of a day and night are divided into six-hour periods beginning from midnight, the fatalities are distributed over these periods as follows: 11, 10, 7, and 11—thus fairly evenly. In our clinic the ward round in each room takes from a half to one hour. Had the 39 fatalities not occurred during a ward round more frequently than at other hours, only 0.8 to 1.6 fatalities should have occurred during them. But these deaths totalled 5. (In Case 1 death did not occur until two hours after the round, although the fatal attack began during it.)

A closer association between these fatalities than is provided by mere coincidence is strongly suggested by the course of several individual cases. It also seems that the explanation for this phenomenon can be found in the state of excitement that may be brought on in some patients by the doctor's visit. Two deaths occurred when the patients were told that the time for their discharge, so eagerly awaited, had come (Cases 3 and 5). In two cases (Cases 1 and 6) the patient habitually got excited during the visit. Perhaps it was no coincidence that three deaths occurred in connexion with the round of the physician-in-chief, repeated only weekly or bi-weekly in each ward.

On the basis of the foregoing it is possible that there may be a serious hidden risk in ward rounds for the patient with myocardial infarction, since on these occasions he is subjected to an unusually severe emotional stress. This danger is clearly very difficult to avoid in the case of an unusually labile patient, but it is always possible to reduce it. The adoption of the following precautions may lead to improvement in this respect.

(1) To ensure that the attending doctor is aware of the risk, and takes heed of it in his attitude to the patient. According to Stroud (1945), the most important point in treatment is a sympathetic attitude on the part of the doctor towards his patient. (2) It is advisable not to emphasize excessively the importance of ward rounds to a patient with myocardial infarction. Where such emphasis is made it may not be the doctor's fault so much as owing to the attitude of the nursing staff. The patient may well have been told of the great importance of the round of the physician-in-chief, the beds may have been made with great care and speed, and other special preparations made for the expected visit. Presumably the patient's state of mind, susceptible to excitement, receives an added stimulus from this general state of bustle in the ward. This is by no means the case everywhere, but, so far as I can see, these disadvantages increase as the "formal" side of hospital life becomes more pronounced. (3) The administration of sedatives when any signs of a state of excitement are observed in a patient with myocardial infarction is naturally very important. But, obviously, the mental rest secured by this means is not the same as that resulting from a successful removal of the factor accounting for the development of mental excitement.

Summary

Six out of 39 hospital patients affected with acute myocardial infarction who died more than seven days but less than six weeks after the onset of the infarction did so during or shortly after ward rounds. This cannot be dismissed as a coincidence. Four of the ward rounds in connexion with which the deaths occurred involved, even to the casual observer, an unusually heavy mental stress to the patient. In two cases discharge from hospital, eagerly awaited by the patient, was to be decided upon at that very occasion. In another two cases the round was that of the physician-in-chief, made only once or twice a week.

The conclusion is that the ward round may sometimes constitute such a heavy strain on the patient that in cases in which this stress may be deleterious, as in myocardial infarction, it may constitute a danger. Means of reducing this risk are discussed.

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ARRESTED MENTAL DEVELOPMENT INDUCED BY LEAD-POISONING

BY

J. W. G. GIBB, M.B., Ch.B., D.C.H.

AND

J. F. MacMAHON, M.A., M.D., D.P.M.

Physician-Superintendent, the Manor Hospital, Epsom, Surrey

This paper is based on the clinical history of a boy aged 7½ who, as result of lead ingestion, suffered arrested mental development and is now a mentally defective person in institutional care. The data on which his case history has been compiled are derived from the interim reports of clinicians who attended him at various stages of his long illness and his mother's account of the sequence of events and their attendant circumstances. The case is reported in part chronologically, and in part in the order in which relevant information materialized, so that the diagnostic problems which arose may be appreciated as they were presented to the physicians concerned and so that the importance of early and adequate diagnosis in such cases may be emphasized.

