Childhood leukaemia and poliomyelitis in relation to military encampments in England and Wales in the period of national military service, 1950-63

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Abstract

Objective—**To determine if any excess of childhood leukaemia was associated with the large and increasing numbers of national military servicemen in 1949 and 1950, particularly in rural districts. This would be a further test of the hypothesis that childhood leukaemia can originate in an infection, the transmission of which is facilitated by an increased number of unaccustomed contacts in the community.**

Design—**Rural and urban districts, aggregated by county, were ranked by proportion of servicemen, and five groups containing similar numbers of children were created. In addition, individual local authority districts were ranked and grouped in tenths. Mortality from childhood leukaemia 1950-3 was examined in these groups. Data on infectious diseases were also examined, as well as data on leukaemia in later periods.**

Setting—**England and Wales.**

Subjects—**Children aged under 15 years.**

Results—**In 1950-3 but not subsequently a significant excess of leukaemia in children under 15 was found in the fifth of county groupings with the highest proportions of servicemen. This was due mainly to a significant excess in children under 2 years (and especially in those under 1 year) in rural districts. It was confirmed among the tenth of local authority districts with the highest proportion of servicemen. These rural areas showed significantly more notifications of, and deaths from, poliomyelitis among children than the rural average.**

Conclusions—**The findings support the infection hypothesis. That the excess of leukaemia was greatest in children under 1 year suggests transmission of infection among adults and thence to the fetus. The pattern of spread of poliomyelitis may also have been influenced by the presence of large numbers of servicemen.**

Introduction

Recent findings indicate that population mixing, particularly in new towns in rural areas, can lead to increases in childhood leukaemia as predicted by a hypothesis on transmission of infection.[1 2] A striking example of one type of population movement is that arising from national military service in Britain after the second world war. The introduction of military service in 1947, together with extensions of the service period in 1949 and 1950, produced striking demographic effects. In the 1951 census many areas had an appreciable excess of men, reflecting the presence of military camps. Indeed, in 15 local authority districts, mainly rural, servicemen outnumbered civilian men of working age.

The conditions of military life, particularly as they applied to men doing national service, prevented free contact with local people, so this is not a typical example of population mixing. Nevertheless, direct and indirect contacts between servicemen and local residents were inevitable and probably not confined to contact with those married "regulars" who lived in local communities. Moreover, the relatively crowded conditions in camps have particular relevance to the infection based hypothesis, as high levels of social contact promote transmission of infective agents.

Theory as well as previous findings would suggest that the effect of local concentrations of servicemen on the spread of infection would be greatest in rural districts. We therefore studied mortality from leukaemia among children in the early 1950s in these areas of England and Wales.

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BMJ 1991;303:1357-62

Methods

The period 1949-53 is the most appropriate period in which to study any early effects on mortality from leukaemia because national service was introduced in 1947. The 1951 census is the only source of details about the distribution of servicemen in England and Wales around that time, and this period is centred on the census year, as in the registrar general's extensive study of area mortality.[3] However, no leukaemia data by area are available for 1949, a year in which national service was extended from 12 to 18 months (as it was again in 1950 to two years[4]), causing substantial increases in servicemen. We therefore chose the period 1950-3 (as did the registrar general for cervical cancer, which also lacked area data for 1949). We used two methods.

Firstly, from published and unpublished tables dating from 1950[5] we examined deaths from leukaemia in England and Wales in three available childhood age groups: below 1 year, 1-4 years, and 5-14 years. We then abstracted the most detailed data by area—namely, those for the aggregated rural and the aggregated urban districts of each county for the years 1950-3. The corresponding 1951 census populations, and proportions of servicemen, for these areas were obtained and those for the aggregated rural districts of counties were then arranged in ascending order of the proportions of servicemen[6]; the same procedure was followed for the urban areas. We created five groups from these accumulated populations; the groups consisted as closely as possible of one fifth of the total rural population of children aged under 15 in England and Wales; five similar urban groups were also formed. This arbitrary division into fifths represented a balance between obtaining reasonable expected numbers of deaths in each of the smaller (rural) groups and avoiding too low a limit for the proportions of servicemen in the category containing the highest concentration of servicemen.

