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The Problem in Treating Brain Diseases

- Overall, brain diseases cost the UK **£27 billion** every year.¹
- One of the main challenges in treating many brain diseases is that most drugs do not get to the brain.²

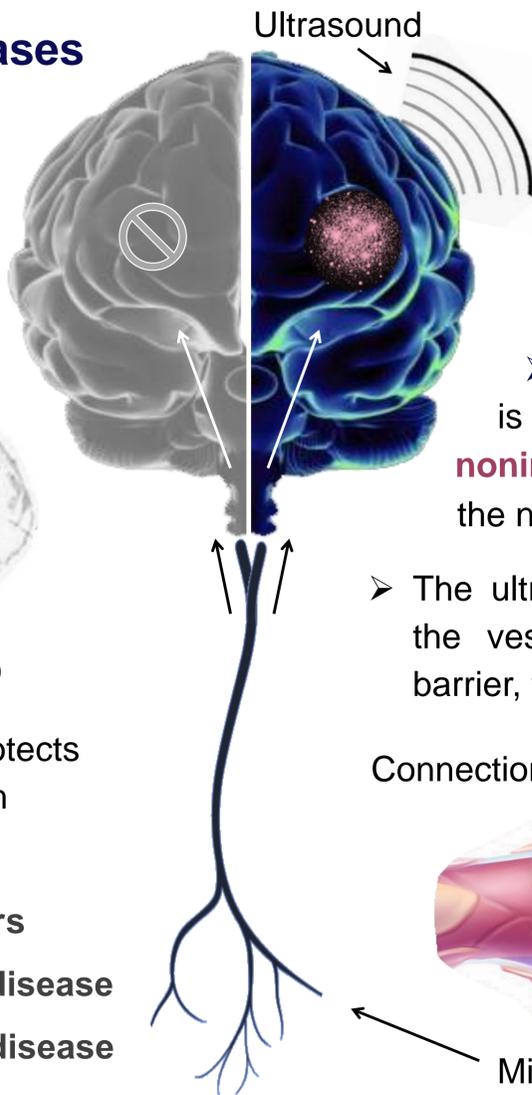


Drugs get everywhere except in the brain (white)

- This is due to the blood-brain barrier which protects the brain from **toxic substances** but also from **therapeutic drugs**.

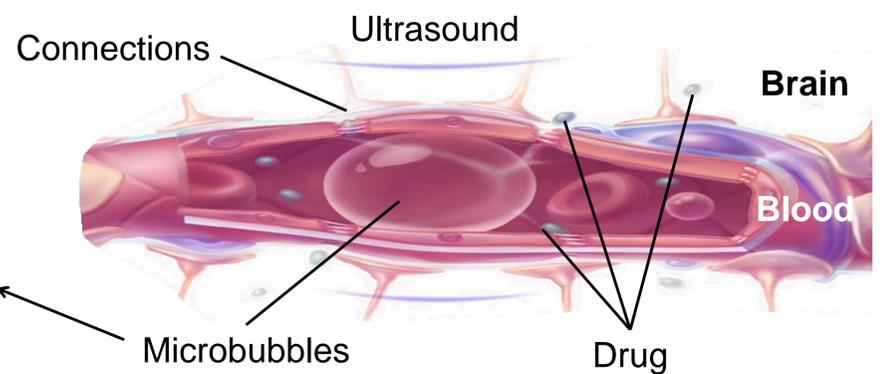
- This problem prevents us from effectively curing brain diseases such as:

Brain Tumours
Alzheimer's disease
Parkinson's disease



Ultrasound and Microbubbles get Drugs into the Brain

- The blood-brain barrier protects the brain by tightly connecting the cells that form the blood vessels.
- **Focused ultrasound** and **microbubbles** is the only method that can **locally** and **noninvasively** deliver **drugs** to the brain without the need for surgery.
- The ultrasound makes the bubbles oscillate inside the vessels, temporarily opening the blood-brain barrier, finally allowing us to get drugs into the brain.

