H. Kuni, Marburg[1]

# A Cluster of Childhood Leukaemia in the Vicinity of the German Research Reactor Jülich


## Abstract

In 1990-1992 four cases of acute leukaemia (AL) are reported from the villages Niederzier and Huchem-Stammeln, parts of the local Government Niederzier, about 5 km in the south-east of the atomic research reactor of Jülich, Germany, aged 5, 6, 12 and 15 years. In the neighbour village Titz, in the distance 5-10 km from the Jülich reactor, 1984, 1986 and 1990 three further children suffered from AL. This cluster is highly significant. In the next distance region 10-15 km in the period 1980-1993 10 cases of AL of childhood are observed in comparison to 5.16 expected (p=0,038).

This is the fourth cluster of childhood leukaemia observed nearby a German research reactor. The special environmental factors of the region are discussed.


## Observations

Inhabitants of Niederzier, a local government about 5 km in the south-east of the atomic research reactor of Jülich, North Rhine-Westphalia, Germany, have informed about a frequent occurrence of childhood leukaemia in their village. Tab. 1 (p. 2) presents characteristic data of the cases. All sick are males and suffered from an acute lymphatic leukaemia (ALL).

The transformer station is one of the biggest plants in Europe. The dwelling houses of the children are not in close distance to high-tension lines. The brown coal power station Weisweiler is situated approx. 12km in the south-west of the village. Many inhabitants are firing brown coal briquettes. The parents of

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[1] Horst Kuni, MD, University Professor, Clinical Nuclear Medicine, Medical Centre of Radiology, Philipps-University Marburg, D 35033 Marburg/Lahn

Abbreviations: AL acute leukaemia,; ALL acute lymphatic leukaemia; IMSD Institut für Medizinische Statistik und Dokumentation, Mainz, running a registry of childhood malignancies covering FRG since 1980, since 1991 also the former GDR; FRG Federal Republic of Germany; GDR former German Democratic Republic

children no. 1 and no. 2 are complaining about smoke from coal firing in the neighbourhood. The dwelling houses of the children in Niederzier are in a distance of approx. 1200-1500m to the brown coal surface mining Hambach situated on the east side of the village. A large scale producer of strawberries in the village sprays plant-protective agents very frequently. The father of child no. 4 has the occupation of a spraying varnisher.

Only the parents of child no. 3 are self-supplying with eggs of chicken kept on open-air.

Tab. 1: Cases of ALL in Niederzier,
in chronological order by year of diagnosis. age at diagnosis.
Vil village
N Niederzier
S Stammeln in Huchem-Stammeln
Since date of immigration, if non-resident
P immigration of parents
F immigration of father
M immigration of mother
Med. Medical radiation exposure since more than two years before diagnosis
KFA distance to Jülich research plant (centre) in m, rounded to 100m
TS distance to transformer station (centre) in m, rounded to 100m
Rem. remarks on other hazards

| Year | Age | Vil | Since | Med. | KFA | TS | Rem. |
|---|---|---|---|---|---|---|---|
| 1990 | 5 | N | 1981 P | skull 2* | 4700 | 900 | time of X-ray ?, diagnosis 3/90 |
| 1990 | 15 | N | 1975 P | none | 4800 | 800 | 2y resident in Arnoldsweiler (approx. 10km of KFA) |
| 1991 | 12 | S | 1979 M | none | 6000 | 1600 | feet 90, jaw 2*, hand 11/91, diagnosis 12/91 |
| 1992 | 6 | N | 1984 F | none | 3800 | 1600 | nose 2* 8/91, hip 2* 4/92, diagnosis 10/92 |

The number of children living in the villages is presented in tab. 2 (p. 2).

Tab. 2: Children in Niederzier (N) and Huchem-Stammeln (HS) aged below 15 and below 20 years (data: district administration Düren)

| Vil | Children <15 | | | | Children <20 | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1990-1992 | 1990 | 1991 | 1992 | 1990-1992 |
| N | 577 | 566 | 578 | 1721 | 764 | 764 | 774 | 2302 |
| HS | 708 | 720 | 751 | 2179 | 918 | 946 | 970 | 2834 |
| Total | 1285 | 1286 | 1329 | 3900 | 1682 | 1710 | 1744 | 5136 |

To estimate the expected cases the increasing trend of incidence of acute childhood leukaemia seen in the German registry of childhood malignancies of IMSD in children below 15 years of age in the period 1980-1990 [6] was linear extrapolated to the period 1990-1992. The region of Niederzier was classified as environs with very high density of population with 97.7% of the mean incidence of the Federal Republic of Germany (without the former GDR). The estimated incidence is shown in tab. 3 (p. 3).

