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Role of Mathamatics Calculations on Pharmaceutical Fields

Ashwin Singh Chouhan[1], Manish Gaur[2]

[1,2]Jai Narain Vyas University (New Campus), Jodhpur (Raj.) India 342003

Address for Correspondence: Ashwin Singh Chouhan, 587, Daulat Niwas 10th B Road Sardarpura Jodhpur, Rajasthan India 342003, E-mail: ashwinsingh26061992@gmail.com

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ABSTRACT

Background. Mathematics is important in Pharmaceutical calculations. A mistake in a in a calculation or measuring could lead to serious consequence, such as under dosing or overdosing This, in turn, may lead to inadequate treatment or drug toxicity. Virtually all tasks within Pharmaceutical calculations relate to mathematics and calculations: dispensing the correct volume of a solution, compounding a medication or determining a dose. These tasks involve basic arithmetic as well as an understanding of fractions, rounding numbers, ratios and proportions and percentages.

Method and material: We conducted this research paper by observing the different types of reviews, as well as conducting and evaluating literature review papers.

Result. One of the most important areas of study for the pharmacy specialist is pharmaceutical calculations. A person might know a great deal about pharmacology, but if he cannot perform a pharmaceutical calculation, that knowledge cannot be applied in a practical way.

Conclusions. The study of this sub course will help give you the knowledge and skill required to perform many types of dosage calculations.

Keywords: Pharmaceutical Calculation, Scope, Weight, Volume, Dose, Ratio, Density, Proportion, Temperature etc

INTRODUCTION

Mathematics is important in Pharmaceutical calculations. A mistake in a in a calculation or measuring could lead to serious consequence, such as under dosing or overdosing This, in turn, may lead to inadequate treatment or drug toxicity. Virtually all tasks within Pharmaceutical calculations relate to mathematics and calculations: dispensing the correct volume of a solution, compounding a medication or determining a dose. These tasks involve basic arithmetic as well as an understanding of fractions, rounding numbers, ratios and proportions and percentages.

Pharmaceutical calculations are the area of study that applies the basic principles of mathematics to the preparation and safe and effective use of pharmaceuticals. A pharmacist should have a thorough knowledge on weights and measures to have a complete understanding of various types of calculations involved in dispensing of dosage form. Therefore, the use of calculations in pharmacy is varied and broad-based. Calculations are performed by the pharmacists in traditional as well as in specialized practice settings. Whether a pharmaceutical product is produced in a large scale or a small scale pharmacist engage in calculations to achieve standards of quality. The preparation of various dosage forms and drug delivery systems containing carefully calculated, measured, verified, and labeled quantities of ingredients enables accurate dosage administration.

Scope of Pharmaceutical Calculations:

The use of calculations in pharmacy is varied and broad-based. It encompasses calculations performed by pharmacists in traditional as well as in specialized practice settings and within operational and research areas in industry, academia, and government. In the broad context, the scope of pharmaceutical calculations includes computations related to:

- Chemical and physical properties of drug substances and pharmaceutical ingredients;
- Biological activity and rates of drug absorption, bodily distribution, metabolism and excretion (Pharmacokinetics);
- Statistical data from basic research and clinical drug studies;
- Pharmaceutical product development and formulation;
- Prescriptions and medication orders including drug dosage, dosage regimens, and patient compliance;
- Pharmacoeconomics; and other areas

Whether a pharmaceutical product is produced in the industrial setting or prepared in a community or institutional pharmacy, pharmacists engage in calculations to achieve standards of quality. The difference is one of scale. In pharmacies, relatively small quantities of medications are prepared and dispensed for specific patients. In industry, large-scale production is designed to meet the requirements of pharmacies and their patients on a national and even international basis. The latter may involve the production of hundreds of thousands or even millions of dosage units of a specific drug product during a single production cycle. The preparation of the various dosage forms and drug delivery systems (defined in Appendix C), containing carefully calculated, measured, verified, and labeled quantities of ingredients enables accurate dosage administration.

Fundamentals of Pharmaceutical Calculations

Pharmaceutical calculations are the area of study that applies the basic principles of mathematics to the preparation and safe and effective use of pharmaceuticals. It is the application of mathematics that require the study. To have a complete understanding of various types of calculations which are involved in dispensing, it is desirable that the pharmacist should have a thorough knowledge regarding weights and measures which are used in calculations. They are two systems of weights and measures
(1) The Imperial System
(2) The metric System (or) International System

Imperial System:

It is an old system of weights and measures.