The age specific death rates from leukaemia in England and Wales at ages under 1, 1-4, 5-9, and 10-14 years in the period 1950-3 were applied to the relevant populations in each of the urban and rural fifths to produce expected numbers of deaths. The ratios of observed to expected deaths from leukaemia were expressed as ratios relative to the value for the group with the lowest proportion of servicemen (group I). Tests were applied for heterogeneity and for trend.[7] The 95% confidence intervals were also calculated for the relative risks for the highest categories of servicemen where there was evidence of a significant upward trend in risk.[8]

Secondly, we realised that, instead of reflecting effects of proximity to large numbers of servicemen, a relation at the above county level might be indirect, owing to a relatively high incidence of the disease in groups of counties that happen to include large military encampments. We therefore investigated the matter at a finer level, that of individual local authority districts. No age specific data on leukaemia for such areas in 1950-3 are held by the Office of Population Censuses and Surveys, and computerised records of deaths date back only to 1959. However, details of deaths from leukaemia in the 1950s had been provided by the registrar general for an earlier study, and with these it was possible to reproduce the published numbers of deaths from childhood leukaemia—for example, for 1950-3 to within 17 (98·7% of the total). Details, including the local authority district of usual residence, were abstracted from these records and integrated in a computer file with population and other details from the 1951 census of the 1473 local authority districts of England and Wales. The 1473 districts were then arranged in ascending order of the proportion of servicemen among all men in 1951.[6] The previous division into fifths was inappropriate here as the unduly low limit for the highest fifth (category I, in which servicemen made up only 1·5%) would have offset the advantage of the proportions in the highest local authority districts (up to 69%). The earlier groupings were therefore halved, creating tenths; each category then had approximately a tenth of the children aged 0-14 years in England and Wales. In the individual local authority districts in the highest category the proportion of servicemen ranged from 5% to 69%.

Ratios of observed to expected deaths were calculated for 1950-3 using national age specific rates, and the same approach was used for the two succeeding five year periods, 1954-8 and 1959-63. The same statistical tests were applied as with the county analyses.

We attempted to determine whether any excess of leukaemia affected the children of local residents, servicemen, or both. The only population data for children of servicemen in the 1950s are those of births in 1951.[9] As the standard regions each held similar proportions of servicemen who were married,[6] births in 1951 were used as the basis for examining deaths from leukaemia at the youngest ages in servicemen's children, taken as being geographically distributed broadly in proportion to servicemen themselves.

Available data on deaths and notifications of childhood infectious diseases were examined by fifths of rural and urban districts and, for notifications of certain infections of special interest, by local authority districts, grouped in tenths.

Results

LEUKAEMIA IN COUNTY AGGREGATIONS OF URBAN AND OF RURAL DISTRICTS

Table I shows the proportions of servicemen in 1951 in the five urban and the five rural categories together with the corresponding numbers of children aged under 15. The uneven numbers of children in certain of the urban fifths reflect the large populations of certain counties intersected by "ideal" dividing points (Lancashire in group II, London and Middlesex in group IV). Urban-rural differences in the distribution of servicemen are reflected in their concentration in the highest urban (1·5-11·3%) and rural (9·0-27·1%) fifths. (The appendix shows details of the composition, by county, of urban and rural fifths.)

Table II shows the observed to expected ratios of deaths from leukaemia, by urban and rural fifths, at

TABLE I—*Percentages of servicemen in subgroups consisting as nearly as possible of similar numbers of children*

	Aggregates of urban counties		Aggregates of rural counties	
Category	% Of servicemen	No of children aged 0-14 years (000s)	% Of servicemen	No of children aged 0-14 years (000s)
I	0·53	1355	2·05	369
II	0·69	2226*	4·17	374
III	1·13	936*	5·65	396
IV	1·46	1841*	9·01	378
V	11·30	1442	27·10	374

	Aggregates of local authority districts	
Category	% Of servicemen	No of children aged 0-14 years (000s)
I	0·31	971
II	0·38	975
III	0·45	961
IV	0·50	973
V	0·59	929
VI	0·67	999
VII	0·88	976
VIII	1·50	967
IX	5·21	972*
X	68·65	967**

*29% of children were in rural districts. **63% of children were in rural districts.

