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**GASTRIC ACIDITY OF THE NEWBORN**

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During the past century, many authorities have been interested in the acidity of the gastric contents in the neonatal infant. Early investigations were markedly limited by the belief that stomach tubes were dangerous when used on newborns. Late in the eighteenth century, however, there were a number of investigations performed in Europe. It was not until 1913 that an American showed any interest in this subject. At that time, Hess<sup>1</sup> took samples of gastric contents from fifty-five infants under fifteen hours of age and found them all to be highly acid. Griswold and Shohl<sup>2</sup> found some twelve years later that there was a pH range of from 4.4 to 1.7 on the twenty-five babies from whom they took samples. The mean pH on this group was 2.6.

In the early 1940's, several men again were testing gastric acidity in newborns. Ritter<sup>3</sup> took samples from thirty-six infants one-half to fourteen hours old and found a pH range from 4.6 to 1.3. Miller<sup>4</sup> followed the fasting acid on newborns for the first month of their lives and found the acidity to be highest during the first and second day, decreasing slowly until the seventh day, and then remaining at that lower level.

It has been noted that although many men have investigated the acidity of the newborn, only one investigator, Hugo Huhtakangas, took repeated specimens from the same infant in an effort to ascertain if there is any change in the pH of the gastric contents during the first twenty-four hours. Huhtikangas<sup>5</sup> set out to

answer two questions: first, to find out what the reaction of the stomach contents of the newborn was immediately after birth, and second, to find out if there are any changes in the reactions during the period from birth up to the first feeding. This investigator had twelve infants in this series. Four had samples taken within the first fifteen minutes and then each hour through the first four hours. Two had samples drawn first during the second fifteen minutes and then each hour through the first four hours. One had his first sample drawn during the third fifteen minutes and then each hour through the first five hours. The first samples on the other five infants were taken from the first to the fourth hour of life with repeat samples taken every hour for four hours.

These investigations showed that the specimens taken during the first fifteen minutes had a range of pH 7.60 to 6.62 with a mean of 7.17. The range on those taken during the second fifteen minutes was pH 7.12 to 4.69 with a mean of 5.90. There was only one specimen taken during the third fifteen minutes, and that one had a pH of 3.95. The range on the one hour specimens was pH 6.12 to 1.69 with a mean of 4.08. By the end of two hours, the range in pH is from 6.3 to 1.38, and the mean had dropped to 2.46. By the fifth hour the range was from 1.81 to 1.21 with a mean of 1.53.

Bradley and Tilghman<sup>6</sup>, in 1952, cast some doubt in the

validity of Huhtikangas' work. After passing a glass electrode into the stomach of forty-one babies, they took direct readings of the pH of the gastric mucosa of the fundus. They found that the range of pH on the nineteen babies under twenty-four hours of age to be from 2.64 to 1.57 with a mean value of 2.10. It must be noted, however, that the youngest of these babies was three hours old. The range on those babies that were from twenty-four to forty-eight hours old was 2.72 to 1.19 with a mean value of 2.03. These authors also noted that Huhtikangas' mean value for the samples on the 260 infants from five to twenty-four hours old was 1.45, which is somewhat lower than their mean value of 2.10 on a comparable group:

With the above noted information in mind, we set out to confirm or disprove Huhtikangas' work with a larger series of infants. We were primarily interested in emptying the stomach of the newborn as soon as was practicable and then noting the pH of the specimens taken one hour later. Thus we would have a fairly accurate check on the degree of acidity of the gastric juices secreted during that hour. The third specimen was obtained four hours after the second and gave us a further check on the degree of secretory activity of the gastric mucosa during this early newborn period. A fourth and final specimen was taken twenty-four hours after delivery. All of the infants had been fed before this last specimen except cases 120,287, 120,230,

and 120,291.

All of the specimens were obtained by passing a No. 9 or No. 10 French, soft rubber catheter into the stomach and aspirating the contents with a 5 or 10 cc. syringe. An attempt was made to aspirate the entire stomach contents for the first three samples. For the fourth sample, only enough was taken to easily determine the pH of the specimen. The average volume of the initial specimens was 1.9 cc. The samples taken one hour later averaged 1.53 cc. in volume. The five hour samples averaged 1.32 cc. All of the samples were taken immediately after the tube was passed into the stomach. After the specimens were obtained, they were stored in a refrigerator at from 6° to 0° C. until the evening of the day they were drawn when the pH of the sample was determined on a glass electrode type pH meter.

