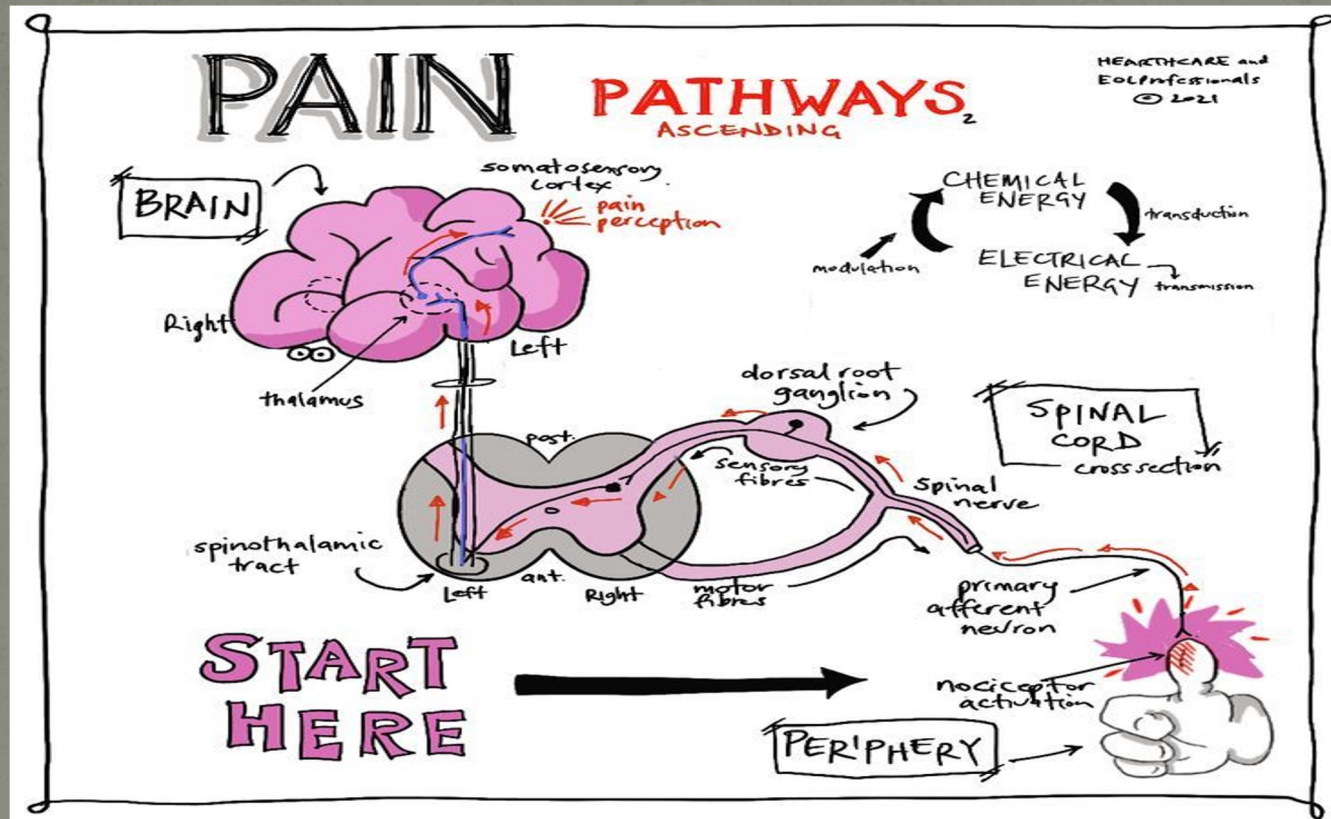


Basic principles of pain pathways and action potentials



Presented By: Andy Baum, CRNA, MSN

Disclosures

I have no relationships to disclose

Goals:

Introduction to action potentials and pain pathways

Pharmacology- Opioid Alternatives

Trivia!!