Case History

The patient's mother, a woman of apparently average intelligence, reported that her son was an only child. His birth weight was 6½ lb. (2.9 kg.), and both pregnancy and delivery were uncomplicated. He developed normally in infancy, sitting up at 7 months, walking at 17 months, and talking at 18 months. By the age of 2 years he had achieved sphincter control and was repeating nursery rhymes. He was duly inoculated against diphtheria and whooping-cough, and the family doctor confirms that he was a normal infant. The mother states quite definitely that the child was more than 3 years old when he had an illness, diagnosed as "food-poisoning" and associated with intestinal symptoms and an itchy rash. In the course of about six weeks the latter faded; but thereafter he developed a cough, worse at night, accompanied with almost continuous vomiting. She says that whooping-cough was prevalent at the time and the illness was so diagnosed, although the child did not "whoop."

A neurologist, consulted when the patient was aged 5, reported that the severe illness, believed to have been whooping-cough, occurred when the child was 2½; but in all other matters confirmed the mother's version of the past history. His opinion was that the severe illness may have been encephalitis, following or complicating whooping-cough, and that its sequelae were regression and an acquired aphasia (both receptive and executive). Thus the child's performance I.Q. was only 58. The mother was therefore advised to send this ineducable boy to an occupation centre while he was kept under observation at the outpatient department. He was given a course of glutamic acid.

The third medical report relates to the patient's condition when he was 5½ and under observation at another hospital. He had been referred because he was unable to talk, ignored

people, and was very fearful. The father, aged 33, was described as being emotionally immature, solitary, and like his son in his inability to form emotional relationships. It seems that incompatibility and housing difficulties caused the parents to separate by mutual consent for a period of a year in 1951-2. On examination the patient was found to be a sturdy child with incontinence of faeces but not of urine. Mentally he was withdrawn, preoccupied, and unable to talk. On the Merrill-Palmer scale his mental age was 3½ years, but full testing proved impossible. During his six weeks in hospital he was noisy at first, but later quieted down; his play activities were simple and he delighted in sand and water. He played with faeces when opportunity offered and he tended to place everything that he handled in his mouth. He did not associate with the other children, and seemed to be so sensitive to the noise they made that he sought comfort from the nurses. On January 31, 1953, he was transferred to a fever hospital with varicella. The diagnosis of his mental condition was "infantile autism." His prognosis was "poor."

The fourth medical report describes the patient's condition when he was seen at his parents' home in October, 1953 (aged 6½). His parents complained that they could not cope with the child because of his extreme restlessness, screaming fits at night, and constant overactivity indoors and out. It was noted that in his restless phases he appeared to be extraordinarily sensitive to noise and covered his ears with his hands to exclude it. As he had become unsuitable for further care at the occupation centre, the parents were at their wits' end and begged for assistance. Ultimately they agreed that the child might be admitted temporarily to a mental deficiency hospital so that they might have a rest.

Developments after Admission to the Manor Hospital

The patient was admitted (without an order) in January, 1954, for a period of seven weeks. His general condition and behaviour were as already reported, and he was found to be very constipated—however, enemata proved to be effective, and after no more than a few weeks on a liberal diet his screaming fits ceased; his general condition improved considerably and he became more co-operative, even regaining the ability to dress himself. He returned home in March, but on April 9 the health visitor reported that his restlessness and his screaming fits had recurred. He was accordingly "dealt with" under section 3 of the Mental Deficiency Act, 1913, and was "placed" at the Manor on May 28.

Clinically, the sequence of events which had attended his earlier short stay was repeated, and after a month he was transferred to the children's ward. Thereafter his condition deteriorated: from being almost hyperkinetic he became dull and languid. He refused food, and his only solace appeared to be tasting rubbish and eating paint scratched from the walls. Appropriate investigations were undertaken and the positive results were: blood Hb, 88%; R.B.C., 4,700,000 per c.mm.—the red cells were hypochromic and punctate basophilia was conspicuous. X-ray examination of the long bones revealed areas of increased opacity, most marked at the lower ends of the femur, radius, and ulna, and the upper end of the tibia.

