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A Standardized Autopsy-Protocol—Problems and Solutions

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Summary. With the use of the pathologic-anatomical autopsy protocol the problem and the development of the optical mark reader form is described from its first conception as a standardized protocol in 1971 up to the final optical mark reader form. In the first phase, a standardized protocol with 2.055 questions was introduced at the Institute of Pathology of the University of Heidelberg and was tested about 4.500 autopsy cases. A detailed comparison between the information content of a free text protocol on the one hand and the standardized protocol on the other hand showed that the standardized protocol is more useful in getting detailed information in anatomic pathology. The relationships between the findings and the diagnoses on the one hand and the scale distribution and the possible classification of diagnostic interpretation on the other is discussed thoroughly. For the grouping of the parts of the optical mark reader form these results were of considerable importance. A program which transforms the data into a clear text in the German language belongs to the standardized protocol. This program is written in FORTRAN IV and needs a minimal storage area. Evaluation results as well as examples of text and program complete the paper.

Key words: Protocol — Optical Mark Reader Form — Free-text Synthesis — Diagnosis — Pathology.

Zusammenfassung. Anhand des pathoanatomischen Sektionsprotokolles wird ausführlich die allgemeine Problematik und der Werdegang eines Markierungsbeleges von seiner ersten Konzeption als standardisierter Erhebungsbogen im Jahre 1971 bis zum fertigen Markierungsbeleg beschrieben. In der ersten Entwicklungsstufe wurde ein standardisiertes Protokoll mit insgesamt 2055 Fragen eingeführt und an ca. 4500 Obduktionsfällen erprobt. Ein detaillierter Vergleich zwischen dem Informationsgehalt eines Freitextprotokolles und dem standardisierten Protokoll ergab, daß das standardisierte Protokoll zur Erhebung detaillierter Information auch in der pathologischen Anatomie besser geeignet ist. Ausführlich wird auf die Beziehungen zwischen Befund und Diagnose auf der einen sowie der Skalenaufteilung und der möglichen Zuordnung diagnostischer Interpretation auf der anderen Seite eingegangen. Für die Aufteilung der Gliederung des Markierungsbeleges waren diese Auswertungen von großer Bedeutung. Zum Protokoll gehört ein Klartextausdruckprogramm in Deutsch, das in FORTRAN IV geschrieben ist und mit einem sehr geringen Speicherplatz auskommt. Auswertungsergebnisse sowie Text- und Programmproben vervollständigen die Studie.

Schlüsselwörter: Protokoll — Markierungsbeleg — Klartextsynthese — Diagnose — Pathologie.

1. Special Problems of the Protocol in the Pathological Anatomy

It is an open secret that many institutes of pathology have not drawn up reports of obduction findings in years. The so-called autopsy protocol has silently vanished above all at local institutes of pathology. It was replaced by a "more detailed" pathological-anatomic diagnosis, which is supplemented by data on the "size and number" of some organ findings and includes some histological details. In drawing up a medical opinion, he who is continually required to consult these

reports is often disappointed at how little is to be gained from a diagnosis in itself accurate, which however fails to explain certain other problems perhaps not quite recognized at the time of the autopsy.

One of the main reasons that protocols are no longer written is that there is a lack of typists. Furthermore, the reason is given that one cannot always expect a future pathologist to sacrifice time and energy for protocollary work. There is much to be said to this point. The educational value of a good and extensive protocol cannot be praised highly enough. To our unforgotten professor of internal medicine from Kiel, Helmut Reinwein, we own the realisation of the famous Russian proverb: "What you have written with the pen, you cannot erase with the ax". This proverb is surely of genuine eternal worth. Every experienced editor knows that manuscripts which the author has not worked out by hand are much less concentrated and thus—in terms of the length of the written piece—the informational content is much less.

He who has—as a anatomo-pathologist with many years of professional experience, that is, at the most varied places of work and under the most diverse working conditions,—in peacetime and in wartime—, come to know *how much* can depend on a correctly drawn up written report of the results of a professionally executed autopsy, will regard with great uneasiness all attempts to fit findings into a preconceived pattern. There are many reasons, both factual and subjective, for the inner reserve, the intellectual objection of the professional to a "formalised protocol" (Höpker, 1972). The "knot of objections" is not easy to undo.

"Form" and "language" have been essentially interrelated since the time of Goethe's opera on the natural sciences. They embody the anthropomorphic form of expression in several respects: from a purely objective point of view, but also as a function of what one could term intellectual insight. By turning to operationalised problem-solving, a differentiated characterisation of the facts of a case must openly by foregone. It will only be possible to mention more detailed morphological findings in individual cases by means of an accurate and polished language.

The *Heidelberg Academy of Sciences* sponsors the programme "mathematical logic" with particular interest. The much-abused set-theory is developed on the basis of a "formal" language. The languages used by computer science in automata theory are simplified formal languages. The success of the mathematic logician in the precise composition of formal languages has been an impulse to linguists in their attempt to describe the structure of the natural forms of expression, thereby improving upon the traditional grammatical systems. We are of the opinion that the time has come for the "language of the pathologists" to entrust itself to a "generative" grammar.