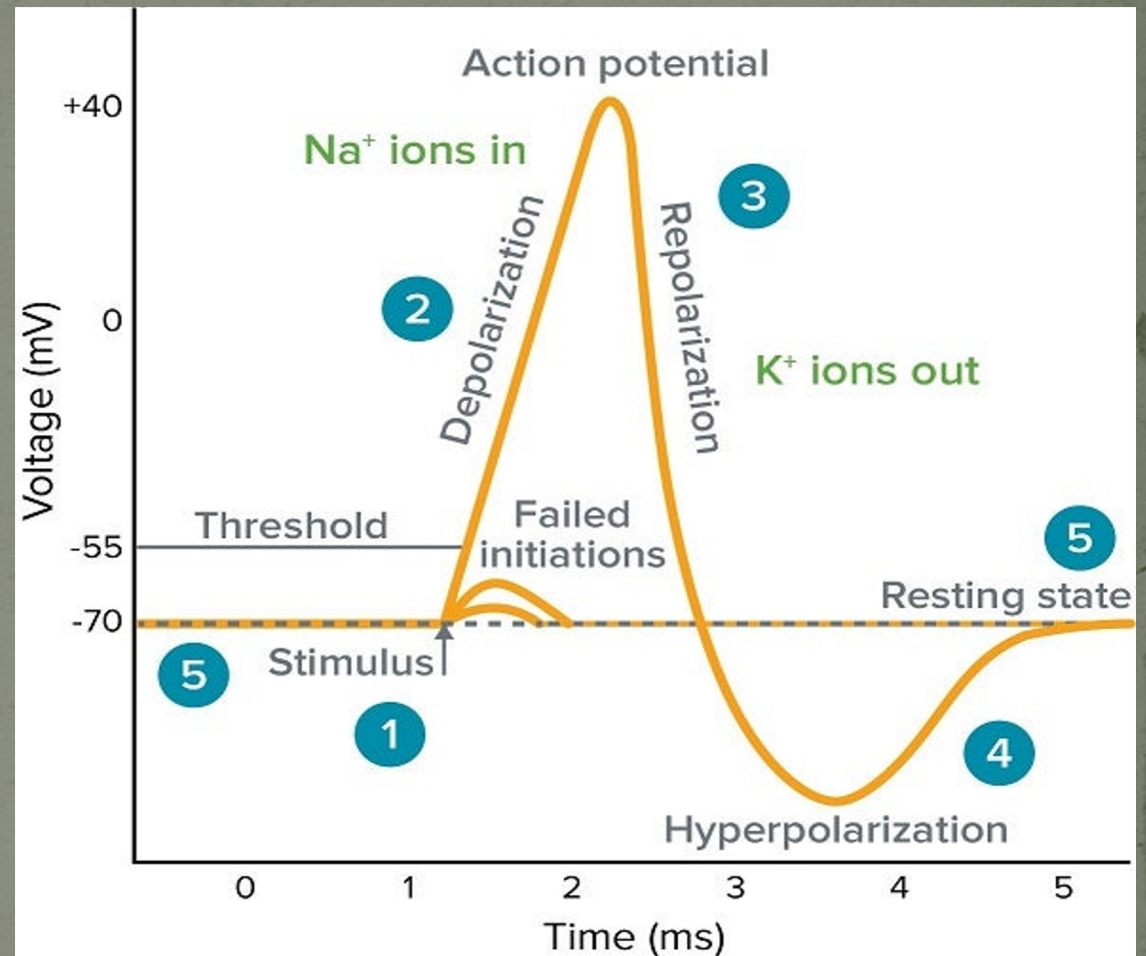
What "Pain Killing Medication" was featured in a "One Day, One Game" issue of ESPN The Magazine?

True or False:

a patient can have just about any surgical procedure performed and have minimal/ zero exposure to opioid narcotics?

Action Potentials- Physiologic Communication

- **Threshold**
 - if reached pain signal is activated...
- **Depolarization**
 - All or Nothing response @ Threshold
 - Na⁺ ion/ channels
- **Repolarization**
 - attempt to get back to baseline
 - K⁺ ion/ channels
- **Hyperpolarization**



Pain Pathways

Transduction-

Process by which a noxious stimulus (i.e. thermal, chemical, or mechanical stimuli) is converted to an electrical impulse (action potential) in the sensory nerve endings

Transmission-

Conduction of electrical impulses to Central Nervous System CNS (through 1st, 2nd, and 3rd order neurons). The major connections for these nerves located in the dorsal horn of spinal cord and thalamus with projections into the somatosensory cortices