Measurement of Weight in Imperial System:

Weight is a measure of the gravitational force acting on a body and is directly proportional to its mass. The imperial system is divided into two parts for the purpose of measurement of weight. These are
(a) Avoirdupois System
(b) Apothecaries System

(a) Avoirdupois System:

In this system the "pound" is the standard unit for weighing, and all measures are derived from the Imperial Standard Pound (Lb), thus

- 1Lb =16 oz (avoir)
- 1Lb =7000 grains
- 1oz =437.5 grains

(b) Apothecaries System: This system is also known as the Troy system. The grain is the standard unit in this system and all other units are derived from it.

- 20 grains = 1 scruple
- 60 grains = 1 drachm
- 480 grains = 1 ounce
- 8 drachms = 1 ounce
- 12 ounces = 1 pound (Lb)
- 5760 grains = 1 poun

Measurement of Capacity In Imperial System:

The standard unit for capacity is same in both the Avoirdupois and Apothecaries systems. The "gallon" is the standard unit and all other measures of capacity are derived from it.

- 1 gallon = 160 fluid ounces
- ¼ gallon = 1 quart
- 1/8 gallon = 1 pint
- 1/160 gallon = 1 fluid ounce
- 1/8 fluid ounce = 1 fluid drachm

- 1/60 fluid drachm = 1 minim
- 1 quart = 40 fluid ounces
- 1 pint = 20 fluid ounces
- 1 fluid ounce = 480 minims
- 1 fluid drachm = 60 minims

Metric System (Or) International System:
The International System of Units (SI), formerly called the metric system, is the internationally recognized decimal system of weights and measures. This system was formulated at France in the late eighteenth century. Today, the pharmaceutical research and manufacturing industry, the official compendia, the United States Pharmacopeia—National Formulary, and the practice of pharmacy reflect conversion to the SI system. The reasons for the transition include the simplicity of the decimal system, the clarity provided by the base units and prefixes of the SI, and the ease of scientific and professional communications through the use of a standardized and internationally accepted system of weights and measures. The base units of the SI are the meter and the kilogram. Each table of the SI contains a definitive, or primary, unit. For length, the primary unit is the meter; for volume, the liter; and for weight, the gram (although technically the kilogram is considered the historic base unit).

Measure of Length
The meter is the primary unit of length in the SI

- 1 kilometer (km) = 1000.000 meters
- 1 hectometer (hm) = 100.000 meters
- 1 decameter (dam) = 10.000 meters
- 1 decimeter (dm) = 0.100 meter
- 1 centimeter (cm) = 0.010 meter
- 1 millimeter (mm) = 0.001 meter
- 1 micrometer (µm) = 0.000,001 meter
- 1 nanometer (nm) =0.000,000,001 meter

Measure of Volume
The liter is the primary unit of volume. It represents the volume of the cube of one tenth of a Meter, that is, of 1 dm3.

- 1 kiloliter (kl) =1000.000 liters
- 1 hectoliter (hl) =100.000 liters
- 1 decaliter (da) =10.000 liters
- 1 liter (l) =1.000 liter
- 1 deciliter (dl) =0.100 liter
- 1 centiliter (cl) =0.010 liter
- 1 milliliter (ml) =0.001 liter
- 1 microliter (µl) =0.000001 liter

Measure of Weight
The primary unit of weight in the SI is the gram, which is the weight of 1 cm3 of water at 4^0C, its temperature of greatest density.

- 1 kilogram (kg) = 1000.000 grams
- 1 hectogram (hg) = 100.000 grams
- 1 decagram (dag) = 10.000 grams
- 1 gram (g) = 1.000 gram
- 1 decigram (dg) = 0.1000 gram
- 1 centigram (cg) = 0.010 gram
- 1 milligram (mg) = 0.001 gram
- 1 microgram (µg or mcg)=0.000, 001 gram
- 1 nanogram (ng) = 0.000, 000,001 gram

Relation of the System to Other Systems of Measurement:
Some Useful Equivalents:
Equivalents of Length

- 1 inch = 2.54 cm
- 1 meter (m) = 39.37 in

Equivalents of Volume

- 1 fluid ounce (fl.oz.) = 29.57 ml
- 1 pint (16 fl oz.) = 473 ml
- 1 quart (32 fl. oz.) = 946 ml
- 1 gallon, US (128 fl. oz.) = 3785 ml
- 1 gallon, UK = 4545 ml

