# Brain Abscess: Management and Outcome Analysis of a Computed Tomography Era Experience with 973 Patients

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**Key words**
- Brain abscess
- Cranial infections
- Health care
- Otogenic
- Paranasal
- Sinusitis
- Trauma

**Abbreviations and Acronyms**
**BA**: Brain abscess
**CD**: Cluster of differentiation
**CI**: Confidence interval
**CSF**: Cerebrospinal fluid
**CT**: Computed tomography
**ENT**: Ears, nose, and throat
**GOS**: Glasgow outcome score
**HIV**: Human immunodeficiency virus
**ICE**: Intracranial empyema
**ICH**: Intracerebral hematoma
**ICSD**: Intracranial suppurative disorders
**KZN**: KwaZulu-Natal
**LP**: Lumbar puncture
**MRI**: Magnetic resonance imaging
**OR**: Odds ratio
**SVR**: Spontaneous ventricular rupture
**TB**: Tuberculosis bacilli

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OBJECTIVE: **Brain abscess (BA) is a neurosurgical emergency and despite significant medical advances, it remains a surgical challenge. A single institution's two decade computed tomography era management experience with BA is reported.**

METHODS: **A retrospective analysis of patients with BA, admitted to the Department of Neurosurgery, Wentworth Hospital, Durban, KwaZulu-Natal, South Africa, was performed. The medical records were analyzed for demographic, clinical, neuroimaging, neurosurgical and otolaryngology management, microbiological characteristics, and their relationship to outcome.**

RESULTS: **During a 20-year period (1983–2002), 973 patients were treated. The mean age was 24.36 ± 15.1 years (range: 0.17–72 years) and 74.2% (n = 722) were men. The mean admission Glasgow Coma Score was 12.5 ± 2.83. The majority of BAs were supratentorial (n = 872, 89.6%). The causes were otorhinogenic (38.6%), traumatic (32.8%), pulmonary (7%), cryptogenic (4.6%), postsurgical (3.2%), meningitis (2.8%), cardiac (2.7%), and "other" (8.6%). Surgical drainage was performed in 97.1%, whereas 19 patients had nonoperative management. The incidence of BA decreased during the study period. Patient outcomes were good in 81.3% (n = 791), poor in 5.3% (n = 52), and death (13.4%, n = 130) at discharge. The management morbidity, which included postoperative seizures, was 24.9%. Predictors of mortality were cerebral infarction (odds ratio [OR] 31.1), ventriculitis (OR 12.9), coma (OR 6.8), hydrocephalus (OR 5.1), dilated pupils (OR 4.8), bilateral abscesses (OR 3.8), multiple abscesses (OR 3.4), HIV co-infection (OR 3.2), papilledema (OR 2.6), neurological deterioration (OR 2.4), and fever (OR 1.7).**

CONCLUSIONS: **Optimal management of BA involves surgical drainage for medium-to-large abscesses (≥2.5 cm) with simultaneous eradication of the primary source, treatment of associated hydrocephalus, and administration of high doses of intravenous antibiotics. The incidence of BA is directly related to poor socioeconomic conditions and therefore, still poses a public health challenge in developing countries.**

## INTRODUCTION

Brain abscess (BA), a neurosurgical emergency, is usually fatal if left untreated. Although uncommon in developed countries, this form of intracranial suppuration is still prevalent in developing regions of the world, primarily due to disparate socioeconomic conditions.

The first significant advance in the treatment of these intracranial suppurative disorders (ICSD) was the introduction of antibiotics, albeit still with high mortality of 40% to 60% (5, 7, 12). The introduction of computed tomography (CT) resulted in earlier diagnosis and accurate localization. Further advances in micro-organism isolation and identification, superior antimicrobials with greater cerebrospinal fluid (CSF) penetration, and stereotactic aspiration has resulted in a contemporary mortality of less than 10% (9). However, in underdeveloped regions of the world where basic surgical treatment is often only possible, the impact of improving socioeconomic conditions with concomitant improvement of health care delivery cannot be overestimated in driving down morbidity and mortality.

The 106-bed unit at Wentworth Hospital, Durban, South Africa, was the sole public sector neurosurgical referral center for the province of KwaZulu-Natal (KZN) and served a population of nine million people

until its closure in December 2002. This report describes this single institution's unique experience with the management of BA and factors that significantly impacted outcome.

## MATERIALS AND METHODS

The clinical and demographic data of all patients treated at Wentworth Hospital, Durban, KZN, South Africa, the only tertiary referral center in the region, were prospectively entered into a computerized databank since January 1983. A retrospective audit of all patients admitted with BA from 1983 to 2002 was extracted from this databank. The identification of frank pus in brain parenchyma, or the ventricle (after rupture of a rim enhancing, periventricular lesion) was the sole requirement for inclusion into the study. Patients with other forms of intracranial empyemas (ICE) who developed BAs and patients with BAs who developed ICE were also included. Patients included in this study have been the subjects of previous reports (20, 24–29, 37).

