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and

INTERNATIONAL FEDERATION OF CLINICAL CHEMISTRY

SCIENTIFIC DIVISION
COMMITTEE ON QUANTITIES AND UNITS†

PROPERTIES AND UNITS IN THE CLINICAL LABORATORY SCIENCES I. SYNTAX AND SEMANTIC RULES

(IUPAC–IFCC Recommendations 1995)

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Properties and units in the clinical laboratory sciences—I. Syntax and semantic rules (IUPAC–IFCC Recommendations 1995)

Synopsis

This document is an updating of previous recommendations on the presentation of properties and their values in clinical laboratory sciences from IFCC, IUPAC and WHO.

It forms part of the ongoing effort towards 'standardization' of transmission of laboratory request and report across cultural/language domains while avoiding standardization of the language used by clinicians or laboratory practitioners.

Subsequent documents will list the kinds-of-property and the properties used in clinical laboratory sciences.

Preface

The present document is the first part of a series on properties measured in the clinical laboratory sciences initiated in 1987.

The series will comprise:

I	Syntax and semantic rules
II	Kinds-of-property
III	Terms and code values
IV	Properties and code values
V	Properties and units in Thrombosis and Haemostasis
VI	Properties and units in Drugs of Abuse
VII	Properties and units in Inborn Errors of Metabolism
VIII	Properties and units in Microbiology

The size and complexity of part III and IV is such that they will be presented in electronic format. This is for ease of handling and to facilitate expression of concepts in different languages.

The overall aim is access by electronic media of:
'Compendium of terminology and nomenclature of properties in clinical laboratory sciences'.
'Glossary of terms in quantities and units in clinical chemistry'.
'Properties and units in the clinical laboratory sciences'.

The following colleagues have contributed significantly to part I on Syntax and semantic rules through correspondence and discussions:
Kjeld Jørgensen (Denmark); Christopher Rigg (The Netherlands); Georges Férard (France); Peter Felding (Denmark); René Dybkær (Denmark); Renze Bais (Australia); J Lindemans (The Netherlands).

FOREWORD AND SCOPE

This document is an updating of previous recommendations on the presentation of quantities and units in clinical laboratory sciences from IFCC, IUPAC and WHO. It is harmonized with a document summarizing and updating recommendations on terminology nomenclature, syntax, convention and units prepared for IFCC–IUPAC: Compendium of nomenclature and terminology of properties in clinical laboratory sciences - "The Silver Book". In press.

As the present document thus emanates from the efforts of the Commission–Committee on Quantities and Units (in Clinical Chemistry), i.e. its members over many years, it is presented as a C-QU(CC) recommendation.

The standard systematic names for properties in clinical laboratory sciences are intended to serve as 'point d'appui' or 'bridge' for mapping and translation.

Each property is structured according to IUPAC–IFCC syntax rules and the terms (semantic part) defining the property follow recommendations by international organizations.

Standard systematic names and codes are to be used as a bridge between formats in different 'cultural' areas of language or local technical language, to ensure unambiguous and fully informative communication.

It is not intended that they be used to standardize the language used by individual clinicians or laboratory practitioners.

INTRODUCTION

Basic research in biology and medicine and innovations in laboratory methodology have greatly increased the range of properties available to medical staff to help them in decisions on diagnosis and prevention of disease, and treatment of patients.

The plethora is now such that the individual doctor may have insight into or understanding of only a few of the properties offered to him from the various clinical laboratory specialities. Further, recent development tends to blur the boundaries between the various disciplines of clinical laboratory sciences and the same properties are being reported differently in different disciplines.

The terminology used by one laboratory speciality may vary even within the speciality, and may be incomprehensible to another speciality. This is a minor inconvenience to the laboratory specialities, each one being concerned essentially with its own area of activity. However for the user, this is unsatisfactory and it may even hinder treatment of the patient.

Why this document? The document is intended to address issues in clinical laboratory sciences in general and as such is not confined to issues in clinical chemistry.

It is part of the ongoing international effort to agree on some sort of 'standardization' of the transmission and presentation of 'laboratory results'. Schematically, a simple laboratory report could look like Table 1.

