OBSERVATIONS ON
RECURRENT VOMITING WITH ACETONURIA
IN CHILDREN

by

HUGH MACKENZIE KING, M.B., Ch.B. (Edin.)

April, 1947.

TABLE OF CONTENTS

Preface

Definition

Introduction

Objects of the Present Work

Clinical Analysis

The Attack

Family Histories

Differential Diagnosis

Extracts from Case-Histories as Illustrations

Clinical Discussion

General Discussion

Summary and Conclusion

Tables

References

Appendix - Original Case-Histories (Volume II)

PREFACE

The present work is a description of original clinical observations on children suffering from attacks of recurrent vomiting. These were made over a period of fourteen years, during the course of general practice in a mining and agricultural area.

The scope of the present work is limited to observation and simple side-room tests. Biochemical analyses were not carried out on these cases. This has already been done on an extensive scale by other workers. Consequently, it is hoped that this omission will not detract from the value of this attempt to add further information from the purely clinical aspect to the considerable body of knowledge which already exists on this subject.

I have pleasure in acknowledging my indebtedness to Professor N. Morris for his encouragement and advice; the following account of this work was written on his suggestion.

DEFINITION

Recurrent vomiting is an abnormal clinical state which is observed at any period between infancy and puberty. It is characterised by irritability and restlessness in the prodromal stage and later by acetonuria which in the average case is followed by vomiting. Usually the condition clears up spontaneously but recovery is hastened by the administration of alkali by mouth. The disturbance usually recurs after varying intervals during which the child is apparently normal. Subsequent attacks are identical with those which have gone before. Attacks may occur in early infancy and tend to become less frequent from the age of seven to eight years, until at puberty they usually have ceased to occur.

INTRODUCTION

Rotch (1903) in the fourth edition of his text-book on "Paediatrics" describes cyclic or recurrent vomiting as a form of vomiting of such importance that it must be spoken of as a disease by itself. Two years previously Marfan (1901) and subsequently others, had accurately defined the condition as a separate clinical entity which was characterised by vomiting and acetonuria, the smell of acetone being sometimes detected in the breath. The fact of ketosis, then, was established as a necessary criterion in diagnosis and in the differentiation of this form of vomiting from other types but it was not clear whether the state of ketosis was primary or secondary.

To test this question, exhaustive metabolic experiments have been carried out on normal and susceptible children with a view to producing a condition of ketosis, and determining whether the resultant type of ketosis was accompanied by an attack of vomiting comparable to that seen in the condition under discussion. Ketosis indicates an interruption in the metabolism of fat and there is evidence to support the view that complete metabolism of fat is dependent on an adequate supply and utilisation of carbohydrate. It is well known that excessive fat intake /

intake with a minimum of carbohydrate feeding will produce circumstances in which ketone bodies are readily formed. At the same time the effects of starvation and subsequent appearance of ketonuria is also well known, especially in children, and can be simulated clinically by restricting the intake of carbohydrate food. Utilising these principles, some workers have given high fat diets while others have limited the carbohydrate intake.

Limitation of carbohydrate intake.

Hilliger (1914), Knoepfelmacher (1921), Ross S.G. and Josephs, H.W. (1924), Seckel, H. (1927), Heymann (1929) (1931) (1932) (1933), Siwe, S.A. (1934) claim to have produced by this means attacks similar to those of cyclic vomiting. Hilliger in discussing his results believed that some degree of adrenal dysfunction was present as indicated by the low blood sugar value obtained. On the other hand, Knoepfelmacher believed that ketonuria was due to a sudden holding on to glycogen by the liver; this he thought was the result of defective function of the sympathetic nervous system.

Salomonsen, L. (1929) (1930) (1932), Weichsel, M. (1933), Schloss, J. (1930), Ellis, R.D.B. (1931) failed to produce attacks of cyclic vomiting by this means.

Ketogenic /

Ketogenic Diet

Ström, J. (1935) working with six patients succeeded in reproducing the symptoms of cyclic vomiting by administration of a ketogenic diet after a period of starvation. He also stated that attacks of vomiting may occur without the appearance of ketonuria. Salomonsen, L. (1929) (1930) (1932) (1932) Weichsel, M. (1933) Ellis, R.W.B. (1931). Schloss, J. (1930) Dods and Lorimer (1933) were unable to produce the typical symptoms using a similar procedure. But Heymann (1929) (1931) in patients fed on a ketogenic diet successfully induced attacks one hour after the subcutaneous injection of adrenalin.

The results of these experiments by independent workers on different material is difficult to assess, but the weight of evidence appears to support the conclusion of Salomonsen, L. (1929), viz:-

(1) Carbohydrate metabolism is not seriously disturbed in these patients; the blood sugar and the glycogen storage remains relatively constant.

(2) There is no obvious difference in the fat metabolism in these children, as compared with the normal, because:

    (a) Ketogenic experiments produce similar results in both groups.

    (b) The susceptible child appears to fast normally.

Graham /

Graham, S. and Morris, N. (1933) state that of three hundred cases examined on admission to the Royal Hospital for Sick Children, Glasgow, 54.7% showed ketonuria; no reference is made to the effect that any of these cases suffered from cyclic vomiting. Again Dods and Lorimer (1935) found that 46% of six hundred and eighty five admissions to the Royal Alexandra Hospital for Children showed ketonuria.

Accordingly, it appears that purely metabolic considerations do not afford a comprehensive explanation as to the essential nature of this syndrome. Further, in this connection, it is interesting to note that Salomonsen, L. (1929), having extensively studied the metabolism of these children, suggests that the condition may be purely nervous in origin. My clinical observations during these past years have indicated that this condition is a nervous imbalance or disorder; this will be fully discussed in the following work.

OBJECTS OF THE PRESENT WORK

It would seem justifiable, therefore, to present the following clinical observations to demonstrate that:

(1) The presence of ketosis is the essential feature of recurrent vomiting, the latter being secondary to a high concentration of acetone.

(2) This condition is invariably met with in a definite type of child who shows evidence of nervous hyperexcitability even from the first few weeks of life.

(3) This physical type may be hereditarily transmitted.

A discussion of the findings follows, and the relationship between ketonuria and the neuro-labile character is examined in an attempt to find an explanation for the occurrence of this condition.

CLINICAL ANALYSIS

The Susceptible Child

Home Surroundings

The Family Background

The Developing Child

The Child at School

The Child at Play

Puberty

Adult

CLINICAL ANALYSIS

Observations have been recorded on a series of children, in number thirty-six, individual members having been seen for periods varying from three days to fourteen years, during the normal course of general practice. The area from which they are derived (the great majority have been resident in the district, as have their parents, for the whole of their life-time) is an agricultural area in the Carse of Stirling. Two coal-mines are worked in the area and two villages are made up almost entirely of the mining community.

Each child exhibited the criteria necessary for a diagnosis of recurrent vomiting, viz: acetonuria and attacks of vomiting which recurred after varying intervals, without any other significant physical abnormality. A total number of one hundred and thirty three separate and distinct attacks were observed, each child showing apparently normal health in the interval. The incidence of other complaints common to children was low.

A summary of twenty-five cases from the series with respect to the age at onset of the condition; the period of observation, the total number of attacks observed and the response to alkaline therapy is given in Table I.

The /

The following statements are based on personal clinical observations during a period of eighteen years.

THE SUSCEPTIBLE CHILD

These children always have a characteristic appearance - they are small and pale, with bright eyes and red lips, thin and nervous, shy and excitable, and rather attractive in manner.

They are difficult to get to know, but once their confidence has been gained they are very friendly. They always appear to me as doll-like or "small-edition" types.

Even in a mining village the clean and tidy habits of these children are remarkable, when most others are usually begrimed and dirty soon after they leave their homes. They do not take an active part in the more boisterous games and belie Shakespeare's Schoolboy by their punctual willingness to attend school, where they are usually bright with good records of work.

HOME SURROUNDINGS

Relative to their social position their homes are above the average. They are kept clean in spite of the difficulties in a mining village where the houses are quite close to the pit. Regularly prepared meals are provided, unlike the common practice /

practice in such villages where a piece of bread and jam is the usual fare. I have no recollection of ever having seen any of the children in the series carrying "pieces" outside or to school.

These children are in bed at a reasonable hour in the evening, a rare occurrence in a mining village.

Running about with bare feet in summer is not often seen. How much of this is due to the parents and how much to the child's own fear of danger is difficult to assess.

THE FAMILY BACKGROUND

Invariably one or each of the parents is of the nervous worrying type. They devote a lot of their time to the proper care of their children and their homes as did their parents before them. Often a history of similar attacks can be obtained regarding one of the parents.

The dramatic nature of the illness and its recurrence often creates an anxious outlook on the part of the parents. With the recurrence of the attacks they show marked anxiety even though the transient nature of the condition is evident.

During eighteen years only three cases have been seen in one-child families.

THE DEVELOPING CHILD

(1) Breast fed babies never appear to suffer from attacks /

attacks of recurrent vomiting while on the breast. The onset invariably occurs after breast feeding has been stopped. The mother often gives a history that the child has always been of a nervous nature and that he or she is very easily disturbed e.g. by a dog barking in the house or by someone making a noise or talking too quickly or loudly to the child when asleep; in these circumstances the child wakes up with a start and cries. This can usually be quickly overcome if the mother takes the child in her arms and talks to him. In these houses I have noticed that the baby is always prominent in the minds of the parents - "Don't make a noise you will waken the baby" they will say. Apart from this increased excitability these babies usually have very nice natures and are contented. The child is usually rather pale and of a thin type. The parents take a delight in telling one that though he is thin he is "wiry". At the age of six months the child does not show any signs of "cutting teeth" - this may even be delayed till one year. Occasionally the child will have one or two teeth at about six months or even earlier but the others are very much later in making their appearance. (see Table I).

About this time the breast feeding is often supplemented with milk and solid food. At this stage /

stage breast fed babies may begin to show actual attacks of recurrent vomiting. It is often noticed that the child is very fretful, pale, off his food, constipated - this is often put down by the mother and others to teething even though no teeth are appearing. Another common sign about this time is the appearance of heat spots which seem to make the child even more fretful. These heat spots invariably recede by the time the sickness begins.

The first two or three feeds may have been retained in the stomach for a quarter to half an hour or longer before being vomited. This interval, unless treatment is started,rapidly shortens until the food is vomited immediately it is taken; later the vomiting comes on when no food has been taken. I have noticed that the attacks are fewer during the night than during the day and this fact is often helpful in treatment. The breath at this stage smells strongly of acetone and the child is usually constipated except in the type where diarrhoea is the more prominent sign. Even without any special treatment the condition now begins to correct itself. Acetone disappears from the breath and the child soon appears normal again. The actual duration of the sickness may vary from two or three attacks to two or three or four days and nights of sickness.

At the end of a severe attack the child is very pale, often listless and shows obvious loss of weight.

The appetite rapidly returns and lost weight is quickly regained, although the child may remain pale for some considerable time afterwards. I have not seen eruption of teeth in association with attacks at this stage.

The child may have a racurrence in weeks or months, or may not have another attack for years after. There is definitely no periodicity. Although no further attacks of vomiting may occur, acetone can often be found in the urine especially when any of the prevomiting signs and symptoms are evident e.g. heat spots. An acetone concentration varying from positive to double positive may be obtained in many cases, and clears up without any specific treatment.

The child starts walking about the normal time of twelve to thirteen months and learns fairly quickly the art of walking.