TABLE II—*Standardised ratio of observed to expected numbers of deaths from leukaemia by age group and proportion of servicemen in population of aggregated urban and rural parts of counties. Figures in parentheses are observed numbers of deaths*

	Age <1 year		Age 1-4 years		Age 5-14 years		Age 0-14 years		
Category*	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban plus rural
I	1·00 (6)	1·00 {(1)	1·00 (92)	1·00 (19)	1·00 (91)	1·00 (21)	1·00 (189)	1·00 (41)	1·00 (230)
II	1·39 (14)	(4)	0·94 (145)	0·77 (15)	0·96 (142)	1·13 (24)	0·97 (301)	0·99 (43)	0·97 (344)
III	2·41 (10)	1·49 (4)	0·71 (46)	1·23 (25)	0·71 (44)	0·88 (20)	0·76 (100)	1·07 (49)	0·84† (149)
IV	1·08 (9)	0·38 (1)	0·85 (112)	1·27 (25)	1·11 (134)	1·31 (28)	0·98 (255)	1·24 (54)	1·02 (309)
V	2·40 (15)	4·13 (11)	0·95 (95)	1·62 (32)	1·20 (116)	1·34 (28)	1·12 (226)	1·65 (71)	1·21* (297)
p Value for heterogeneity	>0·05	<0·01	>0·05	>0·05	<0·05	>0·05	<0·05	<0·05	<0·01
95% Confidence interval, group V *v* group I		1·25 to 15·21		0·89 to 2·97	0·90 to 1·59			1·11 to 2·47	1·01 to 1·44
Trend (p value)	2·1 (>0·05)	6·0 (<0·01)	0·5 (>0·05)	5·0 (<0·05)	3·3 (<0·05)	1·4 (>0·05)	1·3 (>0·05)	8·7 (<0·01)	5·6 (<0·01)

*Category I has lowest proportion of servicemen; category V has highest proportion.

TABLE III—*Standardised ratios of observed to expected numbers of deaths from leukaemia by age group in local authority districts grouped into tenths by proportion of servicemen*

Category*	Age <2 years: No of observed deaths	Age <2 years: Ratio of observed to expected deaths	Age 2-4 years: No of observed deaths	Age 2-4 years: Ratio of observed to expected deaths	Age 5-9 years: No of observed deaths	Age 5-9 years: Ratio of observed to expected deaths	Age 10-14 years: No of observed deaths	Age 10-14 years: Ratio of observed to expected deaths
I+II†	32	1·00	103	1·00	75	1·00	48	1·00
III	13	0·82	51	1·00	33	0·89	24	0·96
IV	18	1·10	55	1·05	38	1·01	29	1·19
V	9	0·58	44	0·88	33	0·92	21	0·90
VI	12	0·70	59	1·08	51	1·35	22	0·87
VII	21	1·29	49	0·94	42	1·10	26	1·05
VIII	16	0·99	51	0·98	43	1·14	20	0·82
IX	16	0·99	51	0·98	46	1·22	28	1·13
X	31	1·90‡	46	0·88	40	1·06	26	1·08
p Value for heterogeneity	<0·05		>0·05		>0·05		>0·05	
Trend	4·7*		0·3		1·77		0·02	
Highest rural categories:								
IX	6	1·29	14	0·93	11	1·00	10	1·38
X	21	2·07§	29	0·88	23	0·97	14	0·92
Highest urban categories:								
IX	10	0·87	37	1·00	35	1·32	18	1·03
X	10	1·63	17	0·87	17	1·21	12	1·34

*Category I+II has lowest proportion of servicemen; category X has highest proportion.
†Includes 60% of missing cases (to nearest whole number), namely 2, 4, 2, 2 respectively in the four age groups.
‡95% Confidence interval 1·13 to 3·20.
§95% Confidence interval 1·39 to 3·37.

ages under 1 year, 1-4, 5-14, and 0-14 years. The ratios are expressed relative to the value in the group with the lowest proportion of servicemen (group I) except for leukaemia in children aged below 1 year in rural areas, for which groups I *and* II were combined because there was only a single death in group I. A significant trend ($p<0·01$) of leukaemia below age 15 together with a significant excess was found in the highest combined fifth for servicemen (ratio of observed to expected deaths, 1·21). This is mainly due to a more noticeable excess in rural areas, which show a ratio of 1·65 in the highest fifth and a significant trend ($p<0·01$). This in turn reflects excess deaths in rural areas in children below 1 year (ratio 4·13; trend $p<0·01$) and aged 1-4 years (ratio 1·62; trend $p<0·05$).

