AL-Mustaqbal university college
Pharmacy department

Pharmaceutical calculation

Ghada Ali PhD candidate
Dhelal Fouad Mohammed
ghada.ali@mustaqbal-college.edu.iq
dhilal.foad@mustaqbal-college.edu.iq

Electrolyte Solutions: Milliequivalents, Millimoles, and Milliosmoles

Lec 4

Introduction

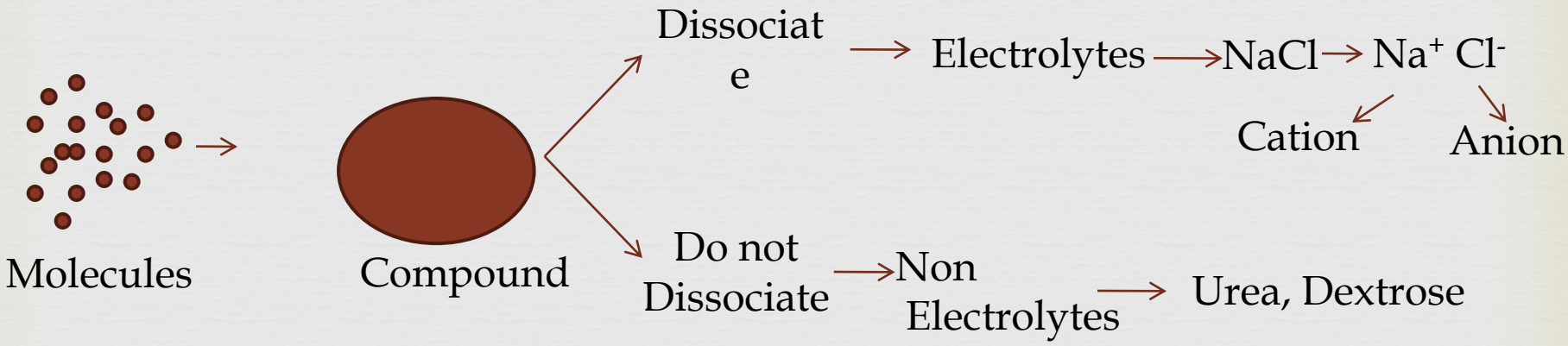
Electrolytes vs. Non - electrolytes

Compounds in solution are often referred to as either electrolytes or non – electrolytes

- Substances that do not dissociate are called non-electrolytes (urea, dextrose) – remain intact
- Those with varying degrees of dissociation are called electrolytes (NaCl)
- Electrolyte ions in blood plasma include cations (Na^+, K^+, Ca^{2+}, and Mg^{2+}) and anions (Cl^-, HCO_3^-, HPO_4^{2-}, SO_4^{2-})

- Electrolytes in human body fluids play an important role in maintaining acid-base balance in body.

- Electrolytes help regulate metabolism in the body and control volume of water in the body.



Pharmaceutical Application

- Electrolyte preparations are employed to treat fluid and electrolyte imbalances in the body.

- Available as oral solutions, syrups, dry granules to be dissolved in water/juice, capsules, tablets and also intravenous infusions.

Milliequivalents

- A chemical unit used by pharmacists, physicians, manufacturers and clinicians across USA to express electrolyte concentration in solution.

- Internationally, molar concentrations (mmol/L or μmol/L) are employed.

- A mEq measures the chemical activity of an electrolyte in solution

- A mEq represents the total number of ionic charges in solution, and the valence (charge) of the ions.

