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Poliomyelitis in pregnancy : a review of the literature and a report of thirty additional cases

James Weldon Fergus
University of Nebraska Medical Center

POLIOMYELITIS IN PREGNANCY

A REVIEW OF THE LITERATURE AND A REPORT OF THIRTY ADDITIONAL CASES

James W. Fergus

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I. Introduction

Although Poliomyelitis has been known as a disease entity for many years, the consideration of its possible relationship to pregnancy was not considered until less than twenty-five years ago. Since that beginning, the subject has become increasingly more prominent through the years due to the increased number of studies and reports which have appeared in the literature.

It is the purpose of this paper to report in detail a series of thirty cases of Poliomyelitis in Pregnancy which were seen in Nebraska from Nineteen Hundred and Forty to Nineteen Hundred and Fifty-Four. This is the first report from Nebraska of a series this large. It is also the aim of this paper to review the literature dealing with the subject and compare the results of the Nebraska series with the results reported by other investigators, in order to derive a well-rounded, accurate picture of the relationship of Poliomyelitis and Pregnancy if any such relationship does exist.

II. History

Most of the articles and studies of Poliomyelitis as a complication of pregnancy have been published in recent years.

It was not until Nineteen Hundred and Thirty-Two that McGoogen (1) published the first paper which actually discussed the relationship between Poliomyelitis and Pregnancy. Before this time there had been a number of articles in the literature dealing with Poliomyelitis, but not one mentioning Pregnancy associated with the disease.

In the intervening years, there have been a number of outstanding authorities who have maintained a constant interest in the study of Poliomyelitis in Pregnancy and have written numerous articles in the literature dealing with this subject. Paula Horn (2), has studied the cases of pregnant Poliomyelitis patients for a peridd of twenty years in Los Angeles County, California, has written many articles on the subject between Nineteen Hundred Thirty-Four and Nineteen Hundred Fifty-Five, and is one of the outstanding authorities on the subject today. Her latest paper, published in Nineteen Hundred and Fifty-Five with an accumulation of three hundred twenty-five cases, is the largest series reported to date and many of her findings and conclusions are mentioned later in this paper. W. L. Aycock (3) has written a number of fine articles on the subject, most of them during the earlier years of study. W. Mengert (4),

both with associates and in his own right, is a real authority on the management of the pregnant Poliomyelitis patient and has written a number of excellent articles. Many other out-standing physicians and investigators who have been working in this field have contributed much to our present knowledge of Poliomyelitis, and although there is insufficient space to list all their names, their reports, findings, and conclusions will stand for themselves as they are quoted throughout the remainder of this paper.

Our knowledge of Poliomyelitis in Pregnancy has come far since the first few articles, and now much is known about incidence, mortality, severity, and improved management so that we as physicians can better care for our patients and give our patients more to look forward to in regards to prognosis and healthy, rapid, complete recovery.

III. Report of Cases

Figure (I) is an outline report of thirty cases of Polio-myelitis in Pregnancy seen in Nebraska between the years of Nineteen Hundred and Forty and Nineteen Hundred and Fifty-Four.

These case reports were extracted from the files of Douglas County Hospital, Methodist Hospital, Immanuel Hospital, and other hospitals in Omaha, from Lincoln General Hospital and Bryan Memorial Hospital in Lincoln, and from the personal files of private obstetricians and general practitioners who saw and treated these patients during their Poliomyelitis.

Some of these reports are incomplete or lacking in certain aspects, but most are sufficiently complete that much information can be extracted and many sound conclusions can be derived from the material presented in the following table.

This information and the conclusions derived from it will be discussed along with a review of the world literature on the subject in a later portion of this paper.

Fig. I

Case No.	Age	Para.	Grav.	Gest. (mo.)	Paralysis	Outcome of Preg.	Sp. Fluid Cells	Residual Paralysis	Fetal Sex
1.	24	III	IV	5	Spinal	?	64	Mild	?
2.	23	I	II	3	Spinal	Aborted	16	?	?
3.	30	IV	V	4	Bulbar	?	447	None	?
4.	30	?	?	4	None	?	?	?	?
5.	27	I	II	6	Spinal	?	?	?	?
6.	18	?	?	5½	Bulbar	Died Undel.	?	Pat. Died	?
7.	25	I	II	5½	Spinal	Prem. Del.	?	Mild	M
8.	28	I	II	5½	Spinal	Norm. Del.	?	Mild	M
9.	28	?	?	7	Bulbar	Stillborn	113	Pat. Died	M
10.	21	I	II	8½	Spinal	Norm. Del.	175	Mod.	M
11.	?	I	II	7	None	Norm. Del.	?	None	M
12.	21	I	II	7	Bulbar	?	31	None	?
13.	25	I	II	2	None	?	125	None	?
14.	26	III	IV	7½	Spinal	Norm. Del.	158	?	F
15.	26	II	IV	8	Spinal	Prem. Del.	154	Mod.	M & F
16.	22	I	II	4½	None	?	173	None	?
17.	39	?	?	3	Bulbar	Died Undel.	181	Pat. Died	?
18.	25	I	II	8½	Bulbar	C-Sect.(surv.)	548	Pat. Died	M
19.	?	III	IV	8	Bulbar	Stillborn	331	Pat. Died	F
20.	?	?	?	3	Spinal	Norm. Del.	?	?	?
21.	?	II	IV	8	Spinal	Norm. Del.	67	Mild	M

Fig. I (cont.)

Case No.	Age	Para.	Grav.	Gest. (mo.)	Paralysis	Outcome of Preg.	Sp. Fluid Cells	Residual Paralysis	Fetal Sex
22.	?	I	II	9	Spinal	Norm. Del.	313	Severe	M
23.	?	II	III	8½	Bulbar	?	10	?	?
24.	20	II	III	4½	Spinal	Norm. Del.	285	Mod.	F
25.	?	0	I	8½	Spinal	?	57	?	?
26.	21	I	II	8	Bulbar	?	609	Pat. Died	?
27.	21	?	?	5	Spinal	?	?	Mod.	?
28.	29	?	?	7	Spinal	?	?	Mod.	?
29.	22	II	III	8	None	Norm. Del.	?	None	F
30.	32	?	?	9	Spinal	?	?	None	?

IV. Experimental Data

As interest developed in the problems connected with Polio-myelitis and Pregnancy from a clinical standpoint, experimental investigators were also attacking the problem from an experi-mental laboratory standpoint.

Weaver and Steiner (5) in 1944 were the first to carry out experiments in this field. They innoculated sixty-four pregnant cotton rats with virus of the Armstrong-Lansing strain, but were unable to obtain any significant results. They suggested that either the choridnic gonadotropins or else some substance active in the formation or metabolism of these hormones may play a role in the apparent resistance to Poliomyelitis displayed by pregnant females during the first trimester.

Byrd (6) in 1950 innoculated two hundred twenty-seven pregnant mice and an equal number of non-pregnant ones with Lansing strain Poliomyelitis virus. He concluded that the disease had a shorter incubation period in the pregnant mice and also caused a higher incidence of abortion.

Knox (7) in 1950 innoculated one hundred pregnant Swiss white mice and one hundred non-pregnant Swiss white mice with Col SK strain of murine Poliomyelitis virus. She found that pregnant mice have an increased susceptibility to Poliomyelitis and that, beginning with the fourth day, mortality in the preg-nant group climbed progressively until it reached an incidence two times as high as in the control group. es in the control group. es in the control group.

Although it is impossible to project the results of mice experiments to human expectation, these experiments do illustrate the fact that there are probably extra factors involved in the pregnant female which do influence the course of disease or the susceptibility to the Poliomyelitis virus, and which are not ordinarily present in the non-pregnant Poliomyelitis victim.

V. Discussion

A. Incidence of Poliomyelitis in Pregnancy as Compared to the Incidence in the General Population.

From the very beginning of the increasing interest in the relationship of Poliomyelitis and Pregnancy, investigators have speculated about the incidence of the disease in pregnancy as compared to its incidence elsewhere.

McGoogen (1) in 1932 commented that in view of the fact that there were many articles in the literature dealing with Poliomyelitis, but almost none mentioning the disease as a complication of pregnancy, the occurence of Poliomyelitis in women during pregnancy must be rare.

Aycock (3) in 1941 stated that in view of the expected incidence of Poliomyelitis being one case per one thousand individuals, this would make the expectation of Poliomyilitis in Pregnancy approximately one case per fifty thousand pregnancies. Using this expectation in the 1939 epidemic in Detroit, one would have expected one case of Poliomyelitis in Pregnancy to appear, but four cases were seen, so he concluded that the incidence must be increased in pregnancy.

Baker and Baker (8) in 1947 reported thirty pregnant patients in a group of six hundred ninety-five patients with Poliomye-litis and concluded that this indicated a higher incidence than would occur by chance alone.

