A REVIEW OF PSYCHOLOGICAL WORK AT THE BRAIN INJURIES UNIT, EDINBURGH, 1941-5*

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The psychological work at the Brain Injuries Unit has developed along three principal lines. In the first place, we have given much attention to the study and assessment of specific patterns of cognitive disability associated with cerebral injury or disease. This work was inspired by urgent practical demands, but has incidentally given rise to some research studies that I shall review briefly at the end of this paper. In the second place, we have explored certain psychological techniques which may have value in neuropsychiatric diagnosis. And, in the third place, we have endeavoured to adapt, where possible, general psychological principles and methods to concrete problems of re-education and resettlement. The work as a whole has been under the general direction of Prof. D. K. Henderson and Mr. Norman Dott, the Directors of the Unit, and undertaken in close association with Dr. A. Paterson.

Problems and Methods of Assessment

I would like to preface my review of our work with some general remarks on the methods of psychological assessment and their place in clinical science. It is not uncommonly supposed that the psychologist is the fortunate possessor of an esoteric tool which in deference to current fashion I shall call the *mental test*. Now, a mental test is often conceived to measure in a more or less accurate way some specific ability, aptitude, or trait. It is apt to be regarded as the exclusive property of the psychologist, who alone is held competent to wield and interpret it. An attitude of this kind to psychological work is both unfortunate and misleading. Strictly speaking, nothing psychological is truly measurable, and a so-called mental test is nothing more than a device for eliciting some specific psychological response under controlled conditions of examination. Thus conceived, it is plain that the neurologist who examines his patient for nominal aphasia is conducting a mental test; so also is the psychiatrist who determines a patient's orientation for time or place by means of suitably chosen questions. But in cases of this kind evaluation is very easy because every normal person can be relied on to give the correct response. When we turn to functions such as memory, intelligence, and thought, and the immensely complicated repertoire of habits and skills to which they give rise in the educated individual, it is plain not only that the normal limits of individual variation are very wide but also that the potential directions of breakdown are many and varied. Simple clinical tests are in consequence seldom sufficient in assessing the psychological sequelae of cerebral lesion, and the demand for more highly controlled methods is easy to understand. Hence the appearance on the neurological scene of the academic psychologist.

In the early stages of our work I must admit that we laboured under a certain sense of false security engendered by the admitted success of standardized test techniques in assessing normal intellectual capacity. In a situation which *prima facie* would seem to call for the greatest caution, we psychologists showed a certain disposition to rush in where angels—and eminent neurosurgeons—rightly fear to tread. Bitter experience has since taught us to recognize that methods adapted to measure intellectual capacities in children and normal adults can seldom be applied with profit in assessing the disabilities of the neurological patient. We now appreciate that a mental test, to have genuine practical value, must be based on intimate and thorough clinical observation. My colleague Dr. Andrew Paterson has issued a timely warning in urging that premature stereotyping of methods of examination may cause us to ignore or undervalue the diverse manifestations of organic

intellectual impairment that form the stock-in-trade of the clinical neuropsychiatrist (Paterson, 1944).

Before we standardize any particular test method we must make very sure that it adequately covers the clinical conditions to which it has reference. This presupposes not only an adequate clinical experience of the conditions concerned but also suitably directed experimental research. Whereas we are now beginning to gain the requisite experience, and have developed a number of more specific techniques in accordance with it, it has not as yet been possible to undertake large-scale standardization of particular procedures. Some of our most helpful tests are still rough-and-ready and are flexible enough to adapt in a provisional way to a wide range of variation both in previous level and in pattern of disability. We hope to standardize some of these tests after the war. In the meantime, we interpret them as best we can and supplement them with a number of procedures, developed elsewhere, that may happen to meet the practical demands of routine assessment. The latter include Babcock's deterioration scale (Babcock, 1930), originally devised to provide a quantitative measure of deterioration in the organic psychoses, and the Wechsler-Bellevue intelligence scale (Wechsler, 1941), both in its original form and as modified by Reynell (1944), for assessing post-traumatic intellectual loss. We have also made an eclectic use of the various types of test advocated by Goldstein to assess disorders of abstraction and conceptual thought (Goldstein, 1942; Goldstein and Scheerer, 1941; Trist and Trist, 1943). In studying more specific disabilities, especially of language, certain of the tests devised by Burt (1922), Head (1926), and Weisenburg and McBride (1935) have found application in our work. In general, although we take full advantage of existing norms for tests, we have not been chary of modifying an accepted procedure if this appears to be in the best interests of clinical expediency. What is thereby lost in statistical certainty may, it is hoped, be compensated by resulting gain in practical utility.