Truly reliable autopsy reports can only be obtained if *during* the obduction all findings are dictated *immediately* to an experienced typist "into the typewriter" or "on tape". The best protocols are had when an experienced pathologist dictates all findings in the order in which they are determined to a well-trained typist, in clear language free of foreign terms, so that any educated layman can obtain a sufficiently accurate picture of the disease and the death of the deceased.

These techniques of our autopsy practice are *mastered* by only very few pathologists today. Material difficulties are also encountered (lack of qualified co-workers, diminishing of the so-called working hours). If one is thus forced to switch to the

writing of autopsy reports *after* the end of the obduction, then one should seriously consider the use of a formalised protocol.

Our group has been working on an optimal solution to this problem for 4 years. The stage of development now finally seems to have been reached which makes it possible to extrapolate from a "questionnaire" in which the pathologist has to mark in answers. This means than an accurately filled-in computer form provides the matrix for a protocol which is automatically expressed in formal language.

It will in future thus depend on the pathologist's conscientiously marking in the form. A "formalised protocol" will thus result, which certainly is not ideal but does contain a relatively greater amount of information than a conventional protocol drawn up by a not entirely experienced pathologist!

The following elucidates this astounding observation: Since there are probably foreign doctors working at all pathological institutes and it is above all for them that a linguistically perfect protocol provides extreme and sometimes insuperable difficulties, our experiment represents an "operationalised solution" to the problem, i.e. it frees the foreign pathologist from this serious hindrance. The "formal language" of our protocol possess a genuine *convertibility*: our Heidelberg protocol can without difficulty be transposed into any other scientific language,—also automatically.

In a time in which the special pathological anatomy is about to enter a new phase, due to the possibilities available in data processing, and in which it will probably be possible for pathologists—by abstracting the sum of their experiences—to finally and reliably set up a general morphological pathology, our formalised protocol appears as a "medium of exchange" of international communication in the field of scientific "currency". As long as, through the observations of the internist H. E. Bock (1968) and the pathologists E. Kirch (1956) as well as H. H. Jansen and R. Nedden (1972), autopsy examinations appear *indispensable*, all pains must be taken in order to—by means of a reliable protocol-technique which it will also be possible to use in smaller institutes—help in the formulation of universal laws of nature.

The standardized autopsy protocol was introduced at the Institute of Pathology of the University of Heidelberg in 1971 (Höpker, 1971). The first application was an investigation protocol of six pages. The descriptive findings of the investigated case were marked with a check. After a trial time of six months, a standardized autopsy protocol was formulated to satisfy the following formal and material conditions:

1. The protocol serves at the same time as a control for the data fed into the computer.

2. The marked information should be transformed into a complex and linguistic errorless "free" text in the German language.

3. From the evaluation of information criteria we expected an answer to the following questions:

a) Is a standardized protocol comparable to a free-text protocol with the advantages of the latter?

b) Are we able to give a quantitative description of the correlations between findings and diagnosis in anatomic pathology with the help of this standardized protocol?

4. Furthermore a smooth transition between the standardized protocol and the planned optical mark reader form was required.

We shall describe our experiences with the standardized protocol from the practical and the theoretical view, i.e. loss of information compared to the free-

text protocol and the problems of the best scaling. We shall discuss some correlations between the gross anatomical findings and the diagnoses; further we shall give a detailed description of the text synthesis program. On request this program can be sent either on a magnetic tape or on computer cards for a minimal charge.

2. Experiences with the Standardized Protocol

The standardized protocol has been in use since January 1, 1972 and has been used up to now for about 4500 autopsies. This detailed protocol contains on 22 pages a maximum of information obtainable with the help of a general protocol. This information is in general the maximum required from the pathologist. All in all the protocol consists of 2.055 questions with 4.943 possible answers. The length of the protocol is due to the attempt to test the relevance of the marked information against the diagnoses recorded at the same time. Furthermore we were able to compare the advantages and the drawbacks of the standardized protocol with those of the free-text protocol in use up to that time.

Many pathologists found to be very bothersome and said that it most especially hampered their own flow of ideas when they had to mark stereotype questions irrelevant to the case being examined. Because the number of irrelevant findings ("zero-findings") is dependent upon the degree of differentiation and therefore upon the length of the protocol, the total number of irrelevant findings to be marked is very high in the present standardized protocol. The tiring effect on the pathologist is proportional to the length—in general. It is therefore not surprising that about a third of the pathologists have marked irrelevant findings only sporadically (between 70 and 95% of all irrelevant findings).

A further disadvantage was mentioned often: complex relationships could not be marked with the desired accuracy or in the manner the pathologist desired (for example: condition after several gastric or intestinal operations, the simultaneous existence of bronchopneumonic lesions and infarct foci in the lung). Therefor, we included some space for additional handwritten notes after every chapter. (A chapter is in general limited to an organ or an organ system). But these possibilities were used seldom. In our opinion, this was mostly because these data have to be written again in the summary of the patho-anatomical diagnoses.

Many pathologists complained about the length of time necessary to mark all the information. In general they needed one hour per case. However, one of us (H.) marked most of his cases in 10 minutes, seldom did he need more than 20 minutes.

