SHORT REPORT

The effect of tuberculous meningitis on the cognitive and motor development of children

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Objective. To evaluate and compare the different degrees of cognitive and motor impairment of children surviving tuberculous meningitis (TBM), with a view to establishing areas amenable to remedial intervention.

Design. Neurodevelopmental testing of a previously reported cohort, performed 1 - 7 years after completion of 9 - 12 months of treatment of TBM.

Setting. Bloemfontein and environs.

Participants. A total of 19 subjects out of a possible 25 (76%) in a geographically accessible area.

Main outcome measures. Cognitive and fine and gross motor development.

Results. Cognitive and motor development were scored and expressed as percentages of those expected for normal children of similar age and background. The median cognitive development was 66.9% (95% confidence intervals (CIs) 59.1 - 73.2). The degree of impairment was similar for all 10 cognitive areas tested, ranging from 61.8% to 70.4%. The median fine motor development score was 63.6% (95% CIs 54.7 - 81.5). The median gross motor function score was 51.2% (95% CIs 36.4 - 77.1). Comparison of impairment between stage 2 and stage 3 disease showed median differences of 28.7% (95% CI 2.7 - 55.1) ($P = 0.02$) for cognitive function, 21.6% (95% CI –9.9 - 54.1) ($P = 0.15$) for fine motor function, and 35.2% (95% CI 14.2 - 59.6) ($P = 0.01$) for gross motor function. No TBM relapses had occurred.

Conclusions. Our findings show the occurrence of marked generalised impairment of cognitive and motor development following TBM, with no specific areas amenable to early remedial intervention. Shortened treatment regimens of 9 - 12 months were effective, but prevention of TBM remains the priority.

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Tuberculous meningitis (TBM) is a disastrous disease that can interfere severely with neurodevelopment during childhood. Several studies[1-3] have shown the adverse effects thereof. The epidemiology and outcome of TBM in a group of 75 children admitted to a hospital in Bloemfontein during a 5-year period has been reported previously.[4] No long-term follow-up studies of the survivors have been undertaken. The aim of this study was to evaluate the cognitive and motor development of some of these patients following discharge from hospital and completion of a 9 - 12-month standard 4-drug antituberculosis regimen.

A major problem in the past has been the lack of availability of appropriate tests for evaluating cognitive functions in children from disadvantaged communities. This study made use of a test battery that was suitable for children from developing countries.

A further aim of the study was to determine whether there were specific areas of cognitive development that were more severely affected by the disease, so as to facilitate early remedial intervention.

Patients and methods

Nineteen children out of a possible 25 (76%) were traced for follow-up, 1 - 7 years (average 3 years) after discharge from hospital. All of them resided within a radius of 60 km from Bloemfontein, which made tracing practicable. The average age of these children was 6 years and 3 months (range 2 - 9 years). On initial admission 63% of the children had been diagnosed with stage 2 disease, 32% with stage 3 and only one with stage 1, according to the British Medical Research Council diagnosis classification.[5]

Cognitive and motor functions were evaluated by one of two occupational therapists by means of the Herbst test battery.[6] Results were compared with those of a group of normal children of similar age and background. The children's test ages were expressed as a percentage of their chronological ages. Non-parametric analysis, viz. 95% confidence intervals for medians of differences, was undertaken because of the small sample sizes and skew data distributions.

The Herbst test is culturally equitable, offers variation to maintain attention span, is applied playfully, is enjoyed by most children and can be completed in a short time. The test's reliability and validity are well established and confirmed.[6]

The test kit evaluates three neurodevelopmental aspects. Cognitive development is assessed by 10 subdivisions covering concepts of direction, form, colour and number, analysis and synthesis, and picture perception. Fine motor development is assessed by tasks such as cutting, colouring in and writing, and gross motor development by tasks like walking, catching and throwing.

The measuring devices include colourful beads and blocks, shape boards and cards, plastic puzzles, scissors and a stop-watch, which are all contained in an attache case.

Results

For the sake of simplicity an average percentage was calculated for the 10 different cognitive areas tested. Two of the children in the study group were so severely handicapped that they could not be tested formally; they were allotted the minimum possible score.

In Fig. 1 the test ages of the study group are expressed as percentages of their chronological ages. It is clear that the medians of all three areas of neurodevelopment tested are below the expected 100%, with gross motor functions being the worst affected.

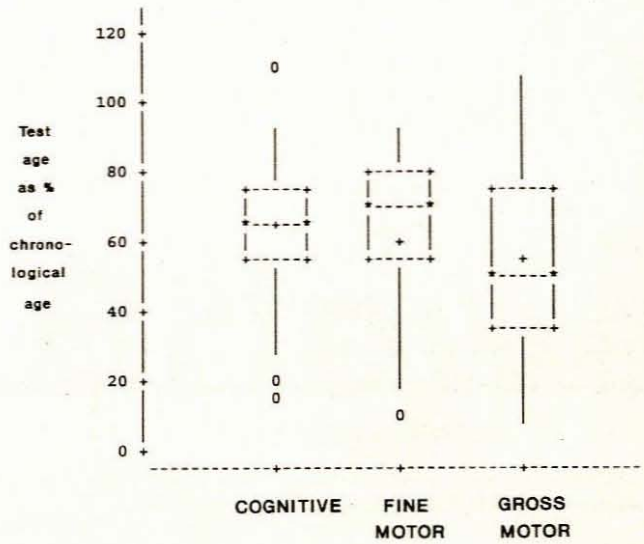

Fig. 1. Test ages of the study group expressed as percentages of their chronological ages.