Fox and Waisman (9) in 1947 decided after a review of the

literature that the incidence of Poliomyelitis was greater in the pregnant group than the non-pregnant group, and that the glandular changes which occur in pregnancy might be a possible explanation for the discrepancy.

Taylor and Simmons (10) in 1948 reviewed twenty-five cases of Poliomyelitis in Pregnancy taken from a group of nine hundred cases of Poliomyelitis in which one hundred thirteen were fe-males between the ages of seventeen and forty years. They con-cluded that the incidence of disease in pregnancy is two times greater than the incidence in the non-pregnant group, and that this may be due to the chronic fatigue of pregnancy.

Fox and Belfus (11) in 1950 stated that in their study of thirty-three cases, fifty-seven per cent of married females in the childbearing years who were admitted for Poliomyelitis were pregnant. Since this is far in excess of the percentage of pregnancy in the general population, they concluded that there must be an increased incidence of Poliomyelitis in Pregnancy.

Danial (12) in 1951 reviewed the literature and concluded that marked sensitivity to Poliomyelitis exists during pregnancy.

Weinstein, Aycock, and Feemster (13) in 1951 stated that of one thousand seven hundred and seventy cases of Poliomyelitis in Massachusetts, eighty-two were females between twenty and forty years of age. The expectation of pregnancy in this group from random chance would be approximately ten cases, but in ac-tuality was twenty cases or two times the expectation.

Priddle, Lenz, Young, and Stevenson (14) in 1952 stated that the expected incidence of pregnancy among one hundred eighty-six females admitted to the Poliomyelitis service of Herman Kiefer Hospital, Detroit, Michigan was eleven and one-half cases, but the actual number admitted was thirty-four cases or triple the expectation.

Cobb, Stuart, and Mengert (15) in 1953, in a review of the literature, concluded that the incidence of Poliomyelitis in Pregnancy is increasing and that there is some evidence that it is increasing disproportionately rapidly as compared to the increase in the general population.

Hunter and Millikan (16) in 1954 reported forty-nine instances of pregnancy in their group of one hundred ninety females of reproductive age who had Poliomyelitis. Forty-four of the non-pregnant portion were single and thus not likely to be preg-nant on that account, so this resulted in a corrected pregnancy incidence of thirty-four per cent. This is much higher than the five to ten per cent incidence of pregnancy in the general population of childbearing females as shown by other studies.

McCord, Alcock, and Hildes (17) in 1955, in a report of fifty-one cases from the Winnepeg, Canada Munincipal Hospital, concluded that the per cent of pregnant females admitted to the hospital with Poliomyelitis was significantly higher than the per cent of other adult groups admitted.

Horn (2) in 1955 reported the following numbers of cases

seen in the 1950 Poliomyelitis epidemic in Los Angeles County, California.

Poliomyelitis and Pregnancy	33
Poliomyelitis without Pregnancy	172
Pregnancy without Poliomyelitis	90,234
Remainder of Females of Childbearing Age	885,527

These figures indicate that the Poliomyelitis attack rate in this series was one and nine-tenths times higher in pregnancy. When the Chi Square was calculated for this incidence, it was eleven and five-tenths, which means that this percentage could have occured by chance only once in one hundred instances and thus was considered significant.

Berquist and Sadler (18) in 1955 reported that of five hundred and sixty-eight patients with Anterior Poliomyelitis, eighty-eight were females between fifteen and forty years of age and twenty-four were pregnant. This is an incidence of twenty-seven per cent which is approximately three times the incidence that would be expected.

Siegel and Greenberg (19) in 1955 , in a report of eighty-seven cases of Poliomyelitis in Pregnancy in New York City, found that the total average annual rate of Poliomyelitis in the general population was six and six-tenths cases per one hun-dred thousand popula ion, that the total average sate in the pregnant group was twelve and seven-tenths cases per one hun-dred thousand population, and that the rate in the non-pregnant

group was six and one-tenth cases per one hundred thousand population. From this, they concluded that the incidence of Poliomyelitis was fifty-nine per cent higher in women who were pregnant than would be expected in the general population of women of the childbearing age group.

Lathrop, McAllister, Johnson, and Hughes (20) in 1956 studied twenty-five patients with Poliomyelitis who were older than fifteen years and found eight were pregnant. This is an incidence of thirty-two per cent which agrees with most of the other studies in which it is shown that the incidence of Poliomyelitis is two to three times increased in the pregnant group.

As we do not have the records of the total number of pregnant women or the total number of women with Poliomyelitis during the years from which our series is taken, we cannot draw any valid conclusions as to the comparison of incidences of the pregnant and non-pregnant groups in our study. However, it is fairly evident from a review of the literature that there must be an increased incidence of Poliomyelitis in Pregnancy and this increased incidence is probably somewhere between two and three times the average incidence in the general population.

In regard to the factors which are involved in this increased incidence, chronic maternal fatigue and the endocrine changes of pregnancy have been suggested, but there is no real substantial evidence to support either of these postulations. Therefore, this particular phase will need more thorough study before any well founded conclusions can be established.

B. Incidence of Poliomyelitis as Compared to Trimester of Onset.

Many investigators have observed come correlation between the incidence of Poliomyelitis in Pregnancy and the trimester in which the disease first appears. This is an interesting aspect for study, especially to discover the reason why sus-ceptibility should change with the progress of pregnancy and thus perhaps be able to take means to reduce this susceptibility to the disease.

The incidence of cases by trimester in the world literature is illustrated by Figure III, page 16, and the results of our own series are shown by Figure II, page 14. The apparent increase in the incidence of Poliomyelitis in the last trimester in our series is not born out by a comparison with the world lit-erature and may be a reflection of the small number of cases in our series or a sampling error in the selection of cases.

Fig. II

Incidence of Poliomyelitis in Each Trimester of Pregnancy

First Trimester	4	13%
Second Trimester	10	33%
Third Trimester	16	53%
Total	30	100%

The analysis of the literature indicates approximately an equal scattering of cases among the three trimesters and although there is a slightly higher incidence of cases in the

second trimester, this increase of six to ten per cent above those incidences in the third and first trimesters respectively is not remarkable.

Therefore, it would be safe to conclude from this study that Poliomyelitis may occur at any stage in the progress of the pregnancy and that there is probably no correlation between the incidence of the disease and the trimester of onset.

Fig. III

Incidence of Cases by Trimester - World Literature

	I	II	III	Total
Aycock (1941)	9	19	23	51
Blair, Robertson, and Robertson (1944)	1	1	4	6
Baker & Baker (1947)	7	16	7	30
Taylor & Simmons (1948)	8	11	6	25
Horn (1948)	50	41	22	113
Schaefer & Shaw (1949)	7	7	4	18
Kos (1949)	2	0	3	5
Brehm (1951)	0	2	0	2
Paquet & Schwarz (1951)	0	0	2	2
Garlick (1951)	0	0	2	2
Kaminek & Fuchs (1953)	0	0	1	1
Jackowski (1953)	0	0	1	1
Carpenter, Cohen, Colman, and Plotkin (1954)	0	0	1	1
Hunter & Millikan (1954)	13	19	17	49
McCord, Alcock, and Hildes (1955)	14	20	14	48
Berquist & Sadler (1955)	6	6	12	24
Weinstein & Meade (1955)	14	30	16	60
Nebraska (1940-54)	4	10	16	30
Total	135	182	151	468
	(28.9%)	(38.9%)	(32.3%)	(100%)

C. Incidence of Cases Compared to the Degree of Severity.

Although all degrees of paralysis are seen in Poliomyelitis in Pregnancy, there have been a number of attempts to classify the cases and derive a correlation between pregnancy as a complication and the severity of the paralysis.

Gifford and Hullinghorst (32) in 1948 after a review of the literature commented that of one hundred seventy cases reported, there was bulbar involvement in twenty-three per cent, spinal involvement in thirty-seven per cent, and no paralysis in eight per cent. In thirty-two per cent of cases, the degree on paralysis was not reported.

Kos (24) in 1949 reported five cases, one of which had no paralysis, three of which had spinal paralysis, and one of which had bulbar paralysis.

Paquet and Schwarz (26) in 1951 reported two cases; one with spinal paralysis and one with resperatory paralysis.

Brehm (25) in 1951 reported two cases; one with spinal and one with bulbar paralysis.

Priddle, Lenz, Young, and Stevenson (14) in 1952 reported that in their series of thirty-four cases, twenty-one per cent had bulbar paralysis, forty-four per cent had spinal paralysis, and thirty-five per cent had no paralysis. They also commented that the incidence of paralysis in females who had been pregnant within twenty months of the onset of Poliomyelitis was slightly higher than in the non-pregnant group, indicating that

maternal fatigue may be a factor.

Anderson, Anderson, Skarr, and Sandlar (33) in 1952 re-ported seventy-five cases from the 1946 epidemic in Minnesota, twelve of which had bulbar involvement, fifty-eight of which had spinal paralysis, and five of which had no paralysis. They concluded that there was no evidence of greater severity occur-ing among pregnant victims of Poliomyelitis than among non-pregnant married females of the childbearing age group who con-tracted the disease.

