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...for the Fat Lady

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Approximately 1% of the Pediatric in-patients at Yale-New Haven Hospital in 1972 were diagnosed as having meningitis. Many investigators have devoted considerable time to the study of the etiology, diagnosis, and treatment of both bacterial and viral meningitis. Relatively little energy, however, has been devoted to the investigation of the long-term sequelae of bacterial meningitis in children. It is the purpose of this study to investigate the long-term sequelae of bacterial meningitis in a group of children hospitalized at Yale-New Haven Hospital between 1960 - 1970, using as a control population, a group of children hospitalized at the same hospital, at approximately the same time, with the diagnosis of viral meningitis.

Ross (1) reported the mortality rate of meningococcal meningitis, at the time when anti-serum was the only treatment available, to be approximately 60%. With the use of sulfa or sulfa and penicillin, the mortality rate fell to 20%, however, he noted the incidence of long-term sequelae to be approximately 30% in both groups. Trolle (2) reported that 65.8% of her patients with meningococcal meningitis in the pre-chemotherapy period died as compared to 11.9% with the introduction

of chemotherapy. Fifty-four percent of the cases in the pre-chemotherapy period and 50% of those who had received chemotherapy suffered sequelae, however, with the advent of chemotherapy she noted a decrease in the incidence of severe sequelae from 41% to 17%. Alexander [3] noted a pre-antibiotic mortality rate in all forms of bacterial meningitis of 90% and a post-antibiotic rate of 20%. Nelson [4] discovered a 60% incidence of sequelae in all forms of bacterial meningitis prior to the advent of antibiotics.

At various times and at various institutions there has been a great deal of variety in the antibiotic therapy of bacterial meningitis. For the purposes of this study, the literature over the past 25 years dealing with the long-term sequelae of bacterial meningitis has been divided into two periods. During the first period a patient with a bacterial meningitis of unknown etiology was usually treated with sulfadiazine, penicillin, and streptomycin until an organism was identified. If the agent were H. influenzae or if no organism were isolated, the patient would be continued on the "triple therapy". If the agent were pneumococcus, the patient was usually placed on penicillin and if the agent were

N. meningitidis the patient was usually placed on sulfadiazine, penicillin, or a combination of both. During the latter, or broad-spectrum antibiotic period, ampicillin or chloramphenicol was in some way incorporated into the above regimens for the treatment of most cases of bacterial meningitis.

Bloor et al. [5] performed one of the earliest studies in the prebroad-spectrum antibiotic period. In 1950, his group studied 44 children all of whom had been hospitalized between 1945 - 1948 with H. influenzae meningitis - 20% of these children had been 9 months old or less at the time of their acute illness. Ten children had died, 5 had been lost to follow-up, and the remaining 29 were given complete physical, developmental, and neurological examinations, as well as EEG studies. The 29 survivors were classified into two groups: the "good results" [18 children with no sequelae] and the "poor results" [11 children with retarded developmental levels, behavior problems, and/or severe

neurologic deficits). The authors noted that 71.0% of the "poor result" group had seizures during their acute illness, whereas only 18.7% of the "good result" group had seizures during their acute illness. Forty-four percent of the "good result" children had no neurologic sequelae, the remainder having only minimal abnormalities such as asymmetric reflexes, except for one child with a hearing deficit. Twenty percent of the "poor result" children had no neurologic sequelae, the remainder having such marked neurologic deficits as hydrocephalus, bilaterial nerve deafness, and hemiparesis. None of the "good result" group and 10 of the 11 "poor result" group were found to have developmental retardation. Of the 12 EEG's performed on the "good result" children, 58.3% were abnormal, and of the 9 EEG's performed on the "poor result" children, 77.7% were abnormal. The authors noted a poorer prognosis in children 9 months of age or less at the time of their acute illness and in children who had seizures at the time of their acute illness. They concluded that approximately 60% of the survivors in their series were free of sequelae, while 21% of the survivors had major neurologic sequelae. Davis et al. [6] in

1950 performed physical and psychological examinations on 105 children at an unspecified time after they had been hospitalized with bacterial meningitis between 1940 - 1947. They found no impairment in the children with pneumococcal or H. influenzae meningitis who had been treated with sulfadiazine. They also found that the development of those children who were less than 2 years old at the onset of their meningitis was, in general, considerably poorer than those who were older than 2 years. Fox [7] in 1953 reviewed 323 cases of meningococcal meningitis hospitalized between 1936 - 1945. Questionnaires were sent to all 323, but only 178 [55%] were returned. The subjects ranged from 5 weeks to 66 years of age at the time the questionnaires were sent. Forty point five percent reported some long-term sequelae. The highest incidence of residual effects was reported in the first year following the acute illness, with a tendency for complaints to subside with the passage of time. Headaches were the most common complaint [32%]. Other complaints included joint pain, muscle pain, muscle twitching, fainting, and convulsions [1 person]. Sixty-four percent claimed their symptoms were aggrevated by various conditions

such as the weather and their level of activity. Twelve point three percent complained of impaired hearing. Smith (8) in 1954 studied 409 children who had been admitted between 1944 - 1953 with bacterial meningitis. All of the information concerning sequelae was obtained from the patients' charts. Twenty-five percent of the children were 6 months old or less, and 47% were 1 year old or less at the onset of their illness. Of the 106 patients diagnosed as having H. influenzae meningitis, 90 (86%) survived without sequelae, 8 (7%) died, and 8 (7%) were left with sequelae such as convulsions, retardation, ataxia, spasticity, deafness, and hydrocephalus. Of the 71 patients diagnosed as having meningococcal meningitis, 56 (79%) survived without sequelae, 12 (17%) died, and 3 (4%) had marked residua similar to that found in the H. influenzae group. Of the 41 patients with pneumococcal meningitis, 22 (54%) recovered without sequelae, 6 (14%) died, 13 (32%) had marked residua including deafness, hydrocephalus, quadraplegia, aphasia, behavioral problems, precocious puberty, and spasticity. The author noted that subdural effusions were not a common or serious complication. In total, of the 281 survivors, 50 (18%)

had sequelae. In 1954, Moltke et al. (9) reviewed 169 patients who had had bacterial meningitis between 1950 - 1952. They found no correlation between the duration of illness before admission or the height of the fever and the speed of recovery or the mortality rate. The presence of seizures, or other serious neurologic or systemic complications, was correlated with a poor prognosis. It was also demonstrated that the younger the patient, the poorer the prognosis. In 1955 Desmit (10) did a follow-up study of a group of children who had been treated for bacterial meningitis between 1949 - 1954. All of the children were given physical and psychological examinations at least 6 months after being discharged from the hospital. Of the 102 survivors, 16 (16%) had sequelae which interfered with their normal life and development (the sequelae were similar to those noted in the above studies). It was felt that in some cases there had been the suggestion, on a clinical basis, of a meningoencephalitis rather than simply a meningitis, and that in these cases the prognosis was considerably poorer.

In one of the better studies of the prebroad-spectrum antibiotic period, Bergstrand et al. [11] reviewed 85 children who had been hospitalized with bacterial meningitis between 1947 - 1954. Although most of these patients had not been treated with chloramphenicol, the authors noted that data being published at this time [12, 13, 14] showed an apparent reduction in long-term sequelae with the use of chloramphenicol. Of the 85 patients, 8 [9.5%] were lost to follow-up, 70 [82.5%] were given physical and neurological examinations, and information regarding 7 [8%] was obtained indirectly. Fourteen patients [16.5%] were found to have had sequelae at the time of their discharge and 15 patients [19%] were found to have had sequelae at follow-up [3 patients who had sequelae at discharge recovered, and 4 patients demonstrated vestibular damage at follow-up that had not been detected at discharge]. The sequelae noted at follow-up included: mental retardation [5 children], hydrocephalus [2 children], paresis [7 children], convulsions [4 children], ataxia [3 children], deafness [5 children], and vestibular problems [6 children]. There was no correlation between the duration of illness prior to treatment and the

incidence of sequelae. McNeil [15] in 1958 evaluated 97 children hospitalized between 1948 - 1957 with bacterial meningitis through questioning of their parents either by letter or phone. Fifty-eight percent of the children had been 1 year old or less at the onset of their acute illness. Twenty-eight of the 97 children [28%] were found to have sequelae. Subdural effusions were an infrequent complication and were not associated with a poor prognosis. The presence of seizures at the time of the acute illness was associated with a poor prognosis. Kresky et al. [16] in 1962 reviewed 155 children hospitalized between 1951 - 1955 with bacterial meningitis. Twenty-four [15.5%] had died, 49 [31.5%] were lost to follow-up, and the remaining 80 [53%] were given physical, neurological, and psychometric examinations. In addition, interval histories were obtained and EEG's performed. All 80 children were felt to be normal before the onset of their meningitis and at the time of their discharge from the hospital. Twenty-eight children [34%] had neurologic sequelae, 8 being severe and 20 being subtle. The I.Q.'s of the 50 children who were tested were no different

