Editorial

Concentration and content

Xavier Fuentes-Arderiu

Clinical Laboratory Sciences Consulting, Barcelona, Catalonia, Spain

Corresponding author: 2461xfa@gmail.com

Abstract

One of the more frequent activities in health sciences is the measurement of biological quantities. Frequently, when reading biomedical books and journals some confusion on the metrological meaning of biological quantities related to the concepts 'concentration' and 'content' may be observed. Classically, a *concentration* is an amount of any type *per* volume of liquid or gas system, whereas *content* is an amount of any type *per* mass of liquid or gas or solid system. However the concepts 'concentration' and 'content' alone are still ambiguous because, depending on the type of amount of the component (analyte) *per* volume or mass of a system, there are different types of concentrations and contents. This article attempts to give a clarification of these concepts, mainly based on international recommendations about nomenclature and terminology of metrology, chemistry and clinical laboratory sciences.

Key words: concentration; content; quantity; metrology; terminology

Received: February 04, 2013 *Accepted: April 16, 2013*

One of the more frequent activities in healthcare is the measurement of biological quantities such as body mass, body temperature, blood pressure or plasma cholesterol concentration. Unfortunately, when reading biomedical journals some confusion related to the basic metrological concepts and terms may be observed. Among these concepts, concentration is one of the more important ones, because the different types of concentration are the most frequently generic quantities taken into account. But other generic quantities, such as the different types of contents, are often taken into account and often confused with concentration. Clarification of these concepts is necessary.

In practice, when we are considering a solution or a suspension, it is to say, an amount of any type *per* volume of liquid or gas we are dealing with a *concentration* (please, forget the not recommended term "level"). But, when we are considering an amount of any type *per* mass of liquid or gas or solid system we are dealing with a *content* (please, forget "level" again).

However the concepts 'concentration' and 'content' alone are still ambiguous because, depending on the type of amount of the component (analyte) *per* volume or mass of a system, there are different types of concentrations and contents (1-3):

substance concentration: amount-of-substance of a component divided by the volume of the system [measurement unit: mol/L]

Example: Substance concentration of glucose in spinal fluid.

substance content: amount-of-substance of a component divided by the mass of the system [measurement unit: mol/kg]

Example: Substance content of arsenic in hair.

catalytic-activity concentration [or *catalytic concentration* in short]: catalytic activity of the component divided by the volume of the system [measurement unit: kat/L]

Example: Catalytic concentration of alkaline phosphatase in plasma.

catalytic-activity content [or *catalytic content* in short]: catalytic activity of the component divided by the mass of the system [measurement unit: kat/kg]

Example: Catalytic content of adenine phosphoribosyltransferase in fibroblasts protein.

number concentration: number of defined particles, or elementary entities, of a component in a system divided by the volume of that system [measurement unit: 1/L]

Example: Number concentration of erythrocytes in blood.

number content: number of entities of a component divided by the mass of the system [measurement unit: 1/kg]

Example: Number content of eggs of *Enterobious vermicularis* in feces.

mass concentration: mass of the component divided by the volume of the system [measurement unit: kg/L]

Example: Mass concentration of protein in urine.

mass content: [This unofficial concept (and term) is equivalent to 'mass fraction' and, consequently, is not defined in this text.]

volume content: volume of an (isolated) component divided by the mass of the system [measurement unit: L/kg]

Example: Volume content of blood in a patient.

It should be kept in mind that the same SI unit may be used to express the values of quantities of different kind, i.e. volumic mass and mass concentration use kg/L, and osmolarity and substance concentration use mol/L. Thus, according to the International Federation of Clinical Chemistry and Laboratory Medicine and the International Union of Pure and Applied Chemistry recommendations (3), when describing a quantity, whether in a book or a scientific journal, the kind of quantity should always be included.

Finally, it can be said that reading some major texts on basic metrological concepts (4,5) would be very useful for any chemical or clinical laboratory.

Potential conflict of interest

None declared.

References

1. *Richter W. Recommendations on quantities, symbols and measurement units for publications in ACQUAL. Accred Qual Assur 2007;12:497-8. http://dx.doi.org/10.1007/s00769-007-0273-6.*
2. *International Union of Pure and Applied Chemistry. Compendium of chemical terminology - The Gold Book. Available at: http://goldbook.iupac.org. Accessed April 16, 2013.*
3. *Rigg JC, Brown SS, Dybkaer R, Olesen H, for IUPAC and IFCC: Compendium of terminology and nomenclature of properties in clinical laboratory sciences: the Silver Book (Recommendations 1995). Oxford: Blackwell Scientific Ltd; 1995. p60.*
4. *Joint Committee for Guides in Metrology. International vocabulary of metrology – Basic and general concepts and associated terms (VIM). JCGM 200:2012. Sèvres: Bureau International des Poids et Mesures; 2012. Available at: http://www.bipm.org/utils/common/documents/jcgm/JCGM_200_2012.pdf. Accessed April 16, 2013.*
5. *De Bièvre P, Dybkaer R, Fajgelj A, Brynn Hibbert DB. Metrological traceability of measurement results in chemistry: concepts and implementation (IUPAC Technical Report). Pure Appl Chem 2011;83:1873-935. http://dx.doi.org/10.1351/PAC-REP-07-09-39.*