NUCLEAR MEDICINE TECHNOLOGY AND TECHNIQUES

Edited by BERNIER • LANGAN • WELLS

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FOREWORD

We have been waiting for this book for a long time. There are over 140 programs in nuclear medicine technology in the United States alone, turning out over 850 technologists per year. Some of these are in university medical centers; some are in community hospitals; some are affiliated with community colleges; some are at the baccalaureate level.

In most cases, students have had to search for information in textbooks designed primarily for physicians, in government documents, or in journal articles. This book, edited by three distinguished technologists with over a half-century of experience, represents the efforts of technologists, teamed up with nuclear medicine physicians to produce a single volume that covers the entire field. It covers basic and clinical science and has special features, such as chapters on patient care and the use of computers.

All the authors are involved in educational programs for technologists. Although the book is designed as the basic textbook for student technologists, others such as resident physicians will find it to be very helpful. It will also be a useful reference book to be kept at close hand after the technologist graduates and begins clinical work. Although not a detailed procedure manual, it can provide answers to many questions that arise every day.

I have long believed that a nuclear medicine technologist needs to have more different types of skills than any other person involved in the delivery of health care. Consider the various steps in carrying out a procedure: preparation of the radiopharmaceutical requires expertise in chemistry; expertise in pharmacy to ensure sterility and apyrogenicity, in radiation safety, and in accounting to keep adequate records; expertise in physics to understand the instruments and their proper use; expertise in mathematics and computers; and expertise in all the humanistic skills so necessary in caring for patients. It has been said that the best way to care *for* patients is to care *about* patients. Finally, when the day comes for the technologist to become the chief, he or she must have managerial and leadership skills.

I have never understood how so many technologists have been able to do the job so well. This book will help them to do it even better.

Henry N. Wagner, Jr.

PREFACE

The conceptual development for this textbook in nuclear medicine technology began just prior to the annual meeting of the Society of Nuclear Medicine in 1977. At the time, no textbook existed that encompassed all aspects of the curriculum in nuclear medicine technology training programs. Thus we sought to develop a book that could serve as the primary textbook employed by a student technologist during the course of training. We sincerely hope that this book meets this need.

In selecting contributors, we chose to have both a physician and a technologist collaborate on chapters devoted to clinical nuclear medicine and have selected individuals who are expert in their given subject area. We believe that the technologists contribute greatly to the scope of the technical component of these chapters because these individuals produce the images or data that the physician must interpret.

Our thanks go out to many people involved in the production of this book. To our contributors, for their time, effort, and hard work; to Drs. Barry Siegel, Larry Muroff, Daniel Biello, Philip Alderson, Henry Wagner, and Ralph Robinson for tolerating our absences from work; to the technical and secretarial staffs of our institutions; and, most of all, to our wives and children for just putting up with us.

Donald R. Bernier
James K. Langan
L. David Wells

SECTION ONE

Basic sciences

CONTENTS

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Chapter 1

MATHEMATICS AND STATISTICS

Glenn A. Isserstedt

Excitement and enthusiasm are awaiting you, the student, who has elected to specialize in nuclear medicine technology until you are confronted by and reminded that you should have both a firm foundation in mathematics and the ability to apply its principles to this health-related technology. Even though most students have had prior exposure to the fundamentals of mathematics, your present level of understanding and expertise in applying these basic mathematical principles may need either revivification or fortification, or both. In this, you should not allow your enthusiasm or excitement to wane or deteriorate; however, the potentially "well-rounded" student is challenged to totally understand these basic concepts and other science relationships because they collectively form the lintel upon which the suprastructure of clinical nuclear medicine technology is based.

Not an aspect of science or its pragmatic application through technology escapes quantification. The importance of this introductory philosophy may not necessarily be initially or readily apparent. Therefore to be a further challenge, it is suggested that after reading this entire text, you at least review immediately the chapters dealing primarily with basic science. In this way, you will be able to be conversant with the fundamental parameters, which you will use constantly.

Computers and calculators have been introduced into the contemporary instrumentation available to and used in nuclear medicine facilities, and perhaps even more aspects of space-age technology will be incorporated. If nuclear medicine technologists are not cognizant of these "tools," we may very easily become the passive and physical slaves of automation without any active involvement or cerebration.