Fig. 2 compares the results of children with stage 2 and stage 3 disease. Again all three areas tested are below the expected 100% and in each case stage 3 children are more severely affected than those with stage 2 disease. In Figs 1 and 2, extreme values which are between 1.5 and 3 interquartile ranges (interquartile range is 75th - 25th percentile) away from the nearest quartile are indicated by 0.

In Table I, a comparison of the outcomes of stage 2 and stage 3 illness is presented. As expected the differences between stage 2 and stage 3 illness with regard to cognitive and gross motor development are statistically significant. The differences in impairment of fine motor development between the two stages is not.

Table I. Comparison of outcomes of stage 2 and stage 3 illness

	Median of differences (stage 2 and 3)	95% confidence interval for median of differences	*P*-value (Mann-Whitney test)
Cognitive	28.7	2.7; 55.1	0.02
Fine motor	21.6	–9.9; 54.1	0.15
Gross motor	35.2	14.2; 59.6	0.01

It was not possible statistically to compare the outcome of the single child with stage 1 disease with the outcome of the other children. It is, however, interesting that this child scored highest in all of the tests.

No differences could be found between the degrees of impairment of the different cognitive functions.

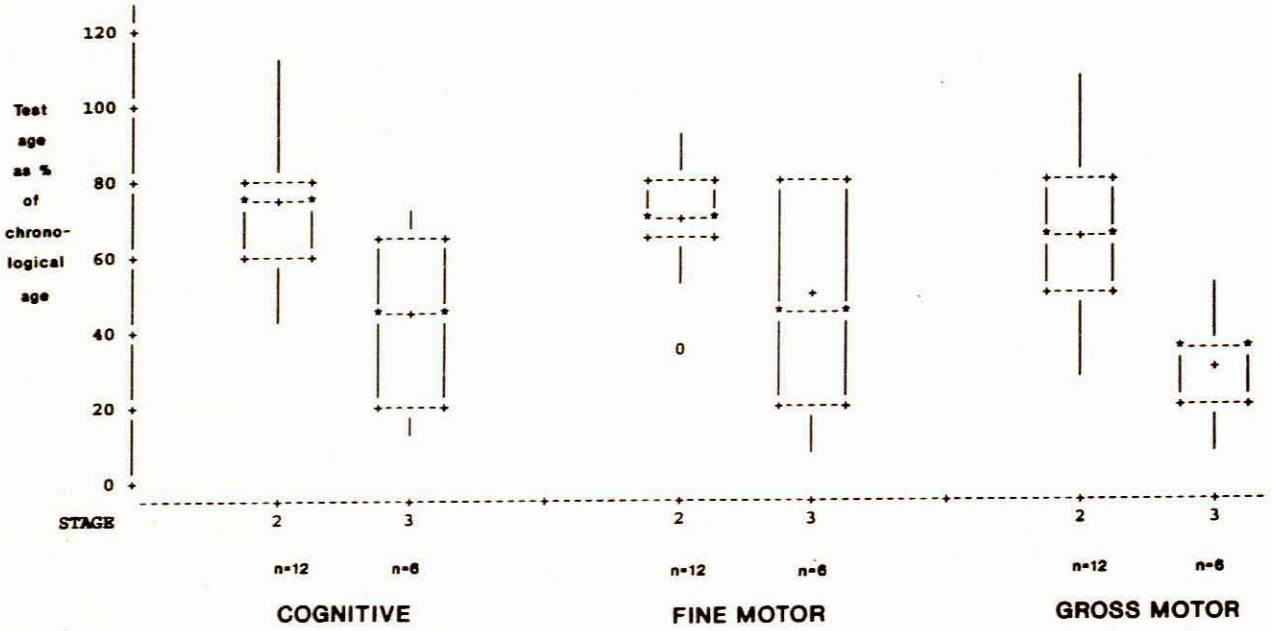

Fig. 2. Test ages of children with stage 2 and stage 3 disease as percentages of their chronological ages.

Among the study group, no patient had a recorded relapse of TBM following discharge from hospital.

Discussion

Previous studies of the late outcome of TBM have focused either on sequelae according to their severity[1] or, as in the case of Arens *et al.*,[2] on the presence of cerebral palsy with or without other neurological complications. Our study concentrated on TBM's effect on cognitive development as this aspect has not been specifically investigated. Although the present study included outcome of motor development, this aspect has been described fully in recent studies.[1-4]

A deficiency of the present study was that language skills could not be evaluated because of language barriers and the problems inherently associated with interpreters. Auditory and visual skills were evaluated indirectly and not formally.

The evaluation of cognitive function in young children has always been difficult. A further important obstacle in the past has been the unavailability of a culturally appropriate test for children from disadvantaged communities. The Herbst test was developed specifically to evaluate motor and cognitive school readiness in black preschool children, but may be applied at any age.

The results of our study were not unexpected and confirm what has been shown in many previous studies.[1-4] The finding that gross motor functions were the most severely affected probably reflects the fact than many of the test subjects had either a hemi- or quadriplegia. Similarly it is well known that the prognosis of patients with advanced TBM is worse than that of those diagnosed and treated earlier. The finding that fine motor development impairment between stage 2 and 3 illness was not statistically significant can be ascribed to the small sample size of the subjects tested. What was disappointing, however, was the fact that no differences could be found between the different cognitive areas tested. If such differences did exist, it would have facilitated remedial intervention to a greater extent.

The optimal duration of treatment of TBM is unknown.[7] Our study group received a maximum of 12 months of antituberculosis treatment while in hospital and some of them were treated for only 9 months. Treatment regimens longer than 12 months have been thought to have lower relapse rates. The fact that none of the children seen at the time of follow-up had relapsed suggests that shorter regimens are just as effective.

In conclusion this study once again highlights the importance of preventing TBM because the long-term sequelae of this dreaded disease place a high premium on South Africa's already meagre sociomedical resources.

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