Radio Frequency radiation related cancer – assessing causation in the occupational/military setting

(On Options for Evaluating Case Series)

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Military/occupational versus the consumer setting

The military /occupational setting has the following attributes:

- Vastly stronger whole-body exposure.
- High peak power pulses (RADAR) included.
- Huge reported Risk Ratios (RR).

This means better opportunity to study biological effects and a great opportunity to improve safety, however:

- Data is hard to obtain, the organizations under study oppose data collection.
- Data was obtained so far only in a very few countries.
- Missing information and partial data.

The radiation levels present now in the military setting may arise in the consumer one via Wireless Power Transfer, 5G and similar.

Options and ethics

- Wait till full data can be obtained, “demand” full data. Same as wait for ever; maybe let whole generations of young people suffer cancer.
- Show that the known data indicates the possibility of risk, thus data collection should be mandatory and exposure should be reduced. Better but the resulting improvement is limited so far. Possibility of risk does not lead to a sufficient corrective action.
- Distill more reliable information present in the collected partial data. This is the current attempt.

The 2011 report by Stein, Nativ and Richter

- 47 cancer patients, previously soldiers and young workers in Israel.
- Full information available about each patient. (age at diagnosis, gender, cancer type, exposure duration and more)
- Patients selected from cancer patients with previous occupational/military RF exposure by a process of self-referral.
- The cancer characteristics as reported in the 2011 study are unusual in many aspects, indicating possible causation of cancer by RF exposure.
- **Cannot estimate Risk Ratio (RR)** since the exposed population size is unknown and so is the total number of cases.

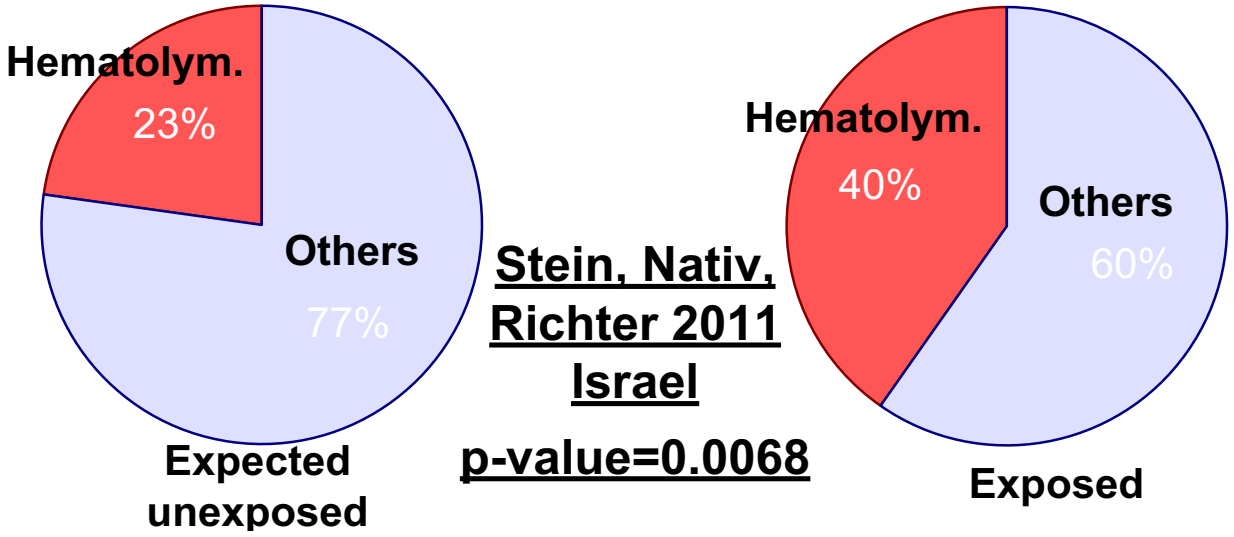
Relative Occurrence (RO)

- The proportion of Hematolymphatic (HL.) patients among all cancer patients. RO=number of HL. cancer patients divided by the total number of patients in the group. $RO=N_{HL}/N_{Total}$
- Readily obtainable from Cancer Registries (CR) for all ages and genders.
- Lends itself to straightforward statistical analysis **using the patients data only.**
- Eliminates many sources of bias, all the patients are selected by the same process.
- Is intuitive, although less informative than the elusive Risk Ratio (RR). If RR is high but uniform for all cancers, no unusual RO will be detected. And RR is the information which really matters to humans.
- Thus RO is useful to examine causation but finally RR will be needed too. No problem, it is indeed available from 3 out of 4 groups of patients reported here.

The statistical analysis performed

- The **observed** RO is the proportion of HL. patients in the group, $RO=N_{HL}/N_{Total}$.
- The **expected** RO was computed from the number of patients in each age/gender category and from the incidence rates for each category in the Cancer Registry. It is influenced by ages in each patient group.
- Under the zero-hypothesis the observed RO should be similar to the expected one with well known probability of deviations, the probability of the observed RO to occur at random is calculated, this is the p-value.
- The procedure is rigorous conventional probability, it is verified by using two somewhat different procedures and by a numerical simulation and presented in the appendix of the paper draft and on the two last slide here.