In the light of these significant findings the mother agreed to give a more detailed account of her son's history at a clinical meeting. She confirmed the details already reported, but not until leading questions were put to her did she state that, before the boy had "food-poisoning" at the age of 3½ years, a set of very old toy lead soldiers had been resurrected for his delectation. These toys left grey dust on his hands, and it was then that he became so constipated and developed cough and vomiting. Although he was very ill there were no convulsions, coma, or paralysis. After a few weeks his physical condition improved, but he ceased to speak and became withdrawn and asocial. By the time he was 4 he had a marked craving for oil, fat, and paint, and discovered discarded (leaded) paint pots and brushes which had been used to decorate the kitchen; *pari passu*, his constipation became complicated with bleeding piles. He lost

previously acquired skills and interests, and took to hiding in cupboards and behind walls of toy bricks. Noise seemed to irritate him and he lost all affection for his parents. At this stage she sought specialist aid, but as treatment had not effected a lasting improvement she reluctantly accepted the inevitable and "placed" her son at the Manor.

Thus the diagnosis of lead-poisoning was made, and it was confirmed beyond all doubt by the further report that a 24-hour specimen of urine contained 435 µg. of lead as compared with 24 µg. in controls of the patient's age group.

Treatment and Progress

Steps were taken to free the circulation of lead. A high-calcium diet supplemented with calcium lactate, iron, and preparations of vitamins D and C was provided; within a week the colic ceased and the constipation was relieved. The child's appetite is now healthy and his complexion positively ruddy. He is more interested in his companions and attempts to join in their games. Noise no longer disturbs him and he is attracted to strangers. He welcomes his mother's visits and sometimes seems to anticipate them. He obeys simple instructions conveyed through the media of voice and gesture. His mutism persists, but he phonates when he hums and croons. He sleeps well and restless overactive behaviour is not so marked, except when he is in strange surroundings. In brief, he is a happier child, but there has been no measurable increase in his cognitive ability. Pica persists, but the casual desultory way he attempts to indulge it is in marked contrast to the drive and energy which attended it some months ago.

In an effort to determine if the patient is an indiscriminate oral experimenter or has certain predilections, a board daubed with eight different items (including fatty, salty, bitter, and sweet substances, together with leaded and non-leaded paints of similar appearance) was placed before him while discreet observation was maintained. In the course of eight minutes he tasted seven different items (he ignored one non-leaded paint) and concentrated almost entirely on just two—fat and lead paint. Three controls of the same age and grading proved to be quite uninterested in the experiment. The very tentative conclusion was reached that he is to a certain extent selective in his taste and has a partiality for fats; but, whether it is the lead or the fat (linseed oil) in the paint and whether "deprivity" or depravity is the motivating factor remains an open question.

Discussion

In the light of after-events it is tempting to speculate about the series of interim diagnoses which marked the progress of this case. Food-poisoning, pertussis, encephalitis, infantile autism, and anemia were, in that order, provisionally postulated to account for the symptomatology; but as the parents seem to have failed to appreciate the relevance of the essential causal factors—pica and lead—it is questionable whether they reported them with due emphasis when they sought advice. Moreover, as children's diets in hospital usually have high calcium and vitamin values it may be assumed that, as occurred at the Manor, once the patient had been under care for a short time the more urgent symptoms were relieved by good feeding. It may be thought that pica was the sequel to pertussis encephalitis and plumbism was its outcome; but, if this contention is correct, encephalitis must have occurred when the patient was about 2½ years old (as reported by the neurologist) and thus before the lead soldiers were "resurrected." The mother, however, insists that the child was more than 3½ years old when he had "food-poisoning" and "whooping-cough," and she is quite certain that he was playing with lead soldiers before he became ill. In the light of this and the implications of other circumstantial evidence that she has adduced, it seems reasonable to infer that the actual sequence of events was as she now describes it.