than a normal school population. Of the 74 EEG's performed, 23% were abnormal [6 showing seizure activity]. Of the 50 patients given psychological examinations, 5 were classified as "brain injured" and 2 as having behavior disorders. It was noted that the number and severity of motor and sensory defects, convulsive disorders, behavior disturbances, and "brain injured" syndromes was significantly greater if the acute illness occurred during infancy [less than 2 years old], was severe and prolonged, and if treatment was delayed for more than 3 days. The authors concluded that the majority of these defects were of such a mild degree that they did not interfere with the child's activity, growth or development. Few of these defects were noted at the time of discharge. Handicapping neurologic sequelae and major brain damage were uncommon with the exception of infants and those treated after 3 or more days of symptoms. A follow-up study of 41 children who had bacterial meningitis between 1952 - 1956 was performed by Hutchison et al. [17] in 1963. Thirty-eight percent of the patients were 6 months old or less, and 55% were 1 year old or less at the

time of their meningitis. Neurologic abnormalities were identified in 7 children (17%), but 2 were of questionable significance. EEG's were abnormal in 11 children (27%) but did not correlate with the clinical or psychological examinations. Psychiatric evaluation demonstrated evidence of organic brain damage in 12% and emotional instability in 29%. However, in 50% of the children identified as emotionally unstable, the mother gave a history of a behavior disorder, and in 70% there was an "environmental defect" identified in the collateral history. Psychological testing revealed 3 children (7%) with defective intelligence and 9 (21%) with evidence of organic brain damage. There was a significant correlation between the severity of complications during the acute illness and the incidence of neuropsychiatric sequelae at follow-up. In conclusion, 11 children (26%) were considered to have long-term sequelae.

Wolff (18) did a study of 179 patients treated between 1937 - 1944 for meningococcal meningitis and concluded, through the use of comprehensive intelligence testing, that meningococcal meningitis

during the first 6 months of life has a prolonged effect on the intelligence of the child. In children between 6 months and 1 year of age the effect of meningitis on subsequent intelligence is still discernable but much less severe, and in children over 1 year of age, meningococcal meningitis has little or no effect on the child's subsequent intelligence. The last major study of the prebroad-spectrum antibiotic period was that of Haggerty and Ziai [19] in 1964, in which they reviewed 100 cases of bacterial meningitis in children between 1951 - 1953. Approximately 3 years after discharge from the hospital, each child was given a neurological, psychological, audiometric, and EEG examination. Eighteen percent were found to have some sequelae which were categorized as follows: mental retardation 7%, behavior problem 7%, seizures 1%, deafness 3%, hemiplegia 3%, and speech problems 1%. It was also noted that the younger the child at the time of their acute meningitis, the greater the likelihood of some late sequelae.

The first major study of the long-term sequelae of bacterial meningitis in children to include a large percentage of children that had been treated with a broad-spectrum antibiotic [chloramphenicol]

was undertaken by Sproles et al. [20] in 1969. Forty children all of whom had had H. influenzae meningitis between 1951 - 1964 were given physical, neurological, audiometric, EEG, psychometric, and psychological evaluation. Interval and social histories were also obtained. Fourteen patients had been less than 6 months old and 24 patients had been less than 1 year old at the time of their acute illness with the mean age being 8 months. Seven [17.5%] children had died. Of the survivors, 4 [12%] were incapable of independent function, 11 [33%] were handicapped but not impeded to the extent that remediation was impossible [i.e. mild depression of I.Q., poor school performance, abnormal EEG, hearing loss, speech defect, minimal brain dysfunction, and behavioral problems], and 18 [55%] were completely normal. It is of interest that all of the severely handicapped children had had an interval of at least 5 days between the onset of symptoms and the initiation of treatment and that 3 of the 4 were less than 1 year old at the time of their acute illness. Keller et al. [21] in 1971 did a study of 145 children hospitalized between 1961 - 1962 with bacterial, viral, and tuberculous meningitis.

Sixteen percent had died and 23.4% were lost to follow-up. The remaining 87 (61%) were given physical, neurological, audiometric, visual, and psychological examinations 4 - 5 years after having been discharged from the hospital. Thirty-two percent of the bacterial meningitis group were found to have neurologic sequelae, 32% to have impaired psychological and intellectual development, and, in all, 35% to have severe sequelae and 30% to have mild sequelae. The authors noted that the younger the child at the time of their acute illness, the more likely was the occurrence of a complicated course and long-term sequelae.

In 1972 Wiebe et al. (22) did a follow-up, in an unspecified manner, of 194 patients hospitalized with bacterial meningitis in 1965. Most of the patients were children and none were neonates. Nine point four percent of the survivors were noted to have neurologic sequelae such as motor retardation, deafness, hydrocephalus, facial nerve palsy, visual problems, mental retardation, and quadraplegia. It was observed that a fatal outcome was much more common in children less than 1 year of age at the onset of their meningitis, but the incidence of sequelae in survivors did not show this relationship. There was no sex difference

in the incidence of morbidity and mortality, and subdural effusions, although complicating the course of 8% of the patients, did not lead to an increased incidence of late sequelae. Duration of illness before hospitalization, previous antibacterial therapy, and the persistance of fever after admission, in certain cases, showed a relationship to prognosis, but not a statistically significant one. Sell et al. [23] reviewed 99 children who had H. influenzae meningitis between 1950 - 1964. Eleven children [11%] had died, 56 children were brought in for histories, physical, neurological, audiometric, and psychological examination, and 32 children were evaluated through questionnaires [only 19 of the 32 returned]. The great majority of the children were less than 1 year old at the time of their acute meningitis. The majority of the survivors were treated within 72 hours of the onset of illness, however, 14 were treated 5 - 14 days after the onset. The median interval between onset of illness and treatment was 2½ days. Seven of the 56 children [12.5%] that were examined showed significant neurological findings including spastic hemiparesis, spastic quadraplegia, chorioretinitis with nystagmus, and petit mal seizures combining the information from the examinations and questionnaires, it

was concluded that 5% of the survivors had severe sequelae, 30% had significant sequelae, 16% had possible sequelae, and 49% had no evidence of sequelae. There was no correlation between age at onset of illness, interval between onset and therapy, or complications in the hospital and the child's subsequent I.Q. That same year Sell et al. [24] compared the performance of 21 children who had had H. influenzae meningitis at 2 months - 3 years of age on the Wechsler Intelligence Scale for Children with 21 nearest-aged siblings who had not had meningitis. The post meningitis children were found to have a significantly ($p < .05$) lower I.Q. than the control children even though they had all been considered to be free of long-term sequelae. In a similar study, Sell et al. [24] compared the performance of 25 children who had had bacterial meningitis on a battery of three psychological tests with 25 nonmeningitic controls matched by age, sex, social class, and classroom membership. The post-meningitic group scored significantly lower [p not specified] than the control group on all three tests even though they had all been considered to be free of long-term sequelae.

The literature over the past 15 years dealing with the long-term sequelae of viral meningitis has been extremely sparse. Muller et al. (25) in 1958 performed a rather extensive follow-up study of 238 patients hospitalized between 1946 - 1954 with the diagnosis of meningo-encephalitis of "unknown cause". Seventy-eight of the 238 patients (33%) were less than 15 years of age at the onset of their illness. All were given clinical, sociomedical, EEG, and psychological examinations. One hundred and thirty eight controls, comparable with the patients according to the "social twin" principle were subjected to similar evaluations. No difference between the patients and controls could be demonstrated on the physical, neurological, or psychological evaluations. In addition, no difference in occupational status, school performance, or social adjustment could be found between the patients and controls. The frequency of abnormal EEG's was higher in the patients than in the controls, however, the results of the EEG's in the patient group showed no correlation with the clinical or psychometric findings.

