DIET, WEIGHT CONTROL, AND TOXAEMIA IN PREGNANCY

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Stockbreeders and veterinarians have long been aware of the importance of a good diet during pregnancy and lactation in animals. Dairy farmers have shown that milk production varies with the nature of the diet, particularly in the later part of pregnancy. There is ample evidence that fertility, dentition, the form of the bony pelvis, the size and the well-being of the foetus in utero, the process of labour itself and the susceptibility of the animal to infection, are to a considerable extent dependent on the food with which it is fed. This knowledge applies with equal force in the human field.

Recent work at the Nuffield Institute for Medical Research has shown in sheep a relation between pregnancy toxaemia and diet. It has been found that by overfeeding pregnant ewes so that they made large weight gains and then suddenly and severely restricting their diets toxaemic symptoms were induced. Parry (1954) has reported that toxaemic ewes showed some evidence of an abnormal renal circulation and at necropsy the normal ratio of the adrenal to thyroid weight was doubled. By limiting weight gain during early pregnancy in two groups of ewes, the mortality was reduced from 15 to 20 per cent. to less than 1 per cent. As there are so many points of similarity between toxaemia in pregnancy in women and the condition found in ewes, the Nuffield Foundation is supporting further research in this important problem.

Nutritional Strain of Pregnancy in Women

Is there a special nutrition problem in pregnancy? There is ample scientific evidence that pregnancy is a 'diet efficiency' test. During the last trimester of pregnancy the foetus deposits 70 per cent. of its total birth weight and during this same period lays down two-thirds of its calcium phosphate, three-quarters of its protein, four-fifths of its iron and all but 7 per cent. of its fat. The foetus makes a particular demand upon the mother's iron and calcium and it is dependent on the mother's food supply for essential amino-acids and vitamins, especially the fat-soluble vitamins.

It is during the last trimester of pregnancy that major complications involving mother and foetus may arise. During lactation there is an even greater nutritional strain. For every 500 ml. of breast milk produced the nursing mother requires about 24 g. of good quality protein in her food, in addition to her own daily requirements of protein. Of calcium she needs three times as much as the non-pregnant woman.

During this period of physiological strain, borderline states of malnutrition may be revealed which otherwise would have remained latent.

While working in Hong Kong I saw many cases of vitamin B1 deficiency. Early in pregnancy the mother might appear quite normal but later incipient beri-beri showed itself with each additional month of pregnancy until the mother was brought into hospital water-logged and in extremis. In some cases it was the strain of labour that precipitated the condition of acute avitaminosis. There was a distinct relationship between the presence of beri-beri and toxaemia of pregnancy. When these two conditions were associated, mortality from the toxaemia was very much greater.

The effects of drain upon maternal calcium are seen in osteomalacia or adult rickets (Maxwell's disease). Professor Preston Maxwell, one-time director of the Peiping Union Medical College, had the unusual experience of seeing pelvic contraction develop in a Chinese woman in whom the inter-schial diameter contracted by 2 cm. within two years. When the maternal diet is markedly deficient in vitamin A the baby may be born with keratomalacia. Women suffering from osteomalacia will sometimes give birth to babies showing signs of congenital rickets.

Observations on the effect of maternal malnutrition upon the foetus were made in Holland in 1945-46. During this famine winter 50 per cent. of the women in Rotterdam and The Hague suffered from amenorrhoea and were probably infertile. Birth weights of infants decreased and rose again after restoration of food, in a manner indicating that foetal weight gain was particularly
related to the maternal diet of the last half or trimester of pregnancy. Significant decline in birth length also occurred, but was less clearly apparent than the change in weight. These findings are similar to what has been found in sheep. When maternal undernutrition was marked during late pregnancy the weights of new-born lambs were reduced by almost 50 per cent., while the lengths were much less sharply decreased.

