Current treatments of pain heavily rely on opioids, resulting in significant side effects such as addiction, tolerance, leading to the Opioid Overdose Crisis as we know of today. Smart drug delivery systems may provide an effective solution. Here I present the development of externally-triggerable drug delivery systems for on-demand, repeatable and adjustable local anesthesia, where the timing, duration, and intensity of nerve block can be controlled through external energy triggers such as light and ultrasound. In addition to traditional pharmacological approaches, bioelectronic platforms to enhance our insights into the diagnostics and mechanisms of pain and will also be discussed. Through pharmacological, optical, and electrical toolsets, we aim to develop effective therapeutic solutions to neurological disease states.

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