American Journal of Diseases of Children

Vol. 9

APRIL, 1915

No. 4

THE INFLUENCE OF POSTURE ON DIGESTION IN INFANCY *

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Success in infant-feeding depends not only on the composition of the food, but also on the way in which it is given. The manner of feeding and the management of the child between feedings have received scant attention, yet there are certain points of considerable importance in this connection disregard of which may result in unsuccessful feeding, no matter how carefully the food is prescribed.

Posture has an important bearing on digestion in infancy. For many years the teaching of doctors and nurses has been that an infant must be put to sleep in the horizontal position immediately after feeding. Many mothers, however, hold the child upright after feeding before putting him down to sleep. It is believed that one of these plans is correct and the other wrong, both in theory and practice, and that the Roentgen ray has demonstrated the truth of this. The way in which posture can affect digestion depends on two main factors.

The first factor concerns the anatomy of the stomach. Roentgenography has shown the fallacy of the old idea that the stomach in infancy is vertical in position. There are several "types" of stomach which resemble the adult types in a general way, but the shape of the stomach depends on the amount of food and gas present, pressure from the outside, posture, etc. These different types have no especial importance. There are certain anatomic features which have to be borne in mind. The esophagus enters the abdomen by an opening in the diaphragm, almost in the mid-line, in contact with the aorta and the ventral surface of the bodies of the vertebrae. The cardiac orifice lies just to the left of this position and the cardia is held firmly to the posterior abdominal wall by the esophagus as it pierces the diaphragm. The fundus of the stomach lies in the left paravertebral groove, that is,

* Received for publication Jan. 25, 1915.

* Presented in part at the Pediatric Section, N. Y. Academy of Medicine, April, 1914. From the Pediatric Division and Roentgen-Ray Laboratory, St. Luke's Hospital.

in the lateral recess formed by the projection forward of the vertebral column into the abdominal cavity. The fundus reaches a plane considerably dorsal to the cardiac orifice. It is covered in front only by the liver and extends to the anterior abdominal wall. The pyloric end of the stomach is pushed forward by the vertebral column, pancreas and duodenum. The pyloric opening is directed backward toward the duodenum, but lies in a plane which is ventral to that of the cardia. The cardiac opening is behind the center of the anteroposterior diameter of the stomach.

The second factor is that there is a certain amount of gas in the stomach of every individual. This is a matter of common knowledge, but has been emphasized by the Roentgen ray. Practically every roentgenogram taken in the erect position shows a bubble of gas in the fundus end of the stomach (*Magenblase*). In the prone position it is not possible to estimate accurately the amount of gas present, as will be shown later. This gas may be derived from three sources, namely, swallowed air, gastric fermentation and intestinal gas.

Gastric fermentation is rare and is an important source only when there is stagnation from obstructed pylorus or from gastric atony of extreme degree. Intestinal gas does not commonly pass back into the stomach in all probability. Swallowed air accounts for the gas in the stomach in the large majority of cases. Air-swallowing takes place constantly, though to a variable degree. The size of the pharynx is such that it is rarely filled completely with food at the time of each swallowing act, and its anatomic relations prevent its collapse on a small amount of fluid. Air is constantly present in the pharynx and some air is forced down with the food by the contraction of the swallowing muscles. It is often possible to hear a child gulp down air with each swallow of milk. More or less air may be swallowed with saliva or nasal or bronchial mucus between feedings. Tongue-suckers, thumb-suckers and babies with a "comforter" habit suck and swallow air a considerable part of their waking hours. Infants fed on liquids swallow more air than older children fed on solids or semisolids. The more solid food is swallowed in a bolus and more completely fills the pharynx, while liquids are swallowed a few drops at a time. The smaller amount of air swallowed with semisolids may possibly be the explanation of the cessation of vomiting in the refractory cases in which no liquids are retained, but semisolid porridge is retained.

Usener,¹ in a paper on *Aerophagie*, noted the air-bubble in older children to be smaller than in infants. He stated also that the gas in the stomach has been proved to contain only oxygen, nitrogen and carbon dioxid or merely the constituents of air. He explained the mechanism

1. Usener: Ztschr. f. Kinderh., 1912, v, 440.

of the comparatively large amount of air swallowed by infants as follows: The horizontal position is probably one cause of air-swallowing, as it is in adults in bed with acute illness or after operations who often have great difficulty in swallowing properly and often swallow air with liquids. In nurslings each small drop of milk on reaching the region where the swallowing reflex is initiated starts the reflex and causes swallowing of air with the milk.

Flesch and Peteri,² with the fluoroscope, saw an air-bubble appear with the first swallow and fill one-third to one-fourth of the stomach during the feeding in both breast-fed and bottle-fed infants.

