SUBDURAL EMPYEMA - A CLINICAL STUDY.

- ARNOLD BOK M.B.Ch.B.;
F.C.S.(S.A.) Neurological Surgery

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SUMMARY:

Subdural empyema is a relatively rare condition that carries a high mortality if not treated adequately. The experience at Groote Schuur Hospital over 8 years from 1979 to 1986 was reviewed. 47 cases of subdural empyema following on contiguous or distant infection, or where the source was not known, were included in this study. Subdural empyema following cranial operation, head trauma-, or meningitis was excluded. Computer Tomographic scanning facilitated early diagnosis and pinpointed subdural collections, and was used postoperatively, to locate residual subdural pus, which was then drained.

The results indicate that an aggressive approach using modern radiological techniques to guide surgical procedures, vastly improves the outcome from subdural empyema. The mortality rate was only 8,5%, while 72,3% of our patients were cured and returned to pre-disease activity. The availability of Computer Tomographic scanning in the management of subdural empyema improves the outcome of patients treated with burrhole drainage and diminishes the need for craniotomy. Rare cases may even be managed with antibiotics only.

It remains important to deal with the source of subdural empyema - paranasal in 31, otogenic in 10, osteitis in 2 and not known in 4 of the patients. Anaerobic organisms (28%), which are difficult to culture, and contribute to the high incidence of sterile cultures (32%),play an important role in subdural empyema. Chloramphenicol remains the most useful antibiotic.

In the long term only 18,6% of patients had seizures and only 16,3% had focal neurological signs. Complications, especially brain abscess developed in 5 cases where pus was not drained adequately initially, and this contributed to a poorer outcome. Steroid administration did not seem to affect the management of subdural empyema.

Repeated surgical drainage and administration of broad spectrum antibiotics remain the mainstays of the treatment of subdural empyema.

KEY WORDS:

Empyema - Subdural space - source - surgical drainage - organisms cultured - antibiotics - epilepsy - outcome.

INTRODUCTION:

An empyema is an infection spreading in a preformed space.

Subdural empyema (S.E.) can be divided into four groups :

1) Following trauma or surgery, where the infection is introduced directly into the subdural space.

2) As a complication of meningitis.

3) Following hematogenous spread from a distant infection.

4) As a result of direct spread from a contiguous infection, e.g. sinusitus, mastoiditis or local osteitis.

The diagnosis of S.E. arising as a complication of cranial trauma or operation is often made easier by the presence of external evidence of infection. These patients are already hospitalised in most cases and on antibiotic therapy, which is also true for cases of S.E. complicating meningitis. If we accept that early diagnosis of S.E. is the key to adequate and effecetive treatment, then the outcome of S.E. caused by cranial trauma or operation, or complicating meningitis will be influenced by these factors.

Williams divides S.E. into spontaneous, i.e. cases as a complication of meningitis, contiguous infection or haematogenous spread of infection, and secondary, i.e. cases post trauma or post cranial surgery. He also states that the diagnosis and treatment of secondary S.E. is relatively easy and the prognosis relatively good. *(84).
Smith et al exclude cases of post-meningitic S.E. that were not grossly purulent from their reviews *(72), presumably because the treatment of such cases is simplified by the fact that such collections are easily drained via burrholes.

The incidence of S.E. has not decreased despite prophylactic surgery for ear infections and the availability of newer anibiotics *(84). The role of surgery and the type of operation performed for drainage of pus has also been questioned in the management of S.E. The availability of computerised tomographic (C.T.) scanning has made the diagnosis of S.E. easier and this earlier diagnosis may have improved the outcome. The role of steroids and of anticonvulsants in the management of S.E., and the organisms responsible and their susceptibility to various antibiotics also need clarification.

To answer these questions, a study was performed of all the cases of S.E., arising from a contiguous extradural infection, or from haematogenous spread from a distant infection, diagnosed at Groote Schuur Hospital over an 8

year period from January 1979 to December 1986. The following factors were documented:

1) Incidence of S.E.
2) Age and sex of patient.
3) Presenting symptoms and signs.
4) Duration of clinical illness until diagnosis is made.
5) How often lumbar punctures (L.P.) are performed for an incorrect diagnosis of meningitis.
6) Whether haemoglobin (Hb), erythocyte sedimentation rate (E.S.R.), and white cell count (W.C.C.), are helpful in the management of S.E.
7) C.T. scan findings.
8) Source of S.E.
9) Type of drainage operation performed for S.E. and for the primary cause.
10) Organisms cultured from subdural pus.
11) Sensitivity to various commonly used antibiotics of organisms cultured.
12) Type of anticonvulsant used and duration of use.
13) Outcome after S.E.
14) Incidence of post-S.E. convulsions.
15) Occurance of complications in S.E. patients that affected the outcome.
16) The influence of regular C.T. scanning on outcome.

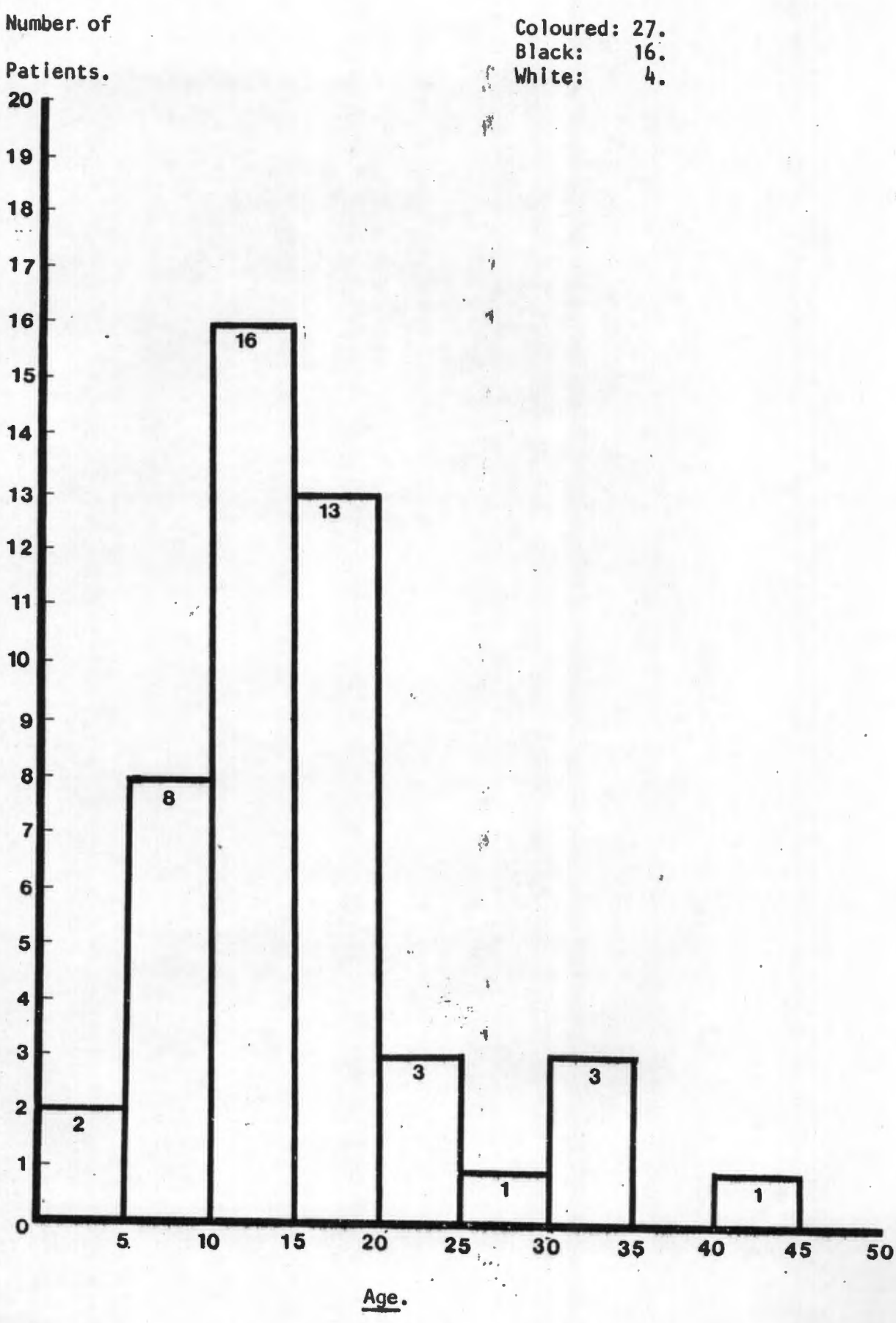
Clinical Material and Methods:

All patients admitted during the eight year period from January 1979 to December 1986, with S.E. complicating paranasal sinus infection, mastoiditis, or skull osteitis not due to penetrating trauma or surgery; or following hematogenous spread from a distant source, were included in the study. S.E. cases following direct skull trauma, post-cranial surgery infection or meningitis were excluded. Information was collected retrospectively from case notes for 4 years prior to 1983 and prospectively for 4 years since 1983.

