

SURVIVAL IN TRAUMATIC TRANSVERSE MYELITIS

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Abstract. Spinal cord injury resulting in paraplegia or tetraplegia has from time immemorial led to early death. Mortality figures as high as 80 per cent over a few years have been noted.

Following World War II as a consequence of the intensive care extended to these casualties, the mortality has been significantly diminished. The mortality has been studied on three occasions by the authors and two previous papers have been published, the first in 1961 and the second in 1968.

The present paper is based on a mortality and longevity study which covers the period from 1 January 1945 to 30 November 1973, an interval of 29 years less one month. It deals with the mortality of spinal cord injured persons following treatment in Lyndhurst Lodge Hospital and reveals that there has been significant improvement over the period of study.

Key word: Transverse myelitis.

Introduction

THIS is a report of the third study conducted by the authors on the survival of persons who having suffered traumatic spinal cord lesions subsequently underwent rehabilitation treatment at Lyndhurst Lodge Hospital in Toronto, Canada. The period covered in this study is from 1 January 1945 to 30 November 1973, an interval of 29 years, less 1 month. This includes the persons who were studied on the two previous occasions, the first of which dealt with the interval from 1 January 1945 to 31 December 1958 (Breithaupt *et al.*, 1961) an interval of 14 years and the second from 1 January 1945 to 31 December 1966 (Jousse *et al.*, 1968) or 22 years. The numbers involved are for the first study, 599, for the second, 965, and for the third, 1501. Not all were injured between 1 January 1945 and the closing date noted, for the majority of World War II injuries were incurred before the opening of Lyndhurst Lodge in January 1945. Also a few civilians injured prior to January 1945 were included, if treated at Lyndhurst Lodge. To be included, the casualty must have survived the first acute hospital admission and have been transferred to Lyndhurst for participation in the rehabilitation programme.

As more than 90 per cent of those treated at Lyndhurst Lodge have been discharged to their own domiciles in the community, this study reflects not only the efficacy of the education and treatment programme at Lyndhurst but as well the quality of ongoing medical care and supervision available in the community to which the man or woman returned. The large majority were residents of the Province of Ontario but a few took up residence in other Provinces of Canada. A very small proportion lived in the U.S.A., the British Isles, or on Continental Europe, some being from Iron Curtain States.

Intermittent catheterization was not performed on these persons.

The three studies have been sponsored by the Manufacturers Life Insurance

Company.¹ The objective has been to follow each individual to the last known address. For those who had died, the place and date of death was determined and, if known, the cause of death.

Methodology

The method of search was to direct a questionnaire to the last known address. One thousand, one hundred and twenty-six such were mailed or handed out with a reply being received from 717 (64 per cent). At the time of mailing 326 of the total of 1501 persons were known to be dead. Forty-nine were still under treatment and had not left hospital (Lyndhurst) for the first time. Two hundred and eighty-three who did not reply to the questionnaire or were not otherwise contacted were traced through the Workmen's Compensation Board of Ontario, the Canadian Paraplegic Association, the Department of Veteran's Affairs of Canada, the Manufacturers Life Insurance Company or by means of phone calls to doctors and hospitals.

One hundred and two were reported as dead. This, in addition to the 326 known to be dead at the time the questionnaire was sent out. Twenty-four could not be located up until the end of November 1973. Four of this group were subsequently traced and found to be alive. However, they were not included in the study. Thus, 98.5 per cent of 1501 were identified and included in the report. Of the 1501, 428 or 26 per cent are known to be dead (Table I).

Results

Table I shows the mortality from all causes as it relates to the four diagnostic classifications of injured persons, namely, partial and complete, paraplegia and tetraplegia.

Percentage mortality was determined in comparison with that for the general population based on a normal standard rate for 1000 life years of exposure for comparable age-groups in the Canadian population.²

TABLE I
Mortality from traumatic transverse myelitis

	Patients	Deaths	Mortality Expected (%)
Partial paraplegia	450	119	181
Partial tetraplegia	353	87	223
Complete paraplegia	484	153	464
Complete tetraplegia	214	69	1163
Total	1501	428	

¹ The statistical work was done by Mr D. Ross, B.Sc., under the direction of Mr J. L. Cummins, F.S.A., and Dr D. J. Breithaupt, Medical Vice-President. The Retail Credit Company (now Equifax) achieved follow-up on nine-tenths of those who did not answer the Lodge questionnaire.