In 1962, King and Karzon [26] reviewed 93 children out of a group of 130 children who had been diagnosed as having ECHO 6 meningitis and 9 children out of a group of 21 children who had been diagnosed as having meningitis due to other enteroviruses. All of the children had had meningitis in 1955 and were given physical and neurological examinations at least 3 years after their acute illness. In addition, an interval history and review of systems was obtained for each child. Many non-specific complaints were elicited in the histories from both meningitis groups, such as changes in behavior, easy fatigability, headaches, stiffness or subjective weakness of the back or legs, the onset of which was associated with the acute illness. Twenty percent of the ECHO 6 group, and 78% of the other enterovirus group, were noted to have minor abnormalities on physical examination including: absent abdominal reflexes, absent or diminished cremasteric reflexes, asymmetric deep tendon reflexes, scoliosis, kyphosis, weak anterior neck muscles, and back and/or hamstring spasm. In all, 25% of the post-meningitis children had some neurologic finding. A control group of 44 children

with no history of CNS disease was studied in a similar manner. Many of the same complaints were elicited by history from the controls as had been obtained from the meningitis group. In addition, 27% of the controls had neurological abnormalities similar to those noted in the meningitis group. Although the controls were not comparable to the patients in socio-economic and hospitalization background, the appreciable number of minor neurologic changes noted in this group led the authors to minimize these same findings in the post-meningitis group. No instance of a clear-cut disability in neuromuscular function was noted in the post-meningitis group. Azini et al. [27] in 1969 found no neurological or auditory sequelae in 33 children who had had mumps meningo-encephalitis. Vivell [28] in 1970 reviewed the German literature on viral meningitis and concluded that the prognosis after viral meningitis is uniformly good, unless there is a component of encephalitis accompanying the meningitis. In 1970, Similia et al. [29], after studying a group of patients who had had adenovirus meningoencephalitis, concluded that, even though the clinical picture is severe and the mortality is high, patients who

survive adenovirus meningitis sustain no irreversible lesions. That same year Levitt et al. [30] did a follow-up study of 64 documented cases of CNS mumps, 13 diagnosed as mumps meningoencephalitis and 55 diagnosed as mumps meningitis. Nineteen patients [16 meningitis and 3 meningoencephalitis] returned for neurological, psychological, and audiometric examination. Nineteen controls matched by age, sex, and socio-economic class were given similar evaluations. Eighteen of the CNS mumps group were felt to be completely normal while 1 child in this group was felt to demonstrate minimal brain damage, poor school performance, poor coordination, dyslexia, and hyperactivity although no intellectual impairment was noted. The one child with the obvious sequelae had been diagnosed as having mumps meningoencephalitis. Torphy et al. [31] in 1970, while following 40 children who had had ECHO 30 meningitis, had information regarding sequelae volunteered in 7 cases, either from the patient or their parents. Complaints included increased irritability, headaches, parathesias, difficulty concentrating, and intermittent photophobia present 5 - 13 weeks after the acute illness.

Fee et al. [32] in 1970 did a follow-up study of 18 children hospitalized between 1958 - 1967 with viral meningitis. An interval history was obtained from the patients' mothers, a physical and comprehensive neurological examination was performed, behavioral questionnaires were sent to the patient's mother and teacher, and a Beery test of visual-motor integration and an EEG were performed on all of the patients at least 10 years after their discharge from the hospital. Three of the 18 [17%] had seizures during their hospitalization. All of the children were free of sequelae at discharge and presently felt to be completely well. Only 1 of the 18 [6%] had an abnormal EEG, and in that case the EEG findings could not be correlated with any clinical signs or symptoms. Sixty-seven percent of the children demonstrated a variety of minor abnormalities on various examinations. These abnormalities were quite similar, however, in nature and number to those which King and Karzon [26] had reported in their control population. Consequently the authors concluded that little significance could be attributed to these findings. One patient was found to have a neurotic behavior disorder, one patient had abnormal

visual-motor integration, and one patient had both a neurotic behavior disorder and poor visual-motor integration. Two of these 3 children with obvious sequelae had hospital courses complicated by seizures. The authors concluded that unless seizures are present at the time of the acute illness, the prognosis in viral meningitis is uniformly good. Finally, Keller et al. [21] in 1971 noted that of 41 children who had been diagnosed as having viral meningitis between 1961 - 1962, 12% were found to have neurological sequelae when examined 4 - 5 years after discharge. Ten percent of the 41 children were found to have severe psychological and intellectual abnormalities, 12% to have mild psychological and intellectual abnormalities, and 78% to have no psychological or intellectual impairment. In all, 10% of the post-viral meningitis children were found to have severe sequelae, 29% were found to have light sequelae, and 61% were found to have no sequelae.

There are many factors which make it difficult to generalize from the studies cited above [see tables 1 and 2 for summary of literature]. Other than the division into pre and post broad-spectrum antibiotic

BACTERIAL MENINGITIS - Table #1

Author	Dates of Study	Number of Survivors	% with Sequelae	Age at Onset	% Hearing Deficit	EEG	Interval btw onset & treatment	Subdural Effusions	Fever
Bloor	1945-48	29	40	+	10	-			
Davis	1940-47	105	0	+					
Fox	1936-45	323	60		12			-	
Smith	1944-53	281	18						
Moltke	1950-52	169	-	+			-		-
Desmit	1949-54	102	16						
Bergstrand	1947-54	77	19		6		-		
Kresky	1951-55	80	34[10]*	+	10	-	+ if 73		
Alexander [33]	1954	189	12						
McNeil	1950-57	117	28		7			-	
Hutchison	1952-56	41	26		15	-			
Haggerty	1951-53	92	18	+	3				
Sproles	1951-64	33	45[12]*	+	12		+ if 75		
Keller	1961-62	59	65[35]*	+					
Wiebe	1965	171	9	+	2		? +	-	
Bell	1950-64	75	51[35] *		16		? +		

- = correlates with increased incidence of long-term sequelae
- = doesn't correlate with increased incidence of long-term sequelae
* Severe Sequelae in [ ]

BACTERIAL MENINGITIS - Table #1 [Con't.]

Author	Seizures	Concom. Enceph.	Controls
Bloor	+		No
Davis			No
Fox			No
Smith			No
Moltke	+		No
Desmit		+	No
Bergstrand			No
Kresky			No
Alexander [33]			No
McNeil	+		No
Hutchison			No
Haggerty			No
Sproles			No
Keller			No
Wiebe			No
Sell			No

BACTERIAL MENINGITIS - Table #1 (Con't.)

Author	Seizures	Concom. Enceph.	Controls
Bloor	+		No
Davis			No
Fox			No
Smith			No
Moltke	+		No
Desmit		+	No
Bergstrand			No
Kresky			No
Alexander (33)			No
McNeil	+		No
Hutchison			No
Haggerty			No
Sproles			No
Keller			No
Wiebe			No
Sell			No

VIRAL MENINGITIS - Table #2

Author	Dates of Study	Number of Survivors	% with Sequelae	EEG	Concomitant Encephalitis	Seizures	Control
Muller	1946-54	238	0	-			Yes
King	1955	102	0				Yes
Vivell	1970		0		+		No
Azini	1969	33	0				No
Similia	1970		0				No
Levitt		19	0		+		Yes
Fee	1958-67	18	17(6)*	-		+	Yes
Keller	1961-62	41	39(10)*				No

+ = correlates with increased incidence of long-term sequelae
- = doesn't correlate with increased incidence of long-term sequelae
* Severe Sequelae in ( )

use, there is no control of the type of therapy, antibiotic or otherwise, that these children received while acutely ill. There is a great variance in age, sex, race, socio-economic status, and incidence of complications during hospitalization among the various groups studied. In addition, there is no control of the interval between the onset of illness and the onset of therapy, the interval between discharge and follow-up examination, or the type of follow-up examinations that were performed. Given these limitations, one can still extract several important concepts from the literature on both bacterial and viral meningitis. It is of great interest that only one [24] of the studies of the long-term sequelae of bacterial meningitis over the past 25 years used a control group. Several of the authors [17, 19, 23] expressed reservations about conclusions drawn from their own and earlier uncontrolled studies. The percentage of children with long-term sequelae in the bacterial meningitis studies ranged from 0% to 65% with the greatest cluster being around 20%. Nine studies [5,6,9,16,18,19,20,21,22] demonstrated that the younger the child at the onset of the bacterial meningitis, the more likely is the occurrence of residual damage. In no study was EEG examination

shown to be a useful means of identifying the long-term sequelae of bacterial meningitis, and in those cases in which abnormal EEG's were noted, no clinical correlates could be established [5, 16, 17]. In three studies [5, 9, 15] seizures during the acute bacterial meningitis were shown to correlate with a higher incidence of long-term sequelae. The three studies which examined the issue of subdural effusions in bacterial meningitis [8, 15, 22] concluded that they were uncommon and not associated with a poor prognosis. A number of studies suggested that an interval of greater than 3 days between the onset of symptoms and the onset of therapy is associated with a higher incidence of long-term sequelae [16, 20, 22, 23]. The incidence of hearing deficits following bacterial meningitis was consistently reported as approximately 10%. In one study [9] the height of the fever during the acute illness was not found to correlate with the incidence of long-term sequelae, and in one study [10] the presence of meningoencephalitis rather than simply meningitis was found to correlate with a higher incidence of long-term sequelae.