Table 1. Parts of a laboratory report

Administrative data (from–to etc.)
Patient identification, date and time(s)
Property 1 = result 1
Property 2 = result 2
Property 3 = result 3
....
Remarks (Any free-text comment)

A report may be elaborate with for example some quantities being grouped with a common heading. Further, some 'result *x*' may itself be an interval, a list, a table or a graph.

Only quantities and results are considered here, because these are the areas where interdisciplinary problems are found. In particular, the document lists examples of quantities, relevant to various laboratory disciplines, given with a meaningful nomenclature and a common flexible structure. A subsequent part of the document will present a more extensive list.

The present recommendation is a balance of the existing partly conflicting recommendations from several international bodies, suitably extended to meet the needs of to-day's clinical practice.

CONCEPTS AND DEFINITIONS

Some words and concepts. To facilitate understanding and use of the rules, some words and concepts are briefly explained in their contexts in the following, beginning with the more general ones.

A **measurement** is a description of a property of a system by means of a set of specified rules, that maps the property onto a scale of specified values, by direct or 'mathematical' comparison with specified reference(s),

The demand for rules makes 'measurement' a scientific concept in contrast to the mere colloquial sense of 'description'. However, in the present definition, 'measurement' has a wider meaning than given in (elementary) physics. Even a very incomplete description of, for instance, a patient (at a stated time) has to be given by a set of measurements, that are easier to manage and grasp.

In the present context, the object described is generally a **patient**, but could be any related object, e.g. a portion of food. In any case, it has to be identified in some unequivocal way, and the ID has to be given together with the local **calendar time** or period for which the reported measurement values are applicable.

Any information about the object's preparation for measurement, or state at measurement time may be given, whenever such information is considered relevant for a subsequent clinical evaluation.

System: Demarcated arrangement of a set of elements and a set of relationships between these elements.

Component: Definable part of a system.

Kind-of-property: Attribute of phenomena, bodies or substances that may be distinguished qualitatively.

EXAMPLES
colour (value: green; blue; ..), transparency, length (value: long; short; 2 m; 5 m; ...), amount-of-substance (value: 2 mol; 5 mol; ..).
Note 1: Kind-of-property includes the concept kind-of-quantity . All kinds-of-property may be related to nominal (ex. green; blue) and ordinal scales (ex. small; large), but kinds-of-quantity are generally related to difference (ex. 10 °C (i.e. 10 °C more than an arbitrary zero)) or ratio scales (length 2 m or 5 m).

Property: Set of data elements (system, component, kind-of-property) common to a set of particular properties.
EXAMPLE
Substance concentration of glucose in blood plasma.
Note 1. Information about identification, time and result is not considered.

Particular property: Property of a given object (phenomenon, body or substance).
Note 1: '*Particular property*' includes the concept of *particular quantity*.
Note 2: The adjective 'particular' may be omitted, if no ambiguity is caused.

STANDARDIZED REQUEST AND REPORT OF CLINICAL LABORATORY RESULTS

The parts of a request and a report are presented in Table 2.

Table 2. Standard systematic description and some recommended sources of names and symbols

Elements		Sources of recommended terms
Particular property		
1 Identification and time		
1.1	identification of patient (ID)	
1.2	date and time(s) of sampling	
2 Property		
2.1	system	Nomina Anatomica
2.2	component	WHO, IUPAC, IFCC, IUBMB
2.3	kind-of-property	ISO, IUPAC, IFCC
3 Result		
3.1	equality, inequality or other operator	
3.2	value	
3.3	prefix	SI
3.4	unit	SI, WHO, IUPAC, IFCC, IUBMB
4 Remarks		

'Administrative data' (Table 1) are not dealt with further, because they are governed by local usage and pertain to a medical record in general.

Essential for a *request* (Table 2) is part 1 and 2, that is information on patient identification, time or time interval for sampling, and information on the property requested.

The laboratory *report* on a particular property comprises the three subdivisions 1, 2 and 3.

To each element in part 2 may be added a specification as a parenthetic suffix for clarification or identification.

