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Team B7: Delivery of a Biodegradable Hydrogel to Improve Hemostasis After Intracerebral Hematoma Evacuation

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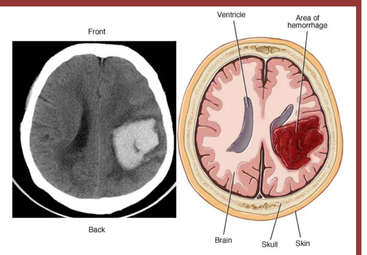
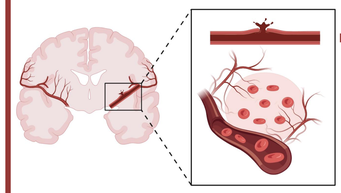
BACKGROUND

Intracerebral hematoma (ICH)

- Subtype of stroke
  - Hematoma forms within brain parenchyma
- Prevalent issue after treatment
  - Postoperative re-bleeding



ICHs are 10-20% of all strokes → 40% survival in 1st month



➡ **Needs statement**

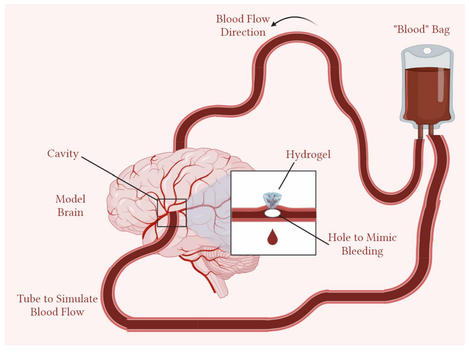
- Address postoperative re-bleeding in ICH to…
  - Support brain vasculature
  - Prevent rebleeds

OBJECTIVES

Biocompatibility
- Safe within the brain microenvironmental conditions & body temp

Fast Degradation
- Degrade within 5-7 days to reduce material presence long term

Slow Stanching
- Tamponade effect as it polymerizes
- Slow to prevent shock but fast to mitigate blood loss



DESIGN & RESULTS

Hydrogel

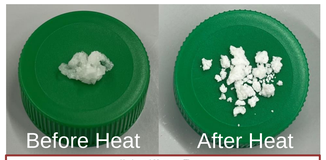
- PLGA-PEG-PLGA copolymer, MWs of 1000 g/mol each
- Both PLGA and PEG are FDA approved
- Congeals at body temperature
- Goal of rapid degradation within about a week

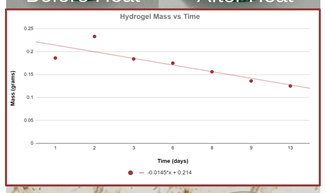
Results

13-day hydrogel degradation:
- Start mass = 0.186 g (day 1)
- Final mass = 0.125 g (day 13)

➡ Line of best fit projects ~14.7 days to degrade (0.0145 g/day)

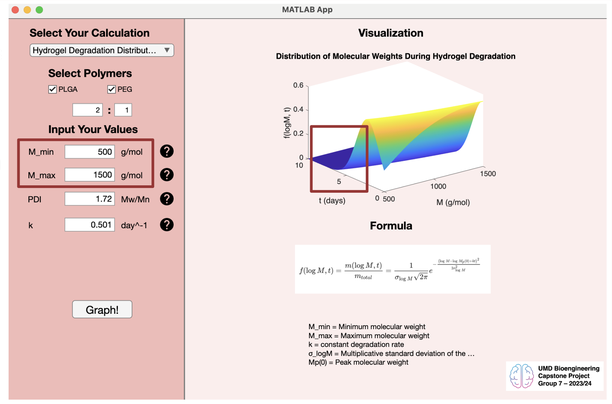
➡ Mass increase on day 2 likely due to swelling





MATLAB App

- Calculates several models proposed in biopolymer literature
- Four models chosen:
  1. Hydrogel degradation distribution
  2. Swelling ratio
  3. Mesh size
  4. Crosslink density
- Many existing models found in literature rely on generalizations & assumptions



Results

➡ At range slightly above & below our hydrogel specifications, got ~5 days for degradation

➡ MATLAB App could be applied as a tool in biopolymer research

Brain Model

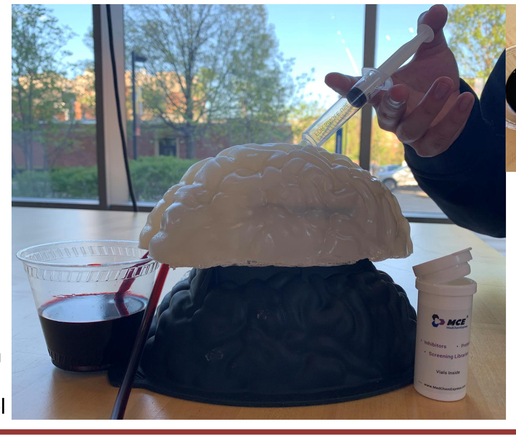
- Agar & water recipe in 1.5:28 Tb ratio
- Flexible prototype of conditions for hydrogel delivery
- Model of anatomy permits visualization of blood flow & bleeding

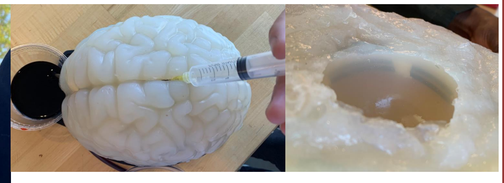
Results

➡ Holds 1.24 L volume

➡ Hole & tubing create space for ICH evacuation

➡ Closed cavity permits contained bleeding model





Entire System

- Embedded tubing to simulate blood flow
- Red color with brain transparency provides visualization of flow
- Tubing near cavity for cut & represent bleeding

Results

➡ Circulation of 12.5 mL of blood flow per cycle that can be disrupted for bleed model

ETHICAL CONSIDERATIONS

Necessary animal testing on rodents	Hemostatic Efficacy
	Biocompatibility
	Degradation
Extensive human clinical testing required	Consent form health care proxies
	Consent from patient who have high risk of ICH rebleeding
Beneficiaries	ICH Patients
	Doctors
Non-beneficiaries	Patients of low socioeconomic status who cannot afford it

CONCLUSIONS & FUTURE WORK

Conclusions

➡ **Optimized Hydrogel**
- Meets formulation, degradation, & safety needs for ICH treatment

➡ **MATLAB App**
- Accurately calculates hydrogel specifications to assist in optimization strategies

➡ **Brain Model**
- Successful prototype for planning emergency room procedures to implement the hydrogel

Future Work

- *Ex vivo* tests on tissue samples
- Animal testing
- Human clinical trials
- Drug loading (thrombin)
- Application to other injuries
- Storage mechanisms

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