In a community where diet is faulty or restricted the children and mothers, expectant and nursing, suffer first. This does not mean, however, that the baby born of an undernourished woman is necessarily small and feeble, and it is a not unusual experience in obstetrics to see ill-fed and unfruitful women give birth to babies who are apparently healthy and of average weight.

It may be argued that the above are extreme examples of malnutrition and not applicable to the better economically developed countries. But no one can deny that there are groups in the population of these countries who do not enjoy optimum nutrition, that is, a state of well-being such that no improvement can be effected by a change in diet. It is now accepted that adequate nutrition plays an important part in maintaining the normal health of a mother and her baby. It is the quality not the quantity of food that counts.

Control of Weight

Weight should be controlled during pregnancy. At every visit to the clinic the mother’s weight should be accurately measured, and if there is an increase of more than 1 lb. (454 g.) per week her diet should then be restricted. Some obstetricians view even an increase of more than $\frac{1}{2}$ lb. (227 g.) as abnormal and try to limit the total weight gain during pregnancy to 20 lb. (9,080 g.). The reason for the attention to this aspect of pregnancy during recent years is the recognition of the clinical fact that a sudden and rapid increase of weight may herald toxaemia of pregnancy. On the other hand, there are some women who put on many pounds in weight yet pass through pregnancy and labour normally. This group usually remains overweight after pregnancy. By regular weighing it is possible to detect the sharp rise in weight which sometimes occurs before the classical symptoms of toxaemia present themselves.

During the first trimester there is little gain in weight, in fact there may be a loss. It is during the second and third trimesters that the weight increases. In the last trimester about half the total gain takes place and for the last 24 weeks of pregnancy there is an average gain of about 1 lb. (454 g.) per week. Of this 24 lb. (10,896 g.) increase, 14 lb. (6,356 g.) is distributed as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>lb.</th>
<th>g.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baby</td>
<td>7</td>
<td>(3,178)</td>
</tr>
<tr>
<td>Placenta</td>
<td>1</td>
<td>(454)</td>
</tr>
<tr>
<td>Amniotic fluid</td>
<td>1$\frac{1}{2}$</td>
<td>(681)</td>
</tr>
<tr>
<td>Increase in weight of uterus</td>
<td>2</td>
<td>(908)</td>
</tr>
<tr>
<td>Increase in blood</td>
<td>1</td>
<td>(454)</td>
</tr>
<tr>
<td>Increase in weight of breasts</td>
<td>1$\frac{1}{2}$</td>
<td>(681)</td>
</tr>
</tbody>
</table>

The 10 lb. (4,560 g.) that remain are accounted for by increased deposit of fat and fluid. A very real attempt should be made to keep the total weight gain between 20 lb. (9,080 g.) and 24 lb. (10,896 g.) for two reasons, (1) the risk of pregnancy toxaemia can be lowered and (2) most women are sensitive about their body curves not returning to normal after the pregnancy.

In many women the abnormal weight gain is due to perversion of appetite and excessive in-gestation of food of high calorie value (carbohydrates and fats). There is, on the other hand, a physiological reason for the increase in weight apart from the reproductive weight gain of the products of conception.” During pregnancy there is much greater elaboration of these hormones, oestrogen and other steroids, that are responsible for sodium and fluid retention. Thus it is important to reduce sodium intake in order to restrict excessive gain in weight in pregnancy. The mother should be given a list of foods to avoid. Salt should not be used in cooking and bicarbonate of soda or ‘salts’ taken as medicine.

Below is Diet A which should be taken when there has been a rapid increase in weight. This can be taken as an out-patient for some weeks, provided vitamins and minerals are prescribed as extras.

**Diet A**

(University College Obstetric Hospital. Antenatal Clinic)

**1,800 Calorie Diet for Pregnancy**

(Low carbohydrate, high protein, restricted salt)

90 to 100 g. protein

You should eat all the following foods each day; no more and no less:

Two pints of whole milk.
One large portion of lean meat (not less than 3 oz.).
One to two eggs.
One large helping of fish, offal, poultry or rabbit, not fried.
Take only occasionally, bacon, ham, tinned meat, cheese or sausage to replace the above.
3 oz. National bread (three medium slices) with butter or margarine, thinly spread.
Two portions of fresh fruit.
Two potatoes—each the size of an egg (4 oz.); boiled, baked or mashed, not roasted or fried.
One helping of root vegetables or peas, beans or lentils occasionally.