Equivalents of Weight

- 1 pound (lb, Avoirdupois) = 454 g
- 1 kilogram (kg) =2.2 lb [1]

Conversion Table for Domestic Measures:

- 1 drop = 0.06ml
- 1 tea spoonful = 5ml
- 1 desert spoonful =10ml
- 1 tablespoonful =15 ml
- 1 wine glassful = 60 ml
- 1 tea cupful = 120 ml
- 1 tumbler full =240 ml

Ratio, Proportion and Variation Ratio:

The relative magnitude of two quantities is called their ratio. Since a ratio relates the relative value of two numbers, it resembles a common fraction except in the way in which it is presented. Whereas a fraction is presented as, for example, 1⁄2, a ratio is presented as 1:2 and is not read as ''one half,'' but rather as ''one is to two.''

Proportion:

A proportion is the expression of the equality of two ratios. It may be written in any one of three standard forms:

- a : b = c : d
- a : b :: c : d
- a/b = c/d

Each of these expressions is read: a is to b as c is to d, and a and d are called the extremes (meaning ''outer members'') and b and c the means (''middle members'').

Density, Specific Gravity, and Specific Volume Density:

- Density (d) is mass per unit volume of a substance. It is usually expressed as grams per cubic
- Centimeter (g/cc). Because the gram is defined as the mass of 1 cc of water at 4^0C, the density of water is 1 g/cc.

Density may be calculated by dividing mass by volume, that is:

- Density = $\frac{\text{Mass}}{\text{Volume}}$

Specific Gravity:

Specific Gravity (sp gr) is a ratio, expressed decimally, of the weight of a substance to the weight of an equal volume of a substance chosen as a standard, both substances at the same temperature or the temperature of each being known. Specific gravity may be calculated by dividing the weight of a given substance by the weight of an equal volume of water, that is:

- Specific gravity = $\frac{\text{Weight of substance}}{\text{Weight of equal volume of water}}$

Dissolution of drugs

The rate of dissolution of solids is described by the Noyes–Whitney Equation:

$$\frac{dW}{dt} = \frac{DA}{\sigma}(CS - C)$$

where d*w*/d*t* is the rate of increase of the amount of material in solution dissolving from a solid; *c*s is the saturation solubility of the drug in solution in the diffusion layer and *c* is the concentration of drug in the bulk solution, *A* is the area of the solvate particles exposed to the solvent, δ is the thickness of the diffusion layer and *D* is the diffusion coeffi cient of the dissolved solute.

Density versus Specific Gravity:
The density of a substance is a concrete number (1.8 g/ml in the example), whereas specific gravity, being a ratio of like quantities, is an abstract number (1.8 in the example). Whereas density varies with the units of measure used, specific gravity has no dimension and is therefore a constant value for each substance (when measured under controlled conditions). Thus, whereas the density of water may be variously expressed as 1 gm/ml, 1000 gm/l, or 621⁄2 lb/cu ft, the specific gravity of water is always 1.

Percentage, Ratio Strength and Other Expressions of Concentration
Percentage:
The term percent and its corresponding sign (%) mean ‘‘by the hundred’’ or ‘‘in a hundred, ‘and percentage means ‘‘rate per hundred’’; so 50 percent (or 50%) and a percentage of 50 are equivalent expressions. A percent may also be expressed as a ratio, represented as a common or decimal fraction. For example, 50% means 50 parts in 100 of the same kind, and may be expressed as 50⁄100 or 0.50. Percent, therefore, is simply another fraction of such frequent and familiar use that its numerator is expressed but its denominator is left understood.

Percentage Preparations:
The percentage concentrations of active and inactive constituents in various types of pharmaceutical preparations are defined as follows by the United States Pharmacopeia:

Percent Weight-in-volume (w/v) expresses the number of grams of a constituent in 100 ml of solution or liquid preparation and is used regardless of whether water or another liquid is the solvent or vehicle. Expressed as % w/v.
Percent volume-in-volume (v/v) expresses the number of milliliters of a constituent in 100mL of solution or liquid preparation. Expressed as % v/v.

