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## TOXOPLASMOSIS AND PREGNANCY

BY

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### INTRODUCTION

A LARGE number of cases of infantile toxoplasmosis, the disease defined by Wolf and his colleagues (Wolf, Cowen and Paige, 1939; Wolf and Cowen, 1939; Paige, Cowen and Wolf, 1942; Cowen and Wolf, 1945), have been reported during the last 10 years. Frenkel and Friedlander (1951), Sabin (1942, 1948), Piekarski (1950), Thalhammer (1951) and others have collected these cases and assembled the results of microbiological research on animals.

The frequency of antenatal inception of toxoplasmosis in human beings has not yet been given thorough study. The present investigation aims to throw light on the question of how often toxoplasmosis is responsible for abortion, intra-uterine death of the foetus, neonatal disease and death, and infantile disease and malformation. The diagnostic value of serological tests for toxoplasmosis in antenatal care and obstetrics will also be discussed and likewise the manner of antenatal inception of toxoplasmosis. The possibilities of preventing intra-uterine toxoplasmosis and whether or not antenatally diagnosed toxoplasmosis justifies termination of pregnancy are two other problems which will be scrutinized.

### SURVEY OF LITERATURE

It has been established by experiments on animals that the microbes are spread by the

blood to the different parts of the body during the first two weeks after infection. While this goes on, a rapidly increasing titre of antibodies can be demonstrated. It appears that the distribution of microbes by way of the maternal blood begins to cease when antibodies appear in the circulation and, when they reach a high level, the parasites are only found sporadically in the tissues and in an inactive form as intracellular aggregations (Cowen and Wolf, 1950, 1951).

Antibodies to *Toxoplasma* have been found in a large number of presumably healthy persons, the frequency varying from a few to 50 per cent of the subjects examined (Callahan *et al.*, 1946; Holmdahl, 1949; Kunert and Jüptner, 1952; Macdonald, 1949; Piekarski, 1950; Sabin, 1942). They can be demonstrated with several different methods. Only three of them will now be mentioned. In Sabin's rabbit test and the egg test worked out independently by Alm (1948) and Macdonald (1950) the serum's capacity to inhibit the activity of living *Toxoplasma* is estimated. The egg test has proved to be the better of these two tests. In the dye test of Sabin and Feldman (1948), the method most used nowadays, the antibody strength is determined by a microbiological staining method. The results of the egg and dye tests are equal as regards quality, but the dye test seems to give more accurate quantitative results (v. Zeipel and Linder, 1951).

After infection with toxoplasmosis, the dye

test titre rises to a high level (Bengtsson, 1950; Gard *et al.*, 1949, 1952; Jelke, 1950; v. Zeipel and Linder, 1951). The high titres seem to persist for at least 6 months, and then sink slowly over a period of several years. It has been possible to demonstrate antibodies as late as 10 years after infection.

In the case of pregnancy there is obviously a risk of infection of the foetus during the acute phase when the parasites are present in the maternal blood. This has been borne out by several experimental studies on animals (Cowen and Wolf, 1950, 1951; Eichenwald, 1948; Jacobs and Jones, 1950). On the other hand, it is not certain whether the microbes can infect the foetus after the parasites have left the blood. Some authors maintain that a high antibody titre means a large risk of infection of the foetus. Others maintain that it protects the foetus from latent toxoplasmosis (Holmdahl, 1951, 1952; Macdonald, 1950), pointing out that the number of women with a high antibody titre is large in comparison with the few cases of infantile toxoplasmosis observed.

The clinical picture of infantile toxoplasmosis includes internal hydrocephalus, intracerebral calcification, chorioretinopathy and psychomotor disorders. In acute and sub-acute cases there are also changes in the cerebrospinal fluid with monocytic pleocytosis and an elevated protein content. Occasionally, however, the picture is dominated by intestinal symptoms with enlargement of the liver and spleen and jaundice. These signs are often present at birth, but in many cases do not appear until weeks or months have passed. According to Sabin and Feldman (1949), intracerebral calcification is always present.

It is still uncertain whether toxoplasmosis can cause abortion. There are a few cases reported in which a woman had a miscarriage directly before or after giving birth to a baby with toxoplasmosis. However, it has not been possible to prove that *Toxoplasma* caused the miscarriages. A number of cases of intra-uterine foetal death have been ascribed to toxoplasmosis, the assumption being based on evidence of the infection in the maternal serum. In my opinion, none of these cases is sufficiently authenticated.