Grulee³ thinks that the gas mostly comes from gastric fermentation due to stagnation from short-interval feeding. If this were true, the air-bubble should be absent when children are fed at long intervals. In our observations such children, however, show gas-bubbles but little smaller than those fed too often. The character of the eructated gas suggests fermentation only in cases of extreme gastric stagnation.

Figures 1, 2 and 3 demonstrate the source of the gas in the stomach. This infant was given her usual bottle with bismuth 1:8. She took the first half ounce in about two minutes. Three minutes later the first exposure was made (Fig. 1). It shows a lateral view of the child held in the horizontal position. There is a small amount of milk in the stomach with a moderate bubble of gas between it and the anterior abdominal wall. The child was held in the horizontal position and then given $1\frac{1}{2}$ ounces more of the food in three minutes. Figure 2, taken at ten minutes from the beginning of the feeding, shows a very large amount of gas above (ventral to) the milk. The stomach is greatly distended already. The child was crying and was uncomfortable even with half of the feeding in the stomach. The child was then given $1\frac{1}{2}$ ounces more, but this was taken badly and the last half ounce of the feeding was absolutely refused. About fifteen minutes were spent in trying to get the food down; different nipples were tried, but the child could swallow no more. Figure 3—eighteen minutes after Figure 2—shows why the last half ounce was refused. The enormous gas-bubble plus the milk had so distended the stomach that no more could be taken. This gas must have been swallowed air, since it has appeared during the feeding, there was no stagnation of food from the last meal, and the gas appeared too rapidly to be the result of fermentation. The food contained no substance which could form gas with the gastric juice in amount large enough to distend the stomach to this extent. The bismuth subcarbonate used does not evolve gas

2. Flesch and Peteri: *Ztschr. f. Kinderh.*, 1911, p. 227.

3. Grulee: *Infant Feeding*, Saunders, 1914.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 1.—Child, aged 4 months; shown also in Figures 2, 3, 4, 5 and 6. History of vomiting since birth, on breast and bottle. Nursed eight weeks. Given usual feeding, that is, fat 2 per cent., lactose 6 per cent., protein 1.75 per cent. Four ounces every three hours, six feedings a day. To this $\frac{1}{2}$ ounce of bismuth subcarbonate was added. One-half ounce was taken in the first two minutes. Plate taken five minutes after feeding was begun. Supine position, left side against the plate. There is a small amount of milk in the stomach, with a small bubble of gas anterior to it. There is much gas in the small intestine.

Fig. 2.—The child was then given $1\frac{1}{2}$ ounces more food in three minutes. Plate taken ten minutes after feeding was begun. Supine position, left side against the plate. There is a large air bubble in front of the milk, which has gravitated to the back part of the stomach. A little bismuth has entered the small intestine. Note the position of the esophagus.

Fig. 3.—The child was then given $1\frac{1}{2}$ ounces more of the feeding. This was taken with difficulty, and the remaining $\frac{1}{2}$ ounce was refused. Child seemed in pain, cried and regurgitated a small amount. Plate made twenty-eight minutes after feeding was begun. Position same as above. Enormous bubble of air distending stomach. Note double pouch of fundus and pyloric end of stomach (as in cases of dilatation) in both Figures 2 and 3.

Fig. 4.—Thirty minutes after feeding was begun. Erect position, abdomen against the plate. Milk has gravitated to the lower part of the stomach, forcing air to the upper part. After this plate there was a large eructation of gas. The child at once stopped crying and went to sleep.

Fig. 5.—Thirty-five minutes after feeding was begun. Position same as in Figure 4. Air bubble has disappeared. Note migration of pylorus toward left, as compared with Figure 4.

Fig. 6.—Thirty-seven minutes after feeding was begun. Supine position, left side against plate. The stomach has contracted on the food; little or no gas remains. There is one inch difference in the anteroposterior diameter of the abdomen in Figures 3 and 6. A good deal of bismuth has entered the small intestine. The double pouch appearance seen in Figure 3 is gone.

with hydrochloric acid under 0.5 per cent. This gas-bubble must be composed largely if not entirely of swallowed air.

