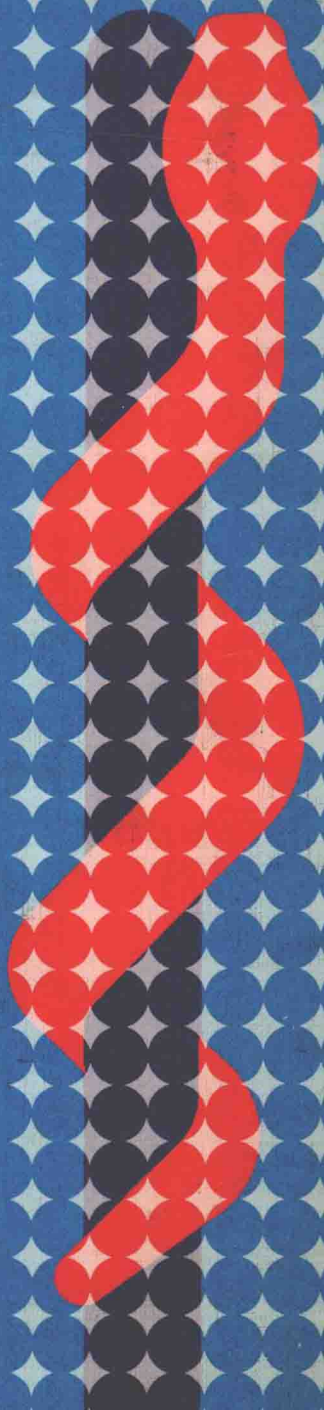
Data in medicine
Collection, processing and presentation

Robert S. Reneman and Jan Strackee (eds.)



Instrumentation and Techniques in Clinical Medicine vol. 1

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DATA IN MEDICINE: COLLECTION, PROCESSING AND PRESENTATION

A PHYSICAL-TECHNICAL INTRODUCTION FOR PHYSICIANS AND BIOLOGISTS

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DATA IN MEDICINE: COLLECTION, PROCESSING AND PRESENTATION

INSTRUMENTATION AND TECHNIQUES IN CLINICAL MEDICINE

Volume 1

Data in medicine: Collection, processing and presentation. A physical-technical introduction for physicians and biologists.

edited by ROBERT S. RENEMAN and JAN STRACKEE

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PREFACE

Nowadays clinical medicine is to a great extent dependent on techniques and instrumentation. Not infrequently, instrumentation is so complicated that technical specialists are required to perform the measurements and to process the data. Interpretation of the results, however, generally has to be done by physicians. For proper interpretation of data and good communication with technical specialists, knowledge of, among other things, principle, advantages, limitations and applicability of the used techniques is necessary. Besides, this knowledge is required for critical comparison of systems to measure a certain variable. Critical evaluation as well as comparison of techniques and instruments ought to be an essential component of medical practice.

In general, basic techniques and instrumentation are not taught in medical schools nor during residencies. Therefore, physicians themselves have to collect practical information about principle, advantages and limitations of techniques and instruments when using them in clinical medicine. This practical information, focussed on the specific techniques used in the various disciplines, is usually difficult to obtain from handbooks and manufacturers' manuals. Hence a new series of books is started on instrumentation and techniques in clinical medicine.

The aim of these series is to provide a clear and critical survey of what technology has to offer to clinical medicine in the way of possibilities and how the latter should be used. For example, limitations as well as advantages will be presented when feasible. The authors have been asked to write their chapters with the above mentioned consideration in mind and to use a more or less instructive style. Volumes on instrumentation and techniques in diagnostic radiology, angiology, otorhinolaryngology, nuclear medicine and cardiology are on their way.

The specific volumes are preceded by an introductory volume which covers the three main aspects of instrumentation, being collection, processing and presentation of data. Although most chapters are devoted to these aspects, some chapters, e.g. chapters 2, 3 and 4, stress even more fundamental points. In these chapters it is shown that properly measuring a phenomenon is heavily tied to prior knowledge of the way the phenomenon comes to us and of the disturbance factors, the latter going under the universal name of noise.

The allocation of the chapters in relation to three different aspects is roughly as follows. Chapter 1 is a more or less philosophical approach to data collection. The chapters 9 and 10 will deal with processing. Chapter 11 is purely about presentation. The chapters 5 and 6 cover all three aspects and the chapters 2, 3, 7 and 8 are a mixture of collection and processing. Chapter 4 about radioactivity, which deals with collection and processing, was included because we considered the basic information presented in this chapter to be of interest to the users of most of the specific volumes of the series.

Techniques using, for instance, ultrasonic waves or monochromatic light (laser) and techniques based upon electromagnetic induction are not included in this introductory volume. It seemed more appropriate to discuss these techniques, which are in fact applications of relatively simple physical laws, in the specific volumes.

Formulas were used by some of the authors. This has been a point of discussion because in general physicians are not acquainted with the use of these mathematical relations. However, for the application of certain principles, formulas have to be used. *A compromise was found by modelling the content of the chapters in such a way that one simply can skip the formulas and still retain the scope of a chapter.*

It is the aim of the introductory volume to supply the reader of the specific volumes of the series with some basic information which might facilitate their use. Besides, this book may be of interest to physiologists, pharmacologists, physicists, electronic engineers, technicians and to all those who enter the domain of biomedical research for the first time.

We wish to express our thanks to the different authors and to the publishers for the care they have taken in producing this book. But most of all we would like to thank Mrs. Els Geurts and Mrs. Mariet de Groot for carrying the heavy secretarial load with fortitude and for their help in preparing the manuscripts.