In contrast to the bacterial studies, approximately half of the viral studies used control groups. The importance of controls in studies of this nature is evidenced by the experience of King [26] and Fee [32] who both found a high incidence of minor neurologic abnormalities in a long-term follow-up of their patients who had survived viral meningitis but minimized the significance of these findings when their controls presented with a similar incidence of the same abnormalities. Furthermore, there was much more accord regarding the incidence of long-term sequelae in the viral literature than in the bacterial. Of the 8 major studies cited above, 6 reported no long-term sequelae in survivors of viral meningitis, 1 reported sequelae in 39% of the survivors [6% if only serious sequelae are considered], and 1 reported sequelae in 17% of the survivors [10% if only serious sequelae are considered]. In the two studies in which EEG's were used [25,32] the authors found them to be of little value in identifying neurologic sequelae. Two studies [28, 30] demonstrated a higher incidence of long-term sequelae in children who had had meningoencephalitis rather than simply meningitis. The one study which examined the effect of seizures on

the prognosis of meningitis [32] demonstrated a higher incidence of long-term sequelae in children who had seizures during their acute viral meningitis.

Methods

The charts of all of the children hospitalized at Yale-New Haven Hospital between 1960 - 1970 with bacterial meningitis were reviewed. All diagnoses had been confirmed by positive CSF cultures. Children were excluded if they had been less than 1 year of age at the time of their hospitalization, if they had been hospitalized prior to contracting meningitis (birth not included), if there were any evidence of physical, neurological, or behavioral abnormalities prior to the hospitalization for meningitis as described in the hospital record, or if the family had moved and could not be contacted. Children less than 1 year of age were excluded because of the difficulty in diagnosing this entity in neonates and the inability to obtain adequate follow-up on children who had not yet entered school. Information concerning etiology, age at onset, sex, race, interval between onset of symptoms and treatment, highest temperature in the hospital, length of hospitalization, complications in the hospital, and sequelae noted at discharge was obtained from each

child's chart. The patients ranged from 1 - 6 years of age at the time of their acute illness, with a mean age of 2.5 years $\pm$ 1.3 years. Of the 32 children, 15 were male, 17 were female, 3 were black and 24 were white. H. influenzae was cultured in 24 cases [78%], N. meningitidis in 6 cases [20%], and pneumococcus in 2 cases [5%]. Although H. influenzae was consistently shown to be the most common etiology of bacterial meningitis in children, in no study did it account for such a large percentage of the cases [8, 10,11,15,16,17,22]. Most of the children with H. influenzae meningitis were treated with ampicillin, chloramphenicol, or a combination of chloramphenicol and sulfa. Most of the children with meningococcal or pneumococcal meningitis were initially treated with penicillin, chloramphenicol, and sulfa and then with penicillin and/or sulfa if the oganism turned out to be meningococcus or with penicillin if the organism turned out to be pneumococcus.

It was decided to use a group of children who had been hospitalized with viral meningitis as a control. The evidence that children who survive an acute episode of viral meningitis sustain no long-term sequelae, as has been noted above, is fairly convincing. In addition, by choosing as controls a group of children who had a CNS lesion, it was hoped to control for the parental

and iatrogenic anxiety often associated with CNS disease. Finally, it was felt that the hospitalization itself was a factor that should be controlled. Ideally, the controls should have been matched for age, sex, race and socio-economic class, but due to the relative infrequency with which children with viral meningitis are hospitalized, this was simply not possible. A group of 19 children who had been hospitalized between 1964 - 1970 with viral meningitis were randomly selected from the chart files of Yale-New Haven Hospital. Only 1 child had a positive CSF viral culture (Coxackie 9). The others were judged to have had a viral etiology on the basis of their CSF indices and negative bacterial cultures of their blood and CSF. Two children had been treated for approximately 3 days prior to admission with Procaine Penicillin G and upon admission had viral CSF indices and negative blood and CSF cultures. In light of the evidence that short-term penicillin therapy does not alter the CSF indices in bacterial meningitis (34) and in view of the shortness of their hospital courses (2 days), both children were believed to have had viral meningitis. Children were excluded on the same basis that had been

applied to the bacterial group, and the same information was obtained from their charts. The patients ranged from 1 - 9 years of age at the time of their acute illness, with a mean age of 6.6 years $\pm$ 2.4 years. The viral group was significantly [$p < .01$] older at the onset of their acute meningitis than the bacterial group. Of the 19 children, 12 were male, 7 were female, 3 were black and 16 were white. All were treated with only supportive care while hospitalized. The viral group was evaluated an average of 5.8 years $\pm$ 2.0 years after their acute illness and the bacterial group an average of 9.7 years $\pm$ 3.2 years after their acute illness. There was a significantly [$p < .01$] greater interval between discharge and follow-up in the bacterial group than in the viral group.

Ideally, all of the children in both groups would have been given comprehensive physical, psychological, neurological, and psychiatric evaluations. In addition, interval histories would have been obtained and questionnaires sent to each child's school. Unfortunately, lack of time, money, and personnel precluded such an extensive investigation, and questionnaires were chosen as a decidedly inferior, but nevertheless

reasonable alternative. The parents of each child were called, informed about the study, and asked to complete a questionnaire and allow a similar questionnaire to be sent to their child's school (see Form #1 and Form #2 in the Appendix). A questionnaire was then mailed to the parents of every post-bacterial meningitis (PBM) child and every post-viral meningitis (PVM) child. A similar questionnaire was mailed to the school that each child presently attended, unless requested otherwise by the parents. Both questionnaires were constructed primarily from a form used by the Yale-New Haven Cystic Fibrosis Clinic to follow the development of their patients and from a form used by the National Institute of Mental Health in a study of behavior problems in twins. In addition, questions were constructed to inquire specifically about long-term sequelae noted in previous studies. Parents and schools that had not returned their questionnaires within 3 weeks were called again, and additional forms were mailed when necessary. Of the 32 forms sent to the PBM parents, 29 (91%) were returned, and of the 30 forms sent to the PBM schools, 29 (97%) were returned. Of the 19 forms sent to the PVM parents, 18 (95%) were returned, and of the 17 forms sent to the PVM schools, 15 (88%) were returned.

Results

There were 88 questions on the school form, all but 6 were of the "True-False" variety. For each question, the number of "True" responses in the PBM and PVM groups was tabulated and the totals compared using the Chi Squared test with the Yates correction. Only 3 questions (see Table 3) showed a statistically significant ($P < .03$) difference between the number of "True" responses in each group. In all three cases the PVM group had more "True" responses than the PBM group. The other questions were evaluated using arbitrary standards established for the purposes of this study (see form in appendix for criteria) and no significant difference was noted in the responses of the two groups. There were 97 questions on the parent form, all but 4 were of the "True-False" variety. For each question the number of "True" responses in the PBM and PVM groups was tabulated and the totals compared using the Chi Squared test with the Yates correction. There were only 4 questions (see Table 4) which showed a statistically significant ($p < .03$) difference between the number of "True" responses in each group. In all 4 cases the PBM group had more "True" responses than the PVM group. The other questions were evaluated using arbitrary standards established for

Table #3

NUMBER OF POSITIVE RESPONSES ON SCHOOL FORM*

	Question #	PBM (N = 29)	PVM (N = 15)	X^2
Part I	1	2	0	N.S.
	2	4	2	N.S.
	3	0	3	N.S.
	4	3	0	N.S.
	5	2	3	N.S.
	6	7	3	N.S.
Part II	1	2	1	N.S.
	2	1	0	N.S.
	3	0	1	N.S.
	4	1	2	N.S.
	5	2	1	N.S.
	6	4	1	N.S.
	7	3	2	N.S.
	8	4	1	N.S.
	9	2	1	N.S.
	10	7	4	N.S.
	11	6	1	N.S.
	12	1	4	N.S.
	13	0	1	N.S.
	14	2	1	N.S.
	15	2	2	N.S.
	16	6	7	N.S.
	17	3	3	N.S.
	18	2	3	N.S.
	19	2	2	N.S.
	20	4	0	N.S.
	21	3	3	N.S.
	22	3	5	N.S.
	23	2	2	N.S.
	24	0	0	N.S.
	25	2	1	N.S.
	26	2	0	N.S.
	27	4	5	N.S.
	28	1	1	N.S.
	29	1	1	N.S.
	30	2	3	N.S.
	31	1	6	$p < 0.01$
	32	0	0	N.S.
	33	2	2	N.S.
	34	2	1	N.S.
	35	6	5	N.S.
	36	6	8	N.S.

Table #3 (Con't.)