RESULTS:

47 patients qualified for inclusion into this study - 32 males and 15 females. All ethnic groups were represented, although the majority of patients belonged to the so-called coloured group; probably representative of the patient population at Groote Schuur Hospital. Most patients were in their teens. (figure 1.)

FIGURE 1:


Number of Patients.
Coloured: 27.
Black: 16.
White: 4.
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
2
8
16
13
3
1
3
1
5
10
15
20
25
30
35
40
45
50
Age.

27 patients lived locally in Cape Town and surrounding areas and 18 patients were referred from hospitals outside the Western Cape, mainly from the East London region.

The diagnosis of S.E. was not always made early in the illness and the period from clinical illness to a definite diagnosis being made, varied from 1 to 21 days, with an average of 8,1 days.

Focal signs i.e. hemiparesis, cranial nerve palsies or swelling of the face helped in making an early diagnosis. In patients who presented with the more typical symptoms of headache, pyrexia and neck stiffness, the diagnosis was often delayed, or a wrong initial diagnosis of meningitis was made. A decreased level of consciousness did not always help in making the correct diagnosis. In patients where ear infections were the source of S.E., the diagnosis was correctly made earlier than in other patients. (Average 7,2 days).

Presenting symptoms and signs are tabulated below:

TABLE 1:

CLINICAL FINDINGS.	Number of patients.
Pyrexia	43
Headache	37
Neck Stiffness (meningismus)	33
Decreased level of consciousness	33
Hemiparesis	20
Seizures	19
Swelling of the face	17
Nausea/vomiting	12
Infected/discharging ear	10
Papilloedoema	7
Cranial nerve palsy	7
Blocked nose	3
Dysphasia	2
Proptosis	1

Lumbar punctures for clinically suspected meningitis were performed in 31 patients. These cases presented with headache, pyrexia and neck stiffness, but 23 of them were not fully conscious and 12 had hemiparesis or cranial nerve palsies. Four patients who had papiloedoema on admission to the Neurosurgical unit, had already had a lumbar puncture at referring hospitals.

The cerebro-spinal fluid (C.S.F.) picture was not specific in these 31 patients and varied from a normal cell count and chemistry in 3 patients, to a gross leucocytosis with up to 800 polymorphs and 140 lymphocytes. The average cell count was 116,7 polymorphs and 35,4 lymphocytes. The average C.S.F. protein level was 0,50 mmol/l. (range 0,1 - 2,0 mmol/l.) and the average C.S.F. glucose level 3,23 mmol/l. (range 0,4 - 5,1 mmol/l.) Globulin varied from 0 to two plus (average trace). In no patient were organisms seen microscopically on gram stain or cultured from the C.S.F.

Haematological Investigations:

Haemoglobin values varied from 8,3 g% to 18,4 g%; average 11,6 g% (normal - males 13,3 - 17,3g%; females 11,6 - 15,6g%).

The peripheral blood white cell count was not always raised, but the average value was 14,36x10 000 . (range 6,0 - 34,6x10 000) (normal - 4-11x10^3).

Erythrocyte sedimentation rates were helpful in the diagnosis of an infective process and was raised in all patients, average 105,04 cm/sec (range 54 - >150 cm/sec). (normal - males 0-15 cm/sec; females 0-12 cm/sec.)

The erythrocyte sedimentation rate decreased in most patients on therapy, but was not useful to indicate whether residual intracranial pus was still present.

Radiological Investigations:

Skull radiographs, performed in all but 3 patients, were abnormal in 34 patients and normal in 10 patients. The paranasal sinuses were reported as abnormal in 29 cases with either opacification and or a fluid level being noted. In 5 patients sclerosis of one or other mastoid region was present. In one patient whose skull radiograph appeared normal, a subsequent tomogram of the mastoid sinuses revealed opacification. Areas of skull osteitis were seen on two skull radiographs.

Computer tomographic (C.T.) scanning was performed in all patients and was abnormal in each instance. A low density collection in the subdural space was seen in 44 patients, but in 3 cases only an isodense shift of the midline structures was seen. All three of these patients presented during the first three years of the study and were scanned on a C.T. scanner with poor resolution by present standards. The subdural collections seen on C.T. scanning were distributed as follows:

13 over the left convexity;
15 over the right convexity;
4 bilaterally over both hemispheres;
2 purely in the interhemispheric region;

6 combined over the left hemisphere plus in the interhemispheric space, and

4 combined right hemisphere plus in the interhemispheric space.

Patients whose C.T. scans showed an isodense midline shift only, had shift to the right in 2 cases (left sided collection) and shift to the left in the other patient. (right sided collection).

An angiogram was carried out in one patient whose initial C.T. scan had only shown an isodense midline shift. The angiogram identified the surface subdural collection.

Other Special Investigations:

Radio-isotope brain scans were performed in 2 patients prior to C.T. scanning, and both revealed areas of increased uptake over the correct hemisphere.

Source:

The primary source of the S.E. was infection in the paranasal sinuses in 31 cases, chronic ear infection with mastoiditis in 10 cases and osteitis of the skull in 2 cases. The source of the infection was identified on skull radiographs, or at operation when pus was drained from a sinus or mastoid that was explored on clinical suspicion. In 4 patients no source for the S.E. could be identified. These patients had no evidence of local or systemic infection that might have caused the S.E.

Management:

The management of S.E. patients followed recognised criteria, and differed only in the application of therapeutic methods.

Antibiotics:

All patients were commenced on intravenous antibiotic medication as soon as the diagnosis of S.E. was confirmed. Antibiotic drugs were started as soon as pus had been sent for Bacteriological investigation. Antibiotic combinations differed somewhat depending on the choice of the initial doctor who saw the patient. A combination of Penicillin G 5mu 6 hourly, Chloramphenicol 500 mg 6 hourly, and Metronidazole 500 g 8 hourly, was used in all but 7 patients. Three patients received only Penicillin G and Chloramphenicol, two patients a combination of Cloxacillin and Chloramphenicol, one patient a combination of Ampicillin, Sulfadiazine and Metronidazole, and one patient received Ampicillin, Tobramycin, Chloramphenicol and Metronidazole.

Pus specimens obtained at operation from the paranasal sinuses, mastoid cavity; and/or subdural space, were sent for aerobic and anaerobic culture in all patients at the time of operation, and antibiotic regimes were changed if cultures indicated the need. No growth was obtained in aerobic or anaerobic culture in 15 cases. Single organisms grew in 23 cases and mixed organisms in 9 cases. A detailed analysis of this data is given in Table 2.

Penicillin resistance occurred in twelve organisms cultured, and the Penicillin G was changed to Cloxacillin in 11 cases and to Cephamandole in the other.

Resistance to Metronidazole was present in three organisms in vitro. These organisms were sensitive to Chloramphenicol. Treatment with Chloramphenicol and Metronidazole was continued in all three patients.

TABLE 2:

PARA-NASAL	OTOGENIC	OSTEITIS	UNKNOWN	
17	1	2	1	SINGLE ORGANISM
5	4	0	0	MIXED ORGANISM
9	5	0	3	NO GROWTH

Tobramycin was later added to the antibiotic regime in 2 patients - in one case because of Tobramycin sensitivity shown in vitro, and in the other case on clinical grounds in a patient who remained pyrexial after surgical drainage of S.E. and whose culture showed no growth.

Vancomycin was added in one patient where a staphylococcus aureus which was resistant to Penicillin, but sensitive to Vancomycin and Cloxacillin was cultured. The Penicillin G was also changed to Cloxacillin in this patient.

Chloramphenicol was used in 46 patients and none of the organisms cultured showed resistance to Chloramphenicol. No complications due to Chloramphenicol administration occurred.

Organisms cultured and the incidence of antibiotic resistance in vitro are shown in Table 3.

In one patient where no source for the S.E. was indentified, a blood culture grew a streptococcus milleri, not resistant in vitro against the standard battery of antibiotics. The same organism was cultured from the subdural pus.