Remarks (part 4) relating to diagnosis, medication, haemolysis or hardware breakdown are not included, except when needed for the interpretation of results such as pretreatment of patient in functional quantities.

SYNTAX

System(specification)—Component(specification); kind-of-property(specification)

System. The rules are
- initial upper-case letter, except for any alphanumeric indications of, for instance, chemical structure
- full name or an abbreviated or coded form of one or a few letters
- specification in parenthesis following the name without a space

- elements of specification in lower-case letters when unabbreviated, in abbreviated or coded form according to given lists, and separated by a semicolon and a space
- A long dash (em dash) or two hyphens following the name, code, or parenthesis, and without a space, separating system from component
- no space before the component

Component. The rules are
- initial upper-case letter, except for any alphanumeric indications of, for instance, chemical structure
- unabbreviated systematic or other recommended name
- final part of a composite name transposed to the front to group related properties in alphabetic list, the two parts separated by comma and space
- names of two covalently bound parts of a compound separated by a hyphen without space before or after
- names of two or more parts of a component, having a complex structure, joined by a hyphen without space before or after and with the word 'complex' at the end of the component name
- names of two or more distinct entities regarded as one component, separated by a plus sign without space before or after
- names of two separate entities entering into numerator and denominator respectively of a ratio between two quantities of the same system and having the same kind-of-property, both names with initial upper-case letter and separated by a slash with no space before or after
- specification in parenthesis following the name without space
- elements of specification separated by semicolon and space
- a semicolon following name or parenthesis without a space and separating component from kind-of-property
- a space before the kind-of-property

The component name may be used to put a list of properties in alphabetical order.

Kind-of-property. The rules are
- initial lower-case letter
- full name or an abbreviation
- specification in parenthesis following the name or abbreviation without a space
- elements of specification in full, in abbreviated or coded form, separated by semicolon and space

In documents from ISO, IEC, CEN and CENELEC, including documents in the English language, the decimal mark is a comma on the line. The same convention is followed by IFCC and the IUPAC Clinical Chemistry Division in their recommendations.

To facilitate the reading of numerical values with many numerals/digits, groups of 3 digits may be separated by a small space out from the decimal mark .

Composite structures

In some cases, a request for a single property elicits a report with several properties or a result consisting of a set of values or a matrix of values. Such situations require special formats.

Header
The name or part of the name of the property used for the request may be considered as a header and printed in italics.

A request for one property elicits several particular properties
The requested property is given as a header and the measured properties are listed separately in extensive form, usually with accepted abbreviations and symbols.

One requested property elicits a matrix of values
Formally, a two-dimensional matrix may be reported as a composite result.

Expression by other properties
It may not always be feasible to determine the function of the organism or one of its organs by direct means; then a related property must suffice.

SEMANTIC RULES

The terms used in clinical laboratory reporting are best spelled out in full because specialization in medicine and in the clinical laboratory sciences precludes insight into more than just a few areas of specialization. However, in order to save space the use of abbreviations is unavoidable. To assist with interdisciplinary, international, and interlingual communication, the number of accepted abbreviations and codes should be kept to a minimum. They should be recognizable to a variety of language groups by being derivated from Greek or Latin.

Ideally, such abbreviations and codes should not be the same as other symbols, abbreviations or codes recommended by IUPAC or IUBMB.

Only one term or name has been selected in each instance. It is appreciated that routine use in some English-speaking countries differs from the standard systematic name proposed, for example 'Haemoglobin' (e.g. Britain) and 'Hemoglobin' (e.g. United States).

System

When applying terms pertaining to humans only clinically relevant expressions are used. By plasma is meant the blood plasma such as it occurs in the patient. EDTA plasma, serum, etc. are artefacts needed for laboratory processing and are judged irrelevant to the doctor treating the patient.

The names used for anatomical structures are from Nomina Anatomica (6th edition, 1989). Other systems or components (e.g. Air, Food, Dust) are named in accordance with the Concise Oxford Dictionary (8th edition, 1990).

For systems (or components) defined as a kind-of-entity, the distinction between singular and plural (with -s) is essential to indicate whether the object is a single entity or a collection of entities.