TABLE 12.1 BLOOD PLASMA ELECTROLYTES IN MILLIEQUIVALENTS PER LITER (mEq/L)

CATIONS	mEq/L	ANIONS	mEq/L
Na^+	142	HCO_3^-	24
K^+	5	Cl^-	105
Ca^{++}	5	HPO_4^{--}	2
Mg^{++}	2	SO_4^{--}	1
		$Org.\ Ac.^-$	6
		$Proteinate^-$	16
	154		154

TABLE 12.2 USUAL REFERENCE RANGE OF BLOOD SERUM VALUES FOR SOME ELECTROLYTES[a]

CATION/ANION	mEq/L	SI UNITS (mmol/L)
Sodium	135–145	135–145
Potassium	3.5–5.5	3.5–5.5
Calcium	4.6–5.5	2.3–2.75
Magnesium	1.5–2.5	0.75–1.25
Chloride	96–106	96–106
Carbon Dioxide	24–30	24–30
Phosphorus	2.5–4.5	0.8–1.5

[a] Reference ranges may vary slightly between clinical laboratories based, in part, on the analytical methods and equipment used.

The equivalent is formally defiened as the amount of a substancece which will either :

- React with or supply one mole of hydrogen ions in an acid –base reaction, or
- React with or supply one mole of electrons in a redox reaction

Calculations of Milliequivalents

Equivalent = mass of a given compound / Equivalent weight

Equivalent weight = molecular weight / valence

To convert milligrams (mg) to milliequivalents (mEq)

mEq = (mg x valence) / molecular weight

To convert mEq/mL to mg/mL

mg/mL = (mEq/ml x molecular weight) / valence

CALCULATIONS CAPSULE

Milliequivalents

To convert milligrams (mg) to milliequivalents (mEq):

$$mEq = \frac{mg \times Valence}{Atomic,\ formular,\ or\ molecular\ weight}$$

To convert milliequivalents (mEq) to milligrams (mg):

$$mg = \frac{mEq \times Atomic,\ formula,\ or\ molecular\ weight}{Valence}$$

To convert milliequivalents per milliliter (mEq/mL) to milligrams per milliliter (mg/mL):

$$mg/mL = \frac{mEq/mL \times Atomic,\ formula,\ or\ molecular\ weight}{Valence}$$

TABLE 12.3 VALUES FOR SOME IMPORTANT IONS

ION	FORMULA	VALENCE	ATOMIC OR FORMULA WEIGHT	EQUIVALENT WEIGHT[a]
Aluminum	Al^{+++}	3	27	9
Ammonium	NH_4^+	1	18	18
Calcium	Ca^{++}	2	40	20
Ferric	Fe^{+++}	3	56	18.7
Ferrous	Fe^{++}	2	56	28
Lithium	Li^+	1	7	7
Magnesium	Mg^{++}	2	24	12
Potassium	K^+	1	39	39
Sodium	Na^+	1	23	23
Acetate	$C_2H_3O_2^-$	1	59	59
Bicarbonate	HCO_3^-	1	61	61
Carbonate	CO_3^{--}	2	60	30
Chloride	Cl^-	1	35.5	35.5
Citrate	$C_6H_5O_7^{---}$	3	189	63
Gluconate	$C_6H_{11}O_7^-$	1	195	195
Lactate	$C_3H_5O_3^-$	1	89	89
Phosphate	$H_2PO_4^-$	1	97	97
	HPO_4^{--}	2	96	48
Sulfate	SO_4^{--}	2	96	48

[a] Equivalent weight $= \dfrac{\textit{Atomic or formula weight}}{\textit{Valence}}$

Example Calculations of Milliequivalents

- **What is the concentration, in milligrams per milliliter, of a solution containing 2 mEq of potassium chloride (KCl) per milliliter?**

Molecular weight of KCl = 74.5

mg/mL = (mEq/mL x molecular weight) / valence
= 2 x 74.5 = 149 mg/mL, answer.