Until this time the exciting cause is often very difficult to elicit and would appear in the main to be dietetic.

From the age of one to two years the nervous factor becomes more and more noticeable - the attack being associated with some form of excitement e.g. visitors /

visitors or visiting - or parties or any other occasion when much attention has been focussed on the child, sometimes together with over-eating and fatigue. Such a history is often obtained. (see Case 10).

Later anticipation as a cause becomes more and more evident, e.g. the child having been to a children's party now looks forward to going to another. When this is discussed by the parents or older brothers and sisters, marked interest is shown. He becomes excitable and off his food; he may show heat spots and disturbed sleep, one, two or three days before the party, and then nausea, acetonuria which may be followed by typical vomiting supervene. (see Case 18).

(2) Bottle fed babies on the other hand may show evidence of an attack at a much earlier age, e.g. three to four weeks. Here also the increased excitability is evident, e.g. the child who has been feeding and thriving well becomes easily disturbed and restless during the night so that subsequently a few sleepless nights may be reported. Such a history may be given before a typical attack or the appearance of heat spots which are usually receding by the time sickness develops. Teething here again is delayed. The child remains nervous, rather small, thin and pale. He is shy and difficult to get to know /

know, but once his confidence is gained he is very friendly, affectionate and trusting. The early features of the attack, in contra distinction to the breast fed baby, are very suggestive of a dietetic exciting cause. (see Case 8).

Mentally these children are invariably bright and at the varying ages their ability to play with toys is often remarkable - boys with mechanical toys and girls with the making and dressing of dolls.

THE CHILD AT SCHOOL

On enquiry at school I have found that these children are always bright and very attentive with good school records. They are always punctual and can be seen walking to school on the pavement unlike most of the other children who seem to take a delight in going through the ploughed fields and ditches or in playing football on the way.

Apart from the attacks of recurrent vomiting they do not appear to be more liable than the average child to the other illnesses of childhood. (see Table I). The time which they do lose at school on account of recurrent vomiting is quickly made up and they are usually well forward in their age group. The local schoolmaster, who kindly checked the school records and supplied most of the above notes, said "They are bright and intelligent and give their /

"their teachers little trouble".

THE CHILD AT PLAY

In accordance with their nature they do not take part in the more boisterous games. Consequently I have never been called to treat any of them for accidents. This is especially noticeable during the holidays, when accidents in a country mining village are an everyday occurrence. They do not show the excesses and boisterous spirits of other children. Their shy and rather timid natures are very evident, but once their confidence is gained they are very friendly and will talk to one on the road when the other children are far too busy with their own amusements.

PUBERTY

As the child grows older and approaches puberty the incidence of attacks lessens and by puberty they have entirely ceased to occur.

Their shy and reserved natures are still evident and the parents state that they remain very nervous. The mother of Case I has told me recently that after any undue excitement e.g. a Youth Club Party or a tiring day at work her daughter suffers from nocturnal enuresis.

Their general build by this time appears normal.

In Case I and 15 menstruation commenced at fifteen /

fifteen years two months and fifteen years and four months. Neither case appears to suffer from any menstrual disorders and in no case have I observed evidence of acne; in fact these cases generally are free from skin lesions.

Up till now no case has been operated on for appendicitis, a finding common in the histories of their parents.

ADULTS

The increased nervous excitability of cases with a known history of recurrent vomiting in childhood remains markedly evident in their adult life. The majority have had artificial teeth since their early 'teens. This fact associated with their late teething is a very interesting observation. The grandfather of one of the families in the series stated that "We get our teeth late and lose them early". Histories given by parents of their children who are now adults are often very informative, some of these histories going back thirty-five years.

(see history of W.D. Appendix)

THE ATTACK

Prevomiting Signs and Symptoms

The Onset: Time of occurrence and types of Vomiting.

The Vomitus

The Relationship between Acetonuria and Vomiting

Factors influencing the onset of Attack.

Treatment

THE ATTACK

PREVOMITING SIGNS AND SYMPTOMS

In all cases various signs and symptoms have been noted before vomiting takes place, and these include - late teething, heat spots, anorexia, occasionally voracious appetite, loss of colour, constipation and occasionally diarrhoea, over-excitability, tiredness, indefinite abdominal pains, "hanging" and fretfulness, and catarrhal affection of the upper respiratory tract. Other cases may show a constant premonitory sign, e.g. incessant pressing or rubbing of the buttocks as in cases 6 and 7. These features, together with a history of similar attacks in other members of the family, or in the parents, almost always point to the possibility of the occurrence of recurrent vomiting.

THE ONSET: TIME OF OCCURRENCE AND TYPE OF VOMITING.

Immediately after the ingestion of food the child may complain of nausea, exhibit dry retching, or may actually return the contents of the stomach. If the condition has been one of respiratory catarrh, vomiting or retching may become manifest at the end of a spasm of coughing. The vomiting then becomes insistent and overshadows the whole clinical picture. The interval between ingestion of food and its rejection /

rejection by the stomach rapidly shortens from about one hour until the mere taste of food, or even water, precipitates emesis. Later, vomiting takes place when neither food or drink has been tasted and may be precipitated in infants by the act of lifting or moving them, and in older children by the act of sitting up hurriedly in bed. In the majority of cases, however, no external precipitating cause is evident. The interval between attacks which have no relation to food shows a considerable variation in time, from ten to fifteen minutes to two to three hours or longer. It is important to note that vomiting is more frequent by day, and that treatment of the child in a darkened room free from noise and excitement may be effective in reducing the frequency of attacks.

Vomiting as the most evident is the pre-eminent sign which gives its name to the condition. There is no regularity in the interval between attacks, which may very from four to five weeks to a period of years. The vomiting is always forced and involuntary, older children describing it as "first a sick feeling, then a feeling that one wants to be sick, and finally a feeling that one has got to be sick". With the onset of nausea, they look around for a suitable vessel and indicate with their hands that /

that they are about to be sick, and in many cases there is no time to ask for a receptacle. In some cases they may give a short cry, keep their mouth open, fix the chest and hold this position for several seconds before retching begins, then after a varying interval, according to whether food has been taken recently or not, actual vomiting takes place.

THE VOMITUS

In the early stages the vomited material consists of ingested food, which is altered according to the length of time during which it has been retained in the stomach. Milk is always returned in a curdled state. At a later stage, food is returned unaltered, even before it has reached the stomach, and a little bile is often brought up at the end of the attack. When the act is spontaneous and unrelated to food, the vomitus consists of mucus, bile-stained watery mucus or pure bile.

The vomitus at the beginning may be pure blood (see Case 16) and may be quite alarming, both in amount and suddenness of its appearance.

Two examples are presented as representative of the condition - one which occurs in infancy and the second in early childhood. (see Cases 8 and 17).

THE RELATIONSHIP BETWEEN ACETONURIA AND VOMITING.

The close association between vomiting, due to a known cause, and the appearance of acetone bodies in the urine is already well known. In the majority of cases, acidosis is an effect of prolonged vomiting. Usually, acetone bodies are present in the late stages, and are the result of dehydration with consequent disturbance of the acid-base equilibrium. This explanation is well founded on clinical observation and physiological principles. Although the immediate mechanism may vary in each case, or group of cases, it is an incontrovertible fact in cases other than recurrent vomiting, that whatever the mode of production, acetonuria is secondary to vomiting.

In the present series of cases, it has been shown that vomiting and acetonuria are closely associated. On further examination, however, it has been found that acetonuria is invariably present before actual vomiting occurs. This finding has been common to all cases observed. It may be stated further that the amount of acetone present in the urine is an index of the probability of the occurrence of vomiting. That is, vomiting will not occur, or has not been observed, when a single plus of acetone has been detected, but will occur when this /

this concentration rises to triple plus. This relationship in three cases is illustrated in Table 2. On no occasion has vomiting been observed without a high concentration of acetone being first present in the urine. Acetone may be present in small concentration without vomiting, the amount usually rising with the natural progress of the condition until vomiting occurs. This relationship is a very interesting one, and has been confirmed to occur in the order quoted above. The table below shows the above relationship between the intensity of acetonuria and the incidence of vomiting in a total of one hundred and fourteen observations on twenty-four cases. Cases 5, 7, 9 and 10 will be quoted in full to demonstrate this relationship between acetonuria and vomiting.

Relationship between Acetonuria and Vomiting.

Degree of Acetonuria	No. of Observations	Incidence of Vomiting
Triple positive	59	59
Double positive	36	2
Positive	19	nil

FACTORS INFLUENCING THE ONSET OF ATTACKS

In many cases no obvious precipitating cause is apparent. However it has been observed in others that, /

that, apart from the typical diathesis, a determining factor is present, namely, some circumstance of mental stress or excitement. This is usually clearly evident in the older children. (see Cases 18,22,23).

These emotional stimuli include circumstances associated with a children's party, first attendance at school, resumption of school after a long holiday or school examinations. The actual incident may not in itself precipitate the attack but the anticipation of the event is a definite and essential precipitating cause.

Apart from emotional stress or anticipation peripheral irritation plays a part in the immediate causation, e.g. round worms, injury to finger, mild infection such as tonsillitis and otitis media.

In infants it is uncommon to find the condition occurring while the child is being breast-fed. However, on substitution of cow's milk the condition may immediately become apparent.

In this series attacks have not been commonly associated with"teething". Other intercurrent illnesses which may affect the child e.g. diphtheria do not appear to be associated with acetonuria and vomiting.

TREATMENT /

TREATMENT

The principal lines on which treatment was instituted in these cases are:-

(1) Rest - physical and mental.

(2) Diminution of the fat and protein in the diet and addition of carbohydrate in the form of glucose or sucrose.

(3) The administration of weak alkalis in the form of sodium bicarbonate or (sodium citrate).

Since the disease is invariably associated with over-excitability, and since this mental state is closely related to the cause of the disease, it becomes desirable, if not imperative, to allay fear and worry, and to exclude all possible occasions of excitement, even to the extent of nursing the child in a completely darkened and noise-free room. The nature of the condition should be explained to the parents so that even when the state of the child appears immediately alarming, they will be aware of the recuperative powers which are still present. The education of parents along these lines is of considerable immediate advantage, and may diminish the severity of attacks and possibility of recurrence. They should also be informed of the curative effect of small doses of sodium bicarbonate so that they may be induced to administer these when signs of impending attacks are observed.

During /

During the attack, when persistent vomiting is present, glucose in water, together with sodium bicarbonate, the whole being flavoured with orange juice, should be given in teasponnful doses as often as possible, and in as much amount as the child will retain. The larger the amount of sodium bicarbonate the better are the prospects of immediate cessation of vomiting, and increased tolerance. Fluid should then be given, in increasing amount, to replace the loss which has occurred. Large doses of glucose are well tolerated in most cases. Babies, specially, tolerate large doses of sodium bicarbonate. When vomiting has been controlled, equal parts of skimmed milk and water, to which sugar has been added can be given. In intervals between feeds, sodium bicarbonate drinks should also be administered, the latter being given over a total period of three weeks, or until the urine is acetone free. If the foregoing has been retained, and the urinary acetone is diminishing, the following are added to the diet - porridge, or shredded wheat, bread or biscuits, potatoes, jelly, syrup, treacle or honey. An increased amount of skimmed milk should also be given, and if this is well tolerated, the child should be returned to ordinary diet, avoiding of course, so far as is practicable, an excessive amount of fat. The supply /

supply of vitamins A and D should be added in the form of a concentrated preparation e.g. Adexolin.