For thirteen of the physiological systems, a symbol derived from the Greek, Latin, or both, can be recommended (Table 3). Essentially such symbols are as defined by IUPAC–IFCC [Hill 1991]. 'S' for serum is included because of its widespread use, although it is not a 'clinical' system but an artefact.

Specification to system

Specification to the system may have one of two purposes: to circumscribe the term or to indicate sampling conditions. The two types of specification are separated by a semicolon, and the ones on sampling conditions are mentioned last. Some of the common system-related specifications are given codes to narrow the term (Table 4). The specifications needed may represent a supersystem or a subsystem.

EXAMPLES
Haemoglobin(Amniotic fluid)
Patient(Urine)
Blood(capillary; fasting patient)

Table 4. System related codes

Name	Code
arterial	a
arteriolar (commonly called capillary)	c
cultured	cult.
day; collected over or change in 24 h	d
fasting	f
venous	v

Component

Names used for components are the official names according to rules of nomenclature for inorganic, organic and biological chemistry, that is of IUPAC, IUBMB - ISO - of WHO (INN) - BAN - USAN - Martindale and names recommended by international societies, e.g. International Society for Thrombosis and Haemostasis and International Committee on Taxonomy of Viruses. Abbreviations are to be avoided, also when the system is given by code.

When more than one component is part of the name, they are joined by a '+' sign with no space before or after the names.

For ease of use in daily medical practice, the usual way of presenting a component name is sometimes transposed. In this way the first part of a component name functions as a header for listing of related properties.

Specification to component

For some chemical components an entity has to be specified (obligatory), and in some cases a traditional word as a specification is helpful (occasional).

EXAMPLES of entitic specifications are
Haemoglobin(Fe)
Haemoglobin(Fe_4)
Base(site binding H^+)
Nitrogen(N)

EXAMPLES of occasional specifications are
Chromium(III)
Chromium(IV)
Calcium ion(free)
Calcium(total)

Table 3. System codes for English standard systematic nomenclature

English		Derivation		*Danish*	*Dutch/ Flemish*	*Finnish*	*French*
System	*Code*	*Greek*	*Latin*				
Amniotic fluid	Amf	Αμνον		Amnion-væske	Amnion-vocht	Lapsivesi	Liquide amniotique
Blood	B	Αιμα	Sanguis	Blod	Bloed	Veri	Sang
Cerebro-spinal fluid	Csf		Cerebrum Spinum	Cerebrospinal-væske	Cerebrospinaal vocht	Aivoselkäy-dinneste	Liquide céphalo-rachidien
Erythrocyte(s)	Erc(s)	Ερυθρος	Cytos	Erythrocyt	Erytrocyt	Erytrosyytti	Erythrocyte
Expectorate	Ex		Ex pectus	Ekspektorat	Fluimen	Yskös	Matières expec-torées
Faeces	F		Faex	Fæces	Faeces	Uloste	Fèces
Haemoglo-bin	Hb	Αιμα	Globus	Hemoglobin	Hemoglobine	Hemoglobiini	Hémoglobine
Leukocy-te(s)	Lkc(s)	Λευκος	Cytos	Leukocyt	Leukocyt	Leukosyytti	Leucocyte
Patient	Pt		Patiens	Patient	Patiënt	Potilas	Patient
Plasma	P	Πλασμα		Plasma	Plasma	Plasma	Plasma
Serum	S		Serum	Serum	Serum	Seerumi	Sérum
Thrombocyte(s)	Trc(s)	θρομβος	Cytos	Thrombocyt	Trombocyt	Trombosyytti	Thrombocyte
Urine	U		Urina	Urin	Urine	Virtsa	Urine