TABLE 3 :

A) PARANASAL SOURCE:

ORGANISMS CULTURED	NUMBER OF PATIENTS	ANTIBIOTIC RESISTANCE	NUMBER OF PATIENTS
Streptococcus Milleri	10	Nil	0
Microaerophilic streptococcus	3	Metronidazole	1
Streptococcus mitior	3	Penicillin, Cloxacillin, Erythromycin, Clindamycin	0
Anaerobic streptococcus	1	Nil	0
Beta-haemolytic streptococcus	2	Metronidazole	1
Staphyloccocus Aureus	2	Penicillin	2
Haemophylus Influenzae	1	Nil	0
Microaerophilic diphtheroids	1	Penicillin, Metronidazole	1
Diphtheroids	1	Nil	0
Gram negative bacilli	1	Nil	0
Staphyloccocus epidermidis	1	Nil	0
Peptococcus	1	Nil	0
Alpha haemolytic streptoccocus	1	Penicillin	1
Mixed anaerobes	1	Nil	0

TABLE 3 :

B) OTOGENIC SOURCE:

ORGANISMS CULTURED	NUMBER OF PATIENTS	ANTIBIOTIC RESISTANCE	NUMBER OF PATIENTS
Protein mirabilis	5	Amoxycillin, Tetracyclin	1 , 2
Clostridium species	1	Penicillin	1
Bacteroides fragilis	2	Penicillin	1
Staphylococcus	1	Penicillin	1
Beta haemolytic streptococcus	1	Nil	0
Corynebacterium diphteria	1	Tetracyclin	1
Peptococcus	1	Clindamycin	1

TABLE 3:

C) OSTEITIS:

ORGANISM CULTURED	NUMBER OF PATIENTS	ANTIBIOTIC RESISTANCE	NUMBER OF PATIENTS
Non group A beta -			
Haemolytic streptococcus	1	Nil	0
Staphylococcus Aureus	1	Penicillin	1

Surgical Drainage: (S.E.):

Surgical drainage of the empyema was carried out in 46 patients. In one patient the collection was deemed small enough to manage without drainage, and only the source, i.e. the paranasal sinuses in this case, were drained.

Burrholes were used to drain subdural collections in 28 cases; an initial craniectomy in 7 cases, and a craniotomy initially in 11 patients. Thirteen patients who initially only had burrhole drainage, later needed a more extensive surgical procedure, i.e. a craniectomy or craniotomy. Table4 shows the surgical procedures used initially and later when repeat drainage was indicated. All patients had post-operative C.T. scans and evidence of residual pus in the subdural space was used to indicate the need for repeat drainage.

Adding cases where a craniectomy was performed as a repeat procedure to those with initial craniectomy or craniotomy, the incidence of re-aspiration between cases who had burrholes only and cases with more extensive surgical drainage procedures can be compared. The results are shown in Table 5.

TABLE 4 :

Surgical Drainage Procedure Performed :

Initial Procedure	Number of Cases	Drain Used/Not Used		Repeat Procedures	Number of Re-drainages
Burrholes	28	13	-	Burrholes reopened	15
				Craniectomy	7
		-	15	Burrholes reopened	16
				Craniectomy	6
Craniectomy	7	2	-	Reopening Craniectomy	2
		-	5	Reopening Craniectomy	6
Craniotomy	11	4	-	Reopening Craniotomy	3
		-	7	Reopening Craniotomy	13

TABLE 5 :

Burrhole drainage versus craniectomy/craniotomy drainage

Procedure	Number of Cases	Number of Repeat Aspirations Needed
Burrholes	28	44 (157,1%)
Craniectomy	7	8 (114,3%)
Craniotomy	11	16 (145,5%)

Surgical Drainage: (Source):

The primary source for the subdural empyema was drained surgically in the majority of cases. Table 6 shows how the sources were managed. In cases where definite collections of pus were seen in the paranasal sinuses or mastoid, drainage was carried out immediately. Where there was doubt about the source, drainage was sometimes delayed. Pus was found in all cases where the source was drained.

TABLE 6 :

Management of Primary Source of S.E.:

Source	Immediate Drainage	Delayed Drainage	Average Delay (days)	No Drainage
Paranasal sinuses	20	5	8	6
Otogenic	7	2	11	1
Osteitis	2	0	-	0
Not Known	0	0	-	4

OTHER MEDICATION:

Anticonvulsants were prescribed for all but one patient. Phenytoin was used primarily in the majority. Phenobarbitone was administered to 2 cases during the earlier years of the study; and added to Phenytoin-therapy in 5 patients with uncontrolled seizures. During later years the Phenytoin dosage was increased in such patients and polypharmacy was avoided. One patient was a known epileptic on Carbamazepine prior to his admission with S.E., and Phenytoin was added to his anticonvulsant regime. One patient never had any seizures and did not receive anticonvulsants over a four week period of follow-up. Table 7 gives a breakdown of anticonvulsant usage.

On follow-up anticonvulsants were stopped in 13 patients who had been seizure free for a period of 6 months. They remained seizure free. 30 patients were still on anticonvulsants at last follow-up and their seizures were all well controlled. The 4 patients in this study who died, were on anticonvulsants until their death.

TABLE 7 :

Anticonvulsant Usage in S.E.:

Drug Used	Number of Patients Total:	Weeks of Follow-up (Average)	With Seizures at Presentation	With Seizures at Follow-up
Phenytoin	38	23,7	16	5
Phenobarbitone	2	76	2	2
Phenytoin + Phenobarbitone	5	46	1	1
Phenytoin + Carbamazepine	1	6	1	0
Nil	1	4	0	0

Dexamethasone was used in 13 patients and not used in 16 patients. The records regarding steroid administration were lost in the other 18 patients in this series. There was no specific indication for Dexamethasone administration and their use depended on the approach of the initial doctor who treated the case.

The eventual outcome of cases on steroids and not on steroids are given in Table 8.

TABLE 8:

Steroid Usage:

Steroids Used:	Number of Patients	Outcome: (Number of patients)			
		Excellent	Good	Poor	Dead
Dexamethasone	13	10	0	1	2
Nil	16	12	1	2	1
Not Known	18	13	2	2	1

COMPLICATIONS:

Complications occurred in 18 patients following drainage of the subdural empyema, as shown in Table 9. (some patients developed more than one complication).

Two of the patients who died developed brain abscesses which were tapped, one developed a severe respiratory infection and one suffered a respiratory arrest the day following initial burrhole drainage. At repeat craniectomy residual pus was present in the subdural space.

TABLE 9:

Complications that occurred:

	TOTAL	Number of Cases:		
		Burrholes	Craniectomy	Craniotom
Brain Abscess (frontal)	: 5	3	1	1
Ventriculitis	: 2	1	1	0
Hydrocephalus requiring a shunt	: 3	2	1	0
Delayed skull osteitis	: 2	1	1	0
Craniotomy bone flap removed because of wound infection	: 2	-	-	2
Severe respiratory infection	: 2	1	0	1
Respiratory Arrest	: 1	1	0	0
Subgaleal abscess	: 1	1	0	0
Brain infarct on later CT scan	: 1	1	0	0
Subdural haematoma	: 1	1	0	0
Phenytoin sensitivity	: 1	0	0	1
Died	: 4	3	0	1

OUTCOME:

Outcome from S.E. in this study was divided into four groups, as follows:

Excellent: Well, with no focal signs, no seizures, back to pre-disease activity.

Good: Well, with minimal focal signs, or seizures that are well controlled on anticonvulsants, back to pre-disease activity.

Poor: Disabled by hemiparesis or hemiplegia, or by seizures that are difficult to control. Not able to function at a pre-disease level.

Dead: Patients who died from their S.E. or of complications thereof.

The overall outcome in this study is shown in Table 10.

Known presenting symptoms or signs and the treatment modalities that may affect outcome are compared with outcome in Table 11.

T A B L E 1 0 :

Overall outcome from S.E., comparing various forms of initial surgical drainage procedures.