According to these experiences, the desired optical mark reader form should be changed as follows:

1. It must be shortened.

2. The marking of the irrelevant findings must be reduced to a tolerable extent. However, this must be done with minimal loss of information.

3. Complex relationships must be included briefly.

3. Comparison of the Free-Text and the Standardized Protocol

In comparing the free-text protocol with the standardized protocol we studied 51 findings. We looked for the data in both protocols of the same experienced pathologist. In this investigation we distinguished the following groups:

0: information not existing,
1: complete information existing,
2: incomplete information existing,
3: information can be presumed from the context,
4: organ, organ system or finding not checked,
5: additional written information (only standardized protocol).

We selected 100 protocols at random from six different pathologists written within a time interval of 2 years and checked them over. The main investigation was focused primarily on the side findings, i.e. those findings which are unimportant for the diagnoses of an autopsy in explaining the cause of death, or those diseases correctly connected with the cause of death. An earlier comparison of the main findings showed the equivalence of the free-text protocol and the standardized one. For example, the description of myocardial infarctions due to age and the extent of the organic change showed that the standardized had a slight advantage over the free-text protocol. But in general the side findings are more important for the statistical analysis than the main findings, although up to now there are no critera for the statistical quality of side findings.

As shown in Table 1 the non-existent information in the standardized protocol is only 1/10 of the corresponding part of the free-text protocol. Therefore, the percentage of complete information in the standardized protocol is nearly twice as high as in the free-text protocol. The incomplete information, the information which can be extracted from the context and the part of the examinations not checked remained nearly the same in both protocols. It is remarkable that the statement "not checked" increased from 36 (free-text protocol) to 58 (standardized protocol). Obviously the gain in information lies not only in the increase of positive findings but also in the improvement of the quality of findings, i.e. in this case based on the "honesty" of the data.

In a further investigation, we tried to correlate the content of information of the free-text protocols with the standardized protocols of the same pathologists. It was noted that those pathologists who had written a free-text protocol with more information in general also marked the data of the standardized protocol better than others. These pathologists had the greatest increase of information too, which was up to 42% of the investigated 51 informations data.

Table 1. Comparison of the standardized and free-text protocol

	Data not present	Data completely present	Data incomplete	Data to be presumed from the context	Not checked	Extra
	0	1	2	3	4	5
	%	%	%	%	%	%
Standardized Protocol	253 4,9	4299 84,3	299 6,0	133 2,6	58 1,1	58 1,1
	%	%	%	%	%	
Free (dictated) Protocol	2215 43,5	2503 49,0	252 5,0	94 1,8	36 0,7	—

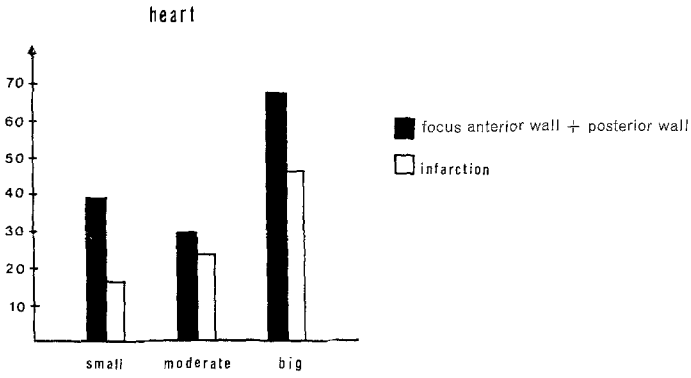

Fig. 1

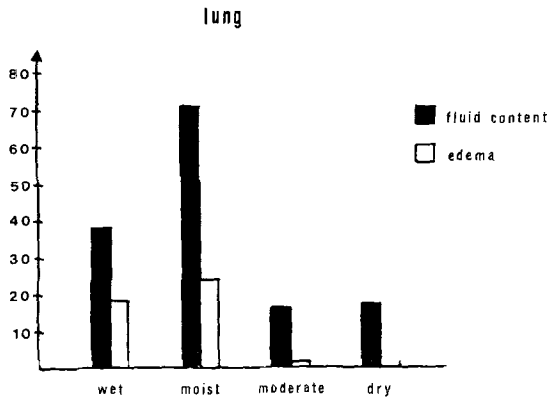

Fig. 2

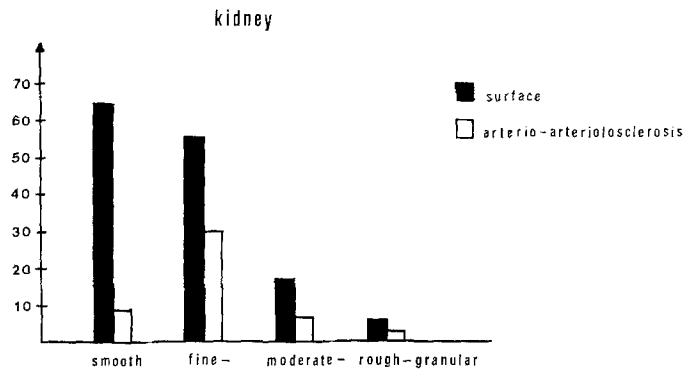

Fig. 3

Figs. 1—3. Correlations between findings and diagnoses. The correlations of the corresponding diagnoses are close. The scales show only 3 or 4 rows each