System	*German*	*Greek*	*Italian*	*Norwegian*	*Portuguese*	*Spanish*	*Swedish*
Amniotic fluid	Amnion-flüssig-keit	Αμνιακονυγρον	Liquido am-niotico	Amnion-væske	Líquido amniótico	Líquido amniótico	Amnion-vätska
Blood	Blut	Αιμα	Sangue	Blod	Sangue	Sangre	Blod
Cerebro-spinal fluid	Rücken-markflüs-sigkeit	Εγκεφαλονωτιαι ονυγρον	Liquido cefa-lo-rachidiano	Cerebrospinal-væske	Líquido céfalorra-quideo	Líquido cefalorra-quídeo	Hjärnrygg-märgs-vätska
Erythro-cyte(s)	Erythro-zyt	Ερυθροκυτ-ταρον	Eritro-cita	Erytro-cyt	Eritró-cite	Eritro-cito	Erytro-cyt
Expectorate	Auswurf	Αποχρεμψις	Espettorato	Ekspektorat	Expectoração	Expecto-racion	Expectorat
Faeces	Faeces, Stuhl	Κοπρανα	Feci	Fæces	Fezes	Heces	Avföring
Haemoglo-bin	Hämoglo-bin	Αιμοσφαιρινη	Emoglobina	Hemoglobin	Hemoglobina	Hemoglobina	Hemoglobin
Leuko-cyte(s)	Leuko-zyt	Λευκοκυτταρον	Leuco-cita	Leuko-cyt	Leucó-cito	Leuco-cito	Leuko-cyt
Patient	Patient	Νοσηλευομενος	Paziente	Pasient	Paciente	Paciente	Patient
Plasma	Plasma	Πλασμα	Plasma	Plasma	Plasma	Plasma	Plasma
Serum	Serum	Ορος	Siero	Serum	Sôro	Suero	Serum
Thrombocyte(s)	Thrombo-zyt	θρομβοκυτ-ταρον		Tromocyt			Trombocyt
Urine	Urin, Harn	Ουρα	Urina	Urin	Urina	Orina	Urin

Kind-of-property

The names of the kinds-of-property follow the rules given by IUPAC–IFCC 1995. Apart from these, some names given to properties by WHO 1992 are also applied.

Specification to kind-of-property

Names of kinds-of-property may be supplemented with specifications necessary to avoid misunderstandings. Specifications are mandatory, for, inter alia 'functional' quantities, for which the name is followed by : '(procedure)'.

The specifications are related to the measurement procedure, including previous events, time-related information, calibration, and notes on the analytical procedure.

EXAMPLES
(60 min after oral load of glucose 278 mmol)
(1994-08-10 09:30; 1994-08-13 09:30)
(-08-10 09:30; Δt = 3 d)
(Δt =3 d; 94-08-13 09:30)
or for short-term variation
(94-08-10 09:30; 11:15) or (24 h)
(IRP 67/40); and (30 °C; King & King).

RESULT

Values

Numerical values should be written in accordance with international rules, the last digit containing the uncertainty.

'Text' values, for instance 'green' or '*Staphylococcus aureus*', are written in full.

Prefixes

Prefix symbols (Table 5) have been applied throughout in the present document. Although the prefixes hecto, deca, deci and centi are part of the BIPM 1991 recommendation, they have been omitted because in the clinical laboratory factors and multiples in steps of a factor 1 000 are preferred.

Only one prefix should be attached to a numerator unit-symbol of a compound unit-symbol. The prefix together with a unit-symbol represents a new unit.

The unit 'one' is omitted throughout.

Table 5. Prefix names and symbols

Factor	Prefix Name	Prefix Symbol
10^{24}	yotta	Y
10^{21}	zetta	Z
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a
10^{-21}	zepto	z
10^{-24}	yocto	y

Units

The units used in the lists are the ones given in Table 6 or a combination of these. SI units are preferred, but have to be supplemented with units from various biological fields to reflect the 'state-of-the-art'. The unit 'one' (symbol '1') of dimensionless quantities is not stated.

Table 6. Status of units in SI

SI status	Name of unit	Symbol or abbreviation	Recognition authority
SI base unit			
	kilogram	kg	BIPM
	metre	m	BIPM
	mole	mol	BIPM
	second	s	BIPM
SI derived unit			
	katal[1]	kat	IUPAC, IFCC, IUBMB
	degree Celsius	°C	BIPM
	pascal	Pa	BIPM
Off-system unit	litre[2]	l, L	BIPM
	minute	min	BIPM
	hour	h	BIPM
	day	d	BIPM
	arbitrary unit	arb. unit	no recognition
	international unit	int. unit	WHO and legal status

Note 1. Conversion of unit for enzyme activity (U) to unit for catalytic activity (kat) is 60×10^6 U = 1 katal. The non-coherent unit U was originally suggested by IUB in Recommendation 1964.