Cowen and Wolf (1950, 1951) showed in animal experiments, however, that *Toxoplasma* can lead to specific inflammatory lesions in the foetus and intra-uterine death. Analysis of the responsibility of toxoplasmosis for human intra-uterine mortality must be done by statistical procedures, for autolysis leads to the obliteration of any inflammatory changes present.

Ever since cases of antenatally acquired toxoplasmosis were first demonstrated, it has been assumed that the microbes are transferred to the foetus via the placenta, but not until recently has it been possible to establish this fact. Cowen and Wolf (1950, 1951) showed by extensive experimental studies on pregnant mice that specific inflammatory lesions occur in the placenta during the second week of infection. However, they could not find a single instance of renewed dissemination to the placenta by the blood stream after the infection had been checked by antibodies.

On the other hand, every attempt to transfer *Toxoplasma* by way of the placenta to the foetus in primates has failed. Even when pregnant monkeys were inoculated with *Toxoplasma* 2 or 3 weeks before delivery, the infection was not spread to the foetus. The negative results may be due to the fact that only small series of experimental animals could be used (Cowen and Wolf, 1950).

Despite the fact that hundreds of cases of congenital toxoplasmosis in humans are reported, only 2 are described in which the mother showed signs of acute infection during the latter part of pregnancy, the 7th and 8th month, respectively (Adams, 1948; Farquhar and Turner, 1949). These 2 women had multi-ocular tender and inflamed lymph nodes and a finely mottled eruption. The signs and symptoms of toxoplasmosis in the adult do not seem to differ from those of a mild infection (Plaut, 1946; Tomlinson, 1945). The majority of persons with serological evidence of recent toxoplasmosis can never relate anything of note.

#### PRESENT STUDY

##### *Material*

The present study covers the 23,260 babies born at the two maternity hospitals in the city of Göteborg during the years 1948 to and includ-

ing 1951. They represent about 95 per cent of the children born in Göteborg during this period. Of these, 633 were stillborn or died within a week after birth. All the foetuses classed as stillborn were at least 35 cm. long. All these 633 children were autopsied. The central nervous system was examined with the naked eye and a few sections studied microscopically, except in cases of great maceration, anencephaly and cranioclasia. When inflammatory changes were present, more extensive microscopical study was made.

All the living children were examined by paediatricians on at least two occasions during the first week of life. About 21,000 of them were followed up regularly during the first year by paediatricians at the city child welfare clinics. On any signs of cerebral lesion the children were sent to the medical department of the Göteborg Children's Hospital.

The study also includes a serological study of a large number of women. One series, which I described in an earlier study (Holmdahl, 1949), includes the following cases, collected successively as they came to the maternity hospitals: 108 women with children born dead or dying soon after birth, 113 women giving premature birth, 101 women with an inexplicable abortion in the 2nd to 6th months, and 32 women giving birth to children with major developmental defects. The serological examination of these women was undertaken with the egg test. The children were examined on the lines just described. Whenever the mother had an antibody titre of 100 or more, however, the central nervous system of the child was given a more thorough histopathological examination if it was stillborn or died shortly after birth. If it was alive, its skull was roentgenographed and its eyes examined with the ophthalmoscope.

For control purposes, 233 women with a normal delivery and normal children were examined with the egg test as well as 94 presumably healthy non-pregnant women. The latter were included to see whether pregnancy was associated with non-specific antibody formation.

The second series consists of 415 women chosen at random from the ones coming to the

out-patient department for antenatal care. These women were examined with the dye test and 270 of them with repeated tests until their child was born. Furthermore, 93 women with abortions in the 2nd to 6th months were examined with the dye test, one test at the time of the miscarriage and another 2 to 6 weeks later.

In addition, 59 aborted ova and 158 placentas were examined histopathologically and any inflammatory changes discovered checked with the antibodies in the maternal serum.

#### *Serological Methods*

The two serological tests for Toxoplasma-neutralizing antibody used in this study are described by von Zeipel and Linder (1951) in a publication from our virological department. In the egg test, the strength of titre is given as the ratio between the average number of Toxoplasma colonies in the negative serum controls and in the serum tested. In the dye test, the titre is given as the highest dilution of serum with which at least 50 per cent of the microbes are injured by the antibodies.

