

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

future volumes

Angiology

edited by M. VERSTRAETE

Otorhinolaryngology

edited by B. H. PICKARD

Nuclear Medicine

edited by K. H. EPHRAIM

Diagnostic Radiology

edited by P. P. G. KRAMER

and others

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 phenome-

non 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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TABLE OF CONTENTS

List of contributing authors

XIII

1	Observation: how, what and why; LEO VROMAN	1
1.1	Introduction	1
1.2	Problems in the observer	1
1.2.1	Linear thinking	1
1.2.2	Homogenization	2
1.2.3	Perspective	5
1.2.4	Circularity	5
1.3	Problems in the observed	6
1.3.1	Interfaces	6
1.3.2	Image intensification	7
1.4	Significance	9
2	Physical concepts; L. H. VAN DER TWEEL, J. VERBURG	11
2.1	Introduction	11
2.1.1	General	11
2.1.2	Circulatory aspects	12
2.1.3	Acoustical aspects	14
2.2	Mechanical-electrical analogues	16
2.3	Hemodynamics	23
2.3.1	A simplified model of blood pressure ("Windkessel" model)	23
2.3.2	The pulse wave	26
2.4	Pressure recording with catheters	33
2.5	Cardio-acoustics	37
2.5.1	General	37
2.5.2	Transducers on the chest wall	39
2.5.3	The mechanical impedance of the chest wall	45
2.5.4	Mechanical impedances of phonocardiographic microphones	45
3	The electronic approach to measurements; B. VELTMAN	53
3.1	Introduction	53
3.2	Digital circuits	62
3.3	Analogue circuits	72

4	Radioactivity; RICHARD B. KING, JAMES B. BASSINGTHWAIGHTE	79
4.1	Introduction	79
4.2	An overview of the physics of radioactive emissions	79
4.2.1	Atomic structure	79
4.2.2	Modes of decay	80
4.2.3	Stabilization after radioactive decay	83
4.2.4	Activity and half-life	83
4.3	Radiation detection system	85
4.3.1	Gamma detectors	85
4.3.2	Beta detectors	86
4.3.3	Signal processing	87
4.3.4	Processed gamma spectra	88
4.3.5	Processed beta spectra	89
4.4	Tracer sample counting	91
4.4.1	Gamma counting with a single tracer	91
4.4.2	Gamma counting with multiple tracers	92
4.4.3	Beta counting with a single tracer	94
4.4.4	Beta counting with multiple tracers	96
4.4.5	Decay corrections	97
4.4.6	Relative doses with reference to the experiment design	98
4.5	Applications	100
4.5.1	Applications of tracer dilution techniques to the measurement of volume and flows	100
4.5.2	Applications of tracer exchange techniques to the estimation of transmembrane fluxes	106
4.5.3	Neutron activation analysis	111
5	Image formation; HAROLD WAYLAND	115
5.1	Introduction	115
5.2	Image formation on the ray theory	116
5.2.1	Light gathering power of a lens	122
5.2.2	Depth of focus and depth of field	123
5.3	Optical resolution	126
5.4	Aberrations of spherical lenses and mirrors	129
5.4.1	Spherical aberration	130
5.4.2	Astigmatism	131
5.4.3	Coma	132
5.4.4	Curvature of field	132
5.4.5	Distortion	133
5.4.6	Chromatic aberration	134
5.4.7	Correction of aberrations	135
5.5	Resolution of lenses: the modulation transfer function	136
5.6	Choosing lenses	143
6	Photographic and television recording of images; HAROLD WAYLAND	145
6.1	Introduction	145
6.2	Detectability of an optical signal	149
6.3	The photographic process	151

6.3.1	Some fundamental concepts	151
6.3.2	Structure of photographic films	152
6.3.3	Properties of photographic emulsions	153
6.3.4	Resolution	158
6.3.5	Some comments on the use of photographic systems	159
6.4	Electronic aids to image sensing and recording	163
6.4.1	Some fundamental concepts	163
6.4.2	Image intensifiers	164
6.4.3	Television	166
6.5	Color recording	179
7	Storage systems; HENK G. GOOVAERTS, HENK H. ROS, HANS SCHNEIDER	181
7.1	Introduction	181
7.2	Graphic recorders	181
7.2.1	Recorder mechanism	182
7.2.2	Recording format	184
7.2.3	Writing principles	184
7.2.4	General properties	187
7.3	Storage from the oscilloscope screen	190
7.4	The magnetic tape recorder	191
7.4.1	Introduction	191
7.4.2	Head properties	191
7.4.3	Tape characteristics	192
7.4.4	Direct recording	192
7.4.5	Frequency modulation	193
7.4.6	Pulse-code modulation	194
7.4.7	Recording codes	196
7.4.8	Tape transport mechanism	197
7.4.9	Time base error, flutter, and noise	198
7.4.10	Cassette recorders	200
7.4.11	Digital recorders	200
7.5	Transient recorders	201
7.6	Card and tape punchers	202
7.7	Digital memories	203
7.8	Videotape recording	203
8	Automation; JOHN D. LAIRD	207
8.1	Introduction	207
8.2	Analysis of automation of measurements in clinical medicine	208
8.2.1	Introduction	208
8.2.2	The data acquisition phase	209
8.2.3	The data processing phase	209
8.2.4	The interpretive phase	209
8.2.5	The decision phase	210
8.2.6	The action phase	210
8.3	Application of automation to measurements in clinical medicine	210
8.3.1	Introduction	210
8.3.2	Reasons for automating a particular task	211
8.3.3	Automating the acquisition/processing phase	212