NUMBER OF POSITIVE RESPONSES ON SCHOOL FORM*

Question #	PBM (N = 29)	PVM (N = 15)	x^2
37	5	5	N.S.
38	4	4	N.S.
39	1	3	N.S.
40	1	3	N.S.
41	0	1	N.S.
42	1	1	N.S.
43	1	3	N.S.
44	1	1	N.S.
45	1	2	N.S.
46	0	0	N.S.
47	1	3	N.S.
48	0	1	N.S.
49	1	1	N.S.
50	2	4	N.S.
51	1	5	$p < 0.03$
52	1	1	N.S.
53	1	0	N.S.
54	2	4	N.S.
55	0	1	N.S.
56	1	3	N.S.
57	1	5	$p < 0.03$
58	1	0	N.S.
59	1	2	N.S.
60	3	2	N.S.
61	4	2	N.S.
62	0	1	N.S.
63	1	4	N.S.
64	0	1	N.S.
65	1	4	N.S.
66	0	2	N.S.
67	1	4	N.S.
68	6	3	N.S.
69	0	1	N.S.
70	0	1	N.S.
71	4	6	N.S.
72	2	2	N.S.
73	0	1	N.S.
74	2	2	N.S.
75	1	1	N.S.
76	0	1	N.S.

Table #3 [Con't.]

NUMBER OF POSITIVE RESPONSES ON SCHOOL FORM*

Question #	PBM [N =29]	PVM [N = 15]	X^2
77	1	3	N.S.
78	4	1	N.S.
79	0	2	N.S.
80	2	0	N.S.
81	2	3	N.S.
82	1	1	N.S.

*See appendix for actual form

Table #4

NUMBER OF POSITIVE RESPONSES ON PARENT FORM*

	Question #	PBM (N = 28)	PVM (N = 18)	X^2
Part I	1	9	8	N.S.
	2	5	1	N.S.
	3	1	1	N.S.
	4	7	2	N.S.
	5	3	1	N.S.
	6	3	0	N.S.
	7	1	1	N.S.
	8	0	1	N.S.
	9	2	0	N.S.
	10	5	2	N.S.
	11	6	7	N.S.
	12	5	1	N.S.
	13	11	10	N.S.
	14	6	4	N.S.
	15	7	0	$p < 0.01$
	16	2	1	N.S.
	17	7	6	N.S.
	18	5	4	N.S.
	19	4	4	N.S.
	20	11	11	N.S.
	21	1	0	N.S.
	22	2	0	N.S.
	23	0	0	N.S.
	24	1	1	N.S.
	25	7	6	N.S.
	26	2	5	N.S.
	27	5	1	N.S.
	28	3	1	N.S.
	29	1	1	N.S.
	30	6	4	N.S.
	31	11	9	N.S.
	32	2	2	N.S.
	33	2	1	N.S.
	34	8	4	N.S.
	35	1	1	N.S.
	36	1	1	N.S.
	37	3	0	N.S.
	38	0	0	N.S.
	39	4	0	$p < 0.03$
	40	7	5	N.S.

Table #4 (Con't.)

NUMBER OF POSITIVE RESPONSES ON PARENT FORM*

Question #	PBM (N = 28)	PVM (N = 18)	X^2
41	5	5	N.S.
42	4	5	N.S.
43	11	8	N.S.
44	9	8	N.S.
45	13	7	N.S.
46	3	2	N.S.
47	2	2	N.S.
48	0	1	N.S.
49	4	4	N.S.
50	0	0	N.S.
51	0	0	N.S.
52	2	4	N.S.
53	3	1	N.S.
54	2	4	N.S.
55	6	0	$p < 0.02$
56	5	1	N.S.
57	5	0	$p < 0.02$
58	1	1	N.S.
59	0	2	N.S.
60	13	9	N.S.
61	7	6	N.S.
62	5	1	N.S.
63	0	1	N.S.
64	5	5	N.S.
65	5	4	N.S.
66	6	4	N.S.
67	5	3	N.S.
68	4	2	N.S.
69	1	0	N.S.
70	8	5	N.S.
71	2	3	N.S.
72	2	3	N.S.
73	1	1	N.S.
74	8	4	N.S.
75	0	1	N.S.
76	1	1	N.S.
77	4	1	N.S.
78	3	0	N.S.
79	1	0	N.S.
80	5	4	N.S.

Table #4 (Con't.)

NUMBER OF POSITIVE RESPONSES ON PARENT FORM*

	Question #	PBM (N = 28)	PVM (N = 18)	X^2
	81	3	1	N.S.
	82	4	3	N.S.
	83	13	7	N.S.
	84	1	0	N.S.
	85	3	1	N.S.
Part II	1	1	0	N.S.
	2	1	0	N.S.
	3	3	1	N.S.
	4	3	5	N.S.
	5	2	1	N.S.
	6	6	1	N.S.
	7	0	0	N.S.
	8	1	1	N.S.
	9	10	3	N.S.
	10	6	5	N.S.
	11	18	11	N.S.
	12	4	3	N.S.

*See appendix for actual form

the purposes of this study (see form in appendix for criteria) and no significant difference was noted in the responses of the two groups. In an attempt to analyze the forms in another manner, the questions were divided into 12 variables: speech, hearing, vision, gross neurological (coordination and perceptual-motor integration), affect, self-image, anti-social and oppositional behavior, reality testing, general health, interpersonal relationships, intelligence (attention, memory, achievement), and habits. For each child, the total number of "True" responses to all of the questions in each variable was used to compute an index. The indexes of the PBM children were then compared to the indexes of the PVM children (see Table 5). There were only 4 variables which showed a significant ($p < .05$) difference between the PBM and PVM indexes (hearing, gross neurological, reality testing, and affect) and in 3 of the 4 variables, the PVM group had a higher mean index than the PBM group. "Hearing" was the only variable in which the PBM group had a significantly greater index than the PVM group. Seven of the 32 PBM children (22%) had a hearing

VARIABLE INDEXES - Table #5

VARIABLE	PBM Mean	PBM SD	PVM Mean	PVM SD	T-Test
1 - Speech	0.28	± 0.85	0.21	± 0.42	$p > 0.05$
2 - Hearing	0.38	± 0.75	0.05	± 0.23	$p < 0.04$
3 - Vision	0.25	± 0.57	0.47	± 0.84	$p > 0.05$
4 - Gross Neurologic	1.39	± 1.38	2.32	± 2.26	$p < 0.05$
5 - General Health	1.60	± 1.66	1.26	± 1.09	$p > 0.05$
6 - Antisocial and Oppositional Behavior	3.43	± 4.30	4.47	± 5.10	$p > 0.05$
7 - Self-Image	1.63	± 2.03	2.47	± 1.95	$p > 0.05$
8 - Intelligence	1.40	± 1.88	2.47	± 2.52	$p > 0.05$
9 - Interpersonal Relationships	4.38	± 4.42	3.84	± 3.17	$p > 0.05$
10 - Reality Testing	0.78	± 1.18	1.53	± 1.50	$p < 0.03$
11 - Affect	2.56	± 2.75	4.16	± 3.24	$p < 0.04$
12 - Habits	2.20	± 1.60	3.21	± 2.80	$p > 0.05$

problem which was not present prior to their acute bacterial meningitis, and only 1 of the 19 PVM children (5%) had a hearing problem which was not present prior to their acute viral meningitis. The PVM children were absent an average of 7.4 days $\pm$ 4.8 days and the PBM children were absent an average of 9.6 days $\pm$ 9.6 days during the 1972-1973 school year with no significant difference ($p > .05$) between the two groups. The general school achievement of each child, as assessed by their teacher, was converted to a numerical standard as follows: outstanding = 5, above average = 4, average = 3, below average = 2, and poor = 1. The average ranking of the PVM children was 2.8 $\pm$ 0.94, and the average ranking of the PBM children was 3.4 $\pm$ 1.00 with no significant difference ($p > .05$) between the two groups. The mean interval between the onset of symptoms and treatment in the PBM group was 31 hours $\pm$ 19 hours and in the PVM group 33 hours $\pm$ 23 hours ($p > .05$). Only 1 child in the PVM group and 1 child in the PBM group had an onset of symptoms greater than 72 hours prior to treatment. The highest in hospital temperatures for the PBM group had a mean of 39.6°C. $\pm$ 0.7°C. and for the PVM group a mean of

38.8°C. ± 0.7°C. with the PBM group having a significantly higher ($p < .01$) in hospital maximal temperature than the PVM group. The PBM children had an average hospital stay of 10.9 days ± 3.6 days, while the PVM children had an average hospital stay of 4.5 days ± 3.9 days. The PBM group was hospitalized for a significantly ($p < .01$) longer period of time than the PVM group. Nine of the 32 PBM patients (28%) had complications during their hospitali-- zation which included: facial nerve paralysis, subdural effusions, papilledema and retinal hemorrhages, ocular palsy and ptosis, seizures, orbital cellulitis, otitis media, ataxia, inappropriate ADH secretion, and apneic spells. Four of the PBM children (12.5%) were discharged with residua: 2 with questionable hearing loss and ataxia, 1 with resolving subdural effusions, and 1 with mild ataxia. One of the 19 PVM patients (5%) had a complication during their hospitalization which was seizures. None of the PVM children were discharged with evident sequelae. In summary, although the PBM children had a significantly greater length of hospitalization, maximal in hospital temperature, incidence of in hospital complications, and incidence of sequelae at discharge than the PVM children, there was no significant difference between the two groups in general school

achievement, number of days absent, or in the way that they were evaluated on the parent and school questionnaires except for the significantly higher incidence of hearing problems in the PBM children.

