It has long been recognized that toxæmia is frequently associated with beriberi, and in these cases both diseases are susceptible to the administration of vitamin B. Hamlin (1952), in Australia, has reduced the incidence of toxæmia by recognizing excessive weight gain as an early sign of toxæmia and by impressing on such patients the importance of lowering their weight by a high-protein, low-carbohydrate, and high-vitamin diet. The importance of the protein and vitamin in Hamlin's work, and the vitamin B in treatment of beriberi cases, is corroborated by the work of Nelson and his colleagues, who found that pregnancies in rats bred on a diet deficient in protein and vitamin B₆ could be maintained only with progesterone. I have already demonstrated the value of the administration of progesterone in the treatment of toxæmia in its early symptomatic stage.

From this it would appear that there is a close connexion between progesterone, protein, and vitamin B₆ in the maintenance of pregnancy. On the one hand, Hamlin has reduced the incidence of toxæmia with a high-protein and high-vitamin diet, and, on the other, the administration of progesterone achieves a like result, while Nelson and others have shown the close connexion between both treatments in their experiments on rats. If the role of progesterone is similar in humans and in rats it would suggest that protein and vitamin B₆ play an important part in the production of progesterone in the body. Should this be so, would it not explain the enigma of the success of vitamin B in the toxæmic beriberi cases and its failure when applied in the prophylaxis of toxæmia in Britain? Does it not also explain the success of Hamlin's slimming diet in Australia and its failure when applied here? The essential element for success in each instance is sufficient dietary protein, which in this country is lacking. The prohibitive cost of a high-protein diet for the average mother in Britain compels her to resort to a low-protein, low-carbohydrate diet for reducing her weight in pregnancy.

Conclusion

Toxæmia of pregnancy is one of the greatest dangers both to the pregnant mother and to the unborn child. Its aetiology is still unknown, and whatever light can be thrown on this subject may help towards eliminating this serious condition. Evidence is produced that lack of progesterone may be one of the important factors in the causation of the disease, and the prophylactic treatment with progesterone seems to have achieved worth-while results in its first year of experimental operation by reducing the incidence of toxæmia from 9% to 2.1%.

This preliminary study has certainly yielded interesting and encouraging data, and it is hoped that similar trials will be instituted elsewhere, for the subject obviously merits further study.

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LACTATION AND HEREDITY

BY

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In recent years investigations have shown that only about 50% of our babies are breast-fed for three months (Hughes, 1948; Dummer, 1949) and that the cause of failure is unknown in about one-half of the cases (Robinson, 1943; Royal College of Obstetricians and Gynaecologists, 1948). Although a wide variety of environmental factors are known to affect the duration of breast-feeding, yet basically the outcome will often depend upon the initial adequacy of the lactation—that is, the quantity and quality of the milk produced. Hytten (1954a, 1954b, 1954c, 1954d, 1954e) has pointed out that this may be genetically determined. We have found only four papers which make any attempt to assess the effect of heredity upon human lactation; their results, together with our own, are summarized in Table I.

TABLE I.—*Relation Between Mother's and Daughter's Breast-feeding Performance: Comparison Between Published and Present Series*

	Mother a "Good Nurse"		Mother Not a "Good Nurse"	
	No.	Proportion with Daughters who are "Good Nurses"	No.	Proportion with Daughters who are "Good Nurses"
Bunge (1900) ..	237	53%	147	1%
Winternitz (1922) ..	115	61%	15	73%
Robinson (1939) ..	81	76%	19	53%
Pfändler (1949) ..	217	83%	118	49%
Present series ..	397	60%	63	43%

* In each series the relationship in question is between the mother and one specified daughter (the propositus). Widely differing criteria of a "good nurse" have been used (see text).

Bunge accepted a woman as a good nurse only if *all* her children (with a few specified exceptions) had been fully breast-fed for nine months, but Winternitz was less rigorous and used only three months' breast-feeding of one specified daughter as a criterion. Neither appeared to recognize the cardinal difficulty of distinguishing between environmental and hereditary effects. On the other hand, Robinson and Pfändler both concluded that the association they demonstrated was the result of environmental factors, though Pfändler believed also in a genetic one. We have tried to throw further light on the problem by investigating the capabilities of two generations of women and also by means of a twin study.

Present Investigation

The investigation included 943 women who first attended an antenatal clinic (A.N.C.) in Edmonton between April, 1952, and June, 1953. It will be convenient to refer to these women as the "subjects." Whenever the word "mother" is used it will refer to the subject's mother; the mother-daughter relationship is that between the subject's mother and the subject. The "current" infant is the one born to the subject after the pregnancy for which she attended the A.N.C.