As much as you can get of green vegetables and salad.
Do not add salad dressings or oil.
DO NOT EAT ANY OF THE FOLLOWING FOODS:
Sweets, chocolate, sugar.
Jam, marmalade, honey, syrup. You may take a
little sugarless jam or marmalade occasionally.
Cakes, pastry, pudding (cereal or sponge), biscuits,
breakfasts cereals.
Cocoa, Horlicks, Ovaltine, etc.
If you wish to take breakfast cereal you should omit
your allowance of potatoes (one medium helping—½ oz.
is equal to 4 oz. potatoes).
DO NOT FORGET TO TAKE YOUR (orange juice, cod
liver oil or vitamin pills, iron pills) EVERY DAY.
DO NOT ADD SALT TO YOUR FOOD AT TABLE.
TAKE NO FRIED FOOD.

This diet corresponds to the National Research
Council U.S.A. recommended allowance except for
iron, nicotinic acid and vitamin D. The border-
line calcium level is only attained through the use
of skimmed milk, of which a larger quantity can
be used than of whole milk without raising the
calorie value. Calcium and iron supplements are
necessary as well as vitamin supplements, A, B
complex, C, D, as the actual vitamin contents of
fruit and vegetables are always doubtful. Food
yeast, which is a good source of vitamin B, might
be used to improve the flavour of the skimmed
milk.

**Diet in Pregnancy Toxaemia**

Pregnancy toxaemia is associated with variou-
biomedical phenomena. In pregnant and non-
pregnant women there is a constant ratio of the
cell mass volume to that of extra-cellular fluid.
Although in normal pregnancy both increase yet
there is not a disproporionate increase in extra-
cellular fluid volume. It is in pre-eclampsia that
there is an excessive amount of extra-cellular fluid,
and with water and sodium retention oedema de-
velops. It has already been suggested that salt
restriction should be included in any dietetic
treatment. Sodium restriction will reduce, but
only slowly, the oedema in those cases of excessive
weight gain. It is for the purpose of promoting a
more rapid loss of tissue fluid that ion exchange
resins have been introduced as a form of therapy.
This treatment should be reserved only for those
cases in which pre-eclampsia with severe oedema
develops early in pregnancy when the foetus is
barely viable.

Dieckmann (1952) has shown that patients who
develop pre-eclampsia in late pregnancy gain ex-
cessive weight as early as the 13th week (see Fig. 1).

From Fig. 1 it will be seen that in those women

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**FIG. 1.—Weight-gain in pregnancy (after Dieckmann et al, 1952, p. 862).**

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who had a gain in weight from the 20th to the 30th week greater than 7.7 lb. (3.5 kg.) there was an increased incidence of pre-eclampsia later in pregnancy.

A large-scale experiment at the Women's Hospital, Sydney, by Hamlin (1953) has shown that eclampsia and severe pre-eclampsia can be prevented by means of diet and weight control. The most important weapons in this attack were (1) diet instruction from earliest pregnancy, (2) weight control in early and in mid-pregnancy and (3) the recognition of pre-eclampsia in its pre-hypertensive phase. Before this regime was instituted, there was an average incidence of one booked eclampsia in every 350 cases of pregnancy. With careful diet and weight control the eclampsia rate fell to 1 in 7,000 deliveries. The incidence and severity of pre-eclampsia was so reduced that during the final 18 months of the campaign induction of labour between the 30th and 37th week of pregnancy was rarely performed and Caesarean section for this indication was not employed at all. The perinatal mortality (combined stillbirths and neonatal deaths) also fell from 25 per 1,000 births in 1947 to 11.9 per 1,000 births by the end of 1951. This was a salvage of foetal life at the rate of 50 babies per annum. The critical period of weight increase was between the 20th and 30th week of pregnancy, or in any earlier ten-week period. If any patient, whether primigravida or multigravida, did not increase her weight by more than 8 lb. (about 3½ kg.) during the period, then in the vast majority of cases she did not have pre-eclampsia, either mild or severe.