#### *Results of Investigation*

Two cases of infantile toxoplasmosis were discovered in the 23,260 children born at the maternity hospitals in Göteborg during the years 1948 to and including 1951. They will now be briefly described.

CASE 1. A primigravida aged 17 had an uneventful pregnancy and a child weighing 3,400 g. was normally delivered at term. A week later it was reported to be well. The mother noticed shortly after birth, however, that one eye was smaller than the other. Breast-feeding was satisfactory and the child gained 500 g. in 7 weeks. At 8 weeks it was noted that the circumference of the skull had increased from 38 cm. at birth to 44.5 cm. Other abnormalities noted were bilateral microphthalmus, bilateral healed chorioretinitis and intracranial lunate calcifications. Ventriculograms revealed severe internal hydrocephalus. The cerebrospinal fluid was clear and contained a large amount of protein but a normal amount of cells and no Toxoplasma. The antibody titres of the mother and child can be seen from Fig. 1.

CASE 2. A multipara aged 32 had had 2 normal deliveries 12 and 6 years previously and both children were living and well. She suffered from sore throat on several occasions during pregnancy. A month before delivery the children brought home some baby birds which died in the house. The patient got another sore throat at this juncture and a few weeks later, in the

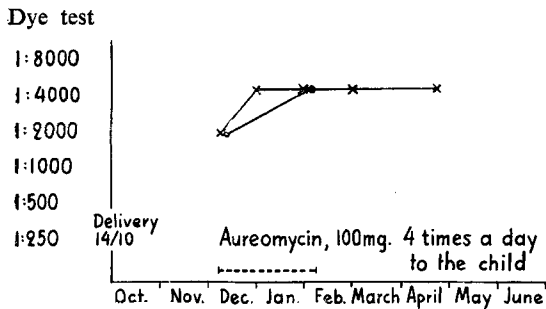


FIG. 1

Serological data from Case 1. o—o titre curve for mother, x—x titre curve for child.

8th month of pregnancy, she gave birth. The baby was extremely immature and cyanotic and had an abnormally large spleen and liver. It died 3 hours after birth. Autopsy revealed pulmonary atelectasis with exudate in the pleurae and pericardium. The spleen and liver were enlarged and congested. The meninges were hyperaemic and the subdural space contained a large amount of clear golden brown fluid. The cerebral parenchyma was congested and disintegrating, and presented numerous soft and granulated foci of

all sizes up to that of a hazel nut. The microscope showed meningo-encephalitis with extensive necrosis and calcification, areas infiltrated by lymphocytes and plasma cells, and in one section intracellular accumulations of parasites corresponding in size and shape to *Toxoplasma* (Fig. 2). The dye test titre in the maternal serum was 1:4000 three days after delivery and 1:2000 four months later. The serum of the child was not examined.

Table I shows the results of the egg test in the 233 women with a normal pregnancy and delivery. The test was made at the time of delivery. It also gives the data from 94 women who said that they had never been pregnant. Table II contains the results of the dye test in 415 women who came to the hospital for antenatal care and in 270 of these women given two or more tests up to the time of their delivery. The latter women are grouped according to the highest titre found in any of the tests.

Ten of the last mentioned women had a titre of 1:250 or more in one of the tests. Table III gives data from 8 of these cases. The other 2 are not included because the titre, never higher than

TABLE I

*Toxoplasma-Neutralizing Antibodies in Healthy Women, Women Aborting in the Second to the Sixth Months and Cases of Obstetrical Abnormality (Egg Test)*

	No. of cases	< 5 per cent	> 5	
			Total	> 100 per cent
Women with normal pregnancy and delivery ... ..	233	33.9	60.1	9.4
Healthy non-pregnant nulliparae ... ..	94	42.6	57.4	4.3
Abortions not accompanied by fever ... ..	102	43.1	56.9	2.0
Stillbirth ... ..	53	41.5	58.5	5.7
Child died shortly after birth ... ..	55	40.0	60.0	9.1
Premature birth ... ..	113	42.5	57.5	6.2
Major developmental defect in child ... ..	32	43.8	56.2	3.1