The material which was examined: there were 204 samples taken from fifty-three consecutive births occurring between 7 A.M. and 11 P.M. at the University of Nebraska Hospital. Of these fifty-three newborns, twenty-nine were males and twenty-four were females. There were twenty-three caucasian babies, twenty-seven negroes two Indians, and one oriental. Of the fifty-three babies, one was delivered by Cesarean section, and the rest were delivered vaginally. The birth weights ranged from 2156 grams to 4313 grams. There were three prematures or infants that weighed less than 2500 grams at birth. One newborn,

Case No. 120,287, was an erythroblastotic baby and had an exchange transfusion during its first twenty-four hours. The mother in Case No. 120,725 had an acute pyelonephritis at the time of delivery, and the mother in Case No. 120,474 had a positive serology. Other than in these three instances, there were no complications encountered.

Table number one which follows is a complete listing of the pH's of the specimens obtained and the time after delivery that they were taken. Those pH's followed by an "m" indicate that the sample was made up entirely of a thick mucinous material. Those followed by a "b" indicates that the specimen was bile-stained.

In graph "A", we have plotted the median pH values of the four samples--the newborn sample, the one hour sample, the five hour sample, and the twenty-four hour sample--against time. From this graph we can see that most babies have a relatively neutral reacting gastric content at time of delivery. Within one hour after birth, the pH of the stomach contents drops to 3.05

This is an increase in acidity of about 500 times. By the time the baby is five hours old, the pH has dropped to 2.15, which is ten times as acid as it was only four hours earlier. After twenty-four hours the pH had risen to 3.8, but it must be noted that all but three of these babies had been fed before the twenty-four hour specimen was obtained. It is of interest