Cognitive Disability in Cases of Cerebral Lesion

I now pass on to review our work on assessment of intellectual disability in cases of cerebral lesion. Although it has been possible to do a certain amount of work on *acute* conditions, this in general is of research interest only (Paterson, 1942; Paterson and Zangwill, 1944a; Zangwill, 1945). The routine activity of the psychologist centres round the assessment of *residual disability*. Every patient in whom intellectual impairment is either suspected or to be excluded is referred to the psychologist for examination before discharge. But we make it a general rule that every case of this nature should first be seen by the neuropsychiatrist, who can not only advise on specific psychological investigations but also determine, where necessary, if mental testing in any form is desirable. I need not stress the pronounced catastrophic reaction to which many organic patients are prone and which in outspoken cases renders detailed testing inexpedient. In the post-traumatic conditions, likewise, admixture of psychoneurotic symptoms may render it essential that any mental testing done should be under intimate psychiatric direction. If only for these reasons, it is my firm opinion that the psychologist should invariably work in the closest association with the psychiatrist and, from the point of view of clinical management, under his personal direction. I have already indicated that my outstanding good fortune in this respect has preserved me from many of the pitfalls that beset the non-medical investigator.

The patterns of intellectual disability liable to be associated with cerebral lesions are so diverse that a comprehensive review would be out of the question. I shall therefore make no mention here of our work on the grosser syndromes recognized by clinical neurology—the aphasias, apraxias, agnosias, and disorientations—nor the well-recognized syndromes, such as confusion and dementia, which fall in the province of psychiatry. I shall also omit discussion of the conceptual disorders to which Goldstein and his school (1941, 1942) have devoted attention and which we have had occasion to study in cases with lesions of the frontal lobes. I shall confine myself to a brief selection of our findings which have had a decided practical bearing on the work of this unit.

* A paper read to the Society of British Neurological Surgeons in Edinburgh on June 1, 1945.

Firstly, we have been greatly struck by *the prevalence of cognitive disabilities which, in more outspoken form, are rightly ascribed to focal lesions*. In many cases, of course, the appearance of such disabilities is not surprising, as they reflect residual impairment from an appropriately localized lesion. Even so, in their reduced form of persistent defect of spelling, grammar, calculation, word choice, visual synthesis, or spatial judgment, they not uncommonly elude routine neurological examination. A more interesting finding, to which my colleague Dr. Paterson has already drawn attention (Paterson, 1944), is the prevalence of this type of disability in the clinical picture of what is usually termed generalized post-traumatic intellectual impairment. In this condition, disabilities of a relatively specific character can often be detected on careful examination and, as Paterson (1944) insists, almost certainly have localizing significance. I may add that their practical significance is often very considerable.

Secondly, we have been able to establish beyond reasonable doubt that focal disorders of visual perception, manual skill, language, and calculation, in their incipient or residual forms, commonly take the shape of what the psychologist is wont to call *decrement of special abilities*.* Thus cases showing a very mild residual *dysphasic* syndrome are prone to fail rather grossly on special tests of high-grade comprehension and reasoning well within their previous grasp. This disturbance is often described by the patient himself in terms of difficulty in ordering his thoughts or in expressing himself effortlessly in an exacting discussion. Mr. Norman Dott has suggested the term "supra-dysphasia" for this condition, which warrants wider recognition. The use of special tests gives a helpful objective check on the patient's introspection, and is especially indicated in cases in which fine comprehension and formulation are of occupational relevance. We have likewise noticed that incipient or residual agnostic-apraxic disorders are almost invariably expressed on tests of intelligence stressing spatial judgment and manipulative skill. Tests of this character, often called "performance tests" (Kohs, 1927; Pintner and Paterson, 1935), appear well adapted to assess the finer grades of visual-constructive disability, and have the advantage of being thoroughly standardized in the normal. We have found them especially helpful in studying cases with lesions of the parieto-occipital region of either hemisphere, and gross deterioration of performance is not uncommon in cases which show no disturbance on the simpler tests that normally form part of the clinical examination for agnosia and apraxia. Here our field dovetails into clinical neurology. The importance of performance tests is further stressed by the fact that the majority of skilled and semi-skilled manual occupations make demands on precisely those forms of judgment and co-ordination required for proper performance in the test situation. One may add that the existence of well-circumscribed disabilities, whether of language, visual analysis, or constructive capacity, raises in an acute form the whole problem of the cerebral representation of ability, and suggests a profitable mode of attack on the cortical localization of intelligence in man.