Omissions.—As a criterion of successful breast-feeding applicable to the current infant we chose the maintenance of uncomplemented breast-feeding of a single normal infant for eight weeks. The reason why we chose this period was

that most of the women brought their children to the post-natal clinic (P.N.C.) at or after the eighth week. There were, however, 88 who attended earlier, and these had to be omitted from the main analysis. This number could have been reduced by taking a shorter period than eight weeks, but this would have been unrealistic, as many unexplained failures of lactation take place in the second month. These 88 women were probably not representative of the main group, but a separate analysis showed that their omission was unlikely to have biased our results. The total number of omissions from the main analysis is given in Table II.

TABLE II.—*Causes of 210 Omissions from Main Analysis*

Stillbirths or abortions	51
Neonatal deaths or major congenital deformities	14
Twins (pairs)	13
Inadequate information given at P.N.C.	11
Attended P.N.C. before the eighth week	88
Failure to attend P.N.C.	33

At their first visit to the A.N.C. the women were asked a number of questions, the most important being, "Were you breast-fed?" and, if so, "For about how long?" Women who did not know the answers were given the opportunity to ask their mothers and reply at their second attendance.

At the P.N.C. particulars of the duration of breast-feeding were recorded in reply to the questions: "When did you first give the bottle regularly?" and, "When did you completely give up breast-feeding?" There is often an interval of several weeks between these dates, and at any given time the proportion of partly breast-fed infants may be of the order of 10% of the whole series. For most of this analysis we have concentrated our attention on the wholly breast-fed infants. In asking questions about the breast-feeding of other members of the family no such distinction was practicable. In referring to the previous generation we have simply used the criteria "breast-fed" and "not breast-fed," although a large majority of those in the former group claimed that breast-feeding lasted at least three months.

Mother-Daughter Analysis

After making the deductions referred to above there remain 733 women for the main mother-daughter analysis. Of these, 316 (43%) were primiparae. The mothers of these women can be divided into four groups: (1) those who breast-fed all their children, (2) those who breast-fed some, (3) those who fed none, and (4) those for whom no information was available. Table III shows the percentages of daughters who maintained complete breast-feeding of the current infant for at least eight weeks.

TABLE III.—*Relation Between Mother's and Daughter's Breast-feeding Performance*

Mother's Performance*	No.			Percentage of Daughters Breast-feeding for 8 Weeks†		
	Total	Primip.	Multip.	Total	Primip.	Multip.
1. All children breast-fed	397	180	217	60	62	58
2. Some " "	125	47	78	51	47	54
3. No " "	63	26	37	43	42	43
4. No information of breast-feeding	148	64	84	41	47	37

* The mother's performance is judged by whether, according to her daughter, all, some, or none of her children were breast-fed, no length of time being specified.

† The daughter's performance is judged by whether, after the pregnancy which brought her into this survey, she maintained uncomplemented breast-feeding for eight weeks.

The trend of the percentages for groups 1, 2, and 3 suggests that there may be a genetical factor involved in successful breast-feeding, but before accepting this conclusion it is necessary to exclude the possibilities (a) that the relationship is a spurious one which might be explained by some extraneous difference between the groups, and (b) that the factor at work is an environmental rather than a hereditary one.

There are many factors—social, medical, and obstetric—that have at one time or another been thought to influence

breast-feeding performance. It has not been our intention to confirm or refute these theories; we asked questions about some of these factors for the sole purpose of ensuring that the groups of women with different family histories of breast-feeding were comparable in regard to other factors which *might* have influenced their breast-feeding. The factors shown to be evenly distributed between groups 1, 2, and 3 are: age; parity; social class (Registrar-General); standard of housing (assessed by health visitor); stage of pregnancy at first antenatal attendance; full-time work during pregnancy; general health before pregnancy; complications of pregnancy, delivery, and puerperium; place of delivery (three hospitals or at home); birth weight of infant; length of stay in hospital.

Factors of possible importance that we did not record were weight and physique, and we cannot rule out the possibility that many of our poor lactators of group 3 are simply the small, poorly built daughters of similar mothers. Such a hypothesis, however, would not conflict with the one we are investigating, although it might throw a different light upon it.