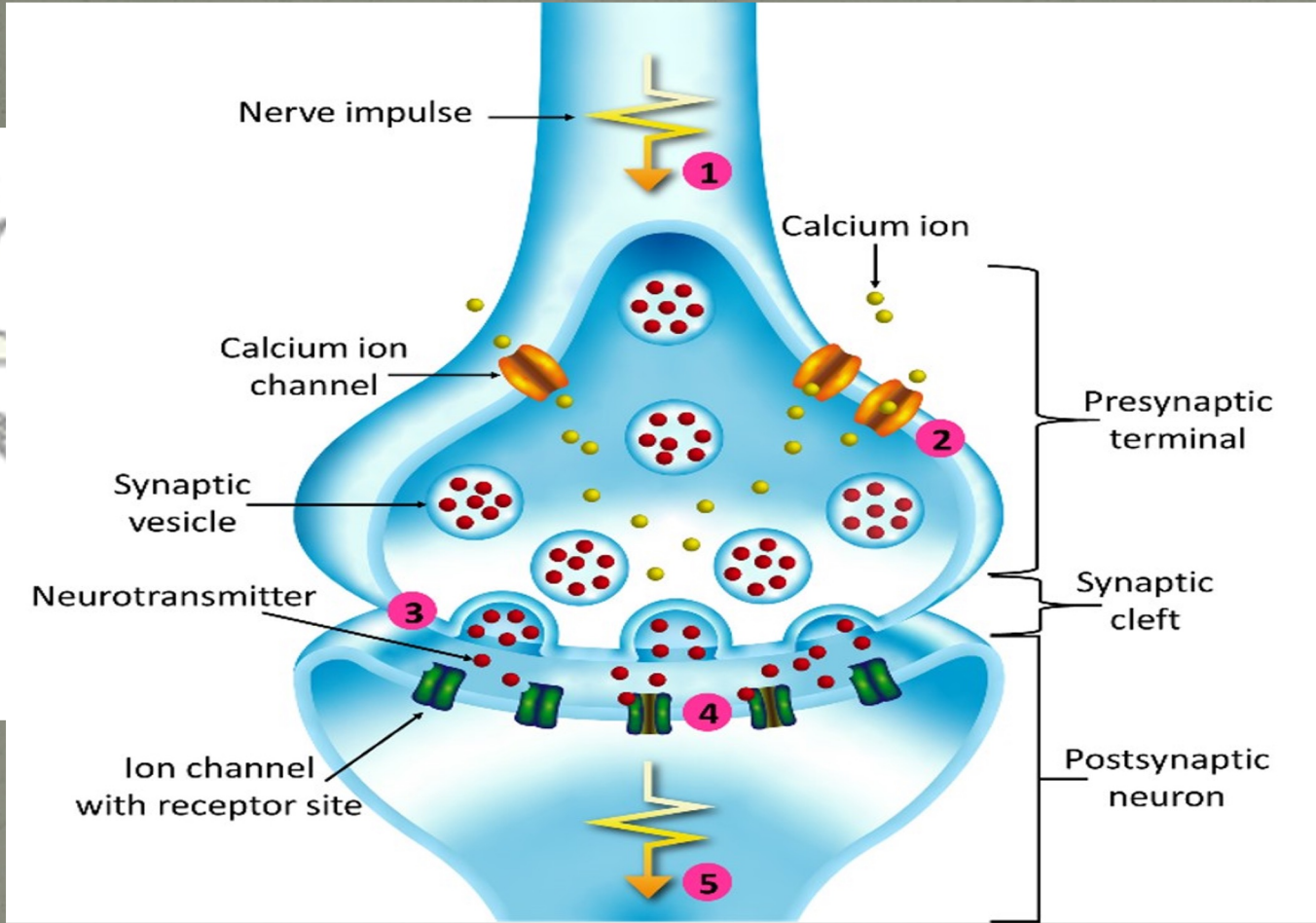
- Basically how and action potential travels from periphery to CNS