Percent weight-in-weight (w/w) expresses the number of grams of a constituent in 100 g of solution or preparation. Expressed as: % w/w. [2]

Examples of Pharmaceutical Dosage Forms in Which the Active Ingredient Forms in Which the Active Ingredient is Often Calculated and Expressed on A Percentage Basis:

S.No	Percentage Basis	Examples Of Applicable Dosage Forms
1	Weight-in-volume	Solutions (e.g., ophthalmic, nasal, otic, topical, large-volume parenterals), and lotions
2	Volume-in-volume	Aromatic waters, topical solutions, and emulsions
3	Weight-in-weight	Ointments, creams, and gels

Temperature Measurement:
The temperature is generally measured in pharmacy by using either Fahrenheit or Centigrade thermometers. The relationship of Centigrade(C) and Fahrenheit (F) degree is 9C = 5°F-160

Calculation of Doses:
General Considerations Dose:
The dose of a drug is the quantitative amount administered or taken by a patient to produce the desired therapeutic effect. The dose may be expressed as a single dose, the amount taken at one time; a daily dose; or a total dose, the amount taken during the course of therapy. A daily dose may be subdivided and taken in divided doses, two or more times per day depending on the characteristics of the drug and the illness. The schedule of dosing (e.g., four times per day for 10 days) is referred to as the dosage regimen.

Prediatric Dose
Pharmacopoeia gives the range of quantities for adult dose for 24 hours by oral route and by any other specified route. Adult dose and prediatric doses are different. In order calculate paediatric dose, the following formulae are used:
Dose Calculation Based on Age
Young’s rule

$$\text{Dose of child} = \frac{\text{Age of the child x Adult dose}}{(\text{Age} + 12)}$$

Dilling's rule

$$\text{Dose of child} = \frac{\text{Age in year}}{(20)}$$

Cowling's rule:

$$\text{Dose of child} = \frac{\text{Age at next birthday (in years) x Adult dose}}{24}$$

Fried's rule for infants:

$$\text{Dose for infant} = \frac{\text{Age of the infant (in months) x Adult dose}}{150}$$

CALCULATIONS OF DOSE BASED ON BODY WEIGHT:

Clark's rule

$$\text{Dose for child} = \frac{\text{Weight of the child (in lb) x Adult dose}}{\text{150(average wt of adult in lb)}}$$

A useful equation for the calculation of dose based on body weight is:

$$\text{Patient's dose (mg)} = \frac{\text{Patient's weight (kg) x Drug dose (mg)}}{\text{1(kg)}}$$

CALCULATIONS OF DOSE BASED ON BODY SURFACE AREA:

A useful equation for the calculation of dose based on body surface area is:

$$\text{Patient's dose} = \frac{\text{Patient's BSA (m}^2\text{) x drug dose (mg)}}{1.73(\text{m}^2)}$$

The SI unit conversions for the units of measurement most commonly used in the pharmaceutical field. SI units are used throughout with, where appropriate, imperial units reported in parentheses.

Area

- 1 square inch (in2) = 6.4516 _ 10–4 square meter (m2)
- 1 square foot (ft2) = 9.29030 _ 10–2 square meter (m2)
- 1 square yard (yd2) = 8.36127 _ 10–1 square meter (m2)

Density

1 pound per cubic foot (lb/ft3) = 16.0185 kilograms per cubic meter (kg/m3)

Energy

1 kilocalorie (kcal) = 4.1840 _ 103 joules (J)

Force

1 dyne (dynes) = 1 _ 10–5 Newton (N)

Length

- 1 angstrom (A˚) = 10–10 meter (m)
- 1 inch (in) = 2.54 _ 10–2 meter (m)
- 1 foot (ft) = 3.048 _ 10–1 meter (m)
- 1 yard (yd) = 9.144 _ 10–1 meter (m)

Pressure

- 1 atmosphere (atm) = 0.101325 megapascal (MPa)
- 1 millimeter of mercury (mmHg) = 133.322 pascals (Pa)
- 1 pound per square inch (psi) = 6894.76 pascals (Pa)

Surface tension

1 dyne per centimeter (dyne/cm) = 1 millinewton per meter (mN/m)

Temperature

- Celsius (8C) = (1.8 _ 8C) þ 32 Fahrenheit (8F)
- Fahrenheit (8F) = (0.556 _ 8F) –17.8 Celsius (8C)

Viscosity (dynamic)

- 1 centipoise (cP) = 1 millipascal second (mPa s)
- 1 poise (P) = 0.1 pascal second (Pa s)

Viscosity (kinematic)
1 centistoke (cSt) = 1 square millimeter per second (mm2/s)
Volume

- 1 cubic inch (in3) = 1.63871 _ 10–5 cubic meter (m3)
- 1 cubic foot (ft3) = 2.83168 _ 10–2 cubic meter (m3)
- 1 cubic yard (yd3) = 7.64555_10–1 cubic meter (m3)
- 1 pint (UK) = 5.68261 _ 10–4 cubic meter (m3)
- 1 pint (US) = 4.73176 _ 10–4 cubic meter (m3)
- 1 gallon (UK) = 4.54609 _ 10–3 cubic meter (m3)
- 1 gallon (US) = 3.78541 _ 10–3 cubic meter (m3)

Method and material: We conducted this research paper by observing the different types of reviews, as well as conducting and evaluating literature review papers.