Food taken by a child enters the stomach and gravitates to its lowest part, displacing the gas present to the highest part. The behavior of liquid and gas in the stomach does not differ from that of liquid and gas in a glass bottle or any other receptacle. When the child is held in a horizontal position the liquid food therefore gravitates to the posterior part of the stomach, that is, the fundus end, and forces the gas present to the anterior part of the fundus and to the right end of the stomach. Since the cardiac orifice is situated well back against the vertebral column, it follows that it will be covered by the liquid and that the gas cannot escape into the esophagus. It can escape only through the pylorus, if at all. If the amount of food plus gas is enough to distend the stomach, either food and gas must be forced out through the pylorus, or regurgitation of food must take place through the esophagus until the tension on the stomach wall is relieved. The horizontal position causes a perfect water-lock to form as far as the gas and the cardiac opening are concerned. This may be readily imitated by taking a bottle two-thirds full of liquid. When the bottle is held on its side no air can escape through the bottle mouth. When the bottle is held upright, the gas can escape with ease if under pressure.

When a child is held upright the liquid gravitates at once to the dependent part of the stomach displacing the gas to the highest part — that is, to the upper part of the fundus — and this makes it possible for the gas to escape by the esophagus. This often takes place at once as soon as the child is held erect.

Figures 3 to 6 show the effect of posture. Figure 3, as stated above, shows the enormous distention of the stomach with gas in the horizontal position. Two minutes later the child was held upright and Figure 4 shows the milk at the lower, the gas at the upper part of the stomach. The child was then held against the mother's shoulder, patted gently on the back and at once eructated a large amount of gas. He then became perfectly quiet, stopped crying and dozed. Figure 5 — five minutes later — shows that the gas has been almost entirely eructated and that the stomach has contracted on the food. Figure 6 — two minutes later — shows again a lateral view, in the supine position. There is only a small bubble of gas against the anterior abdominal wall. The rest of the stomach has contracted on the food. The pyloric end shows well and there is a good deal of bismuth in the intestines. The comparison between Figures 3 and 6 is most instructive, and corresponded to the physical signs in the epigastrium and to the child's comfort. To one seeing only the picture shown in Figure 6 it would not seem possible that the same stomach could hold the amount of gas shown in Figure 3.

Figures 7, 8, 9 and 10 also demonstrate what happens when an infant is fed in the ordinary horizontal position and is allowed to remain in that position. This child was a normal healthy child of 6 months in the hospital while his mother was undergoing an operation. He was given his usual bottle with one-half an ounce of bismuth subcarbonate, which he took readily and easily. During the feeding he was kept in the horizontal position. His abdomen, which was moderately distended before feeding, became much more so during the feeding and the child showed every sign of acute discomfort. He began to cry, squirmed as if in pain and at the time of the first exposure, three minutes after feeding, began to regurgitate milk. This took place easily without any violent vomiting effort.

The Roentgen ray shows the reason for these phenomena. Figure 7 shows a lateral view of the abdomen in the supine position. The milk in the stomach has gravitated into the posterior part and has displaced the gas to the anterior part of the stomach. The esophagus shows plainly as the child was regurgitating during the exposure. Its position well below the level of the milk shows plainly. It is perfectly evident that no gas can possibly escape from the esophagus until enough milk has been vomited to uncover the cardiac orifice of the stomach.

The child was then held erect and the second exposure two minutes later shows the immediate effect of gravity. The milk has gravitated to the bottom of the stomach, forcing the gas to the upper part of the fundus, and it was now *possible* for the first time for the gas to escape. After this exposure the child was patted on the back rather forcibly and he cructated gas several times. This was done easily and no milk was vomited. The entire aspect of child changed at once. He stopped crying and went to sleep. Figure 9 shows his stomach five minutes later (ten minutes after feeding). The stomach has lost all of its gas except a small bubble just at the cardia, which is overlapped by the liver shadow. The stomach has contracted down on the milk and small amounts of bismuth have entered the small intestines. The child was then again put on its back. Figure 10 shows the stomach contracted down on the milk and illustrates its oblique position from above downward and forward to the right. The contrast between Figures 7 and 10 is as striking as was the contrast in the aspect of the infant.

The horizontal prone position is better than the supine, because the liquid food gravitates to the anterior part of the stomach and forces the gas to the posterior part. This places the cardiac orifice above the level of the fluid, and makes it possible for the gas to escape by the esophagus. This is perhaps the reason why so many infants sleep better "on their stomachs" than on their backs.

Figure 7

Figure 8

Figure 9

Figure 10

Fig. 7.—Healthy child, aged 6 months; shown also in Figures 8, 9 and 10. Given usual feeding of 6 ounces plus $\frac{1}{2}$ ounce of bismuth subcarbonate. Feeding taken eagerly in ten minutes; considerable air swallowed with it. Position horizontal during and after feeding. Plate made three minutes after feeding. Child held in supine position, left side against the plate. Child very uncomfortable; vomited during first exposure. Milk and bismuth are in the posterior part of the stomach, gas in the anterior part. Esophagus is shown well below the level of the fluid, lying on the bodies of the vertebrae. Considerable gas in the intestine.