Table 2 shows the diet used by Hamlin (1953) for normal pregnancy. The main restriction in this diet is carbohydrate, with increase in protein and mineral vitamin constituents.

A further investigation in Australia by Hipsley (1953) has shown that pregnancy toxaemia is related to the amount of dietary ‘fibre’ (lignin, cellulose, hemicellulose). Those races who have a very low fibre content are more prone to severe pregnancy toxaemia. In Southern India there is much eclampsia and the diet consists of refined foodstuffs, white rice and flour (sharps). On the other hand, in Indonesia pregnancy toxaemia is rare and the diet composed of crudely milled and
Table 2

The Diet Used for Normal Pregnancy

<table>
<thead>
<tr>
<th></th>
<th>Protein</th>
<th>Fat</th>
<th>CHO</th>
<th>Calories</th>
<th>Thiamine</th>
<th>Acid</th>
<th>Ca</th>
<th>Fe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>g.</td>
<td>g.</td>
<td>g.</td>
<td></td>
<td>units</td>
<td>mg.</td>
<td>mg.</td>
<td>mg.</td>
</tr>
<tr>
<td>Breakfast:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oatmeal, ½ cup</td>
<td>3</td>
<td>2</td>
<td>20</td>
<td>106</td>
<td>162</td>
<td>—</td>
<td>15</td>
<td>1.2</td>
</tr>
<tr>
<td>Egg, one</td>
<td>6</td>
<td>6</td>
<td>—</td>
<td>80</td>
<td>75</td>
<td>—</td>
<td>30</td>
<td>1.5</td>
</tr>
<tr>
<td>Bread, 1 oz.</td>
<td>2</td>
<td>—</td>
<td>15</td>
<td>69</td>
<td>61</td>
<td>—</td>
<td>7</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunch:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat, 3 oz.</td>
<td>14</td>
<td>19</td>
<td>—</td>
<td>240</td>
<td>32</td>
<td>—</td>
<td>8</td>
<td>2.7</td>
</tr>
<tr>
<td>Lettuce, ½ oz.</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>11</td>
<td>—</td>
<td>—</td>
<td>0.1</td>
</tr>
<tr>
<td>Tomatoes, 4 oz.</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>6</td>
<td>17</td>
<td>20</td>
<td>12</td>
<td>0.4</td>
</tr>
<tr>
<td>Raw carrots (grated), ½ oz.</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>—</td>
<td>6</td>
<td>0.05</td>
</tr>
<tr>
<td>Bread, 2 oz.</td>
<td>3</td>
<td>—</td>
<td>30</td>
<td>137</td>
<td>122</td>
<td>—</td>
<td>14</td>
<td>1.2</td>
</tr>
<tr>
<td>Orange, 4 oz.</td>
<td>—</td>
<td>—</td>
<td>11</td>
<td>40</td>
<td>64</td>
<td>47</td>
<td>34</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supper:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat, 4 oz.</td>
<td>18</td>
<td>26</td>
<td>—</td>
<td>320</td>
<td>72</td>
<td>—</td>
<td>16</td>
<td>3.6</td>
</tr>
<tr>
<td>Potatoes, 4 oz.</td>
<td>1</td>
<td>—</td>
<td>16</td>
<td>68</td>
<td>104</td>
<td>12</td>
<td>8</td>
<td>0.8</td>
</tr>
<tr>
<td>Cabbage, 3 oz.</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>10</td>
<td>25</td>
<td>20</td>
<td>16</td>
<td>0.3</td>
</tr>
<tr>
<td>Pumpkin, 4 oz.</td>
<td>—</td>
<td>—</td>
<td>6</td>
<td>27</td>
<td>—</td>
<td>4</td>
<td>10</td>
<td>0.4</td>
</tr>
<tr>
<td>Apple, 4 oz.</td>
<td>—</td>
<td>—</td>
<td>13</td>
<td>48</td>
<td>40</td>
<td>11</td>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk, 2 pints</td>
<td>19</td>
<td>26</td>
<td>38</td>
<td>473</td>
<td>241</td>
<td>47</td>
<td>54</td>
<td>5.5</td>
</tr>
<tr>
<td>Butter, 1 oz.</td>
<td>40</td>
<td>44</td>
<td>52</td>
<td>756</td>
<td>406</td>
<td>11</td>
<td>1,400</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>87</td>
<td>120</td>
<td>170</td>
<td>2,123</td>
<td>1,259</td>
<td>125</td>
<td>1,580</td>
<td>14.01</td>
</tr>
</tbody>
</table>

