ACIDOSIS: ITS IMPORTANCE IN NOSE AND THROAT SURGERY IN CHILDREN.*

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Acidosis is a term which, until a comparatively short time ago, was supposed to indicate the presence in the urine of acetone bodies and this usually associated with diabetes. Normally, the body is continually producing acids and it is also excreting and neutralizing them. It is not the mere presence of acetone bodies that determines acidosis. In children they are not a frequent cause. A slight acidosis is the rule in health, but the quantitative difference between the presence of acetone bodies and their production in amounts to threaten life is an enormous one.

We say that acidosis exists when so much bicarbonate is lost from the blood, that the administration of a certain amount of bicarbonate fails to diminish the urinary acidity. Meat and proteins tend to increase the tendency to acidosis. In a vegetable diet the reverse is true. Normally, the blood has the power of neutralization of acid and a slightly alkaline reaction is maintained. Minute changes in the reaction of the various body fluids may so disturb the functions as to render life impossible. For instance, a change in the blood reaction from normal to neutral, or a change from the reaction of ordinary tap water to that of distilled water would cause death.

The constituents of the blood which regulate the reaction are sodium bicarbonate, the acid and alkaline phosphates and protein. It is estimated that in the course of twenty-four hours, the amount of acid produced and given off by an adult would be equivalent to several hundred cubic centimeters of concentrated hydrochloric acid. These acids are carried from the tissue by the blood to the lungs from the points of highest concentration to the lowest. Henderson calls the carbonates of the blood the first line of defense. And thus dyspnea or hyperpnea aids in ridding the body of carbonic acid and helps to maintain a normal limit. The kidneys remove acid phosphates by their specialized activity and leave behind part of the base

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with which the acid was combined. Proteins have the property of uniting with acids without undergoing much change in reaction. Ammonia production also assists in maintaining this defense against the acids produced.

While very little scientific work has been done on the condition of acidosis as a complication or sequel of tonsil and adenoid operations, there seems to be a more or less definite relation between the two. Whether or not it is simply the anesthetic, the shock or some change produced by the removal of this tissue, is the problem that remains to be worked out.

Sajous reports 383 cases in which an anesthetic was given for various surgical operations. In forty-six cases symptoms of acid intoxication were present. In some of these, grave symptoms occurred; in others the condition was only found by a routine urine examination. In seventeen cases symptoms were present on entrance, in twelve they developed within twenty-four to forty-eight hours later. In seventeen cases which developed after admission there was an assignable cause. Death resulted in six cases.

Beven and Favill collected, in 1905, twenty-nine scattered cases which were very similar in regard to acid intoxication and late poisoning effects from anesthetics. One typical case is reported in detail. A large amount of anesthetic was required, but the patient was soon conscious, with a pulse of 102° and temperature of 101°. About forty-eight hours later the symptoms of poisoning were quite marked. The child talked incoherently and exhibited evidences of great fright. The pulse rate increased and the delirium continued. Later on, periods of marked excitement occurred. Death took place five days after the operation with rising temperature, irregular, rapid pulse and Cheyne-Stokes respiration. During the last two days there was a sweetish acetone odor to the breath. Symptoms which are common in most cases, were not mentioned here: persistent vomiting without any apparent cause, and air hunger, dyspnea and cyanosis.

In Boston there was reported a case of death from acidosis in a child operated upon for tonsils and adenoids. Another surgeon operated on his own child for adenoids and death resulted from acidosis in about forty-eight hours. In Detroit, recently, a patient died of acidosis following a tonsil and adenoid operation. In Chicago, a number of cases have been reported,

none of them being fatal, however. Dr. Dean, of Iowa University, has had two marked cases of acidosis following operation. One case developed in two days following the operation. There was continuous vomiting without fever and the child did not appear to be ill. There was a marked acetonuria, which cleared up quickly by the use of large doses of sodium bicarbonate. His second case was one where the symptoms began the second day following the operation and the child became comatose. The urine was markedly acid. Large doses of sodium bicarbonate relieved the comatose condition, but the acetonuria persisted. This child developed scarlet fever in three days. The operation was evidently performed during the period of incubation. There is a question as to what was responsible for the acidosis which persisted, and the child died about fourteen days following the operation.

Dr. Dean is now observing a series of cases in which no attempt is being made before operation to prevent acidosis. Last Saturday he operated on a child thirteen years old for tonsils and adenoids. The urine was perfectly normal before the operation. On the second day there was marked acidosis with violent vomiting. The condition was promptly relieved by an injection of five per cent sodium bicarbonate per rectum.

Recently in my own practice I have had two cases in which there were quite marked symptoms of acidosis, following operation for removal of tonsils and adenoids.

Case 1. Male, age three and one-half years, had adenoids and very large tonsils, which touched in the median line. Ether anesthesia was used, the same being vaporized and warmed. The time required from the beginning of the anesthetic to the completion of the operation was about thirty minutes. Thirty-six hours following, the temperature was 101° and the pulse 110, and at this time the child began vomiting. Attempts to take food or water would bring on an attack and the child constantly complained of being very thirsty. There was acetonuria present. The administration of two ounces of 5 per cent sodium bicarbonate solution per rectum repeated three times at two hour intervals cleared up the symptoms promptly.