The signs, symptoms, and treatment of plumbism in children have been described so comprehensively in the literature

that further comment on them is scarcely necessary. It may be observed, however, that hyperacusis, which so tormented this child, seems to have determined, in part at any rate, his rather hyperkinetic behaviour. Its origin must nevertheless remain a matter for speculation.

Only a score of cases of lead-poisoning in children have been reported during the present century in this country, and, of these, 10 have been described by Burrows *et al.* (1951) and Millichap *et al.* (1952) during the post-war period. They have certain features in common which indicate the need—indeed, the urgent necessity—for appropriate consideration and action by public authorities, medical practitioners, parents, and others concerned with child health.

Pica

Pica is certainly one of these features. Almost indiscriminate oral sampling is of course a characteristic developmental phenomenon in children of less than 2 years; but, if parental management is prudent and well-informed no harm is done. In some, the habit may persist until the sixth or eighth year; in others it may recur, in a more selective fashion, after it has been outgrown: in such cases it may be interpreted as failure to emerge from, or as regression to, the so-called "oral-erotic" phase. As stated by Sheldon (1951) it may be due to "chronic intestinal indigestion" with or without associated enuresis, temper tantrums, or night terrors. It may follow encephalitis, or point towards amentia; but even in low-grade aments it is met less frequently than might be expected. There is no doubt, however, that more often than not it precedes plumbism in children, and, as its serious implications are not always realized, diagnoses may be inadequate unless the relevant questions are asked.

Legislation has certainly served to protect workmen from lead-poisoning, and propaganda appears to be effective in ensuring that painted toys and nursery equipment are lead-free when they leave the factory; but, in this day and age when there is a premium on self-help in the home, the "handyman," and the "handy-woman" too, may unwittingly imperil their children's prospects of normal mental growth and general well-being through carelessly leaving lead-paint containers about the home and applying lead paint to household fittings. Lead paint is still often used on exterior wooden surfaces, and this, in point of fact, was found to be the case at the Manor; formerly it was used much more extensively, and thus may lie (unsuspected) on interior surfaces, masked by more recently applied lead-free coats. The amateur home decorator is, however, apt to believe that the best paints are leaded, and in his enthusiasm he is prone to buy them, perhaps from surplus war stocks sold cheaply in street markets, and then proceed to apply them, with more zeal than discretion, to the new baby's cot or perambulator, toys or play-pen, the kitchen walls, or the dingy recesses around the scullery sink. Millichap *et al.* (1952) listed the sources of plumbism in childhood as follows: painted woodwork, 9; nipple shields, 4; toy soldiers, 2; fumes from burning battery casings, 2; drinking-water, 1; and toilet powder, 1. Thus paint and toy soldiers account for more than half the cases reported in this country during the present century, and the patient described adds to their number.

Mental Sequelae

The grave consequences of lead-poisoning, in terms of mortality, paralysis, paresis, optic atrophy, and epilepsy, are widely recognized, but it is clear that its disastrous effects on the progress of mental development are generally underestimated. Levinson and Zeldes (1939) studied 26 Chicago cases and found that 5 of the patients had died in the acute stage; they followed up only 9 of the survivors for periods not exceeding 3½ years and graded 1 as blind, mute, and helpless, 2 as being epileptic and mentally subnormal, and no more than 3 as being normal, mentally and physically. McKhann and Vogt (1933) reviewed 89 hospital cases at Boston and found that 12 were latent and 77 showed signs of lead intoxication. Of the latter, 11 died, 45 had

"encephalitis," and 4 neuritis; 12 had permanent sequelae, half being mentally retarded. McKhann (1932) suggested that the neurological manifestations of lead-poisoning usually subside without serious consequences if the ingestion of lead is stopped and its removal from the circulation hastened by securing its deposition in the bones in an inert form. No doubt this view is correct, so far as the most urgent and dramatic symptoms are concerned; but it is unlikely that if follow-up techniques had then been practised he would have made quite so sweeping a statement—indeed, Byers and Lord (1943) have shown that, of 20 cases discharged from hospital as "cured," favourable prognoses, even in "mild" cases, were almost invariably falsified by the event. Lord's reports on the mental sequelae of plumbism are admittedly incomplete (Byers explains that after Lord's death he prepared her records for publication); nevertheless, they merit earnest consideration, because they are the only available published data on the important question of prognosis in terms of mental growth.

