

Table 24. *Formulations of commonly used epidural steroids.*

Amount of steroid	Depo-Medrol Methylprednisolone			Aristocort Triamcinolone Diacetate	Kenalog Triamcinolone Diacetate	Celestone Betamethasone
	20 mg/mL	40 mg/mL	80 mg/mL	40 mg/mL	40 mg/mL	6 mg/mL
Polyethylene glycol 3350	29.5	29.1	28.2	30	--	--
Polysorbate 80	1.97	1.94	1.88	2	0.4	--
Benzyl alcohol	6.9	6.8	6.59	--	--	3.4
Dibasic sodium phosphate	9.3	9.16	8.8	9	9	--
Edetate disodium	--	--	--	--	--	7.1
Edetate disodium	--	--	--	--	--	0.1
Benzalkonium chloride	--	--	--	--	--	0.2

shows formulations of commonly used epidural steroids. Dexamethasone is not being discussed since it is a nonparticulate and short-acting steroid with the least side effects, but it is associated with some side effects.

Overall, systemic side effects are significant with the influence of corticosteroids on the metabolism of carbohydrates, fats, proteins, and purine. They can also affect electrolyte and water balance and may affect the functions of the CNS and of the cardiovascular, renal, endocrine, reproductive, and immune systems, as well as the bones and muscles (1077). Long-term effects may be caused directly by excess glucocorticoid in the circulation or indirectly through suppression of the HPA. It is also common that patients presenting to interventional pain management may be taking long-term steroids for multiple medical problems and also may be receiving intra-articular steroid injections.

The specific effects on the immune system are especially worrisome during the COVID-19 pandemic. While there are no data available with regard to the effects of epidural administration of glucocorticoids on the immune system, there are data available regarding systemic administration with high dose glucocorticoid therapy, equivalent to doses of 40 mg or more of prednisone per day. With high doses, there is an immediate risk of infection due to inhibition of phagocyte cell function, which abates after completion of therapy (1085). In patients with rheumatoid arthritis, acute effects of 1 gm of intravenous methylprednisolone showed development of leukopenia within 2 hours of the dose, which peaked at 6 hours, and resolved by 24 hours. In addition, doses of less than 40 mg, considered as low to moderate, have been shown to reduce T lymphocytes with delayed hypersensitivity responses. With long-term low dose

usage, some inhibition of immune responses may increase with the duration of therapy (1086). Multiple issues related to vaccination have been discussed in the past (1087-1089); however, not specifically with the COVID-19 virus. Considering the literature, short-term therapy with low dose within appropriate duration of 6 to 13 weeks may not have any significant effect. The Advisory Committee on Immunization Practices (ACIP) (1090) and the CDC (1091) advise to defer live vaccinations for at least one month after discontinuation of high dose systemically absorbed glucocorticoid therapy administered for 14 days.

10.2 Side Effects of Local Anesthetics

Historically, the use of procaine was extensively utilized following cocaine; however, the introduction of lidocaine in 1948 and bupivacaine, which was introduced in 1963, has been extensively used outside of the epidural space with lidocaine also used for intra-articular injections in chronic pain management. The mechanism of action of intravenous lidocaine in neuropathic pain cannot be explained by blockade of voltage-gated Na⁺ channels alone. The clinical effects include reduction of spontaneous pain, allodynia, and hyperalgesia. Further, local anesthetic infusions have been utilized in various types of pain providing longer term relief than the expected duration of the local anesthetic (1092). Local anesthetics also have systemic and local toxic effects. Systemic toxicity relates to the relatively narrow difference between therapeutic plasma levels and toxic levels (1093). Peak plasma levels are determined by the dose and rate of systemic absorption. The genes controlling the subunit of Na⁺ channels give rise to different pharmacological and biophysiological profiles of Na⁺ channels through the body (1092). Overall, levobupivacaine