Discussion

There are many shortcomings in the earlier studies of the long-term sequelae of bacterial meningitis in children, the most obvious being the lack of controls. The experience of King and Karzon [26] and Fee et al. [32] in this matter has already been discussed. In addition, many of the other studies [7, 16, 17, 31] reported sequelae of questionable significance including: headaches, joint pain, muscle pain, muscle twitching, "Rombergism", impaired fine motor function, increased irritability, intermittent photophobia, and difficulty concentrating. A control population of "normal" children would have certainly helped one in assessing the significance of these findings. These studies attest to the importance of establishing the prevalence of certain neuropsychiatric abnormalities in the "normal" population before inferring any significance from their presence in children who have had bacterial

meningitis. As Beatrice Kresky [16] observed in her post-meningitis patients: "The number of neurologic and mental defects appears to be directly proportional to the thoroughness of observation". One cannot help but wonder, if the same does not obtain in a "normal" population of children. The present study attempted to circumvent this problem by using a control population of "normal" children. The nature of this control population has already been discussed in an earlier section. Unfortunately, there are many deficiencies in this control group which are probably significant and which should be corrected in any future studies of this nature. The controls should have been, but were not, matched by age, sex, socio-economic class, and classroom membership. In addition, the controls should have been, but were not, matched for the interval of time between the discharge from the hospital and the follow-up. Finally, the hospitalization itself is a factor that one would want to control. Kresky et al. [16] noted that nearly half of their patients were left with residual anxiety 3 - 5 years after their acute bacterial meningitis, most of which related specifically to the hospital experience.

It may be erroneous to assume that a hospitalization of 10.9 days (mean length of hospitalization for the PBM group) is comparable to a hospitalization of 4.5 days (mean length of hospitalization for the PVM group) in terms of its residual effect on a child.

A number of earlier studies used unspecified [12] or inadequate [7, 8, 11] modes of follow-up such as the patients' charts, indirect information, or a form comprised of 8 "true-false" questions completed by the patients themselves. In addition, two studies which used questionnaires [7, 23] had rather poor response rates (less than 60%), which raises the possibility of a skewed population. The use of questionnaires in the present study is an obvious shortcoming in spite of the excellent response rate (greater than 90%). Several earlier studies used comprehensive examinations in their follow-ups but lost a significant percentage (greater than 25%) of their patients to follow-up. This again raises the question of a skewed population, and one can speculate that the children who were free of sequelae felt it unnecessary to return, or perhaps the children who had sustained the most sequelae were too incapacitated to return. In any case, it is hoped

that in future studies follow-up will include comprehensive physical, neurological, psychiatric, and psychometric evaluation, as well as interval histories, EEG's, and investigation of the school situation, and that a concerted effort will be made to have as many children as possible return for a follow-up evaluation.

It is impossible, in the present study, to identify a particular child as normal or abnormal, free of sequelae or having sequelae. All that can be said is that, aside from the significantly greater prevalence of hearing problems in the PBM children as compared to the controls, no significant difference could be appreciated between the two groups of children. Interestingly, 22% of the PBM children had a hearing problem which is a greater percentage than in any of the earlier studies cited above. The small sample size of the present study made it impossible to investigate the relationship between various in hospital complications and the long-term prognosis, as had been done in many earlier studies. It is hoped that future endeavors of this nature will pursue this important line of inquiry.

The use of controls may explain, in part, the difference between the results of the present and earlier studies, but it certainly is not the entire explanation. A large percentage of the patients in the earlier studies were less than 1 year of age at the onset of their acute illness, while in the present study children less than 1 year of age were automatically excluded. As noted above,

the evidence that the younger the child at the onset of their bacterial meningitis, the more likely is the occurrence of residual damage, is fairly substantial [5,6,9,16, 18,19,20,21,22]. This could certainly explain, at least in part, the discrepency between the results of the present and earlier studies. A number of earlier studies [16,20,22, 23] had suggested that an interval of greater than 72 hours between the onset of symptoms and the onset of therapy was associated with a higher incidence of long-term sequelae. In many of the earlier studies this interval was either not specified or greater than 72 hours for a large percentage of the patients. Sell [23], for example, found a mean interval of 36 hours between onset of symptoms and therapy in her children, which is comparable to the mean of 31 hours in the present study. Fourteen of her 75 children, however, had been treated after greater than 72 hours of symptoms, whereas in the present study only 1 of 32 children was treated after greater than 72 hours of symptoms. It would have been most interesting if Sell had reported the incidence of long-term sequelae in these 14 children, but unfortunately she did not. This difference in intervals could also explain, at least in part, the discrepency between the results of the present and earlier studies.

It would have been desirable in the present study to correlate the interval between onset and treatment, the incidence of seizures, the height of the temperature, the incidence of complications, and the prevalence of residua at discharge with the incidence of long-term sequelae, as was done in earlier studies, but due to the inability to identify individual children as having or not having sequelae this was simply impossible. The present study does demonstrate, however, that although the PBM children had a higher maximal in hospital temperature, a greater number of in hospital complications, and a greater number of residua at discharge than the controls, there was no significant difference between the two groups (other than the prevalence of hearing problems) noted at the time of follow-up. McNeil (15) had found 2 children who had residua noted at discharge but not at follow-up, and 12 children who had residua noted at follow-up, but not at discharge. Keller (21) found that 14% of the children who had residua at discharge had none at follow-up, and 12% of the children who had residua at follow-up had none noted at discharge. The importance of extensive discharge and follow-up evaluations of all children who have had bacterial meningitis is certainly obvious.

The most important issue that the present study raises is that perhaps the long-term prognosis which most pediatricians today associate with bacterial meningitis is too pessimistic. As Haggerty and Ziai [19] observed: "The physician must be careful not to paint too bleak a picture of the future of the child with little or no handicap....". Bacterial meningitis is a potentially lethal disease which understandably evokes a great deal of parental concern. Fee et al. [32] noted that: "Most of the mothers expressed long-standing anxieties regarding the residual effects of their childs' meningitis and actively sought reassurance." Green and Solnit [35] have demonstrated that "the parental reactions to an acute, life-threatening illness in a child may have long-term psychologically deleterious effects on both parents and children." It is conceivable that the prognosis which the pediatrician presents to an anxious mother whose child has bacterial meningitis may have a greater effect on that child's future development than the bacterial meningitis. The results of the present study suggest that further examination of the long-term sequelae of bacterial meningitis is warranted and that a pediatrician who is caring for a child with bacterial meningitis should display a great deal of caution in discussing with the parents the long-term prognosis for that child.

Summary

A group of 32 children who had been hospitalized with bacterial meningitis between 1960 - 1970 were compared with a control group of 19 children who had been hospitalized with viral meningitis between 1964 - 1970. A questionnaire was sent to the parents and school of each child in an attempt to assess the prevalence of long-term sequelae in children who have had bacterial meningitis. Except for a significantly higher incidence of hearing problems (22%) among the bacterial meningitis group as compared to the controls, no significant difference was observed between the two groups.

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Form #1 - Parent Questionaire

CHILD'S NAME _____

THE YALE-NEW HAVEN HOSPITAL PEDIATRIC DEPARTMENT IS ASKING PARENTS TO FILL OUT THE FOLLOWING FORM IN CONJUNCTION WITH A STUDY OF CHILDHOOD MEMINGITIS. THIS INFORMATION WILL BE USED FOR NO OTHER PURPOSE AND WILL BE CONSIDERED STRICTLY CONFIDENTIAL. PLEASE ANSWER ALL OF THE QUESTIONS ABOUT THE ABOVE NAMED CHILD BY PLACING AN "X" IN THE APPROPRIATE BOX.