The first RO results



- **Is it statistically significant?** Yes, the chance of this to happen at random without causation by the exposure is $p=0.0068 < 0.01$.
- **Could it be a mistake?** Yes. Any single study can be mistaken due to hidden influences and other problems, consistency with other studies done elsewhere is needed ta arrive at a conclusion. Done below.

The statistical assumption

- The self referral process is assumed not influenced by cancer type. Will HL. patients participate in self-referral more than other cancer patients? We think such influence would be moderate at most.
- This could influence only one group of patients (2011), not the three other reports presented below. No self referral process in those.
- The analysis of RO of testicular cancers of this 2011 group provides additional reassurance that the assumption above is correct.

Testis cancer as control

- The RO analysis was repeated for testis cancer on same group. The observed RO was very near the expected one. 6 out of 40 patients, RO=0.15, expected RO=0.147.
- This serves as a sanity check indicating that a significant cancer type exhibited the expected RO despite the high number of patients; in contrast to the HL. cancer. Both RO are the result of the same self referral process and of the same analysis, this provides some reassurance against hidden problems in the method.

The three studies consistent with ours

- **The antenna ranges cluster, Peleg 2009**. 5 cancer patients, 3 of which hematolymphatic (HL.). Risk Ratio (RR) for all cancers 8.3, $p<0.01$. We calculated HL. RO as 0.6, $p=0.04$. This confirms the suspicion of causation stated there and links it to all the other studies reported here.
- **Szmigielski, 1996.** Extensive study of the Polish military sector. About 238 HL. cancer patients in the exposed group. RR for all cancers 2, $p<0.05$, RR HL. of 6.3, $p<0.001$. We calculated HL. RO of 36%, $p<<0.001$. This restates the conclusions of Szmigielski from a new viewpoint which may rule out some sources of bias (We think Szmigielski, 1996 is very reliable without our help).
- **Belgium, RADAR operators, Degrave 2009**. RR of HL. cancers of 7.2, 95%CI 1.09-47.9. RR of other cancers much smaller-> High HL. RO. Degrave analyzed death rates rather than incidence rates in the other three studies so the resulting RO is different and hard to compare to ours. The HL. RO in the exposed group was 11/133=8.3% while that in the control group was 1/72=1.4%.

Main references

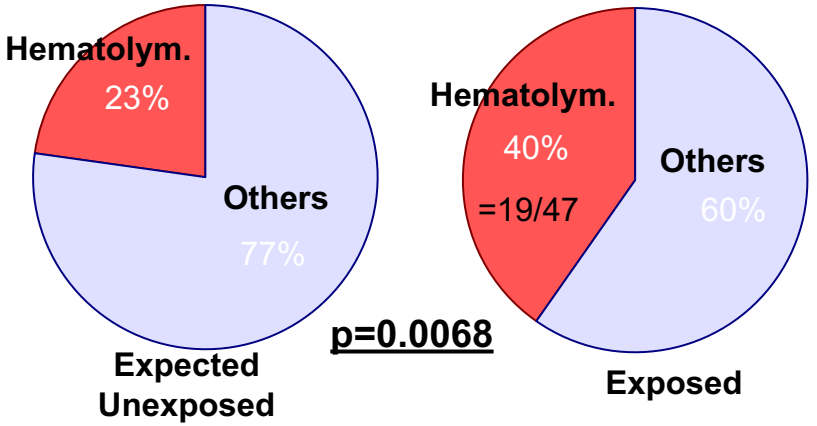
- Stein Y., Levy-Nativ O., Richter E.D., "A sentinel case series of cancer patients with occupational exposures to electro-magnetic non-ionizing radiation and other agents", Eur. J. Oncol. - Vol. 16 - N. 1 - March 2011 http://ejoncology.it/site/, http://www.mattioli1885journals.com/index.php/Europeanjournalofoncology/issue/view/282
- Peleg M., "Report on a cancer cluster in an antenna ranges facility", IEEE International Conference on Microwaves, Communications, Antennas and Electronics Systems (COMCAS), 9-11 Nov. 2009, Tel Aviv. DOI 10.1109/COMCAS.2009.5386048
- Stanislaw Szmigielski: Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. ; The Science of the Total Environment 180 (1996) 9-17
- Maylis Telle-Lamberton : Radiofrequency devices and hemolymphatic cancer, Int. J. Cancer: 127, 997–998 (2010) VC 2009 UICC
- Degrave E, Meeusen B, Grivegnee AR, Boniol M, Autier P. Causes of death among Belgian professional military radar operators: a 37-year retrospective cohort study. Int J Cancer 2009;124:945–51.

The whole picture

High RO and high RR appear together in all studies where both are known.

High HL. RO provides additional link between those four studies.