Case 2. Female, age five years, tonsils and adenoids removed under ether anesthesia as in Case 1. The entire time required was thirty minutes. Twenty-four hours after operation vomiting began. Temperature and pulse were 99.5 and 100 respectively. Vom-

iting in this case began on any attempt to swallow. No acids were found in the urine. The symptoms in this case cleared after the administration of one injection of two ounces of 5 per cent sodium bicarbonate per rectum.

There are many opinions regarding the cause of these various manifestations, and doubt is expressed by some concerning the existence of such sequels, but there have been reported in this country during the last year more deaths from acidosis following this operation than from any other. Idiosyncrasy, gastrointestinal disturbances, disturbed metabolism and nervous influence are some of the explanations offered. No matter what the cause may be it is certain that we do have an acidosis in a proportion of cases and even though they have not been recognized nor received treatment, they do not necessarily **prove** fatal.

There is such a wide range of acid production and retention in the body that it is very difficult to say when acidosis is present. How are we to detect any tendency toward this condition?

1. The urine is examined and we find abnormal acids, which shows that there is a disturbance of ordinary metabolism. Fatal acidosis may occur, however, when no abnormal acids are found in the urine.

2. We must look for evidence of unusual activity in the body's defenses by determining the amount of ammonia and its relation to the total nitrogen output. In the acidosis due to the inorganic substances as when the excretion of acid phosphates is interfered with, there is not an increase in the ammonia. A high ammonia coefficient should always make us suspicious of acidosis and further tests should be made.

3. By testing the alveolar carbon dioxide tension, we find it diminished in acidosis, because there is a decrease in the carbonate in the blood, part of it being used to neutralize the excess from the tissue. There is a deviation then from the normal reaction of the blood and an accumulation of carbon dioxide. This gives rise to an important symptom of acidosis, dyspnea and air hunger.

4. By testing the blood plasma for its bicarbonate content. Roughly this can be done by estimating the amount of bicarbonate which we must give in order to bring about a change in the reaction of the urine. This is spoken of as the tolerance for alkalis.

5. Testing the reaction of the blood by the use of some indicator.

In order to carry out many of these tests a well equipped laboratory is necessary, but we should make a thorough physical examination in all cases before administration of an anesthetic. The urine should be carefully examined and some one test made on the blood before and after operation. Meat, proteins, etc., increase the tendency to acidosis as does starvation. To this latter fact may be partly due, the tendency for this class of cases to be more susceptible to acidosis. Because they are usually not given any food for twelve hours before the operation and on account of the difficulty in swallowing, it is difficult to get them to take much nourishment for some time following. Meat should be restricted and a vegetable diet given for several days before operating. Do not starve the patient. Fifteen grains of bicarbonate of soda three times daily for two or three days should be prescribed, and if any tendency to acidosis is found by the tests used, we should give per rectum a solution containing forty-five grains of bicarbonate of soda one-half hour before operation. We should prevent, if possible, any of the conditions which tend to produce acidity of the blood, excessive muscular activity, excessive emotional excitement, surgical shock and the use of an excessive amount of anesthetics. Morphine before the anesthetic delays and prevents the acidosis but when given after the anesthetic has been started it seems to interfere with the normal mechanism by which the acidity is neutralized.

The symptoms of acidosis which develop after operation are dyspnea, or air hunger, nausea and vomiting without apparent cause or brought on by the slightest attempt to swallow, though the patient may be very thirsty. This vomiting is usually cyclic or recurrent. Headache occurs in most cases. Drowsiness and delirium. There may be present slight fever but often the temperature is subnormal. If the acidosis is due to the acetone group, there will be the characteristic odor to the breath, and the presence of these acids in the urine. If, however, the acidosis is due to the inorganic salts, this latter will not be true and it does seem that many of the acidoses associated with tonsil and adenoid surgery are inorganic in type.

The treatment, regardless of the type would be to empty the intestine by a warm enema of magnesium sulphate, glycerin and

water. This to be followed by colonic irrigation with 5 per cent solution of bicarbonate of sodium, which may be repeated several times or may also be given intravenously or subcutaneously, but if given by the latter method we must be sure that none of the bicarbonate has been converted into carbonate as sloughing of the tissues may result.

Much remains to be learned as to the connection between acidosis and tonsil and adenoid operations; one German article has been written on the subject but I was unable to get a reprint. We do know that some relation does exist but the anesthetic certainly plays an important part in producing the condition.

I believe that we can all recall cases that had symptoms due to acidosis. While not always fatal, some unfortunate results could have been avoided had we made a more careful physical and laboratory examination of these patients.

The tonsil and adenoid operation is to-day regarded by many, especially general surgeons, as a very minor operation and is performed without any preliminary examination or preparation whatever. It is the purpose of this paper to emphasize the importance of more closely observing our nose and throat cases before operation and carrying out some of the more simple tests for acidosis. If we would all make and record these observations and the final results, we would have some very interesting and valuable statistics a few years hence.

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