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Cholera Therapy in Children—Some Practical Hints for the Treatment of Acute Diarrhea[1]

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In epidemics of cholera in endemic areas children constitute the majority of affected patients. The mortality rate is higher in children probably because they suffer from a greater number of complications than adults. Some complications, like hypoglycemia and hypokalaemia, (low potassium syndrome) seem to occur almost exclusively in children. Due to physiological immaturity of the fluid and electrolyte regulatory mechanism, small children with cholera often present as cases who must be dealt with much more urgently than adult patients. Therefore, problems associated with cholera therapy in children are being separately considered in this symposium. Although the problems discussed deal with cholera only, they are applicable to other acute severe diarrheas occuring in children.

Intravenous Fluids used in cholera

The intravenous solution used most commonly for routine hydration and replacement of diarrheal fluid at the Pakistan-SEATO Cholera Research Laboratory is called 5:4:1 or the "Dacca Solution". It contains 5 grams of NaCl, 4 grams of $NaHCO_3$ and 1 gram of KCl in a liter of solution giving a concentration of Na 133 mEq, K 13 mEq, HCO_3 49 mEq and Cl 100 mEq. This fluid is used for adults as well. Studies at the P-SCRL (Rahaman *et al.*, 1968) and other places (Griffith *et al.*, 1966, Mahalanabis, 1968) have shown that sodium concentration in stool from paediatric cholera is only around 100 mEq/L, while it is the value of 133 mEq/L in the 5:4:1 solution. However, no complications due to high concentration of sodium have occurred in children treated by us who were given 5:4:1. The lack of complications from this cause is probably due to our practice of encouraging children to drink plain water as soon as they are able to sit up. Comatose children with cholera who are unable to drink water, cannot correct an impending electrolyte imbalance in this fashion and may require the administration of intravenous solutions in which the concentration of sodium is reduced, or the alternation of dextrose/water with the

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solution of higher sodium concentration.

We also routinely add glucose to a concentration of 1% to the intravenous solutions used* to treat children weighing less than 15 kg., to prevent hypoglycemia. This will be further discussed below.

Isotonic Bicarbonate

Some children are admitted in a state of profound acidosis, evidenced by rapid, deep, often gasping respiration. In these children approximately ½ to 1/3 of the initial rehydration fluid requirement is given as isotonic bicarbonate (12 gm. of sodium bicarbonate in a liter of distilled water). This is very effective in correcting the acidosis, and by this correction contributes to better distribution of blood in these patients (Harvey *et al.*, 1968).

The problems associated with pediatric diarrhea may be classified into two broad categories:

A. Those which need immediate attention to save the life of the child.

B. Those which may occur and/or can be dealt with at a later time.

A. Immediate problems

Difficulties in starting an infusion: Children with cholera are brought to the hospital usually after they have reached a state of profound shock and dehydration, as shown by absent pulse at the radial site, poor skin turgor, sunken eyes and lack of response on stimulation. Some of these children are literally at the point of death and may actually begin to gasp and die within minutes, while attempts are being made to start an infusion. A child in this state represents a medical emergency and an all out attempt must be made to start an intravenous infusion immediately. A needle can often be placed in the usual sites, but if necessary unconventional sites must be used to start the infusion.

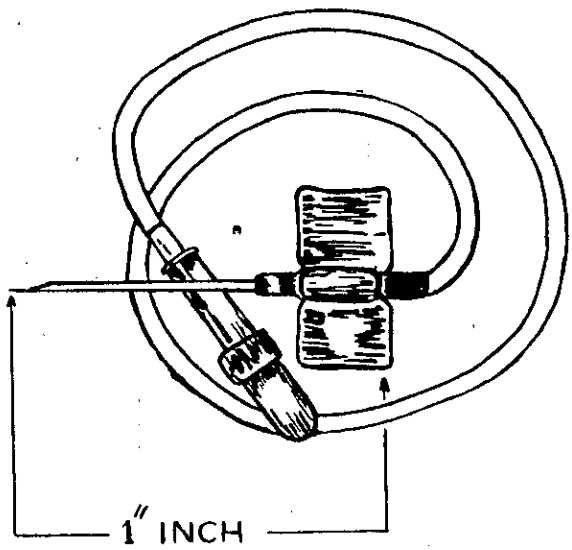

Fig. 1. Scalp vein needle.

