

WHO-COORDINATED INTERLABORATORY QUALITY CONTROL STUDIES
ON LEVELS OF PCBs, PCDDs AND PCDFs IN HUMAN MILK AND BLOOD

A. ERSBOELL

Danish Research Service for Plant and Soil Science, Lyngby, Denmark

M. NYGREN

Swedish Defence Research Establishment, Umeå, Sweden

E. YRJÄNHEIKKI

WHO Regional Office for Europe, Copenhagen, Denmark

ABSTRACT

The WHO Regional Office for Europe is coordinating international interlaboratory quality control studies on levels of PCBs, PCDDs and PCDFs in human milk and blood in order to improve the reliability and comparability of data from research laboratories. The results from the second round of these studies were reviewed by a WHO Consultation held in Rovaniemi, Finland, in June 1990. Based on comprehensive statistical analyses of the results from laboratories, 12 out of 16 laboratories qualified for PCDD/PCDF analyses in milk and 12 out of 15 for PCDD/PCDF analyses in blood. Six out of 10 laboratories qualified for PCB analyses in milk and 4 out of 6 for PCB analyses in blood.

INTRODUCTION

The WHO Regional Office for Europe is coordinating interlaboratory quality control studies on levels of PCBs, PCDDs and PCDFs in human milk and blood as part of its overall project on the health effects of these chemicals. The results of the first round of the studies, on human milk only, were evaluated at a consultation held in Umeå, Sweden, in August 1987. At that meeting it was recommended that the studies should be continued and that a new round should be organized every second year from 1988 onwards.

On the basis of that recommendation, the Regional Office planned the second round of studies, and participants in a consultation held in Copenhagen in February 1988 designed the study protocol, including analysis of both blood and milk. They also agreed on the practical aspects of the studies including coordination, laboratory work, reporting and timetable, which were subsequently discussed in further detail at two informal meetings of laboratory representatives in Umeå in August 1988 and in Toronto in September 1989.

The second-round studies were coordinated by a team consisting of Professor B. Jansson (Swedish Environmental Protection Agency), Dr M. Nygren (Swedish Defence Research Establishment), Mr R. Vaz (Swedish National Food Administration) and Dr E. Yrjänheikki (WHO Regional Office for Europe). The laboratory work of preparing samples for analysis was carried out by Dr Nygren with the assistance of Dr Yrjänheikki. The final date for completing the laboratory studies and reporting the results to the Regional Office was 28 February 1990.

The main purpose of the Consultation held in Rovaniemi, Finland, 5-6 June 1990, was to evaluate the results received, using a statistical analysis carried out on behalf of the Regional Office, and to agree on the criteria to be applied to evaluate which of the laboratories are actually qualified to perform the analyses required. Other aims were to discuss the analytical procedures used, to identify weak points and advise on improvements, and to consider the need for further activities to ensure the reliability and comparability of the laboratory analyses.

The Consultation was attended by 22 experts from 15 countries, one observer and two WHO staff members.

DISCUSSION

In accordance with the study design, each laboratory had received samples from three subpools of human milk and three subpools of blood plasma. In both cases, two of the subpools had been fortified with certain PCDD and PCDF congeners, the third subpool being unfortified. For PCBs no fortification had been performed. The study design required that two of the subpools be analysed and the results reported before the final subpool was shipped to participants. All analyses were to be in triplicate.

The original deadline for completion of the study was 28 February 1990. In practice, results were accepted until 20 March, allowing nine additional sets of results to be considered. Within the revised timeframe, results for PCDDs and PCDFs were received from 19 laboratories and for PCBs from 10 laboratories. These laboratories had not all analysed both milk and blood.

The coordinating committee had met on 20 March 1990 to evaluate the statistical treatment of the results, which had been prepared for presentation at the Consultation. Individual laboratories were identified only by code numbers, the key to which was not revealed until the discussion was over. The statistical treatment assessed repeatability and reproducibility, as indicators of precision and accuracy, merging the results into a single score for each laboratory. For PCDDs/PCDFs, the treatment weighted the contribution made to the score by each congener according to the Nordic scheme of toxic equivalents. Using other current schemes such as the International Toxic Equivalent Factors (I-TEF) would not have altered the outcome significantly. The scoring also included a penalty for missing data.

Since the variability of fat measurements, especially for blood, was unsatisfactory, the entire statistical treatment was based on the results obtained for whole samples rather than on the basis of fat weight. The reasons for the variability were discussed, with particular reference to the possible influences of different methodologies.

During the Consultation, the statistical treatment based on scores was supplemented by calculations of the coefficients of variation, without weighting by toxic equivalent factors, and by consideration of the differences in the results reported for fortified and

unfortified samples. On this basis, a decision was reached as to which of the laboratories are currently able to demonstrate an acceptable standard of analysis and are thus qualified to perform such analyses.

Practical difficulties encountered during the analysis were discussed. These included some problems with evaporation of shipped standards, blank analyses which gave significant levels in some laboratories, and the consequences of an inadvertently high fortification level for one congener in two of the subpools of blood. Many of the laboratories reported that they had had only limited prior experience in performing these analyses for blood.

It was agreed that the quality control studies needed to be repeated in two years' time, using the same study design; that a reliable and consistent method of fat determination must be used in future studies; and that quality control studies specifically related to fat determinations were needed.

