A Multi-Centre Clinical Follow-Up Database as a Systematic Approach to the Evaluation of Mid- and Long-Term Health Consequences in Chernobyl Acute Radiation Syndrome Patients

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Abstract: This paper describes scope, design and first results of a multi-centre follow-up database that has been established for the evaluation of mid- and long-term health consequences of acute radiation syndrome (ARS) survivors. After the Chernobyl accident on 26 April 1986, 237 cases with suspected acute radiation syndrome have been reported. For 134 of these cases the diagnosis of ARS was confirmed in a consensus conference three years after the accident. Nearly all survivors underwent regular follow-up examinations in two specialised centres in Kiev and in Moscow. In collaboration with these centres we established a multi-centre clinical follow-up database that records the results of the follow-up examinations in a standardised schema. This database is an integral part of a five step approach to patient evaluation and aims at a comprehensive base for scientific analysis of the mid- and long-term consequences of accidental ionising radiation. It will allow for a dynamic view on the development of the health status of individuals and groups of patients as well as the identification of critical organ systems that need early support, and an improvement of acute and follow-up treatment protocols for radiation accident victims.

1. Introduction

The multi-centre clinical follow-up database described in this paper is an integral part of a methodological framework for the evaluation of mid- and long-term health consequences in patients surviving the acute radiation syndrome (ARS). After the Chernobyl nuclear power plant disaster on 26 April 1986, a total of 237 persons were suspected of having an ARS due to irradiation. Following acute care in hospitals mainly situated in Moscow and Kiev the 199 surviving patients (28 died during the acute disease) were under regular follow-up investigation in Hospital No. 6 of the Institute of Biophysics in Moscow, and the Clinical

Department of the Scientific Center of Radiation Medicine of Ukraine. Additionally, 14 of the patients with the most severe skin injuries had repetitive follow-up examinations in the Dermatological Department of the Ludwig-Maximilians-University, Munich, Germany.

2. Methodology: Five Step Approach to Patient Evaluation

The multi-centre clinical follow-up database is an integral part of a general methodological approach to patient evaluation. This five step approach (Fig. 1) consists of the following five steps: (1) Design of a follow-up questionnaire reflecting the reality of repeated follow-up examinations, time flow and the implication of different centres in following-up a single patient (Weiss et al. 1995). (2) Design of the conceptual, logical and physical database schema (SQL for Microsoft Access 2.0 and/or Oracle 7); design of a form-based questionnaire-like user-interface for putting-in and browsing patient data (Microsoft Access 2.0); assuring data quality by data validation through integrity constraints that are reflecting the semantics of the clinical data. (3) Population of the database; integrating the data from different participating centres. (4) Further data integration for a common view on acute-care (Baranov et al. 1994) and follow-up clinical data; user interface design. (5) Analysis of the data in order to improve the knowledge on mid- and long-term consequences of ARS and give recommendations for their prevention in acute care and subsequent follow-up as well as recommendations for standardised follow-up examinations for patients after ARS. Data analysis techniques include the visualisation of individual health dynamics, evaluation of health trouble rates in different groups of patients and in relation to the initial exposure situation.

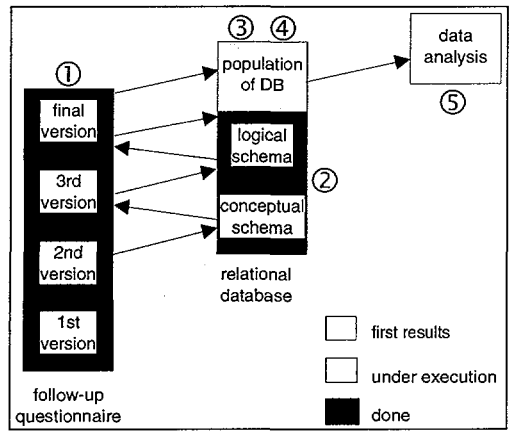

Fig. 1: Overview on Methodology

3. Population under Investigation

After the Chernobyl accident on 26 April 1986, 237 persons were suspected of suffering from an acute radiation syndrome (ARS). A later revision of all cases resulted in a confirmation of 134 cases while 103 could not be confirmed. 28 victims died from acute complications, 10 died during the follow-up period (October 1995). 199 persons are still alive and most of them are under regular follow-up. The patients undergoing follow-up examinations performed by the three centres in Kiev, Moscow and Munich form the study population of

the follow-up study and the computer database. Tab. 1 shows the number of follow-ups performed so far.