*10 grams glucose per liter bottle

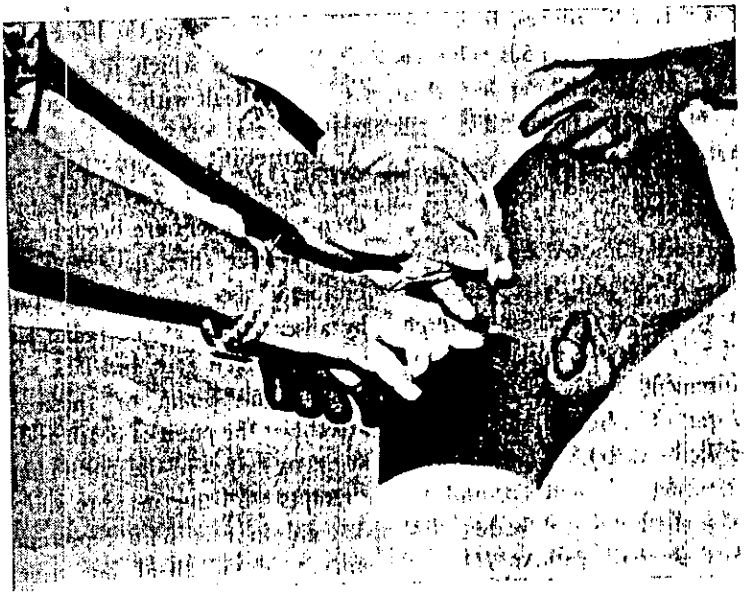

Fig. 2. Infusion through femoral vein

Fig. 3. External Jugular Venipuncture

It should be understood that it can be very difficult to start an infusion in a small child even when he is fully hydrated. It becomes even more difficult when the child is in shock as all the superficial veins become almost invisible. If the child is fat and dark skinned, it is sometimes impossible to locate a vein at the usual sites. Attempts should be made to start an infusion at several sites by several physicians (when available) at once.

Scalp-Vein Needle: For starting an infusion quickly, scalp vein needle is most helpful (Fig. 1). It is a needle on which a length of polyethylene tubing is fixed and at the end of which there is a plastic attachment which can be connected to the infusion set. The needle has a flexible plastic guard not unlike a butterfly making it very convenient to hold the needle and canulate a vein at almost any site. Once these scalp vein needles are fixed to the skin by a piece of adhesive plaster, the length of polyethylene tubing allows the arm to have a certain amount of freedom of movement without displacing the needle from the veins.

In our experience the scalp vein needle is an essential piece of equipment when dealing with cases of severe dehydration in children. These needles have enabled us to save many a life.

Unconventional Sites for Infusion: In severe dehydration and shock almost all the superficial veins of the body are collapsed. One may lose valuable time by persisting in attempts to do venipuncture at the conventional sites like the antecubital veins. One should try to start an infusion at a site which takes the least amount of time. The following two sites have been found to be the most convenient in this regard:

1. *Femoral Vein:* This is the best site to start an infusion quickly. It is a large vein situated at an easily accessible part of the body in children and can be quickly located. The femoral vein is placed just medial to the femoral artery which can be palpated even in a dying child. The method of femoral infusion is illustrated in Figure 2. It should be ascertained that the needle is in the vein, shown by pressure of blood in the syringe which can be drawn off with a slight amount of suction (in contrast to femoral artery which if punctured will push bright red blood into the syringe without any suction). The syringe should then be disconnected and infusion started through the needle which should be held between the thumb and forefinger for the duration of the infusion.

If the artery is punctured the needle should be withdrawn immediately and firm pressure applied for at least 5 minutes.

2. *External Jugular Vein:* This is another important site for starting an infusion in an emergency. By applying a little pressure on the lower part of the neck with the hand, these veins can be visualized and punctured. If a child is made to cry, these veins become even more prominent. Figure 3 illustrates this.

Once some amount of fluid has been infused and dehydration is partially corrected, the superficial veins become visible and/or palpable. Depending on the circumstances, this may take between one-half to one hour. Without stopping the original infusion, venipuncture with another needle should be made at a more convenient site and the infusion bottle connected to the new needle.

Conventional Sites for Infusion: The most popular sites for intravenous infusion with the general practitioners are the antecubital veins of both arms. These sites are fine as long as the infusion is of short duration. However, when the duration of infusion is prolonged as in cholera, antecubital sites are a poor choice. The arm and forearm begin to feel stiff shortly after infusion is started at this site. There is also danger of 'double puncture' of the veins with even slight flexion of the elbow joint. For these reasons antecubital veins are used in cholera when other veins are not easily available.

Other veins popular for long continued infusion are those situated on the back of the hands, and medial malleoli of the tibia. When scalp vein needles are used these sites allow the patients to have a certain amount of freedom of movement and make the children somewhat less uncomfortable and irritable while continuing infusion for a very long time.

Acidosis in Children: Loss of bicarbonate through stool is an important feature of cholera and acute diarrheas. This leads to acidosis which is very common in children admitted in a state of severe dehydration from diarrhea. Occasionally this is further aggravated by metabolic acidosis due to both hypoxia caused by sluggish circulation in shock, and also to ketosis brought about by starvation. In acidosis, in which the pH of fresh arterial blood may fall to a level sometimes below 7.0 instead of normal value of 7.4, respiration becomes hurried and deep.