4. Correlations between Findings and Diagnoses

Formal and contextual correlations between findings and diagnoses are closely connected with the type of scales used in the findings (Höpker *et al.*, 1973). Therefore

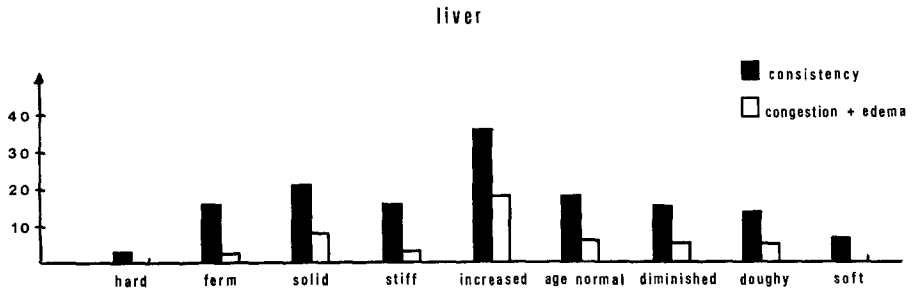

Fig. 4

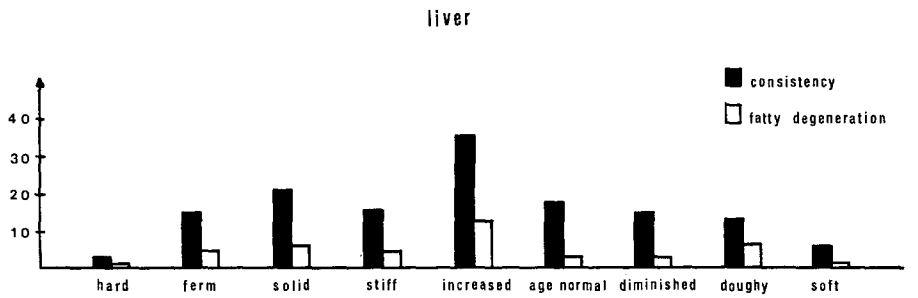

Fig. 5

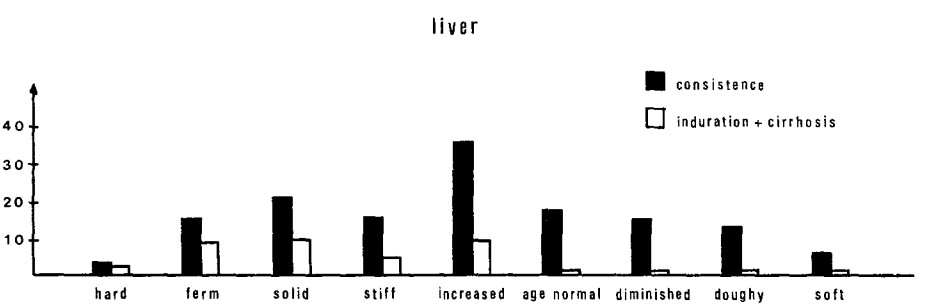

Fig. 6

Figs. 4—6. Correlations between findings and diagnoses. The scale with 9 rows is too wide and differentiated, the number of cases decreases rapidly in the different classes

we considered the question of whether the distribution of the findings according to the different scales is sufficient for a statistical analysis and wheter in certain, very simplified single cases we could find gross relationships between findings and diagnoses. The Figs. 1–3 show the correlations between finding and diagnosis. The scales have only 3 or 4 rows each. The correlations of the corresponding diagnoses are close. Furthermore the frequency distribution of the autopsy cases due to the findings on the one hand and the diagnoses on the other hand is so good that there was no necessety to change these scales. We could transform them without any essential change in the optical mark reader form.

However, many other findings show a different situation. In the Figs. 4–6 the findings of the consistency of the liver are plotted against the diagnoses "fatty

I. Äußere Besichtigung

A. Zeichen des Todes: keine–Totenflecke; Extremitäten–Stamm–Auflage–abhängige Partien nicht–wegdrückbar
Totenstarre: obere–untere Extremitäten nicht–gelöst
Körpertemperatur: ausgekühlt/warm

B. Körperbau: Pykniker/Athlet/unauffällig/Astheniker/leptosom

C. Ernährungszustand: stark/deutlich/leicht adipös/Altersnorm/reduziert/kachektisch

D. Muskulatur: kräftig/Altersnorm/atrophisch

E. Haut: Tätowierungen am rechten Ober- u. Unterarm
keine–Hämatome/Blutungen wo:
keine–Hautabschürfungen/Wunden wo:
keine–Narben wo:
Operations–Wunden/–Narben: frisch (bis 7 d) / älter (bis 30 d) / alt (mehr als 30 d) Re Ober- und re Unterbauch
primär/sekundär verheilt
keine–Drainage wo:
Kolorit: hell–mittel/dunkel–braun/gelb/grau kein–Ikterus
Zustand nach zeitlich zurückliegender Appendektomie + Cholecystektomie.