Thirdly, we have found that *some degree of memory or learning defect is outstandingly common in cases of cerebral lesion of all types*. In the past psychologists working with neurological material have been prone to concentrate on the *deterioration* of pre-existing knowledge and capacity. While this is no doubt both interesting and important, it is often of even greater practical consequence to ascertain whether a given patient retains his old capacity to learn from experience and to acquire novel information, habits, and skills. This question arises both with reference to the re-education of specific disabilities and to the advisability of re-settling patients in an occupation necessitating special training. As Isserlin (1923) showed in the last war, the use of experimental methods of studying memory often enables us to detect a degree of impairment too slight to make itself apparent on ordinary examination but quite severe enough to constitute a real practical disability.

In our own work we have not uncommonly found that a relatively severe learning defect is quite consistent with good preservation of the previous level of knowledge and ability. The learning defect in some cases appears general, affecting all spheres of psychological function (as in the Korsakov syndrome, but in much less degree). In other cases, however, especially those with focal lesions, the learning defect is often restricted to a particular performance field, such as language or spatial orientation. Here it almost certainly has localizing value, and may persist long after the grosser focal symptoms have cleared up. We have found simple learning tests (Zangwill, 1943) of decisive help in assessing memory defects, both local and general in type. Their use in post-traumatic conditions, especially, is to be advocated as a routine procedure. In this connexion I may recall that Air Vice-Marshal Symonds has commented that the post-traumatic patient not uncommonly gives the impression of being less of the man and more of the child (Symonds, 1940). Perhaps I may be allowed to add that so far as his memory is concerned he is liable to give us the complementary impression of being less of the young adult and more of the old man.

As a postscript to this review of assessment I should like to call attention to certain points of method which have special relevance to the psychological worker. In the first place one must never allow oneself to forget that *every response on a mental test must be evaluated with strict reference to the conditions under which it is elicited*. Organic symptoms at the psychological level are by no means always absolute and constant in the sense of a visual field defect or a total aphasia. Even at the level of the cerebral integration of ocular movements, Gordon Holmes (1938) and others have stressed the part played by interest and incentive in calling forth a response that cannot be elicited under the ordinary conditions of clinical examination. In ideational apraxia it is well known that the complex acts involved in purposive manipulation of objects can often be performed normally in an accustomed and properly motivated setting. It is only when the same acts are demanded under the relatively artificial conditions of examination that the patient is apt to break down and display his disability (Lange, 1936). It is therefore only to be expected that the results given on tests of the higher mental functions in the psychological laboratory will by no means necessarily give one an adequate appraisal of the patient's capability to handle comparable tasks under everyday conditions. This difficulty can never be wholly overcome in experimental psychology, and, if only for this reason, I should like to pay special tribute to Miss de Brisay and her staff of occupational therapists at this hospital, who have ungrudgingly given us the benefit of their experience and observation in arriving at a just appraisal of a patient's work capacity. But for their help much of the work undertaken in the psychological laboratory would have remained academic and sterile.

In the second place, I would like to call attention to the *variability, fluctuation, and proneness to fatigue* of brain-injury performance on sustained mental work. This was well brought out by Goldstein (1919, 1942) in his careful laboratory studies during the last war, and has again been raised by Paterson (1944) in view of our similar experience to-day. It follows that an assessment based on a single short psychological examination may give a most misleading impression of a brain-injured patient's capacity to cope with protracted work. We therefore prolong psychological observation and testing over a lengthy period—in some cases over weeks and even months—in order to reach a fair appraisal of the true level. We also check our findings at frequent intervals against the patient's work record in the occupational therapy department. In special cases we have even arranged to give a patient an extended practical trial in a line of work akin to his own and under realistic conditions. A procedure of this kind, though not always easy to arrange, can be exceptionally rewarding.