TABLE NO. 1

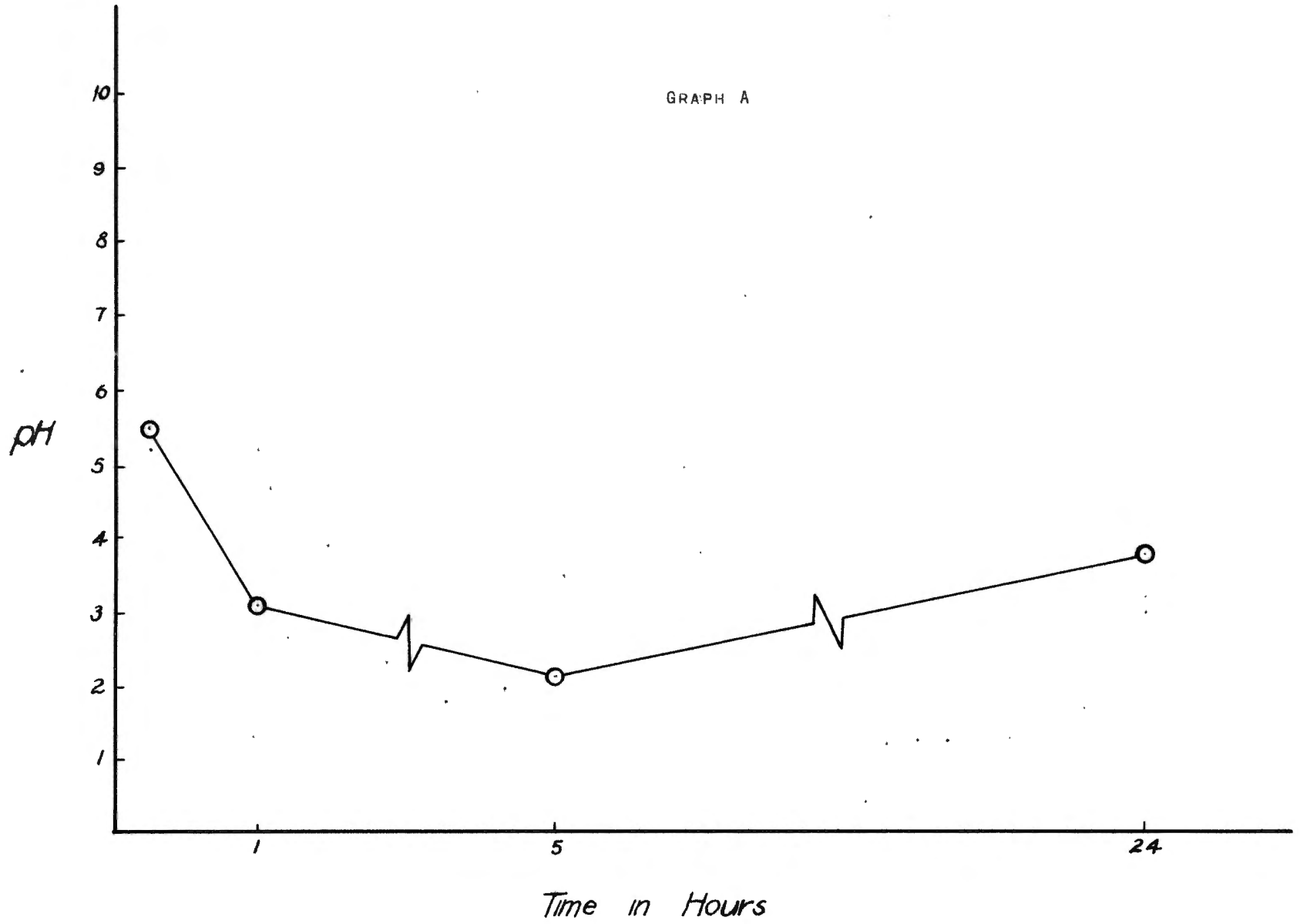
HOSP. NO.	SEX	RACE	BIRTH WT.	MIN. AFTER DELIVERY											24HR		
				15	30	45	60	75	90	105	120	315	330	345		360	
120133	F	O	3260 GM.	8.0				3.2					1.5				--
120275	M	N	2948 GM.	6.1				5.5					3.3				4.2
119926	F	W	3572 GM.	2.3				1.6					2.1				3.3
120329	M	N	3012 GM.		6.9				7.5M					2.2			1.9
120342	M	W	3292 GM.		7.3				4.3					2.1			4.5
120319	M	W	3439 GM.		5.7				2.3					1.9			3.6
120364	M	W	3453 GM.		3.9				2.7					1.6			5.6
120474	F	N	3292 GM.		4.6				2.5					2.9			4.4
120743	F	N	2951 GM.		3.6				2.7					4.2			2.1
120158	M	N	3746 GM.			3.7				2.9				2.2			2.3
120171	M	W	3093 GM.			6.2				2.4				2.3			1.3
120187	F	N	2639 GM.			6.1				4.4				1.4			2.9
120215	M	N	3235 GM.			5.3				2.2				1.3			4.0
120230	F	W	2213 GM.			5.8				3.2				2.1			4.5
120184	M	N	2979 GM.			6.1				--				1.7			4.1
120231	F	N	2497 GM.			5.9				--				--			--
120291	F	W	2156 GM.			2.7				3.2				1.6			2.2
120336	M	N	3178 GM.			4.1				7.2M				8.3M			4.9
120354	M	N	3518 GM.			5.4				2.8				2.9			4.3
120356	M	W	2525 GM.			4.2				2.8				3.0			5.1
120369	M	N	3476 GM.			7.2				4.0				2.9			2.9
120487	F	W	2979 GM.			8.4				7.6				2.6			5.0
120486	M	W	3419 GM.			4.0B				2.3B				1.8			2.5
120509	F	N	3178 GM.			5.8				2.1				2.0			4.5
120540	F	N	2979 GM.			3.6				1.9				1.3			2.3
120542	F	W	3235 GM.			2.5				1.9				1.3			3.8
120307	F	I	3518 GM.			4.3				2.1				2.8			4.0
120653	F	W	4171 GM.			6.9				7.6				3.8			5.6



TABLE NO. 1 (CONT'D)