The above scheme of treatment is satisfactory in all cases, and the essential points are - the intake of a sufficient amount of fluid, together with alkali in the form of sodium bicarbonate. In the treatment of accessory symptoms, Milk of Magnesia is the safest and most satisfactory aperient, which is often surprisingly well retained, even in the vomiting phase. Diarrhoea, which is sometimes present, responds well to reduction of the amount of glucose and an increase in the sodium bicarbonate. Some children show a catarrhal bronchitis which may often be disregarded until vomiting is controlled - they then respond quickly to a mixture of Tinct. Opii Camphorata (B.P.) and Syrup of Squills, and the application, if necessary, of a light Kaolin poultice on the back.

The incidence of dental decay urges the necessity for immediate attention to the teeth. If these cannot be saved by stopping, and when extraction is necessary, it is advisable for the doctor in attendance to perform this operation himself, since he, having gained the confidence of the child, will cause less general disturbance than the dentist with whom the child is probably less familier.

As /

As a rule, sedatives are not necessary, it being often sufficient for the parent to inspire confidence of recovery, and to avoid circumstances of excitement, either in their own behaviour, or in that of the child.

FAMILY HISTORIES

While the possible influence of immediate exciting factors in the causation of this condition has been mentioned before, it must not be forgotten that these operate on a suitable soil. Since the mental and physical types susceptible to this condition have already been discussed, it seems opportune at this stage to draw attention to the hereditary tendency which has been observed in one family i.e. definite and similar physical and mental characteristics have been inherited and almost every child has shown at some stage in his life attacks typical of the condition.

The history of the "D" family through four generations is given in tabular form (see Table 3).

In this table individuals noted to suffer from delayed dentition and from early loss of teeth, liability to heat spots and in one instance congenital pyloric stenosis are indicated. The close and frequent association of these disorders with recurrent vomiting in the same individuals or siblings will be apparent. This association will, however, not be further discussed in the present Thesis as it is not material to the main line of argument.

Cases /

Cases of recurrent vomiting have been recorded in more than one member of three other families; five individuals in three generations were affected in the family whose tree is figured in Table 4, (family of Cases 10-13).

DIFFERENTIAL DIAGNOSIS

While an absolute assessment of the clinical condition can always be made following examination of the urine, in which acetone is present in high concentration, and by noting the response to treatment, difficulty may arise in the exclusion of such states as acute gastritis, appendicitis, intussusception, tuberculous meningitis, congenital pyloric stenosis and occasionally pneumonia. In most cases a careful examination of the child and an accurate history will determine the true condition. In infancy, acute persistent vomiting may be the first sign of an early tuberculous meningitis in a child whose face generally appears to indicate apathy and mental dulness. These signs are in sharp contr-distinction to the mentally clear and alert appear-ance of the recurrent vomiting child, although he may be quiet from exhaustion and who may exhibit a marked degree of thirst which is not seen usually in the meningitic case. Further, a sudden onset of vomiting in a previously healthy child is quite different from the slowly progressive and at first occasional vomiting of the cerebral type. In the latter, acetone may make its appearance in the urine, but this will only be so after persistence of vomiting for some time, in contrast to the converse state of affairs /

affairs which exists in the true case of recurrent vomiting. No response to alkaline therapy will be seen in meningitis.

In those conditions arising from an intra-abdominal cause, there are invariably some physical signs present on examination of the abdomen, such as rigidity in the right iliac fossa, or a palpable tumour in the same region. These are not present usually in the case of recurrent vomiting unless, of course, the possibility of appendicitis has been discussed within hearing of the child who has attained the use of reason. In such a case, rigidity may be present in some part of the abdomen, but is usually a subjective sign which will be present without a true history indicative of appendix lesion, and without any pyrexial disturbance. In acute gastritis, there is usually high temperature and a furred tongue, associated with pain and tenderness in the epigastrium; none of these findings are present in recurrent vomiting.

Pyloric stenosis always manifests itself at a much earlier age, usually by two weeks.

Finally, it is suggested that, in the case of a child over the age of one year, cyclic or recurrent vomiting should not be diagnosed unless there is a definite history of delayed teething.

EXTRACTS FROM CASE-HISTORIES AS ILLUSTRATIONS

Case 8	Typical Case - Infancy
Case 17	Typical Case - Childhood
Case 5, Case 7, Case 9, Case 10	To illustrate relationship between Acetonuria and Vomiting.
Case 18, Case 22, Case 23	To illustrate the occurrence and significance of Emotional Stimuli
Case 28	To illustrate effect of Sodium Citrate in Diet.

TYPICAL HISTORY - INFANCY.

CASE 8. NAME R.S. DATE OF BIRTH 7.10.36 AGE 49 DAYS

Previous History

This baby has been artificially fed since birth, and has shown apparently normal health.

History of Present Illness

During the past ten days this child has been troubled with nausea, and occasional sickness after food. At the present time, he is now showing constant and violent sickness, which occurs without relation to food. Heat spots have been noticed all over his body.

On feeding with milk, there is an immediate vomiting reaction; between each feed he brings up mucus which is occasionally bile-stained towards the end of the act.

Medical Examination

The child is covered with scattered heat spots which show evidence of recession. There is definite evidence of loss of weight, and the child appears very drowsy. He breathes quietly, and shows no respiratory distress.

The temperature is normal; the pulse rate is within normal limits. The tongue is slightly coated with greyish fur, and shows no evidence of ulceration. The chest and abdomen show no abnormality /

abnormality on inspection, palpation, percussion and auscultation.

Small feeds were advised, with dilution of the feed by water (milk one part, water two parts).

During the next two days, the child's condition deteriorated with increasing sickness, restlessness and constipation. No fever was detected, and no apparent abnormality could be found. The pulse rate increased in rapidity, and dehydration became very evident until the child lapsed into a state of listlessness, and showed sighing respirations and hollowing of the abdomen. Pallor became very marked and at noon on 27:11:36 a strong smell of acetone was detected.

At this stage, the child was given sips of boiled water and sugar half hourly, and was kept warm by hot bottles between blankets. Some of this feed was retained, and at 7 p.m. on the same day the temperature rose to 100 degrees, and the respirations increased; the pulse became very rapid, and the child appeared dangerously ill. Acetone was still present in the breath.

Alkaline therapy was instituted at this stage. (For details see page).

On the following day 28:11:36, it was reported that the child had slept part of the night, and showed very /

very little sickness. Most of the feeds were retained, and the bowels had moved. On examination, the temperature had fallen to 99 degrees, respirations were normal, and acetone was still present in the breath (a sample of urine was not obtained before this time). The child appeared better, and was asleep at the time of the visit.

Two to three ounces of sugar and water were then given three to four hourly, together with sodium bicarbonate and water (one teaspoonful of sodium bicarbonate to the pint of water, flavoured with orange juice) night and morning. Milk of Magnesia was advised as an aperient.

Further progress was one of uninterrupted recovery, with return of temperature to normal, and a disappearance of acetone from the breath. Feeds with an increasing content of milk were given, while the alkaline therapy was continued.

On 30.11.36 the child appeared quite normal, was sleeping well, and caused no complaint from the mother. By this time, he had gained weight, and showed a normal temperature and pulse. On the following day, the normal feed of skimmed milk and water with extra sugar and sodium bicarbonate at night was advised. Milk of Magnesia to be given when required. After the 5.12.36 one drop of Halibut /

Halibut Liver Oil was given night and morning. The sodium bicarbonate was discontinued after the 9:12:36 and the child subsequently appeared healthy.

Notes

On 29:11:36 information was offered by the Mother that the milk from a special T.T. cow had been kept for this child. This milk was exceptionally rich, more than half showing a head of cream. She also stated that when the cream had been taken off, this milk was superior in quality to that of ordinary unskimmed cow's milk. The mother was advised to remove the cream and dilute this milk before feeding the child.

Social Conditions

The parents of this child are well-to-do farmers, who married late in life - this is their first child. The father is very nervous, inclined to be neurotic and is a member of a large family. No family history of similar attacks have been obtained on the father's side. The mother has always been healthy, is not a member of a large family and appears to be a quiet sensible person.

Second Attack

On 5.4.37 at age of six months a history of heat spots and increasing restlessness, with nausea and pallor during the previous five days was obtained.

The /

The mother stated that he had been "hanging" and "sleepy", that he had vomited very soon after his feeds, that he was constipated and showed some loss of weight. Up till this time, no complaints about his condition were made.

On examination, he looked pale and listless with evidence of heat spots which were clearing. The tongue was furred, no teeth were seen, the pulse and temperature were within normal limits, breathing appeared normal, but a faint smell of acetone was noticed in the breath. No abdominal tenderness or other abnormality was noticed. He passes urine frequently, a sample of which was examined - acetone triple positive was found - no other abnormal constituents were detected.

The child was fed on skimmed milk and water (one to two parts, with extra sugar) and alternate sodium bicarbonate orange drinks. One dose of Milk of Magnesia was given.

On the following day, no further sickness was observed, the bowels had moved and the child seemed fairly comfortable, apart from some thirst. The heat spots were now hardly visible. The amount of acetone in the urine gradually diminished until on 17.4.37 none was detected. The child continued to thrive, and made a complete recovery by 23.4.37.

Commentary /

Commentary on Case 8.

The preceding history appears to be a simple disturbance of digestion in a child a little more than a month old. The associated vomiting, and consequent lack of food portends the development of very rapid deterioration in a baby of this age. It should be noted that no physical abnormality was apparent to account for the development of this condition. Perhaps the only cause which should be considered is congenital pyloric stenosis, but this is usually met with earlier in life, and shows usually, physical signs of peristalsis in the upper abdomen, tumour and projectile vomiting. A previous history of difficulty with feeding is almost constant. Further, in the above case, the presence of acetone is a notable feature at a very early stage in the illness. Although it could be argued that the latter is secondary to the occurrence of vomiting, it is suggested that because of the close relationship in time between the occurrence of vomiting and the presence of a marked content of acetone, that the question, propter or post hoc, should be left an open one.

It is my opinion that the incidence of acetonuria and the relatively rapid response to alkaline therapy, definitely excluded the possibility that this condition /

condition has been the result of a mechanical obstruction in the region of the pylorus.

TYPICAL HISTORY - CHILDHOOD

CASE 17. NAME T.L. DATE OF BIRTH 28:1:42

Complaints

Attacks of sickness.

Previous History

This child was breast fed for one year. First tooth appeared at ten months, he walked at fourteen months, and has always been healthy.

History of the Present Illness

27:11:43. During the past week or so he has shown loss of appetite, listlessness, constipation and intermittent irritability and has exhibited attacks of sickness, intermittently. At the present time, the intervals between attacks are very short and the constant vomiting has been followed by marked loss of weight. He is very thirsty, but cannot keep drinks of water down.

Physical Examination

(Age one year ten months). The patient is a small, thin, nervous child, who is pale and fretful. He breathes normally and shows no evidence of heat spots. The tongue is furred and shows no evidence of ulceration; his throat appears normal. No abnormality is demonstrated in the chest or abdomen on physical examination. The heart sounds are normal; /

normal; the pulse rate is fast, and the temperature is normal. The pupils are dilated.

During the examination he vomited watery bile-stained mucus immediately after he had taken a little water to drink. (In view of the history of similar attacks in the patient's brother, the condition was diagnosed as cyclic vomiting). A dose of Milk of Magnesia, followed by sips of water and sugar was advised.

