IOWA | Iowa Head and Neck Protocols

Maximum Recommended Doses and Duration of Local Anesthetics

Monday, May 8, 2017

See also: Medication Errors (/node/1133)

Reference by Example

Example calculation - lidocaine when administered without vasoconstriction

- Total dose that can be used
  - Maximum dose of lidocaine (plain, without vasoconstrictor) is 4.5 mg/kg (not to exceed 300 mg)
  - Example patient weight - 10 kg
  - Total dose that can be used for this patient = 4.5 mg/kg x 10 kg = 45 mg
- Maximum volume of lidocaine administered
  - Depends on concentration (see conversion table below)
  - E.g. for ***1%* lidocaine**: contains ***10 mg of lidocaine per 1 mL***
  - Max volume of ***1% lidocaine*** that can be administered to a 10 kg patient = 45 mg / ***10mg/m***L = 4.5 mL

Overview

Systemic toxicity may occur from administration of local anesthetics and is related to the serum concentration of the drug as it is absorbed into the circulation. This serum concentration is influenced by the dose, site, and method of drug administration (Berde & Strichartz, Butterworth et eds, Catterall & Mackie, Curtis et al, Rosenberg et al, Schwartz & Kaufman).

Local anesthetics may be injected or topically applied to skin and mucosal membranes. Topical application usually results in a more rapid and potent analgesic response when applied to mucous membranes -which are more permeable to drug absorption - when compared to intact skin (Butterworth et eds). The state of the chosen site also influences serum drug concentration. Tissue characteristics such blood supply (increased vascularity) and integrity of surface epithelium (if disrupted) can increase systemic uptake of local agents and lower the maximum safe dosage (Butterworth et eds, Catterall & Mackie, Schwartz & Kaufman, Rosenberg et al).

Vasoconstricting agents are often included with both topical (e.g. nasal spray, 4% lidocaine with 1% phenylephrine) and injectable (e.g. 1% lidocaine with 1:100,000 epinephrine) anesthetics.

The maximum safe dosage of local anesthetics, whether topical or injected, is generally increased when used in combination with a vasoconstricting agent. Serum concentration increases at a slower rate when blood flow is diminished at the site of treatment as the anesthetic is sequestered. This same process will increase the duration of analgesic effect for a given anesthetic when administered along with a vasoconstrictor (Berde & Strichartz, Catterall & Mackie, Drasner, Hilal-Dandan & Brunton, Schwartz & Kaufman).

Due to concern of ischemia and necrosis, use of local anesthetic-vasoconstrictor combination solutions is generally discouraged in areas with limited blood supply with reports indicating these areas may include the digits, penis, tip of the nose, and earlobe (McGee, Nolan).

Other factors to be considered prior to administering local anesthesia include the age of the patient and conditions such as renal dysfunction, hepatic dysfunction, heart failure, and pregnancy. The metabolism and excretion of local anesthetics plays a major role in determining serum drug concentrations -- any factor that modifies these parameters will also influence appropriate drug dosing for these patients (Rosenberg et al).

Local anesthetics can be classified as either amide (e.g. lidocaine) or ester (e.g. tetracaine).

Primary systemic toxicities of local anesthetics are central nervous system (CNS) dysfunction which is initially CNS stimulation manifesting as tremors and/or convulsions. Subsequently CNS depression may occur with respiratory failure and cardiovascular disturbances (Catterall & Mackie, Curtis et al).

If ingested orally, ester-type anesthetics may initially cause gastric irritation and related symptoms of vomiting and abdominal pain (Curtis et al). Methemoglobinemia can occur as a more delayed presentation (Curtis et al). Sedative effects of local anesthetics may be synergistically increased when using these drugs in combination with narcotics.

Common Maximum Recommended Doses

A compilation from references: AAP, AAPD, Cote, Wilson, & Work Group on Sedation; Access Pharmacy drug monographs; Berde & Strichartz; Butterworth, Mackey, & Wasnick (eds.); Catterall & Mackie; Cousins & Bridenbaugh (eds.) 2009; Dorian 2015; Drasner; Hilal-Dandan & Brunton (eds.); Keddis; Micromedex; Rosenberg, Veering, & Urmey 2004; Schwartz & Kaufman 2015; Williams & Walker 2014.

The values cited below include all consistent recommended values from the above sources, with the exception of: maximum values recommended by Butterworth et eds for procaine alone (12 mg/kg) and bupivacaine alone (3 mg/kg); by Berde & Strichartz for total dose of procaine alone (500 mg) and total procaine with epi (600 mg).

These doses are based on risk for systemic toxicity and possible death. Maximum values to avoid local toxicity may be much lower.