HOSP. NO.	SEX	RACE	BIRTH WT.	MIN. AFTER DELIVERY											24HR.	
				15	30	45	60	75	90	105	120	315	330	345		360
120663	M	W	3366 GM.			7.3				6.7				2.2		3.4
120664	M	N	2866 GM.			7.1				6.2				4.3		3.1
120704	F	N	3376 GM.			2.6				2.6				1.2		5.1
120143	M	N	3292 GM.				3.0				1.8				1.3	2.0
120159	F	W	3575 GM.				7.4				7.3				2.0	4.3
120173	F	W	3518 GM.				6.6				4.1				1.4	2.4
120175	M	N	3405 GM.				3.0				6.0				2.7	3.8
120179	M	N	2979 GM.				3.1				1.8				6.8M	3.8
120199	M	W	2951 GM.				7.1				7.1M				6.8M	3.6
120246	F	I	4256 GM.				6.7				2.3				1.1	2.9
120260	M	N	2951 GM.				3.3				2.8				2.0	4.5
120288	M	N	3008 GM.				2.8				4.8				2.3	3.5
120287	F	W	3958 GM.				6.9				6.1				--	2.7
120376	M	W	3264 GM.				5.5				2.3				1.8	4.9
120381	M	W	4313 GM.				4.8				4.1				5.2M	2.7
120424	F	W	2838 GM.				7.7				5.0				3.0	6.0
120439	F	W	2851 GM.				6.1				4.7				1.7	3.4
120635	M	N	2554 GM.				4.1				3.2				2.6	5.2
120634	M	W	3462 GM.				--				6.5				4.0	4.1
120725	M	N	3192 GM.				4.7				6.0				6.0	4.9
120745	F	W	2866 GM.				4.7				2.2				1.5	--
120228	F	W	3815 GM.					4.0				2.7			3.4	--
120259	M	N	3264 GM.					6.8				2.2			1.3	4.9
120373	F	N	3008 GM.					2.6				1.9			1.6	3.2
120526	M	W	3093 GM.					2.6				2.5			2.2	2.3