Hunter and Millikan (16) in 1954 stated that in their series of forty-nine cases, bulbo-spinal type paralysis was present in twenty-two per cent of cases, whereas the same type of paralysis was present in twenty-one per cent of non-pregnant women with Poliomyelitis.

McCord, Alcock, and Hildes (17) in 1955 reported fifty-one cases and found twelve cases with bulbar paralysis, twenty-six with spinal paralysis, and twelve cases with no paralysis.

Berquist and Sadler (18) in 1955 in a report of twenty-four cases found four cases with bulbar paralysis, seven cases with spinal paralysis, and eight cases with no paralysis. In our own series, of thirty patients, nine had bulbar paralysis, sixteen had spinal paralysis, and five had no paralysis, which is in fairly good agreement with other workers.

It would seem from this study that in Poliomyelitis there is probably little or no correlation between pregnancy as a

complication and the severity of the paralysis. All degrees of paralysis occur in patients who are pregnant, but the incidence and the severity do not seem to be significently increased or decreased in the pregnant group as compared to the non-pregnant group.

D. The Relationshi of the Trimester of Onset to the Severity of Disease.

The relationship of trimester to severity is very im-portant not only in estimating the prognosis in individual cases, but in trying to determine what factors enter into the deter-mination of the severity of the paralysis.

Gifford and Hullinghorst (32) in 1948 after reviewing the literature stated that the incidence of bulbar involvement was increased in the last trimester.

Taylor and Simmons (10) in 1948 reported twenty-five cases and found that of nineteen patients in the first and second trimesters, there were no fatalities and only two had residual paralysis. However, of six patients in the third tri-mester, there were three deaths, and of the three patients who survived one had bulbar paralysis, and two had severe residual paralysis. They commented that their study refuted statements previously made by others, that estrogens protect the patient from disease, because in their experience late pregnancy, at which time estrogens are most abundent, is apparently the time at which the patient's resistance to the virus is the lowest. They found that recovery during the first seven months of gestation was good and commented that estrogen and progesterone may be protective during early pregnancy. They also said that the severity of the disease in late pregnancy may be due to the sudden and massive destruction of the neurotropic virus

with the accompanying profound tissue response or to the chronic fatigue of pregnancy.

Weinstein, Aycock, and Feemster (13) in 1951, in a report of twenty cases, concluded that patients who develop Poliomyelitis early in pregnancy usually suffer no ill effects, but if parturition takes place in the acute phase of the disease or shortly thereafter, ar increase in the severity of paralysis or extension of paralysis to muscles not already involved is frequently encountered. The mechanism involved is not known, but this phenomenon may be due to the abrupt hormonal changes at the time of parturition.

Priddle, Lenz, Young, and Stevenson (14) in 1952 stated that in their series of thirty-four cases, all of the most severe cases occured during the first six months of gestation. This observation was in opposition to previous papers by several other investigators.

Anderson, Anderson, Skaar, and Sandler (33) in 1952 reported seventy-five cases, in which there was a slight concentration of the more serious cases in the two to five month gestation group.

Hunter and Millikan (16) in 1954 reported forty-nine cases and decided that the more severe forms are not limited to any particular trimester.

Weinstein and Meade (31) in 1955 reported a series of sixty cases and concluded that the paralytic type of Poliomyelitis

occurs most often between the fifth and the seventh month of gestation.

McCord, Alcock, and Hildes (17) in 1955, in a report of fifty-one cases, stated that the length of hospital stay, being a fairly accurate index of severity, would suggest no increase in the morbidity encountered in third trimester patients.

Berquist and Sadler (18) in 1955 concluded from their study of twenty-four cases that mortality and paralysis are worse during the last trimester. This was decided from the fact that all their deaths and all their respiratory paralysis cases occured during the third trimester.

The results of our own study are outlined to Figure IV, page 22, and show an overall predominance of spinal paralysis, but a marked increase in the incidence of the spinal and bulbar forms in the third trimester. These findings agree fairly closely with previous studies in most respects.

Fig. IV

Onset in Trimester as Compared to Severity of Disease

Trimester	I	II	III	Total
No Paralysis	1	2	2	5
Spinal Paralysis	2	6	8	16
Bulbar Paralysis	1	2	6	9

Except for the Priddle, Lenz, Young, and Stevenson (22) paper, most of the investigators are in agreement that there is

an increase in the severity of disease associated with the lat-ter portion of pregnancy. Therefore, this observation should be taken into account if one wishes to prognosticate in an in-dividual case and should be a guiding principle to encourage more vigorous observation and treatment of the third trimester

patient. In regard to the etiology of this predominance of sev

erity late in pregnancy, there is little evidence available on which one may base a theory. The answer may lie in the estro-gen and progesterone levels, the destruction of neurotropic virus, or the chronic fatigue of pregnancy. This point merits more exhaustive study in the future.

E. Incidence of Cases Classified by Parity and Gravidity.

It is of interest to attempt to decide whether there is any relationship between the parity or gravidity of the patient and her individual susceptibility to Poliomyelitis, because if such a relationship were known to exist, the patients who fell into the categories known to be more susceptible could be more carefully observed and extreme care to avoid exposure to Polio-myelitis could be exercised.

Gifford and Hullinghorst (32) in 1948 analyzed the literature and concluded that the most frequently seen group of cases with Poliomyelitis in Pregnancy was the Gravida I classifica-tion, the second most frequently seen group was Gravida II, and thus the frequency continued down in a regular graduated decline to Gravida VI.

Bowers and Danforth (34) in 1953 reviewed the literature and found that thirty-one per cent of cases occured in the Gravida I classification, forty-two per cent in Gravida II, seven-teen per cent in Gravida III, and small per cents in the other classifications. This study indicates that the highest incidence is probably in the Gravida II group.

McCord, Alcock, and Hildes (17) in 1955, in their report of fifty-one cases, showed that the great predominance of cases seen by them were in the Gravida II classification. The next most common classifications were Gravida I and III, the inci-dences being about equal.

Weinstein and Meade (31) in 1955, in a study of sixty patients, reported that six and two-thirds per cent of patients were Gravida I, about forty-seven per cent were Gravida II, and about forty-seven per cent were greater than Gravida II. There was an especially high incidence of Poliomyelitis, actually ninety-four per cent, among the thirty to thirty-six year old females who were multi-gravida when they became ill. They concluded, that in view of their observation that the ratio of multi-gravidity to primi-gravidity in Poliomyelitis is approximately four to one, but in healthy females is approximately two to one, there must be an increased incidence of Poliomyelitis in multi-gravida patients.

Siegel and Greenberg (19) in 1955 reported eighty-seven cases and found to their satisfaction, that there was a direct association between the number of children in the household and the incidence of Poliomyelitis in Pregnancy.

The results of our own series are outlined in Figure V, page 26, and concur with most of the other recent reviews in illustrating that the highest incidence of Poliomyelitis is in the Para I, Gravida II group. There seems to be a trend through the years for the predominance of cases to shift from the Gravida I group to the Gravida II group. Whether this trend is a reflection of better diagnosis, increased resistance of women carrying their first baby, or increasing maternal fatigue is not known.

Fig. V

Cases by Parity and Gravidity

Para	0	I	II	III	IV	V	VI
No.	1	12	5	3	1	0	0

Gravida	0	I	II	III	IV	V	VI
No.	0	1	12	3	5	1	0

This increased incidence is probably not too significant at the present time in view of the fact that the predominance of pregnancies are in Gravida I and Gravida II women, thus creat-ing the greater likelyhood of a pregnant woman contracting Polio-myelitis at Gravida II. However, if the trend continues to shift into the higher gravidity classifications, it will become significant, as then it will be extremely important to protect the multi-gravida patient from exposure to Poliomyelitis.

In regard to the relationship of a high parity to the severity of disease after Poliomyelitis is once contracted, Weinstein and Meade (31) in 1955 commented that the paralytic type of Poliomyelitis occurs most often in Para II patients. This observation is borne out by our own series as shown in Figure VI, page 27, which indicates that the predominance of the more severe forms occured in Para I and Para II women. However, this finding is probably not too remarkable in view of the fact that, overall, most of the cases of Poliomyelitis occur in the Para I and Para II groups, and thus one would expect the

predominance of the severe cases to also fall into these groups.

Fig. VI

Onset of Poliomyelitis in Multiparous Patients as Compared to the Severity of Disease

Parity	0	I	II	III	IV	V
No Paralysis	0	3	1	0	0	0
Spinal Paralysis	1	6	3	2	0	0
Bulbar Paralysis	0	3	1	1	1	0

F. Incidence of Cases Compared to the Age of the Patients.

The question of whether there is a relationship between the age of the pregnant patient and the susceptibility to Poliomyelitis has been analyzed by various investigators through the years.