	NUMBER OF CASES	OUTCOME			
		EXCELLENT	GOOD	POOR	DIED
Burrholes	28	20 (71,4%)	2 (7,1%)	3 (10,7%)	3 (10,7%)
Craniectomy	7	5 (71,4%)	1 (14,3%)	1 (14,3%)	0 (0%)
Craniotomy	11	8 (72,7%)	1 (9,1%)	1 (9,1%)	1 (9,1%)
No surgery	1	1 (100%)	0 (0%)	0 (0%)	0 (0%)
Total	47	34 (72,3%)	4 (8,5%)	5 (10,6%)	4 (8,5%)

TABLE 11

Relationship of presenting features and treatment modalities to outcome:

Presenting Features	Surgical Procedure	Outcome (Number of cases)			
		Excellent	Good	Poor	Dead
Conscious, no seizures, no focal signs.	Burrholes	4	0	0	0
	Craniectomy	2	0	1	0
	Craniotomy	2	0	0	0
Conscious, no seizures, with focal signs.	Burrholes	0	0	0	1
	Craniectomy	0	0	0	0
	Craniotomy	0	1	0	0
Conscious, with seizures, no focal signs.	Burrholes	1	0	0	0
	Craniectomy	0	0	0	0
	Craniotomy	1	0	0	0

T A B L E 1 1 (Cont.)

Presenting Features	Surgical Procedure	Outcome (Number of cases)			
		Excellent	Good	Poor	Dead
Conscious, with seizures, and with focal signs.	Burrholes	0	1 ↓	0	0
	Craniectomy	0	0	0	0
	Craniotomy	0	0	0	0
Unconscious, no seizures, no focal signs.	Burrholes	0	1 ↓	0	0
	Craniectomy	2+2 ↓	0	0	0
	Craniotomy	1	0	0	1
Unconscious, no seizures, with focal signs.	Burrholes	1+1 ↓	0	1 ↓	2 ↓
	Craniectomy	0	1	0	0
	Craniotomy	2	0	0	0

T A B L E 1 1 (Cont.)

Presenting Features	Surgical Procedure	Outcome (Number of cases)			
		Excellent	Good	Poor	Dead
Unconscious, with seizures, no focal signs.	Burrholes	6+1 ↙	0	1 ↙	0
	Craniectomy	1	0	0	0
	Craniotomy	1	0	0	0
Unconscious, with seizures, and with focal signs	Burrholes	1+3 ↙	0	1 ↙	0
	Craniectomy	0	0	0	0
	Craniotomy	1	0	1	0

(The arrow ↙ indicates patients who had initial burrholes which were later extended into a craniectomy.)

DISCUSSION

HISTORICAL PERSPECTIVE:

Although a case of S.E. at autopsy had been described as early as 1812 *(71), the whole problem of intracranial sepsis was clarified by the publication of Macewen's now classical monograph on this topic in 1893. *(57). Prior to the availability of antibiotics, the treatment of brain abscess was "marsupialisation", with insertion of a drain. When antibiotics became available, this form of surgical drainage was abandoned because of problems with brain herniation, and the instillation of antibiotics through cannulae into the abscess cavity became current therapy for intracerebral abscess.

The same principle was used in the treatment of S.E. Multiple catheters were inserted into the subdural space through multiple burrholes, and used to inject antibiotics.*(4)(70)(86). This led to an improved outcome from S.E., with some patients surviving, whereas survival after intracranial infection prior to antibiotics was rare. *(49) The problem was not solved however and the mortality and morbidity of S.E. remained high.

Courville described the preferred route of spread of subdural pus in 1944. *(19) This extensive spread over the convexities of both hemispheres, under the frontal lobes, along the Sylvian fissure and along the interhemispheric fissure, makes adequate drainage of pus by insertion of catheters not under direct vision difficult. Instilled antibiotics are also not likely to reach all the organisms in such a complex space.

Recognition of the problems of S.E. drainage by catheters that were inserted blindly, lead to the use of extensive craniectomies to pursue pus in the subdural space. Reports by Botterel and Drake *(12) and Stern and Boldrey *(75), showed results that were superior to those obtained by burrholes. Extended craniectomy is however a tedious procedure causing much blood loss and a poor cosmetic result. The use of a craniotomy to drain subdural pus therefore seemed logical. Le Beau reported the first sizeable series on craniotomy for drainage of S.E., in 1949. *(51).

The advantages of a craniotomy rather than burrholes or craniectomy for S.E. drainage, seemed certain after the report of Bannister et al in 1981 *(5), showing that the mortality rate was reduced three fold by the use of

craniotomy drainage versus burrhole-drainage. This however, was a retrospective study over 20 years, and many of their patients were treated prior to the availability of C.T. scanning.

Kaufman et al suggested in 1983 that the use of C.T. scanning in the treatment of S.E. may make a difference by enabling surgeons to place burrholes accurately. *(46). The report by Luken et al however, has cast doubt on the usefulnes of C.T. scanning in S.E. patients. *(56).On the other hand, Leys et al even advocates managing S.E. only with antibiotics and follow up C.T. scanning, without the use of surgical drainage . *(53).

At Groote Schuur Hospital S.E. is a relatively common condition, and 47 cases were treated during the eight years of this study, all with the use of repeated C.T. scanning. No fixed management policy was used, and the treatment of patients with S.E. was individualised according to the choice of the Neurosurgeon on duty when the patient was admitted. Thus various forms of therapy can be compared.

INCIDENCE

Williams found that the incidence of S.E. was not decreasing in his referring region, despite the use of prophylactic surgery for ear infections and the availability of newer antibiotics. *(84). He also documented an incidence of 3-4 cases per million population.

The incidence at Groote Schuur Hospital during the period of this study, was nearly 6 cases per year; although the incidence seemed to decline since 1985, when C.T. scanning and Neurosurgical services became available in the Eastern Cape. The majority of our cases live locally, which tends to substantiate the observation by Williams *(84) that the availability of prophylactic surgery for sinus and ear infections, as well as antibiotic use, do not prevent the occurence of S.E.

The age distribution of cases in this study conforms with that in published reports. *(82). 85% of cases were under 20 years of age, and 62% were in their teens. Only one patient was over 35 years of age. A striking male predominance was present, in contrast to most studies where the male dominance was slight. *(84)

The ethnic distribution of patients in this study probably reflects the referral pattern of patients to Groote Schuur Hospital. The relatively low incidence amongst the black population, might indicate that the diagnosis is missed in areas where sophisticated medical services are not immediately available.

When one compares the incidence of cerebral abscess to that of S.E., the incidence of 5 to 1 differs from that found by Gurdjian, where brain abscess was twice as common as S.E. *(35). The study of 79 cases of intracranial suppuration over 3 years seen at Baragwanath Hospital, Johannesburg, included 25 cases of S.E. Solitary intracerebral abscesses were present in 32 of their patients. Trauma, including penetrating trauma to the skull was, however not excluded as an etiological factor. *(2).

PREDISPOSING FACTORS:

In the large series by Bannister et al the presumed source of infection in their 66 cases was paranasal in 45 patients (68%), otogenic in 15 (21%), post trauma in 2, other osteomyelitis in 3, a lung abscess in 1 and congenital heart disease in 1. *(5). Cyanotic heart disease is a well described cause for brain abscess. *(39). Haematogenous spread may also occur from other systemic infections, eg. dental abscess or renal tract infection. *(14)(30)(41). Bacterial seeding may be to cortical vessels first, with resultant vasculitis, vessel rupture and brain abscess, with secondary breakthrough into the subdural space. *(29). Another mechanism that has been suggested, is haematogenous bacterial seeding to a chronic subdural haematoma. *(17)(18).

S.E. following cranial surgery, skull traction, penetrating skull trauma and infected effusions post meningitis are also included in many studies. This makes interpretation of the outcome from S.E. difficult because these cases are easier to diagnose due to a higher clinical suspicion than for S.E. following paranasal or otogenic infection, or from haematogenous spread. In this study all cases of subdural infection following skull trauma, cranial surgery or meningitis were therefore excluded.

Paranasal infection is also the main cause of S.E. in this study (66%) followed by otogenic infection (21%). No cause was found in 4 cases in spite of a careful clinical and radiological search.

S.E. following paranasal infection arises mostly from the frontal sinuses, *(18)(66) but may also arise from the ethmoid and sphenoid sinuses, and even from the maxillary antra. *(84) In our study pus was drained from the frontal sinuses in most cases, but the ethmoid sinuses were responsible in a few cases, and pansinusitis was present in some cases. Delayed S.E. after trauma to the frontal sinuses which interfered with their normal drainage has also been described. *(64).

PATHOGENESIS:

A direct communication between the infected sinus or mastoid cavity and the extradural space is sometimes found. In the majority of cases this is not the case however, indicating that the infection had spread through intact skull. Infection may traverse naturally occurring portals of entry, such as the olfactory foraminae, the labyrinth and thereafter the internal auditory meatus and the vestibular aqueduct, congenital deficiencies, fissure fractures and suture lines. *(63). Infection may also spread from the veins of the sinus mucosa, via diploic veins to the intracranial cavity. *(59).

