Chapter XII

Structured Content and Connectivity of Medical Information—The Medical Data Web

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INTRODUCTION

To a large extent, medicine is an information-processing endeavor. It is all the more surprising, therefore, that computer technology has not yet developed very far in successfully supporting this activity. The areas where computer support is most advanced in medicine are signal processing and ‘data’ generation, as well as in the administrative domain. However, the huge area that encompasses the main part of the physician’s clinical activity has only marginally been touched upon by information-processing systems. The reason for this might well lie with the problem that medical ‘information’ is mainly a matter of connecting pieces of data together. The sheer complexity of these connections is, however, beyond classical database technology. The best and easiest way to express such complex information has been written (and spoken) text, until now. A long tradition of how written medical reports are formulated and stored in patient records and how scientific reports are published in medical journals has been built up.
When one analyses such reports and medical thinking in general, it becomes very obvious that data elements, like results of laboratory tests, X-ray pictures, or any other clinical observations carry little information on their own. They become meaningful only when they are embedded in a specific context and connected to other data elements. It is here, where computer technology is badly needed not to replace the doctors’ thinking but to support their decision process in a way that the patient can profit from this connectivity and from global medical knowledge.

**Connectivity of Medical Information**

A typical medical data element is a result from a laboratory test. To properly interpret such a result, connections have to be made to reference values, to test parameters like method, sensitivity, specificity, and likelihood ratio, to preexisting results of the same test for that patient, to other test results, to the clinical context, and last but not least to the scientific literature. Such connections might be precise and stringent, or they might be loose and interpretable. There might be lists involved from which the doctor has to choose the appropriate item, or the required target element might be not accessible or be even missing. The connection might be to targets within the same domain of activity, or they might point to distant locations like other databases or other documents, in the same information system or some other system. In any case, medial data connectivity is not of a quality that can be adequately modeled in a relational database.

To give an example, we could look at CD4-lymphocytes, a laboratory parameter that is regularly used to monitor HIV infection (Figure 1). A number of 250 for CD4 would probably give the treating physician enough information because the context is obvious to her. But the connectivity is extensive (see figure): She assumes that the number 250 refers to cells per microliter in the metric system, and CD4 refers to a subpopulation of lymphocytes, a type of white blood cell. She assumes that the measurement has been done by a method known as flow cytometry in a sample collected from the peripheral blood in an EDTA tube. It will not be obvious what reagent has been used for staining the CD4-cells, what type of apparatus to measure them, and what confidence interval such a measurement has. She knows that the reference value in the normal population is above 500, but the link to the publication that asserted that value and described that control population is not apparent. Of course she has to know from which patient the sample has been drawn and at what time and date. But then she should also know earlier results of the same test to compare to the current result. CD4 values are not only expressed in absolute cell numbers per microliter but also relatively as percentage of...
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