Attitude to Breast-feeding

We attempted to throw some light on the reasons for early failure of lactation by asking women their views on breast-feeding at the first antenatal attendance. In addition, primigravidae were asked their mothers' views. It is not to be expected that many women will express hostility towards breast-feeding at an A.N.C., and it is perhaps surprising that even as many as 38 (5%) did so. The relation between the breast-feeding performance and the attitude is given in Table IV.

TABLE IV.—*Relation Between Subject's Attitude to Breast-feeding at Her First Antenatal Clinic and Her Subsequent Performance*

Subject's Attitude to Breast-feeding	No.	Proportion Breast-feeding for 8 Weeks*
In favour	599	55%
Doubtful	19	42%
Against	38	32%
Not known	77	51%

* See note to Table III.

If the attitude of these women is analysed according to the performance of their mothers, we find that 3.7% of those in group 1 (good breast-feeders) had daughters who were hostile, compared with 8.8% and 7.7% in groups 2 and 3. Taking these figures in conjunction with Table III, we see that at least a small proportion of the mother-daughter association can be accounted for by the daughter having formed her views on breast-feeding in the light of her mother's experience. It might be argued that *all* the association could be accounted for in this way if we were able to get an unbiased assessment of the subject's views at the A.N.C. But this does not seem likely: if the subject's attitude antenatally were the sole factor, we would expect the performance of the 38 who were bold enough to express their hostility at the clinic to do much worse than Table IV suggests.

The primigravidae in the series were asked whether their mothers had "strong views" on breast-feeding. None reported strong views against. The proportion strongly in favour was higher in the mothers with a good performance, but there is no evidence, as is shown in Table V, that the

TABLE V.—*Relation Between Mother's Attitude to Breast-feeding and Daughter's Performance (Primiparae Only)*

Mother's Attitude to Breast-feeding	No.	Proportion of Daughters Breast-feeding for 8 Weeks*
Strongly in favour	139	55%
No strong views	142	55%
Mother dead	36	56%

* See note to Table III.

mothers' views had any effect on their daughters' performance. The evidence given in Table V is probably the best we have in favour of the hereditary hypothesis.

Significance of Milk Yield in First Week After Delivery

During the course of the investigation Sydow (1952) published a paper showing that the duration of breast-feeding was to a large extent determined by the yield of milk at the end of the first week after delivery; his figures, together with those of Hytten (1954c) and our own, are shown in Table VI.

TABLE VI.—*Relation Between Milk Yield and Duration of Breast-feeding*

Sydow (1952): 6th-day yield ..	< 200 ml. 68	200 ml.— 334	300 ml.— 620	400 ml.— 363	500 ml.— 193	600 ml. + 261
No. of cases ..						
Breast-feeding at 2 months ..	56%	93%	95%	95%	95%	98%
Breast-feeding at 6 months ..	22%	58%	64%	69%	72%	75%

Hytten (1954c): 7th-day yield ..	< 300 ml. 35	300 ml.— 41	450 ml.— 31	600 ml. + 18
No. of cases ..				
Breast-feeding at 3 months ..	26%	46%	58%	78%

Present Series: 7th-, 8th-, or 9th-day yield ..	< 15 oz. (425 ml.)	15 oz.— (425 ml.) 54	20 oz. + (567 ml.) 45
No. of cases ..	30		
Breast-feeding at 2 months ..	20%	48%	64%

The publication of Sydow's paper suggested that we might usefully include a similar study in the present investigation. Test weighs were therefore carried out on the seventh, eighth, or ninth day on 129 of the babies born in two hospitals and who were included in the survey; to the amount of milk taken by the infant was added the weight of residual milk expressed after each feed by means of a simple breast-pump. It was not possible to make the series a consecutive one; nor were Hytten's rigorous methods used—for example, for ensuring that the breast was entirely emptied. But any possible bias or inaccuracy thus introduced can hardly have been linked with the hereditary factors which it has been our primary object to investigate. In comparing the three series in Table VI it must be borne in mind that different criteria were adopted for inclusion in the series and for determining the duration of breast-feeding. Absolute differences are therefore to be expected; the common feature is the striking correlation. The early milk yield is evidently a most important prognostic sign.

How can this be related to the family history? Unfortunately our series is not large enough for a full analysis. All we can do is to show, in Table VII, that there is no close association between the mother's performance and her daughter's yield.

TABLE VII.—*Relation Between Mother's Breast-feeding Performance and Daughter's Milk Yield on 7th, 8th, or 9th Day*

Mother's Breast-feeding Performance*	No.	Percentage Distribution of Test Weigh		
		< 15 oz. (425 ml.)	15 oz.— (425 ml.)	20 oz. + (567 ml.)
1. All children breast-fed ..	71	23	42	35
2, 3. Not all children breast-fed ..	28	29	39	32
4. No information ..	30	20	43	37

* See note to Table III.

