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Development of novel targeted drug delivery systems for the treatment of epilepsy

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Epilepsy is characterized by abnormal electrical activity within the brain, which can result in either generalized or partial seizures. In order to control seizure activity a person must take anti-epilepsy medication, normally in the form of a tablet. The goal is to deliver the drug to the brain in quantities sufficient to eliminate seizures without causing adverse effects. In 30% of the cases, sufferers of epilepsy are unable to be medicated due to the dose required to suppress seizures causing adverse side effects. In addition, other anti-epilepsy treatment such as brain surgery or vagus nerve stimulator (VNS) implantation is very expensive treatments and needs high technology and advanced equipment. Therefore there is a need to develop a delivery system for these epilepsy sufferers that is therapeutic but not toxic and also accessible and affordable for every patient all over the world. Recently there has been much interest in the use of polymeric carriers as localized delivery devices especially for the central nervous system. Bypassing the blood-brain barrier, a polymeric carrier implanted directly into the brain tissue allows the possibility of therapeutic levels of drug being confined to the region of interest, thus eliminating systemic toxicity compared to oral drug administration. Among polymers conducting polymers (CPs) have been shown to act as very effective drug reservoir with the ability to deliver drugs upon electrical stimulation. However, one limiting factor for these CP systems is their limited drug loading capacity which restricts the life time of delivery. In order to improve the drug delivery lifetime of the CP device we aimed to develop a CP drug delivery system whereby the drug is encapsulated within a reservoir and release is mitigated by opening and closing a CP "gate". During my research designing and producing of this gate has been done. I have produced a CP gate which is a platinised PVDF membrane upon which polypyrrole with different counterions has been deposited. I have demonstrated that it is possible to open and close this gate as a function of applied electrical stimulation. Therefore, I have investigated and successfully controlled the transport of lacosamide which is an antiepilepsy drug (AED) through this gate under non-stimulated, stimulated and pulsed potential conditions. At the next stage of my research I studied the interaction of the drug molecules with the surface of conducting polymer and demonstrated that the affinity of drug molecules to the surface of CP gate can affect the transport behaviour. Also, I have been investigating a new gate design that utilizes a hollow PVDF fibre which acts as a drug reservoir and transport gate simultaneously. The fibres are platinised and then coated with polypyrrole with different counterions. Drug release from inside of these fibres to outside has been investigated at non-stimulated, stimulated and pulsed potential states. Epilepsy is a chronic disease which unfortunately causes so many difficulties in patients' personal life and can impose severe limitations to their life. The current antiepilepsy treatments have some severe side effects or they are very expensive treatments which is not affordable for all patients everywhere in the world. I hope my research is the beginning of a promising pathway to find a treatment for epileptic patients, which can treat all of them with a reasonable price and minimum side effects, also, bring hope and happiness to their life.

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