March 1979

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1 OBSERVATION: HOW, WHAT AND WHY

Leo Vroman

1.1 Introduction

We can now measure picograms of a pure molecular species, and lightyears of nearly empty space. Will we eventually be able to measure everything, and will we then understand it all? Or nothing? Could it be that numbers will prove themselves symbols, not of precision, but of our blind senses and mind? I believe there are properties in both the living observer and the life observed, that we must face and focus on, before we try to focus on the perhaps less real world of numbers beyond. I believe some properties within ourselves may be unavoidable obstacles: our tendency of thinking along lines, of homogenization, circularity and perspectivation are products of the life processes we observe with. The specific functionalities of shaped or patterned interfaces, and of amplification or image intensification in real life, on the other hand, are products of the same processes rendering measurement doubly difficult.

1.2 Problems in the observer

1.2.1 *Linear thinking*

We cannot walk a branched path. Even in thought, we can fully enter only one world at a time, and where more than a few – such as total reality – could await us, uncertainty blends them to a merciful fog, softening this confusing spectacle of our future and leaving only the moving spot clear where something aims our line of steps. We cannot imagine a path as if not taken. You probably know the kind of trick drawing that appears to show a flight of steps seen from above, but that at other moments looks to you like a flight of steps seen from below. We cannot see the steps both ways at once. We stop and rest our minds as soon as we arrive on solidly familiar ground.

1.2.2 *Homogenization*

We seem addicted to returning and repetition as the only form of harmony assuring us that there is no need to observe more than a fraction of reality, and assuring us that eternity, though unfathomable, does exist. We pay for this addiction: to absorb anything new, we must digest it into familiar parts, believing that this completes our process of understanding; and we ourselves, to be understood, must speak only in words defined by earlier words. Repetition – in time as well as in space – easily leads to counting. Conveniently, our senses distinguish many entities as bulk: a cloud, a noise, a mood, a day, a season, each a mass of grey, sadness, hours, defined by some uniform property of their subunits, and these subunits can be counted to give us a number representing an important property of the whole. But in real life, no two subunits are ever alike; even in a crystal, each atom occupies a different, unique place in relation to the crystal's borders. If we knew everything, each subatomic particle in the universe would show us its very individual history and destiny, and we would have neither the need nor the ability to speak of masses or of numbers; we would no longer add 1 and 1 of anything, to arrive at the number 2. But many of us would not even be happy with that prospect, because our very senses prefer repetition, and so, from grouping and counting, we easily go to ranking. We even rank each other, expressing work in money and sports in points. To be good, we must be better than others, and from rating how good we are, we drift into rating how well we are. Minicomputers with a memory harder than ours can now accept your blood, perform about 20 tests on it, print these values as bars on a background of other bars that indicate the accepted normal ranges . . . normal for a pool of blood samples from strangers who may share with you no more than their sex. This unstable hematological profile of yours, or even your entire medical one, is a display as variable as a reflection of the moon on a windswept ocean, its statistical "normal" shape a blurred disc that could just as well be the sun. Your facial profile, rather than your medical one, is the shape your friends will recognize out of thousands, no matter how you turn. Of course your face, like the reflection of that moon, is also a statistical mean; your grimaces around this mean, as well as the microscopic turbulence in it (see below under "perspective") cannot hide it for long. And yet, only a small mask hiding part of your face can make you unrecognized. Without your nose, your eyes do not seem the same as usual.

The numbers representing measurements of your life processes taken out of context often also lack the desired meaning. The minicomputer that looked at your blood is a little bit aware of the complex web of physiological interactions from which its data are plucked. For example, nothing may seem more absolutely clear and diagnostically numerical than a red blood cell count, but it has little meaning without information on the size of the cells and the concentration of hemoglobin in them. The computer adds these to the list it prints, and makes a few calculations to indicate how well the red cells function, but it probably will miss the most essential information: with a sample of blood taken after your death, the computer may still tell you that you are well, because it has been built with our own tendency to count and therefore to homogenize. Not only silent about the red cells still in your body, it also failed to ask how much you weigh, what altitude you are living at, what work you do, how anxious you are – all questions about conditions that strongly affect the number of red cells circulating, and that should affect the number of red cells per cubic millimeter regarded as normal for your own personal situation.

The more forces we know at work, the less satisfied we are with a single value for their summed effect. There is no end: to become more and more meaningful, measurements need other ones of things farther and farther removed. For example, we found that in certain breeds of rats under a certain chronic stress, the adrenal weight increased, while body weight decreased in one breed, increased in another. We measured the ascorbic acid contents of the adrenals in these chronically stressed rats under a mild, acute stress – the latter causing a depletion of ascorbic acid in relation to adrenal hormone production. Usually, the concentration (mg ascorbic acid per 100 mg adrenal mass) is reported. But since the adrenal weights had increased, how could they serve as proper reference? And if the ascorbic acid had performed a function in the adrenals which in turn must have served the entire body, would not the drop in ascorbic acid weight have to be related to the total animal's body weight? But then, should we not first try to find out which parts of the body were served most and with what normal requirements these parts draw on the adrenals?

Let me give you another example of one measurement requiring more and more others to gain meaning. The clotting of human blood plasma involves a series of reactions among 10, or perhaps more, proteins. Five of these have been named after the first patients discovered without: Hageman, Fitzgerald, Fletcher, Christmas, and Stuart factor. Even normally, each of these factors is present in such minute amounts, has such bland properties other than its individual function, and hides its function so well as merely one small link in the smoothly functioning clotting chain, that we can only find it if broken, and can only identify it by matching its broken chain with other ones. Factors VIII and IX, for instance, were distinguished from each other only when someone found that the blood from certain