Tab. 1: Numbers of patients and follow-up examinations in the three examining centres

Centre	approx. nb. of performed follow-up examinations	nb. of patients followed-up in 1994
Kiev	> 1200	168
Moscow	> 350	18
Munich	~ 60	15

3. Results

After filling-in the data from the original patient records into the questionnaire data can be entered into the computer database by the use of an Microsoft Access based set of computer forms. Putting the data directly from the patients records into the database is also possible but needs further steps for data validation. Since the beginning of 1995, the clinical follow-up database is in the phase of population after having been tested by several case examples in the year before.

Follow-Up Data Available			⇒	Follow-Up Questionnaires			⇒	Included in Follow-Up Database		
	patients	exams.			patients	exams.			patients	exams.
Kiev	168	>1200		Kiev	2	20		Kiev	2	20
Moscow	18	>350		Moscow	14	135		Moscow	9	69
Munich	14	~60		Munich	10	10		Munich	0	0
total	**199**	**>1600**		**total**		**165**		**total**	**11**	**89**

Fig. 5: Number of patients and number of examinations (available, reported, in database; October 1995)

4. Discussion

The clinical data collected in the three examination centres represent a base of enormous scientific value. Our effort has the objective to make these data available for scientific analysis. (1) An increased availability to a larger scientific community can be achieved by using English language and a common standardised terminology for the documentation of the clinical data. (2) If the same standardised and structured schema is used for the documentation of all follow-up examinations later comparison of case histories will be much easier. (3) The availability for scientific analysis can be increased by storing the clinical data in a computer. Compliance to database standards (SQL, ISO/IEC 9075) enhances the interoperability. Additionally, the relational database model allows for flexible data access paths and to answer a large variety of research questions. (4) The data from all participating centres are stored by the help of the same database schema. This allows for an integration into a single clinical database and provides research and practice with the complete history of follow-up examinations during the last 10 years even if a patient has been followed-up by different centres.

Together with the possibility of integrating the rapidly growing follow-up database with another database comprehensively documenting the acute course of acute radiation syndrome widens the range of questions that can be answered by the help of this well-structured multi-centre clinical follow-up database.

During the database development process and the following database population we were faced with the following problems. (1) Clinical data are person-related and require measures protecting the privacy. The gold standard is only to store anonymised data. Since data from different follow-up examinations of the same patient have to be connected to each other the examining centres agreed on a common table of patient codes that is used to fill in the follow-up questionnaires and allows to link all data of an individual patient. (2) The data reported in the questionnaires is not perfect. A sound quality control procedure was required to get reliable data. The first measure in this direction was feed back from the data entry personnel (medical students). A second were the build-in integrity constraints of the database.

5. Conclusion and Outlook

The multi-centre clinical follow-up database lays a sound foundation for patient evaluation after acute radiation syndrome (ARS). Once populated with a larger number of cases, this valuable research tool will be at the disposal of an international group of scientists to be used as a source for new knowledge on mid- and long-term consequences of this rare disease including the generation of hypothesis by explorative data analysis and testing formerly stated hypotheses.

The continuation of regular follow-up examinations and the input of their results into this multi-centre database seems necessary to us. Continuous analysis should accompany this process. An extension to include cases from others than the Chernobyl accident - as already performed for the acute period database - should be discussed.

The comprehensive database schema and its relational design have shown to be difficult to handle by novices. It seems to be useful to supplement the existing forms-based graphical user interface for data entry and browsing with an easy-to-use graphical user for flexible data visualisation. Possible functions are: (1) to present the health dynamics of an individual case, (2) to find similar cases from the database, and (3) to present multiple cases for comparison.

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