F. Behaarung:
Kopf: hell–mittel–dunkel/grau–blond–braun–schwarz/voll–gelichtet–fehlend
kein–Hirsuitismus
Axillae: Altersnorm/reduziert/fehlend
Körper: männlicher Typ/Altersnorm/weiblicher Typ nicht–vermindert
Scham: männlicher Typ/Altersnorm/weiblicher Typ nicht–vermindert

G. Kopf:
Augen: halb/ganz–offen/geschlossen
Pupillen: rechts: weit/mittelweit/eng–seiten–un–gleich
links: weit/mittelweit/eng–seiten–un–gleich
rechts/links–größer/kleiner–rechts/links
Iriden: grau/grün/blau/braun kein–Arcus senilis
Skleren: grau/blau/weiß/ikterisch
Konjunktiven: nicht–gereizt
Mund: nicht–geschlossen kein–Fremdinhalt
Gebiß: vollständig/lückenhaft/fehlend nicht–/teil–saniert
keine–Teil–/Voll–/Prothese keine–Zahnstümpfe /Zahnhälse nicht–freiliegend
Nase: kein–Fremdinhalt
Ohren: rechts: kein–Fremdinhalt
links: kein–Fremdinhalt

a

Fig. 7a and b. First part of the standardized protocol: external inspection. The figures show the checked protocol form and the computed text consisting of the same information

degeneration", "hyperaemia and oedema", "induration and cirrhosis". The scale with 9 rows is very wide and differentiated, accordingly the number of cases very rapidly decreases in the different classes. As can be seen there is no clear peak as the Figs. 1–3 show. The reasons for these phenomena are the following:

1. AEUSSERE BESICHTIGUNG

AUSGEKUEHLTER LEICHNAM EINES 70-JAEHRIGEN MANNES VON UN-
AUFFAELLIGEM HABITUS UND LEICHT ADIPOESEM ERNAEHRUNGSZU-
STAND. LEICHENSTARRE IST AN ALLEN GELENKEN AUSGEBILDET.
NICHT WEGDRUECKBARE TOTENFLECKE AN DEN EXTREMITAETEN, AN
DEN ABHAENGENDEN PARTIEN UND AM STAMM. MUSKULATUR ALTERS-
ENTSPRECHEND. HAUT VON NICHT IKTERISCHEM, HELLGRAUEM KOLO-
RIT. NARBEN VORHANDEN. PRIMAER VERHEILTE ALTE OPERATIONS-
NARBEN. DAS KOPFHAAR IST GELICHTET UND HELLGRAU. DIE AXIL-
LARBEHAARUNG IST ALTERSGERECHT AUSGEBILGET. VERMINDERTE TY-
PISCH MAENNLICHE KOERPER- UND SCHAMBEHAARUNG. DIE GANZ GE-
OEFFNETEN AUGEN ZEIGEN SEITENGLEICHE PUPILLEN, BEIDE SIND
MITTELWEIT. KONJUNKTIVEN REIZLOS, SKLEREN WEISS, IRIDEN
GRAU, MIT ARCUS SENILIS. IM GESCHLOSSENEM MUND FINDET SICH
KEIN FREMDINHALT. MUNDHOEHLE ZAHNLOS. KEINE PROTHESE, BEIDE
OHREN FREI VON FREMDINHALT. NASE FREI. GUT SICHTBARE EIN-
FLUSSSTAUUNG DER VENEN IM HALSBEREICH. INJEKTIONSMALE FIN-
DEN SICH RECHTS. BRUSTKORB FASSFOERMIG IM GANZEN STARR.
RIPPENKNORPEL VERKNOECHERT, SCHMALER EPIGASTRISCHER WINKEL.
RIPPENFRAKTUREN VORHANDEN. BEIDE MAMMAE DIFFUS WEICH. ACH-
SELLYMPHKNOTEN BEIDERSEITS REGELRECHT UND WEICH. AM BRUST-
KORB KEINE INJEKTIONSMALE UND KEINE ZEICHEN EINER REANIMA-
TION. DIE BAUCHDECKEN SIND SCHLAFF UND BEFINDEN SICH UNTER
THORAXNIVEAU. DER NABEL IST GEPFLEGT UND REIZLOS. GENITO-
ANALREGION REIN, AM AFTER FINDEN SICH AEUSSERE HAEMORRHOI-

Fig. 7b

1. The superimposing of different phenomena of the finding. The findings are correlated with the diagnoses plotted according to weight. For example the oedema of the liver can be lead to an increase of this consistency as well as of its induration.

2. Difficulties in the definition of the findings. The point from which, for example, the change in the consistency of a liver may be considered to be "doughy" is quite fixed at the same institute, but the system of findings to be used may be to small or not adaquate. For example, the fatty degeneration of the liver is more than the epithelial vacuols found in a routine microscopic investigation.

3. Lastly, interaction-phenomena between a pre-established system of classification of findings and a similar "arbitrary" classification of diagnoses. "Arbitrary" in the sense that both classifications are founded on preformed information which cannot be excluded totaly through these correlations.

5. Free-Text Synthesis

A program system TESY (TExt-SYnthesis) was written to transform the marked data into a linguistically corrected text in the German language. This program system satisfies the following conditions:

1. To get the widest compatibility, TESY is written in FORTRAN IV.

2. TESY is not dependent on the contents of text data nor on the hardware of the input and the output (it may be used for doctors' summary of findings from different specialist lines).