Such difference as there is between group 1 and the combined groups 2 and 3 is in the expected direction, but it is certainly not statistically significant, nor is it large enough to make it likely that all the daughter's genetic potentiality (if it exists) is manifested in the early yield. The importance of these observations is discussed later.

Discussion

There are great difficulties in the way of demonstrating the existence of genetic factors in lactational performance. For a knowledge of the breast-feeding performance of the first generation we have to rely on the memory and honesty

of women being interviewed 20–30 years later. We have not overcome this difficulty, but we have, unlike previous investigators, minimized one of its chief dangers by putting our questions to our second generation at the beginning of their pregnancy. This eliminates an important source of possible bias; in particular the primigravidae, who formed almost half our series, had to answer the questions in ignorance of their own lactational powers. The genetic influence of the father is obviously even more difficult to assess than that of the mother, for it involves going back another generation. If both parents contribute equally to the lactational ability of the daughters, as in dairy cattle, then in confining ourselves to the mothers we cannot expect such a clear-cut result as if we had been able to take the fathers into account.

But the greatest difficulty in all these studies is that of separating environmental from hereditary influences. Family traditions are probably as firmly rooted in matters concerning the rearing of children as in any other human activity. We have already shown how we have tried to rule out the possibility that the association we have demonstrated is primarily an environmental one, by analysing such factors as social grade and attitude. We cannot pretend that our arguments are conclusive; we have eliminated some of the more obvious possibilities, but many of the factors that go to make up family tradition are too elusive to be caught in the net of an investigation of this sort.

Additional evidence is supplied by our confirmation of the findings of Sydow and of Hytten that the outcome of a lactation is usually determined at its outset, and by our twin study (to be published). Unfortunately only a few pairs of identical twin mothers were obtainable and the numbers were too small for firm conclusions to be drawn. Nevertheless, comparison with the performance of fraternal twin mothers showed a greater correlation between the identical pairs. We therefore feel that a good case has been made for the importance of the genetic influence.

We did not set out to investigate the mechanism through which heredity might operate. In the field of dairy research (Johansson, 1950; Mahadevan, 1951) it is now believed, following on the experience gained with artificial insemination, that the heritability of total yield is low (about 20%), whereas the inheritance of butter-fat content is high and easily bred for (Edwards, 1955, and personal communication). That the former may also be true in the human field is suggested by the findings in Table VII, in which no correlation is shown between the mothers' performance and the daughters' early yield; but we have not investigated the daughters' output of butter-fat. If this were genetically determined then presumably there would be a consistent pattern throughout lactation and between successive lactations. Hytten (1954a) has in fact shown that after the first week the level of fat content is remarkably stable and characteristic for each individual mother but may vary from lactation to lactation. This latter observation was based on a study of only six women with two lactations; a larger series might reveal greater consistency. There is certainly scope for much more work here.

There are, of course, other ways in which genetic factors might determine lactational performance. For instance, the duration of breast-feeding must be affected to some extent by the storage capacity of the breast, and there may be other aspects—for example, hormonal—of "staying-power" which are open to genetic influence. The work of Engel (1941, 1947) and of Hytten (1954b) on the functional glandular capacity of mammary tissue requires further development. Heredity might also act in a non-specific manner by affecting the mother's ability to stand up to stress. Hypogalactia might be increasing for the same reasons as other psychosomatic disorders (Halliday, 1948).

The importance of heredity at any one time is determined by the extent to which genetic factors have previously been operative. In the days when artificial feeding was extremely hazardous the ability to breast-feed was a condition of survival. In those circumstances subsequent lactational

failure would be more likely to be due to environmental than to inherited causes. In recent years bottle-feeding has become almost as safe as breast-feeding, and a generation of bottle-fed babies has grown up to perpetuate this trait. Hence genetic factors might well be responsible, in part at least, for the rising incidence of bottle-feeding, and they probably now contribute much more towards lactational failure than was the case when potentially poor lactators were eliminated by natural selection in infancy.

Theoretically selective breeding might counteract to some extent the above effects, for, as any film-goer and magazine-reader must know, modern society applauds the well-developed feminine bust. This, however, is not the only characteristic that makes a man choose a mate, and, even if it were, it must be realized that the large breast does not necessarily contain the greatest amount of functional glandular tissue.