I

		TRUE	FALSE
1.	OFTEN UNTIDY		
2.	IS AFRAID OF GOING ANYWHERE ALONE		
3.	STEALS		
4.	GRINS AFTER BEING REPRIMANDED		
5.	UNABLE TO FOLLOW SIMPLE DIRECTIONS		
6.	SPEECH IS DISCONNECTED, INCOHERENT		
7.	SEEMS OFTEN OBLIVIOUS TO SURROUNDINGS		
8.	STUTTERING		
9.	SLOVENLY IN APPEARANCE		
10.	IGNORES OTHERS WHEN SPOKEN TO		
11.	SHORT ATTENTION SPAN		
12.	GRABS THINGS FROM OTHERS		
13.	BOSSES OTHERS AROUND		
14.	BRAGS AND BOASTS		
15.	BECOMES FATIGUED EASILY		
16.	MAKES STRANGE NOISES		
17.	IS A PICKY AND FINICKY EATER		
18.	IS OVERWEIGHT		
19.	IS AFRAID OF NEW SITUATIONS		
20.	WORRIES		

		TRUE	FALSE
21.	TWITCHES AND JERKS		
22.	AWKWARD USING HANDS		
23.	HAS TICS		
24.	UNABLE TO TIE SHOE LACES		
25.	TENDS TO BLAME OTHERS FOR THINGS HE HAS DONE		
26.	POOR CONCEPT OF TIME		
27.	DENIES KNOWLEDGE OF WRONGDOING, EVEN WHEN CONFRONTED WITH PROOF		
28.	NOT CHOSEN FOR SPORTS OR ACTIVITIES BY PEERS		
29.	WETS BED OR SOILS SELF AT NIGHT		
30.	LIES		
31.	FREQUENTLY LOUD, CLOWNING, GIGGLING		
32.	POOR MEMORY		
33.	LACKS SENSE OF HUMOR		
34.	CRIES EASILY		
35.	WILL NOT PARTICIPATE IN SPORTS OR SHARING ACTIVITIES		
36.	SHOWS SIGNS OF EXCESSIVE SEXUAL CURIOSITY		
37.	CLINGS TO PARENTS OR OTHER ADULTS		
38.	HAS SEIZURES		
39.	HAS FREQUENT NIGHTMARES		
40.	QUICKLY AND DRASTICALLY CHANGES MOODS		
41.	IS OVERACTIVE		
42.	HAS UNPREDICTABLE BEHAVIOR		

		TRUE	FALSE
43.	IS EASILY DISTRACTED		
44.	DEMANDS MUST BE MET IMMEDIATELY		
45.	IS EASILY FRUSTRATED		
46.	IS DESTRUCTIVE		
47.	SUCKS THUMB		
48.	CHEWS ON CLOTHES OR BLANKETS		
49.	DEMANDS TO BE CENTER OF ATTENTION		
50.	WAKES UP FROM SLEEP SCREAMING		
51.	HURTS HIMSELF		
52.	DOES NOT ACT HIS AGE		
53.	WILL NOT DO SCHOOL WORK, EITHER IN CLASS OR AT HOME		
54.	SEEMS LESS MATURE THAN MAJORITY OF PEERS		
55.	STRIKES PEERS WHO DO NOT COMPLY WITH HIS/HER WISHES		
56.	BELITTLES OWN WORK OR CALLS HIMSELF STUPID		
57.	APPEARS CLUMSY WALKING, RUNNING, JUMPING, ETC.		
58.	DIFFICULTY HOLDING AND MANIPULATING PENCILS AND CRAYONS		
59.	DISPLAYS ODD FACIAL GRIMACES, STRANGE GESTURES, OR ODD MOVEMENTS		
60.	VERBALLY AGGRESSIVE WHEN REFUSED PERMISSION TO DO AS HE PLEASES OR WHEN REPRIMANDED		
61.	FORGETFUL ABOUT HOMEWORK, LUNCH MONEY, LIBRARY CARD, THINGS AT HOME		

		TRUE	FALSE
62.	FREQUENTLY PUSHES, FIGHTS, KICKS, OR BITES OTHER CHILDREN		
63.	AFTER STRIKING CHILDREN, PUTS ARM AROUND THEM		
64.	IS AFRAID CHILDREN DO NOT LIKE HIM		
65.	DAYDREAMS FREQUENTLY		
66.	PLAYS WITH MATCHES		
67.	DEMANDS EVERYTHING BE JUST SO		
68.	SETS GOALS TOO HIGH		
69.	IS CRUEL		
70.	IS SNEAKY		
71.	IS NOT ABLE TO ENJOY HIMSELF		
72.	IS OVERLY AFFECTIONATE		
73.	IS OVERLY SUSPICIOUS		
74.	ACTS OVERLY DRAMATIC		
75.	GETS INTO TROUBLE WITH POLICE		
76.	SHAKES		
77.	IS SELFISH, WILL NOT SHARE		
78.	DIFFICULTY PRONOUNCING SIMPLE WORDS IN SPEECH AND IN READING		
79.	KNOCKS OR TEARS DOWN OTHERS' WORK		
80.	WILL START A JOB AND QUIT, THROWING GOOD WORK AWAY		
81.	COVERS EYES AND EARS WHEN BEING CORRECTED		
82.	NEVER ASKS FOR HELP		
83.	HAS TEMPER OUTBURSTS		

		TRUE	FALSE
84.	HAS TOO MUCH FANTASY		
85.	FEELS OF LITTLE VALUE		

PLEASE ANSWER ALL OF THE FOLLOWING QUESTIONS

1. SINCE THE HOSPITALIZATION FOR MENINGITIS HAS HE/SHE HAD ANY CONVULSIONS OR SEIZURES? _____YES _____NO
   IF YES, HOW OFTEN? _____

2. IS HE/SHE PRESENTLY TAKING ANY MEDICINE REGULARLY? _____YES _____NO
   IF YES, WHAT, AND FOR WHAT REASON? _____

3. APPROXIMATELY HOW MANY DAYS OF SCHOOL HAS HE/SHE MISSED IN THE PAST YEAR?
   _____ LESS THAN 1 WEEK
   _____ A COUPLE OF WEEKS
   _____ A MONTH (Significant Answer)
   _____ MORE THAN A MONTH (Significant Answer)

4. DOES HE/SHE HAVE ANY PROBLEMS WITH THEIR EYES OR VISION?
   _____ YES _____NO
   IF YES, EXPLAIN _____

5. DOES HE/SHE HAVE ANY SPEECH DIFFICULTIES? _____YES _____NO
   IF YES, EXPLAIN _____

6. DOES HE/SHE HAVE A HEARING PROBLEM? _____YES _____NO.
   IF YES, EXPLAIN _____

7. DOES HE/SHE HAVE A WEAKENED OR PARALYZED ARM OR LEG?
   _____YES _____NO
   IF YES, EXPLAIN _____

8. HOW IS THIS CHILD DOING WITH HIS/HER SCHOOLWORK?
   _____ APPEARS COMPLETELY DISINTERESTED, GIVEN UP TRYING (Significant Answer)
   _____ DOING ALL RIGHT BUT COULD DO BETTER
   _____ FEEL THAT HE/SHE IS DOING HIS/HER BEST

9. HAS THIS CHILD USUALLY A NORMAL AMOUNT OF ENERGY?
   _____ BOUNDING WITH ENERGY (Significant Answer)
   _____ JUST NORMAL AMOUNT OF ENERGY
   _____ TIRED, SLUGGISH, OR LACKING ENERGY
   _____ VERY SLUGGISH, TIRED, OR LACKING ENERGY (Significant Answer)

10. DOES HE/SHE WEAR GLASSES? _____YES _____NO
IF YES, EXPLAIN _____

11. HAS HE/SHE EVER HAD HIS/HER HEARING TESTED? _____YES _____NO
IF YES, EXPLAIN _____

12. ARE THERE ANY OTHER PROBLEMS IN THE HEALTH OR EDUCATION OF THIS CHILD? PLEASE SPECIFY: (Significance of answer evaluated independently for each child)

PLEASE RETURN THIS FORM IN THE ENCLOSED ENVELOPE AS SOON AS POSSIBLE. THANK YOU VERY MUCH FOR COOPERATING WITH OUR STUDY.

orm #2 - School Questionnaire

CHILD'S NAME _____

THE YALE-NEW HAVEN PEDIATRIC DEPARTMENT IS ASKING THE TEACHER OF THE ABOVE NAMED CHILD TO FILL OUT THE FOLLOWING FORM AND RETURN IT IN THE ENCLOSED ENVELOPE AS SOON AS POSSIBLE.