Fig. 8.—Five minutes after feeding. The child was held in the erect position, the anterior abdominal wall held against the plate. The gas has been forced upward to the upper pole of the stomach by the fluid which has gravitated to the lower part. After this plate the child was held upright, and was patted on the back. He eructated gas twice in considerable amounts. He immediately became more quiet, stopped crying and went to sleep.

Fig. 9.—Ten minutes after feeding. Position same as last plate. The gas has all been expelled from the stomach except a very small bubble just at the cardia, that is, just to the left of the vertebral column. The stomach is contracting down on the food. The splenic flexure contains a good deal of gas. This was overlapped by the stomach in the last picture.

Fig. 10.—Fifteen minutes after feeding. Position supine, left side against the plate, as in first plate. The stomach has contracted, and a peristaltic wave constricts it in the middle. A very small bubble of gas lies between the level anterior line of the fluid and the anterior abdominal wall.

This is shown in the third series of radiograms. Figure 11 shows the same large air-bubble in the anterior part of the stomach, the child being in the supine position. The child was turned over into the prone position and the illustration shows the air-bubble forced back by the milk which now occupies the anterior part of the stomach (Fig. 12). The position of the esophagus does not show, as the child was not vomiting, but it can be determined by noting the bodies of the vertebrae, and remembering that the esophagus lies about 1 cm. from their ventral surface. This is well above the level of the liquid.

The third picture (Fig. 13) shows the child held erect. He eructated some at once so that the bubble in the fundus end is smaller than in the last plate. He was then placed face downward and a plate made with the rays directed from behind forward (Fig. 14). This is the usual prone picture and shows how impossible it is to estimate the amount of gas present in this position, as it overrides the milk and only shows as a rim at the fundus end. It also shows the mobility of the pyloric end of the stomach, which is here pushed well over to the right of the mid-line (Contrast Fig. 13). The effect of posture and pressure has made two apparently different "types" of stomach.

The child was then held up and eructated gas twice, without vomiting. The next picture (Fig. 15) shows a decidedly smaller air-bubble. The last picture (Fig. 16) taken from right to left in the supine position shows the fundus end of the stomach contracted down on the milk and only a small bubble present toward the pyloric (anterior) part of the stomach. The contrast between Figures 11 and 16 is again striking enough to account for a good deal of difference in the comfort of the child.

If the child is kept horizontal from one feeding to the next the result depends on how much air is swallowed with the food, the capacity of the stomach and the ease with which the child vomits. If a large amount of air is swallowed, vomiting nearly always takes place, usually in the form of simple regurgitation, but occasionally the vomiting may be violent and projectile. Children vary greatly in the amount of air swallowed and in the degree to which the stomach will bear distention. Some will swallow and retain an enormous air-bubble without vomiting, but the usual result is rejection of part of the food by mouth until the tension on the stomach wall is relieved. The effect on the stomach of the extreme distention seen in some cases must be unfavorable to digestion. It seems as if there must be interference with secretion by the pressure on the mucosa and blood vessels. If the gas is expelled, then the stomach is free to contract and secrete. When the child is *kept* in the horizontal supine position the gas is gradually forced through the pylorus, and must traverse the intestine before escaping,

for even if part of the food is vomited the gas cannot escape by mouth. If the gas is in large amount it causes intestinal colic. This symptom may often be entirely relieved by assisting the expulsion of the gas by mouth, so that it need not be passed through the intestine. The symptom of "colic" is probably due in many cases to painful gastric distention, as well as painful intestinal peristalsis. The frequency with which colic accompanies regurgitation is suggestive of their common origin.

Figures 17 to 20 illustrate this point. Figure 17 shows the gas-bubble as usual at the anterior part of the stomach. The child eructated all the gas as soon as he was held upright, so Figure 18 shows no gas in the stomach. Figure 19, in the prone position, shows the change in shape and position of the stomach due to pressure on the abdomen, compared with Figure 18. Figures 17, 18 and 19 all show a large amount of gas in the small intestine. In Figure 20—five hours and twenty-five minutes after feeding—there is still bismuth in the stomach. This child was fed every three hours, so that the second feeding was taken before the stomach was empty and mixed with the residue of the first. The child should have been fed every four hours. The cecum contains almost all of the rest of the bismuth except a small amount in the small intestine. This corresponds to the usual mechanism of a rapid passage of food through the small intestine. The transverse colon is full of gas, namely, that which was in the small intestine in Figures 17, 18 and 19. There is very little gas in the small intestine. This is in accordance with the fact that the gas taken in with the bismuth meal was expelled by mouth, and therefore was not passed through the intestine as would have been necessary if the child had been kept in the horizontal position.