² The percentage mortality figures shown in the various tables are ratios of actual to expected mortality where the expected mortality is based on the 1965-1967 Ontario population mortality as published by the Dominion Bureau of Statistics, catalogue No. 84527, January 1971.

TABLE II

Cause of death	Number of deaths	% of total deaths
Renal failure	132	30.8
Cardiovascular disease	87	20.4
Respiratory	52	12.2
Neoplasm	42	9.8
Cerebrovascular accident	29	6.8
Pressure sores	19	4.4
Suicide	18	4.2
Gastro-intestinal	18	4.2
Others	15	3.5
Accidental	7	1.6
Liver disease	5	1.2
Unknown	4	0.9
Total	428	100

TABLE III

Deaths

	Autopsy	No autopsy	Unknown
Partial paraplegics	47	68	4
Partial tetraplegics	35	52	1
Complete paraplegics	76	75	2
Complete tetraplegics	28	40	0
Total	186	235	7
	43% of total deaths	55% of total deaths	2% of total deaths

The difficulty in assessing the risk for incomplete lesions is acknowledged for the impairment of function for this group ranges from negligible to profound and incapacitating. The mortality risk may vary accordingly. By contrast complete lesions provide a standard measurable degree of disablement for each level of injury and as a consequence the findings are more meaningful in this group.

Complete cord lesions are defined as such after careful and repeated neurological examinations over many months have revealed 'complete paralysis below the level of cord injury—complete loss of all modalities of sensation including anal and rectal sensation and complete visceral and sphincteric paralysis' (Botterell *et al.*, 1975). Incomplete lesions by contrast manifest impairment of motor and sensory function to any extent short of total abolition.

For the 428 persons who have died Table II shows the cause of death attributed in 409 instances. Four are unknown and 15 are grouped as 'others'. The percent-

age of total is shown in the right-hand column for each cause. Causes of death are not divided into the two categories used by Tribe *et al.* (1969) namely related to paraplegia and unrelated to paraplegia. This is so because it has never been clear to the authors just what causes are in fact related to paraplegia. Indeed, one of the purposes of this study is to determine any possible relationship existing between causes of death and transverse myelitis other than the established relationship for renal failure and decubiti.

The determination of the cause of death was supported by autopsy in 43 per cent of cases (Table III). No autopsy was performed in 235 instances or 55 per cent of the total deaths and for seven cases or 2 per cent it is not known if an autopsy was performed.

In Tables IV to IX comparison is made between death in transverse myelitis and the leading causes of death in our general population which are cardiovascular disease, cancer, respiratory disease, accidents and suicide.

Table IV, containing all partial lesions, has been divided into two age-groups for statistical purposes. The ages selected are 20-44 (24 years) and 45-64 (19 years).¹

TABLE IV
Total of partial lesions

Cause of death	No. of deaths	Expected in 1971 Canadian population
Age-group 20-44		
Accidents	5	5
Cardiovascular disease	8	2
Cancer	4 { bladder (1) brain (1) bowel (1) general (1) }	1
Suicide	3	1
Age-group 45-64		
Cardiovascular disease	21	20
Cancer	17 { lung (4) bowel (3) larynx (3) stomach (2) skeletal (1) prostatic (1) mouth (1) Hodgkins (1) general (1) }	9
Accidents	—	2
Respiratory	12	1
Suicide	5	1

¹ 'Leading causes of death by sex in various age groups #5.45, page 226 Canada Year Book 1973.'

Excepting accidental deaths, which are unchanged, the overall totals reveal increased mortality for the major causes of death. In cardiovascular disease, this increase is noted only in the younger age-group and for respiratory disease only in the older age-group. Suicide and cancer are increased in both age categories.

The unavoidable lack of homogeneity of data entering into the three studies, in addition to the small number of deaths reported in many of the tables where the results have been analyzed by cause of death and age, means that the results must be interpreted with caution. This is especially true where less than four deaths are reported in any category.