Result. One of the most important areas of study for the pharmacy specialist is pharmaceutical calculations. A person might know a great deal about pharmacology, but if he cannot perform a pharmaceutical calculation, that knowledge cannot be applied in a practical way. To prepare and dispense medications, you must be capable of performing a variety of pharmaceutical calculations. You must be constantly aware of one fact-an error made in a dosage calculation can harm a patient.

CONCLUSION

The study of this sub course will help give you the knowledge and skill required to perform many types of dosage calculations. The pharmaceutical calculations help the pharmacist to calculate the amount or concentration of the drug substance in each unit or dosage portion of a compounded preparation at the time of dispensing. Pharmacist must perform calculations and measurements to obtain theoretically 100% of the amount of each ingredient in compounded formulations.

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REFERENCES

[1]. Howard C Ansel Pharmaceutical calculations 14th edition Lippincott, Williams and Wilkins pg;1-105
[2]. Bentley's Textbook of Pharmaceutics 8th edition E.A. Rawlins pg 323-334
[3]. Cooper and Gunn's Dispensing for Pharmaceutical Students 12th edition S.J.Carter pg 31-66
[4]. Brown MC. Introduction to pharmaceutical calculations. Am J Pharm Educ. 2003;67:73–81.
[5]. Ramanathan M, Chau RI, Staubinger RM. Integration of Internet-based technologies as learning tools in a pharmaceutical calculations course. Am J Pharm Educ. 1997;61:141–8.
[6]. Ramanathan M. Use of multiplatform CD-ROMs for disseminating supplementary learning materials in a pharmaceutical calculations course. Am J Pharm Educ. 1999;63:333–8.
[7]. Delafuente JC, Araujo OE, Legg SM. Traditional lecture format compared to computer-assisted instruction of pharmacy calculations. Am J Pharm Educ. 1998;62:62–6

[8]. Lust E, Vuchetich P, Monaghan M. Effectiveness of pharmacy calculation education via the internet: A comparison between campus-based and web-based student performance. American Association of Colleges of Pharmacy Annual Meeting. 2002;103(Jul):33.
[9]. O'Sullivan TA. Comparison of pharmacy calculations taught by traditional lecture vs self-study. American Association of Colleges of Pharmacy Annual Meeting. 1998;99(Jul):98.
[10]. Kier KL, Parteleno PA, Gulbis BE, Mosler CR, Milks MM, et al. Development of a competency exam to assess the skills of pharmacy students via WebCT technology. American Association of Colleges of Pharmacy Annual Meeting. 1999;100(Jul):125.
[11]. Ansel H, Stoklosa MJ. 12th ed. Baltimore, Md: Lippincott Williams and Wilkins; 2006. Pharmaceutical Calculations.
[12]. O'Sullivan TA. Washington, DC: American Pharmacists Association; 2002. Understanding Pharmacy Calculations.
[13]. Zatz JL, Teixeira MG. 4th ed. Hoboken, NJ: Wiley-Interscience; 2005. Pharmaceutical Calculations.
[14]. Khan M, Strauss S, Reddy IK. 2nd ed. Lancaster, Penn: Technomic Publishing Company; 2000. Pharmaceutical and Clinical Calculations.
[15]. Zlatic TD. Re-visioning Professional Education: An Orientation to Teaching. Kansas City, Mo: American College of Clinical Pharmacy; 2005. pp. 96–103.
[16]. Herout PM, Erstad BL. Medication errors involving continuously infused medications in a surgical intensive car unit. Crit Care Med. 2004;32:428–32.
[17]. Oldridge GJ, Gray KM, McDermott LM, Kirkpatrick CMJ. Pilot study to determine the ability of health-care professionals to undertake drug dose calculations. Intern Med J. 2004;34:316–9.
[18]. Williams E, Talley R. The use of failure mode effect and criticality analysis in a medication error subcommittee. Hosp Pharm. 1994;29:331–2. 334–7.