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7. Approaches towards a Combined Data- and Knowledge-base for Analytical Quality Specifications in Clinical Chemical Laboratories

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INTRODUCTION

It is not realistic to believe that the management of every clinical chemical laboratory is willing to go through literature and reports and try to collect all clinical and technical background material for estimating numerical values of 'clinical goals' and for listing the 'quality specifications' for all kinds of measurements of their laboratory. As the clinical and especially the technical background material has a rapid turnover time it seems to be most suitable to collect the material in continuously updated computerized database systems.

A complete database ought to cover several hundred different types of components and the measurement of each component may be applied in many different clinical situation. It is thus not possible - in this report - to build up an extensive database. I have, however, in this preliminary list tried to present a number of different and illustrative examples, which can be used as models for an extended list and finally a real database.

A database for this purpose will always contain two types of data:

1. those describing the (analytical) measurement procedures and
2. those describing the clinical (and the normal) situations in which it is appropriate to apply the measurement procedure.

Quality assurance specifications and quality control procedures will come out as consequences of these two types of data. We have found it most appropriate in this presentation to use System--Measurand (Analyte) as the primary key in our data base. In many clinical settings one kind of measurement (analysis) is not giving the diagnosis or the advice for treatement. In such circumstances one or more clinical situtations must be defined.

Furthermore, in one clinical situation, it may be necessary to use the measurand in combination with a set of other measurands - from the clinic, the diagnostic radiology department and the clinical laboratories. This may turn up to be a very complex assessment. Examination of a few key-examples will, however, soon learn us to draw conclusions, valid for a number of analogous examples.
I am confident that we in the future will see several groups working with combined data- and knowledge-bases within this area and we feel sure that computerized such bases is an excellent medium for rapid exchange of information and knowledge.

EXAMPLES OF COMBINED DATA- AND KNOWLEDGE-BASES FOR AQSpecs

The following list have been written using the dataprogram Microsoft Excel® 3.0. This program does not allow writing characters as subscripts, instead they have been written within [ ]. The abbreviation c* has been used for the 'conventional true value'. The measurands are listed in alphabetic order. In each segment clinical goals calculated in different ways are listed first, followed by recommendations from proficiency testing bodies. A few examples have been given: S--Creatinine, B--Haemoglobin and S--Urate, in which the clinical goals have been expressed as fractions of easily understandable physiological functions or by logical reasoning obtained pathological processes.

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	A	B	C	D
1				
2	**S--ALBUMIN**			
3				
4				*Numerical values (random errors)*
5	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.012
6	**Clinical goals**	**Biol/Clin. app.**	transfer of ref. values	CV[A]<0.04 (bias 0);=0 (bias 0.02)
7				
8	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.014 (0.018)
9	**Anal. Qual. Sp.**	**US prof. test.**		
10				
11	**Pt(U)--ALBUMIN, massrate**			
12				
13				*Numerical values (random errors)*
14	**Clinical goals**	**Accep. anal. perform.**	technical consideration	CV[A]<0.10
15				
16	**P--ALLOPURINOL + OXIPURINOL**			
17				
18				*Numerical values (random errors)*
19	**P-ALLOPURINOL**			
20	**Clinical goals**	**biomed. model**	estim. param. k[A31]	CV[A]<0.04
21	**P-OXIPURINOL**			
22	**Clinical goals**	**biomed. model**	estim. param. k[A31]	CV[A]<0.04
23				
24	**S--BILIRUBIN**			
25				
26				*Numerical values (random errors)*
27	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.094
28	**Clinical goals**	**Biol/Clin. app.**	interview clinicians	CV[A]<0.11
29				
30	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.11
31	**Anal. Qual. Sp.**	**US prof. test.**		
32	**Anal. Qual. Sp.**	**German Ringvers.**		CV[A]<0.07
33				
34	**S--CALCIUM**			
35				
36				*Numerical values (random errors)*
37	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.008
38	**Clinical goals**	**Hypercalcemia**	differencial diagnosis	CV[A] 0.01-0.02
39				
40	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.009 (0.015)
41	**Anal. Qual. Sp.**	**US prof. test.**		
42	**Anal. Qual. Sp.**	**German Ringvers.**		CV[A]<0.033
43				
44	**S--CHOLESTEROL**			
45				
46				*Numerical values (random errors)*
47	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.04
48	**Clinical goals**	**Biol. approach**	total biol variation	
49	**Clinical goals**	**Hyper-**	within & total biol var.	CV[A]<0.03
50	**Clinical goals**	**cholesterol-**	within & total biol var.	CV[A]<0.02
51	**Clinical goals**	**emia**	within & total biol var.	CV[A]<0.03
52				
53	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.027
54	**Anal. Qual. Sp.**	**US prof. test.**		
55	**Anal. Qual. Sp.**	**German Ringvers.**		CV[A]<0.06
56	**Anal. Qual. Sp.**	**US Educ. Prog.**		CV[A]<0.03