TABLE V
Total of complete lesions

Cause of death	No. of deaths	Expected in 1971 Canadian population
Age-group 20-44		
Accidents	2	4
Cardiovascular disease	11	2
Cancer	5 { bladder (3) lung (1) general (1) }	1
Suicide	8	1
Age-group 45-64		
Cardiovascular disease	15	11
Cancer	4 { bladder (2) breast (1) bowel (1) }	5
Accidents	—	2
Respiratory	—	0.6
Suicide	1	0.6

Table V contains all complete lesions and reveals similar findings to those for partial lesions for the younger age-group. It must be borne in mind that this study is based on persons who have survived the early acute care and entered on the rehabilitation phase.

Tables IV and V reveal significantly increased mortality for cardiovascular disease and cancer. There may be some association with renal disease for the former. The increased incidence of cancer is related to a variety of sites and appears not to affect any specific organ. All tetraplegics are particularly at risk from respiratory disease. Where respiratory death is increased the early deaths from this cause known to approach 50 per cent of total deaths are not included.

It will be recalled that partial lesions constitute a group whose members may experience disablement ranging from minor to major incapacity. Nevertheless, there is a significant increase in deaths from cardiovascular disease and cancer for the younger age-group in this classification.

TABLE VI
Total of partial paraplegia

Cause of death	No. of deaths	Expected in 1971 Canadian population
Age-group 20-44		
Accidents	3	4
Cardiovascular disease	6	1
Cancer	4 { bladder (1) brain (1) general (1) }	0.7
Suicide	1	0.8
Age-group 45-64		
Cardiovascular disease	12	13
Cancer	10 { lung (3) larynx (3) stomach (1) skeletal (1) prostatic (1) mouth (1) }	7
Accidents	—	2
Respiratory	5	0.7
Suicide	4	0.7

In the older age-group there is a significant increase in respiratory deaths and suicide (Table VI).

Table VII suggests a trend toward greater mortality for cardiovascular disease and suicide for the younger age-group. However, one must not consider this as significant on the basis of the few involved.

The older age-group reveals a significant increase for respiratory deaths and cancer. The increase for cardiovascular disease is of questionable significance.

In Table VIII a significant increase in mortality from cardiovascular disease, cancer and suicide is shown for the younger group. The 45-64 year group mortality from cardiovascular disease is again of questionable significance.

Table IX reveals a significantly increased mortality from cardiovascular disease in the younger group.

Table X shows by decades the age of onset of traumatic transverse myelitis. The well-known peak (Jousse, unpublished, Kraus *et al.*) occurring in the third decade is repeated. Nevertheless, almost as many occur after age 30 (717) as before (784).

It is thus seen to be a disorder which strikes many in the prime of life when physical resources are maximal and personal adaptability most flexible. The majority of victims may reasonably expect many years of survival. Hence measures of prevention must needs be sought diligently together with betterment of rehabilitation for those who become disabled.

Table XI reveals the causes of mortality by decades omitting the first. Renal failure remains at the top of the list by a wide margin to the end of the eighth

TABLE VII
Total of partial tetraplegia

Cause of death	No. of deaths	Expected in 1971 Canadian population
Age-group 20-44		
Accidents	2	2
Cardiovascular disease	2	0.8
Cancer	—	0.5
Suicide	2	0.5
Age-group 45-64		
Cardiovascular disease	9	6
Cancer	7 { bowel (3) general (1) lung (1) stomach (1) Hodgkins (1) }	3
Accidents	—	0.8
Respiratory	7	0.3
Suicide	1	0.3

TABLE VIII
Total of complete paraplegics

Cause of death	No. of deaths	Expected in 1971 Canadian population
Age-group 20-44		
Accidents	1	3
Cardiovascular disease	4	1
Cancer	4 { bladder (3) general (1) }	0.8
Suicide	6	1
Age-group 45-64		
Cardiovascular disease	13	9
Cancer	4 { bladder (2) breast (1) bowel (1) }	4
Accidents	—	1
Respiratory	—	0.5
Suicide	1	—

TABLE IX
Total of complete tetraplegia

Cause of death	No. of deaths	Expected in 1971 Canadian population
Age-group 20-44		
Accidents	1	1
Cardiovascular disease	7	0.6
Cancer	1 lung (1)	0.3
Suicide	2	0.3
Age-group 45-64		
Cardiovascular disease	2	2
Cancer	—	1
Accidents	—	0.2
Respiratory	—	1
Suicide	—	0.1