Note 2. The symbol 'l' is used in this document.

ELEMENTS OF AN ENTRY IN PART IV OF PROPERTIES AND UNITS IN THE CLINICAL LABORATORY SCIENCES: 'Properties and code values'

The terms recommended (entries 1 to 6) are given in bold, that is: the code value, the standard systematic name, and the unit.

1 [QUXXXXX]
Code value.

2 Name of system and parenthetic specification spelled out in full, and followed by a long dash.

3 Alphanumeric chemical prefixes to component name.

4 Recommended name of component and parenthetic specification. Shifted to the left for searching and sorting.

5 Kind-of-property and parenthetic specification.

6 Unit

7 Example in abbreviated form.

8 Molar mass (*M*) for conversion from other units.

9 Presently recommended calibrator.

10 Previous calibrators.

11 Other name(s) or code value(s).

12 Authority: Code value for the international organization recommending the name of the component or the combined elements of an entry.

13 Note with any further information.

Entry:
1 **QU03192**
2 **Plasma—**
4 **Plasminogen activator, tissue type;**
5 **arbitrary concentration(enz.; IS 86/670; procedure)**
6 **international unit/litre**
7 P—Plasminogen activator, tissue type; arb.c.(enz.; IS 86/670; procedure) = ? int. unit/l
8 *M* = 60 000 g/mol
9 Calibrator: WHO 2nd IS 86/670
10 Previous calibrator(s): WHO 1st IS 83/517
11 Not recommended term(s): Blood plasminogen activator; t-PA; Tissue plasminogen activator; Vascular plasminogen activator
12 Authority: ISTH/SSC93

Entry:
1 **QU01037**
2 **Amniotic fluid—**
3 ***N*-**
4 **Acetylgalactosamine-4-sulfatase;**
5 **catalytic activity concentration(37 °C; procedure)**
6 **microkatal/litre**
7 Amf—N-Acetylgalactosamine-4-sulfatase; cat.c.(37 °C; procedure) = ? µkat/l
11 Not recommended term(s): Arylsulfatase B; Chondroitinase; Chondroitinsulfatase; Chondrosulfatase
12 Authority:IUBMB/ EC 3.1.6.12

Entry:
1 **QU01446**
2 **Plasma—**
4 **Calcium ion(free);**
5 **substance concentration**
6 **millimole/litre**
7 P—Calcium ion(free); subst.c. ≅ ? mmol/l
8 *M* = 40,080 g/mol
11 Not recommended term(s): Coagulation factor IV
12 Authority: IFCC/C-BGE

Entry:
1 **QU02821**
2 **Urine—**
4 **Microorganism;**
5 **detection(procedure)**
7 U—Microorganism; detection(5 % blood agar) = *Escherichia coli; Proteus vulgaris*
12 Authority:

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INDEX OF ABBREVIATIONS

BAN	British Approved Name
C-BGE	Committee on Blood Gases and Electrolytes of the IFCC
C-QU	Committee on Quantities and Units of the IFCC/SD
C-QUCC	Commission on Quantities and Units in Clinical Chemistry of the IUPAC/VII
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
EC	Enzyme Committee of the IUBMB
ICSH	International Committee for Standardization in Haematology
ID	Identification
IEC	International Electrotechnical Commission
IFCC	International Federation of Clinical Chemistry
INN	International Nonproprietary Names of WHO
ISO	International Organization for Standardization
ISTH	International Society of Thrombosis and Haemostasis
IUB	International Union of Biochemistry (since 1991 IUBMB)
IUBMB	International Union of Biochemistry and Molecular Biology
IUPAC	International Union of Pure and Applied Chemistry
SD	Scientific Division of the IFCC
SI	International System of Units
SSC	Scientific and Standardization Committee of the ISTH
USAN	United States Adopted Name
VII	Divison VII, Clinical Chemistry, of the IUPAC
WHO	World Health Organization