On the following day, a specimen of urine was examined, and showed acetone triple positive. No other abnormality was detected on physical examination but, however, he was still showing violent attacks of sickness, and cried out for water, which was brought up immediately after being taken; no bowel movement was recorded. Later in the day he lay very quietly in bed and looked very ill. At this time his temperature was 99.2 degrees and the pulse had increased in rapidity. The mother was advised not to disturb the child, and to feed sips of water and sugar, alternated by sodium bicarbonate water, without lifting.

Definite improvement was observed on the following day. It was reported that he had slept during most of the night and that he had taken three to four ounces of sodium bicarbonate water since the last /

last attack of vomiting. The acetone content of the urine had diminished to double positive on the third day. Thereafter, he showed steady improvement, fretfulness persisting rather longer than any of the other signs. His diet was increased, containing extra sugar; the sodium bicarbonate was continued. The urinary acetone was reduced to a trace nine days after the first visit.

Six days later he had two attacks of vomiting, for which no apparent reason could be found. These accompanied by restlessness, fretfulness and constipation. No physical abnormality was found on general examination. The urine, however, on the morning after this fresh attack, showed a double positive content of acetone. This was present despite the fact that sodium bicarbonate was still being administered, and the diet contained a minimum of fat and extra carbohydrate. The usual signs accompanied this fresh disturbance, especially very marked thirst. He vomited once, two days later, and intermittently, not more than once per day for the next three days. Restlessness, thirst and irritability remained prominent features of his condition. Acetonuria disappeared three weeks after the beginning of the second attack. About this time, his mother called at the surgery and reported that the patient had passed /

passed an "Airth Worm about ten inches long (see footnote). Since this event the child has been very much better and "more like himself".

Three months later, another attack was reported, this being preceded by general malaise, nausea and constipation. The interval between vomiting gradually shortened until he was unable to keep down even water. On examination, the child was pale and he lay quietly in bed. No evidence of heat spots was noted. The tongue was furred, and the tonsils showed evidence of slight inflammation. Respirations were normal, the pulse was fast and the temperature was 99.6 degrees. No abnormality was detected in the chest or abdomen.

A triple positive content of acetone was found in the urine. On treatment with sips of sugar and water, sodium bicarbonate water and a dose of Milk of Magnesia, he showed signs of improvement. No further sickness was recorded, temperature and pulse returned to normal, the redness in the throat subsided, and the content of acetone in the urine disappeared in a matter of three days. He was returned to his ordinary diet, with the injunction that a little sodium /

Airth is the name of a neighbouring village and is the term used locally to describe a round worm, probably from the frequency of infestation in that district.

sodium bicarbonate should be given in orange juice every second or third day.

Commentary on Case 17.

The outstanding features of the above case are restlessness, irritability, which preceded nausea, and subsequent vomiting in a child who shows late teething. No physical basis could be found for the presence of an organic or general infectious disturbance. The incidence of acetonuria in a very marked degree is a prominent sign, which has been noted early in the illness. It is not without significance that the brother of this patient, at about the age of two years, showed similar attacks of vomiting, which subsided without any definite line of treatment; his mother states that the eruption of teeth was delayed also in his case.

One important point, which cannot be overlooked in the assessing of this case, is the report of the mother that a round worm had been passed. This is readily coupled with the signs of tonsillar inflammation which accompanied his second attack. It appears easy, therefore, to postulate an immediate cause for this condition of ketosis, which showed ready response to alkaline therapy. It is possible that the round worm has acted as an irritative stimulus with definite effect on the digestive apparatus of the patient.

Similarly /

Similarly, it is possible that the inflammation in the tonsils may have preceded the general digestive disturbance of the second attack, especially as the gastric signs showed prominence. It is worth noting that the patient is very nervous and jumpy, and that these characteristics seemed to be common to the rest of the family.

The immediate response to alkaline treatment shown in the general improvement and the comfort of the child before any demonstrable diminution in the acetone content of the urine, appears as a definite feature. With prolonged treatment, acetonuria subsides gradually. It does not disappear till some time after vomiting has ceased.

Later, restlessness disappears, although a recurrence of this sign, as a precursor of a second attack, appears to be an inherent consequence of the nervous and excitable character.

Subsequent attacks, however, are essentially and often in detail, similar to the first, and show no less ready response to treatment.

The possibility, therefore, still remains in an excitable child, that a source of peripheral irritation may precipitate an illness of this kind.

TO ILLUSTRATE RELATIONSHIP BETWEEN ACETONURIA AND VOMITING
CASES 5,7,9 and 10.

CASE 5. NAME E.D. AGE 1 YEAR

Previous History

Artificially fed. Teething at ten months. Walking at fourteen months. Since the age of six months this child has shown intermittent attacks of heat spots, which have not been associated with the general disturbance.

History of Present Illness

During the previous three to four days the child has gone off its food, lost colour and has been "hanging". He has been very irritable and has shown numerous heat spots, and during this time occasional slight attacks of sickness have been observed. At the present moment vomiting has become more constant, and more violent at times, even during the night. On examination,the child looks pale, is restless and shows evidence of loss of weight. Heat spots are present and the breath smells strongly of acetone. The temperature and pulse are normal. A specimen of urine showed a triple positive content of acetone.

Sips of sugar and water with alternate drinks of sodium bicarbonate water were advised. On the following day, it was reported that the attacks of vomiting were less frequent and less severe.

Temperature /

Temperature and pulse still remained normal, and the child appeared more comfortable. Thereafter, no sickness occurred, even on an increased diet. The urinary content of acetone diminished on the second day to double positive.

Six days after the first visit, the child began to refuse food, became again very irritable, and showed slight diarrhoea. The urine acetone rose to triple positive. On the following day nothing could be retained, vomitus was then slightly bile-stained and showed a quantity of mucus; it was noted by the mother that these bouts of sickness only occurred when any fluid was offered the child. Thirst was very marked, and the acetone content remained at triple positive. Only sugar and water were given in small quantities, alternately with sodium bicarbonate drinks. On the following day there was a considerable improvement, more fluid being retained for periods up to twenty minutes. The vomitus showed no evidence of bile staining, the diarrhoea stopped, and apart from thirst, the child seemed comfortable. The diet was then increased by adding skimmed milk and extra sugar, but alkalis were still given. Similar repeated attacks of sickness occurred during the following two months, always with an intervening period of apparent normality. The urine usually became free of acetone after /

after about ten days from the beginning of the attack.

After about two months the child improved generally, the appetite became healthy and weight was rapidly regained. Until the time of writing, the patient has shown several signs of impending attacks as have been described; signs such as anorexia irritability, and sometimes mild diarrhoea with heat spots, these usually being accompanied by pallor. When the mother notices these signs she puts the child to bed, stops all fatty foods, and incorporates skimmed milk instead of full milk, with extra sugar in the feed, and gives sodium bicarbonate drinks night and morning. It should be mentioned, however, that acetone is present in the urine at these times to the extent of double positive. Vomiting does not occur.

On treatment, the general condition improves showing apparently that the treatment adopted has a beneficial effect, and obviates the more severe degrees of this condition which were observed in the first attack.

CASE 7 /

CASE 7. NAME C.N. AGE 1½ YEARS

Previous History

The patient was naturally fed for three to four months and thereafter was brought up on artificial food. Teething occurred at one year old and the child walked at eleven and a half months.

History of Present Illness

The mother states that she has been losing weight and has gone very pale in the past few days. She is very listless and she has gone off her food. Occasionally after meals there has been some vomiting, but no diarrhoea. When vomiting did occur, it was usually observed about five minutes after the taking of food. In the interval between vomiting attacks she seemed quite comfortable, but showed no desire for food. On examination, the patient is found to be a thin, small, very nervous child. Some heat spots are present, showing signs of regression. No evidence of vaginal or rectal irritation was found, but the urine contained acetone double positive. Sugar and albumin were not found.

All fats were removed from the diet and the patient was fed on skimmed milk and extra sugar. Thereafter, no more sickness was observed and the patient rapidly regained weight. The urine became free of acetone within seven days.

When /

When seen at the age of three years and three months the patient had had attacks of vomiting during the previous two days. The mother stated at this time that she had had several mild attacks since the last visit, each accompanied by heat spots, anorexia, pallor and irritability. When the child was put to bed, and deprived of all fats from the diet, she became well again within three or four days. No actual vomiting was noted.

The history of the present attack at this time was similar in all respects to that described at the age of one and a half years. In addition, numerous ulcers were noticed on the tongue - pulse and temperature were normal and a triple positive content of acetone was present in the urine. There were no other physical abnormalities observed. The vomiting persisted during the next day and the child became irritable and thirsty. On appropriate treatment with sugar and water and sodium bicarbonate water in small amounts frequently, the general condition improved, sickness disappeared very quickly and the urinary acetone diminished. Within four days, the child showed a very good appetite and only a trace of acetone. The diet was increased, she was allowed up and she continued thereafter to put on weight. The urine was clear of acetone at the end of three weeks.

At the age of four and a half years, another attack was observed, which was entirely similar to those occuring previously. There was one difference, however, namely the presence of a painful adenitis in the neck - no other physical abnormality was detected. On appropriate treatment, she improved, and the urine became free of acetone after one month. (It should be mentioned that sickness was observed only when the acetone content was triple positive).

The adenitis was treated by the application locally of Kaolin poultices. Adexolin was also given. The glands, however, rapidly improved after vomiting had ceased. The father stated that he was worried about the frequent incidence of these attacks. Consequently, I suggested that another opinion should be sought. The late Dr McLennan was consulted, and the diagnosis of cyclic vomiting in this case was confirmed by him. Parents were given advice along the same lines as have been mentioned above.

Other Illness

About the age of four and a half years, this child developed whooping cough, during which acetone was present in the urine in concentration varying from a trace to double positive. At six years of age she developed diphtheria and was removed to hospital. No acetone was found in the urine.

At /

At the age of seven years ten months, another attack was observed, which was associated with heat spots, pallor irritability and anorexia. One additional feature was present, namely, complaint of indefinite pains in the abdomen, round the region of the umbilicus, and constipation.

CASE 9. NAME M.S. AGE 3½ YEARS

Previous History

The child was breast fed and showed teeth at nine to ten months, walked at fourteen months. She is said to have suffered from heat spots since the age of ten months. Apart from slight attacks of bronchial catarrh, sometimes associated with vomiting, this child has enjoyed fairly good health.

History of Present Illness

The mother complains that the child is off her food, is pale and appears very tired and irritable. Cough is troublesome at night. She has been slightly constipated during the past two years.

On examination, the child appears nervous and thin, and flushes readily. The tongue is furred, the pulse rate fast and the temperature reading 99. No definite abnormality was detected in respiratory system or elsewhere. Milk of Magnesia was advised and a sedative cough mixture was prescribed. Ten days later following steady improvement, the child appeared /

appeared well, active and showed a normal appetite.

Four months later, history of similar symptoms was obtained, with the additional information that the child felt pained after the intake of solid food. Cough was present, and at first vomiting was noted during the night following a spasm of coughing. Later, vomiting became more frequent, occurring every half hour, sometimes related to food and at other times apparently spontaneous. The child states that she knows when an attack of vomiting is impending, and becomes very excited with this knowledge.

Physical Examination

The child is very thin, pale and behaves in a very nervous fashion. The breath smells strongly of acetone, the tongue is furred, temperature normal, pulse rate is within normal limits, except immediately following an attack of vomiting. No abnormality is detected in the chest or abdomen, the urine on examination contains triple positive concentration of acetone, a trace of albumin; no sugar is found. Sips of sugar and water alternating with sodium bicarbonate drinks were advised.