TABLE X
Age of onset of spinal cord injury

	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79
Partial paraplegia	7	41	163	96	71	46	24	2
Partial tetraplegia	3	71	101	53	41	52	30	2
Complete paraplegia	7	64	192	118	63	28	9	3
Complete tetraplegia	1	48	86	40	22	14	1	2
Total	18	224	542	307	197	140	64	9

decade. The increased deaths due to cardiovascular disease, respiratory disease, suicide and neoplasms are significant. The highest incidence of suicide falls in the fifth decade whereas the highest incidence of onset of traumatic transverse myelitis is in the third decade. This suggests that suicide is not necessarily an impulsive act during the first depressive phase but is frequently a carefully considered act.

Table XII presents the female deaths by type of lesion. It reveals a trend towards a more favourable mortality rate for the female than the male as is noted in the general population. Thus, although constituting 13.2 per cent of the total patients, but 10.8 per cent of the total deaths occurred in females.

TABLE XI

Primary cause of death by age-groups

	10-19	20-29	30-39	40-49	50-59	60-69	70-79	Over 79
Renal failure	2	24	22	23	29	18	10	4
Cardiovascular	—	2	9	14	16	27	10	9
Respiratory	1	5	7	6	17	8	6	2
Cerebrovascular accident	—	—	4	5	7	11	2	—
Suicide	—	2	3	9	2	1	1	—
Gastro-intestinal	—	3	3	4	3	2	1	2
Pressure sores	—	5	2	4	4	2	2	—
Liver disease	—	—	3	1	—	1	—	—
Neoplasm	—	—	6	4	8	19	4	1
Unknown	—	—	—	1	2	1	—	—
Others	—	2	4	5	2	1	1	—
Accidental	—	2	3	2	—	—	—	—

TABLE XII

Female deaths

	Patients	Deaths
Partial paraplegia	46	7
Partial tetraplegia	42	10
Complete paraplegia	82	17
Complete tetraplegia	28	12
Total	198	46
	13.2% of total patients	10.8% of total deaths

Discussion

It has long been known that the mortality in traumatic spinal cord casualties is very high during the first weeks or months following onset with a peak death rate during the first 2 weeks (Botterell *et al.*, 1975). Indeed prior to World War II this mortality trend continued until all but a few sturdy survivors numbering 10 to 20 per cent of the total lived beyond a 10-year period. It is therefore of interest to learn the mortality when the first 10-year period of exposure is omitted. Table XIII provides this information through comparison with Table I.

In this table the mortality has been determined for exposure after 10 years, that is from 10 to 20 years or until the time of death or the present date (1973) if survival exceeds 10 years. Comparison with Table I results (right-hand column) reveals improvement in mortality in all four categories, most marked for complete tetraplegic casualties. Many of the spinal injured casualties have now been exposed for three decades and a few are into the fourth.

In the early post World War II period it was recognized from our first study that the mortality rate had been markedly altered and 80 per cent or more survived for longer than 20 years. Indeed our total mortality is now only 26 per cent.

In order to make a comparison of mortality over two approximately equal periods of time Table XIV has been prepared. The total interval of 29 years has been divided into two periods, January 1945 to December 1958 and January 1959 to November 1973.

The mortality rate (actual over expected) for these two periods reveals a significant betterment for the latter period in the last three categories. The increased mortality from 1959 to 1973 in the first category suggests that only more severely involved incomplete paraplegics were referred to Lyndhurst in the latter 15-year period as compared with the earlier period.

In Table XV a comparison is made between our three studies. The bracketed figures represent the ratio of actual deaths to expected deaths as determined in our first study terminating in 1958 and published in 1961 using the then current mortality figures. In the first column headed 1960, the mortality

TABLE XIII

Percentage mortality (after 10 years' exposure)

	Deaths	% mortality	Table I % mortality
Partial paraplegia	70	158	181
Partial tetraplegia	29	216	223
Complete paraplegia	86	443	464
Complete tetraplegia	21	851	1163

TABLE XIV

Actual/expected mortality (%)

	Jan. 1945-Dec. 1958	Jan. 1959-Dec. 1973
Partial paraplegia	(10 deaths) 135%	(20 deaths) 245%
Partial tetraplegia	(20 deaths) 480%	(22 deaths) 202%
Complete paraplegia	(24 deaths) 568%	(21 deaths) 301%
Complete tetraplegia	(14 deaths) 1487%	(25 deaths) 1140%

TABLE XV

Actual/expected mortality: a comparison of three studies

	1960*	1968	1973
Partial paraplegia (139)	195%	118%	181%
Partial tetraplegia (220)	308%	216%	223%
Complete paraplegia (475)	665%	400%	464%
Complete tetraplegia (1256)	1758%	1200%	1163%

* These mortality percentages have been adjusted by the factor 1.4 for the difference in the mortality tables used in the 1960 study published in 1961.