The second line of defense is the dura mater, which offers considerable protection against infection due to its structure and good blood supply. The dura mater may completely resist penetration by infection so that an extradural abscess is formed.

Penetration of the dura mater probably takes place along the course of small vessels which traverse it, and by developing septic thrombophlebitis may provide convenient pathways. The membrane swells as a result of the inflammatory reaction and granulation tissue forms. This is called pachymeningitis.

If the wall of a venous sinus is involved, thrombosis ensues, which may involve the whole sinus wall and cause thrombosis, or remain restricted to part of the sinus circumference. Veins which cross the subdural space may also be involved, spreading infection in that space. *(29). A purulent exudate may form on the inner surface of the infected dura mater. If this accummulates rapidly, it spreads widely and a subdural empyema is formed.

There is still no satisfactory explanation for the speed of spread and lack of encapsulation in some cases and the definite encapsulation seen in others where localised subdural abscesses are formed. Virulence of organisms and speed of production of granulation tissue may be factors. *(19)(29). No definite difference in virulence of infecting organisms has however been shown.

The arachnoid provides further resistance to spread of infection. In subdural empyema there is often no leptomeningeal infection. *(63).

Extension of pus seems to occur mainly in a posterior direction, possibly aided by gravity. *(19). The pus tends to accumulate in the Sylvian fissure, from where it courses towards the basal cisterns. The interhemispheric fissure is also invaded. The basal surfaces of the frontal and temporal lobes are rarely reached by exudate, probably due

to the close approximation of these lobes to the internal surface of the skull.

The extent of spread to the opposite hemisphere varies greatly, and probably depends on the amount of pus present, the ease of communication beneath the inferior free margin of the falx cerebri, and perhaps the duration of infection. *(19). The cases where bilateral subdural pus was present in this study, had been ill for 10,1 days on average (range 4-21 days), which is longer than the average for the whole series, (8,1 days). Bilateral S.E. remains relatively uncommon. *(30).

Pus is rarely limited to the interhemispheric space. *(19)(80). This is borne out by the low incidence of only two cases (4,3%) in this study.

Osteomyelitis of the skull, whether focal or spreading, is an uncommon accompaniment of S.E. Conversely, in recognized cases of osteomyelitis of the skull, subdural infection is also not common. From these observations one would conclude that these two lesions result from essentially different routes of extension of infection from the frontal sinus. *(19).

The osteomyelitis of the skull causing S.E. in the two cases in this series, probably resulted from earlier scalp trauma, although this was not obvious at the time of presentation.

CLINICAL PRESENTATION:

The importance of making a diagnosis of S.E. early in the course of the disease to effect an improved outcome, has been stressed in the literature. *(68). This study does not support this statement. Patients whose outcome was judged as excellent had an average duration of illness prior to a diagnosis of S.E. being made of 7,76 days (range 1-21 days); the figure for patients with a good outcome was 10,0 days (range 5-21 days) versus 10,04 days (range 3-21 days) for those with a poor outcome and 8,44 days (range 3-21 days) for patients who died.

Common presenting symptoms and signs in the series by Williams were, in decreasing order of frequency, impaired consciousness, headache, hemiparesis, acute seizures, pyrexia, meningismus, vomiting, papilloedoema, ophthalmoplegia, hemianopia and dysphasia. *(84). Other studies also indicate that pyrexia, headache, loss of consciousness, hemiparesis and epilepsy are common presenting features. *(3)(46)(62)(67)(80). Smith et al also found these features commonly in 12-16 year old patients. In their patients in the 6 weeks to 2 year age group, fever, neck stiffness, bulging fontanelle, vomiting and lethargy were most common *(72), although many of these cases of S.E. were complicating meningitis. A case of S.E. presenting with retinal thrombophlebitis has been described. *(74).

In this study pyrexia occurred in nearly all the patients. Headache, neck stiffness and a decreased level of consciousness were also very common findings. Seizures and a hemiparesis occurred in less than half of the patients as presenting features. Although patients with S.E. often have severe neurologic abnormalities when first seen, appropriate therapy usually produces complete or nearly complete recovery. *(25).

DIFFERENTIAL DIAGNOSIS:

Intracranial suppuration was suspected in all the patients in this study. Meningitis was the favoured diagnosis, and 31 (66%) of our cases had lumbar punctures performed before the diagnosis of S.E. was made. Once meningitis had been disproved on C.S.F. results, brain abscess was usually the next choice, and arrangements for C.T. scanning and transfer to the Neurosurgical Unit were made. It is interesting to note that lumbar punctures were performed in a significant number of patients where clinical contra-indications in the form of a depressed level of consciousness, focal signs or even papiloedoema were present. Lumbar puncture in the presence of raised intracranial pressure carries well known risks. *(16)(24)(69). There was however no definite incidence of deterioration in the clinical picture of any of the patients following lumbar puncture, and the outcome was in fact worse in cases where no lumbar puncture was performed, as shown in Table 11.

TABLE 11:

OUTCOME WITH/WITHOUT LUMBAR PUNCTURE

	Total No. of patients	Excellent	Good	Poor	Died
after lumbar puncture	32	26	1	2	3
without lumbar puncture	15	8	3	3	1

DIAGNOSIS:

Lumbar puncture and cerebro-spinal fluid (C.S.F.) analysis:

Cerebro-spinal fluid analysis is not helpful in making a diagnosis of S.E. In this study C.S.F. analysis varied from completely normal chemistry and cell count to grossly abnormal protein, globulin and glucose levels and severe pleocytosis. The only distinguishing feature from bacterial meningitis, with which S.E. is often confused, was the total abscence of positive organism cultures in the C.S.F. This indicates the barrier effect of the arachnoid layer.

Reports in the literature show C.S.F. pleocytosis, increased protein content and increased glucose content to be typical, but not consistent, and normal C.S.F. analysis was not encountered. *(18)(46)(68).

Blood white cell count (W.C.C.):

The occurrence of normal values in 23,5% of patients in this series needs to be noted. The limited value of peripheral white cell counts in the diagnosis of intracranial abscess has been documented previously. *(29).

Erythrocyte sedimentation rate (E.S.R.):

In this series the E.S.R. was a helpful investigation, and was raised in all cases. It remains a non-specific indication of inflammation, and there are reports of normal E.S.R.'s in brain abscess. *(27).

Skull Radiographs:

The value of skull radiographs was found to be significant in this series, and 77% of cases where these were available, had abnormalities noted on skull radiographs. These abnormal findings were related to the paranasal sinuses and mastoid region, or to areas of skull osteitis and were therefore not diagnostic of S.E., but of a possible source. Shift of the pineal to indicate a possible extracerebral collection was not noted in any of our cases. This is due to the low incidence of pineal gland calcification in such a young population.

Hitchcock et al found that only 5% of plain x-ray films of the skull were normal in their series. *(40). The abnormalities also pointed more to infection in a possible contiguous source than to S.E. as such. Kaufman et al found clouding of at least one sinus present in all 15 of their patients with S.E. secondary to sinusitis. *(46).

Radio-isotope brain scanning:

This was helpful in the two cases in this series where it was performed. C.T. scanning has however replacecd radio-isotope scanning to a large degree. With the availability of later generation C.T. scanner, the indication for radio-isotope brain scanning has become tenuous. The past decade has seen a definite shift away from radio-isotope studies for nervous system pathology. The technology available for investigation of central nervous system pathology has changed and the statement by Crocker et al in 1974 that brain (isotope) scanning "was the most sensitive and accurate investigation in the early diagnosis and localization of intracranial abscess", *(21) is no longer true.

Angiography:

In only one patient in this series was an angiogram performed, and in this case the subdural collection was shown. A C.T. scan in this particular case indicated a shift of the midline structures, but did not show the surface collection. C.T. scanning made the diagnosis of S.E. in all other cases in this series, and surface collections and interhemispheric collections were well shown on later generation C.T. scanners.

Our findings differ therefore from those of Luken and Whelan, who found normal C.T. scans in all four of their cases with primary S.E. *(56). Other authors have also documented normal C.T. scans in the presence of S.E. *(88). Angiograms showed the subdural collections in these cases, and they therefore came to the conclusion that "reliance on C.T. scanning is hazardous, and angiography is the procedure of choice." The use of angiography in S.E. is well documented. *(11)(28)(78)(81).

With the availability of C.T. scanners with better resolution, angiography, with its inherent risks, is an unnecessary investigation in S.E. patients according to the findings in the study.