Children vary greatly in their ability to relax the cardia, and eructate, some doing it easily and apparently voluntarily, while others do it only with great difficulty. The instinctive posture which many mothers assume (if not taught otherwise by nurse or doctor), when they hold the baby up against the shoulder after nursing, is the one in which the baby can most easily get rid of this undesirable swallowed air. Patting on the back aids the process of eructation, and it sometimes requires patting of considerable force. Slight pressure on the epigastrium may be needed, the mother grasping the baby's abdomen with her free hand and gently rubbing and pressing the stomach with her thumb, as he rests against her shoulder. At times the eructation may be violent and the contraction of the stomach so forcible and rapid that a small amount of milk comes up with the air. The amount of regurgitation from this cause is negligible, compared to the comfort given the baby by relieving his gastric distention. The air does not always all come up at once, often requiring several eructations. In

Figure 11

Figure 12

Figure 13

Figure 14

Figure 15

Figure 16

Fig. 11.—Healthy child, aged $6\frac{1}{2}$ months; shown also in Figures 12, 13, 14, 15 and 16. Given usual feeding of $5\frac{1}{2}$ ounces with bismuth subcarbonate $\frac{1}{2}$ ounce. Taken well, no vomiting. Plate made two minutes after feeding was finished. Supine position. Right side against the plate. Enormous bubble of gas in stomach. Fluid line well above site of esophagus.

Fig. 12.—Three minutes after feeding. Prone position. Left side against the plate. The milk has gravitated anteriorly, forcing the gas to the posterior part of the stomach. The position of the vertebrae show that the esophagus is now above the fluid line. The child was then held erect and eructated gas at once.

Fig. 13.—Four minutes after feeding. Erect position. Abdomen against the plate. The air bubble is at the upper part of the fundus, in a position whence escape is easy by the esophagus.

Fig. 14.—Five minutes after feeding. Prone position, the child's abdomen in contact with the plate. Note the gas only as a rim at the fundus end and the position of the pylorus compared with the preceding (Fig. 13). The child was again held upright and eructated more gas.

Fig. 15.—Eight minutes after feeding. Erect position. The gas bubble is still smaller in Figure 13.

Fig. 16.—Nine minutes after feeding. Supine position. Right side against the plate. There is only a very small bubble at the anterior part of the stomach. The stomach has contracted down on the milk. Compare Figure 11.

some cases (as in Figs. 1 to 6) a baby has to be held up every two to three minutes during the feeding to prevent vomiting from air swallowing. It is seldom possible to remove all the gas even when the baby eructates easily, but the small remaining amount causes no discomfort as a rule.

An illustrative case is that of the child from which Figures 1 to 6 were made. This was the second child, a large baby at birth. The labor was easy and short. She was breast-fed for two months, every two hours for twenty minutes. The milk then failed and the mother gave equal parts of milk and water with a "pinch" of sugar in each 5-ounce feeding, given every two hours by day during the third month. About 45 ounces were said to have been given in a day. The child was seen first at three months; weight 9 pounds 6 ounces. The nutrition was not very good, but the child was otherwise in fair condition except for a much-distended abdomen. She had vomited after nearly every feeding since birth, at times violently, but generally had simply regurgitated part of each feeding. The stools were three or four a day, yellow, soft, with occasional curds. She had some colic, and expelled a good deal of gas from the bowels. She slept well from 10 to 6, but the sleep was disturbed during the day. She had been fed in the horizontal position and had been put to bed in that position as a rule, but had occasionally been held up, and had eructated gas. A diagnosis was made of too frequent feeding, too large a total amount, air-swallowing and postural vomiting. The following formula was prescribed:

Milk, 4 per cent.....	18 ounces	367 calories	Fat.....	2.4 per cent.
Lactose, 3 level table- spoonfuls		116 calories	Sugar.....	6 per cent.
Water	12 ounces	483 calories	Protein.....	2.1 per cent.
	<u>30 ounces</u>	Energy quotient.....		52 per pound

Fed $4\frac{1}{4}$ ounces every three hours; seven feedings.

The mother was carefully instructed to hold the child erect after each feeding in the routine manner (see summary).

One week later there was no gain in weight; still 9 pounds, 6 ounces. The child still vomited; the mother was discouraged and said the child was hungry. The milk was increased 2 ounces making the formula fat, 2.65 per cent., sugar, 6.3 per cent., protein, 2.4 per cent.; caloric value 554; energy quotient, 59 per pound.