Applications to Differential Diagnosis

The experience which we have gained in delimiting the finer grades of organic intellectual impairment has proved of help from time to time in differential diagnosis of organic and psychogenic sequelae of head injury. In the field of memory impairment, for example, our work with appropriate tests

* The term "special ability" is used here in a general sense without specific factorial connotations. Brig. Stephenson has suggested to me that the more typical forms of circumscribed disability (verbal, spatial, etc.) might find an interpretation in terms of the factor-psychology, and Lashley (1937) has made similar suggestions in a discussion of intelligence and cerebral localization in general.

(Zangwill, 1943) has proved valuable in enabling one to distinguish with fair confidence between a true organic decrement of learning and the more capricious interference with memory so often found in the psychoneuroses. Our work in assessing milder grades of dysphasia has likewise given us some basis for evaluating non-organic disorders of language. Cases of psychogenic stammer, for instance, seldom show decrement on verbal intelligence tests, which is the rule in focal dysphasic conditions. Atypical behaviour on aphasia tests has also led us on occasion to suspect an emotional involvement which psychiatric opinion confirmed.

Among more specific psychodiagnostic methods which we have explored I shall mention only the Rorschach method (Klopfer and Kelley, 1942). Our experience with this procedure has been rather less happy than that of some of its more zealous advocates. In rare cases this method has provided important data bearing on post-traumatic deterioration or has given us evidence of an abnormal personality make-up complicating the organic reaction. In the majority of post-traumatic cases, however, the test findings have added little of real value to expert psychiatric assessment.

In the earlier stages of the war we found intelligence tests very helpful in distinguishing between deterioration and pre-existing mental deficiency. With the adoption of large-scale selection techniques, however, high-grade defectives have practically vanished from our Service material.

Re-education

I come now to the last major province of our work—namely, its bearing on re-educational procedures. Under Mr. Norman Dott's tireless enterprise the joint activities of the clinical, psychological, and auxiliary therapeutic members of the unit have reached a very high level of integrated endeavour. The psychologist's contribution can be summarized under three headings. These are, first, advice regarding re-educational procedures in patients with psychological handicaps; secondly, periodic psychometric assessment of progress made; and, thirdly, preliminary exploration of techniques which might govern re-education of special disabilities.

Advice as to method of re-education is based on careful investigation and testing in individual cases. This involves not only proper mapping-out of the major disabilities but also determination of the patient's probable capacity to profit from training in the various performance fields affected. The choice of any particular method of re-training is governed both by general principles, in particular those laid down by Goldstein (1919, 1942), and by the balance of findings in the individual case. *Direct* re-training, in which the lost function is built up anew by tuition and exercise, is indicated especially in the expressive speech disorders. *Indirect* training, making play with what have been called substitution and detour methods, is generally called for in cases with receptive language disorders, especially reading. The particular programme of re-education in any given case will thus depend very largely on the individual patient and the balance of ability and disability which he presents.

Assessment of progress in patients undergoing prolonged re-education on account of psychological disabilities is undertaken every two or three weeks. In a considerable number of cases, for the most part aphasics undergoing prolonged speech therapy, we have been able to obtain detailed records of progress during the whole course of rehabilitation. Evaluation of this material is helping us to arrive at conclusions bearing on the types of aphasic syndrome which yield most adequately to re-education and the optimal length of treatment indicated.

We have undertaken some experimental studies of re-education methods with especial reference to reading, writing, and calculation. This work has been done with the active collaboration in the first place of Mrs. H. Mitcheltree, formerly speech therapist to this hospital, and more recently of Miss E. Butfield, my present colleague in the unit. We have devoted considerable attention to re-training alexic patients on the compensatory basis of kinaesthesia and touch, in some cases with conspicuous success. We have also made special investigations of acalculia with a view to improved re-educational procedures. Here, too, our tentative methods have met with limited success. Another field to which we have devoted

study is the *re-education of brain-injured children*. Here the position is complicated by the fact that we have to consider not only the re-education of what has been lost but the educational prognosis. Intensive study associated with practical educational work has in some cases enabled us to advise both parents and teachers as to educational management of children with residual dysphasia and other types of scholastic handicap. This field obviously calls for development, but careful follow-up studies will be needed before general conclusions can be drawn.