Kleinberg and Horwitz (35) in 1941 reported thirteen cases of Poliomyelitis in Pregnancy which were all between the ages of seventeen and twenty-eight years.

Blair, Robertson, and Robertson (21) in 1944 reported six cases all within the twenty to twenty-six year age group.

Gifford and Hullinghorst (32) in 1948 after a review of the literature decided that the highest incidence of Polio-myelitis in Pregnancy occurs between ages twenty-four and twenty-six, with the predominance of all cases falling between twenty and twenty-eight years of age.

Bowers and Danforth (34) in 1953 in a review of the literature concluded that the incidence of Poliomyelitis in Pregnancy is highest at ages twenty to twenty-nine years.

Weinstein and Meade (31) in 1955 reported sixty cases and found that there is little or no difference in the incidence of Poliomyelitis in those women who were in the first two trimesters in the twenty to twenty-four year age group, but that there is an increased incidence in those women who were in the third trimester and in the twenty-five to thirty-six year age group.

Siegel and Greenberg (19) in 1955 in a report of eighty-seven cases found that the attack rate of Poliomyelitis rose progressively with age and was marked in the thirty-five to thirty-nine year age group.

The results of our own series are shown by Figure VII, page 29, and indicate that the highest incidence is probably between ages twenty-one and thirty years, with an average age of twenty-five and three-tenths years. Although all but three of our cases fell into this range, extremes are possible, our youngest case being eighteen years old, and our oldest thirty-nine.

Fig. VII

Incidence of Onset of Poliomyelitis Compared to Age of Patient

Age	18	19	20	21	22	23	24	25
No. of Cases	1	0	1	4	2	1	1	3
Age	26	27	28	29	30	31	32	33
No. of Cases	2	1	2	1	2	0	1	0
Age	34	35	36	37	38	39	40	
No. of Cases	0	0	0	0	0	1	0	

In view of the fact that the majority of pregnancies probably occur in the eighteen to thirty year age group, it is not surprising that most investigators report the major portion

of their cases to be in or near this range. Only in one review, that of Siegel and Greenberg (19), was there a really marked variation from the remainder of the literature. In the Weinstein and Meade (31) paper, they stated that there was a marked increase in the twenty-five to thirty-six year age group, but this included only third trimester patients and thus introduced an additional variable factor. So in summary of these observations, it is fairly safe to postulate that there is probably no significant relationship between the age of the pregnant patient and her susceptibility to Poliomyelitis.

G. Outcome of Pregnancies Complicated by Poliomyelitis.

As one of the aspects in the treatment of the pregnant patient with Poliomyelitis is directed at obtaining the least possible incidence of fetal loss, the statistics relating to the outcome of the pregnancies and the types of fetal loss encountered are very important in the study of Poliomyelitis in Pregnancy.

As abortion is a common cause of fetal loss, an outline of the incidences of abortion in Poliomyelitis from the world literature is presented in Figure VIII, page 32, and indicates that fourteen per cent of all pregnancies in which Poliomyelitis is a complication end in abortion.

McGoogen (1) in 1932 commented that Poliomyelitis ex-hibited no demonstrable effect on the pregnancy.

Strauss and Bluestone (36) in 1946 commented that the infant who is delivered vaginally within a respirator is exposed to the possibility of air embolism, pulmonary embolism, and/or increased intra-cranial pressure due to the changing pressures in the respirator, and that this may have a definite effect on fetal survival figures.

Baker and Baker (8) in 1947 reported a twenty-three per cent abortion rate, which they felt was higher than usual, but commented that the Poliomyelitis probably had little influence on the course of Pregnancy.

Fox and Belfus (11) in 1950 commented that the rate of

Fig. VIII

Incidence of Abortion in Poliomyelitis - World Literature

		Cases	Abortions	Per Cent
1.	Kleinberg & Horwitz (1941)	13	1	7.7%
2.	Blair & Robertson (1944)	5	1	20.0%
3.	Baker & Baker (1947)	30	7	23.3%
4.	Taylor & Simmons (1948)	25	2	8.0%
5.	Schaefer & Shaw (1949)	18	3	16.7%
6.	Fox & Belfus (1950)	33	7	21.2%
7.	Hunter & Milliken (1954)	49	8	16.3%
8.	Horn (1955)	325	43	13.0%
9.	Berquist & Sadler (1955)	24	5	20.8%
10.	McCord, Alcock, & Hildes (1955)	51	7	13.7%
11.	Nebraska (1940-1954)	30	1	3.3%
	Total	603	85	14.1%

abortion in Poliomyelitis was not unusual, but felt that the patients who did abort usually did so during the acute phase of the illness.

Nettleblad (37) in 1950 concluded that unusual presentations are more likely to occur in patients who have had Polio-myelitis before or during Pregnancy, and that this complication would effect the outcome statistics by virtue of the added obstetrical hazards of an unusual presentation.

Bowers and Danforth (34) in 1953, in their review of the literature stated that a striking finding was that in babies delivered at or near term in patients who had contracted Poliomyelitis during the first or second trimester, the birth weights were distinctly sub-normal for the period of gestation. No explanation was given for this finding.

Horn (2) in 1955 stated that abortion, if it occurred, was more often associated with critical illness and the high febrile reactions commonly seen in the acute phase of the disease.

Berquist and Sadler (18) in 1955 reported an overall fetal loss of fifty per cent, of which forty per cent were abortions and of which another forty per cent died because of maternal death. However, they concluded that the rate of abortions was no nigher than that seen in the non-Poliomyelitis group and that growth and development of the infant was not effected by this disease.

The outcomes in our own series are tabulated in Figure IX, page 34, and show an extremely low incidence of abortion. This may be due to lack of diagnostic acumen in ferreting out the Poliomyelitis patients who did not know they were pregnant at the time of the onset of disease or who gave inaccurate histories of a possible abortion.

Fig. IX

Outcome of the Pregnancy

Normal Delivery	9
Premature Delivery	2
Stillborn	2
Abortion	1
Desearean Section	1
Died with Mother Undelivered	2

The overall incidence of abortion as reported in the world literature does not appear to be significantly different from the overall incidence of abortion in the general pregnant population. Therefore, Poliomyelitis probably has no effect on the tendency of the pregnant patient to abort.

It would seem likely that due to the additional diffi-culties and hazards of delivering patients inside respirators, of delivering patients with unusual presentations, and deliver-ing dying patients with increased haste, there would be some

increased fetal mort=lity and morbidity encountered. However, with increasing knowledge and skill in handling the pregnant patient with Poliomyelitis, this morbidity should be held to an ever decreasing minimum.

In regard to the fetal wastage due to death in utero as a result of maternal mortality, this is hard to control until we have better means of treating the mothers afflicted with the more serious forms of the disease.

Several investigators have recorded instances in which the vaginally delivered infant died of Poliomyelitis post-partum, the disease probably being contracted from fecal con-tamination at the time of birth. Although this event is probably rare, it serves to emphasize the need for extreme care in the practice of sterile technique when performing a delivery compli-cated by the added hazard of the Poliomyelitis virus.

H. Incidence of Maternal Mortality.

Maternal mortality is one of the most important aspects in the study of Poliomyelitis in Pregnancy, and if any know-ledge can be gained as to etiology or methods of reducing mortality, it will be very important to a physician taking care of a pregnant Poliomyelitis patient. Only the question of incidence will be discussed here, as the causes of maternal mortality are to be discussed in a later section of this paper.

The incidences of maternal mortality from the world literature are outlined in Figure X, page 37, and indicate an overall death rate of seven and six-tenths per cent with seven hundred and twelve cases being reported in the literature. This includes the thirty cases from our own series in which six patients died, making a twenty per cent mortality incidence. This per cent is considerably higher than any of the other studies which reported on more than one case. It is not known why the mortality in Nebraska from 1940-1954 was so high, but may be due to a sampling error, with an unusually large number of severely involved cases being included in our series. If that is not the reason, then one must assume that some other factor such as tardy diagnosis, insufficient availability of iron lungs, incompentent management, decreased resistance of patients to the virus, or some other unforseen possibility is the basis for the discrepancy.

Cobb, Stuart, and Mengert (15) in 1953 after a review of

Fig. X

Maternal Mortality - World Literature

		Cases	Mort.	Per Cent
1.	Blair, Robertson, & Robertson (1944)	6	1	16.6%
2.	Fox & Waisman (1947)	14	2	14.2%
3.	Taylor & Simmons (1948	25	3	12.0%
4.	Schaefer & Shaw (1949)	18	1	6.0%
5.	Kos (1949)	5	1	20.0%
6.	Fox & Belfus (1950)	33	4	12.1%
7.	Priddle, Lenz, Young, & Stevenson (1952)	34	1	2.9%
8.	Sindrum & Van Der Wey (1952)	1	1	100.0%
9.	Kaminek & Fuchs (1953)	1	1	100.0%
10.	Nilsson (1953)	1	1	100.0%
11.	Hunter & Millikan (1954)	49	3	6.0%
12.	Horn (1955)	325	17	5.2%
13.	Berquist & Sadler (1955)	24	3	12.5%
14.	Siegel & Greenberg (1955)	87	2	2.9%
15.	McCord, Alcock, & Hildes (1955)	51	6	11.8%
16.	Lathrop, McAllister, Jonnson, & Hughes (1956)	8	1	12.5%
17.	Nebraska (1940-1954)	30	6	20.0%
	Total	712	54	7.6%

the literature concluded that the maternal mortality as seen in pregnant patients with Poliomyelitis is not significantly different from that seen in non-pregnant patients with Polio-myelitis. Mengert (4) commented in his editorial on manage- ment that the increased incidence of maternal mortality seen in the third trimester in some series may be due to the added insult of a forced delivery which was enough to turn the tide against a patient who was already fighting for her life against acute Poliomyelitis.