TABLE II

*Toxoplasma-Neutralizing Antibodies in Healthy Pregnant Women and Women Aborting in the Second to Sixth Months (Dye Test)*

	No. of cases	Negative result in 1:110 dilution per cent	Positive result in dilution	
			>1:10 per cent	>1:250 per cent
Healthy women on first visit for prenatal care during early pregnancy ... ..	415	51.8	48.2	2.4
Group of these given several tests during pregnancy	270	51.5	48.5	3.8
Miscarriage with and without fever ... ..	93	45.2	54.8	2.2

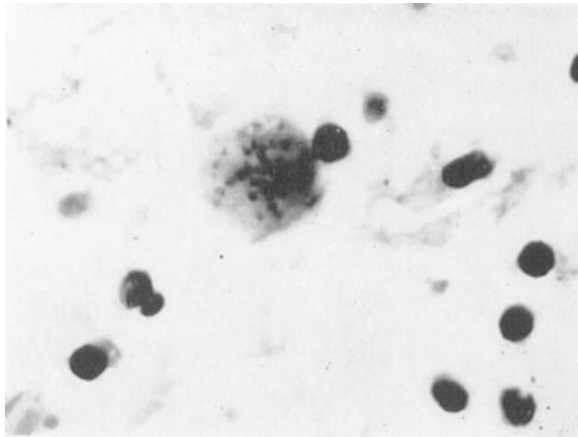


FIG 2  
Parasitic cyst in a focal inflammatory and necrotizing  
lesion in the cerebral white matter.

S.C.H.

TABLE III

*Data from 8 Cases in Which Maternal Serum Showed Dye Test Titre of 1:250 or More During Pregnancy*

Mother		Child	
Clinical features	Dye test (Roman numerals indicate month of pregnancy)	Clinical features	Dye test
1-gravida aged 24, formerly healthy, had acute bronchitis in fourth month of pregnancy. Pulmonary roentgenograms were normal.	III -1:10 V +1:1000 VI +1:2000 VII +1:4000 IX +1:8000 5 months after delivery +1:500	Normal child, normally delivered, weighing 3,090 g. Roentgenograms of skull and ophthalmoscope showed nothing abnormal. Placenta grossly and microscopically normal and cultures gave no Toxoplasma.	Umbilical blood: +1:8000. 5 months old: +1:50
3-gravida aged 37, formerly healthy, had uneventful pregnancy.	IV +1:1000 VI +1:2000 VII +1:1000 X +1:1000 5 months after delivery, 1:50	Normal child, normally delivered, weighing 3,780 g. Roentgenograms of skull and ophthalmoscope showed nothing abnormal. Microscopic study of grossly normal placenta showed foci of leukocytic infiltration.	Umbilical blood: +1:500 5 months old: 1:10
2-gravida aged 20, formerly healthy, had uneventful pregnancy. Delivered at another hospital.	VIII +1:2000 X +1:1000 5 months after delivery, +1:1000	Normal child, normally delivered, weighing 3,540 g. Roentgenograms of skull and ophthalmoscope showed nothing abnormal.	3 months old: +1:500 6 months old: +1:10
1-gravida aged 37, had typhoid fever 6 years earlier. Gave premature birth. Emigrated to the U.S.A. after discharge from hospital.	VII 1:250 VIII 1:500	Premature child developed uneventfully and was discharged healthy.	
4-gravida aged 37, formerly healthy, had uneventful pregnancy.	III +1:500 IV +1:250 VI +1:250 X +1:50 3 months after delivery, 1:2000	Normal child, normally delivered, weighing 4,000 g.	3 months old: +1:10
1-gravida aged 21, had gonorrhoea just before conception. Uneventful pregnancy.	III +1:1000 IV +1:250 V +1:2000 VI +1:1000 3 months after delivery, +1:2000	Normal child, normally delivered, weighing 3,750 g. Roentgenograms of skull and ophthalmoscope showed nothing abnormal.	3 months old: +1:50
1-gravida aged 19, formerly healthy, had uneventful pregnancy.	III +1:2000 IV +1:1000 VI +1:1000 4 months after delivery, +1,1000	Normal child, normally delivered, weighing 3,060 g.	4 months old: +1:10
1-gravida aged 21, formerly healthy, had uneventful pregnancy.	IV +1:50 VI +1:250 VII +1:250 X +1:500 4 months after delivery, +1:50	Normal child, normally delivered, weighing 3,430 g. Placenta grossly and microscopically normal.	4 months old: +1:10



1:250, decreased successively with every test. All the children of the women in Table III were healthy and exhibited no signs of toxoplasmosis.