One week later, the child still vomited a great deal, but had gained 14 ounces, weight 10 pounds, 4 ounces. The mother was then carefully questioned and said that the child vomited whether she was held up or left flat, but admitted she had not held the child up after every feeding, but only when the baby cried or seemed restless.

The whole purpose of the routine was again carefully explained and the mother was told to hold the child erect *before feeding, in the middle of the feeding and at the end of the feeding.*

One week later, vomiting was much less; weight 10 pounds, 10 ounces; same formula.

One week later, there was no more vomiting; weight 11 pounds, 2 ounces; same formula.

One week later, there was no more vomiting; weight 11 pounds, 14 ounces; same formula.

General comfort greater, sleep quiet, no colic. Energy quotient 50. The roentgenograms show that this child swallowed an excessive amount of air. During feedings it was possible to hear a gulping sound with each swallow.

Different nipples were tried, and the food was given slowly and rapidly without result. It is evident that this child swallowed as much air in taking 2 ounces of food as the average child does in taking a much larger amount, and therefore it was absolutely necessary that an opportunity be given to get rid of the air in the middle of the feeding, before the stomach became too greatly distended. We believe that this is an example of a large number of cases which are diagnosed as "nervous vomiting," "habitual vomiting" or even as pylorospasm.

Many very feeble babies vomit whenever put down on their backs even if held upright until the gas has all been expelled. The cardiac sphincter seems to have no power, and the milk simply flows out of their mouths whenever gravity has a chance to act. This may be stopped, in some cases at least, by constantly keeping the basket or bed at an angle of about 45 degrees, and never letting the child assume a horizontal position. The prone position may be borne, but it is better to have the head well raised.

The time taken at the bottle or breast is of importance. We believe that it is better for a child to take a feeding too rapidly than too slowly. Rapid nursing may choke the baby and cause coughing, gagging and vomiting if the pharynx fills too rapidly. Slow feeding, that is, twenty to thirty minutes, only multiplies the number of swallowing acts, diminishing the amount of milk and increasing the amount of air taken in each swallow. The old argument against rapid feeding is probably based on cases in which an enormous amount of milk was obtained from very full breasts and regurgitated from *overfeeding*, not from *rapid* feeding. If an infant is weighed every minute while nursing a full breast it is often found that 50 per cent. of the milk is taken in the first two to three minutes, 75 per cent. in the first five minutes and after that the amount per minute decreases rapidly. Such infants show no more signs of discomfort or indigestion and do not vomit more than others, unless they stay at an empty breast sucking and swallowing air. A case may be cited in which a 6-weeks baby obtained from $2\frac{1}{2}$ to 3 ounces in forty seconds and showed no signs of discomfort. The mother had to use a watch to time the feedings. If nursed one minute he vomited from overfeeding. Rapid feeding, therefore, in itself causes no symptoms, and except in the case of feeble infants there is no good reason why a feeding should not be taken in five to ten minutes, or at most in fifteen rather than the traditional twenty.

This is quite contrary to the usual teaching. Nurses are taught that the baby must spend twenty minutes at a bottle. Experience shows that the holes in the nipple must be made very small indeed to prevent a strong child from emptying a bottle in ten minutes. It is much better to have four or five large holes so that the milk runs freely without shaking the bottle when it is inverted, and let the baby regulate the

Figure 17

Figure 18

Figure 19

Figure 20

Fig. 17.—Healthy child, aged 7 months; shown also in Figures 18, 19 and 20. More or less vomiting since birth. Given usual feeding with bismuth subcarbonate $\frac{1}{2}$ ounce. Feeding taken readily in fifteen minutes. Child kept in horizontal position. No vomiting or apparent discomfort. Five minutes after feeding. Supine position. Left side against plate. There is a large bubble of gas in the anterior part of the stomach. The milk lies in the posterior position. The small intestines contain a good deal of gas.

Fig. 18.—Eight minutes after feeding. Erect position. Abdomen against plate. As soon as this child was held erect the gas came up as a loud eructation. There is practically no gas left in the stomach, which has contracted down on the food. A little bismuth has entered the small intestine.

Fig. 19.—Seventeen minutes after feeding. Position prone—anterior abdominal wall against the plate. The difference in shape of the stomach between this and Figure 18 is striking. The pylorus has moved well over to the right, probably due to pressure on the abdomen by the surface upon which the child was lying. A good deal of bismuth has entered the small intestine.

Fig. 20.—Five hours, twenty-five minutes after feeding. Erect position. There is considerable bismuth still in the stomach, due to short interval feeding. The rest of the bismuth is in the cecum except for a small amount in the intestine, which contains little gas. The gas which was in the small intestine is now in the colon.

time for himself. Puny infants often become so discouraged at sucking at a nipple with the usual small holes that they will not try to take the bottle at all.