CONCLUSIONS

1. The variability of fat measurements, especially for blood, was unsatisfactory, possibly because of the variety of methods used. Because of this, the results from this study were interpreted on a whole-sample basis.
2. After consideration of both the accuracy and the precision of the analyses of PCDDs and PCDFs in milk, it was concluded that 12 laboratories were qualified out of a total of 16 which reported results (Fig. 1).
3. For the analysis of PCDDs and PCDFs in blood, the difficulties are greater and it was concluded that a wider range of variation should, for the time being, be regarded as acceptable. This wide tolerance was regarded as necessary in order not to restrict unreasonably the number of laboratories producing new data for health risk assessment; but all except a very few of these laboratories are urgently recommended to seek ways of improving the quality of their results. Twelve laboratories qualified out of 15 submitting results (Fig. 2).
4. For the analysis of PCBs in milk, it was concluded that six laboratories qualified out of 10 submitting results (Fig. 3).
5. For the analysis of PCBs in blood, it was concluded that four qualified out of six submitting results (Fig. 4).

RECOMMENDATIONS

1. It was recommended that only results from laboratories which had qualified in this or some other appropriate study should be used by the Regional Office for further health risk assessment.

2. In future studies, a design committee should specify the exact methods for fat determination to be followed by all laboratories. In general, laboratories are encouraged to improve the reliability of their fat determinations, noting that simple and easily applied methods are preferred.

3. In the case of those laboratories which did not fulfil the criteria for qualification, it was particularly recommended that they take steps to improve their methodology before performing further analyses. Furthermore, they were strongly recommended to take part in future interlaboratory quality control studies.

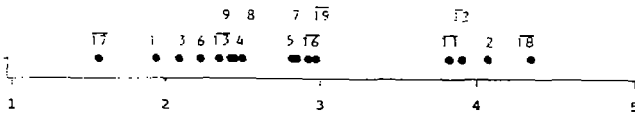
4. It was recommended that a further interlaboratory quality control study should be conducted in two years' time for both PCDDs/PCDFs and PCBs. The determination of PCBs should include at least the congeners with IUPAC numbers 28, 52, 77, 101, 118, 126, 138, 153, 169 and 180. Other congeners might also be considered.

5. It was recommended that in future studies the design committee should specify the information to be reported, and that this should include details of detection limits and recoveries. The exact method by which these are to be determined should be specified by the committee. The design of the study should also require analysis of blanks at a specified frequency. Failure to report all the information requested may result in penalties or rejection of the results.

Figure 1:

MILK - PCDDs AND PCDFs
 Final Score (Nordic Model)
 based on reproducibility and repeatability (weight factors 1.0 and 0.8)

Laboratory	Score
17	1.56244
1	1.93598
3	2.08411
6	2.22572
13	2.34970
9	2.42153
4	2.44922
8	2.49775
5	2.81778
7	2.84934
16	2.92179
19	2.96960
11	3.82653
12	3.90403
2	4.07129
18	4.34320

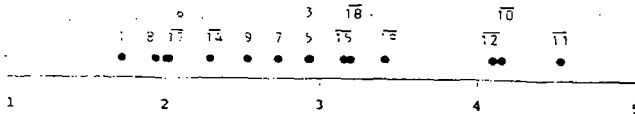


Laboratories 11, 12, 2 and 18 did not qualify

Figure 2:

BLOOD - PCDDs AND PCDFs
 Final Score (Nordic Model)
 based on reproducibility and repeatability (weight factors 1.0 and 0.8)

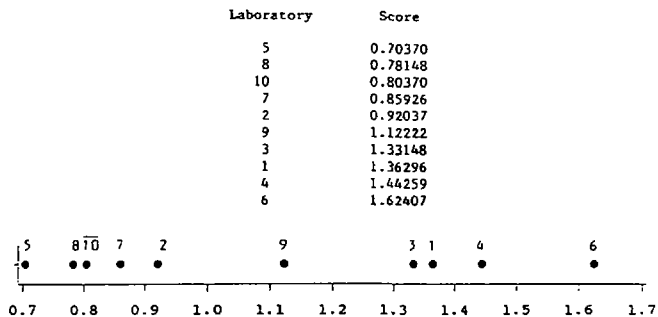
Laboratory	Score
1	1.71664
8	1.93838
17	2.00595
6	2.02097
14	2.29331
9	2.53588
7	2.73206
5	2.92562
3	2.93562
15	3.15402
18	3.19567
19	3.41563
12	4.09513
10	4.14832
11	4.51790



Laboratories 12, 10 and 11 did not qualify

Figure 3:

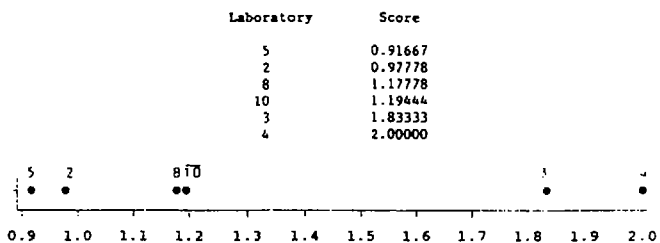
MILK - PCBs
 Final Score
 based on reproducibility and repeatability (weight factors 1.0 and 0.8)



Laboratories 3, 1, 4 and 6 did not qualify

Figure 4:

BLOOD - PCBs
 Final Score
 based on reproducibility and repeatability (weight factors 1.0 and 0.8)



Laboratories 3 and 4 did not qualify