Table 3

Extract from article on 'Dietary "Fibre" and Pregnancy Toxaemia,' Brit. med. J., 22/8/53, p. 421

Showing Correlation of Fibre Content of Diet with Incidence of Eclampsia or Pregnancy Toxaemia

<table>
<thead>
<tr>
<th>Group</th>
<th>Description of Diet</th>
<th>Dietary Fibre Grading*</th>
<th>Eclampsia† or Toxaemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Guinea natives, Fijians</td>
<td>Starchy roots, green leaves, nuts, fruit, plus small amounts of fish and meat</td>
<td>++ ++</td>
<td>0</td>
</tr>
<tr>
<td>Punjab</td>
<td>Home-pounded wheat, starchy roots, pumpkin, fruit plus a little milk</td>
<td>+ ++ +</td>
<td>+</td>
</tr>
<tr>
<td>Transkei (South Africa)</td>
<td>Meal porridge, milk, eggs and small amount of meat</td>
<td>++ ++</td>
<td>0</td>
</tr>
<tr>
<td>Java</td>
<td>Home-pounded rice, green leaves, maize, starchy roots, little fish</td>
<td>++ ++</td>
<td>+</td>
</tr>
<tr>
<td>Celebes</td>
<td>Home-pounded rice, greens, coconut. Small amounts of vegetables, melons and fruit</td>
<td>++ ++</td>
<td>+</td>
</tr>
<tr>
<td>Indians (Fiji)</td>
<td>Polished rice, flour (sharps), ghee, coconut oil, dhal. Small amounts sugar, meat and vegetables</td>
<td>+</td>
<td>++ ++</td>
</tr>
<tr>
<td>Indians (South India)</td>
<td>Ditto</td>
<td>+</td>
<td>++ ++</td>
</tr>
<tr>
<td>Colombo</td>
<td>Ditto</td>
<td>+</td>
<td>++ ++</td>
</tr>
<tr>
<td>Europeans (Toronto)' poor' diet group</td>
<td>Inexpensive high-energy-yielding foods. Minimum of 'protective' fruit and vegetables which are more costly</td>
<td>Increased</td>
<td>Reduced</td>
</tr>
<tr>
<td>Europeans (Toronto) 'good' diet group</td>
<td>Increased consumption of fruit and vegetables</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Fibre grading (approximate): ++++ Very high = above 4 g./1,000 cals. + Low = below 1 g./1,000 cals.
†Incidence of eclampsia (approximate): ++++ Very high = 8 eclamptics/1,000 deliveries. + Low = below 1 eclamptic/1,000 deliveries. 0 Absent or very low.
pounded rice, starchy root vegetables, some maize and leafy greens. This diet is rich in fibre. In Holland and Belgium during the German occupation in the last war, rations were low, but there was a marked diminution in the incidence and severity of pregnancy toxemia. During the worst part of the famine the population ate linseed meal, tulip bulbs and sugar beets. With the liberation, calorie intake was greatly increased (especially carbohydrates) and pregnancy toxemia became an obstetrical problem again.