That posture is not without importance in abnormal conditions was shown by a case of pyloric stenosis. This child had a typical history of pyloric obstruction beginning at about six weeks, and had developed a large dilated stomach with tumor, peristaltic wave, projectile vomiting and wasting. The mother refused operation and even hospital treatment. With lavage and careful feeding — at first breast-feeding, then mixed breast and bottle — the child slowly improved, stopped vomiting and began to gain weight. At the time when the Roentgen-ray plates were made the child was 3 months old and gaining slowly. The bottle was not well taken at this time, so only about 2 ounces of feeding with bismuth subcarbonate could be forced down. There was still retention of considerable food in the stomach, and the two ounces of bottle made the child very uncomfortable. The first plate (Fig. 21) was made in the supine position. It shows the great dilatation and the double pouch-shaped stomach. The lower pouch is the pyloric end. The mother wanted to hold the baby upright at once, for she had been carefully taught the importance of so doing. During the time needed to take the first plate the mother became very anxious and begged that the child be held erect. She said: "I know he will vomit, and he has not vomited in two weeks, and I hate to spoil his record."

Her fears were realized, for the child did vomit violently — in a typically projectile manner, just as he had done at the onset of his symptoms. He was held upright immediately after the exposure and at once eructated a large amount of gas. This gas was not only swallowed air, but also the product of gastric fermentation due to stagnation. The residue in this child's stomach resembled kumyss. The child was held erect until the next plate was made (Fig. 22). This was twenty-five minutes later, and during that time he had eructated several times. Figure 22 shows only a small amount of gas in the stomach. The pyloric pouch has contracted down on the milk and a moderate amount of bismuth has entered the intestine. The child was held erect several times before the third exposure and again eructated. In Figure 23 there is almost no gas in the stomach. The intestines are almost free from gas in all the plates of this child. This is the more remarkable since there was known gas production in the stomach. The mother's care to allow the gas to escape from the stomach by the mouth not only was an important factor in stopping the vomiting, but also saved the intestines the necessity of passing the large volume of gas, with resulting colic and distention.

The teaching in practically all training schools for nurses has been that the baby should be kept in the horizontal position after nursing and must on no account be held up, or "moved about." This theory probably had its origin in an effort to counteract the trotting, rocking, jouncing habits of so many mothers — which of course may cause vomiting — the milk being splashed out of the stomach as it would be from a bottle. This does not take place easily, however, unless the child is held horizontally during the trotting or rocking. A careful census has been kept of all trained nurses in charge of infants in the practice of one of us in the last seven years, and only four or five have been found who had evolved the plan of holding the baby erect *as a routine*. A few more have done it at times when the child seemed to have colic or discomfort. Only one nurse has been found who was taught in her training-school that every child should be held up after every feeding.

Nurses train mothers nowadays. A young inexperienced mother takes the word of the trained nurse as law, and when doctor and nurse disagree, the doctor must indeed possess unusual influence over the mother to have an even chance of having his instructions carried out. Small wonder then that most babies are put into their beds to squirm and cry and vomit until enough milk comes up to relieve the distended stomach. After the trained nurse has left, a mother will sometimes pick up the baby and hold him against her shoulder in a desperate attempt to soothe away the colic with a little cuddling and patting. This is done with a guilty conscience at disobeying the nurse's ironclad rule. When the gas comes up and the baby goes to sleep and stays asleep when put back to bed, the mother begins to think. It needs but few repetitions of the experience for the intelligent mother to draw the correct conclusions. Unfortunately, the courage to disobey the nurse's law and the ability to draw conclusions from observation and experiment are rarely combined in one young mother.

Among the poorer classes, where there is no adverse suggestion from the nurse, the baby is often held upright as a routine. It must be admitted that the grandmother is often right on this point, much as she is abused for her interference with modern training and discipline.

Hospital feeding cases are usually examples of the bad results of the horizontal position. In many hospitals the babies are fed in bed and allowed to lie without change of position day in and day out, except when taken up to be bathed or moved to another bed. It is a simple matter to note in practically any case in such a ward that the abdomen is distended, with a large area of gastric tympany. Holding the child erect for a moment will bring up a large bubble of gas, and the percussion note of the epigastrium changes at once. Besides the effect on

the stomach, and on regurgitation, etc., it must be bad for such babies to lie in one position all day. Dr. W. P. Northrup pointed out years ago that it was the lack of holding in the mother's arms which made so many of these children do badly.