Tab. 3: Estimation of incidence of AL per year and per 100,000 children below 15 years of age in the time period 1990-1992 in the FRG (without the former GDR) "FRG" by extrapolation of the trend in the time period 1980-1990 and in Niederzier, regarding the relation of environs with high density of population ("e.h.d.") to "FRG" [after 6].

| | 1990 | 1991 | 1992 | 1990-1992 |
|---|---|---|---|---|
| FRG | 4.45 | 4.52 | 4.59 | 4.52 |
| e.h.d./FRG | 97.73% | 97.73% | 97.73% | 97.73% |
| Niederzier | 4.34 | 4.42 | 4.49 | 4.42 |

The incidence of the age group of children and adolescents below 20 years of age was estimated from the proportion of 88.4% of the age group of children below 15 years seen in the cancer registry of Saarland.

The expected cases of AL are summarised in tab. 4 (p. 3), tab. 5 (p. 3) shows the observed cases and tab. 6 (p. 4) the relation of observed to expected cases. The significance was calculated with the method after Traut as one sided deviation[10, 11]. The relation of observed to expected cases in the age group of children and adolescents below 20 years of age in the time period of three consecutive years 1990-1992 is increased by approx. 20fold, a highly significant result.

Tab. 4: Estimation of the expected cases of AL in Niederzier, Huchem-Stammeln and both together

| | Children < 15a | | | | Children < 20a | | | |
|---|---|---|---|---|---|---|---|---|
| Vil | 1990 | 1991 | 1992 | 1990-1992 | 1990 | 1991 | 1992 | 1990-1992 |
| N | 0.025 | 0.025 | 0.026 | 0.076 | 0.029 | 0.030 | 0.031 | 0.090 |
| HS | 0.031 | 0.032 | 0.034 | 0.096 | 0.035 | 0.037 | 0.039 | 0.111 |
| Both | 0.056 | 0.057 | 0.060 | 0.172 | 0.065 | 0.067 | 0.069 | 0.201 |

Tab. 5: Observed cases of ALL in Niederzier, Huchem-Stammeln and both together

| | Children < 15a | | | | Children < 20a | | | |
|---|---|---|---|---|---|---|---|---|
| OT | 1990 | 1991 | 1992 | 1990-1992 | 1990 | 1991 | 1992 | 1990-1992 |
| N | 1 | | 1 | 2 | 2 | | 1 | 3 |
| HS | | 1 | | 1 | | 1 | | 1 |
| Both | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 4 |

Tab. 6: Relation of observed to expected cases of ALL
p: statistical significance

| | Children < 15a | | | | Children < 20a | | | |
|---|---|---|---|---|---|---|---|---|
| OT | 1990 | 1991 | 1992 | 1990-1992 | 1990 | 1991 | 1992 | 1990-1992 |
| N | 39.9 | 0.0 | 38.5 | 26.3 | 68.1 | 0.0 | 32.5 | 33.4 |
| p | 0.02 | | 0.03 | 0.003 | 0.0004 | | 0.03 | 0.0001 |
| HS | 0.0 | 31.4 | 0.0 | 10.4 | 0.0 | 27.1 | 0.0 | 9.0 |
| p | | 0.03 | | 0.09 | | 0.04 | | 0.11 |
| Both | 17.9 | 17.6 | 16.8 | 17.4 | 30.9 | 15.0 | 14.4 | 19.9 |
| p | 0.05 | 0.06 | 0.06 | 0.0008 | 0.002 | 0.07 | 0.07 | 0.00006 |

## Discussion

The increasing trend of the incidence of acute childhood leukaemia in the period 1980-1990 is attributed by the registry to the increasing completeness of registration since the foundation of the registry in 1980. Therefore the extrapolation of this time trend to the period 1990-1992 more likely leads to an overestimation of the expected cases. The expected cases are overestimated also because not all AL are ALL. The one sided test of significance is justified by the hypothesis of a cause increasing the incidence.

Comparing the results with the observations of the registry of childhood malignancies in Mainz [6] it must be considered that the local government Niederzier was put there into the subregion with a circle of 5-10km around the atomic plant Jülich, because most of the inhabitants are situated in this distance. The inaccuracy of this classification using the relative large borders of local governments is elucidated by the fact, that three of the cases presented here are resident in a distance of less than 5km to the atomic plant.

In the circle 5-10km around the atomic plant Jülich the registry in Mainz (IMSD) reported four cases in the time period 1980-1990. A verification of the registry diminished the cases by one children with an age of 15 years at diagnosis in 1990 (child no. 2) because of the limitation of the registry to children up to 15 years.

In Titz, the neighbourhood village in the circle 5-10km, situated in the north of Niederzier, in 1984, 1986 and 1990, in each year one case was observed by 0.05 cases per year expected [4]. Therefore in total four cases are counted in the circle 5-10km. In 1992 a further case was registered in Titz. Including the three cases in Niederzier in the time period 1990-1993 in both local governments five cases are counted. In the third local government in the circle 5-10km, Aldenhoven, in the western direction of the atomic plant, in the time period 1990-1992 not any case was seen by 1.2 expected cases. (All figures

for expected cases were calculated by the IMSD from the mean incidence of 4.2 per 100,000 children in the FRG (without the former GDR), registered in 1982-1991 [3].