LEUKAEMIA IN INDIVIDUAL LOCAL AUTHORITY DISTRICTS

In this more focused analysis with the individual local authority district as the basic unit (table III), there are major differences in the composition of the tenths from the groups in the previous analysis, even when the proportions of servicemen (shown in table I) are comparable. The highest tenth contains only 40% of the children in the highest rural fifth. (A county in the first fifth with a low proportion of servicemen in, say, its aggregated rural districts may contain certain local authority districts that have a high proportion and are in the top tenth—and vice versa, as shown in the appendix.)

With the above data the ratios of observed to expected deaths from leukaemia were expressed relative to the values in groups I and II. This was useful in allowing for the 17 missing death certificates of children aged below 15 in 1950-3. Since expected numbers were derived from national rates, some of the ratios will be underestimates. To prevent missing certificates biasing the standardised ratios we have made the extreme assumption (conservative to the hypothesis) that three (instead of one) fifths of these belonged to children in group I or II.

As for country aggregates of districts, the greatest excess was in children aged below 1. The ratio of observed to expected deaths was 2·14 in the group with the highest proportion of servicemen (group X; trend, $p<0·01$), being greater in the rural (2·4) than the urban part (1·7). A non-significant excess was found in the rural part of group IX (2·38). In view of the trend in rural districts at ages 1-4 in group V in table II, children aged 1 were examined with those below 1, as in table III. This showed a significant excess in group X below age 2 (1·9), together with a significant trend across the tenths ($p<0·05$). This excess was more definite in rural than urban parts of group X. Indeed, relative to the *rural* parts of groups I and II, which had a low incidence (5 observed, 8·0 expected), the rural excess was appreciably greater than is shown in table III. There was no excess at ages 2-4, 5-9, or 10-14.

An analysis by leukaemia subtype (not shown) was dominated by small numbers, myeloid lymphoid but not monocytic leukaemia were represented in the excess, which was somewhat greater for myeloid leukaemia (groups I and II, four deaths; group X, eight) and unspecified leukaemia (groups I and II, seven deaths; group X, 11). Because the census slightly underestimated the numbers of infants below age 1 (2·1%),[10] we carried out an analysis using numbers of live births by local authority district in 1950-3 for populations below age 1, and in 1949-52 for age 1; the findings were not greatly affected and the significance levels were unchanged.

In the period 1954-8 group X showed no significant excess of leukaemia in any of the four age groups shown in table III (unstandardised ratios of observed to expected deaths 0·76, 0·93, 0·89, 0·86). Similarly, there was no excess in group X in 1959-63 whether the analysis was based on proportions of servicemen in 1951 or 1961 (data not shown). It may be noted in passing that in this period when all but 4% of local authority districts showed a decline in the numbers of servicemen, there was one death from leukaemia in children below age 1 (expected 0·03) in the (rural) area with by far the greatest *increase*, an influx amounting to 31% of the 1961 male population of the district.

CHILDREN OF SERVICEMEN AND CIVILIANS COMPARED

There were seven deaths in children aged below 2 in servicemen's children in group X, of which five were in rural districts. It was judged impractical to obtain birth certificates for all affected children aged below 2, so this was done only for those in rural districts: all the above five cases from group X showed the father as a serviceman at the child's birth and death. In one additional (rural) death (at age 1) in group X, the father was shown as a serviceman only at the birth. All other leukaemias in children below age 2 in group X were regarded as occurring in children of civilians; one of these had an obvious link to a military camp, the father being described as a NAAFI canteen assistant at the child's death at age 2 months.