On the following day, the vomiting had ceased during the night and the patient complained of thirst and hunger. The cough had improved considerably and pulse and temperature remained normal.

On /

On the third day, the child had markedly improved and appeared in all respects normal, apart from the fact that a double plus concentration of acetone was noted. She was returned gradually to normal diet with extra carbohydrate and sodium bicarbonate drinks night and morning. She made an uninterrupted recovery and the urine became clear of acetone at the end of two months.

About four months later, heat spots were very prominent, together with malaise, anorexia, pallor and a feeling of nausea when offered food. No actual sickness was recorded. On two or three occasions she fainted on becoming excited and complained of faintness when she sat up in bed. No physical abnormality was made out on examination, but a double positive concentration of acetone was found in the urine. Cough became very troublesome during the next few days, especially at night time. Four days after the beginning of this attack, actual vomiting occurred after spasms of coughing. She was then given sugar and water and sodium bicarbonate drinks, and from that time showed gradual improvement until on the tenth day the cough had almost disappeared. The appetite had returned to normal and she slept well at night. The diet was gradually increased.

Fourteen days after the onset, the urine contained double /

double positive concentration of acetone. Two days after this, the cough returned, together with restlessness and vomiting during the night. The child also complained of a sore throat. On examination, she lay quietly in bed, the throat showed slight redness and several tender glands were palpable on both sides of the neck. The pulse was rapid and the temperature reading was 103 degrees. Examination of the throat causes sickness and bile-stained mucus was brought up. No abdominal tenderness was detected. She seemed exhausted and showed considerable flushing of the face during examination. Fifteen minutes later, however, she looked pale, lay very quietly in bed and the pulse rate slowed down considerably. A triple positive concentration of acetone was found in the urine. Sugar and water and sodium bicarbonate drinks were advised.

The child's condition deteriorated during the next two days until she looked very ill, with sunken eyes, a very pale face and rapid breathing. The temperature remained normal, but the pulse rate increased. The cough remained troublesome, and although she retained fluids slightly better than before, there remained a strong smell of acetone in the bicarbonate. Sickness was then controlled and with the retention of fluids the general condition improved /

improved. The cough persisted for about another week and the glands in the neck remained slightly enlarged and tender.

Five days after the onset of this attack, the amount of acetone in the urine diminished to double positive. The child maintained a steady improvement, the cough disappearing, while the glands in the neck receded. Two months after the return to normal diet, the urine became clear of acetone.

At seven and a half years of age, an attack similar to those previously recorded was experienced, together with the reappearance of enlarged and painful glands in the neck. Acetone reappeared in the urine, and was present for a period of four weeks. The mother states that one week before this attack the child had been eating chips and she believed that this initiated the illness.

A similar attack was recorded at the age of nine years.

CASE 10 /

CASE 10. NAME G.B. DATE OF BIRTH 27:7:30
AGE 3 YEARS AND 4 MONTHS

Previous History

This child was breast fed for three months;- teeth erupted at thirteen months, he walked at the thirteenth month. During the past two years this child has shown repeated attacks of vomiting, which in the first instance lasted two to three days, more recently the duration of the attack has lengthened to four days. His condition then was diagnosed as a digestive upset associated with teething. The mother states that signs of an impending attack of vomiting are pallor, irritability and general nervous behaviour, followed by anorexia, nausea and finally vomiting. This is associated in the beginning with his feeds, but later small amounts of fluid such as water precipitate vomiting until it occurs without relation to food. In the intervals between actual sickness the child complains of desperate thirst, which he is unable to relieve lest even a small sip of water provokes vomiting again. Early in the attack he becomes constipated, but occasionally has shown mild diarrhoea.

History of Present Illness

During the preceding two to three days this child has gone off his food and has appeared pale, showing /

showing at the same time irritability and restlessness. He now exhibits actual vomiting, which began in the first place after food. This now occurs without relation to food.

Physical Examination

The patient is a small, pale, very nervous child, who shows considerable emaciation. The eyes are bright, and he shows a striking doll-like appearance. The temperature and pulse are normal, the tongue is furred. No ulceration is seen in the mouth, throat or tongue. No heat spots are present. No abnormality in the circulatory or respiratory or gastrointestinal system has been detected on physical examination.

During this, however, it was noticed that abdominal palpation precipitated an attack of vomiting, the vomitus consisting of a small amount of bile-stained watery mucus. The act was preceded by restlessness, flushing of the face, retching and an increased pulse rate. After the act, these signs rapidly disappeared and he settled down quietly in bed, appearing much more comfortable.

Small feeds of sugar and water, alternating with sodium bicarbonate drinks were advised, together with Milk of Magnesia, when necessary. On the following day, the urine contained a triple positive concentration /

concentration of acetone. No other abnormality was found. The mother reported that he had improved and had managed to retain several fluid feeds when these were given slowly. Improvement continued, and two days later the acetone concentration in the urine had diminished to double positive, finally disappearing ten days later. Recovery was uneventful, the mother was advised to look out for premonitory signs and endeavour to prevent over-exertion. Sodium bicarbonate drinks were discontinued and the patient was given a mixture containing Ferri et Ammon. Citrat. grs. iii t.i.d.

Three weeks after the beginning of the attack just reported, the child became irritable and showed pallor, loss of appetite and constipation. No heat spots were present and no sickness was reported. No abnormality was detected on physical examination; the urine contained a double positive concentration of acetone. Treatment with equal parts of skimmed milk and water, together with extra sugar and sodium bicarbonate drinks was instituted. Two days later the urinary acetone had diminished, the general condition had improved and the patient was definitely hungry. The urine became clear of acetone in about ten days and the child appeared healthy, having lost his pallor and irritability.

After /

After a further six months the patient accidentally jammed his finger in a door. He was put to bed and given a dose of castor oil. On the following day he went off his food and during the night vomiting began, increasing in frequency until he could retain neither food nor fluid. Apart from swelling and slight discoloration of the left index finger, consistent with injury of the soft tissues, and dilatation of the pupils, some increase in the pulse rate and slight furring of the tongue, no physical abnormality was found. The urine contained a triple positive concentration of acetone. On the usual treatment, immediate improvement occurred, although for many days he remained very apprehensive of examination and of dressing the finger, which caused no disability four to five days after the incident. After a period of fourteen days the urine became clear of acetone and the child had returned to normal health.

After the age of four years, recurrence of the prevomiting signs, together with acetonuria in double positive concentration was noted on seven occasions, following over-excitement or fatigue. The signs in each case were as described above, and his condition improved immediately when he was kept in bed and given a non-fatty diet, with extra sugar and sodium bicarbonate /

bicarbonate drinks. The acetonuria usually disappeared in about seven days.

Social Conditions and Family History

The patient comes from a good class miner's household where the children are well cared for. A brother of the patient suffers from the same condition. The father of the patient is a member of a large family - he shows scars on the neck indicative of healed tuberculous sinuses. No history of vomiting attacks in his family has been obtained. Patient's mother, however, is a member of a large family, who states that she suffered from vomiting attacks when young. All her teeth have been removed, consequently she has worn artificial dentures since early adult life. Two nieces suffered from cyclic vomiting.

(See family history of Cases 10-13).

TO ILLUSTRATE THE OCCURRENCE AND SIGNIFICANCE OF EMOTIONAL STIMULI
CASES 18,22 and 23

CASE 18. NAME M.F.

Previous History

This child has been artifically fed since birth. At the age of five months two teeth erupted, but no more were seen until ten months. She walked at one year.

Since an early age, the mother states that following any form of excitement this child was certain to have two to three days vomiting. Such an attack showed the following premonitory signs - pallor, anorexia, fatigue and irritability. The vomiting then occurs in relation to food, and later becomes spontaneous. Usually after the second day of vomiting the patient develops mucous diarrhoea which persists until a few days after the sickness has disappeared. It is stated that the patient shows some febrile disturbance during these attacks.

History of Present Illness

Following an invitation to a children's party this child became very excited and talked about the event continuously, repeatedly having a dress rehearsal for the occasion. During the past three to four days she has been "hanging", off her food and /

and feverish, and now she shows actual vomiting and diarrhoea.

Physical Examination

The patient is a very pale, nervous child, who lies somewhat exhausted in bed. No heat spots are seen, the breath smells of acetone, the tongue is furred, the throat appears normal and no definite abnormality is detected in the circulatory, respiratory or gastrointestinal systems. The pulse rate is fast, and the temperature is raised to 101.2 degrees. The vomitus consists mainly of bile-stained fluid. Thick mucus is passed per rectum, the urine contains a triple positive concentration of acetone. A small feed of sugar and water alternated with sodium bicarbonate drinks, flavoured with orange juice was given. The patient improved during the next few days, the diarrhoea was controlled and the acetone content of urine diminished, while the temperature and pulse returned to normal. Within five days the child appeared very well and only a trace of acetone was present in the urine. Fatty content of the diet was restricted during the next few weeks and Adexolin was given after food.

A total number of nine separate and similar attacks were observed, usually prior to return to school after the holiday period and associated with much /

much nervous anticipation and excitement. All these attacks yielded to the treatment outlined above.

Family History

A brother of the patient is subject to cyclic vomiting. Her father is of nervous and excitable temperament, is a foreman electrician and has enjoyed fairly good health, giving no history of cyclic vomiting attacks. The patient's mother is a woman of average type, who is fairly sensible and who has enjoyed good health. She gives no history of sick attacks. The home surroundings are good.

CASE 22. NAME W.R. DATE OF BIRTH 13:8:31

Previous History

The patient was breast fed for seven to eight months. No record of teething was obtained. He walked at eleven to twelve months. He has always been a nervous child who could not be left in a room by himself, who will not go out alone in the dark even for a short distance, and who will not sleep at night unless there is someone in the room and a light burning. Since birth, he has been troubled with heat spots and intermittent sick attacks, lasting usually twelve to fourteen days. His mother states that in her experience eggs and milk pudding and fried food were responsible for the heat spots.

Since a very early age his mother noticed that his /

his breath had rather an unusual sweetish smell during the attacks of vomiting. She states that from twenty to twenty-five separate attacks have occurred up to the present time. On a few occasions the attacks were associated with school examination or a football match, the anticipation of which was sufficient to cause general hypotonia, anorexia and often sickness.

History of Present Illness

(28:2:1944; age of twelve years and nine months) The mother states that patient has shown numerous heat spots recently and now appears very pale, tired and limp, and he has no appetite. He appeared feverish during the night and began to vomit about noon to-day. Since then, vomiting has been very frequent, occurring about every half hour, the vomitus consisting of bile-stained fluid. The child himself complains of pain in the right hypochondrium, and states that sickness began before abdominal pain was experienced.

Physical Examination

The patient is a very nervous boy with flushed face and widely dilated pupils. He insists that his mother must be beside him during examination. The breath smells strongly of acetone, the tongue is furred, the throat appears normal, respiration is easy and regular at normal rate. No abnormality is detected /

detected in the respiratory or circulatory system. The abdominal wall moves freely with respiration. Slight rigidity is present in the right side of the abdomen and tenderness is detected in the right hypochondrium, peri-umbilical region and in both iliac fossae. Pain is not felt on the sudden release of the palpating hand. Deep palpation is possible and no swellings are found. The pupils are widely dilated and react slowly to light. The reflexes are brisk and plantar responses are flexor; no nuchal rigidity is present. The temperature is normal. The urine contains triple positive concentration of acetone.