Comparing the total region in the circle 5-10km in the time period 1990-1993 the relation of five observed cases to 0.73 expected is highly significant with p=0.0009. In the next circle 10-15km in the time period 1980-1993 with ten observed cases to 5.16 expected a significantly increased incidence with p=0.038 was found. Also combining the total region in the circle of 15km around the atomic plant, the significance of the increased incidence of childhood leukaemia remains.

Searching for a common cause for all leukaemia observed in Niederzier the time of onset of child no. 4, aged six years at diagnosis in October 1992, determines the earliest possible time of a causing event, autumn 1986. Assuming also an exposure *in utero* nearly the complete year 1986 must be taken into the account. Eventually an induction of leukaemia by exposure of the parents, mainly by incorporation of radionuclides, must be discussed [1, 8, 9]. The atomic bomb survivors suffering from ALL showed a first accumulation of incidence four to six years after the time of bombing [5]. The mean time interval from 1986 to the year of onset in the four cases observed in Niederzier amounts 4.75 years.

Furthermore the increased incidence of childhood leukaemia observed in circles of 15km around planned nuclear power installations by IMSD must be discussed. One of the five regions analysed and showing an a cluster of leukaemia was Borken, a site of a brown coal power station with a large surface mining near by.

Finally the detail must be elucidated that all sick children are males, even if statistically not significant. The male-female sex ratio of AL is about 55% in the first years of life and increases to more than 60% in the second decade. A significant cluster of leukaemia of male children was reported by Grosche et al. [2] in a circle of 5km around the atomic research reactor Garching near Munich, Germany, in the time period 1976-1981 (SIR 7.83, p<0.05). A second cluster of male children in this time period, although not significant, but suggestive, these authors have seen in a circle of 10km around the atomic research reactor Neuherberg, also near Munich, Germany (SIR1.56, p=0.06). A third cluster in the vicinity of a German research reactor was observed in the circle of 0-10 km around the plant of Rossendorf, near Dresden, 1961-1988 in the former GDR [7]. The increased relative risk of 2.11 (90% confidence interval: 0.92; 4.17) was not significant. The sex ratio was not reported. The pattern of the occurrence of leukaemia during the time period 1980-1990 in the region around Jülich was very similar to that around all atomic power plants in Germany.

A systematically search for the causes of the cluster in Niederzier and Titz by local and regional authorities is missed up to now.

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## References

1. **Gardner, M.J., Snee, M.P., Hall, A.J., Powell, A.J., Downes, S., Terell, J.D.:** Results of Case-Control Study of Leukaemia and Lymphoma among Young People near Sellafield Nuclear Plant in West Cumbria, BMJ 300 (1990), **423**-429

2. **Grosche, B., Hinz, G., Tsavachidis, C., Kaul, A.:** Analyse der Leukämiemorbidität in Bayern in den Jahren 1976-1981, Bayer. Staatsmin. f. Landesentwicklung und Umweltfragen (Hrsg.): Materialien 41, 1987

3. **Haaf, H.G., Michaelis, J.:** Analyse der Erkrankungsrate für kindliche Malignome in der Gemeinde Niederzier, im Landkreis Düren sowie in der Umgebung der Kernforschungsanlage Jülich, IMSD, Manuscript 8/4/1993, 1993

4. **Haaf, H.G., Michaelis, J.:** Letter to Public Health Office Düren, 8/6/93, 1993

5. **Ishimaru, M., Ishimaru, T., Belsky, J.L., Tomiyasu, T., Sadamori, N., Hishino, T., Tomonaga, M., Shimizu, N., Okada, H.:** Incidence of Leukemia in Atomic Bomb Survivors, Hiroshima & Nagasaki, 1950 - 71, by Radiation Dose, Years after Exposure, Age, & Type of Leukemia, Radiation Effects Research Foundation, Hiroshima, Technical Report Series, RERF TR 10-76, 1976

6. **Keller, B., Haaf, G., Kaatsch, P., Michaelis, J.:** Untersuchung der Häufigkeit von Krebserkrankungen im Kindesalter in der Umgebung westdeutscher kerntechnischer Anlagen 1980-1990, IMSD - Technischer Bericht, Mainz, 1992

7. **Möhner, M., Stabenow, R.:** Childhood Malignancies around Nuclear Installations in the Former GDR, Medizinische Forschung 6 (1993), 59-67

8. **Roman, E., Watson, A., Beral, V., Buckle, S., Bull, D., Baker, K., Ryder, H.:** Case-control Study of Leukaemia and Non-Hodgkin's Lymphoma among Children aged 0-4 Years Living in West Berkshire and North Hampshire Health Districts, BMJ 306 (1993), 615-621

9. **Sorahan, T., Roberts, P.J.:** Childhood Cancer and Paternal Exposure to Ionizing Radiation: Preliminary Findings From the Oxford Survey of Childhood Cancers, Amer. J. Ind. Med. 23 (1993), 343-354

10. **Traut, H.:** A Method for Determining the Statistical Significance of Mutation Frequencies, Biom. J. 22 (1980), 73-78

11. **Traut, H., Scheid, W.:** Significance Testing in Mutagen Screening: The Dependence of Statistical Power on the Control Sample Size, Mutat. Res. 272 (1992), 73-77