Modulation-

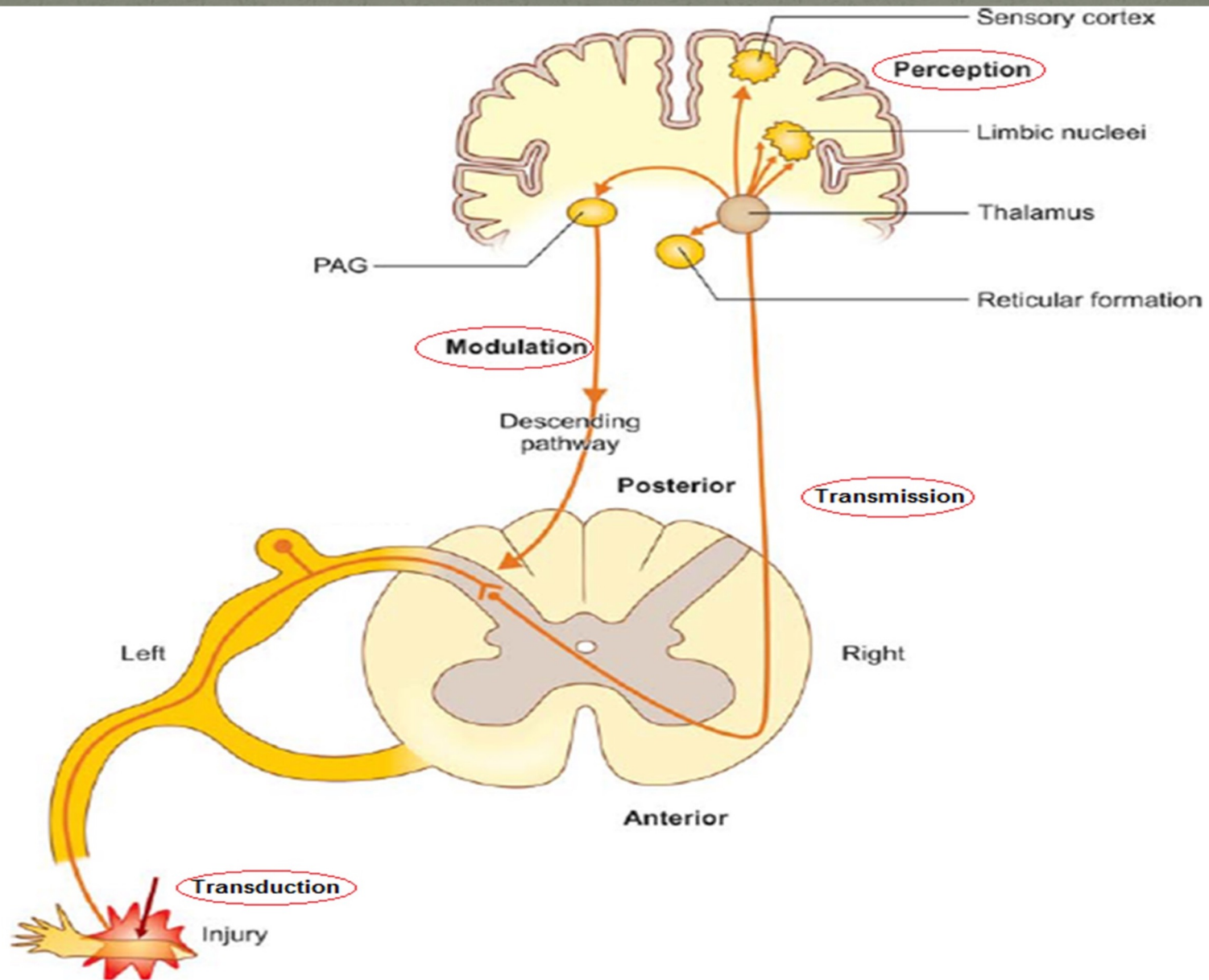
Process of altering **afferent** pain transmission along the pain pathway. Both inhibitory and excitatory mechanisms modulate pain impulse transmission in the CNS and PNS (Modulation can be either inhibitory or augment the nerve impulses)

Perception-

Occurs in the thalamus, where the cortex discriminates specific sensory experiences. Occurs once the stimulus of the pain is recognized by various areas in the brain, primarily within the cortex (somatosensory area).