Sips of sugar and water alternated with sodium bicarbonate drinks were advised. On the following day he showed slight improvement and looked better. The temperature rose to 101 degrees, and he complained of pain in the right iliac fossa, examination of the abdomen having given negative findings.

It was concluded that the localisation of complaint of pain in the right iliac regions was conditioned by a discussion on appendicitis by friends who came to visit him. It was also suspected that the rise in temperature was due to the proximity of a hot water bottle, because on the evening of the same day the temperature reading was normal. Thereafter, his general condition improved considerably, and

within /

within a period of seven days the urine was free of acetone. He then returned to ordinary diet, the mother being advised to give him sodium bicarbonate drinks when necessary.

Family History and Social Conditions

No relevant points were elicited, except that the mother is an excitable person from a large family, all of whom are very nervous. The child's parents are well-to-do shopkeepers. Home conditions are comfortable.

CASE 23. NAME B.D. DATE OF BIRTH 2:8:34

Previous History

Breast fed two to three months; teething seven to eight months; walking eleven to twelve months.

She has always been a very nervous child. Since about two years of age she has suffered from heat spots. Since going to school she has suffered from repeated attacks of sickness. She is very keen on school and does very well. The attacks are always associated with going back to school or with examination.

History of Typical Attack

She has been getting excitable about returning to school; is jumpy during sleep; goes very pale and off food; develops pains in the abdomen, usually the /

the lower part; this is followed by a feeling of going to be sick, then the sick attacks start and she gets repeated sickness; vomitus mainly bile. The urine at this stage is loaded with acetone. Sugar and water and sodium bicarbonate and water, and rest in bed clears it up in one to two days; acetone is clear by the following week. She is a typical cyclic vomiting child; small, thin, pale, exceedingly nervous, bright-eyed and rosy lips. She is never fevered and her pulse is not fast during these attacks. There is no liver tenderness or enlargement. Since going to school I have attended her for such attacks on five occasions.

On the last occasion she had a similar history on the day she returned to school. She had the usual pre-vomiting signs and symptoms followed by abdominal pains mainly centred in the lower part of the abdomen round about the umbilicus, followed by sickness. I saw her in the afternoon. The mother was worred about appendicitis, as one of her friends had a child who had taken similar attacks of pain and sickness and the father was very worried about it. I explained the difference between the child's condition and appendicitis to the mother, but unfortunately the child had heard what was being said and between the child hearing this and the parents repeatedly asking,

I /

I was called back later that evening because the child had now all her pain in the right iliac fossa; the parents were now sure she had appendicitis and wanted the child sent to hospital. The following day when the child was much better I referred the case to hospital; she was put on the waiting list for removal of appendix. I then referred the child to Professor Morris at the Royal Hospital for Sick Children, Glasgow, who confirmed the diagnosis of cyclic vomiting and reassured the parents. Since then the child has kept very well and has had no serious return. The mother was instructed to start treatment; adequate rest; reduced fats; sugar and sodium bicarbonate immediately she saw the pre-vomiting signs and symptoms. The family have now left this district and are now staying in the Borders.

Family History

The parents are in fairly good circumstances. The father is a stationmaster; he is an exceedingly nervous and worrying type. He is a member of a large family. He does not know of any similar attacks in any members of the family. The mother is a well-balanced type. She is the oldest of a family of three. Her mother states that there is no history of such attacks in the family.

TO ILLUSTRATE EFFECT OF SODIUM CITRATE IN DIET

CASE 28. NAME B.S. DATE OF BIRTH 17:2:44
AGE 15 MONTHS.

Previous History

This child weighed six and a half pounds at birth and was artificially fed from the beginning on three parts milk and one part water, with added sodium citrate and sugar. She has always been slightly constipated. At five months the first tooth erupted and there was some delay in the appearance of the others.

History of Present Illness

When this child was about eleven months old the mother discontinued the sodium citrate in the feeds. Thereafter she noticed that the child became more nervous and that an unusual smell developed in the breath, followed by sick attacks. She also states that with the appearance of restlessness, especially at nights, anorexia and constipation, she knew that sickness was apt to follow and usually did so in a few days. The sick attacks continued for about two days and then ceased, only to be followed by a similar experience in about a week. No history of heat spots was obtained. During the previous two days the child has shown violent sickness.

Physical /

Physical Examination

The child is pale and emits a strong smell of acetone from the breath. She is very restless and shows dilatation of the pupils, which react to light. The tongue is furred and no abnormality is noted in the mouth or throat. Examination of the chest and abdomen is negative. No nuchal rigidity is present. All the reflexes appear normal, the pulse rate is increased and the temperature is normal. The urine shows triple positive concentration of acetone, without other abnormal constituents.

One teaspoonful of baking soda in orange flavoured water to be given in small amounts frequently was advised in addition to doses of Milk of Magnesia.

On the following day, the child appeared much better, no report of sickness during the night having been given.

The bowels moved satisfactorily, and apart from thirst the child appeared relatively normal. Skimmed milk was then added to the diet, with extra sugar and baking soda. Improvement continued and the smell of acetone disappeared from the breath on the second day. The urine, however, still contained positive concentration of acetone, which disappeared after the sixth day. Recovery was uninterrupted.

The /

The mother was advised to give small doses of baking soda or sodium citrate on the appearance of early warning signs.

This child is still under observation.

CLINICAL DISCUSSION

The preceding case-histories convey a general impression of the condition which was met with in the entire series. They include the essential and fundamental characteristics of the disease without emphasising, except in the case of the "Airth" worm, points of individual difference.

The general picture is one of nausea and general malaise associated with the appearance of moderate (double positive) acetonuria. This phase is followed by the occurrence of actual vomiting with heavy acetonuria (triple positive). When the concentration of acetone rises to the critical level, vomiting persists in varying degrees of severity for shorter or longer periods, depending upon the individual affected. This is followed usually by spontaneous recovery, the mechanism of which has so far remained unexplained. In a few cases a fatal issue may be the outcome as a result of increasing ketosis centred round the severe dehydration produced by continuous vomiting and concomitant starvation. Only one case in my series proved fatal (see Case 2 Appendix I). One other common feature which may prove to be of considerable significance is the nervous temperament which has been noted in practically every case, some nervous sign such as irritability /

irritability or introspection being usually seen in the early stage.

Until now, no definite clinical reason has been put forward which might explain the onset of this disease, apart from that associated with typical diathesis. On further examination of other cases (18, 22 and 23) it has been observed that an additional factor has been superimposed upon the basic type, namely some circumstance of mental stress or excitement. This is usually seen more clearly in the older patients.

These emotional stimuli include circumstances associated with a children's party, resumption of school after a long holiday, first attendance at school or school examinations. The actual incidents are not in themselves the precipitating factor, but anticipation of these events appears to be the directing cause. The cases in which these factors play a part are those in the older age group, who also show lowering of pain tolerance in marked degree; they are shy and timid, blush easily and invariably show dilatation of the pupils. All these features point to a very definite degree of nervous instability.

These factors are not peculiar to a certain group of children - they are common experiences of all children but the reaction to them appears to be undoubtedly /

undoubtedly increased in intensity in the child subject to cyclic vomiting. He already shows evidence of vasomotor instability indicative of some degree of nervous imbalance, but the latter is seen also in a great many children who show no sign of the recurrent vomiting synodrome. Is it possible, therefore, that the degree of nervous imbalance which is already evident extends into spheres other than vasomotor control, for example, into the field of metabolism? To illustrate the occurrence and significance of emotional stimuli (see Cases 18, 22 and 23).

Apart from the above central stimuli, it is not unreasonable to postulate that peripheral irritative stimuli may also play a part in the immediate causation of this condition. It is already well known that mild infections such as tonsillitis or a mild catarrhal condition of the ear may immediately precede an attack. It is presumed that very little abnormality, apart from a slight pyrexial illness is present, and that the condition resolves itself essentially into one of local irritation, which may amount to actual pain. In the great majority of children such illnesses may cause only slight general disturbance and clear up in about a week. In the susceptible child, however, the condition /

condition deteriorates quickly into one where digestive abnormality becomes the prime feature, and is followed eventually by a typical attack of acetonuria and subsequent vomiting. In several cases this state of affairs has existed, and no other clinical cause, apart from local infection was evident to account for the onset of an attack.

It is worth while noting that with the treatment of digestive upset the local condition of the throat and ear quickly subsides. From the clinical point of view, therefore, it would appear that local irritation from an inflammatory source is obviously a precursor of an attack of cyclic vomiting.

These observations in the older child provide a basis on which a search for a precipitating cause in the infant should be made. This is obviously more difficult, and the conclusion less certain, since the range of irritative stimuli and the subsequent reaction of the child are not so clearly defined. However, it seems justifiable on the above experience, to postulate a similar set of circumstances with regard to the etiology in the infant.

Possible factors may again be grouped into general and peripheral. As regard general factors, it is very difficult to analyse the intimate mother-child relationship, and to opinionate on circumstances /

circumstances which might disturb the child, apart from the possibility of inherited nervous instability. This will be discussed later. As regards peripheral causes, it is interesting to note that the condition is relatively uncommon while the child is being breast fed. If it does occur during this period, the condition is invariably of a very mild type. But when cow's milk has been substituted for breast milk it is not uncommon to find that the condition becomes immediately apparent. In these circumstances it is possible that some difficulty is experienced in the digestion of cow protein, which is present in a higher proportion than the protein in human milk, or that the higher proportion of fat present cannot be dealt with by the child (see History of W.D. sen.). A possible psychological factor based on resentment on the part of the child at the substitution of a bottle for the mother's breast, may play a role whose importance it is difficult to assess.

In connection with the first possibility, the addition of citrate to the feed very often excluded the occurrence of cyclic vomiting, but as soon as citrate is discontinued, the condition may immediately develop (see Case 28). It is not clear whether this effect is due to the anti-coagulant effect of the citrate in the stomach, or whether it is the result /

result of the increased amount of alkaline buffer salts in the blood, which are available to neutralise any tendency to ketosis. The latter explanation seems more probable. Other forms of irritation which may produce nervous imbalance are probably such things as "teething" and the incidence of intestinal worms. It has been noted in several cases that when such possible causes are removed the incidence of recurrent vomiting diminishes or disappears.

GENERAL DISCUSSION

It has been shown in the previous sections that the distinctive characters of recurrent vomiting are nervous instability, ketonuria, vomiting and spontaneous recovery, and that they appear in the order quoted. The first definite sign of disorder is ketonuria, and despite the view of Marfan 1932 who believed that ketosis was merely a symptom, this state must be treated at least clinically as the fundamental basis of this condition.

The appearance of ketones in the blood and urine essentially represent interruption in the process of fat metabolism. These substances appear in excess when there is excessive utilisation or combustion of fat e.g. following ketogenic diet, or under conditions where there is a deficiency of carbohydrate e.g. in starvation, or when there is interference with the utilisation of carbohydrate as in diabetes mellitus. It is characteristic of childhood that ketones are readily developed when the above conditions are reproduced e.g. in starvation, infections, after prolonged vomiting, diarrhoea and delayed chloroform poisoning. The accepted views on this subject are well epitomised in the aphorism "fat burns in the flame of the carbohydrate fire", but in spite of extensive /

extensive evidence in support of the theory thus expressed, our knowledge of ketone metabolism still remains imperfect. Ketone bodies (beta-hydroxybutyric acid, aceto-acetic acid and acetone) are produced from fatty acids in the liver in the process of fat metabolism. It has been stated that these substances can supply the energy requirements of muscle in which they are oxidised to carbon dioxide and water. Whether they are utilised or oxidised in the liver itself remains uncertain. When the supply of carbohydrate is deficient, or when metabolism of carbohydrate is faulty, available fat is called upon to satisfy the metabolic requirements of the body. It has been definitely established in these circumstances that without a certain proportion of glycogen in the liver and perhaps also in the muscles, the complete oxidation of the intermediate products of fat metabolism does not take place, and ketone substances accumulate in the blood and appear in the urine. Thus some justification exists for Rosenfeld's axiom "Ketones (not fat) burn in the flame of the carbohydrate fire".