The first woman in the table is particularly interesting as she seems to have acquired toxoplasmosis during pregnancy. The first dye test gave negative results, but the following ones gave positive results, the titres rising continuously to 1:8000. The rise began in the 4th month in connection with acute bronchitis. Roentgenograms of the lungs were normal and none of the signs typical of acute toxoplasmosis in the adult was manifested.

Two separate series of women aborting in the 2nd to 6th month were examined, one with the egg test (Table I) and the other with the dye test (Table II). The first group were examined with only one test after the abortion, the second one with at least two tests, one after the abortion and the others 2 to 6 weeks later to see whether the titre rose after the abortion. The first group had a temperature below 38°C. at the time of the abortion, but about half the other women had a temperature over 38°C. Cases in which the abortion could be traced to organic or functional defect in the genital organs were not included in these series.

The titres of the women with babies born dead or dying shortly after birth are seen in Table I. A single egg test was made directly after the delivery. The dead children were examined on

the lines previously described. Whenever the mother had a high antibody titre, however, several slides from different parts of the central nervous system were examined histologically. No inflammatory change pointing to toxoplasmosis was found in any case.

The antibody level in the 113 women giving premature birth is also seen in Table I. The children weighed 2,500 g. or less and were examined as previously described. No signs of toxoplasmosis were seen in any case.

Table I also includes the 32 women whose children suffered from major developmental defect. In Table IV these cases are grouped according to the nature of the defect. No clinical or histological signs of toxoplasmosis were seen in any of these children. Two of them had internal hydrocephalus without meningocele. The maternal serum contained *Toxoplasma*-neutralizing antibodies in both these cases. The following is a brief description of them:

(1) A child born healthy at term began to show rapidly progressing hydrocephalus a few days after birth. It died at one year of age with an enormous head. There were no clinical signs of chorioretinitis or encephalo-meningitis, and no evidence of toxoplasmosis was found on pathological examination. An egg test of the mother's serum at the time of delivery revealed a titre of 50, and a titre of 22 in the child at the age of 6 weeks.

TABLE IV  
*Toxoplasma-Neutralizing Antibodies in Women whose Children Suffered from Major Developmental Defect*

Defect	Number of cases	Egg test		
		< 5	Total	> 100
Organic heart disease ... ..	5	1	4	-
Myelomeningocele with or without hydrocephalus	4	3	4	-
Mongolism ... ..	5	1	4	-
Acrania ... ..	3	2	1	-
Ocular aplasia ... ..	1	1	-	-
Diaphragmatic aplasia ... ..	4	3	1	-
Atresia of oesophagus ... ..	1	1	-	-
Umbilical hernia ... ..	1	1	-	-
Hydronephrosis ... ..	1	-	1	-
Fibrosis of pancreas ... ..	1	-	1	-
Deformity of hands and feet ... ..	4	1	3	-
Internal hydrocephalus without meningocele ... ..	2	-	2	1

(2) A hydrocephalic child born at term died a few hours after birth. Autopsy revealed foetal chondrodystrophy, internal hydrocephalus and intracerebral haemorrhage. No signs of inflammation or necrosis in the cerebral meninges or parenchyma were found on gross or microscopical examination, nor any evidence of toxoplasmosis. The maternal serum had an egg test titre of 140 ten days after delivery.

It is seen from Tables I and II that none of the various groups had a significantly increased percentage of women with Toxoplasma-neutralizing antibodies. It may be concluded that the differences between them were due to chance.

Fifty-nine ova from the cases of miscarriage in Table I were examined histologically. Infiltration and necrosis were seen in 35 of them, but the changes showed no correlation to the antibody titre in the maternal serum.

The placentas from 158 of the women in Table I were also examined histologically. No correlation was found between infiltration and necrosis in the placenta and the occurrence of antibodies in the maternal serum. The same was true of calcification in the placenta.