Older children who sit up by themselves regulate this matter under ordinary circumstances, but in acute illness, as pneumonia, there may arise a condition of gastric distention due to the horizontal posture. Raising such patients to the erect posture occasionally aids in the eructation of gas and relieves the pressure on the heart and lungs. This is probably one reason why surgical patients do better in the semi-erect position than when the foot of the bed was raised, as was formerly the general practice.

Medical text-books do not mention the posture of the child after or between feedings as a cause of vomiting or indigestion. The matter is dismissed with the general statement that the child should not be moved about after feeding. Medical writers are also silent on this subject with a few exceptions.

Rosenstern,⁴ in a clinical lecture in Finkelstein's clinic, notes the importance of posture. He says that the practice of mothers and nurses of holding infants up and allowing eructations during and after feeding is regarded by doctors as an evil and is not described in medical text-books, but is found in a few written by nurses. He quotes Wilhelmina Voelzter to the effect that children held up vomit less and sleep better. He also notes that often young children after drinking a while get too full and can hold no more, become uncomfortable and if forced they vomit. If held up after a few minutes they eructate, and often a large amount of air. They will then take more food. This is especially true of children fed on dilute milk mixtures, in the early months, and in hospitals where nurses have no time to hold babies up.

Usener says:

Daily experience teaches us that nurslings who are held up by nurses one-half to one and one-half hours after feeding almost always eructate more or less gas. Many mothers and good nurses hold the baby up during or after feeding from the experience that they take the feeding better, vomit less and are more quiet if they have eructated.

Kilmer⁵ advised holding babies upright for colic to let the bubble which caused the colic escape.

Tweddell⁶ says that after feeding the baby may be picked up if restless, held against the shoulder and patted gently on the back for a minute or two, as a little wind on the stomach may be the cause of the restlessness.

4. Rosenstern: *Deutsch. med. Wchnschr.*, Sept. 26, 1912, p. 1834.

5. Kilmer: *Practical Care of the Baby*, F. A. Davis Company, 1903.

6. Tweddell: *How to Take Care of the Baby*, Bobbs-Merrill, 1913.

Figure 21

Fig. 21.—Child with pyloric stenosis, aged 3 months; shown also in Figures 22 and 23. Onset of symptoms at 6 weeks. Classical symptoms of stenosis or extreme spasm with gradual relaxation of spasm and improvement. Child doing well at this time, but stagnation and fermentation still taking place. Took bottle badly, only 2 ounces of food with bismuth subcarbonate 1:8. Five minutes after feeding. Supine position. Left side against the plate. Huge gas bubble anteriorly. Double pouch of stomach well shown. Child vomited violently just after exposure. Child was then held erect and eructated large amounts.

Figure 22

Figure 23

Fig. 22.—Twenty-five minutes after feeding. Erect position. Abdomen against the plate. There is only a small gas bubble at the cardiac end of the stomach. Considerable bismuth has entered the small intestine. The child was held upright several times during the next half hour and eructated more gas.

Fig. 23.—One hour and fifteen minutes after feeding. Erect position. There is very little gas left in the stomach. The intestines in Figures 22 and 23 show little or no gas. This is instructive in this case with known gas formation in the stomach.

Grulee says:

Colic immediately after feeding is probably from stomach, later from intestinal gas. To expel the stomach gas the child can be held to the shoulder or across the lap.

CONCLUSIONS

Air is swallowed with the food by many if not by all infants.

The erect posture favors eructation of this air; the horizontal posture prevents it.

The horizontal posture, by preventing eructation, is an important cause of vomiting, colic, indigestion and disturbed sleep.

The following routine should be followed in feeding every infant:

Before feeding the infant should be held upright to allow the escape of any gas present in the stomach.

Immediately after feeding the infant should be again held up against the shoulder of the mother or nurse. He may be patted on the back or gentle pressure may be made on the epigastrium to encourage eructation of the swallowed air.

It may be necessary to interrupt the feeding one or more times to hold the child upright to eructate, in cases in which an excessive amount of air is swallowed.

After the gas is eructated the child should be put down to sleep, preferably in the prone position and with the head of the bed raised.

If restless he may be taken up after a short time to see if there is more air in the stomach.

Habitual tongue-suckers need to be held up several times between feedings, as they constantly swallow air. Other suckling habits must be prevented by mechanical restraint.

Feedings should be given at as long intervals as possible, depending on the gastric capacity and the total daily requirements.

A feeding should not be taken too slowly. From five to ten minutes are enough as a rule; fifteen minutes should be the maximum time at bottle or breast.

The importance of posture and the wrong teaching given to physicians and nurses in the past warrant the emphasis laid on so simple a matter.

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