Pain Pathways- animation



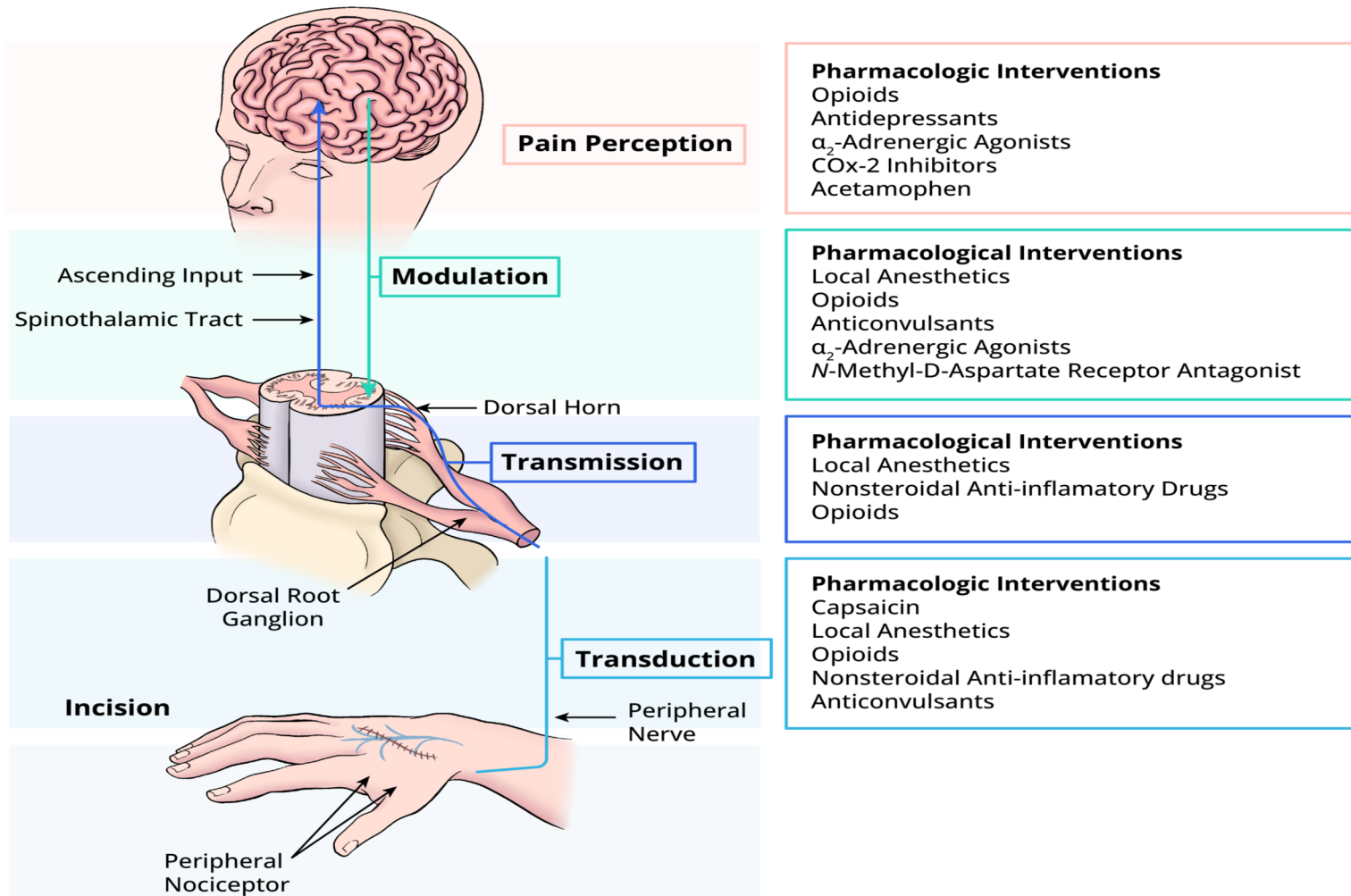
Modulation- Neurotransmitters★

Neurotransmitter	Receptor ¹	Effect on Nociception
Substance P	NK-1	Excitatory
Calcitonin gene-related peptide		Excitatory
Glutamate	NMDA, AMPA, kainite, quisqualate	Excitatory
Aspartate	NMDA, AMPA, kainite, quisqualate	Excitatory
Adenosine triphosphate (ATP)	P ₁ , P ₂	Excitatory
Somatostatin		Inhibitory
Acetylcholine	Muscarinic	Inhibitory
Enkephalins	μ, δ, κ	Inhibitory
β-Endorphin	μ, δ, κ	Inhibitory
Norepinephrine	α ₂	Inhibitory
Adenosine	A ₁	Inhibitory
Serotonin	5-HT ₁ (5-HT ₃)	Inhibitory
γ-Aminobutyric acid (GABA)	A, B	Inhibitory
Glycine		Inhibitory