3. The requirements for the size of the memory and the periphery are minimal. For example, the first version of the program ran on an IBM 360/30 with memory size of 48k Bytes.

4. Missing or wrong information can be omitted or transduced to the "normal" findings with the help of a variable text synthesis.

5. For later statistical analysis, the data are already scaled and can be stored on a magnetic tape or disc.

	Pleura visceralis:	spiegelnd/verdickt nicht–fibrinös/eitrig belegt keine–Schwarte keine–Heller'sche Knötchen keine–primären/sekundären Tumorabsiedlungen solitär/multipel
	Bronchien:	
	Inhalt:	leer/keine–Aspiration Schaum/Schleim/Eiter/Blut
	Weite:	sackförmig/zylindrisch/weit/Altersnorm/eng keine–Querzeichnung
	Schleimhaut:	verdickt/samtartig/zart/vermindert/atrophisch/nekrotisch
	Farbe:	hell/mittel/dunkel–rosa/rot/rost/braun/gelb/grau keine–primären/sekundären Tumorabsiedlungen solitär/multipel
	Arterien:	
	Inhalt:	leer/flüssiges Blut/Speckhaut/Cruor ~~Thromben/Emboli kleine/mittlere/große Äste solitär/multipel~~
	Weite:	weit/Altersnorm/eng
	Intima:	zart/nicht–konfluierende Einlagerungen solitär/multipel
	kleine Gefäße:	nicht/mäßig/stark über Schnittfläche hervortretend
	Venen:	nicht–frei
B. Herz		keine–Mißbildungen keine–Operation
	Größe:	größer/gleich/kleiner als die rechte Leichenfaust
	Epicard:	spiegelnd/verdickt nicht–fibrinös/eitrig belegt frisch/älter/alt
	Fettgehalt:	stark–vermehrt/Altersnorm/stark–vermindert keine/kleine/größere/konfluierende Blutungen solitär/multipel
	Herzskelett:	nicht/mäßig/stark dilatiert
rechts:	Vorhof:	
	Inhalt:	leer/flüssiges Blut/Speckhaut/Cruor/Thromben/Emboli Herzohr: keine–Thromben
	Weite:	nicht/mäßig/stark erweitert Muskulatur nicht–verbreitert
	Endocard:	zart/fibrosiert glatt/geriffelt keine–Blutungen keine–Auflagerungen frisch/älter/alt
	Foramen ovale:	geschlossen/Sonden–/schlitzförmig–/weit–offen
	Kammer:	
	Inhalt:	leer/flüssiges Blut/Speckhaut/Cruor/Thromben/Emboli
	Weite:	kontrahiert/Altersnorm/mäßig–/stark–erweitert
	parietales Endocard:	zart/fibrosiert keine–Blutungen
	Klappen:	Pulmonalklappe: . 8 . . cm . . . . . QF (2) zart/Auflagerungen keine–Stenose/relative–Insuffizienz Tricuspidalklappe: . 13 . cm . . . . . QF (2) zart/Auflagerungen keine–Stenose/relative–Insuffizienz
	Myocard:	
	Stärke:	. . 6 . mm Trabekelrelief stark/mäßig–betont/Altersnorm/flach
	Konsistenz:	fest/brüchig
	Schnitt:	keine–Herde klein/mittel/groß–vereinzelt/dissiminiert frisch/älter/alt
	Farbe:	hell/mittel/dunkel–rosa/rot/lehm/rost/braun
	Papillarmuskeln:	sehr–kräftig/Altersnorm/schwach nicht/mäßig/stark–fibrosiert keine–primären/sekundären Tumorabsiedlungen solitär/multipel

a

HERZ

DAS HERZ ZEIGT KEINE MISSBILDUNGEN. ES IST GROESSER ALS DIE RECHTE LEICHENFAUST. EPICARD SPIEGELND UND NICHT BELEGT, KEINE BLUTUNGEN. ALTERSGERECHTES HERZFETTPOLSTER, BEI IM GANZEN MAESSIG DILATIERTEM HERZSKELETT. DER RECHTE VORHOF HAT FLUESSIGES BLUT ZUM INHALT, DAS HERZOHR IST FREI. ANSCHNITT DES MAESSIG AUSGEWEITETEN VORHOFES IST NICHT VERBREITERT. GESCHLOSSENES FORAMEN OVALE. OHNE AUFLAGERUNGEN, ERSCHEINT DAS ENDOCARD FIBROSIERT, GLATT, OHNE BLUTUNGEN. RECHTE KAMMER MAESSIG ERWEITERT UND ENTHAELT FLUESSIGES BLUT, BEI FIBROSIERTEM PARIETALEM ENDOCARD . DIE 80 MM WEITE, ZARTE PULMONALKLAPPE IST UNAUFFAELLIG. TRICUSPIDALIS 130 MM WEIT, VON ZARTER BESCHAFFENHEIT, RELATIV INSUFFIZIENT. WANDSTAERKE RECHTS VON 6 MM, BRUECHIGES MYOKARD MIT MAESSIG BETONTEM TRABEKELRELIEF. DIE HELL BRAUNE SCHNITTFLAECHE IST FREI VON HERDEN. KRAEFTIG AUSGEBILDETE PAPILLARMUSKELN MIT MAESSIGER FIBROSIERUNG. KEINE TUMORABSIEDLUNGEN SIND VOR-

b

Fig. 8a and b. Corresponding parts of the standardized protocol (chapter "heart") and text synthesis