The above numbers were related to population estimates by distributing, by tenths of local authority districts, the approximately 0·042% of births with servicemen as fathers[7] in proportion to the numbers of servicemen in the groups. This indicated an increase of nearly twofold of leukaemia in children aged under 2 in group X in the children of servicemen and of civilians, though the increase was significant only in children of civilians. In both groups the increase was more than threefold in rural parts of group X, but in servicemen's children it was based on only six cases.

INFECTIOUS DISEASES

Among the notifiable infectious diseases examined that may be transmitted from adults to children, poliomyelitis showed significant excesses both of notifications and of deaths in children aged below 15 in the rural fifth with the highest proportion of servicemen in the period 1950-3; tests for trend across the categories were also significant (tables IV and V). Examination of notification data by local authority district is extremely laborious as these data exist only on microfilm for the 1400 local authority districts and are tabulated separately for each yearly quarter. Thus we abstracted data only for the rural districts in the highest tenth and reference groups. There were significantly (p<0·001) more notifications of poliomyelitis among children below age 15 in rural areas with the highest concentrations of servicemen (table VI). The marked decline in poliomyelitis produced by immunisation prevented any meaningful analysis in rural areas after 1953.

TABLE IV—*Notifications of infectious diseases in children (all ages) in county rural aggregates, 1950-3: observed to expected ratios (standardised to groups I and II)*

	Polio			
Category	Paralytic	Non-paralytic	Total	Meningococcal infections
I	1·00 (433)	1·00 (185)	1·00 (618)	1·00 (134)
II	(590)	(248)	(838)	(153)
III	1·22 (664)	1·38‡ (319)	1·26† (983)	0·92 (140)
IV	0·93 (530)	1·16† (255)	1·06 (785)	0·98 (143)
V	1·22 (626)	1·22 (321)	1·29 (947)	1·00 (144)
p Value for heterogeneity	<0·001	<0·001	<0·001	
95% Confidence interval, group V *v* group I	1·11 to 1·34	1·05 to 1·41	1·19 to 1·39	
Trend (p value)	5·5 (<0·05)	5·5 (<0·05)	26·6 (<0·001)	0 (>0·05)

*Category I has lowest proportion of servicemen; category V has highest proportion.
†p<0·05; ‡p<0·001.

TABLE V—*Deaths from infectious diseases in children under 15, 1950-3: observed to expected ratios (standardised to groups I and II) by groups of county aggregates of rural areas. Figures in parentheses are observed numbers of deaths*

Category*	Polio	Meningococcal infection	Measles	Whooping cough
I	1·00 (20)	1·00 (29)	1·00 (27)	1·00 (46)
II	(20)	(23)	(35)	(40)
III	2·16 (46)	1·19 (33)	0·91 (30)	1·16 (53)
IV	1·38 (28)	0·83 (22)	0·98 (31)	1·33 (58)
V	1·79 (36)	0·76 (20)	0·87 (27)	1·22 (53)
p Value for heterogeneity	<0·01	>0·05	>0·05	>0·05
95% Confidence interval, group V *v* group I	1·15 to 2·64			
Trend (p value)	4·4 (<0·05)	1·5 (>0·05)	0·3 (>0·05)	2·2 (>0·05)

*Category I has lowest proportion of servicemen; category V has highest proportion.

TABLE VI—*Notifications of poliomyelitis and meningococcal infections in children under 15: adjusted observed to expected ratios in rural districts in highest and lowest tenths of districts with highest and lowest proportions of servicemen. Figures in parentheses are observed number of notifications*

	Polio			
Category	Paralytic	Non-paralytic	Total	Meningococcal infection
I+II	1·33 (575)	1·25 (265)	1·31 (840)	1·46 (187)
X	1·34 (1002)	1·51 (503)	1·39 (1505)	0·97 (237)
95% Confidence interval, group X *v* rural parts of groups I and II	1·26 to 1·43	1·38 to 1·65	1·32 to 1·46	

Unadjusted observed to expected ratios for paralytic polio, 1·33; non-paralytic polio, 1·25; all polio, 1·31; meningococcal infection, 1·46.