C.T. Scanning:

As indicated above, C.T. scanning is the investigation of choice in the diagnosis and management of S.E. Not only was the diagnosis made in every case, but the precise location of the subdural collection or collections was shown. All the patients who were scanned on later generation scanners, needed no further investigation. C.T. scans will also show interhemispheric S.E. and cerebral angiography no longer provides the best means of demonstrating an interhemispheric lesion as stated by some authors. *(65)(83).

It is important to note that C.T. scanning affects the management of S.E. patients, because post-operative scans will show residual pus. The exact location of subdural collections of pus is shown, and drainage procedures can be planned accordingly. *(45)(76)(90). The use of C.T. scanning to plan burrholes for drainage of S.E., has obviated the need for craniotomy drainage to achieve a better outcome.

BACTERIOLOGY:

In earlier studies of S.E., the importance of anaerobic organisms was not realized. The survey of the English lterature on the bacteriology of S.E. by Yoshikawa et al found an incidence of only 12% prior to 1974. In these published reports there was a high incidence (27%) of sterile cultures however. *(89). In the study by Heineman and Braude in 1963 on anaerobic infection of the brain, the importance of anaerobic infection in brain abscess, was stressed. Anaerobes were isolated in 15 of their 18 cases. * (38). This contrasts with the high incidence of reported sterile cultures from brain abscess, prior to their study, where the incidence varied from 9% to 63%. *(36)(61).

From consideration of the pathogenesis, the prominence of anaerobes in intracranial abscess, is not unexpected. Anaerobes occur frequently in chronic suppuration of the ear *(15), paranasal sinuses *(26) and lung. *(13).

Yoshikawa et al cultured anaerobes in all four of their cases of S.E. *(89), and stressed the importance of immediate anaerobic cultures. The use of antibiotics prior to taking the pus specimen for culture, and incorrect transport methods and culture media may also contribute to a low incidence of anaerobic culture. *(84). The incidence

in this study of 32% for sterile cultures remains too high, and probably explains the incidence of only 28% for anaerobic organisms on culture. The fact that nearly half of the patients in this study had received some form of antibiotic therapy prior to admission to the Neurosurgical Unit, probably contributed to the high incidence of sterile cultures.

The prevalance of streptococci in S.E. from paranasal infection, was also documented by other investigators. *(8)(40)(46)(70)(84)(86). Staphylococcal infection plays a minor role in S.E. and in brain abscess, when cases following on cranial trauma or surgery are excluded. *(22). A case of Actinomycotic Subdural empyema has been described. *(58). The prevalence of streptococci in maxillary sinus infection was described by Hamory et al. *(37).

Williams found that the outcome from S.E. was worst in cases with sterile cultures. *(84). This was not the case in this study where a poor outcome or death was found in 20% of sterile cultures; in 17,3% of cultures where single organisms were isolated and in 22% of cases where mixed organisms were isolated.

The 22% incidence of mixed cultures in cases where organisms were grown, correlated with the figure found by Williams in 67 cases of intracranial suppuration. *(85). Mixed growths

in our series occurred as commonly as in brain abscess, contrary to the findings of Williams. *(84).

MANAGEMENT:

Antibiotics:

This study confirms the value of Chloramphenicol in the treatment of S.E. No case of organism resistance to Chloramphenicol was found in vitro. This correlated with the 96% in vitro sensitivity of organisms to Chlormaphenicol found by Williams. *(85). There were also no complications related to Chloramphenicol use.

As documented by De Louvois et al *(23), intracranial infection following sinusitic disease, often yield penicillin-sensitive streptococci, whilst infection spreading from otogenic disease, yield a mixed flora. Vastly improved results were documented in the early days following Penicillin administration. *(48). There was, however, a definite incidence of organism resistance to Penicillin in this series. This needs to be remembered, as antibiotic regimes may have to be changed when culture results become available. The incidence of staphpylococcal S.E. is low if post trauma or craniotomy cases are excluded, and the recommendation by Kaufman et al that all S.E. patients should initially receive an antibiotic combination that includes a penicillinase resistant penicillin *(46), seems unnecessary.

Metronidazole resistance occurred, but was uncommon. All three of these metronidazole-resistant organisms were sensitive to Chloramphenicol. Metronidazole crosses the blood-brain-barrier well and is active against the majority of Bacteriodes. *(42). It remains a valuable antibiotic in the treatment of S.E. and its use may influence the outcome from brain abscess. *(1).

The use of Aminoglycosides should be reserved for cases where in vitro sensitivity of the offending organism has been shown. Its penetration into subdural pus is poor. *(23).

The third generation Cephalosporins have also been used in C.N.S. infection. These agents are effective against gram negative bacilli; and have been useful in patients with gram negative bacillary meningitis. *(50). Their use in S.E. should also probably be reserved for cases where in vitro sensitivity has been shown.

This study indicates that a daily combination of Penicillin 20 million units, Chloramphenicol 2 grams and Metronidazole 1500grams, given intravenously, is an effective antibiotic therapeutic schedule. Changes in this regimen will only be needed in the minority of cases once culture results are available. Chloramplenicol administration should not be

stopped however, because technical problems may cause anaerobic cultures to be negative, even when anaerobic organisms are present.

Antibiotic adminstration should be continued until all subdural pus has been eradicated, as shown on C.T. scanning, and until the clinical condition of the patient and the white cell count and E.S.R. are normal. Intravenous antibiotics are used for the first two weeks after admission.

Little is known about the penetration of antibiotics into subdural pus. Black et al have studied penetration of antibiotics into brain abscess. *(10).

Surgical Drianage of the Source:

A careful search should be made for the source in every case of S.E. Skull radiographs are helpful to pinpoint infected paranasal sinuses and otogenic infections. Once a source has been established, this should be dealt with immediately, to prevent re-introduction of septic material into the subdural space. Williams recommends removal of the posterior wall of the frontal sinus at the time of craniotomy for S.E., if the frontal sinus is the source. The mucous membrane is stripped out and a drain left from the sinus cavity through the ostium and via the nose. *(84). In patients in this study multiple sinuses were often infected, and a better approach is probably exploration and drainage of the infected sinus cavities by an ear-nose and throat surgeon under the same anaesthetic as that used for drainage of the S.E. To defer the treatment of the primary focus until the patient has recovered *(73), may lead to recollection of pus in the intracranial space.

The same approach is used if the source is otogenic, and a radical mastoidectomy is carried out. Mastoid surgery may rarely cause intracranial complications, rather than prevent them. *(6).

All osteomyelitic bone should be removed. This would mean extending a burrhole into a craniectomy if the skull

overlying the S.E. collection is involved. This was done in the two patients in this study where skull osteomyelitis was present. Williams feels that mildly infected bone might recover with antibiotics, but also advocates bone removal for extensive osteomyelitis or sequestrum - formation. *(84)

Surgical Drainage of the S.E.:

Even after the advent of antibiotics, surgical drainage of subdural pus remained the mainstay of treatment of S.E. The report by Banister et al in 1981 indicated that a craniotomy for wide exposure of the subdural empyema, was needed for sufficient drainage. This resulted in an improved outcome when compared to the use of burrholes or craniectomy, or even secondary craniotomy for drainage of pus. *(5). The concept of fasioning osteoplastic flaps to evacuate all the subdural pus and to decompress the brain, was supported by Glass *(31) and Le Beau *(51) in 1947 and 1949 respectively. Le Beau et al advised turning a large bone flap for S.E. rather than burrholes for an improved prognosis already in 1973 *(52), and Torrens in 1977. *(77).

With the more widespread use of C.T. scanning in the management of S.E. however, it became possible not only to diagnose the condition earlier, but also to plan surgical procedures according to the location of subdural pus. The C.T. scanner can also be used postoperatively to indicate whether pus had been drained completely, or whether loculations of pus still remained in the subdural space. Re-operations can therefore be planned accordingly. Kaufman et al stated in 1983 that burrhole drainage in the

management of S.E. might be appropriate if C.T. scanning was used to place burrholes accurately. *(46). Joubert and Stephanov had already pointed to the value of C.T. scanning in the surgical management of intracranial suppuration in 1977. *(44). Some authors also consider some S.E. patients too ill to undergo craniotomy drainage. *(55). Performing a craniotomy to deal with intracranial infection may also lead to loss of the bone flap *(33). This occurred in 2 patients in this series.