GRAPH A

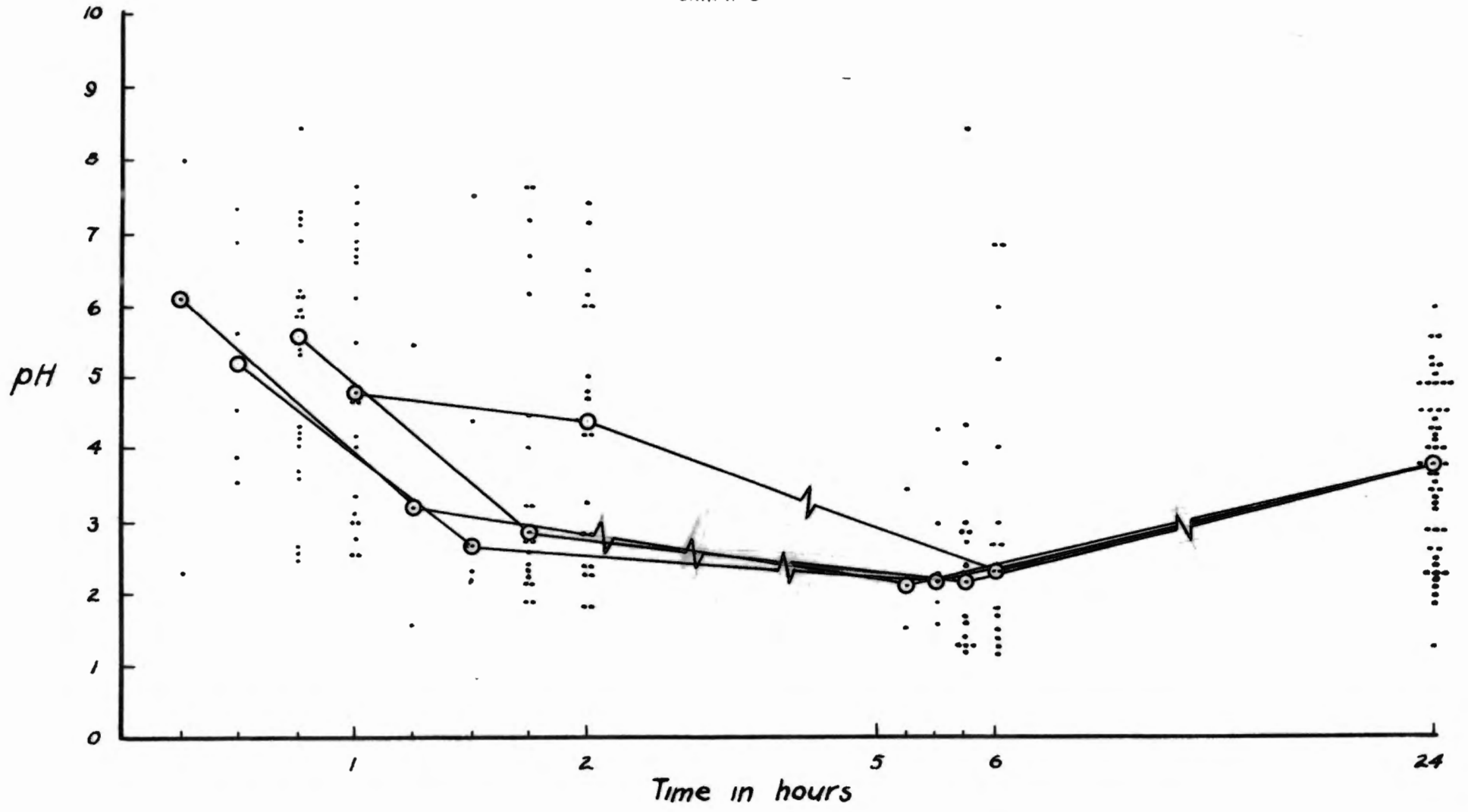


to note that sixty-five per cent of the individual baby's specimens, when plotted pH against time, show a curve similar to the one seen in graph "A" only at varying levels of pH. Another thirteen per cent of these curves vary from that seen in graph "A" only in that the five hour sample is slightly less acid than the one hour sample. Thus it can be said that nearly seventy-nine per cent or forty-one of the fifty-two cases followed this curve in general. There are five other cases in which one or more samples were noted, at the time, to be made up entirely of a thick tenacious mucous. By referring back to Table number one, you will note that all of these samples were nearly neutral in reaction. If we may be allowed to delete these five cases as having been obtained improperly, we have forty-one of forty-seven or eighty-seven per cent of the cases following the curve in graph "A" in general.

Graph "B" is a more detailed breakdown of the cases. Here the cases that were first seen within the first fifteen minutes are carried through to the twenty-four hour sample separately, as are the group that was first seen in the second fifteen minutes, those first seen in the third fifteen minutes, and those seen first forty-five or more minutes after delivery. In this graph, each individual value is also plotted.

In this series of fifty-three cases, there were twenty-nine males and twenty-four females. We could find no significant difference between the values found for the males and the females.

GRAPH B



Of the fifty-three, there were twenty-three white babies, twenty-seven negro babies, two Indian babies, and one oriental baby.

We could find no significant difference between the negro and white babies. Forty-seven of the babies were from forty week pregnancies, three from thirty-eight week pregnancies, two from thirty-six week pregnancies, and one from a thirty-five week pregnancy. There is no apparent difference in the reactions of the stomach contents of the prematures or early babies from those delivered at forty weeks.

**Summary:**

Repeated samples of the stomach contents were obtained from fifty-three newborns. The acidity of each of these samples was determined. It was observed that the pH of the newborns' gastric contents is relatively neutral from fifteen to forty-five minutes after birth--ranging from 8.5 to 2.3 and having a median of 5.55. By one hour later, the pH has dropped to a median value of 3.05 with a range of 7.5 to 1.6. By the time the baby is about five and one-half hours old, the pH of his stomach contents has range of from 8.3 to 1.1 with a median of 2.15. Samples taken when the baby is twenty-four hours old and after it has been fed, have a range of from 6.00 to 1.3 with a median of 3.80. Thus we tend to confirm Huhtikangas' earlier work and show that most newborns have a relatively low acidity at the time of birth, but very soon after birth begin to produce a highly acid stomach secretion.

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