McCord, Alcock, and Hildes (17) in 1955 stated that in their series of fifty-one cases, the maternal mortality rate was similar to the mortality rate seen in other adult groups with Poliomyelitis so long as their ages were relatively com-parable. The predominance of the maternal deaths occurred in the third trimester, but this is not remarkable in view of the well documented observation that the disease is likely to be more severe in the last trimester.

Horn (2) in 1955 agreed with previous writers that there was no demonstrable increase in the severity or mortality in the pregnant victims of Poliomyelitis over that seen in non-pregnant patients in the same age group. She also said that mortality was related to the severity of disease and not neces-sarily to the trimester.

Berquist and Sadler (18) in 1955 further agreed with previous studies in concluding that the maternal mortality in

Poliomyelitis is no greater than the mortality elsewhere in Poliomyelitis, but that maternal mortality is higher in the third trimester.

Laudadio (38) in 1955 stated that he believed from a review of the literature that mortality from Poliomyelitis is increased in Pregnancy from five to twelve per cent overall and more increased with the progress of the pregnancy.

From the world literature and our own series, one may safely conclude that mortality from Poliomyelitis is probably not significantly increased in pregnancy, but that due to the increased incidence of severe disease in the third trimester, the predominance of the mortality is seen in this period of gestation.

I. Causes of Maternal Mortality.

It was not until 1952 that a study in the literature noted the causes of death in the cases of Poliomyelitis in Pregnancy which ended fatally, so it is assumed that either most of the deaths occurring prior to that time were considered to be due to pure respiratory paralysis and thus not remarkable, or else post-mortem examinations were not done and the causes of the deaths were thus not sufficiently well documented to be reported in the literature.

Sindram and Van Der Wey (39) (in 1952) reported one case of Poliomyelitis in Pregnancy which ended fatally from air embolism which was considered to be due to air passed from vagina into uterine veins by the alternate pressure of the respirator.

Nilsson (40) in 1953 reported one case which developed kidney stones and died in renal failure.

Horn (2) in 1955, reported two patients with Poliomyelitis in Pregnancy who died of pneumothorax and six patients who died in toxemia and eclampaia.

McCord, Alcock, and Hildes (17) in 1955 reported one death due to bronchopneumonia, three deaths due to gastro-intestinal hemorrhage, one death due to perforated duodenal ulcer, and one death with tracheo-bronchitis and atelectasis.

Lathrop, McAllister, Johnson, and Hughes (20) in 1956 reported one case of death in Poliomyelitis in Pregnancy due to

pulmonary embolism, which was the first such case to be reported in the literature. They commented that a much higher incidence of pulmonary embolism would be anticipated due to the long periods of inability to move with resulting stasis and phlebothrombosis, but that the low incidence must be due to the young age of the patients, the lack of arteriosclerosis, the fact that the Poliomyelitis virus does not attack blood vessels, or the active physical therapy that is commonly employed in Polio-myelitis patients.

In our own series of thirty cases, the six cases which ended fatally all were fairly well shown to be due to respiratory paralysis plus ascending paralysis which involved vital centers which finally produced changes that could not be sufficiently compensated for by the iron lung. In the cases which died, the iron lung seemed to be of no avail, and the oxygen embarrassment continued with increasing cyanosis and eventual death in spite of active artificial respiration.

It has been shown that although respiratory paralysis is the most common cause, death is possible from other causes, and thus the attending physician's attention must also be directed to other conditions besides respiratory distress. It has also been shown that death may occur in spite of active artificial respiration, but this statement is not intended to imply that artificial respiration is not a valuable means of therapy, as many lives have no doubt been saved by the prompt use of the

iron lung supplemented by trachiotomy if necessary.

J. Incidence of Residual Paralysis.

Taylor and Simmons (10) in 1948 were the first to report the incidence of residual paralysis. In their series of twenty-five cases, two patients were left with moderate residual paralysis and two patients with severe residual paralysis, making an incidence of sixteen per cent.

Paquet and Schwarz (26) in 1951 reported one case, in which the mother survived, but was left with persistent paral-ysis of the lower extremities.

Brehm (25) in 1951 reported one case with residual par-alysis of both legs and slight residual paralysis of the arms.

Jackowski (29) in 1953 reported one case in which there was marked weakness of the abdominal musculature and the leg musculature two months after recovery.

Bowers and Danforth (34) in 1953, in a review of the literature consisting of five hundred eighty-six cases, concluded that the chance of residual paralysis was little, if any, increased by the presence of pregnancy complicating the Poliomyelitis.

Berquist and Sadler (1f) in 1955 reported twenty-four cases and found that thirty-three per cent were left with severe residual paralysis and thirty-one per cent were left with mild residual paralysis. All these cases, however, have reported some improvement in the residual paralysis since the acute phase of the disease.

The results of our own series are outlined in Figure XI,

page 44, and show a total of fifty-nine per cent of patients left with some form of residual paralysis, but this is not as tragic as it might ap ear, as only one case, or less than six per cent, was left with severe paralysis. Most of the cases were classified as mild residual paralysis.

Fig. XI

Residual Paralysis

None	7
Mild	4
Moderate	5
Severe	1

It has been shown that patients with Poliomyelitis in Pregnancy are left with a fairly high per cent of residual paralysis, but it is highly probable, from this analysis, that the incidence of residual paralysis in pregnancy is not actually significantly higher than the incidence in non-pregnant patients with Poliomyelitis. This aspect has not been sufficiently studied to draw any definite conclusions at this time.

K. Relationship of Spinal Fluid Cell Count to Severity of Disease.

McCord, Alcock, and Hildes (17) in 1955, in a report of fifty-one cases at Winnepeg Municipal Hospital, recorded the spinal fluid cell counts of all except eight of their patients. They found that the counts in the patients with no paralysis whatever, varied from seventy to six hundred with a fairly even distribution between the extremes. In those with spinal paralysis, the range was from zero to one thousand eighty cells per cubic millimeter, with the majority of cases ranging from one hundred to four hundred cells. In those with bulbar involvement, the range was seventy-one to four hundred fifty with a fairly even distribution throughout.

The results of our own study are illustrated in Figure XII, page 45 and show elevated counts in all cases. However, as in the Winnepeg series, no clear cut evidence of increased severity of disease with increased cell count is indicated.

Fig. XII

Relation of Spinal Fluid Cell Count to the Severity of Disease.

Paralysis	Range of Cells
None	125 - 173
Spinal	16 - 313
Bulbar	10 - 609
Fatal	113 - 609

It is fairly conclusively shown by this study that high counts may occur in all severities of involvement and that there is probably little if any prognostic significance or diagnostic value with regard to severity of disease to be found in the spinal fluid cell count. Actually, the usefulness of spinal fluid counts in Poliomyelitis in Pregnancy is probably limited to the initial diagnosis, as evidenced by an elevated cell count with a predominence of lymphocytes.

L. Effect of Pregnancy on Respiration.

The question of whether the pregnant uterus interferes with respiration has long been considered by physicians interested in pregnant patients, and is especially important in patients with Poliomyelitis. In many cases, the respiration is much impaired due to the effect of the Poliomyelitis virus and if Pregnancy should further restrict respiration and oxygen exchange, this could be a factor that might cause the death of a patient who would otherwise recover.

McGoogen (1) in 1932, commented that there were reports in the literature of pregnant uteri encroaching on diaphragms and interfering with respiration, and that the respiration in these cases was seemingly improved on termination of the preg-nancy, but that pregnancy should not be interrupted except in those cases in which the uterus encroaches on a diaphragm which is paralyzed.

Strauss and Blumstone (36) in 1946 published a report of a case, delivered by Oesearean Section, in which they stated that the gravid uterus contributed to the respiratory embarrass-ment.

Cobb, Stuart, and Mengert (15) in 1953 concluded, after a review of the literature, that the respiratory embarrassment seen in pregnant patients with Poliomyelitis was a result of the Poliomyelitis and not related to the pregnancy.

Bowers and Danforth (34) in 1953 in a review of the lit-

ature, also agreed that the pregnancy probably has no effect of the respiratory embarrassment.