If ketosis is the essential basis of this condition, it would reasonably follow that the production of ketosis might be followed by signs and symptoms similar to those which have been seen. Attempts /

Attempts have been made in normal and susceptible children to reproduce this disorder by:-

(1) Limitation of carbohydrate intake.

(2) By the administration of ketogenic diets.

In the great majority of cases these experiments have yielded negative results, and in those where positive results are claimed it is doubtful whether these are identical with the natural disorder. It is important to recall in this connection that Salamonsen (1929) concluded that no disturbance of either carbohydrate or fat metabolism could be detected in susceptible children, and that no evidence of defective oxidation of ketones was found in comparison with controls. Therefore, it would seem that the necessity for restricted consideration of these two factors is eliminated, but it still remains open whether some other circumstances determine temporary interference with the oxidation of ketone bodies, or increased production of ketone bodies.

The established facts concerning the occurrence of ketosis clearly indicate that the most frequent determining factor is restriction of the glycogen content of the liver. The storage and utilisation of glycogen is intimately connected with the adrenal glands, over-stimulation of which facilitates glycogenolysis /

glycogenolysis, and at the same time inhibits secretion of insulin (Heymann, 1931). During prolonged secretion of adrenalin the glycogen reserves of the liver may be exhausted when no fresh supply of glucose is available from the alimentary tract. It is of interest to note that Heymann (1929, 1931) following the administration of ketogenic diet claims to have produced attacks of vomiting associated with ketosis one hour after the subcutaneous injection of adrenalin. Ström (1935) suggested that recurrent vomiting was a disturbance of the vegetative nervous system, and noted the significance of adrenalin in provoking a typical attack.

It seems probable, therefore, that adrenal function may be intimately connected with the temporary production of ideal conditions, especially within the liver, during which interference with the oxidation of ketone substances may occur.

The most important clinical feature met with in all cases of the series was nervous instability, or a neurolabile character upon which the influence of emotional stimuli was sufficient to determine the occurrence of typical attacks. This again was associated with signs of vasomotor instability and dilatation of the pupils, indicative of some degree of sympathicotonia. The probability then presents itself that the adrenal glands are thereby over-

stimulated /

over-stimulated with the result that there is marked interference with the glycogen reserve of the liver and the easy production of conditions in which ketosis readily appears. The essential cause, therefore, would seem to be psychogenic in nature operating through the medium of the sympathetic nervous system, and finally, through the adrenal glands. No permanent abnormality in either fat or carbohydrate metabolism would be necessary for the occurrence of the condition. This would explain in great measure the negative results of metabolic experiments and would be compatible with the transient nature of the disorder, and the intervals of normal health between attacks. Perhaps one assumption is necessary, namely, that the capability of the liver to store sufficient quantities of glycogen is below the normal level, and that these may be readily depleted under conditions of sympathetic stimulation, so that interference with oxidation of the intermediate products of fat metabolism is liable to occur.

It is clear that the incidence of ketosis occurs before actual vomiting, and must be regarded as the primary disturbance. The accumulation of acetone and related substances in the blood thereafter, may act as a stimulant to the vomiting centre, or it may be /

be that in an effort to get rid of these products excretion is effected through the mucosa of the alimentary tract, including the stomach, with the result that local irritation is produced with subsequent vomiting. The fact of spontaneous recovery is quite striking, and immediately raised the question - how is this accomplished? It is impossible to deduce the answer to this question without certain knowledge of the mechanism of production and the fate of ketone substances. But at first one is easily drawn to the teleological suggestion that vomiting is the means towards the end, in that, depletion of the hydrochloric acid content of the stomach produces a relative alkalosis which favours the neutralisation of the acid ketone substances. On the other hand, it is possible that the acetone itself may exert a specific depressant action on the sympathetic system, thereby removing the initiating factor. It would be interesting to know the effects of cholinergic drugs during a typical attack.

Besides these cases which exhibit attacks culminating in actual vomiting, there have been observed others in which acetonuria has occurred as the only evidence of abnormality. These cases are considered to represent a less severe degree of nervous /

nervous instability; perhaps also the liver is capable of retaining a larger amount of glycogen which is not readily depleted below the critical level associated with ketosis. With regard to this group, it is of interest to note the experience of Graham and Morris (1933) snd of Dods and Lorimer (1935). These writers observed a high incidence of ketonuria among the general admissions to a children's hospital. None of these cases developed a typical attack and all were admitted for reasons other than suspected recurrent vomiting. It is likely that the concentration of acetone in these children at this time was insufficient to precipitate the typical signs. The fact that ketosis was present may be accounted for, either by the pathological condition which was the reason for admission, or by the exhibition of a neurolabile tendency which may have been adversely influenced by change of surroundings e.g. admission to hospital. Although it is granted that children become rapidly accustomed to their new surroundings and that ketosis, as the result, readily disappears, the possibility of emotional disturbance at, or on, admission, is not over-ruled. There seems no other reasonable explanation of these observations, especially in children who show no organic lesion to account for the appearance of ketonuria.

SUMMARY AND CONCLUSION

An analysis of the signs and symptoms associated with attacks of recurrent vomiting in children from one year to fourteen years has been given. The characteristic features of this condition are:-

(1) Neurolabile character which is hereditarily transmitted in certain families.

(2) Ketosis and subsequent vomiting.

(3) Spontaneous recovery.

(4) Repeated occurrence of identically similar attacks in the intervals between which there is no evidence of abnormality.

It has been shown that ketonuria is the fundamental sign, the occurrence of which precedes vomiting in every case. The influence of emotional and peripheral stimuli in determining the onset of attacks has been noted and discussed.

The opinion has been put forward that recurrent vomiting is a manifestation of a neurolabile character in children, the mechanism of which essentially consists of depletion of the glycogen reserves of the liver under the influence of the adrenal glands, following over-stimulation by the sympathetic nervous system.

TABLES

Table I Summary

Table II Relationship between Acetonuria and Vomiting.

Table III History of the "D" Family.

Table IV Family History - Cases 10-13.

TABLE I

CASES	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
DATE OF BIRTH	23:1:30	14:4:36	14:5:38	2:2:41	7:10:42	26:3:43	12:1:35	7:10:36	25:12:36	27:7:30	9:10:39	6:6:36	18:9:43	11:10:39	5:1:30	31:12:42	28:1:42	23:10:38
BREAST FED	3/12	3-4/12	-	3/12	-	9/12	3-4/12	-	7-8/12	3/12	3/12	-	6/12	9-10/12	-	3/52	12/12	-
TEETHING	9-10/12	9/12	10-11/12	5/12	10/12	14/12	12-12½/12	10/12	9-10/12	13/12	10/12	9/12	None yet	5/12	10/12	15/12	10/12	1st 2/12 Next 10/12
WALKING	12/12	10/12	13/12	11/12	14/12	14/12	11½/12	11½/12	14/12	13/12	10/12	14/12	Not yet	11/12	11-12/12	not yet/12	14/12	12/12
HEAT SPOTS	+	+	+	+	+	+	+	-	+	-	-	-	-	+	+	-	-	-
AGE WHEN FIRST SEEN	4/12 2:12 yrs.	8/12 3:12 yrs.	8/12 1:12 yrs.	1 yr.	1 yr.	8/12 yrs.	6/12 1:12 yrs.	6/52 yrs.	11/12 1:12 yrs.	4/12 3:12 yrs.	10/12 yrs.	7/12 2:12 yrs	3/12 yrs.	3/12 3:12 yrs.	2/12 3:12 yrs.	½/12 2:12 yrs.	10/12 1:12 yrs.	2/12 5:12 yrs
POSITION IN FAMILY	4-4	1-3	2-3	3-3	1-1	1-1	1-2	1-1	1-1	1-2	2-2	2-3	3-3	2-3	2-2	Twin	2-2	1-2
HEREDITARY	+	+	+	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+
PHYSIQUE	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale
EMOTION	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous
EDUCATION	Good	-	Good	-	-	-	Good	Good	Good	Good	Good	Good	-	-	Good	-	-	Good
SOCIAL FACTORS	Good	Good	Good	Good	Good	Good	Good	Good	Good	Fairly good	Fairly good	Fairly good	Fairly good	Fair	Good	Good	Fair	Good
OTHER DISEASES	Diphtheria	Infantile Eczema Scarlet Fever	-	-	-	-	Whooping cough Diphtheria	-	-	T.B. Adenitis	T.B. Adenitis	Scarlet Fever	-	Measles	-	-	-	-

TABLE I

11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
9:10:39	6:6:36	18:9:43	11:10:39	5:1:30	31:12:42	28:1:42	23:10:38	15:7:41	1:11:41	12:7:40	13:8:31	2:8:34	29:3:42	29:3:42
$\frac{3}{12}$	-	$\frac{6}{12}$	$\frac{9-10}{12}$	-	$\frac{3}{52}$	$\frac{12}{12}$	-	$\frac{3}{12}$	$\frac{9}{12}$	$\frac{3}{12}$	$\frac{7-8}{12}$	$\frac{2-3}{12}$	$\frac{3}{12}$	$\frac{3}{12}$
$\frac{10}{12}$	$\frac{9}{12}$	None yet	$\frac{5}{12}$	$\frac{10}{12}$	$\frac{15}{12}$	$\frac{10}{12}$	1st $\frac{2}{12}$ Next $\frac{10}{12}$	$\frac{8-9}{12}$	$\frac{10}{12}$	$\frac{13}{12}$	?	$\frac{7-8}{12}$	$\frac{10-11}{12}$	$\frac{7-8}{12}$
$\frac{10}{12}$	$\frac{14}{12}$	Not yet	$\frac{11}{12}$	$\frac{11-12}{12}$	$\frac{\text{not yet}}{12}$	$\frac{14}{12}$	$\frac{12}{12}$	$\frac{18}{12}$	$\frac{10}{12}$	$\frac{20}{12}$	$\frac{11-12}{12}$	$\frac{11-12}{12}$	$\frac{18}{12}$	$\frac{15}{12}$
-	-	-	+	+	-	-	-	-	-	-	+	+	+	+
$\frac{10}{12}$ yrs.	$2:\frac{7}{12}$ yrs	$\frac{3}{12}$ yrs.	$3:\frac{3}{12}$ yrs.	$3:\frac{2}{12}$ yrs.	$2:\frac{1}{12}$ yrs.	$1:\frac{10}{12}$ yrs.	$5:\frac{2}{12}$ yrs	$1:\frac{9}{12}$ yrs.	2 yrs.	$3:\frac{1}{12}$ yrs.	$12:\frac{9}{12}$ yrs.	5 yrs.	3-4 yrs.	$1:\frac{9}{12}$ yrs
2-2	2-3	3-3	2-3	2-2	Twin	2-2	1-2	2-2	2-3	1-1	3-3	1-1	Twin	Twin
+	+	+	+	+	+	+	+	+	-	-	-	-	+	+
Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Thin Pale	Pale	Inclined to be fat	Thin Pale	Thin Pale	Thin Pale
Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous	Nervous
Good	Good	-	-	Good	-	-	Good	-	-	-	Good	Good	-	-
Fairly good	Fairly good	Fairly good	Fair	Good	Good	Fair	Good	Good	Good	Fair	Good	Good	Good	Good
T.B. Adenitis	Scarlet Fever	-	Measles	-	-	-	-	-	-	Eczema Diphtheria	-	-	-	-

TABLE II

CASE G.B.