Rehabilitation

The results of psychological examination have not infrequently been of help in formulating a general course of rehabilitation and occupational therapy. Thus timely recognition of high-grade defects such as colour agnosia, impaired spatial judgment, and constructive apraxia has on occasion helped to guide Miss de Brisay and her staff in fitting the most adequate available course of occupational therapy to the individual patient. Reciprocally, the therapists' observations have not uncommonly called our attention to special disabilities displayed in a practical setting and suggested more intensive laboratory investigation.

Disposal and Resettlement

The psychologist has, sometimes been in the position to contribute to practical problems of disposal and resettlement by placing his observations in the hands of those called upon to assess an individual case and advise as to his future. In some cases our observations, when taken together with work records in the occupational therapy department, have provided material of direct relevance both to optimal disposal and to proper assessment of compensation and pension claims.

Fundamental Research

The material at the Brain Injuries Unit has proved a veritable gold-mine from the point of view of research on fundamental psychological problems. Owing to war conditions and practical exigencies it has not as yet been possible to communicate all of our material, but I may mention some work on orientation in the confusional state that it has been my privilege to undertake in collaboration with Dr. Andrew Paterson (Paterson and Zangwill, 1944a) and a joint communication from us on visual agnosia and disorientation associated with lesions of the non-dominant hemisphere (Paterson and Zangwill, 1944b). On the more specifically psychological side, I may mention a preliminary report on clinical tests of memory impairment (Zangwill, 1943) and some observations on the Rorschach test in cases of acute head injury (Zangwill, 1945). It is hoped to communicate further research studies shortly.

Conclusions

The main directions of psychological work undertaken in this unit during the past four years have been outlined. These include studies and assessment of high-grade intellectual defects, explorations of adjuvant techniques in neuropsychiatric diagnosis, and practical contributions to re-education, disposal and resettlement. Some contributions to psychological research are also reviewed.

I wish to thank Prof. D. K. Henderson and Mr. Norman Dott, the Directors of the Brain Injuries Unit, for their invaluable guidance, encouragement, and help; and Dr. Wm. McAlister, medical superintendent of this hospital, for his kind permission to study the case material. In its research aspects this work has been made possible by the support of the Rockefeller Foundation.

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ACCIDENTAL INFANT SUFFOCATION

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No special study of the true incidence of infant suffocation appears to have been made in this country or the U.S.A. (see *B.M.J.*, 1945, **1**, 524). The information necessary for an analysis is not available to the investigator except through the coroner, and then only by his closest co-operation, and as over 70% of coroners have no medical qualifications their interest is mainly confined to the purely legal aspect of each case. Further, the coroner's procedure precludes to a large extent the collection of comprehensive data by anyone but that official himself.

In England and Wales cases of death of infants from suspected suffocation are reported to the coroner of the district, either directly or indirectly, by the doctor called in to examine the child at death. If the doctor issues a death certificate certifying the cause of death as asphyxia or suffocation the case reaches the coroner through the Registrar of Births and Deaths under Statutory Rules and Orders, 1927, No. 485, thus ensuring that it does not escape investigation. It may be that a coroner will act on the strength of the doctor's opinion as to the cause of death without necessarily having the confirmation of a post-mortem examination. Prior to 1927 this was usually the case, as

coroner authority to order a post-mortem examination without necessarily committing the case to an inquest if death was found to be due to natural causes. Since that date every death in Birmingham from suspected suffocation of an infant dying in bed with its parents or others, or found dead in a cot, has been the subject of a post-mortem examination conducted by a skilled pathologist. It will be appreciated that all these deaths were entirely unexpected and that no doctor had recently been in medical attendance upon the child during life. The result of this altered procedure is reflected in the statistics in the following manner.