Excitatory NTs- mediate pain

Inhibitory NTs- inhibit pain

Multi-Modal Approach to Pain Mgmt



Multi-Modal Approach to Pain Mgmt

Drugs	Targets	Mechanisms	Functional Consequences	Side Effects
Opioids	G protein-coupled μ -, δ -, κ -receptors	<ul style="list-style-type: none"> ↓ cAMP ↓ Ca^{2+} currents ↑ K^+ currents 	<ul style="list-style-type: none"> ↓ Excitability of peripheral and central neurons ↓ Release of excitatory neurotransmitters 	<ul style="list-style-type: none"> μ, δ: sedation, nausea, euphoria/reward, respiratory depression, constipation κ: dysphoria/aversion, diuresis, sedation
NSAIDs	Cyclooxygenases (COX-1, COX-2)	<ul style="list-style-type: none"> ↓ Prostaglandins ↓ Thromboxanes 	<ul style="list-style-type: none"> ↓ Sensitization of sensory neurons ↑ Inhibition of spinal neurons 	<ul style="list-style-type: none"> Nonselective: gastrointestinal ulcers, perforation, bleeding, renal impairment COX-2: thrombosis, myocardial infarction, stroke
Serotonin agonists	G protein-coupled 5-HT receptors 5-HT ₃ : ion channels	<ul style="list-style-type: none"> ↓ cAMP (5-HT₁) ↑ cAMP (5-HT_{4,7}) ↑ PLC (5-HT₂) 	<ul style="list-style-type: none"> ↓ Release of excitatory neuropeptides ↓ Neurogenic inflammation ↑ Vasoconstriction 	Myocardial infarction, stroke, peripheral vascular occlusion
Antiepileptics	Na^+ , Ca^{2+} channels GABA receptors	<ul style="list-style-type: none"> ↓ Na^+ currents ↓ Ca^{2+} currents ↑ GABA receptor activity 	<ul style="list-style-type: none"> ↓ Excitability of peripheral and central neurons ↓ Release of excitatory neurotransmitters 	Sedation, dizziness, cognitive impairment, ataxia, hepatotoxicity, thrombocytopenia
Antidepressants	Norepinephrine/5-HT transporters Na^+ , K^+ channels	<ul style="list-style-type: none"> ↓ Norepinephrine/5-HT reuptake ↓ Na^+ currents ↑ K^+ currents 	<ul style="list-style-type: none"> ↓ Excitability of peripheral and central neurons 	Cardiac arrhythmia, myocardial infarction, sedation, nausea, dry mouth, constipation, dizziness, sleep disturbance, blurred vision

cAMP, cyclic adenosine monophosphate; COX, cyclooxygenase; GABA, γ -aminobutyric acid; 5-HT, 5-hydroxytryptamine; NSAIDs, nonsteroidal anti-inflammatory drugs; PLC, phospholipase C.

What "Pain Killing Medication" was featured in a "One Day, One Game" issue of ESPN The Magazine?

This article appears in the Nov. 28, 2011, "One Day, One Game" issue of ESPN The Magazine.

IT'S BEEN A WEEKLY -- and sometimes daily -- headline in Dallas: *Tony Romo Gets Pain-Killing Injection*. Ever since he fractured a rib during a Week 2 win over the 49ers, Romo's pregame shots have been news, mostly because he plays QB for America's Team and partly because he's a reality show waiting to happen. But the story also speaks to a

By midseason, the pregame training room of every NFL team looks like a flu clinic. Players line up to get injected with a 1.5 inch, 22-gauge needle filled with Ketorolac tromethamine -- Toradol -- the NFL's most commonly used quick fix for what ails players. Romo has

never revealed whether, in addition to the Reveal vest he wore for almost two months, he was taking Toradol or Marcaine, a numbing shot, or both. "Your first day in the league is the last day you'll ever be 100 percent healthy," says Eagles center *Jamaal Jackson*, an eight-year vet who suffered a torn ACL in 2009 and a torn triceps in 2010. He's no stranger to a game-day shot to help deal with the pain. "That's part of football," he says. "You take every legal advantage possible."

Toradol is a highly potent, nonsteroidal anti-inflammatory (NSAID). Since being approved by the FDA in 1989, the drug has primarily been used in operating rooms to relieve pain associated with outpatient surgery. It is a non-narcotic and not physically addictive. Over the past decade, though, Toradol has taken up secondary residence in NFL locker rooms. The drug, which is basically beefed-up Motrin, comes in pill form. But NFL players typically get injected with a 60 mg shot because it acts faster.

Eddie Matz is a senior writer for ESPN The Magazine. Follow [The Mag](#) on Twitter, and like us on [Facebook](#).

True or False:

a patient can have just about any surgical procedure performed and have minimal/ zero exposure to opioid narcotics?

TRUE!

Opioid Alternatives

Regional Anesthesia/ Interventional Pain Procedures

Non-narcotic adjuncts

NSAIDs/ Steroids

Local Anesthetics

Anti-Convulsants

Anti-Depressants

Alpha 2-Adrenergic Agonists

NMDA Antagonists

Beta- blockers

GLP-1 Drugs (?)



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