable to that described in other studies in developed countries except the high number of patients with disseminated tuberculosis observed in the present study despite a wide use of HAART since 2002. The present findings suggest an urgent need to actively search and treat most HIV-infected patients in the community with HAART before they become severely immunocompromised.

Acknowledgements

The authors wish to thank all medical staffs at the Microbiology and Pathology Departments.

Potential conflicts of interest

None.

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การติดเชื้อของระบบประสาทส่วนกลางในผู้ป่วยติดเชื้อเอชไอวี ที่รับไว้ในโรงพยาบาลจุฬาลงกรณ์, ประเทศไทย

ศิริพร ของสิริวัฒนกุล, ชุษณา สวนกระต่าย

***ภูมิหลัง**: การติดเชื้อของระบบประสาทส่วนกลางเป็นหนึ่งในภาวะแทรกซ้อนที่พบบ่อยที่สุดในผู้ป่วยติดเชื้อเอชไอวี การศึกษามีจุดประสงค์เพื่อหาสาเหตุ ลักษณะทางคลินิก การรักษา และผลการรักษา ในผู้ป่วยติดเชื้อเอชไอวีทั้งหมดที่มีการติดเชื้อของระบบประสาทส่วนกลาง*

***วัสดุและวิธีการ**: การศึกษาแบบย้อนหลังในผู้ป่วยผู้ใหญ่ทั้งหมดที่ติดเชื้อเอชไอวี และมีการติดเชื้อของระบบประสาทส่วนกลางที่รับไว้ในโรงพยาบาลจุฬาลงกรณ์ กรุงเทพมหานคร ประเทศไทย ในช่วงวันที่ 1 มกราคม พ.ศ. 2550 ถึงวันที่ 31 ธันวาคม พ.ศ. 2552*

***ผลการศึกษา**: มีจำนวนผู้ป่วยทั้งหมด 148 ราย ในช่วงที่ศึกษา มีผู้ป่วยชาย 103 ราย (ร้อยละ 69.6) โดยมีอายุเฉลี่ย 36.1 $\pm$ 8.9 ปี (พิสัย 15-75 ปี) ในผู้ป่วย 93 ราย ที่ส่งตรวจพบค่าเฉลี่ยและเปอร์เซ็นต์ของจำนวนเซลล์ CD4 ในขณะรับไว้ในโรงพยาบาลเท่ากับ 64.0 เซลล์/ไมโครลิตร และ 6% (พิสัย 1-684 เซลล์/ไมโครลิตร และ 1-57%) ผู้ป่วย 106 ราย ที่ทราบว่าติดเชื้อเอชไอวีมาก่อน 67 ราย (ร้อยละ 63.2) ที่ได้รับการรักษาด้วยยาต้านไวรัสเอดส์ โดยมีค่าเฉลี่ยของระยะเวลาที่ได้เท่ากับ 16 $\pm$ 2.1 ปี การติดเชื้อของระบบประสาทส่วนกลางที่พบบ่อยที่สุด ได้แก่ เยื่อหุ้มสมองอับเสบจาก Cryptococcus neoformans (56 ราย ร้อยละ 37.8) ตามมาด้วยวัณโรค (53 ราย ร้อยละ 35.8) toxoplasmosis (19 ราย ร้อยละ 12.8) progressive multifocal leukoencephalopathy (6 ราย ร้อยละ 4.1) เยื่อหุ้มสมองอักเสบจาก Varicella-zoster virus (VZV) (4 ราย ร้อยละ 2.7) ฝีในสมอง (3 ราย ร้อยละ 2.1) รากประสาทและไขสันหลังอักเสบจาก Cytomegalovirus (2 ราย ร้อยละ 1.4) เยื่อหุ้มสมองอักเสบจาก Streptococcus pneumoniae (2 ราย ร้อยละ 1.4) สมองอักเสบจาก Herpes simplex virus (HSV) ลิมโฟมาปฐมภูมิของระบบประสาทส่วนกลางที่เกี่ยวข้องกับ Epstein-Barr virus และโรคไขสันหลังที่เกี่ยวข้องกับเอชไอวี (1 รายในแต่ละโรค ร้อยละ 0.7) ผู้ป่วย 22 ราย ถึงแก่กรรม คิดเป็นอัตราตายร้อยละ 14.9 ในบรรดาผู้ป่วย 22 รายนี้ สาเหตุการถึงแก่กรรมที่พบบ่อยที่สุด ได้แก่ เยื่อหุ้มสมองอักเสบจากวัณโรค (9 ราย ร้อยละ 16.9) ตามมาด้วยเยื่อหุ้มสมองอักเสบจาก C. neoformans (9 ราย ร้อยละ 16.1) สมองอักเสบจาก VZV ฝีในสมองจาก Aspergillus และสมองอักเสบจาก HSV (1 ราย ในแต่ละโรค ร้อยละ 4.8)*

***สรุป**: จากความรู้ของผู้นิพนธ์ การศึกษานี้ถือเป็นการศึกษาแรกที่ครอบคลุมในประเทศไทยที่จะหาสาเหตุ และลักษณะทางคลินิกของผู้ป่วยติดเชื้อเอชไอวีที่มีการติดเชื้อของระบบประสาทส่วนกลาง ในการศึกษานี้มีจำนวนผู้ป่วยที่เป็นวัณโรคและภูมิต้านทานต่ำมาก ผลการศึกษานี้จึงนำไปสู่ความต้องการอย่างเร่งด่วนที่ต้องค้นหาและรักษาผู้ป่วยติดเชื้อเอชไอวีในชุมชนก่อนที่ผู้ป่วยเหล่านั้นจะมีภูมิต้านทานต่ำเกินไป*