B. Oberschenkel (rechts)

Form:	nach—außen—/innen gekrümmt Coxa vara/Altersnorm/Coxa valga
Schnitt:	
Corticalis:	schmal/Altersnorm/breit Kalkgehalt vermehrt/Altersnorm/vermindert
Konsistenz:	flüssig/gelatinös/glasig/fest
	hyperplastisch/aktiviert/Altersnorm/Fettmark trocken/feucht
	keine—Herde
	keine—primären/sekundären Tumorabsiedlungen solitär/multipel
Gelenkflächen:	
Hüfte:	nicht—unauffällig
Knie:	nicht—unauffällig

a

TONTEN HORIZONTALEN KNOCHENBAELKCHEN, DECKPLATTE NORMAL
BREIT MIT RANDSPANGENBILDUNG . KEINE TUMOREN VORHANDEN.
ZWISCHENWIRBELSCHEIBEN ALTERSGEMAESS BREIT, NICHT PROLA-
BIERT.

OBERSCHENKEL (RECHTS)

RECHTER FEMUR NACH AUSSEN GEKRUEMMT, SCHENKELHALSSCHAFTWIN-
KEL IN NORMALSTELLUNG. AUF DEM SAEGESCHNITT CORTICALIS AL-
TERSENTSPRECHEND, MIT NORMALEM KALKGEHALT. GELATINOESES,
AKTIVIERTES, MARK. ES WEIST KEINE TUMORABSIEDLUNGEN AUF.
HERDE NICHT VORHANDEN. UNAUFFAELLIGE HUEFTGELENKSFLAECHEN,
KNIEGELENK NORMAL.

b

Fig. 9a and b. Last chapter (femur, right) of the standardized protocol. Note: this protocol belongs to 11 pages free-text synthetized by the computer

At the moment TESY exists in the following form:

1. Data input: card reader or optical mark reader form;
2. Data output: magnetic tape, disc;
3. Text output: line printer (only capital letters);
4. Text storage: disc
5. Installation: IBM/370-125 under DOS-VS
6. Minimal storage need: About 40 kB for a shorter text (around 1 page DIN A 4) with the help of superimposing. With the memory of about 72 kB and superimposing, the length of the text may be of any size desired.

The TESY program consists of a main program, subprograms regarding the —logical—text problems and subprograms belonging to the system. The text synthesis itself is carried out from the subprograms regarding the problems. These "problem subprograms" have to be generated for each new application.

The running of the program includes three steps:

1. The variable text output must be generated before TESY can be used for a specific problem. The program to generate the text is stored together with the next on a disc.—For a better overall view we chose the following scheme: a "chapter" results each time in a half or one page of a printed text. In most cases this is a description of an organ or an organ system. According to the lines in the standardized protocol, i.e. the partition of the scales, a chapter consists of 20–80 blocs each. Each bloc generates a whole or only a part of a text sentence.

2. The blocs consist of fixed, alternative or cumulative elements. These elements can be combined in every possible way, can be omitted or also concluded. Then the data of the text is stored as desired (separation of syllables, ec).

3. In the performed program structure of the bloc subprograms, the part of the program regarding the problems including the taking-over of the data, data checking and text generation is carried out.

In Figs. 7–9 we have put together several protocol texts with the corresponding patterns. Please note, how missing or incomplete information is skipped or the corresponding parts of the text are summarized.

6. Optical Mark Reader Form

To generate the optical mark reader form for the findings of the autopsies we used:

1. The experience from the about 4.500 marked standardized autopsy protocols,

2. a detailed comparison of the information content between the standardized and the free-text protocol,

3. the results from the correlations between findings and diagnoses with the corresponding data of the performed scale partition,

4. a detailed program system for the text synthesis.

The optical mark reader form is arranged like the standardized protocol more or less follows the course of autopsy. Mostly in consideration of later evaluation, the two big groups of disease—the neoplasm and the degenerative vascular disease including their secondary diseasess—have taken up much space. Together with the so-called head data and the organ weights, the circumference of the valves, the cavity fluids, which have to be written down in clear text, all in all 416 questions have to be answered (if all findings are positive). In our experience about 250–300 answers have to be given in an average case.

The reduction of the earlier reported 2.055 questions of the standardized protocol with its 4.843 possibilities of ansers to the 416 questions of the optical mark reader form was undertaken in oder to satisfy the following conditions:

1. The data have to be so differentiated that the peculiarity of the individual case can be described.

2. The value of the information in the scales has to be important.

3. The classification of the findings has to allow a later correlation with the corresponding diagnoses.

Without any doubt the optimal improvement of these scales has only weak correlations to the conditions listed above. The experience and the results of the standardized protocol up to the influence not so much the length of the single chapters but more the structure and the differentiation of the scales and the contents of the protocol itself. In this way the protocol, even in the size of the optical mark reader form, reflects the autopsy practise of the Institute of Pathology in Heidelberg.