Lord screened the records of 71 children who had plumbism, and, having eliminated 12 with gross brain damage on discharge, found that the remaining 59 left hospital "recovered." Of these it seems that only 20 (perhaps the élite) entered the school system and became the subjects of her follow-up studies. From the reports of the medical staff in attendance on these children on their first admission to hospital and from her own inquiries, Lord concluded that they had progressed normally prior to developing plumbism. On their initial admission they were in the age range of 10 months to 7½ years (the mean age being almost 2½ years, with a standard deviation of 17.3 months), and, as regards involvement of the nervous system, 8 presented more or less conclusive signs of encephalopathy and 12 did not. When the whole group was finally reviewed, the age range was 6–15 years and their I.Q.s (mostly on the Stanford-Binet scale) were in the range of 67–109 points (with a mean of 91 and a standard deviation of 12 points).

When the size of the sample is considered, the mean I.Q. of 91 is not really exceptional; but it is highly significant that only one of these patients did passably well at school (she was the only "nipple shield" case in the group and had an I.Q. of 103—the next best was a girl with an I.Q. of 82).

The comparative progress of the encephalopathic and non-encephalopathic cases is shown in Table I.

TABLE I

	No. of Cases	Age Range		I.Q.s	
		On First Admission (Months)	On Last Test (Years)	Average	Range
Encephalopathic	8	11–55	6–12	91	69–109
Non-encephalopathic	12	10–81	6½–15	91	67–105

It may be inferred that the presence or absence of encephalopathy made no material difference to the course of mental development in this group.

As already stated, only one child did passably well at school. I.Q.s of less than 85 no doubt contributed to the failure of five others. In her analysis of the remaining 14 cases Lord made her major contribution to our knowledge of the mental sequelae of plumbism: she showed that "sensorimotor" defects and temperamental anomalies were responsible for their social and educational failure despite the fact that in many instances their I.Q. ratings were in the average range of the general population. Thus, while some were verbally facile, they could not learn to read, write, or do number work, and, when the appropriate battery of tests was applied, their "sensorimotor" disabilities were exposed in terms of their inability to deal with shape, direction, space, and projected imagery. Some also exhibited behaviour disorders which seem (from Lord's account of them) to have resembled some of the sequelae of encephalitis lethargica.

A further point of prognostic significance also emerges. The occurrence of more or less complete arrest of mental development may have typified some cases. The relevant data in terms of declining I.Q.s are given in Table II.

TABLE II

Age when First Admitted (Years)	Intermediate Follow-up Test		Final Follow-up Test	
	Age	I.Q.	Age	I.Q.
4½	5	90	12½	65
6½	6½	100	12½	82
3½	6½	102	7½	91
2½	5½	106	7	92

Lord concluded that plumbism, whether characterized by evidence of encephalopathy or not, leads, even in those cases discharged from hospital as completely recovered, to failure or impairment of the normal processes of growth and development of the cerebral cortex. Support for this conclusion is also to be found in the fact that air encephalography, as indicated by McKhann and Vogt (1933), Levinson and Zeldes (1939), and others, reveals the existence of cortical atrophy in lead-poisoning victims.

There can, indeed, be no doubt about the gravity of the aftermath of plumbism in children, and in the few instances in which adequate follow-up techniques have been applied its consequences have been, even in so-called "cured" cases, deleterious to the progress of mental growth. Hence prognoses must be guarded until the age of at least 16 years has been reached, as it is not until then that intellectual development normally approaches its peak. Moreover, as successful therapy merely diverts lead to the bones, the patient remains, during childhood and adolescence, in a precarious plight. Trifling intercurrent indispositions, missed meals, or temper tantrums may suffice to disturb the acid-base equilibrium of the circulating media and so release lead to do further brain damage.