Birmingham Statistics

During the seven years 1938 to 1944 the total number of deaths reported to me of which asphyxia was considered as a possible cause was 318. Of these, 108 occurred while the infant was in bed with its parent or other person, and as a result of post-mortem examinations only 18 of these 108 were shown to have died from asphyxia occurring mechanically. It is also significant that of the remaining 210 cases in which an infant died while sleeping alone in a bed, cot, or perambulator, post-mortem examination established mechanical suffocation as being the definite cause of death in only 6 cases. Of the deaths 280 were due to natural causes, 152 to respiratory infection alone, and 77 to a respiratory condition associated with otitis media. Table I sets out in detail the age distribution and causes of death in the 318 cases as determined by the post-mortem examination.

Available statistics show that the total number of deaths attributed to asphyxia while in bed with parents or other persons in the Birmingham coroner's area during the seven years 1918 to 1924 was 130 when the estimated population was 550,000, as compared with 18 occurring during the seven years 1938 to 1944 with an estimated population of 1,000,000.

All the post-mortem examinations were conducted by skilled pathologists, including Prof. G. Haswell Wilson, professor of pathology, University of Birmingham; Prof. J. M. Webster,

TABLE I.—Causes of Death (1938-44)

Age	No. of Deaths of Children, occurring in Bed with one or more other Persons, for which Asphyxia was considered a possible cause	No. of Deaths of Children, occurring while alone in Bed, Cot, Perambulator, or other form of Improvised Cot, of which Asphyxia was considered a possible cause	Asphyxia occurring by Mechanical Means while in Bed with Parents or other Person	Asphyxia occurring by Mechanical Means while in Bed, Cot, Perambulator, or other form of Improvised Cot, alone	Asphyxia, cause of which was not definitely established—i.e., by Mechanical Means or Natural Causes	Asphyxia due to Inspiration of Vomit	Bronchopneumonia, Bronchitis, Capillary Complications	Bronchopneumonia or Respiratory Disease with Otitis Media	Bronchopneumonia or other Respiratory Disease with Contributory Cause—i.e., Pyelitis, Toxic Hepatitis	Otitis Media and Mastoiditis	Disease of Larynx	Neonatal Intracranial Haemorrhage	Meningitis	Tracheitis with Infection in Liver and Spleen	Congenital Atelectasis with Enlarged Thymus	Tonsillitis	Status Lymphaticus	Enteritis	Congenital Heart Disease	Atelectasis	Birth Injury	Convulsion—no Apparent Reason	Encephalitis	Immaturity
Under 1 day	2	—	2	—	—	1	11	4	3	1	—	1	—	—	—	—	—	—	1	1	1	—	—	1
Over 1 day and under 1 month	12	17	2	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Over 1 month and under 2 months	31	37	6	2	—	—	38	12	8	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—
Two months and under 3 months	20	46	5	1	—	5	27	17	7	2	—	—	—	—	1	1	—	—	—	—	—	—	—	—
Three months and under 4 months	20	28	3	—	1	—	29	12	2	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Four months and under 5 months	9	23	—	1	—	2	14	10	3	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Five months and under 6 months	4	16	—	1	—	—	11	6	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Six months and under 7 months	4	15	—	1	—	1	9	3	—	2	1	—	—	—	—	—	1	—	—	—	—	—	1	—
Seven months and under 8 months	1	9	—	—	—	—	3	6	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eight months and under 9 months	1	4	—	—	—	—	1	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nine months and under 10 months	—	7	—	—	—	1	3	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ten months and under 11 months	2	5	—	—	—	1	3	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eleven months and under 12 months	2	3	—	—	—	—	3	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	108	210	18	6	3	11	152	77	28	8	1	1	1	1	1	1	1	2	1	1	1	1	1	1

it was then not possible for a coroner to order a post-mortem examination without holding an inquest; therefore the medical opinion as to the cause of death, based on circumstantial evidence and external examination only, was usually accepted. The Coroners' (Amendment) Act, 1926, however, gave the

director of the West Midland Forensic Science Laboratory; Dr. J. M. Smellie and Dr. W. Carey Smallwood, honorary physicians and clinical pathologists on the staff of the Birmingham Children's Hospital; also the pathologists of the Children's and the Maternity Hospitals, Birmingham, and others.