McCord, Alcock, and Hildes (17) in 1955 reported fifty-one cases of Poliomyelitis in Pregnancy and concluded that although one would expect the pregnant uterus to embarrass respiration, in their experience, it did not ever interfere with respiration. This conclusion was largely based on the finding that of all the cases in their series who were in respiratory distress, not one demonstrated any improvement in respiratory symptoms following delivery.

In our own series, it is impossible to state whether the pregnant uterus did play a part in the respiratory embarrass-ment that was seen in some of our cases, as this particular ob-servation was not well documented. However, in view of the ob-servations of the several other authors quoted, it is fairly reasonable to conclude that there is probably little if any effect produced by the pregnant uterus on the respiratory pro-cess.

M. Sex of the Fetus Compared to the Trimester of Onset.

The question of whether there is a relationship between the sex of the fetus carried and the susceptibility of the mother to Poliomyelitis during a certain trimester has been studied by a number of investigators.

Aycock (3) in 1946 was the first to study the problem, and after reviewing two hundred thirty-six cases concluded that there was a marked predominance of male fetuses in the pregnant females who contracted Poliomyelitis during the first trimester, and an overwhelming predominance of female fetuses in those whose onset of Poliomyelitis occured during the third trimester. From these findings, he concluded that there must be an increased susceptibility to Poliomyelitis in the first trimester if the pregnant woman is carrying a male fetus and an increased susceptibility in the third trimester if carrying a female fetus.

Scheefer and Shaw (23) in 1949 reported eighteen cases of Poliomyelitis in Pregnancy and stated that Aycock's original findings and hypothesis were not borne out in their series.

Anderson, Anderson, Skaar, and Sandlar (33) in 1952 reported seventy-five cases and found that there was a dominance of male fetuses among the women in their series and especially in those who contracted Poliomyelitis early in Pregnancy.

Horn (2) in 1955, in her report of three hundred twenty-five cases of Poliomyelitis in Pregnancy, concluded that there was no relationship between the sex of the infant and the tri-

mester of onset of disease.

Berquist and Sadler (18) in 1955 reported twenty-four cases and stated that there was a slight tendency, in their series, for those affected with Poliomyelitis late in their pregnancy to be carrying female fetuses.

The results of our own series are shown by Figure XIII, page 50, and are a reflection of too few cases to be of much significance.

Fig. XIII

Sex of Fetus as Compared to the Trimester of Onset of Poliomyelitis

	I	II	III	Total
Male	0	2	7	9
Female	0	1	4	5

In view of the fact that our own small series does not bear out Aycock's original hypothesis and that there are so many conflicting reports in the literature, it is hard to draw any very valid conclusions from the evidence available. Although there may be a real relationship between the sex of the fetus and the trimester of onset of Poliomyelitis, it appears unlikely at this time, and it is probable that the observations as made by various investigators are purely an element of coincidental, chance distribution.

N. Management of Patients with Poliomyelitis in Pregnancy.

The problem of the best course of management of a patient suffering the hardships of Poliomyelitis in addition to the regular stress of pregnancy is very important, and a problem which should be very carefully considered by any physcian car-ing for a patient afflicted with such a condition.

McGoogen (1) in 1932 stated that very little difficulty should be encountered in delivery of the pregnant Poliomyelitis patient unless there was malposition or disproportion present, and that one should not interrupt the pregnancy unless the uterus encroached on the paralyzed diaphragm, or unless the patient had a severe cystitis.

Kleinberg and Horwitz (35) in 1941 reported thirteen cases of Poliomyelitis in Pregnancy in which they used outlet forceps four times and mid forceps twice, with the remainder of the in-fants being delivered spontaneously.

Strauss and Bluestone (36) in 1946 performed a Cesearean Section on a patient confined to a respirator while they main-tained respiration with the positive pressure of the gas machine. They commented that due to the erroneous belief that during the agonal period preceding death, the patient is prone to have a precipitous delivery, there has been a high fetal mortality due to undue delay in performing a Cesearean Section, with the criti-cal time being used up in futile attempts to resuscitate the mother. In addition, there is a real danger to the infant who

is delivered vaginally in a respirator from the possibility of air embolism, pulmonary embolism, or intra-cranial hemorrhage. As a result, they recommend prompt Oesearean Section to save the infant, in cases where it appears that a fatal outcome for the mother is probable.

Taylor and Simmons (10) in 1948 reported a series of twenty-five cases and stated that uterine contractions proceeded norm-ally in spite of skeletal paralysis, but that low forceps were usually necessary in paralytic cases. With this type of manage-ment, no complications were experienced. However, they also commented that during the last trimester, the patient with Polio-myelitis is a grave risk for operative procedures and such should not be undertaken without careful consideration.

Schaefer and Shaw (23) in 1949, in a review of eighteen cases of Poliomyelitis in Pregnancy, stated that there is no specific treatment of choice, but that "Kenny Packs", prophylactic chemotherapy, and physical therapy are a great aid to fast recovery and the prevention of residual paralysis. They also stated that there was no indication to interrupt pregnancy by Oesearean Section from the standpoint of the effects of the Poliomyelitis.

Paquet and Scharz (26) in 1951 reported two cases. One of these was terminated in an attempt of improve the paralysis, but no benefit was realized, and the paralysis of the lower extremities persisted. In the other case, the mother died of

vena caval thrombosis, and it was suggested that a special iron lung which acted only on the thorax would have been of help. They believed that in a respirator of this type, the lower extremities could have been passively exercised and the vascular complications more easily prevented.

Priddle, Lenz, Young, and Stevenson (14) in 1952 reported that their thirty-four cases of Poliomyelitis in Pregnancy were all delivered either spontaneously or by low forceps.

Sindram and Van Der Wey (39) in 1953 reported a case in which they forced the delivery of a patient with Poliomyelitis who was confined to a respirator. The patient died of air em-b olism, the air presumably being introduced from the vagina into the uterine veins by the alternating pressures of the respirator. The investigators commented that this unusual complication could have probably been prevented by intra-uterine and vaginal packing.

Nelson and Johnson (41) in 1953 reported the delivery of one case in which the respiration was maintained by manual positive pressure with an anesthesia machine.

Nilsson (40) in 1953 delivered a patient, who could only tolerate being out of the respirator for seven minutes at a time, by alternately pulling the patient in and out of the respirator.

Bowers and Danforth (34) in 1953, after a careful review of the literature, concluded that Poliomyelitis has no effect per se on the pregnancy. It may, however, embarrass the respir-

ation, which would secondarily effect the pregnancy, and in which case, a prompt tracheptomy and iron lung therapy should be instituted. Local anesthetic was considered to be the anes-thesia of choice in the delivery of Poliomyelitis victims.

Mengert (4) in 1953, in an excellent editorial on the management of pregnancy complicated by Poliomyelitis, stated that there is a strong national tendency to interrupt pregnancy during the third trimester in spite of the fact that it has been conclusively shown by Cobb, Stuart, and Mengert (15) that respir-ation is not embarrassed by the pregnancy. Pregnancy cannot be terminated, either by Oesearean Section or by Pitocin induction without trauma, and to force delivery in a patient who is al-ready fighting for life against acute disease may turn the tide against her. Mengert believes that the pregnant woman with Poliomyelitis should be treated for the disease by all modern methods including tracheotomy (if necessary), endo-tracheal aspiration of mucous, positive pressure devices, maintainence of fluid and electrolyte balance, and antibiotics, with the pregnancy being ignored unless labor supervenes.

Carpenter, Cohen, Colman, and Plotkin (30) in 1954 reported one case, delivered by Pitocin induction and low forceps, with the operators working through the portholes of the respira-tor. They concluded that the uterus will respond to oxytocics in spite of spinal paralysis, that the complete relaxation of the birth canal which accompanies spinal paralysis makes lac-

erations less likely, and that Cesearean Section is hazardous in the respirator because of the need of an endotracheal air-way. They also felt that because the removal from the respira-tor entailed the need for a tracheotomy and added other hazards, delivery with the aid of forceps manipulated through the port-holes was the method of choice.

Hunter and Millikan (16) in 1954 stated that in their series of forty-nine cases, there was no need to alter the management or resort to Cesearean Section except for obstetrical reasons. In their experience, the anesthesia of choice for vaginal delivery was the pudendal block and the choice for Cesearean Section was local block of the abdominal wall.

McCord, Alcock, and Hildes (17) in 1955 stated that de-livery within a respirator is not difficult with an uncompli-cated vertex presentation, but due to the added difficulties encountered in breech presentations, these deliveries should be done by Cesearean Section in the respirator, or by the vaginal route with an anesthesia machine for positive pressure respira-tion and a proper table for the mechanical manipulations.