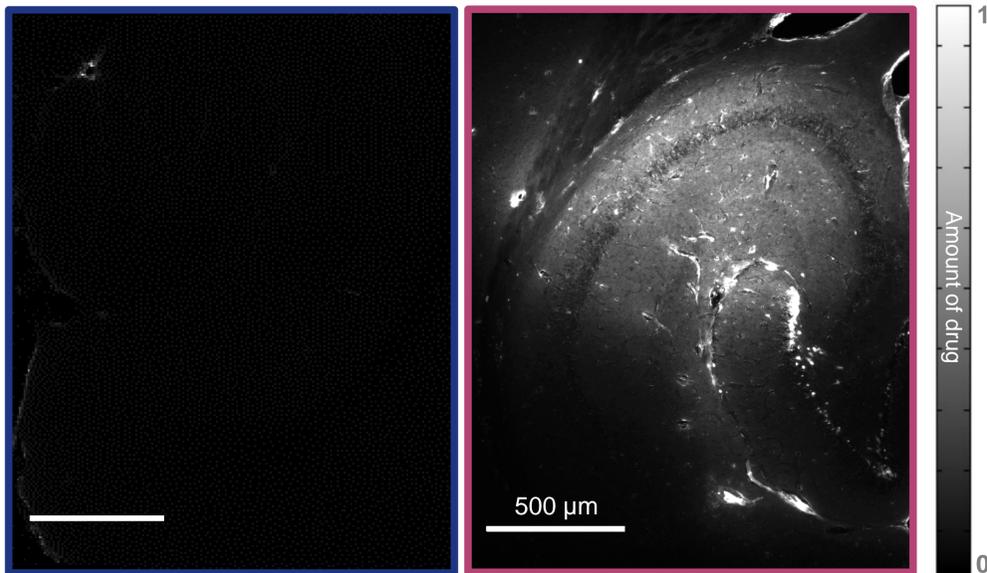


Drug Delivery

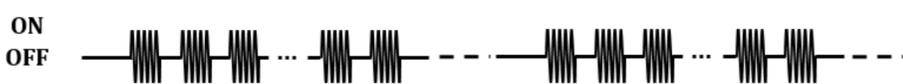
- Ultrasound and microbubbles get drugs into the mouse brain only where the ultrasound is targeted within the brain.³

No Ultrasound

With Ultrasound



- The ultrasound is emitted in very short pulses to enhance a uniform and safe delivery of drugs.⁴⁻⁵



Brain Tissue Recovery

- No drug enters the brain at 10 and 20 min after the ultrasound treatment.

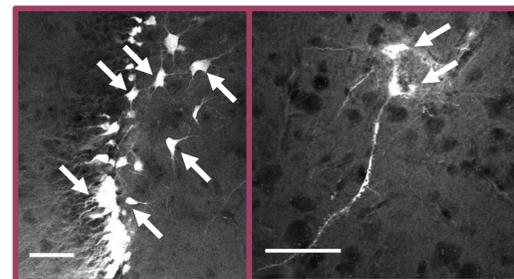
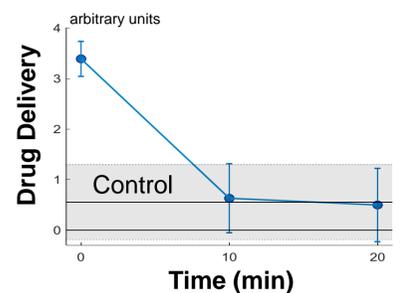
0 min

10 min

20 min



- Thus, the brain recovers to its normal state within just 10 min, preventing side effects from prolonged exposure to the drug and substances in the blood.



- Ultrasound delivers drugs not only into the brain tissue but also into neurons (white arrows).

Conclusion and Future Work

Ultrasound and microbubbles can noninvasively and efficiently deliver drugs to the brain for the treatment of neurological diseases. Our next steps involve testing this technology in a diseased animal model and evaluating the safety of the treatment.

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[2] W.M. Pardridge, *Mol Interv*, **2003**, 3, 90-105, 51. [4] S.V. Morse et al., *Radiology*, **2019**, in press.
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