Discussion

We found significant increases of childhood leukaemia in 1950-3 in relation to the largest concentrations of servicemen in England and Wales, particularly in rural areas. These excesses occurred just after the period of national service (introduced in 1947) was extended in 1949 from 12 to 18 months and in 1950 from 18 months to two years. These extensions, by being applied retrospectively, deferred demobilisation of many servicemen, producing appreciable increases in the number of servicemen. In many areas these numbers were larger, certainly for long periods, even than in wartime.[4] (Before the Normandy landings in 1944, large numbers of troops trained or massed in certain coastal areas of England, but here there had been large scale evacuation of the local population including adults.[11]) In 1951 there were 527 657 servicemen in England and Wales of whom 42% were in rural districts. In 12 rural districts there were more servicemen than civilian men of working age, and in two—Amesbury rural district, Wiltshire, and Richmond rural district (North Yorkshire)—servicemen outnumbered civilian males of all ages, including children.

These demographic changes represent a striking example of influxes of people into areas of low population density; moreover, these changes coincide with the postwar increase in the number of children. Despite the restrictions of movement (especially of national servicemen in camps) many points of direct and indirect contact remained between servicemen in camps and the local civilians: some regular servicemen lived in local communities, some civilians worked in camps, and both groups were often served by the same schools, transport, and other local facilities. The associated excesses of childhood leukaemia are therefore highly relevant to the hypothesis based on infection which postulates that an appreciable increase in the level of new social contacts in a community can increase the incidence of leukaemia.

The excesses of leukaemia occurred in all three branches of the services. They affected the very young children of both servicemen and civilians, though for more than one reason the number of cases of leukaemia may have been underestimated among servicemen. Birth certificates of all children with leukaemia in urban districts were not traced, so that any father who left the forces during his child's short lifetime would have been overlooked. On the other hand, the possible inclusion of one or two children of servicemen in the civilian category would have little effect on the ratio of observed to expected deaths. Substantial numbers of American servicemen were present in rural England during the study period,[12] but cases of leukaemia in their children may have been overlooked (none was recorded in 1950-3) because of their return to the United States after the disease was diagnosed. Servicemen in rural districts included a higher than average proportion of 18 and 19 year olds.[6] Thus, in rural areas the ratio of observed to expected deaths among servicemen's children has probably also been lowered because of an overestimate of the number of servicemen with children. This excess was *highest* (threefold) in rural areas, which weighs against it being due merely to an incorrect assumption about the distribution of servicemen's children.

Tests for trend on the leukaemia data by increasing proportions of servicemen were significant (p<0·05) both in the county aggregates, particularly rural aggregates (table II), and in the local authority district grouped by tenths (table III). There were no steady increases in ratios of observed to expected deaths across the groups (though most groups had only small proportions of servicemen); only at the highest concentrations of servicemen was there a significant excess of leukaemia. This is typical of many infectious diseases, for which outbreaks or epidemics occur only when the number (or the density) of infected and susceptible individuals in the population reaches some critical point, a point specific for the agent in question.

No excess of cases of leukaemia was recorded in 1954-8, a period little affected by the reductions in national service intakes, which started in 1957.[4] By 1961, however, shortly before national service finally ended in 1963, there were 232 097 *fewer* servicemen in the country than in 1951. The failure of the increase of leukaemia to persist beyond the period 1950-3 is consistent with the number of susceptible individuals declining to below some critical level, as would happen at the end of an epidemic of any infective disorder.[13]

It is noteworthy that the significant increase of leukaemia in young children is restricted to those under 2 years. Leukaemia at this age is less common than at ages 2-4, when characteristically there is a peak in incidence. Differences also exist in prognosis and cell type: below age 2 leukaemia is more commonly myeloid; when it is lymphatic, it is more often null or T cell in type than at ages 2-4.[14] Moreover, in the period 1930-60, when mortality from leukaemia at ages 2-4 increased steadily, the rates below age 2 remained fairly constant. In the period covered by this study, the disease was uniformly fatal.