PLEASE ANSWER ALL QUESTIONS ON THE FORM BY PUTTING A NUMBER OR CROSS AS APPROPRIATE IN THE BOXES BY EACH QUESTION. PLEASE GIVE APPROXIMATE NUMBERS IF YOU ARE UNCERTAIN. THANK YOU.

t - I

1. HOW MUCH SCHOOLING HAS HE/SHE MISSED FOR ANY REASON IN THE PRESENT SCHOOL YEAR (SINCE SEPTEMBER, 1972)?
   POSSIBLE ATTENDANCE _____
   ACTUAL ATTENDANCE _____ (A difference of 30 or more days was considered significant)

2. HAS THIS CHILD USUALLY A NORMAL AMOUNT OF ENERGY?
   _____ BOUNDING WITH ENERGY (Significant Answer)
   _____ JUST NORMAL AMOUNT OF ENERGY
   _____ TIRED, SLUGGISH, OR LACKING ENERGY
   _____ VERY SLUGGISH, TIRED, OR LACKING ENERGY (Significant Answer)

3. HOW DOES HE/SHE GET ALONG WITH HIS/HER CLASSMATES?
   _____ HAS NO CLASSMATES AS A FRIEND, TENDS TO BE A LONER (Significant Answer)
   _____ HAS ONE OR TWO FRIENDS, TENDS TO BE FRIENDS WITH ONLY A FEW CLASSMATES
   _____ GETS ALONG WITH MOST OF THE CHILDREN EVEN THOUGH MIGHT HAVE ONLY A FEW FAVORITE FRIENDS

4. HOW IS THIS CHILD DOING WITH HIS/HER CLASSWORK IN SCHOOL?
   _____ APPEARS COMPLETELY DISINTERESTED, GIVEN UP TRYING (Significant Answer)
   _____ DOING ALL RIGHT BUT COULD DO BETTER
   _____ FEEL THAT HE/SHE IS DOING HIS/HER BEST

5. GENERAL LEVEL OF SCHOOL ACHIEVEMENT
   _____ OUTSTANDING
   _____ ABOVE AVERAGE
   _____ AVERAGE
   _____ BELOW AVERAGE
   _____ POOR (Significant Answer)

6. ARE THERE ANY OTHER PROBLEMS IN THE HEALTH OR EDUCATION OF THIS CHILD?
   PLEASE SPECIFY: (Significance of answer evaluated independently for each child)
   _____
   _____
   _____

PLEASE ANSWER ALL OF THE FOLLOWING QUESTIONS BY PLACING AN "X" IN THE APPROPRIATE BOX.

II

		TRUE	FALSE
1.	OFTEN UNTIDY		
2.	IS AFRAID OF GOING ANYWHERE ALONE		
3.	WILL NOT SPEAK TO OTHERS, EVEN WHEN DESKS ARE SIDE-BY-SIDE, UNLESS PEOPLE PERSIST IN TALKING TO HIM/HER		
4.	STEALS		
5.	GRINS AFTER BEING REPRIMANDED		
6.	UNABLE TO FOLLOW SIMPLE DIRECTIONS		
7.	CONSTANTLY AT TEACHER'S DESK		
8.	MAKES UP STORIES		
9.	SPEECH IS DISCONNECTED, INCOHERENT		
10.	QUALITY OF ORAL WORK BETTER THAN WRITTEN		
11.	APPEARS TO HAVE A HEARING PROBLEM		
12.	SEEMS OFTEN OBLIVIOUS TO SURROUNDINGS		
13.	STUTTERING		
14.	SLOVENLY IN APPEARANCE		
15.	IGNORES OTHERS WHEN SPOKEN TO		
16.	SHORT ATTENTION SPAN		
17.	GRABS THINGS FROM OTHERS		
18.	BOSSES OTHERS AROUND		
19.	BRAGS ABOUT MONEY OR OTHER POSSESSIONS		
20.	POOR ATTENDANCE AT SCHOOL		
21.	BECOMES FATIGUED EASILY		

		TRUE	FALSE
22.	FRIENDLESS IN SCHOOL		
23.	MAKES STRANGE NOISES		
24.	MAKES UP WORDS FOR THINGS HE DOES NOT KNOW		
25.	CLINGS TO TEACHER		
26.	UNABLE TO TIE SHOE LACES		
27.	TENDS TO BLAME OTHERS FOR THINGS HE HAS DONE		
28.	YELLS, "I'LL KILL YOU", I'LL DESTROY"		
29.	POOR CONCEPT OF TIME		
30.	DENIES KNOWLEDGE OF WRONGDOING, EVEN WHEN CONFRONTED WITH PROOF		
31.	NOT CHOSEN FOR SPORTS OR ACTIVITIES BY PEERS		
32.	SOILS SELF, WETS SELF		
33.	LIES		
34.	OFTEN BECOMES ILL, WANTS TO GO HOME		
35.	USUALLY HAS ACCOMPLICES WHEN UNRULY		
36.	DOES NOT PARTICIPATE IN CLASSROOM UNLESS ENCOURAGED		
37.	FREQUENTLY LOUD, CLOWNING, GIGGLING		
38.	POOR MEMORY		
39.	CALLS CLASSMATES NAMES AND MAKES OBSCENE GESTURES		
40.	STAYS ALONE IN PLAYGROUND: STAYS ALONE DURING RECESS		
41.	CONSTANTLY GOES TO BATHROOM		
42.	OFTEN LATE FOR SCHOOL, CLASS		

		TRUE	FALSE
43.	LACKS SENSE OF HUMOR		
44.	USES ANY EXCUSE TO GET OUT OF CLASS (E.G., LOCKER, NURSE, BATHROOM)		
45.	CRIES EASILY		
46.	READS LETTERS OR WORDS FROM RIGHT TO LEFT; MAKES READING REVERSALS		
47.	WILL NOT PARTICIPATE IN SPORTS OR SHARING ACTIVITIES		
48.	SHOWS SIGNS OF EXCESSIVE SEXUAL CURIOSITY		
49.	WANTS TO GO HOME		
50.	CAN'T SIT STILL IN CHAIR		
51.	IS THE BRUNT OF JOKES OR PRANKS		
52.	THREATENS TEACHER WITH PHYSICAL VIOLENCE		
53.	REFUSES TO PARTICIPATE IN MESSY ART ACTIVITIES, SUCH AS FINGER PAINTING OR PASTING		
54.	ILLEGIBLE WRITING		
55.	HAS TEMPER TANTRUMS WHEN UNABLE TO WIN OR BECOME THE LEADER		
56.	WILL NOT DO SCHOOL WORK, EITHER IN CLASS OR AT HOME		
57.	SEEMS LESS MATURE THAN MAJORITY OF PEERS		
58.	STRIKES PEERS WHO DO NOT COMPLY WITH HIS (HER) WISHES		
59.	BELITTLES OWN WORK OR CALLS SELF STUPID		
60.	APPEARS CLUMSY IN WALKING, RUNNING, OR JUMPING, ETC.		
61.	WRITTEN WORK INACCURATE OR INCOHERENT		

		TRUE	FALSE
62.	DIFFICULTY HOLDING AND MANIPULATING PENCILS AND CRAYONS		
63.	DISPLAYS ODD FACIAL GRIMACES, STRANGE GESTURES OR ODD MOVEMENTS		
64.	FALLS ASLEEP IN CLASS		
65.	VERBALLY AGGRESSIVE WHEN REFUSED PERMISSION TO DO AS HE PLEASES OR WHEN REPRIMANDED		
66.	VERY SLOW OR IMPRECISE IN COPYING		
67.	OVERLY DEPENDENT ON TEACHERS APPROVAL AND ATTENTION		
68.	FORGETFUL ABOUT HOMEWORK, BOOKS, WRITING TOOLS, NOTICES, LUNCH MONEY, LIBRARY CARD, THINGS AT HOME		
69.	RUNS FROM PLAYGROUND AT SLIGHTEST CONFLICT OR INCIDENT		
70.	DIFFICULTY DISTINGUISHING LETTERS AND NUMBERS		
71.	INCONSISTENT PERFORMANCE (SOME DAYS ALERT AND BRIGHT, OTHER DAYS NOT)		
72.	FREQUENTLY PUSHES, FIGHTS, KICKS, OR BITES OTHER CHILDREN		
73.	AFTER STRIKING CHILDREN, PUTS HIS ARM AROUND THEM		
74.	DIFFICULTY PRONOUNCING SIMPLE WORDS IN SPEECH AND READING		
75.	KNOCKS OR TEARS DOWN OTHERS' WORK		
76.	PULLS FINGERS WHEN CALLED UPON TO SPEAK OR PLAY A GAME		
77.	RAISES HAND BUT ANSWERS ARE IRRELEVANT TO SUBJECT BEING DISCUSSED		

		TRUE	FALSE
78.	WILL START A JOB AND QUIT, THROWING AWAY GOOD WORK		
79.	COVERS EYES AND EARS WHEN BEING CORRECTED		
80.	OFTEN FAILS BECAUSE HE WOULD RATHER DO NOTHING THAN GET A POOR GRADE		
81.	NEVER ASKS FOR HELP		
82.	OFTEN REFUSES TO ANSWER WHEN CALLED UPON, EVEN WHEN HE (SHE) KNOWS THE ANSWER.		

PLEASE RETURN THIS QUESTIONNAIRE IN THE ENCLOSED ENVELOPE AS SOON AS POSSIBLE. THANK YOU VERY MUCH FOR COOPERATING WITH OUR STUDY.

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