Novel drug targeting and delivery techniques: Avenues for the advancement of neuropharmacology

Specificity and localization of drug targeting has long been in an issue in medical research. In clinical treatment, the current dogma is to treat the affected areas and minimize downstream effects elsewhere.[1] The blood–brain barrier (BBB) maintained by the astrocytes in the central nervous system makes this specificity and localization of treatment difficult. Many drugs are either not potent enough at levels safe for the rest of the body or simply cannot pass through the BBB. The BBB creates an isolated circulation within the brain that is typically the root cause of the issues encountered when treating both acute and chronic neurological illnesses.[2]

These issues are notably pronounced in conditions like those seen in arterial ischemic stroke/ischemic stroke. With circulation to specific regions of the brain blocked, reperfusion of the region is complex and time sensitive and, the sooner the reperfusion, the more likely the reduction of the penumbra resulting from the stroke.[3] In addition to the time-sensitive nature of reperfusion, the struggle to deliver drugs to the region when perfusion is weak or limited is also a significant challenge.

The front runner in developing drug delivery has been the field of cancer research. Thanks to techniques developed in attempts to target cancer, there are now new technologies that would greatly benefit neuropharmacological research. The most notable developments have been in the use of DNA origami, high-intensity ultrasound, as well as a plethora of nanocarriers. DNA origami is a technique utilizing the base-pairing aspect of DNA to create packets of compounds contained within a folded DNA complex that responds to specific chemical stimuli to release target drugs. Whereas with ultrasound, there are multiple applications that help to focus drug delivery, either by activating the compounds via ultrasound or by utilizing ultrasound pulses to enable the drugs to slip past the BBB in specific regions.[4] In addition, there are other microscopic delivery mechanisms, termed nanocarriers, which allow for more targeted drug delivery. Some examples of nanocarriers might include lipid droplet carriers, carbon nanotube carriers, viral drug carriers, gold-bound drugs, and dendrimers along with many others.[5-11] In addition, there are laboratories conducting research using multiple methods in tandem; Negisihi *et al*. utilized liposomes and high-intensity focused ultrasound to deliver DNA sequences through the BBB.[12]

With all these alternatives utilized and developed for oncological use, it would behoove the neuropharmacological community to push for applications of these developing technologies in the treatment of neurological disorders, both acute and chronic. Many of the drug-targeting strategies eliminate or mitigate many of the negative side effects seen in the current drug treatment of neurological illness strategies. The majority of these strategies have already been proven safe in humans and efficacious at delivering drugs in a targeted and predictable manner.

With most of the legwork done by researches conducted in other fields, it would be a matter of reviewing literature and attempting to utilize the advances to diseases that affect brain circulation, especially after stroke.

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Conflicts of interest

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References

1. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, *et al*. 2018 guidelines for the early management of patients with acute ischemic stroke: A Guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2018;49:e46-110.
2. Ballabh P, Braun A, Nedergaard M. The blood-brain barrier: An overview: Structure, regulation, and clinical implications. Neurobiol Dis 2004;16:1-3.

3. Jovin TG, Chamorro A, Cobo E, de Miquel MA, Molina CA, Rovira A, *et al*. Thrombectomy within 8 hours after symptom onset in ischemic stroke. N Engl J Med 2015;372:2296-306.
4. Timbie KF, Mead BP, Price RJ. Drug and gene delivery across the blood-brain barrier with focused ultrasound. J Control Release 2015;219:61-75.
5. Rawat M, Singh D, Saraf S, Saraf S. Nanocarriers: Promising vehicle for bioactive drugs. Biol Pharm Bull 2006;29:1790-8.
6. Adams ML, Lavasanifar A, Kwon GS. Amphiphilic block copolymers for drug delivery. J Pharm Sci 2003;92:1343-55.
7. Klajnert B, Bryszewska M. Dendrimers: Properties and applications. Acta Biochim Pol 2001;48:199-208.
8. Malik N, Wiwattanapatapee R, Klopsch R, Lorenz K, Frey H, Weener JW, *et al.* Dendrimers: Relationship between structure and biocompatibility *in vitro*, and preliminary studies on the biodistribution of 125I-labelled polyamidoamine dendrimers *in vivo*. J Control Release 2000;65:133-48.
9. Patri AK, Majoros IJ, Baker JR. Dendritic polymer macromolecular carriers for drug delivery. Curr Opin Chem Biol 2002;6:466-71.
10. Yokoyama M. Clinical applications of polymeric micelle carrier systems in chemotherapy and image diagnosis of solid tumors. J Exp Clin Med 2011;3:151-8.
11. Yokoyama M. Polymeric micelles as a new drug carrier system and their required considerations for clinical trials. Expert Opin Drug Deliv 2010;7:145-58.
12. Negishi Y, Yamane M, Kurihara N, Endo-Takahashi Y, Sashida S, Takagi N, *et al*. Enhancement of blood-brain barrier permeability and delivery of antisense oligonucleotides or plasmid DNA to the brain by the combination of bubble liposomes and high-intensity focused ultrasound. Pharmaceutics 2015;7:344-62.

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