### Patient Management

Patients were transferred to the Unit after telephone and/or telemetric consultation, in the latter years through a network of CT scanners strategically located (11). A contrast-enhanced CT scan of the brain was performed, including fine cuts through the paranasal and mastoid sinuses when otorhinogenic sepsis was suspected. A BA was diagnosed when the contrast-enhanced CT scan showed the presence of a hypodense or isodense intra-axial collection with rim enhancement, whereas opacification of the paranasal sinuses and sclerosis of the mastoid sinus indicated otorhinogenic sepsis.

Emergent surgical drainage was performed if the capsule stage of BA formation had developed. All supratentorial abscesses were approached either by bur hole or limited craniectomy or craniotomy, according to the surgeon's preference. A brain cannula was used to locate the capsule closest to the cortex, which was then incised, opened, and pus drained under direct vision and loculations, when present, were broken down (17, 18). A soft rubber catheter was left in the cavity, and tunneled, avoiding kinking in a subgaleal fashion to exit the scalp and openly drain into a strategically placed sodium hypochlorite-soaked gauze to maintain patency and sterility. The ears, nose, and throat (ENT) procedures or surgical eradication of the primary source, when applicable, was performed after drainage of the BA and under the same anesthetic, if not done at the referral hospital. Infratentorial abscesses were drained by a suboccipital craniectomy, whereas the CSF diversion through a ventriculostomy was immediately performed to relieve a secondary hydrocephalus (22).

Patients presenting with cerebritis had eradication of their primary source followed by intravenous antibiotics and serial CT scans. Any patient with an nonoperated BA that enlarged on antibiotic therapy with surveillance CT or that failed to shrink after 2 weeks of antibiotic therapy had surgery. Since 1995, deep-seated BA were drained with a frame-based stereotactic system (Cosman-Robert-Wells stereotactic frame; Integra Radionics; Burlington, Massachusetts, USA). Excision of the BA was not the primary form of surgical treatment and was generally reserved only after multiple drainages and/or isolation of unusual resistant organisms or fungal BA, which recurred after drainage. Repeat surgery was performed, when necessary, until the BA and its primary source were eradicated.

Microbiological analysis involved aerobic, anaerobic, fungal, and *Tuberculosis bacilli* (TB) culture of the pus. Human immunodeficiency virus (HIV) testing was performed sporadically in patients with a clinical suspicion of HIV/acquired immunodeficiency syndrome, but after 1995, all patients were tested. All patients were initially started on a triple antibiotic therapy—penicillin (100,000 units/kg every 6 hours), chloramphenicol (15 mg/kg every 6 hours), and metronidazole (7.5 mg/kg every 8 hours)—in the postoperative period. The antibiotic regimen was changed, according to sensitivity, and administered intravenously for 6 weeks followed by an additional 6 weeks of oral treatment. Fungal BA was treated with intravenous antifungal agents. All patients received prophylactic dilantin (3–5 mg/kg).

The course of the BA and its primary source (sinusitis) was followed by serial CT scans, together with clinical improvement, usually, at 4-day intervals or sooner if clinically indicated. Outpatient follow-up was performed until complete resolution the BA occurred based on CT scans. A dichotomized Glasgow outcome scale (GOS) (10) was used to determine the outcome: good (GOS 4 or 5), poor (GOS 1–3).

### Statistical Methods

The effect of demographic, clinical parameters, etiology, neuroimaging findings and type of surgery, and among other things mortality, were analyzed using with the $\chi^2$ test and odds ratio (OR) at 95% confidence intervals (CI). Significant outcome predictors on univariate analysis were further analyzed using a logistic regression model. The effect of seasonal variation on the etiology of BA was analyzed using multivariate analysis of variance. In HIV-positive patients, the differences in cluster of differentiation (CD) counts were analyzed using the t-test, whereas the Spearman rank order correlations were formed to determine the relationship between the CD counts.

## RESULTS

### Epidemiology and Demography

During a 20-year study period, 5980 patients of the total admissions (n = 38,763) to the Unit, presented with intracranial infections, of which 973 patients (16.3%) had BA and 1042 patients (17.4%) had ICE, making this the commonest ICSD seen in South Africa. Infratentorial suppuration (i.e., cerebellar abscesses and empyemas) comprised 7.4% of all pus collections.

The majority of patients (51.1%) had been transferred from local hospitals within the same city, 240 patients were referred from rural hospitals within about a 250-km radius of the Unit, whereas 236 patients were transferred from hospitals more than 250 km away. The mean age was 24.36 ± 15.1 years and men were most afflicted (n = 722, 74.2%). Nearly 70% of the patient cohort was in the first three decades of life, and 42.7% were pediatric patients (<18 years).

A decreasing incidence of BA was seen throughout the study period (**Figure 1**). There were two significant peaks in the incidence of traumatic BA: between the years 1987 and 1988, and in 1996, whereas a significant decrease in otorhinogenic BA was noted in 1988. Traumatic BA was more common in the December ($P < 0.001$), January ($P < 0.01$), and February ($P = 0.086$)