Table 3 summarizes the evidence that toxemia is more common when the ‘fibre’ content of the diet is low.

Dietetic Treatment

Already Diet A has been suggested for those women who, in the antenatal clinic, put on too much weight.

When the toxemia is of moderate severity the patient should be admitted, Diet B should be used, and the patient confined to bed.

Diet B

(University College Obstetric Hospital)
(For In-patients Only)
1,200 CALORIE, HIGH-PROTEIN, LOW-SODIUM DIET
(For use in cases of toxemia of pregnancy)

Breakfast
Tea, no sugar, milk for tea 1 oz.
One egg, boiled or poached.
1 oz. low-salt bread, toasted if desired.
½ oz. butter or margarine.
3 oz. orange.

Mid Morning
5 oz. high-protein milk

Dinner
2 oz. stewed beef, no salt in cooking.
3 oz. carrots, no salt in cooking.
4 oz. cauliflower, no salt in cooking.
Rice pudding made of ½ oz. rice and 8 oz. high-protein milk.

Tea
Tea, no sugar, milk for tea 1 oz.
1 oz. low-salt bread, toasted if desired.
½ oz. butter or margarine.
1 oz. lettuce or mustard and cress.

Supper
3 oz. white fish, steamed or grilled.
3 oz. tomatoes grilled.
4 oz. cabbage, no salt in cooking.
1 oz. low-salt bread.
½ oz. butter or margarine.
4 oz. dessert apple.

Bed-time
5 oz. high-protein milk.

<table>
<thead>
<tr>
<th>High-protein Milk</th>
<th>Approximate nutritional content of daily intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 oz. milk</td>
<td>CHO ........................................ 111 g.</td>
</tr>
<tr>
<td>7 oz. water</td>
<td>B .......................................... 93 g.</td>
</tr>
<tr>
<td>1 oz. ‘Casilan’</td>
<td>F .......................................... 43 g.</td>
</tr>
<tr>
<td></td>
<td>Ma ......................................... 563 mg.</td>
</tr>
<tr>
<td></td>
<td>Ca ......................................... 1,222 mg.</td>
</tr>
<tr>
<td></td>
<td>Fe .......................................... 9 mg.</td>
</tr>
</tbody>
</table>

No salt on tray.

In this diet, protein, mineral and vitamin values could not be increased without increasing calorie value, except by the use of concentrates and supplements. Skimmed milk is recommended as a means of maintaining protein and calcium levels in this calorie intake. The protein supplements, such as ‘Casilan’ (Glaxo Laboratories, Ltd.), can be added to the milk. The usual vitamin supplements should be taken and a source of vitamins of the B group should be used as well. This could be in the form of food yeast which can be given to improve the flavour of skimmed milk. Calcium and iron supplements are necessary.

As already mentioned the above diet should be used only when the patient is in bed, and after a week, depending on the condition of the patient (weight loss, blood pressure, albuminuria), it might be possible to increase the calorie intake to 1,500, which would mean simply adding to the above diet 4 oz. of potatoes, ½ oz. of rice and 1 oz. of bread. With amelioration of the disease, the diet is increased to 1,800 calories. During the rest of pregnancy weight is carefully checked and carbohydrate intake strictly controlled.

Conclusion

Pregnancy toxemia is the primary cause of maternal mortality. Not only can it be lethal so far as the mother is concerned but it also contributes to much foetal wastage through intrauterine death and prematurity.

The severe types of this disease can be controlled by simple antenatal measures, which include diet restriction and weight control. It is disappointing that in many obstetric clinics close attention is not given to these measures.

I am grateful to Miss Catherine Harris, S.R.N., Advisory Dietitian, University College Hospital, for compiling the diet sheets.

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W. C. W. Nixon

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