Numbers, related mathematical operations, and mathematical answers do not naturally exist but were and are generated by man to be useful to and assist him in describing quantifiable aspects of "things" with which he is in contact.

We have spent significant time during our previous educational experiences being repetitiously taught to add, subtract, multiply, and divide. In fact, in most cases, we have conditioned our minds so well to subconsciously know the relationship between numbers that we fall very easily into "number traps" when we are confronted by a confusing quantifiable problem with apparently very little practicality. One applicable way, which may be initially difficult if you are used to memorization for short-term use until after an examination, is to *think*. Mathematics is difficult for the average person because of two reasons: (1) Most texts and teachers do not illustrate mathematical operations step by step but say, "It follows that . . . ." and therefore the student must memorize to have any fluency with mathematical operations, and (2) since the student has been so busy memorizing but not knowing why or the reasoning behind it, he has not developed any skill or expertise with thinking mathematically. You do not need to be a mathematical purist or wizard to think mathematically. Before proceeding, decide that you will be self-confident and that you can and will *think*.

BASIC MATHEMATICAL MANIPULATIONS

There are four basic mathematical (that is, arithmetic or algebraic) operations or manipulations that man can perform, but even more basic to them are the two operations of addition and subtraction, with multiplication being a series of repetitive additions and division being a series of repetitive subtractions.

Addition is a mathematical manipulation that is the inverse of (undoes) subtraction and that joins individual and similar units or groups of addends, for example, $4 + 3 = 7$; microcuries + microcuries = microcuries. This operation uses a plus (+) symbol as an index of the required procedure. The result is the *sum* and is independent of the order in which the addition is performed. In other words, since the order of the units or groups can be exchanged or substituted without effect, addition is therefore said to obey the *commutative* and *associative laws*. The significance of these laws is that a list of numbers may be "added up or added down'' to check addition or to rearrange the addends in a specified or preferred order.

Subtraction is a mathematical manipulation that is the inverse of (undoes) addition and that separates individual and similar units or groups, for example, $8 - 2 = 6$; minutes − minutes = minutes. This operation uses a minus (−) symbol as an index of the required action. The result is the *difference* and is dependent on the order in which the subtraction is performed. Special names are given to the number to be diminished, the number subtracted, and the difference:

Minuend − Subtrahend = Remainder
220 lb − 80 lb = 140 lb

Multiplication is a mathematical manipulation that is the inverse of (undoes) division and that requires that the *multiplicand* be increased by the *multiplier;* both of which collectively can be called factors. This operation uses a times sign (×), parentheses or round brackets ( ), a centered dot or multiplication dot (·), or juxtaposed symbols with no intervening sign, as an index of the required action. The result of the operation is called the *product*. Similarly to addition, this operation obeys the *commutative law,* which allows the factors to be rearranged to simplify multiplication, to check multiplication, or to rearrange for a preferred order.

Multiplicand × Multiplier = Product
$4.87/hour × 40 hours/week = $194.80/week

Division is a mathematical manipulation that is the inverse of (undoes) multiplication and that determines how many times the *divisor* is contained within the *dividend;* the result of the operation or the number of times is called the *quotient*. This operation uses a division sign (÷), a ratio sign or colon (:), or a fraction bar (either / or —) as an index of the required action.

Dividend ÷ Divisor = Quotient
2080 hours/year ÷ 52 weeks/year = 40 hours/week

ORDER OF OPERATIONS

Situations may present in which you will be required to translate verbal statements into mathematical expressions or to solve them. To illustrate, express this statement mathematically, ''A patient's weight in pounds (lb) that is 10 lb less than 50 kilograms (kg)''; the answer is as follows:

$$50 \text{ kg} \times 2.2 \frac{\text{lb}}{\text{kg}} - 10 \text{ lb} = 100 \text{ lb}$$

To arrive at the correct answer in this or any example, you must perform the required mathematical operations in a three-step specific sequence called the *order of operations,* which is as follows:

Step 1: Perform any required mathematical operation within any parentheses, bracket, or brace, if they are present; then
Step 2: Perform multiplications and divisions in order of appearance from left to right; and then
Step 3: Perform additions and subtractions in order of appearance from left to right.

The following example will illustrate the above specified order:

Problem: Assume that the table at which you are studying has a width of 35 inches (in) and that the length is 127 cm longer than the width. Calculate and express the perimeter in inches.