Horn (2) in 1955, in her latest paper on the experience with Poliomyelitis in Pregnancy in Los Angeles County, Cali-fornia, states that she believes labor usually proceeds normally to the pelvic floor, at which time one can complete the delivery with outlet forceps and control respiration with a gas machine or a Bennet positive pressure device if necessary.

of choice is the pudendal block or local infiltration of the perineum. In the case of a breech delivery or a Cesearean Section, one should have the use of a gas machine and an ob-stetrical or surgical table.

Berquist and Sadler (18) in 1955 reported twenty-four additional cases and commented that in the management of the pregnant patients with Poliomyelitis, and especially in those with bulbar involvement, it is important to do early tracheotomy and cautious bronchscopy (when necessary). These patients have considerable nasal regurgitation and pooling of secretions due to palatal paralysis and absence of the gag reflex, and thus have interference with good respiration. Their patients with embarrassed respiration were given a tracheotomy plus an endotracheal tube during delivery with respiration controlled by manuel compression of the bag. Outlet forceps and pudendal block were routinely used, and they concluded after careful follow-up study, that there was no damage to any of their infants by oxygen deprivation.

In our own series, the records were sporadic in observations on management of the patients, so it is difficult to draw any valid conclusions in this respect from our study. There were a number of patients who had spontaneous deliveries, a number of patients delivered with the aid of outlet forceps, one Cesearean Section done prior to maternal death with recovery of a live baby, and one post mortem Cesearean Section for a stillborn infant.

It is fairly evident from the literature that many pat-ients will deliver spontaneously without any evidence that the Poliomyelitis effected the delivery, and even in those patients who have severe spinal paralysis, most will fall into labor spontaneously and be able to bring the head down onto the pelvic floor, at which time it can be extracted easily with outlet forceps. This phenomenon is apparently due to the fact that the uterus is separate from spinal nerve innervation and can con-tract forcfully in spite of spinal paralysis.

In almost all cases, one should treat the Poliomyelitis to the best of his ability by ordinary supportive measures, and not attempt to improve the condition of the patient by interruption of the pregnancy, as the benefits thus derived and claimed by several investigators are extremely hard to demonstrate in clinical practice. In addition, the added trauma of the operation may be enough to push the already weakened patient over the brink to severe distress, even to death. Supportive treatment should include rest, general health improvement, passive exercise for paralyzed muscles, hot packs to affected extremi-ties (if helpful), maintainance of fluid and electrolyte bal-ance, prophylactic chemotherapy, and if necessary, early assist-ance of respiration using the iron lung, tracheotomy, or cauti-ous bronchoscopy, as indicated. These measures should then be followed by watchful waiting with full cognizance that some difficulties may be encountered at delivery. It has been shown

that uncomplicated vértex deliveries can be accomplished quite easily even though the mother is enclosed within a respirator, but that if a breech delivery or a Cesearean Section is to be undertaken, one shou'd have a positive pressure gas machine and an adequate operating table available. Anasthesia of choice is the pudendal block and/or local infiltration of the peri-neum, as this type of anesthesia causes the least trauma to the patient, and is least likely to further embarrass maternal respiration or cause cardio-vascular complications.

The indications for Cesearean Section are for obstetrical reasons only, and are the same as in cases not complicated by Poliomyelitis. The only possible exception might be the mother who is not in labor, but is carrying what, in the opinion of the obstetrician, is a viable fetus, and who is rapidly sinking into greater and greater respiratory difficulty with increasing cyanosis in spite of active therapy, as outlined above, to improve oxygenation. Here, one might be justified in going ahead with Cesearean Section in an attempt to save the infant. In regard to post-mortem Cesearean Section, although we have only one report from the world literature available of an infant who survived after being delivered by post-mortem Cesearean Section (Kaminek & Fuchs, 28), we still believe that if in the opinion of the obstetrician there is any chance of obtaining a viable fetus by performing this procedure, he is justified in going ahead in an attempt to recover a live infant.

O. Incidence of Congenital Anomalies.

Schaefer and Shaw (23) in 1949 reported that there were no fetal anomalies observed in the eighteen cases in their series.

Fox and Belfus (11) in 1950 in a report of thirty-three cases of Poliomyelitis in Pregnancy concluded that there was no evidence that Poliomyelitis left any stigma on surviving infants.

Anderson, Anderson, Skaar, and Sandlar (33) in 1952 reported that there was no increased rate of congenital abnormalities in their series of seventy-five cases.

Cobb, Stuart, and Mengert (15) in 1953 concluded that the rate of fetal abnormality is not significantly different from the normal expectancy, and thus there is no useful purpose in a therapeutic abortion to avoid fetal anomalies.

Berquist and Sadler (18) in 1955 in a report of twenty-four cases agreed with the above statements.

Although no fetal anomalies were seen in our own series, no dogmatic statements can be made concerning the incidence of fetal abnormalities in Poliomyelitis in Pregnancy, as the scrutiny of the infants for abnormalities was not a well documented, constant factor. However, inspite of this failing in our report, one may safely conclude from the literature that the incidence of fetal anomalies is probably not increased in the pregnancies complicated by Poliomyelitis.

P. Effect of Poliomelitis on Future Pregnancies.

McGoogen (1) in 1932 commented that very little difficulty should be expected in delivery of a woman who has had Poliomyelitis either preceding or during her pregnancy unless there is malposition or disproportion present.

Nettleblad (37) in 1950 reported a series of sixty deliveries in forty-one women who had had Poliomyelitis at some time preceding delivery. He concluded that there is no evidence that the average labor is longer in patients who have previously had Poliomyelitis than in ones who have never had the disease, but that there is some evidence that unusual presentations are more likely to occur in those who have had Poliomyelitis at some time previous to delivery. He also concluded that there is an increased tendency for a premature delivery in a woman with a history of Poliomyelitis.

Cobb, Stuart, and Mengert (15) in 1953, after a careful review of the literature, concluded that the ability to conceive or bear children was unimpaired in women with Poliomyelitis, but that the big consideration was their ability to care for the children following birth.

Laudadio (38) in 1955 commented that Poliomyelitis in child-hood often results in obliquely contracted pelves which might conceivably seriously effect the outcome of a future pregnancy.

Berquist and Sadler (18) in 1955 reported twenty-four cases of Poliomyelitis in Pregnancy and found that fertility was not

effected in any way by the disease.

Due to the lack of follow-up studies following the initial episode of Poliomyelitis in our own series, no good conclusions can be drawn. However, from the reports above, it is possible to infer that in all probability the extent of difficulty which might be anticipated in future pregnancies following Polio-myelitis would be an occassional mal-presentation, premature delivery, or contracted pelvis. The former two can be very adequately handled by modern obstetrical techniques, and the contracted pelvis can be diagnosed by good pelvic examination and/or X-ray pelvimetry, followed by Cesearean Section, if necessary, without undue hazard to the patient.

VI. Summary.

In the preceding pages, we have attempted to present the problem of Poliomyelitis as a complication of Pregnancy in a well organized, accurate paper.

We have reviewed the literature from Nineteen Thirty-two to Nineteen Fifty-six and have reported a series of thirty cases seen in Nebraska from Nineteen Forty to Nineteen Fifty-four.

A number of aspects have been considered, including incidence, severity, trimester of onset, maternal mortality, residual paralysis, and management. These points and their interrelationships have been discussed and analyzed, and the conclusions derived from the information presented are listed in the follow-ing section of this paper.

We found that there is an increased indicence of Poliomyelitis in Pregnancy, an increased incidence of severe paralysis late in pregnancy, and other notable conclusions, many of which would be of real interest to the physician caring for a patient who was both pregnant and had Poliomyelitis.

It is hoped that one may gain, from reading this paper, an accurate, concise concept of the relationship of Poliomyelitis and Pregnancy.

VII. Conclusions.

1. There is an increased incidence of Poliomyelitis in Pregnancy, and this increased incidence is probably between two and three times the average incidence in the general population.
2. There is probably no correlation between the incidence of Poliomyelitis in Pregnancy and the trimester of onset.
3. There is probably no correlation between pregnancy as a complication of Poliomyelitis and the severity of paralysis.
4. There is an increase in the incidence of severe paralysis associated with the latter part of pregnancy.
5. The highest incidence of Poliomyelitis in Pregnancy is between twenty-one and thirty years, but there is probably no significant relationship between the age of the patient and her susceptibility to Poliomyelitis.
6. There is no increased tendency for the pregnant patient to abort as a result of Poliomyelitis.
7. There is no significant increase in maternal mortality in Poliomyelitis, but most of the deaths which do occur are seen in the third trimester.
8. Maternal mortality may occur from means other than respiratory paralysis.
9. There is probably no significant increase in the incidence of residual paralysis in pregnant patients with Poliomyelitis.

10. There is probably little, if any, effect produced by the pregnant uterus of the respiratory process.

11. There is probably no relationship between the sex of the fetus and the trimester of onset of Poliomyelitis.

12. In most cases, pregnant patients with Poliomyelitis will either deliver spontaneously or at least bring the head down to the pelvic floor, where it can be easily delivered with outlet forceps.