This study indicates that burrhole drainage planned with pre- and post-operative C.T. scanning is compatable with an excellent outcome from S.E. The mortality of only 8,5% overall compares very favourably with other series in the literature where mortality rates ranged from 18% to 35,3% in larger series. *(46)(47). Other authors gave mortality rates of 21,7%; 27% and 28,8%. *(5)(68)(84). Most of these studies also found a significant morbidity. The low mortality (8.5%) in this study is even an improvement on that of the best group (primary craniotomy/craniectomy) in Williams series of 89 cases, where the mortality was 10%. The morbidity in this study was also very low, with only 19,1% of patients affected - 10,6% severely disabled.

If one compares the outcome from S.E. using different forms of initial surgical drainage, the outcome between patients treated initially with burrholes and patients treated

initially with craniotomy, is similar, with mortality rates of 10,7% and 9,1% respectively. There was no death in the nine patients treated initially by craniectomy.

The group of patients who initially had more extensive surgery (craniectomy or craniotomy) had a slightly worse combined morbidity and mortality (27,8%) than the group treated by burrholes (25%). The number of patients with severe disabilities were virtually the same in both groups - 10,7% for burrhole patients versus 11,1% for craniectomy/craniotomy patients. Our numbers are too small to be of statistical significance however. Waiting for pus to localise before drainage is performed may be dangerous. *(54).

This study indicates that an approach to S.E. that ensures adequate removal of subdural pus, which can be attained by regular C.T. scanning to direct surgical procedures, ensures a good outcome. The surgical procedure used for drainage of pus, is less important. The statement by Banister et al *(5), or Williams *(84), that craniotomy drainage should always be used for drainage of S.E. to ensure a good outcome, can therefore not be substantiated.

The use or not of post-operative drains remains controversial. Williams does not use drains *(84), but

other authors recommend their use. *(32). In this study the number of repeat procedures to drain residual pus was reduced when drains were used. Local antibiotics are also used by some authors. *(9)(34)(43)(87).

One patient in this study did not need surgical drainage of his subdural collection, because the empyema was judged small enough to be treated with antibiotics only. (Figure 2) Pus was obtained from the source, the ear in this patient, at radical mastoidectomy, and grew mixed organisms, a Proteus mirabilis resistant to Amoxycillin, and a Bacteroides fragilis resistant to Penicillin. She was treated with Ampicillin, Chloramphenicol, Metronidazole and Tobramycin, and had an excellent outcome with disappearance of the S.E. on follow-up C.T. scan (Figure 3). She was neurologically normal, seizure free but still on Phenytoin when last seen 5 weeks after treatment of her S.E.had started.

There are reports in the recent literature of cases of S.E. treated with antibiotics only, who were followed-up with regular C.T. scanning. Leys et al reports seven cases, six of which needed no surgical drainage. They had no mortality in this series, and only one patient, who needed delayed burrhole drainage, is plagued by epilepsy. They state that treatment of S.E. with antibiotics only, gives a better outcome than surgical drainage plus antibiotics *(53).

FIGURE 2: C.T. Scan showing subdural empyema over the right hemisphere.

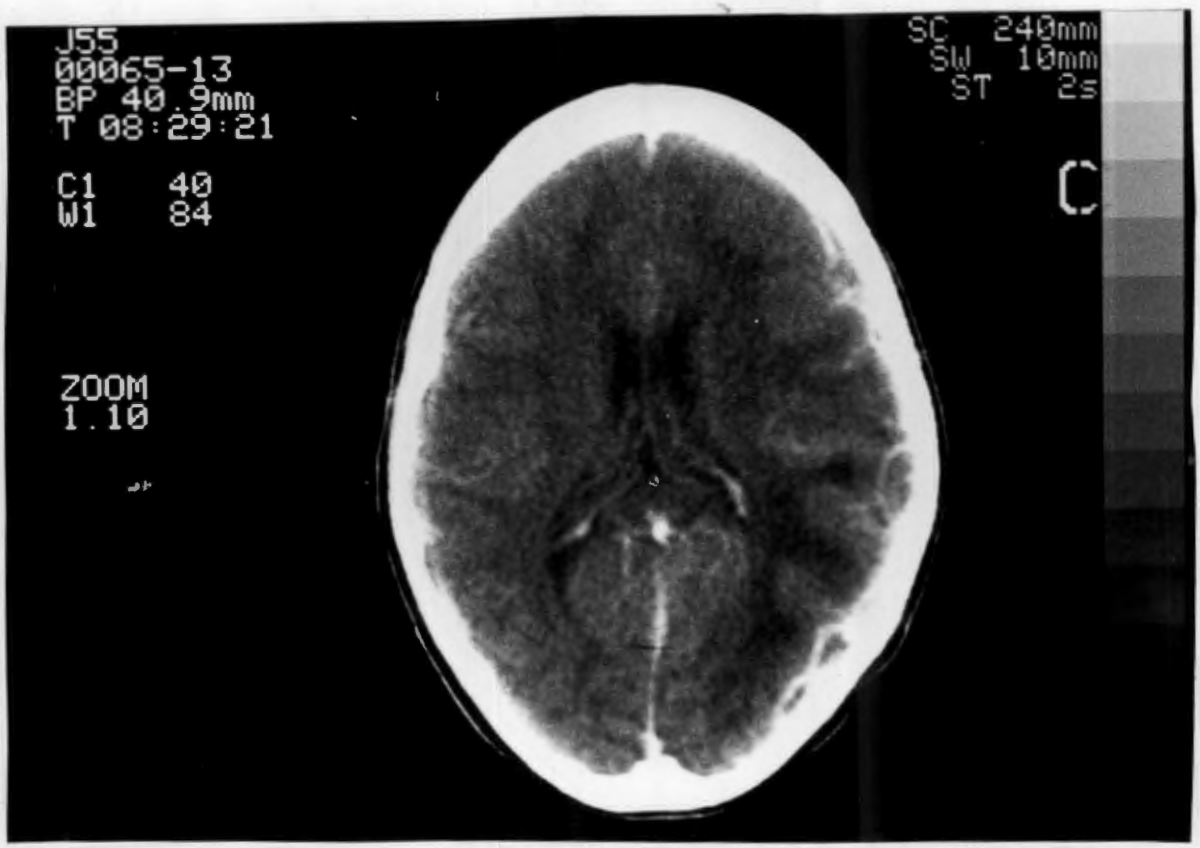
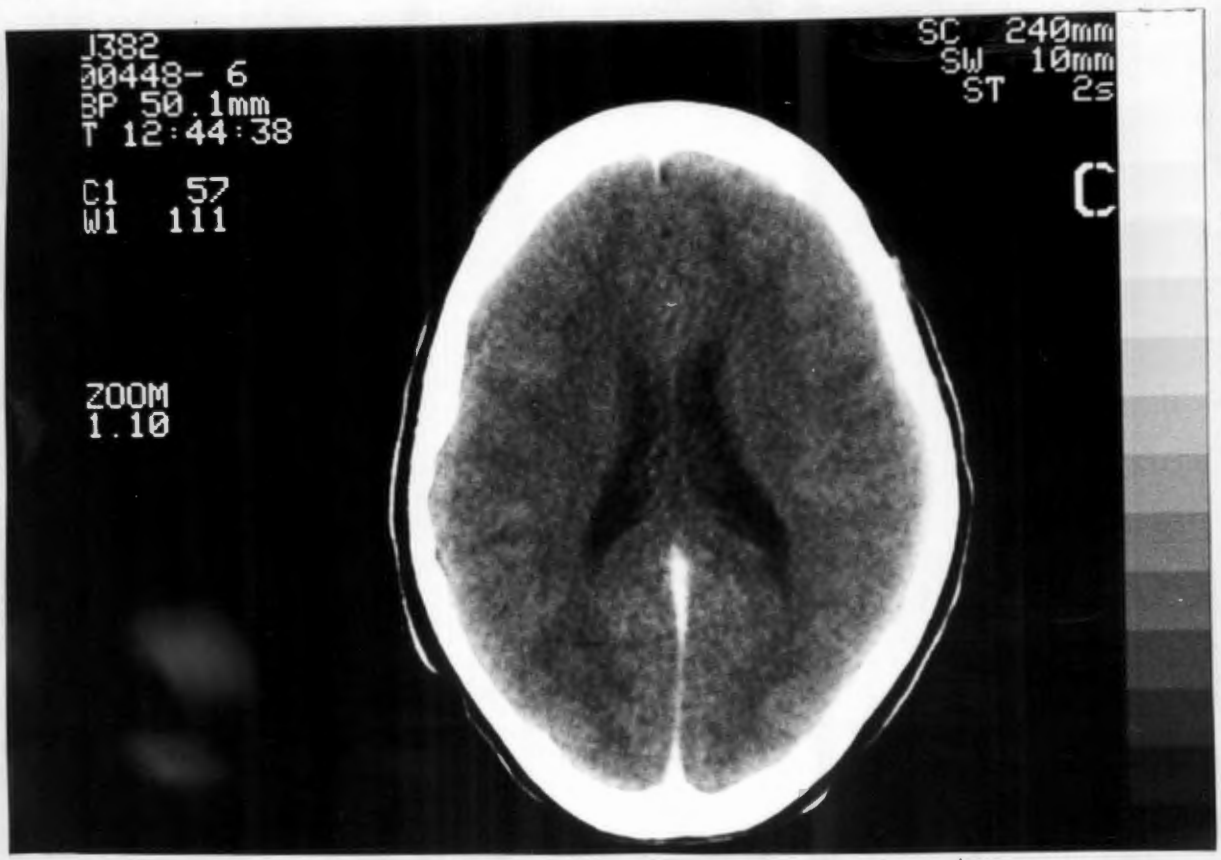


FIGURE 3: C.T. Scan of the same patient two weeks later showing disappearance of the subdural empyema after antibiotic therapy only.