	E	F	G
1			
2			
3			
4	*Numerical values (system. errors)*	*Note*	*References*
5	Bias unchanged	CV[A]<½CV[Bw]	3
6			12
7			
8	Deviation <0.011 (0.028) c*		9
9	Deviation<0.10 c*	Imprecision included	20
10			
11			
12			
13	*Numerical values (system. errors)*	*Note*	*References*
14		Interval 10-40 mg/d	
15			
16			
17			
18	*Numerical values (system. errors)*	*Note*	*References*
19			
20		Insensitive to changes in bias	19
21			
22		Insensitive to changes in bias	19
23			
24			
25			
26	*Numerical values (system. errors)*	*Note*	*References*
27	Bias unchanged	CV[A]<½CV[Bw]	2
28	Deviation<0.10 c*		13
29			
30	Deviation< 0.098 c*		9
31	Deviation<0.20 c* or <6.84 umol/L	Imprecision included	20
32	Deviation < 0.21 c*		1
33			
34			
35			
36	*Numerical values (system. errors)*	*Note*	*References*
37	Bias unchanged	CV[A]<½CV[Bw]	7
38	Bias < 0.02 c*		11
39			
40	Bias changed <0.007 (0.018)		9
41	Deviation <0.25 mmol/L	Imprecision included	20
42	Deviation< 0.10 c*		1
43			
44			
45			
46	*Numerical values (system. errors)*	*Note*	*References*
47	Bias unchanged	CV[A]<½CV[Bw]	7
48	Deviation <0.38 c*	CV[A]<1/4CV[B]	7
49	Bias = 0	2 controls/series	21
50	Bias < 0.03	2 controls/series	21
51	Bias < 0.03	4 controls/ser;2 pat samples	21
52			
53	Deviation <0.041 c*		9
54	Deviation <0.10 c*	Imprecision included	20
55	Deviation < 0,18 c*		1
56	Deviation< 0.03 c*		16

	A	B	C	D
57				
58				
59	**S--CREATININE**			
60				*Numerical values (random errors)*
61	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.022
62	**Clinical goals**	**Biol. approach**	total biol variation	
63	**Clinical goals**	**Renal**	interview clinicians	CV[A]<0.025
64	**Clinical goals**	**insufficiency**	interview clinicians	CV[A]<0.014
65	**Clinical goals**	**Renal**	RGF decrease> 15%	CV[A]<0.036
66	**Clinical goals**	**insufficiency**	RGF decrease> 15%	CV[A]<0.051
67				
68	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.022
69	**Anal. Qual. Sp.**	**US prof. test.**		
70	**Anal. Qual. Sp.**	**German Ringvers.**		
71				
72				
73	**S--FERRITIN**			
74				*Numerical values (random errors)*
75	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.075
76				
77				
78	**S--FERRITIN + TIBC**			
79				*Numerical values (random errors)*
80	**S-FERRITIN**	**Screening haemachro-**	Mean and CV[B] for	CV[A] = 0.056
81	**Clinical goals**	**matosis in a general**	healthy and non-	
82	**S-TIBC**	**population with pre-**	diseased homo-	CV[A] = 0.059
83	**Clinical goals**	**valence 0.003**	zygotes	
84				
85				
86	**B--HAEMOGLOBIN**			
87				*Numerical values (random errors)*
88	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.014
89	**Clinical goals**	**Anemia due to**	interview gen. praction	CV[A] <0.028
90	**Clinical goals**	**blood**	interview gen. praction	CV[A] <0.028
91	**Clinical goals**	**loss**	loss >0.08 blood vol.	CV[A] <0.024
92				
93	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.012
94	**Anal. Qual. Sp.**	**US prof. test.**		
95				
96				
97	**Hb(B)--HAEMOGLOBIN AIc**			
98				*Numerical values (random errors)*
99	**Clinical goals**	**Biol/Clin. app.**	interview clin.+ CV[Bw]	CV[A]<0.037
100	**Clinical goals**	**Biol/Clin. app.**	interview clin.+ CV[Bw]	CV[A]<0.036
101				
102				
103	**S--IRON**			
104				*Numerical values (random errors)*
105	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.10
106				
107	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.16
108	**Anal. Qual. Sp.**	**US prof. test.**		
109	**Anal. Qual. Sp.**	**German Ringvers.**		