Date	Aceton-uria	Vomit-ing
20:11:33	+++	+
28: 6:34	+++	+
10: 8:34	++	-
6:10:34	++	-
20: 1:35	+++	+
1: 9:35	+++	+
13:12:35	+++	+
21: 2:36	+++	+
25: 9:36	++	+
16:10:36	++	-
20: 5:37	+++	+
11: 2:38	++	+
10: 5:39	+	-
26: 5:39	+	-
29: 9:39	++	-
3: 4:40	+	-

CASE A.R.

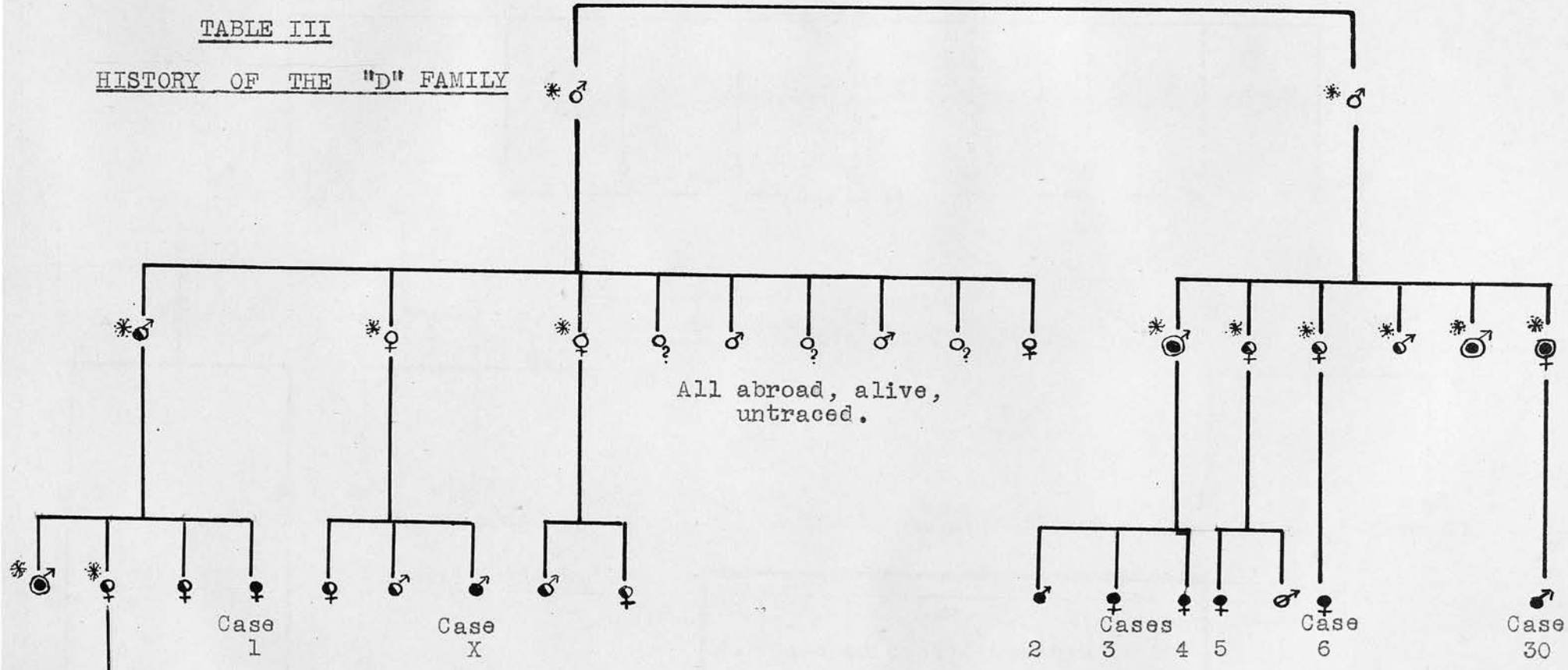
Date	Aceton-uria	Vomit-ing
3:1:43	+++	+
6:3:43	++	-
17:6:43	+	-
3:11:43	++	-
11:4:44	++	-
1:9:44	+	-

CASE M.L.

Date	Aceton-uria	Vomit-ing
3:3:33	+++	+
16:7:33	+++	+
13:10:33	++	-
3:1:34	++	-
9:5:34	++	-
26:5:34	+++	+
14:8:34	++	-
27:12:34	+++	+
28:3:35	+	-
19:4:36	+	-
1:9:36	++	-
7:3:38	++	-

TABLE III

HISTORY OF THE "D" FAMILY



KEY

= Case of Cyclic Vomiting

= Unaffected so far as known

= Delayed dentition: Heat spots

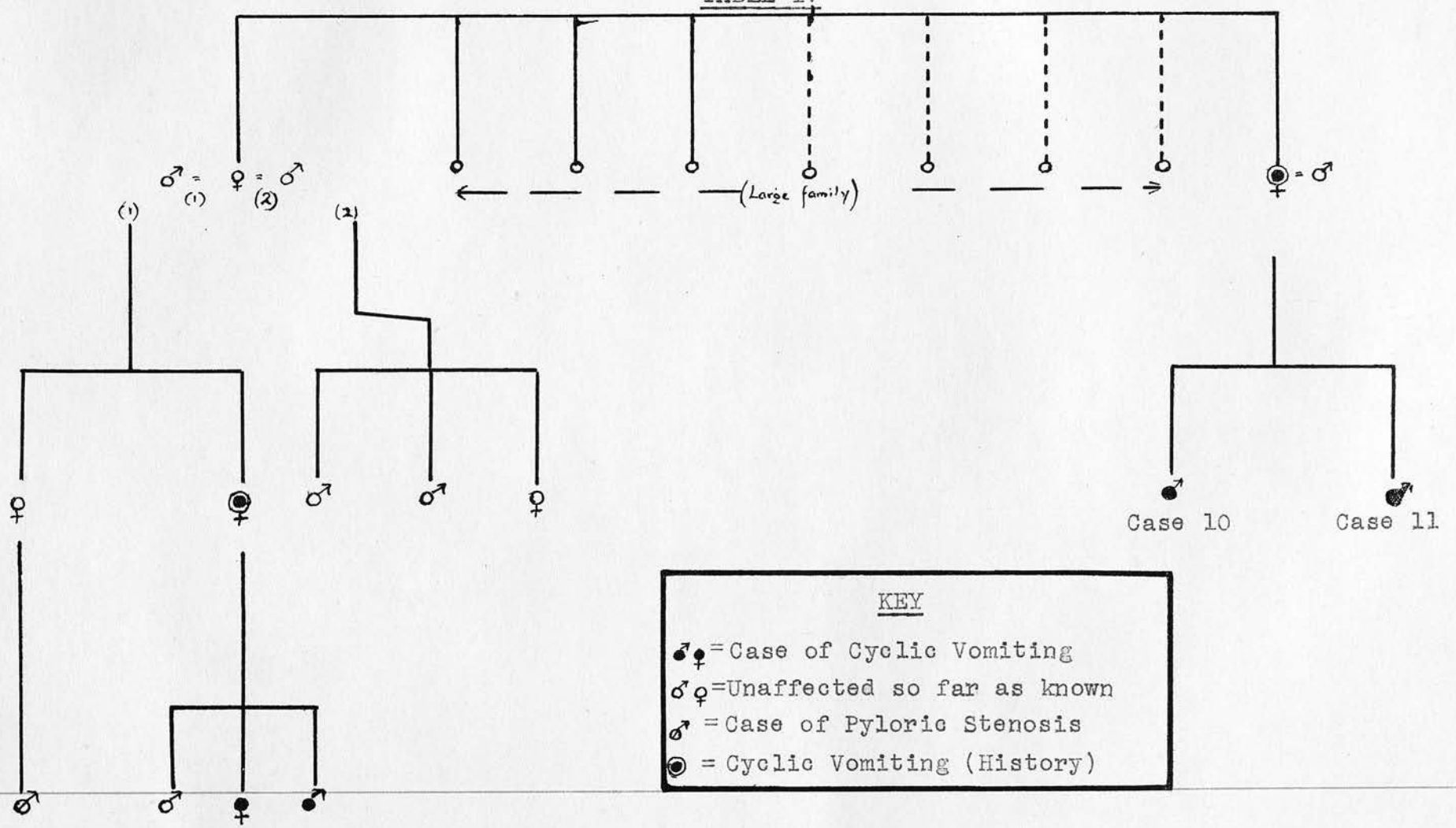
= Cyclic Vomiting (History)

= Pyloric Stenosis

= Case of early loss of teeth.

Case X occurred since this Thesis was prepared.

TABLE IV



FAMILY HISTORY CASES 10-13

REFERENCES

1. Rotch, T.M. "Text-Book of Paediatrics" 4th Ed. Philadelphia 1903.
2. Marfan, A.B. (1901) Arch. Med. des Enf. 4,641.
3. Salomonsen, L. (1929) Act. Paed. 9.
4. " (1930) Amer. Journ. Dis. Children 40, 718.
5. " (1932) Klin. Wochenschr. 11, 581.
6. " (1932) Zeits. f. Kinderh. 53, 66.
7. Weichsel, M. (1933) Monatschr. f. Kinderh. 58, 9.
8. Ellis, R.W.B. (1931) Arch. Dis. Children 6,285.
9. Schloss, J. (1930) Deutsch. Arch. f. klin. Med. 168, 347
10. Ström, J. (1935) Act. Paed., 18, Suppl.III
11. Ross, S.G. and Josephs, H.W. (1924) Amer. Journ. Dis. Children 28, 447.
12. Saekel, H.A. (1927) Munchen. med. Wochenschr. 74, 227.
13. " (1927) Klin. Wochenschr. 6,2316.
14. " (1932) Klin. Wochenschr. 11,1430.
15. Heymann (1929) Zeits. f. Kinderh. 48,230.
16. " (1931) Klin. Wochenschr. 10, 197.
17. " (1932) Klin. Wochenschr. 11,1069.
18. " (1932) Zeits. f. Kinderh. 53,629.
19. " (1933) Zeits. f. Kinderh. 55,502.
20. Siwé, S.A. (1934) Zeits. f. Kinderh. 56,98.
21. Hilliger, Jl.K. (1914) 80,1.
22. " (1921) Monatschr. f. Kinderh. 21,241.
23. Graham & Morris "Acidosis and Alkalosis" Edinburgh 1933.
24. Dods /

24. Dods & Lorimer (1935) Med. Journ. Australia 22, 231.
25. Holt, L.E. & McIntosh, R. (1940) "Holt's Disease of Infancy and Childhood" 11th ed. p. 419, New York and London.
26. Blixenkrone - Miller, N. (1938) Hoppe-Seyl. Zeits. 253, 261.
27. Rosenfeld.
28. Best & Taylor "Physiological Basis of Medical Practice". London 1937.
29. Marfan, A.B. (1932) Arch. Med. des Enf. 35, 505.