#### DISCUSSION AND CONCLUSIONS

##### *Frequency of Antenatal Inception of Toxoplasmosis*

Two cases of infantile toxoplasmosis were found in 23,260 newborn children. While some cases may have escaped notice, it is clear that manifest infantile toxoplasmosis is a rare disease.

It is possible, however, that intra-uterine toxoplasmosis may cause the death of the ovum and that the specific inflammatory changes are concealed by the autolytic disintegration occurring at abortion and intra-uterine foetal death during the last stage of pregnancy. It is likewise possible that the infection heals before the child is born under the influence of the maternal antibodies. Under such conditions the infection is of clinical interest only if it causes a disorder in development—premature birth or malformation. However, if toxoplasmosis is a common cause of these defects, it must be possible to demonstrate more mothers with antibodies in their case than in others.

As is seen in Tables I and II, however, the serological studies did not reveal a significantly

large proportion of women with antibodies in any of the selected series. Furthermore, not a single case of toxoplasmosis was found on pathological examination of the dead children or clinical examination of the living ones whose mothers had a high antibody titre. Because of this, I conclude that toxoplasmosis is only rarely a cause of abortion, intra-uterine foetal death, neonatal mortality, premature birth or defective development in the child.

##### *Value of Serological Tests and Manner of Antenatal Inception*

Antibodies were observed in the serum of about half the women examined. In view of this it may be reckoned that about 11,500 of the women in the entire series of 23,260 mothers had antibodies. About 700 of these had such a high antibody titre (dye test positive in 1:250 dilution or over) that they probably had had an infection within recent years. Nevertheless, only 2 cases of infantile toxoplasmosis were discovered. This shows that it is impossible to draw conclusions regarding diagnosis or prognosis from a single serological test, even in the case of a high titre.

By making repeated tests one can learn to what stage in the antibody curve the case has arrived. A persisting low dye test titre of 1:50 or less was found in 45 per cent of the 270 healthy pregnant women in Table II. In these cases the antibodies were probably the result of an infection years ago. A small percentage of the women in Table III showed a persisting high titre. This was apparently caused by a recent infection, past the clinical stage, however. As mentioned before, all these women gave birth to normal children with no signs of toxoplasmosis. Only 1 woman showed serological evidence of fresh infection, but she, too, gave birth to a healthy child. After delivery the child's titre dropped rapidly, indicating that the antibodies were the result of passive immunization. This case of infection with *Toxoplasma* during pregnancy seems to be the first of its kind to be reported. It shows that the same is true of humans as of monkeys, that the mother can be infected with *Toxoplasma* during pregnancy without the foetus being infected.

Several authors maintain that the frequent



occurrence of antibodies in pregnant women is due to the lowering of resistance associated with pregnancy and that there is a risk of intra-uterine toxoplasmosis when the mother has a high antibody titre. It has been assumed that the conditions are analogous to those occurring in syphilis in pregnant women. A fact militating against this assumption is that only 2 cases of infantile toxoplasmosis were discovered in the present series, though about 700 women showed a dye test titre of 1:250 or more. In my opinion, there is reason to assume that the conditions are the same as in animals. A high antibody titre need not in itself mean that the maternal toxoplasmosis is in an infectious stage. Only in the rare cases where the high titre represents a fresh infection is there a risk of the foetus being infected.

Apart from these exceptional cases, there seems to be no risk of the foetus being infected by *Toxoplasma* when the mother has a high titre of *Toxoplasma*-neutralizing antibodies. Instead, the antibodies seem to protect the foetus. For one reason, the antibodies have a strong inhibiting effect on the parasites *in vitro*.

Another is that, judging from the experimental investigations already mentioned, the microbes' prospects of extracellular existence become so small when antibodies begin to appear in the blood that any inflammation soon heals.

For the same reasons there can be no risk of the foetus of a future pregnancy being infected by *Toxoplasma*, no matter what phase of the infection the mother is in prior to the pregnancy.

On the other hand, there is risk of infection of the foetus during the first 2 weeks of the disease, when the microbes are spread by the blood. This has been shown by a large number of animal experiments, and we may assume that the same is true of humans. How great the risk is, is impossible to say. Judging by experiments on monkeys and the results of this study, it would appear to be of little importance.