- **What is the concentration, in grams per milliliter, of a solution containing 4 mEq of calcium chloride ($CaCl_2 \cdot 2H_2O$) per milliliter?**

Formula weight of $CaCl_2 \cdot 2H_2O$ = 147

mg/mL = (mEq/mL x molecular weight) / valence

= 4 x 147 / 2

= 294 mg/ml = 0.294 g/ml answer

- **What is the percent (w/v) concentration of a solution containing 100 mEq of ammonium chloride per liter?**

Molecular weight of NH_4Cl = 53.5

100 mEq / 1000ml = x mEq /1ml

x= 0.1 mEq / ml

mg/mL = (mEq/mL x molecular weight) / valence

= 0.1 x 53.5 /1

= 5.35 mg / ml = 0.00535 g/ml

= 0.535 % answer.

- **A solution contains 10 mg/100 mL of K ions. Express this concentration in terms of milliequivalents per liter?**

Atomic weight of K = 39

10 mg / 100 ml = x mg /1ml

x= 0.1 mg / ml

mg/mL = (mEq/mL x molecular weight) / valence

0.1 = (mEq/ ml x 39) / 1

mEq / ml = 0.00256 = 2.564 mEq / L

- **A solution contains 10 mg/100 mL of Ca ions. Express this concentration in terms ofmilliequivalents per liter?**

  Atomic weight of Ca 40

  Equivalent weight of Ca 40 / 2 = 20

  mEq/L = (mg / L x valance) / atomic weight

  = (100 mg / ml x 2) / 40

  = 5 mEq/L answer.

- **A magnesium (Mg) level in blood plasma is determined to be 2.5 mEq/L Express this concentration in terms of milligrams?**

  Atomic weight of Mg 24

  Equivalent weight of Mg 24 / 2 = 12

  mg / L = (mEq / L x molecular weight) / valence

  = (2.5 x 24) / 2

  = 30 mg / L answer.

- **How many milliequivalents of potassium chloride are represented in a 15 mL dose of a 10% (w/v) potassium chloride elixir?**

  Molecular weight of KCl = 74.5

  Equivalent weight of KCl = 74.5

  10 g / 100 ml = x / 15 ml

  x = 1.5 g = 1500 mg

  mg = (mEq x molecular weight) / valence

  mEq = (1500 x 1) / 74.5 = 20.13 mEq answer.

- How many milliequivalents of magnesium sulfate are represented in 1 g of anhydrous magnesium sulfate (MgSO4)?

  Molecular weight of MgSO4 = 120

  Equivalent weight of MgSO4 = 60

  mg = (mEq x molecular weight) / valence

  1000 mg = (mEq x 120) / 2

  mEq = 2000 / 120 = 16.67 mEq answer

- **How many milliequivalents of Na would be contained in a <u>30 mL</u> dose of the following solution?**

R/ **Disodium** hydrogen phosphate 18 g
Sodium biphosphate 48 g
Purified water ad 100 mL

1- For Disodium hydrogen phosphate: Formula Na2HPO4.7H2O

Molecular weight = 268 and the equivalent weight =134

18/100 = x / 30 x = 5.4 g = 5400 mg

mEq = (mg x valance) / molecular weight

= (5400 x 2) / 268 = 40.29 mEq

2- For Sodium biphosphate : Formula NaH2PO4.H2O

Molecular weight = 138 and the equivalent weight =138

48/100 = x / 30 x = 14.4 g = 14400 mg

mEq = (mg x valance) / molecular weight

= (14400 x 1) / 138 = 104.35 mEq

- **A person is to receive 2 mEq of sodium chloride per kilogram of body weight. If the person weighs 132 lb., how many milliliters of a 0.9% sterile solution of sodium chloride should be administered?**

Molecular weight of NaCl = 58.5
Equivalent weight of NaCl = 58.5

1 kg = 2.2 lb. Weight of person in kg = 132 lb / 2.2 lb = 60 kg

mg = (mEq x molecular weight) / valence
= (2 x 58.5) / 1 = 117 mg to be received per kg body wight
117 x 60 = 7020 mg = 7.02 g to be recived for this person

0.9 g	100 ml	
7.02 g	x ml	x = 780 ml answer


THANK YOU!