TABLE XVI

Expectation of life (in yr) for partial and complete para- and tetraplegics

Age	1960	1968	1973
A. Partial paraplegics			
20	42 yr	45 yr	42 yr
30	34 yr	36 yr	34 yr
40	25 yr	28 yr	25 yr
50	18 yr	22 yr	18 yr
B. Partial tetraplegics			
20	38 yr	41 yr	41 yr
30	30 yr	32 yr	32 yr
40	22 yr	24 yr	24 yr
50	14 yr	16 yr	16 yr
C. Complete paraplegics			
20	27 yr	34 yr	32 yr
30	20 yr	27 yr	25 yr
40	14 yr	19 yr	19 yr
50	8 yr	12 yr	12 yr
D. Complete tetraplegics			
20	15* yr	21 yr	21 yr
30	11* yr	16 yr	16 yr
40	7* yr	10 yr	10 yr
50	3* yr	5 yr	5 yr

* These mortality percentages have been adjusted to reflect the difference in the mortality tables used in the 1960 study.

percentages have been adjusted by the factor 1.4 to bring them into line with the later studies. It must be borne in mind that the two last studies include all the persons previously reported upon. There has been no improvement in mortality between 1966 and 1973. In fact mortality may have increased.

Table XVIA compares the life expectation for partial paraplegia at ages 20, 30, 40 and 50 years for the three studies. At all ages the 1968 study reveals improvement and equally portrayed is the decline in the 1973 study which may well be a consequence of the fact that we are dealing at Lyndhurst with the more severely disabled incomplete lesions.

For partial tetraplegia, Table XVIB reveals a solid gain of 2 years or more between 1960 and 1968 which is retained but not bettered in the 1973 study.

Table XVIC shows the results for complete paraplegia. Very substantial gains were made between 1960 and 1968, that is of 7 years for ages 20 and 30, of 5 for the 40-year age-group and 4 for the 50-year age-group. The 1973 results show no improvement over 1968 and for 20 and 30 years a slight drop.

The gains for complete tetraplegia between 1960 and 1968 are convincing and are maintained but not bettered in our 1973 study. The overall gains are substantial (Table XVID).

Discussion

In this third study of mortality in traumatic transverse myelitis we have been able to gather information on a significantly larger number of individuals than in our earlier studies. It is particularly significant that whereas the first study included relatively few tetraplegics, as very few survived their first hospital admission, this third study involves a significant number. Of equal importance to the validity of the study is the high percentage of the total group traced and identified.

From our first study we were able to confirm the clinical impression that significant improvement in mortality had taken place in the decade following World War II. From the second we learned that further improvement had been achieved though it was much less dramatic. From the third study, that no demonstrable improvement has been achieved during the past decade and indeed in certain categories we appear to have lost ground.

The causes of death reveal the same pattern in all three studies with renal failure remaining the leading cause though its percentage position is now lower. This reflects improved treatment of urological complications. As well longer survival exposes casualties to the degenerative diseases of later life.

The comparison with the leading causes of death in our society reveals that these subjects are particularly vulnerable to respiratory disease, cancer, suicide and cardiovascular disease. The latter cause appears to have moved up in the younger age-group which may be related to the widespread kidney involvement known to exist.

The diverse sites in which cancer appears in these persons is puzzling but a pattern may develop when larger groups are studied in the future.

It is most important that a similar actuarial type of study be carried out from centres practising intermittent catheterization for a similar period of time. Only in this way will it be possible to make a valid comparison with our cases. One would hope that such a study may reveal marked betterment in mortality from renal disease and perhaps from cardiovascular disease. Above all one would hope for an improvement in the quality of life through lessening of morbidity.