13. Active supportive therapy, consisting of artificeal respiration, prophylactic chemo-therapy, maintainance of fluid and electrolyte balance, passive exercise, and tracheotomy (if necessary), should be carried out early in the pregnant patient with Poliomyelitis.

14. The indications for Cesearean Section are for obstetrical reasons only, and one should not try to improve the respiratory condition by terminating the pregnancy.

15. There is no increase in congenital anomalies in pregnancies complicated by Poliomyelitis.

16. In all probability, the only difficulties which might be incountered in pregnancies following Poliomyelitis would be an occasional mal-presentation, premature delivery, and/or a contracted pelvis.

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IX. Bibliography.

1. McGoogen, L. S., Acute Anterior Poliomyelitis Complicating Pregnancy, Amer. Jour. of Obs. & Gyn. 24:215-224, (Aug.) 1932.

2. Horn, Paula, Poliomyelitis in Pregnancy; A 20 Year Report from Los Angeles County, California, Obstetrics and Gyne-cology 6(2):121-137, (Aug.) 1955.

3. Aycock, W. L., The Frequency of Poliomyelitis in Pregnancy, New Eng. J. of Med. 225(11):405-8, (Sept. 11) 1941.

4. Mengert, W. F., Editorial, Obstetrics and Gynecology (N.Y.) 2(4):427, (Oct.) 1953.

5. Weaver, H. M. and Steiner, G., Amer. Jour. of Obs. & Gyn. 47(4):495-500, (Apr.) 1944.

6. Byrd, C. L., Journal of Neuropathology and Experimental Neurology 9:202-3, 1950.

7. Knox, Alice, Influence of Pregnancy on the Course of Infection with Murine Poliomyelitis Virus, Proc. of Soc. for Exper. Biol. and Med. 73:520-3, (Mar.) 1950.

8. Baker, M. E. and Baker, I. G., Acute Poliomyelitis in Pregnancy, Minnisota Medicine 30(7):729-34, (July) 1947.

9. Fox, M. J. and Waisman, . A., Further Observations on Poliomyelitis in Pregnancy, Amer. J. of the Med. Sciences 214:148-152, (Aug.) 1947.

10. Taylor, E. S. and Simmons, J. M., Acute Anterior Poliomyelitis in Pregnancy, Amer. Jour. of Obs. and Gyn. 56:143-151, (July) 1948.

11. Fox, M. J. and Belfus, F. H., Poliomyelitis in Pregnancy, Amer. Jour. of Obs. and Gyn. 59:1134-9, (May) 1950.

12. Danial, A., Pregnancy and Poliomyelitis, Rev. Path. Comp. 51/628:306-17, 1951. (Abstracted in Exerpta Medica, Obs. and Gyn. 10/5:191, 1952)

13. Weinstein, L., Aycock, W. L., and Feemster, R. F., The Relation of Sex, Pregnancy, and Menstruation to Susceptibility in Poliomyelitis, New Eng. J. of Med. 245/2: 54-8, (July 12) 1951.

14. Priddle, H. D., Lenz, W. R., Young, D. C., and Stevenson, C. S., Poliomyelitis in Pregnancy and the Puerperum, Amer. Jour. of Obs. and Gyn. 63(2):408-12, (Feb.) 1952.

15. Cobb, S. W., Stuart, John, and Mengert, W. F., Poliomyelitis and Pregnancy, Obstetrics and Gynecology 2/4:379-83, (Oct.) 1953.

16. Hunter, J. S. and Millikan, C. H., Poliomyelitis with Pregnancy, Obs. and Gyn. (N.Y.) 4/2:147-54, 1954.

17. McCord, W. J., Alcock, A. J., and Hildes, J. A., Poliomyelitis in Pregnancy, Amer. Jour. of Obs. and Gyn. 69(2):265-7, (Feb.) 1955.

18. Berquist, J. R. and Sadler, W. P., Poliomyelitis Complicating Pregnancy, Minnesota Medicine 38(10):668-673, (Oct.) 1955.

19. Siegel, M. and Greenberg, M., Incidence of Poliomyelitis in Pregnancy, New Eng. Jour. of Med. 253(20):841-7, (Nov. 17) 1955.

20. Lathrop, Fred, Jr, McAllister, Robert, Johnson, Herbert, and Hughes, Frank, Poliomyelitis, Pregnancy, and Pul-monary Emboli, Journal of Med. Soc. of New Jersey 53(4):181-4, (Apr.) 1956.

21. Blair, M., Robertson, C. M., and Robertson, C. E., Anterior Poliomyelitis in Pregnancy, Canadian Med. Assoc. Jour. 51:552-3, (Dec.) 1944.

22. Horn, Paula, Pregnancy Complicated by Anterior Poliomyelitis; Experience in Los Angeles County Hospital with Report of 180 Consecutive Cases, Ann. West. Med. & Surg. 5:93-108, (Feb.) 1951.

23. Schaefer, J. and Shaw, E. B., Poliomyelitis in Pregnancy, California Medicine 70:16-19, (Jan.) 1949.

24. Kos, M. Z., Acute Poliomyelitis during Pregnancy, Ceskoslovenska Gynaekologia, Prague 14/5:306-13, 1949. (Abstracted in Exerpta Medica, Obs. & Gyn. 10/2:514, 1949.)

25. Brehm, W., Anterior Poliomyelitis in Pregnancy, Ohio State Med. Jour. 47:830-1, (Sept.) 1951.

26. Paquet, P. A. and Schwarz, L., Acute Anterior Poliomyelitis and Pregnancy, Gynec. et Obstet. 3/2:174-7, 1951. (Abstracted in Excerpta Medica, Obs. & Gyn. 10/4:528, 1951.)

27. Garlick, C. H., Poliomyelitis in Pregnancy, New Zealand Med. J. 47:599-604, (Dec.) 1948. (Abstracted in Excerpta Medica, Obs. & Gyn. 10/2:514, 1949.)

28. Kaminek, Z. and Fuchs, V., Poliomyelitis in Pregnancy, Lék Listy 9/23:538-540, 1953. (Abstracted in Excerpta Medica, Obs. & Gyn. 10/9:14, (Jan.) 1956.)

29. Jackowski, R., Polsk. Tyg. Lek. 8/33:133-7, 1953. (Abstracted in Excerpta Medica, Obs. & Gyn. 10/7:238, 1954.)

30. Carpenter, F., Cohen, M., Colman, H. I., and Plotkin, D., **Pitocin Induction in Pregnancy Complicated by Acute Poliomyelitis, Amer. Jour. of Obs. & Gyn. 67(3):663-6, (Mar.) 1954.**

31. Weinstein, L. and Meade, R., Amer. Jour. of Obs. & Gyn. 70(5):1026-1032, (Nov.) 1955.

32. Gifford, H. and Hullinghorst, R. L., Poliomyelitis in Pregnancy, Amer. Jour. of Obs. & Gyn. 55(6):1030-6, (June) 1948.

33. Anderson, G. W., Anderson, Genivieve, Skarr, A., and Sandlar, F., Poliomyelitis in Pregnancy, Amer. Jour. of Hygiene 55(1):127-39, (Jan.) 1952.

34. Bowers, V. M., Jr. and Danforth, D. N., The Significance of Poliomyelitis during Pregnancy, Amer. Jour. of Obs. & Gyn. 65(1):54-9, 1953.

35. Kleinberg, S. and Horwitz, T., The Obstetric Experiences of Women Paralyzed by Acute Anterior Poliomyelitis, Surgery, Gynecology, and Obstetrics 72(1):58-69, (Jan.) 1941.

36. Strauss, H. and Bluestone, S. S., Cesearean Section on a Poliomyelitis Patient Confined to a Respirator, Amer. Jourl of Obs. and Gyn. 51:114-120, (Jan.) 1946.

37. Nettleblad, A., Obstetrical Aspects of Acute Anterior Poliomyelitis Existing Prior to or During Pregnancy, Acta Obst. Gyned. Scand. 29/4:329-350, 1950. (Abstracted in Excerpta Medica, Obs. & Gyn. 10/4:76, 1951.)

38. Laudadio, E., Minerva Med. (Torino) 46(I)/47:1734-8, 1955. (Abstracted in Excerpta Medica, Obs. & Gyn. 10/9:155, 1956.)

39. Sindram, I. S. and Van Der Wey, A. D., Poliomyelitis and Pregnancy, Med. Tydschr. Genesk. 96/40:2473-5, 1952. (Abstracted in Excerpta Medica, Obs. & Gyn. 10/6:238, 1953.)

40. Nilsson, D. E., The Delivery of a Quadriplegic Patient Confined to a Respirator, Amer. Jour. of Obs. & Gyn. 65/6:1334-7, 1953.

41. Nelson, R. B. and Johnson, K. W., Poliomyelitis in Pregnancy; Delivery of a Patient Confined to a Respirator, Amer. Jour. of Obs. & Gyn. 65/2:431-2, 1953.