Changing fashions in infant feeding have undoubtedly contributed to the decline in breast-feeding. Insistence on exclusive breast-feeding for six months has resulted in inevitable failure and abandonment in many cases, but the "new" vogue for early introduction of solids may serve to eke out an inadequate lactation for longer. No other mammals have demanded so much from the breast as we have.

In the final analysis it is impossible to separate heredity and environment. Genetic factors would be expected to play a part in the lactational ability of all women. It is therefore the result of the interplay between heredity and environment which determines the success of a lactation. The safety and facility of artificial feeding in modern society mean that environmental factors, such as social conditions, appear to control breast-feeding when in fact they may be merely marginal ones which tip the scales against the breast in a constitutionally poor lactator. According to Hytten, one-third of all women are doomed to fail to produce enough nourishment to support the average infant above a weight of about 11 lb. (5 kg.). Even if glandular inadequacy is largely genetically determined, this does not preclude the discovery of a remedy which could overcome the deficiency. Until one has been found, it may be of some consolation to a mother, genuinely and bitterly disappointed by her failure to feed her baby, to learn that it may well have been due to inborn deficiencies outside her control; she deserves to be spared the unkind suggestion that is sometimes made that she could have fed her baby for longer had she tried.

Summary

An investigation is described in which 943 women (43% primigravidae) were asked at the antenatal clinic about the breast-feeding performance of their mothers. The method of feeding adopted by these women was recorded when they subsequently attended the post-natal clinic.

The principal finding was that of 397 women whose mothers were "good" breast-feeders, as defined for the purposes of the comparison, 60% succeeded in maintaining uncomplemented breast-feeding for eight weeks, compared with 43% for the 63 women whose mothers were not "good" breast-feeders.

This association appears to be independent of environmental factors and of the mental attitude of the mothers and their daughters.

In a small series it was shown that the milk yield at the end of the first week is positively correlated with the duration of lactation.

Absolute proof of the influence of heredity is lacking, but the mother-daughter association and the evidence of a twin study (briefly referred to) point to the probability that genetic factors significantly contribute towards lactational failures, 50% of which are otherwise unexplained.

The possible role of heredity and the mechanism of its application in the declining incidence of breast-feeding is discussed.

A large number of people have been involved in this investigation and we are grateful to all of them for their help. In particular, the main part could not have been attempted without the active co-operation of Dr. D. Regan, area medical officer of Edmonton, who kindly put the resources of his organization at our disposal. Of his assistants, Drs. A. Goggin and M. Brown supervised the completion of the forms at the antenatal and post-natal clinics; Miss H. Bridge, non-medical supervisor of midwives, Miss S. Briggs, superintendent health visitor, and Miss R. Saunders, deputy chief clerk, all worked hard to ensure that the requisite details concerning the confinement and housing were collected and inserted and that the forms, after completion, were dispatched to the staff of the Statistics Department, St. Bartholomew's Hospital, to whom we are also grateful for keeping the records and transferring the data on to punched cards. Our thanks are also due to Mr. K. A. K. Hudson and Mr. A. W. Purdie, who permitted us to investigate the 24-hour yield in some of the patients admitted under their care, and to Miss A. L. G. Hammond and Miss H. Stephenson, superintendent midwives, for their part in obtaining this information.

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PNEUMONIA AND BRONCHIAL VESICULATION ASSOCIATED WITH HERPES ZOSTER

WITH REFERENCE TO OTHER VISCERAL ASSOCIATIONS OF ZOSTER

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Of the rarer manifestations of herpes zoster a motor paralysis of the same spinal or cranial nerve distribution as the skin lesion is the one most often recorded and, on anatomical grounds, the easiest to explain. Certain visceral associations have been described with very suggestive clinical features—for example, abdominal pain and gastro-intestinal haemorrhage with a tenth thoracic zoster (Porteous, 1947); dysuria and increased frequency of micturition with a second and third sacral zoster (Chesterman, 1932)—but there has not as a rule been any conclusive evidence of the specific nature of the visceral lesion. Thus one reads differing opinions regarding the existence of visceral zoster. Kinnier Wilson (1954), while quoting various reports of the condition, considers it to be a doubtful entity, and notes that Head (1910) found no sign of pleural, peritoneal, or other visceral damage in 394 cases of zoster. On the other hand, Gais and Abrahamson (1939) record that out of 137 cases of herpes zoster 42 had visceral symptoms, and Dubois (1926) reported a case which seems