The mental defective described in this paper is aged 7½, but his mental age is only 3 to 4 years. Whether his mental development has been arrested partially or completely, temporarily or permanently, only time will tell—moreover, regression complicates the prognostic problem. Hence, lacking data about the ultimate fate of such cases in late childhood and adolescence, we can only speculate about his future prospects.

Screening and Follow-up Procedures

According to Levinson and Zeldes (1939), correct diagnoses were made only in 10 out of 26 cases when first admitted to hospital, and then only because plumbism had been recorded in other members of the families concerned. Bearing their observations in mind and considering also the implications of the case under discussion—the diagnostic problems it presented, the long period of lead ingestion and illness; the naïveté of the parental attitudes towards pica in general and lead in particular; the fact that the patient is now a mental defective; and the tenuous theoretical foundations on which much of our knowledge of the aetiology of mental subnormality is based—it is impossible to escape making certain obvious inferences.

It must surely follow that many others are naïve, ill informed, or careless about the risks to which they expose their children; therefore the real incidence of plumbism must be far greater than hitherto envisaged. No doubt, too, an unknown number of children are now in special schools and mental-deficiency establishments handicapped in various ways because of undiagnosed plumbism. It is hoped that, in particular, those responsible for the care and training of subnormal and "maladjusted" children will consider the advisability of applying screening procedures to their charges. Past or present association of pica, constipation, and colic might serve as preliminary criteria; thereafter, fuller investigations should be carried out on those who satisfied them. Particular attention might also be given to cases with "sensorimotor" disabilities and those with symptoms suggestive of primitive schizophrenia or hyperkinetic

disease. Lay (1938) indicated that symptoms sometimes regarded as characteristic of the two last-mentioned conditions may be caused by encephalitis, and it is relevant that the patient described was thought by different observers to be the subject of encephalitis, infantile autism, and an approximation to hyperkineticism.

Summary and Conclusions

A case of arrested mental development caused by lead-poisoning has been described and its implications and those of others in the literature have been discussed with particular reference to the following considerations.

1. The diagnosis of plumbism may be delayed over long periods during which serious and possibly irreversible brain damage may be done, with resultant arrest of mental growth, the appearance of "sensorimotor" defects, and both social and educational disabilities.

2. Pica, more often than not, precedes plumbism in children, and, as its implications are not always recognized, its occurrence may not be reported with appropriate emphasis. Hence there is the possibility that lead ingestion is not considered when the presenting symptomatology suggests such conditions as food-poisoning, pertussis, infantile autism, amentia, sensorimotor defects, educational subnormality, hyperkinetic disease, and behaviour disorders.

3. The need for appropriate screening and follow-up procedures has been indicated in light of the probability that the real incidence of plumbism is much greater than hitherto envisaged.

4. It is hoped that the Ministry of Health, local authorities, medical practitioners, parents, and all concerned with child welfare will take appropriate action to safeguard children from exposure to the risks of plumbism.

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Discussing postal treatment in his latest quarterly report, Mr. H. H. BAGNALL, Birmingham's City Analyst, writes: "If a person goes to a pharmacist's shop, as many people hoping for quick and semi-miraculous cures still do, and demands a bottle of 'indigestion mixture,' he must, by the provisions of the Pharmacy and Medicines Act, be supplied with a printed list of the constituents of the medicine, and there is thus some sort of control, although admittedly not nearly enough, over such sales. The same Act, however, allows for the omission even of this simple precaution if an article is made up and supplied for the use of a particular person, being an article prescribed by reference to the needs of that person. The postal quack relies on this provision to avoid giving the composition of his remedies, for, as he sends out a typewritten chart of questions asking for answers to certain stock questions by his prospective patients, it can be said that in a sense he is prescribing for their particular needs. Is it not possible, as a slight check on these long-distance cures and as a preliminary to more thorough action, to require that all stock mixtures, powders, pills, and so on should be labelled with a list of ingredients, unless they are supplied on prescription by a properly qualified medical man?"