The results in this study indicate however, that planned surgical drainage, using C.T. scanning, improves the outcome of S.E. treated surgically. The cases who died had residual pus present at autopsy, in spite of surgical drainage and antibiotic therapy. Only small subdural collections of pus should therefore be treated without surgical drainage, as long as follow-up C.T. scans indicate that the S.E. is responding. Identifying the offending organism from the source or elsewhere, is also important, to ensure that resistance to the commonly used antibiotics, although rare, is not present. The statement by Leys et al *(53), that it is not always necessary to know the causative organism, is probably in correct, and a careful search for the offending organism should be made in every patient with S.E. Non-surgical cure of brain abscesses has also been reported. *(7).

Steroids:

In this study Dexamethsone was used in 13 patients for brain swelling shown on C.T. scan. It was not used in 16 cases, and the records were lost in 18 cases. The use or not of steroids did not significantly affect outcome, with 23,1% of patients on steroids severely disabled or dead versus 18,8% of patients not on steroids. Some authors use steroids routinely in the management of S.E. *(46). There have been no reports of its use exacerbating the infection.

Anticonvulsants:

These are used prophylactically for patients with S.E. who do not present with seizures. *(46). This was also the policy in 26 of the 27 patients in this study who were seizure free on admission. One patient never received anticonvulsants, and remained seizure free.

Patients who present with seizures should be treated with anticonvulsants, usually Phenytoin. Seizures will stop in the majority of patients when the acute illness has been treated, and Williams advocates discontinuing anticonvulsants 6 to 8 weeks following the acute illness. *(84). Only 18,6% of the surviving patients in this series were still plagued by seizures at follow-up; however 65,1% were still on anticonvulsants.

COMPLICATIONS:

Complications following drainage of S.E. occurred in 38,3% of patients in this study. Serious complication that affected outcome were the development of a brain abscess, ventriculitis and hydrocephalus, as well as severe respiratory infection. Of the five patients who developed a brain abscess following S.E. drainage, 2 died, 2 remained severely disabled, and one recovered without focal signs or seizures. One of these patients later developed ventriculitis, when his abscess ruptured into the lateral ventricle. This led to the development of hydrocephalus and necessitated insertion of a V.P. shunt. The patient had a poor outcome.

One other patient also developed ventriculitis diagnosed on C.T. scan, which later caused hydrocephalus. He also needed a ventriculo-peritoneal shunt and remained severely disabled.

Two patients developed severe respiratory infections requiring mechanical ventilation. One of these developed a brain abscess and has already been mentioned. The other patient needed ventilation for a chest infection and poor blood-gases three days following a craniotomy for drainage

of subdural pus. His condition eventually improved and he made an excellent recovery.

One patient suffered a respiratory arrest following burrhole drainage of his S.E. At repeat craniotomy pus was present in the subdural space. He died one week later.

Serious complications occurred in 19,2% of patients treated initially with burrholes, and in 15% of patients in the craniectomy group. The patients who had initial craniotomies had the lowest incidence of serious complications (9,1%). Although the numbers are small, this may indicate the importance of adequate removal of subdural pus. Residual pus was also shown however on C.T. scans in the patients who developed complications, and earlier burrhole drainage of pus shown on post-operative C.T. scans, would probably have prevented these complications from occurring.

OUTCOME:

Various factors have been shown in the literature to affect the outcome from S.E. This study did not lend support to the statement by Bannister et al *(5) and Williams *(84) that craniotomy drainage improved outcome significantly.

Other factors that may influence outcome, are the clinical condition of the patient on admission. Unconscious patients had a worse outcome in most studies. *(5)(46)(79). In this series the outcome was also improved in patients who were conscious on admission, with a mortality rate of 7,1% and combined severe morbidity/mortality rate of 14,3% versus a mortality rate of 9,4% and a combined morbidity/mortality rate of 21,9% for unconscious patients.

The duration of the illness before a correct diagnosis of S.E. was made also influenced the outcome in the report by Renaudin and Frazee: *(68). In this Cape Town series 6 patients were seen within 48 hours of the start of their illness, and all six had an excellent outcome with no focal signs or seizures. That contrasts with a 68,3% excellent outcome in the patients who presented more than 48 hours after their initial illness; and the 72,3% excellent outcome overall.

Age was shown to influence outcome, and older patients did worse in the study by Williams. *(84). In the Cape Town series patients in their first or second decade had a combined severe morbidity/mortality rate of 17,9%, versus a figure of 25% for older patients. The mortality figures were 7,7% and 12,5% respectively.

Kaufman et al felt that if a lumbar puncture was performed in S.E. patients, the outcome was worsened. *(47). In this study 15 patients did not undergo lumbar punctures. Their combined morbidity/mortality rate was 26,7% versus a combined morbidity/mortality rate of 15,6% in patients who did have a lumbar puncture. No patient in this series deteriorated immediately after lumbar puncture, although lumbar puncture in S.E. patients theoretically may cause deterioration and affect the outcome, and should be discouraged.

The occurence of early seizures did not affect outcome in the study by Cowie and Williams. *(20). In thi Cape Town series this was substantiated with death or poor outcome in 15% of patients presenting with seizures, versus 18,5% in 27 patients who did not have initial seizures.

S.E. secondary to paranasal infection showed an improved outcome in Williams' series. *(84). In the Cape Town study the combined severe disability/mortality rate in 31 patients

with S.E. secondary to paranasal sinus infection was 22,6% versus 10% for 10 patients with S.E. post otogenic disease. S.E. secondary to paranasal sinusitis therefore had a worse outcome than S.E. following on otogenic disease.

Regarding late seizures, Cowie and Williams have shown that attacks in the follow-up period will have occurred within the first two years of follow-up in the vast majority of patients. *(20). Williams advocates stopping anticonvulsant treatment 6 to 8 weeks after recovery from the acute illness and reserving such treatment for those who have a subsequent epileptic attack. *(84). The figures in this study indicate that seizure-occurrence seldom continues in the follow-up period, with only 17,0% of cases continuing to suffer seizures. It is reasonable therefore to stop anticonvulsant use once the patient has recovered from the acute illness and is seizure free. Three of the patients still had seizures more than two years post treatment of their S.E. and remained on anticonvulsants.

CONCLUSION:

S.E. remains an important intracranial infection that may cause death and severe disability if not treated adequately. The advent of C.T. scanning has improved the early diagnosis of S.E., which improves the outcome. Pus present after surgical drainage procedures is also shown, and repeat drainage can be performed. Using C.T. scanning to plan the surgical approach vastly improves the outcome from S.E., and diminishes the need for initial craniotomy-drainage to achieve a satisfactory outcome. Some subdural empyema collections shown to be small on C.T. scanning may even be treated without direct surgical drainage.

Remaining pus in the subdural space after initial drainage procedures contribute to the development of complications. C.T. scanning must be performed regularly post-operatively to find residual pus, and this should be drained surgically. It is important to note that S.E. requires multiple drainage procedures in most cases, regardless of the initial form of surgery used.

A broad spectrum antibiotic regime remains one of the mainstays of treatment of S.E. Chloramphenicol was shown to be most effective. The importance of anaerobic organisms and the difficulties in culturing these organisms were shown in this study.

With aggressive early management of S.E., more than 90% of patients should survive and 90% of survivors should have no or minimal disability, enabling them to return to their pre-disease activity. The incidence of epilepsy in survivors is low and can be controlled in most cases.

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