RÉSUMÉ

Les lésions du cordon médullaire qui ont pour résultat la paraplégie ou la tétraplégie ont de toute éternité occasionné une mort prématurée. La statistique révèle une mortalité, au cours de quelques années, de jusqu'à 80%.

Après la guerre mondiale II, résultant des soins intensifs donnés à ces accidents, la mortalité a été très réduite—d'une manière significative. La mortalité a été étudiée trois fois par les auteurs et deux écrits antérieurs ont été publiés, l'un en 1961 et le second en 1968.

Cet écrit est basé sur une étude de la mortalité et de la longévité qui comprend la période depuis janvier 1, 1945, jusqu'à novembre 30, 1973, une intervalle de 29 ans, moins un mois. Il traite de la mortalité des sinistres de lésion du cordon médullaire après traitement médical dans Lyndhurst Lodge Hospital. Il fait ressortir une amélioration significative au cours de la période de l'étude.

ZUSAMMENFASSUNG

Verletzungen des Rückenmarks hinauslaufend auf Paraplegie und Tetraplegie ist immerwährend die Ursache des frühzeitigen Tod gewesen. Sterblichkeitziffer bis auf 80% wurden während einiger Jahre aufgedeckt.

Nach dem Weltkrieg II, folgend der intensiven Pflege dieser Patienten, ist die Sterblichkeit bedeutend vermindert. Die Verfasser haben dreimal die Sterblichkeit studiert und zwei vorhergehende Arbeiten wurden veröffentlicht; die erste in Jahre 1961, die zweite im Jahre 1968.

Diese These ist auf einer Untersuchung der Sterblichkeit und der Langlebigkeit gegründet; sie fast zusammen die Periode von Januar 1 1945 bis November 1973, eine Zwischenzeit von 29 Jahre minus ein Monat. Sie behandelt die Sterblichkeit der Patienten mit Verletzungen des Rückenmarks folgend der Behandlung in Lyndhurst Lodge Hospital, und zeigt eine bedeutende Verbesserung während der Periode der Behandlung.

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General Discussion

DR GREGORY (*U.S.A.*). Could you explain the arithmetic? I don't understand 135 per cent or 480 per cent. What is that a percent of?

DR A. JOUSSE (*Canada*). It is the percentage ratio of the number of paraplegics who died in comparison with the general population actuarially determined. If 1000 people were exposed for so many years, it's usually on an annual basis, a 1000 people from the general population statisticians know at age 20, 30, 40 or 50 how many will die, they don't know which ones will die but they know how many will die in a year. They compare that figure with the actual deaths recorded by paraplegics per thousand per year, for the same age-group. It's a statistical device that the insurance people use to determine expectation of life for insurance purposes.

DR GREGORY. I'm still puzzled over the high percentages. I thought that is 50 per

cent higher mortality or 20 per cent higher or something, not 138 per cent. That sounds strange.

DR A. JOUSSE. Mortality in complete tetraplegia is about 12 times the normal; that's where the 1200 per cent is. And for complete paraplegia about 400 per cent, and for partial paraplegia about 175 per cent, and incomplete paraplegia is 125-135 per cent; something like that.

DR H. J. M. BARNETT (*Chairman*). It must be gratifying to those who had the vision, as Sir Ludwig Guttmann did in Britain and Dr Harry Botterell did in Canada, to set up these paraplegic units to see these survival rates. I wonder, Dr Botterell, if you'd like to make any comment at this point. I just happened to see you there. Any other comments or questions about Dr Jousse's paper.

DR J. BOURRET (*France*). We saw a relatively high incidence of suicides amongst mortality. My question is were the cases of primary attempts of suicide excluded from your whole number of your patients or were they included.

DR JOUSSE. What was that again, Sir?

DR JACQUES BOURRET. We saw in the late mortality, a high incidence of suicide. Now my question: Were among your 1500 patients the cases of primary suicidal attempts excluded or included? The causes of the primary paraplegia?

DR JOUSSE. We couldn't determine that really. I think we only knew of about two people who became paraplegic having attempted suicide by shooting themselves and admitting it afterwards. They were not included excepting one of them who subsequently after he became paraplegic lived for a number of years and did commit suicide successfully; he was included, one of them was not included.

CHAIRMAN. Any other questions. Thank you very much, Dr Jousse.

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