The excess of leukaemia was mainly in rural districts, five features of which may be relevant. Firstly, by analogy with certain infectious diseases, a greater proportion of the population of rural districts would be susceptible to the agent(s) postulated as underlying childhood leukaemia because of the low population density of these districts and their separation from population centres. Secondly, camps in rural districts held more national servicemen than urban camps, as was reflected in their higher proportions of servicemen aged 18 and 19,[5] among whom there would presumably have been more crowding than among "regulars." Thirdly, unlike garrison towns, which were scattered, rural districts in the group with the highest proportion of servicemen (group X) often bordered each other—as in Berkshire, Wiltshire, Norfolk, and Hampshire—and this might intensify their effects. Fourthly, a large rural camp probably makes a greater overall impact on the population in its vicinity than would an urban camp. Finally, most RAF stations are in rural districts. It is conceivable that the relatively high social class of the RAF national service intake[4] might include more people susceptible to infection, which might increase the severity of the postulated epidemics in those rural districts.

Military camps, with large numbers of young men in relatively crowded conditions and frequent arrivals of new susceptible and infected individuals, are well known as settings for epidemics of infectious diseases. Such conditions favour transmission not only of infective agents but also of larger doses of them through repeated contacts with infected individuals. These conditions may therefore be particularly relevant to the hypothesis that childhood leukaemia is a rare response to a commoner infection as intensity of exposure may determine which infected children develop leukaemia.[1,2] Meningococcal infections[15] and haemolytic streptococcal infections[16] have been studied in military camps. Outbreaks of meningococcal infection in such situations are well known, though these mainly occurred in wartime, when the density and mixing of troops was unusually high; then civilians and their children were also often affected.

Certain epidemics of poliomyelitis affected rural areas more severely than urban areas; this implies that there was a higher proportion of susceptible individuals in rural areas. In this study the rural areas with the greatest proportion of servicemen had significantly more poliomyelitis among children than the rural average both in terms of notifications and deaths (tables IV and V). This is an infection, like that postulated as underlying childhood leukaemia, in which only a small proportion of those infected develop an illness.

Appendix

Composition, by county, of urban and rural groupings of population according to proportion of servicemen

	Grouping of county aggregates										No of districts in highest 10th of local authority districts	
	Urban					Rural						
	I	II	III	IV	V	I	II	III	IV	V	Urban	Rural
Anglesey			III						IV		0	1
Bedfordshire			III							V	2	2
Berkshire					V				IV		1	6
Brecknockshire					V		II				1	1
Buckinghamshire					V				IV		2	2
Caernarvonshire	I					I					0	0
Cambridgeshire		II							IV		0	2
Cardiganshire	I					I					0	0
Carmarthenshire	I					I					0	0
Cheshire					V			III			2	2
Cornwall					V				IV		4	4
Cumberland				IV			II				0	2
Denbighshire					V	I					0	0
Derbyshire		II				I					0	0
Devon					V			III			2	4
Dorset					V					V	2	3
Durham	I					I					0	2
Essex				IV			II				2	3
Flintshire		II							IV		0	2
Glamorganshire	I							III			0	1
Gloucestershire			III					III			0	5
Hampshire					V					V	7	9
Herefordshire					V				IV		0	1
Hertfordshire			III			I					1	1
Huntingdonshire			III							V	0	2
Isle of Ely					V	I					1	0
Isle of Wight					V		II				1	0
Kent					V		II				10	4
Lancashire		II							IV		3	2
Leicestershire			III			I					0	0
Lincolnshire:												
Holland		II				I					0	0
Kesteven			III							V	0	3
Lindsey				IV					IV		0	5
London				IV							2	
Merionethshire					V					V	1	2
Middlesex				IV							1	
Monmouthshire		II				I					0	0
Montgomeryshire	I					I					0	0
Norfolk			III							V	0	9
Northamptonshire	I					I					0	0
Northumberland			III				II				0	2
Nottinghamshire			III					III			0	3
Oxfordshire			III							V	0	3
Pembrokeshire					V		II				1	1
Peterborough		II								V	0	1
Radnorshire				IV		I					0	0
Rutland				IV						V	0	1
Shropshire					V					V	1	7
Somerset				IV				III			1	4
Staffordshire	I								IV		0	3
Suffolk:												
East Suffolk				IV					IV		1	3
West Suffolk					V					V	1	3
Surrey					V		II				3	1
Sussex:												
East Sussex			III				II				0	1
West Sussex			III					III			0	1
Warwickshire	I							III			0	4
Westmoreland	I					I					0	0
Wiltshire					V					V	2	9
Worcestershire		II						III			0	3
Yorkshire:												
East Riding		II							IV		0	2
North Riding				IV						V	2	7
West Riding		II					II				0	5