	E	F	G
57			
58			
59			
60	*Numerical values (system. errors)*	*Note*	*References*
61	Bias unchanged	CV[A]<½CV[Bw]	7
62	Deviation< 0.046	CV[A]<1/4CV[B]	7
63	Bias unchanged	Detect +0.17; Prob. 99%	8, 17
64	Dev. <0,16c* when CV[A] 0.036	Detect+0.16;Prob. 95%	14
65	Bias unchanged	CV[Bw]=0.04; Prob. 95%	5
66	Bias unchanged	2 pat samples	5
67			
68	Deviation < 0.028 (0.044) c*		9
69	Deviation<0.15 c* or <26,5 umol/L	Imprecision included	20
70	Deviation<0.18 c*	Imprecision included	10
71			
72			
73			
74	*Numerical values (system. errors)*	*Note*	*References*
75	Bias unchanged	CV[A]<½CV[Bw]	7
76			
77			
78			
79	*Numerical values (system. errors)*	*Note*	*References*
80	Bias unchanged	The two analyses combined.	
81		Prob.99%. Predictive value	22
82	Bias unchanged	of a positive result 0.29.	
83			
84			
85			
86			
87	*Numerical values (system. errors)*	*Note*	*References*
88	Bias unchanged	CV[A]<½CV[Bw]	8
89	Bias unchanged	CV[Bw]=0.027; Prob.95%	18
90	Bias unchanged	CV[Bw]=0.024; Prob.95%	8
91	Bias unchanged	CV[Bw]=0.027; Prob.95%	4
92			
93	Deviation<0.012 c*		9
94	Deviation <0.07 c*	Imprecision included	20
95			
96			
97			
98	*Numerical values (system. errors)*	*Note*	*References*
99	Bias unchanged	Detect+/-1%HbA1c; Prob.0.80	15
100	Bias unchanged	Detect+/-2% HbA1c; Prob.0.99	15
101			
102			
103			
104	*Numerical values (system. errors)*	*Note*	*References*
105	Bias unchanged	CV[A]<½CV[Bw]	6
106			
107	Deviation<0.089 c*		9
108	Deviation <0.20 c*	Imprecision included	20
109	Deviation<0.21 c*	Imprecision included	1

	A	B	C	D
110				
111	**S--POTASSIUM**			
112				
113				*Numerical values (random errors)*
114	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.006
115				
116	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.024
117	**Anal. Qual. Sp.**	**US prof. test.**		
118	**Anal. Qual. Sp.**	**German Ringvers.**		
119				
120	**S--SODIUM**			
121				
122				*Numerical values (random errors)*
123	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.0043
124				
125	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.003 (0.007)
126	**Anal. Qual. Sp.**	**US prof. test.**		
127	**Anal. Qual. Sp.**	**German Ringvers.**		CV[A]<0.02
128				
129	**S--THYREOTROPIN, TSH**			
130				
131				*Numerical values (random errors)*
132	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.097
133				
134	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.081
135	**Anal. Qual. Sp.**	**US prof. test.**		
136				
137	**S--TRANSFERRIN**			
138				
139				*Numerical values (random errors)*
140	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.013
141				
142	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.024 (0.04)
143	**Anal. Qual. Sp.**	**German Ringvers.**		
144				
145	**S--URATE**			
146				
147				*Numerical values (random errors)*
148	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.043
149	**Clinical goals**	**Hypouricemia**	Enzyme deficiencies	CV[A]<0.04
150	**Clinical goals**	**Gout (metabolic/renal)**	Clearance estim -20%	CV[A]<0.02
151				
152	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.042
153	**Anal. Qual. Sp.**	**US prof. test.**		
154	**Anal. Qual. Sp.**	**German Ringvers.**		
155				
156	**S--UREA**			
157				
158				*Numerical values (random errors)*
159	**Clinical goals**	**Biol. approach**	within subj variation	CV[A]<0.052
160				
161	**Anal. Qual. Sp.**	**Europ. work. gr.**		CV[A]<0.063
162	**Anal. Qual. Sp.**	**US prof. test.**		
163	**Anal. Qual. Sp.**	**German Ringvers.**		

	E	F	G
110			
111			
112			
113	*Numerical values (system. errors)*	*Note*	*References*
114	Bias unchanged	CV[A]<½CV[Bw]	7
115			
116	Deviation<0.016 (0.048) c*		9
117	Deviation <0.5 mmol/L	Imprecision included	20
118	Deviation<0.08 c*	Imprecision included	10
119			
120			
121			
122	*Numerical values (system. errors)*	*Note*	*References*
123	Bias unchanged	CV[A]<½CV[Bw]	7
124			
125	Bias changed <0.002 (0.006)		9
126	Deviation <4 mmol/L	Imprecision included	20
127	Deviation <0.06 c*		1
128			
129			
130			
131	*Numerical values (system. errors)*	*Note*	*References*
132	Bias unchanged	CV[A]<½CV[Bw]	7
133			
134	Deviation <0.089		9
135	Deviation <+ /- 3 SD	Imprecision included	20
136			
137			
138			
139	*Numerical values (system. errors)*	*Note*	*References*
140	Bias unchanged	CV[A]<½CV[Bw]	7
141			
142	Deviation< 0.023 (0.048) c*		9
143	Deviation<0.18 c*	Imprecision included	1
144			
145			
146			
147	*Numerical values (system. errors)*	*Note*	*References*
148	Bias unchanged	CV[A]<½CV[Bw]	7
149	Bias unchanged	Concentration < 160 umol/L	4
150	Bias unchanged		4
151			
152	Deviation <0.04(0.084)		9
153	Deviation <0.17c*	Imprecision included	20
154	CV[A]<0.18 c*	Imprecision included	1
155			
156			
157			
158	*Numerical values (system. errors)*	*Note*	*References*
159	Bias unchanged	CV[A]<½CV[Bw]	7
160			
161	Bias change < 0.053		9
162	Deviation<0.09 c* or <0.71 mmol/L	Imprecision included	20
163	Deviation<0.24 c*	Imprecision included	10