ANESTHETIC ***ROUTE OF ADMINISTRATION***	MAXIMUM SINGLE DOSE WITHOUT VASOCONSTRICTOR (MG/KG)	MAXIMUM SINGLE DOSE WITH VASOCONSTRICTOR (MG/KG)	ONSET OF ACTION (MIN)	DURATION OF ACTION IN ISOLATION (MIN) [W/ VASOCONSTRICTOR, IF AVAILABLE]
Esters				
Procaine *infiltration, subcutaneous*	7-10 - not to exceed 1000 mg total	10		20-30 [30-45 w/ epinephrine]
Chloroprocaine *infiltration, subcutaneous*	10-12 - not to exceed 800 mg per dose	14 - not to exceed 1000 mg per dose	6-12	30-60 [60-90 w/ epinephrine]
Tetracaine *topical, skin & mucous membranes* *infiltration, subcutaneous*	1-3 - topical skin, adults: 7g/24h - topical skin, children: 2g/24h - topical mucous membranes: 20 mg/dose - infiltration, subcutaneous: 3 mg/kg per dose	1.5	3-8	120-180
Amides				
Lidocaine *topical, skin & mucous membranes*	3-4.5 - topical skin: 4.5 mg/kg per dose, not to exceed 300 mg	6-7 (infiltration) - not to exceed 500 mg per dose	- infiltration 1-3 - topical skin 3-5	30-120 [120-240 w/ epinephrine]

ANESTHETIC ***ROUTE OF ADMINISTRATION***	MAXIMUM SINGLE DOSE WITHOUT VASOCONSTRICTOR (MG/KG)	MAXIMUM SINGLE DOSE WITH VASOCONSTRICTOR (MG/KG)	ONSET OF ACTION (MIN)	DURATION OF ACTION IN ISOLATION (MIN) [W/ VASOCONSTRICTOR, IF AVAILABLE]
infiltration, subcutaneous	- topical mucous membranes: 4.5 mg/kg per dose, not to exceed 300 mg per dose, maximum 2400 mg/24h - infiltration, subcutaneous: 4.5 mg/kg per dose			
Mepivacaine *infiltration, subcutaneous*	4.5-5 - not to exceed 400 mg per dose - maximum 1000 mg/24h	6.6 - not to exceed 400 mg per dose if with levonordefrin - not to exceed 500 mg per dose if with epinephrine	3-20	45-90 [60-330 w/ levonordefrin, 120 w/ epinephrine]
Bupivacaine *infiltration, subcutaneous*	2-2.5 - not to exceed 175 mg per dose - maximum 400 mg/24h	2.5-3 - not to exceed 225 mg per dose - maximum dose 400 mg/24h	2-10	120-175 [180-480 w/ epinephrine]
Levobupivacaine *infiltration, subcutaneous*	2 - not to exceed 150 mg per dose	3		180-360
Ropivacaine *infiltration, subcutaneous*	2-3 - not to exceed 225 mg per dose	3-4 - not to exceed 225 mg per dose	3-15	120-240 [180-480 w/ epinephrine]

ANESTHETIC ***ROUTE OF ADMINISTRATION***	MAXIMUM SINGLE DOSE WITHOUT VASOCONSTRICTOR (MG/KG)	MAXIMUM SINGLE DOSE WITH VASOCONSTRICTOR (MG/KG)	ONSET OF ACTION (MIN)	DURATION OF ACTION IN ISOLATION (MIN) [W/ VASOCONSTRICTOR, IF AVAILABLE]
Articaine *infiltration, subcutaneous*	n/a	7	1-9	[60-230 w/ epinephrine]

Calculation of Maximum Recommended Dosage:

CONCENTRATION %	**MG/ML**
4	40
3	30
2.5	25
2	20
1	10
0.5	5
0.25	2.5
0.125	1.25

Average Weight of Pediatric Patients

Adapted from the Centers for Disease Control and Prevention Clinical Growth Charts 2001.

Boys:

Age (year)	Mean (kg)	Range - 3% to 97% (kg)
1	10.3	8.4 - 12.7
2	12.7	10.4 - 15.6
3	14.3	11.8 - 17.9
4	16	13 - 21
5	18.5	15 - 24.5
6	21	16.5 - 28
7	23	18 - 31.8
8	25.5	20 - 37
9	28.5	22 - 43
10	32	24 - 49
11	36	26.5 - 56
12	40.5	29 - 63
13	45.5	32.5 - 70
14	51	37 - 76.5
15	56	41.3 - 83
16	61	45.5 - 88.5
17	64.5	49 - 93.5

Girls:

Age (year)	Mean (kg)	Range - 3% to 97% (kg)
1	9.5	7.8 - 11.7
2	12	10.0 - 15.0
3	13.9	11.3 - 17.9
4	16	13 - 21
5	18	14 - 25
6	20	16 - 28.5
7	22.5	17.5 - 33
8	25.5	19.5 - 38.5
9	29	21.5 - 44.5
10	33	24 - 51
11	37	26.5 - 58.5
12	41.5	30 - 65.5
13	46	33 - 72
14	49	36.5 - 77.5
15	52	39.5 - 81.5
16	54	42 - 84.5
17	55	43 - 86

Example calculation - Lidocaine

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  - Maximum dose of lidocaine (plain, without vasoconstrictor) is 4.5 mg/kg (not to exceed 300 mg)
  - Example patient weight - 10 kg
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  - Depends on concentration (see conversion table above)
  - E.g. for 1% lidocaine: contains 10 mg of lidocaine per 1 mL
  - **Max volume of 1% lidocaine that can be administered to a 10 kg patient = 45 mg / 10mg/mL = 4.5 mL**

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