SOLUTION:

1. General: 2 (Width) + 2 (Length) = Perimeter
2. Specific:

a. $2\,(35 \text{ in}) + 2\left(35 \text{ in} + \dfrac{127 \text{ cm}}{2.54 \dfrac{\text{cm}}{\text{in}}}\right) = \text{Perimeter}$

b. $2\,(35 \text{ in}) + 2\left(35 \text{ in} + \dfrac{127 \text{ cm}}{1} \times \dfrac{1 \text{ in}}{2.54 \text{ cm}}\right) = \text{Perimeter}$

c. 2 (35 in) + 2 (35 in + 50 in) = Perimeter
d. 2 (35 in) + 2 (85 in) = Perimeter
e. 70 in + 170 in = Perimeter
f. 240 inches = Perimeter

A pair of parentheses ( ) is the simple-level symbol utilized to indicate a grouping; the second level of complexity is a pair of brackets [ ], which may include a pair of parentheses; the third level of complexity is a pair of braces { }, which may include the previous two levels. The use of all three grouping symbols is illustrated in the following algebraic expression:

$$24 - \left\{4 + \left[\frac{x}{2} + (3 + x)\right]\right\}$$

By substituting the value of 6 for x in the above example, determine the expression's value; any answer other than 8 is incorrect.

FRACTIONS IN REVIEW

Fractions consist of a numerator and denominator. In other words, a fraction represents the quotient of two integers. Several brief descriptions will be helpful.

A *numerator* is the term above or to the left of the dividing line in a fraction; the denominator is divided into this term, which is actually the dividend. A *denominator* is the term below or to the right of the dividing line in a fraction; the numerator is divided by this term, which is actually the divisor.

Fraction types

Proper or simple. The quotient is less than 1 (for example, the width of a piece of imaging film compared to its length):

14 inches/17 inches = 0.8235294

Improper. The quotient is greater than 1 (for example, the comparison of overtime pay to regular pay):

$$\frac{\$6.75/\text{hour}}{\$4.50/\text{hour}} = 1.5$$

Decimal. This fraction type may be expressed as a fraction whose denominator is a power of 10. Proper or improper fractions may be converted into a decimal fractional equivalent form by dividing the numerator by the denominator as follows:

$3/4 = 0.75 \quad 3/2 = 1.5$

Care must be exercised with the number and position of decimal places when you perform additive and subtractive manipulations on decimal fractions. Further, when multiplying decimal fractions, the number of decimal places in the product is the sum of the decimal places in the numbers multiplied.

Handling fractions

Addition and subtraction. The situation will almost never arise in your nuclear medicine technology experience wherein you are required to perform either of these manipulations with any listing of proper fractions:

1. Addition: ¾ + ½ + ⅓
2. Subtraction: ¾ − ⅜ − 3/16

However, a brief review will refresh your basic understanding and familiarization. A suggested and effective alternate method to handle these identified manipulations is to convert the proper fractions to their decimal equivalents and then proceed as indicated by the mathematical indicators or signs.

To complete the comparisons, the decimal-conversion sequence would be represented as follows (note temporary use of zeros to the right of the decimal point):

1. ¾ = 0.7500; ½ = 0.5000; ⅓ = 0.3333
2. ¾ = 0.7500; ⅜ = 0.3750; 3/16 = 0.1875

Therefore:

1. 0.7500 + 0.5000 + 0.3333 = 1.5833
2. 0.7500 − 0.3750 − 0.1875 = 0.1875

For the second example, the lowest common denominator (LCD) is 16. The required treatment and subtractive manipulation are represented as follows:

Step 1: ¾ − ⅜ − 3/16

Step 2: $\frac{3 \cdot 4}{16} - \frac{3 \cdot 2}{16} - \frac{3}{16}$

Step 3: $\frac{12}{16} - \frac{6}{16} - \frac{3}{16}$

Step 4: $\frac{12 - 6 - 3}{16} = \frac{3}{16}$

Step 5: 3/16 = 0.1875

The reasons for the examples and discussion, even though you probably will not be called upon to use these steps in clinical or didactic activities, are that you can very easily *think* mathematically and that the suggested alternate method is mathematically equivalent to the first:

¾	= 0.7500
½	= 0.5000
+ ⅓	= 0.3333

Therefore, the sum is equivalent to 1.5833. You would obtain the same value but in improper fractional form by determining and using the lowest common denominator (LCD). In other words, to add fractions that initially have dissimilar denominators, a common denominator of lowest value must be found and used. From the above example, the number 24 could represent a common denominator, since it is the product of 4 × 2 × 3. However, it is not the lowest; 12 is the lowest common denominator, since each number can be evenly divided into 12. Each numerator will need to be mathematically treated in such a manner to maintain the same relationship with a new denominator of 12 as with their initial and respective denominators. The required treatment and additive manipulations are represented as follows:

Step 1: ¾ + ½ + ⅓

Step 2: $\frac{3 \cdot 3}{12} + \frac{6 \cdot 1}{12} + \frac{4 \cdot 1}{12}$

Step 3: $\frac{9}{12} + \frac{6}{12} + \frac{4}{12}$

Step 4: $\frac{9 + 6 + 4}{12} = \frac{19}{12}$

Step 5: $\frac{19}{12} = 1.583333$

Multiplication and division. Again, in your nuclear medicine technology experience you will almost never need to multiply or divide proper fractions. However, it is very conceivable that these mathematical manipulations will need to be performed on decimal fractions.

The product will need to contain a number of places to the right of the decimal equal to the sum of the decimal places in the numbers multiplied. The following will illustrate this requirement:

1.5 × $4.50/hour = $6.750

The quotient will generally need to contain a number of places to the right of the decimal equal to the number in the dividend minus those in the divisor:

60.000 ml ÷ 4.5 ml = 13.33 ml

UNITS

Rationale

Events that we experience in everyday living and clinical nuclear medicine have both a *quantification* portion and a *qualification* portion.

Example	Quantification	Qualification
Driving in a car	55	miles/hour
Motel lodging	$23.75	1/day
Gamma-ray energy	140,000	eV/1
Radioactive count rate	22.2×10^{10}	counts/minute

The qualification is "what type" and the quantification is "how many." By examination of the qualification portion for each of the above examples, we observe a fraction-resembling entry. These word fractions consist of a word or numerical numerator and a word or numerical denominator. It is important to remember that accompanying all numbers or quantities there must be a qualification portion. No specific information is conveyed by this exemplary statement, "The patient's temperature is 36." Your logical response should be, "36 what?" We most likely know that it means 36 degrees Celsius but we do not know for sure. Without the qualification, the quantification is meaningless and scientifically and technically sloppy. The importance of being precise about the quality or type of data you collect or manipulate cannot be stressed enough. Suppose that you are going to administer a radiopharmaceutical to a patient for an imaging procedure, and on an injection record form you enter "150." Will you remember tomorrow or 1 year later the quality of this numerical datum? Not likely! Was it millicuries or microcuries? Without insulting your intelligence, please train and educate yourself to be totally complete about numerical data. Data need both descriptions—*what* and *how many*.

All the mathematical manipulations that apply to quantity fractions apply to quality fractions. To illustrate, solve the following quality equations by providing either the missing quality fractions or the necessary mathematical operational designations, or both:

1. $\frac{\text{Examinations}}{\text{Day}} \times \frac{\text{Days}}{\text{Week}} \times \frac{\quad}{\quad} = \frac{\text{Examinations}}{\text{Year}}$

2. $\frac{1}{\text{Minute}} \times \frac{\quad}{\quad} = {}^{1}/_{1}$

3. $\frac{\text{Films}}{\text{Procedure}}\ ?\ \frac{\text{Films}}{\text{Box}} = \frac{\text{Box}}{\text{Procedure}}$

In the first example, the missing quality fraction is weeks/year. From the left side, days divide out (that is, cancel out), examination remains in the numerator on the right as it is on the left, and, on the left, we must be able to divide out the weeks from the denominator by placing weeks in the numerator of the missing quality fraction, and, from the right side, we need to end with year in the denominator.

The right-hand side of the second equation is a fraction whose denominator and numerator are of the same type or value, and this equality is most frequently identified by the single number 1. However, as stated above for quality fractions, quantification portions also possess both a numerator and denominator. The missing quality fraction is minutes/1 since we need to be able to divide out minutes in order that the right-hand side results in the illustrated manner.

The third example requires that the first quality fraction be divided by the second quality fraction. When fractions are divided, the law states that the divisor is inverted and multiplied. If this is accomplished, films divide out and box moves to the numerator as is required on the right side.