The size of optical mark reader form was chosen in such a way that the form itself should consist only of *one* page containing the fields and areas of numbers to be marked. Weights of organs as well as the other data with different lengths of numbers (autopsy and biopsy number, age, circumference of the valves, cavity fluids ec.) have to be written down in numbers, which can be automatically fed

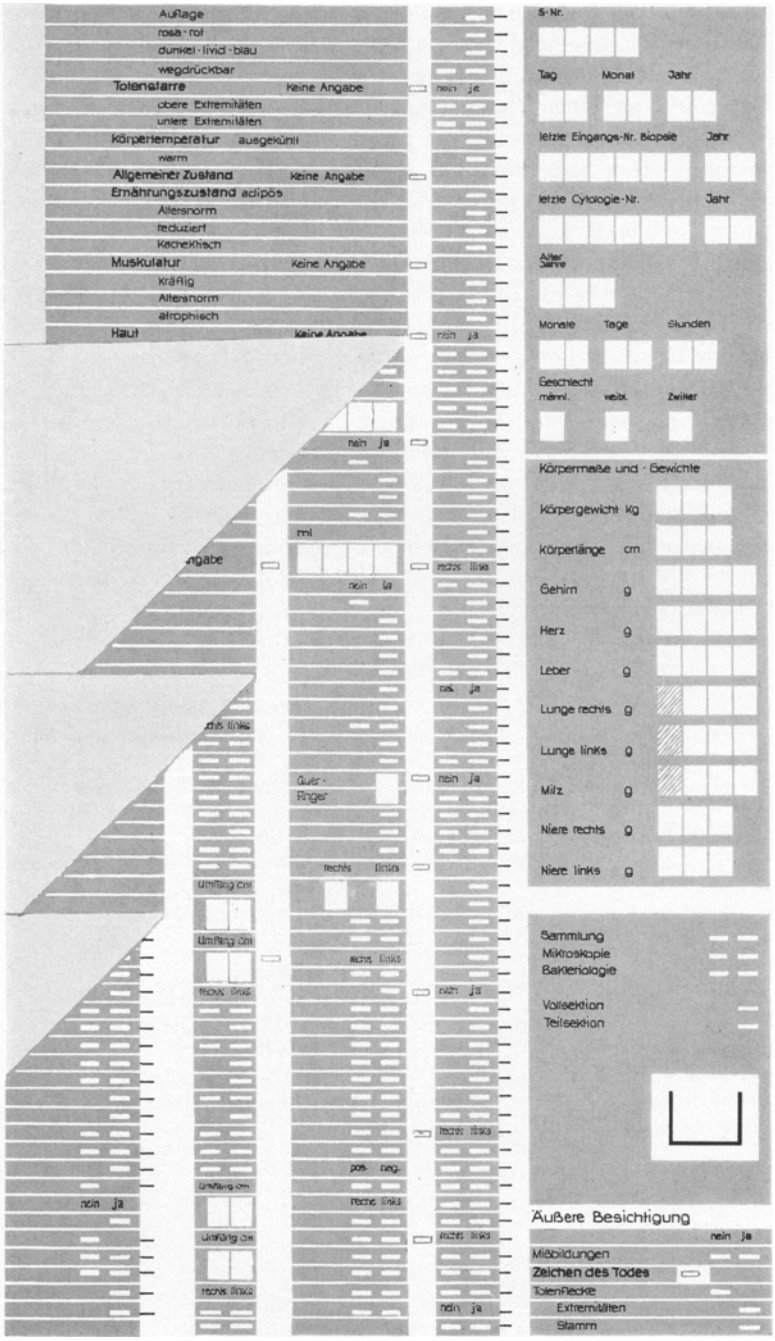

Fig. 10. Part of the optical mark reader form. On the right there are the areas for numera information, on the left the covering pages with instructions ("scales")

into the optical mark reader as well as the information marked with the horizontal pencil lines. Special attention was given to the color and the spatial arrangement of the fields. Here we considered not only arguments for easier programming or the information content but mostly psychological factors. The solution to all these problems was the printing of the explanations of the corresponding areas on several pages, which cover each other. These pages can be turned over to the left. In this way the information is devided and can be marked in a way easy to remember. The printed picture and the partition of the tables are also arranged according to present menomotechnic knowledge (Fig. 10).

To mark the information, the optical mark reader form is inserted into a special plastic covering and the information is marked from the right to the left side row by row. When a row is finished, the corresponding covering page ("scale") is turned to the left and the next row can be marked. After filling out the last row, the form is separated and the covering part is thrown away. Therefore we receive from each autopsy protocol only one page. This form is fed into an optical mark reader (IBM 1288 model 1) and the information is stored on a magnetic tape. From this magnetic tape the free-text protocols are computed and printed out as already described. The length oft the free-text protocol in this version amounts about 3–4 pages DIN A 4 as compared to more than 12 pages of the standardized version used up to now. The data stored on the magnetic type are suitable for further statistical investigations.

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