Infusion of normal or half strength normal saline without bicarbonate or base precursors like acetate and lactate will allow further acidosis to develop. In the usual patient, where acidosis is moderate, 5:4:1 is sufficient to correct acidosis along with the correction of dehydration. In severely acidotic patients, however, infusion of a moderate amount of isotonic bicarbonate solution to correct the acidosis more rapidly is recommended. Injection of a more concentrated solution, such as the 7½% bicarbonate solution available in the local market, is also very effective.

Hypoglycemia: Hirschhorn *et al.*, (1965) have shown that hypoglycemia is not an uncommon complication in children below 15 kg. of body weight. This has also been observed in bigger children and even in adults. The cause is unknown. However, it is a potentially dangerous complication as it may cause permanent brain damage if it lasts for any length of time. Mild to moderate degrees of hypoglycemia (blood sugar between 30–50 mg%) may be asymptomatic and be completely missed by a clinician. Below this level of blood sugar, hypoglycemia may be manifested by lethargy and stuporous condition with the child responding poorly to stimuli. A very low level of blood glucose may lead to convulsions. Infusion of 25% glucose by vein promptly reverses this condition. A prophylactic measure against hypoglycemia is to incorporate 25% glucose into the intravenous solution so that when added to the bottle the final concentration of glucose is approximately 1%.

B. Late complications

Once the patient is properly hydrated the systemic condition of the cholera affected child returns to apparent normality. He is no longer restless and usually sleeps peacefully until roused. Food is usually demanded

and given after a lapse of approximately 8-12 hours, although some children do quite well without solid food for the first 12-18 hours. In about 8 hours time after admission the child begins to purge quite heavily and a close watch should be kept on the fluid balance. It is important to remember that a child weighing 10 kg. may sequestrate more than a liter of fluid in the gut and may even become pulseless without putting out stool. Also quite often they put out as much as one liter of stool at one time and go into shock. Therefore, a close watch should be kept on the pulse and general condition in addition to the stooling rate.

Among the late complications, the most important ones are due to electrolyte imbalance as shown below.

Hypokalaemia: Observations carried out at the P-SCRL and some other centers have shown that stool in children contain more potassium but less sodium than the published values for adults. Therefore, children require more potassium to supplement its loss in stool. If this is not done, a child goes into negative potassium balance and frequently depletes his body potassium. This can produce hypokalaemia shown by lethargy and distension of the abdomen due to intestinal stasis. E.C.G. shows flattening of the T waves, and a prominent U wave. This condition can be reversed by giving more potassium by vein or by mouth. Green coconut water is very palatable and is a rich source of potassium. It can be drunk in large amounts. A 2% solution of potassium bicarbonate in 5% glucose taken orally is also a good way of supplementing potassium.

Hypernatraemia: As a complication it is extremely rare in cholera. It can occur when an unconscious child with defective kidney function is infused with normal saline only and not given water by mouth. It is also a potentially dangerous condition as it may also cause permanent brain damage.

Tetany: Tetany is rather uncommon in children. It is usually caused by a too rapid correction of acidosis and may also occur due to hypocalcemia or hypomagnesimia. Replacement of bicarbonate containing solution by normal saline is usually enough to reverse this condition. Injection of calcium gluconate, magnesium sulphate or breathing into and from a polyethelene bag occasionally helps the victim. The condition is harmless but nevertheless very uncomfortable.

Kidney Failure: When treatment of cholera is started quite early by using the modern replacement solutions, there is no kidney failure. Patients who have been in profound shock for a very long time may develop acute kidney failure. Patients suffering from this condition are usually brought to the hospital after a few days since the onset of cholera. Blood urea nitrogen and creatinine are very high on admission. It should be emphasized that oliguria or anuria in cholera are most commonly the result of insufficient replacement of potassium and/or insufficient correction of acidosis with bicarbonate or lactate. The clinician, thus must ensure that the patient has been adequately managed, and has been in a state of water and electrolyte balance, for some hours (12-24) without the appearance of any urine, before he can make a diagnosis of kidney failure.

Treatment consists of correction of fluid and electrolyte deficit and stopping the infusion or intake of potassium containing fluid or food. Breakdown of potassium in

the body may be diminished by giving a high fat and carbohydrate diet like rice with "ghee" (clarified butter) and sugar or bread with sugar and butter only. After a few days the patient usually begins to pass urine and then goes into a diuretic phase. Some of these children however may remain anuric and in the absence of an artificial kidney or peritoneal dialysis, may die of uremia.

Summary and conclusions

Some of the important and potentially life threatening complications occuring in cholera-affected children, along with measures to tackle them, have been discussed. It is hoped that our physicians will have a better understanding of the seriousness of this disease and deal with complications in an effective manner so as to save as many lives as possible. The suggestions may be helpful in tackling other acute diarrheas as well.

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