As a reminder, but not illustrated by an example, is the requirement that when adding or subtracting quality fractions, a common denominator needs to be determined prior to performing the stated manipulations.

Dimensions

Physical measurement involves the comparison between an observed measure (for example, the length of this page) and that of a standard of some type (for example, a centimeter ruler). Whether by custom, legislation or agreement, various fundamental units have been identified and basically agreed upon. A physical measurement is a combined expression; a product of a number *and* a unit. Different measurements may be equivalent even though they may be represented by different numbers and different units, for example:

$$1 \text{ inch} = 2.54 \text{ centimeters} = 2.54 \times 10^{8} \text{ angstroms}$$

Most of the physical quantities that you will encounter in nuclear medicine technology are derived units, the practical units that are actually defined in terms of fundamental or other basic units. In the past, numerous systems have been developed to interrelate derived units, physical laws, and fundamental units. Approximately 40 years ago, a significant transition was manifested among the fundamental mechanical units of length, mass, and time; namely the change from the cgs (centimeter-gram-second) system to the mks (meter-kilogram-second) system. Yet a third system is frequently utilized; the foot-pound-second (ft-lb-s) system. What is the relevance of this background information to studies and activities in nuclear medicine technology? The answer is, since you have no control over the form in which you will be receiving or are requested to manipulate various laboratory or clinical data, you need to understand and demonstrate an ability to mathematically translate and perform the required calculations.

In anticipation of some of your needs and activities in nuclear medicine technology, Table 1-1 identifies

Table 1-1. Selected physical units with system equivalents and interrelations

Mechanical unit	Symbol	System: mks	cgs	ft-lbm-sec*
Area	*A*	1 m^2	10,000 cm^2	10.758 ft^2
Length	*l*	1 m	100 cm	39.37 in (3.28 ft)
Mass	*M*	1 kg	1000 g (gm)	2.205 lb (453.4 g)
Time	*t*	1 sec	1 sec	1 sec
Volume	*V*	1 m^3 (1000 liters)	1,000,000 cc (ml)	35.28 ft^3 (264.17 gal)

**lbm*, Pound-mass (force) at a distance.

several routinely used mechanical units of physical measurement. The different systems referred to above are illustrated along with their respective units and interrelationships.

In science and technology, quantities are the measurements of properties (for example, area, velocity, volume). Logically, for consistency and comparision, measured properties must be evaluated against a common, nonvariable standard unit. To illustrate, the length and width of a clinical procedure room would be measured in meters or feet, not cubits; the former two being nonvariable standard units, whereas the cubit varies from 18 to 22 inches depending on the person obtaining the measurements.

Basic units may be manipulated to result in derived units, which may be further classified as consistent or nonconsistent.

Consistent: Require no conversion factors; calculations employing this type of derived unit are easier to perform and are more reliable, for example:

$$\text{Velocity} = \text{Meters per second} = \frac{\text{Meter}}{\text{Second}}$$

Velocity (that is, speed) is the derived unit that is generated from the basic units of meter (length) and second (time).

Nonconsistent: Require a conversion factor; calculations employing this type of derived unit are more difficult to perform and are less reliable, for example:

$$1 \text{ atomic mass unit (a.m.u.)} = 1.659 \times 10^{-27} \text{ kg}$$
$$1 \text{ curie (Ci)} = 3.7 \times 10^{10} \text{ d} \cdot \text{sec}^{-1}$$
(disintegrations per second)

In these examples, note that each derived unit (a.m.u. or Ci) is dependent on and requires a conversion factor (coefficient) used in conjunction with basic units of mass (grams) and time (seconds). Specifically, these coefficients are the respective numerical values.

Most of the units with which you will come into contact will be of the nonconsistent, derived type. Therefore, be prepared to remember conversion factors and be extra careful when performing calculations with this unit category.