It is difficult to offer an alternative to an infective explanation for the present findings. A possible relation between leukaemia in children under 1 year and maternal use of drugs such as marijuana[17] cannot be relevant here, since the period in question (1950-3) long preceded any appreciable use of such drugs in Britain. Similarly, a hypothesis about mutations caused by *delayed* exposure to immunological challenges[18] cannot be invoked since it would apply only in leukaemia occurring later than the ages that show the excess in this study.

The findings support the hypothesis that prompted this study—that the presence of large numbers of servicemen, particularly in rural districts, was conducive to an increase in the incidence of childhood leukaemia. They also point to an infection transmitted among adults, as also implied by a recent study of the effects of the population mixing associated with increases in commuting.[19] The increase was greatest in children under 1 year, which suggests intrauterine infection with transmission from the serviceman population, presumably—directly or indirectly—by the husband.

We thank David Dipple, Gina Birch, and Janette Wallis for computing help, Helena Strange for clerical work, and Susan Hill for secretarial assistance. We are also grateful to Dr P Cook-Mozaffari, Dr R Mole, Professor P G Smith, Air Marshal Sir Thomas Stonor, and Professor N Wald for helpful comments. We thank the historical branches of the army and of the Royal Air Force and Mr Trevor Royle for information about national service.

The CRC Cancer Epidemiology Research Group is entirely funded by the Cancer Research Campaign, from which LJK holds a Gibb fellowship.

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(Accepted 16 August 1991)

A randomised trial comparing endometrial resection and abdominal hysterectomy for the treatment of menorrhagia

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BMJ 1991;**303**:1362-4.

Abstract

***Objective*—To determine the advantages and disadvantages of endometrial resection and abdominal hysterectomy for the surgical treatment of women with menorrhagia.**

***Design*—Randomised study of two treatment groups with a minimum follow up of nine months.**

***Setting*—Royal Berkshire Hospital, Reading.**

***Subjects*—51 of 78 menorrhagic women without pelvic pathology who were on the waiting list for abdominal hysterectomy.**

***Treatment*—Endometrial resection or abdominal hysterectomy (according to randomisation). Endometrial resections were performed by an experienced hysteroscopic surgeon; hysterectomies were performed by two other gynaecological surgeons.**

***Main outcome measures*—Length of operating time, hospitalisation, recovery; cost of surgery; short term results of endometrial resection.**

***Results*—Operating time was shorter for endometrial resection (median 30 (range 20-47) minutes) than for hysterectomy (50 (39-74) minutes). The hospital stay for endometrial resection (median 1 (range 1-3) days) was less than for hysterectomy (7 (5-12) days). Recovery after endometrial resection (median 16 (range 5-62) days) was shorter than after hysterectomy (58 (11-125) days). The cost was £407 for endometrial resection and £1270 for abdominal hysterectomy. Four women (16%) who did not have an acceptable improvement in symptoms after endometrial resection had repeat resections. No woman has required hysterectomy during a mean follow up of one year.**

***Conclusion*—For women with menorrhagia who have no pelvic pathology endometrial resection is a useful alternative to abdominal hysterectomy, with many short term benefits. Larger numbers and a longer follow up are needed to estimate the incidence of complications and the long term efficacy of endometrial resection.**

Introduction

Endometrial resection is gaining widespread acceptance as a surgical treatment for menorrhagia. A survey in August 1990 showed that 36 British centres had performed a total of over 4000 endometrial ablation procedures.[1] Seventy per cent of these were endometrial resections with the urological resectoscope.

The technique was initially used for treating intractable uterine bleeding in women who were unfit for hysterectomy because of blood dyscrasias or extreme anaesthetic risk.[2] Follow up showed that most remained amenorrhoeic. Transcervical endometrial resection was subsequently performed for healthy women who suffered from menorrhagia.[3] Most of those who had a complete resection of the endometrium became amenorrhoeic.