8.3.4	Detection strategies	212	
8.4	Automation and the computer	214	
8.4.1	Introduction	214	
8.4.2	If it's so complicated let's put it all in a computer and let it sort it out	215	
8.4.3	How do we "put it in the computer"?	215	
8.4.4	Programming	216	
8.5	Automation and the microprocessor	217	
8.5.1	Introduction	217	
8.5.2	Tentative conclusions	219	
8.6	Pocket calculators and computers as tools in the diagnosis	219	
8.6.1	Introduction	219	
8.6.2	Off-line processing and interpretation	222	
8.7	Automating the decision/action phase	223	
8.8	A last remark	224	
9	Signal processing; JAN STRACKEE, ADRIAAN VAN OOSTEROM		227
9.1	Introduction	227	
9.1.1	Definition of a signal	227	
9.1.2	Purpose of analysis	228	
9.2	Special techniques	228	
9.2.1	Sampling	228	
9.2.2	Digitizing	229	
9.2.3	Discrete Fourier transform	229	
9.2.4	Least-squares approach	232	
9.3	Stochastic signals	235	
9.3.1	Description in terms of statistical parameters	235	
9.3.2	Autocorrelation function	235	
9.3.3	Spectral density	236	
9.3.4	Description in terms of an ARMA process	237	
9.4	Deterministic signals	238	
9.4.1	Model known (as function, as differential equation)	238	
9.4.2	Parameter estimation	238	
9.4.3	Model unknown	241	
9.5	Manipulation	243	
9.5.1	Data reduction	243	
9.5.2	Filtering	243	
9.5.3	Differentiation	252	
9.5.4	Integration	254	
9.5.5	Interpolation	255	
10	Statistical aspects; JOHN H. ANNEGERS		259
10.1	Introduction	259	
10.2	The scope of applied statistics	259	
10.2.1	Introduction	259	
10.2.2	Description of results	260	
10.2.3	Tests of significance	261	
10.2.4	Populations and samples	262	
10.2.5	Measurements and attributes	264	
10.2.6	Non-parametric methods	265	
10.3	Some experimental designs and statistical applications	266	

10.3.1	Paired data	266	
10.3.2	Non-paired data	267	
10.3.3	Analysis of variance, single classification	269	
10.3.4	Multiple classification	270	
10.3.5	Multivariate samples	272	
10.3.6	Correlation	272	
10.3.7	Regression	273	
10.3.8	Covariance	275	
10.3.9	Multiple linear regression	276	
11	Presentation of information for printed publications, slides and posters; LINDA REYNOLDS, HERBERT SPENCER, ROBERT S. RENEMAN		279
11.1	Introduction	279	
11.2	Investigating legibility	280	
11.2.1	The reading process	280	
11.2.2	Methods of research	281	
11.3	Books, journals and reports	283	
11.3.1	Introduction	283	
11.3.2	Type forms	285	
11.3.3	Typography and layout for text	288	
11.3.4	Tables	291	
11.3.5	Graphs, charts and diagrams	295	
11.3.6	Indexes	299	
11.3.7	Bibliographies	300	
11.3.8	Page layout	300	
11.3.9	Paper and ink	302	
11.4	Slides	303	
11.4.1	Introduction	303	
11.4.2	Information content	303	
11.4.3	Sources of material	304	
11.4.4	Size of originals	305	
11.4.5	Character size	305	
11.4.6	Lettering	307	
11.4.7	Layout of text	308	
11.4.8	Tables, graphs and diagrams	308	
11.4.9	Contrast	310	
11.4.10	The use of color	311	
11.4.11	Projection of slides	312	
11.4.12	Overhead projection	314	
11.5	Posters	314	
11.5.1	Introduction	314	
11.5.2	Content	314	
11.5.3	Size	315	
11.5.4	Character size	315	
11.5.5	Character style	316	
11.5.6	Layout for text	316	
11.5.7	Tables, graphs and diagrams	316	
11.5.8	Poster layout	320	
11.5.9	Artwork for posters	320	

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