In 1977, the World Health Organization recommended that the medical community throughout the world adopt the *Système International d'Unités (SI)*. As part of that recommendation and unique to the scientific, medical, and technical communities are certain word prefixes and their numerical equivalents that should be thoroughly understood and extensively utilized. Table 1-2 identifies the numerical equivalents of word and symbolic prefixes that can be combined with word units. Most frequently encountered will be the word prefix followed by the symbol for the unit. In actuality, this word-symbol combination represents a numerical product. To illustrate:

$$1 \text{ cm} = 1 \cdot \text{c} \cdot \text{m} = 1 \times (0.01) \times (\text{meter})$$
$$1 \ \mu\text{Ci} = 1 \cdot \mu \cdot \text{Ci} = 1 \times (0.000001) \times (\text{curie})$$

This format and understanding will be extremely useful when scientific notation is discussed later in this chapter. Several important points to remember about symbols and prefixes are as follows:

1. Prefixes that are numerical and multiples of 3 are preferred: 10^6, 10^3, 10^{-3}, and 10^{-6} = mega, kilo, milli, and micro, respectively.
2. Only one prefix is allowed per unit symbol:
   a. *Incorrect form:* μMg (micro-mega-gram), or $(10^{-6}) \times (10^6) \times$ (gram), needs to be rewritten to the following.
   b. *Correct form:* 1 gram, since the product of the word prefixes is numerically equivalent to 1.0.
3. In general, when expressing a fraction, the numerator should have the prefixes, if possible.
4. All unit symbols are to be written without periods (for example, sec, not sec.).
5. Symbols of units named for individuals are to be capitalized; the others are in lower-cased letters (for example, Gy = gray, but m = meters).

As a result of metrication laws (P.L. 93-380 and

Table 1-2. Numerical equivalents of word prefixes and symbols used with units

Numerical equivalent		Word prefix	Symbol
10^{18}	= 1,000,000,000,000,000,000	exa	E
10^{15}	= 1,000,000,000,000,000	peta	P
10^{12}	= 1,000,000,000,000	tera	T
10^{9}	= 1,000,000,000	giga	G
10^{6}	= 1,000,000	mega	M
10^{3}	= 1,000	kilo	k
10^{2}	= 100	hecto	h
10^{1}	= 10	deka	da
10^{0}	= 1	uni-	
10^{-1}	= 0.1	deci	d
10^{-2}	= 0.01	centi	c
10^{-3}	= 0.001	milli	m
10^{-6}	= 0.000001	micro	μ
10^{-9}	= 0.000000001	nano	n
10^{-12}	= 0.000000000001	pico	p
10^{-15}	= 0.000000000000001	femto	f
10^{-18}	= 0.000000000000000001	atto	a

Table 1-3. Former and replacement units represented by symbols and numerical values

Measured property	Unit		
	Name	Symbol	Numerical value
Exposure to ionizing radiation	roentgen	R	$= 2.58 \times 10^{-4} \frac{\text{coulomb}}{\text{kilogram}}$
			$= 1.6123 \times 10^{15} \frac{\text{ionizations}}{\text{gram of air}}$
			$= 2.082 \times 10^{9} \frac{\text{ionizations}}{\text{cc of air}}$
Absorbed dose			
1. Former	rad	rad	$= 100 \frac{\text{ergs}}{\text{gram}}$
2. Replacement	gray	Gy	$= 1 \frac{\text{joule}}{\text{kilogram}}$
			$= 2.39 \times 10^{-1} \frac{\text{calories}}{\text{kilogram}}$
			$= 10^{7} \frac{\text{ergs}}{\text{kilogram}}$
Equivalent absorbed dose	rem	rem	$= 1 \text{ rad} = 100 \frac{\text{ergs}}{\text{gram}}$
Activity of source			
1. Former	curie	Ci	$= 3.7 \times 10^{10} \frac{\text{disintegrations}}{\text{second}}$
2. Replacement	becquerel	Bq	$= 1 \frac{\text{disintegration}}{\text{second}}$
Distances (microscopic)			
1. Former	micron	μ	$= 10^{-6}$ meter
2. Replacement	micrometer	μm	$= 10^{-6}$ meter
Distances (electron microscopic)			
1. Former	angstrom (Ångström)	Å	$= 10^{-10}$ meter $= 10^{-8}$ cm
2. Replacement	a. nanometer	nm	$= 10^{-9}$ meter
	b. picometer	pm	$= 10^{-12}$ meter
Temperature			
1. Former	Fahrenheit	°F	$= (C \times 1.8) + 32°$
2. Replacement	Celsius	°C	$= (F - 32°) \times 0.55$
Pressure (blood)			
1. Former	atmosphere	mm Hg	= 133.322 Pa
2. Replacement	pascal	Pa	= 0.0075 mm Hg
			= newton/meter^2