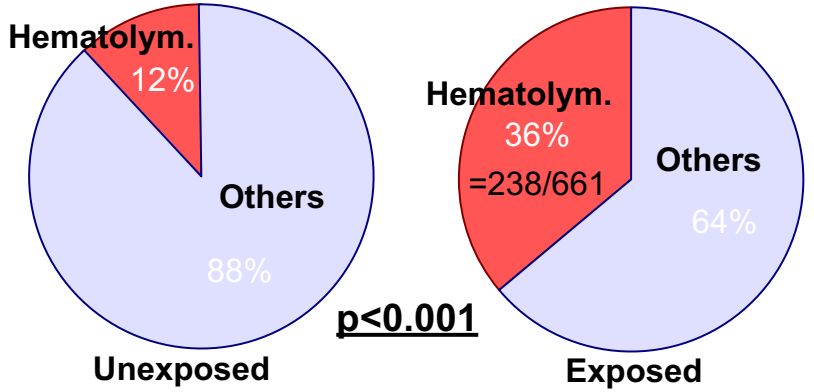
Stein, Nativ, Richter 2011 Israel



p=0.0068

RR unknown

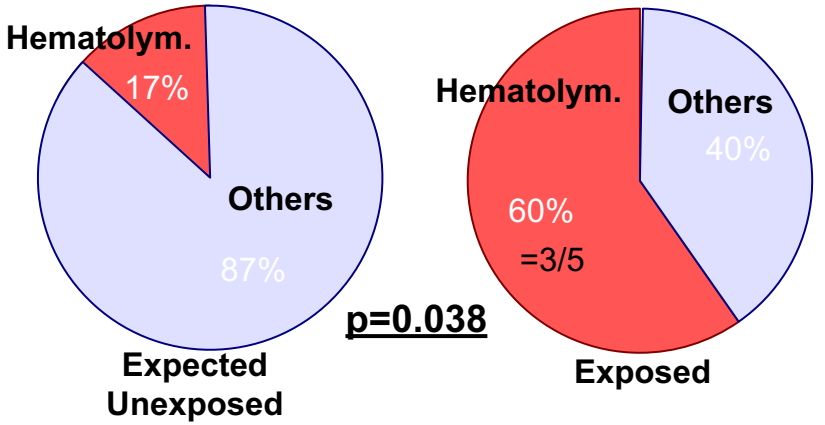
Polish report , Szmigielski 1996



p<0.001

RR all cancers=2, p<0.05
RR HL.=6.3, p<0.001

Antenna ranges cluster, Peleg 2009



p=0.038

RR all cancers=8.3, p<0.05

Belgium, Degrave 2009

HL. RO controls 1.4%, exposed 8.3%

RR HL.=7.2, CI95(1.09-47.9)

Attributes of the RO method

- Is less informative than RR and does not replace it.
- Enabled us to show statistical significance for the 2011 group.
- Enabled us to provide very strong, independent and statistically significant evidence of causation for the 2009 antenna ranges cluster.
- Provides an evidence of consistent abnormal cancer characteristics in the military/occupational setting across 4 independent groups of patients separated geographically and chronologically.

Summary

- Found that hematolymphatic (HL.) cancers occurred in unusually high proportion (RO) among a group of patients (2011) previously exposed to RF. This was shown to be statistically significant, improbable to occur at random – indicating causation.
- Found the same high HL. RO in an independent group from antenna ranges previously reported with extreme Risk Ratio (RR) suspected as caused by RF exposure. Consistency begins to show up.
- Found the same high HL. RO in the Szmigielski extensive study which also reports high RR.
- High HL. Risk Ratio (RR) in the RF occupational/ Military setting was reported elsewhere (Degrave).
- This is a strong evidence of causation and independent of that of Hardell.

Conclusion

- Strong evidence of causation of cancer by exposure to RF radiation in the military/occupational setting was presented, exposure to RF radiation from communication equipment and RADARs almost surely causes cancer, the associated personal risk is very high.
- The evidence comprises highly abnormal and statistically significant hematolymphatic cancer risk consistent across four groups of patients and analyzed in terms of RO and RR.
- Cancer types different from HL. do occur as indicated by Szmigielski , Hardell, animal model studies and others.
- The causation indicated here is consistent with the independent findings among mobile phone users as stated by Hardell based on many previous studies.

Thank you

Computing the p-value – method ‘A’

Patients data: numbers of all and also of hematolymphatic (HL.) cancer patients in each age and gender category in the exposed group.

Cancer Registry (CR) data: incidence rates for all cancers and of HL. Cancers in each category.

The p-value definition: Probability to get at least the observed total number of HL. patients under the no-causation hypothesis given the total number of cancer patients in each age and gender category in the exposed group.

Probability distribution of the number of HL. patients in each category is the usual binomial distribution parametrized by CR data.

Probability distribution of the total number of HL. patients is that of sum over the categories computed conventionally by convolution.

The p-value is the sum over the tail of the last probability distribution.

Computing the p-value – method ‘B’

- The number of patients in each age/gender category is considered a random variable with an unknown probability distribution P(Age, Gender).
- The p-value is computed using a certain approximation of P(Age, Gender) which is verified to be slightly conservative by a numerical experiment.
- Results are very similar to those by method ‘A’
- Both the ‘A’ and ‘B’ methods are valid and independent.
- Details are in the paper draft.