#### *Possibilities of preventing Intra-uterine Toxoplasmosis*

These facts must be taken into account when considering prophylactic measures against intra-uterine toxoplasmosis. The most important measure is to find every case of acute toxo-

plasmosis among the pregnant mothers. The signs and symptoms of acute toxoplasmosis are often of diffuse nature in the adult, the infection generally resembling those of a common infection. Tender lymph nodes occur in some cases, a rash in others. In the case diagnosed serologically in the present series, the mother showed signs of acute bronchitis. For this reason, it is probably rarely that the disease can be diagnosed clinically. Serological evidence of its presence is not obtained until several tests in succession show a continuous rise in titre. In the meantime there is a chance of the foetus being infected. It seems to be difficult, therefore, to prevent the occurrence of infantile toxoplasmosis antenatally.

#### *Does Toxoplasmosis justify Termination of Pregnancy?*

There is no need for legally induced abortion because of transplacental passage of toxoplasmosis to the foetus in an earlier pregnancy, since neither among animals nor humans has infection of this kind been observed in two pregnancies in succession. Nor, for reasons just given, is a high antibody titre at the beginning of the pregnancy any justification for its termination.

If fresh toxoplasmosis has been demonstrated, on the other hand, either by discovery of the microbes or a rapidly rising antibody titre, there is obviously a risk of the foetus being infected. Both the animal data and the results of this study would indicate that the risk is insignificant. In view of this fact, it is my opinion that for the time being the pregnancy should be allowed to proceed in these cases. The question cannot be settled until we have more clinical experience.

In every case of this kind in which there is a risk of the foetus being infected, the mother should be treated with sulphapyridine or aureomycin. It may be possible by this means to prevent transplacental infection or favourably affect a foetal infection already present.

In view of what has just been said, there is no reason to advise a woman against another pregnancy because she has borne a child with congenital toxoplasmosis or because she shows a high antibody titre.

## SUMMARY

Two cases of infantile toxoplasmosis were found among 23,260 newborn babies born in Göteborg during a period of 4 years. They are described. No other case was found, despite systematic examination of all the children in the 633 cases of stillbirth or neonatal death and follow-up examination of nearly all the living children during the first year.

Antibodies to *Toxoplasma*, estimated with the egg and dye test, were found in about 50 per cent of the pregnant women; 3 to 5 per cent of them had a high titre pointing to recent or current toxoplasmosis. Statistical study did not reveal a significantly greater proportion of antibody carriers among the women whose pregnancy resulted in abortion, intra-uterine foetal death, neonatal mortality or a defectively developed child.

Consequently, toxoplasmosis seems to occur rarely among the newborn of Göteborg. The study was likewise unable to prove that toxoplasmosis could cause abortion or intra-uterine death of the foetus, though it did not belie the possibility.

A woman can be infected with toxoplasmosis while she is pregnant without the foetus becoming infected. This was shown by 1 case in which the results of the dye test were negative at the start of the pregnancy but changed to positive in the 4th month with a rapid rise in the titre to a high level.

Antibodies being present in the serum of a large number of completely healthy pregnant women who later bore healthy children, no conclusions as regards diagnosis or prognosis can be drawn from the presence of antibodies, even in high titre. It seems impossible to prevent the occurrence of infantile toxoplasmosis antenatally with the diagnostic possibilities now at hand.

The author is of the opinion that a previous toxoplasmic infection in the mother does not incur any risk for the foetus of a present or future pregnancy. On the contrary, antibodies in the maternal serum probably protect the foetus against toxoplasmosis. The only time when there seems to be risk of the foetus being infected is when a woman without antibodies is infected during pregnancy. It is concluded that

as yet toxoplasmosis is not a sufficient indication for the termination of pregnancy.

This study could never have been made had it not been for the friendly co-operation and generous help of a large number of colleagues at the Sahlgrenska Hospital. I am particularly indebted to the following: the gynaecologists, Professor H. Fredrikson, Professor E. Jerlov, and Dr. A. Kjessler; the paediatricians, Drs. Y. Akerrén and K. Holmdahl; the pathologists, Professor J. Mellgren and Dr. S. Olsson; the virologists, Drs. L. Alm, G. von Zeipel, and L. A. Linder; and the ophthalmologist, Dr. S. Holm.

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