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Emergency Glucagon Injection Device

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MECHANICAL AND NUCLEAR

Emergency Glucagon Injection Device

CAPSTONE DESIGN EXPO 2016

Considerations

Purpose

- In a non-diabetic person
  - Glucagon is a naturally occurring hormone
  - The pancreas uses it raise blood glucose levels
- For a diabetic
  - The pancreas does not naturally regulate it
  - It must be artificially administered during a hypoglycemic seizure
- The existing emergency kit
  - A syringe filled with fluid and a vial containing powdered glucagon
  - Requires time consuming preparation
- Our new design
  - Easy enough for anyone to use
  - Quick and effective

Figure 1: The current emergency kit

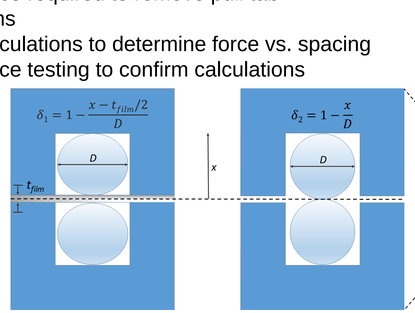
Concept

- Novel components
  - Powdered and liquid medication stored in separate chambers within the same device
  - Pull tab to be easily removed and allow mixing
- Functionality
  - Storage chamber above to prevent powder from potentially clogging needle
  - Mixing is started due to gravity pulling the powder down into the liquid
  - Pull tab design allows for necessary separation without adding complications or room for mechanical failures

Analysis

Calculations

- Challenges
  - Water and air tight
  - Force required to remove pull tab
- Solutions
  - Calculations to determine force vs. spacing
  - Force testing to confirm calculations



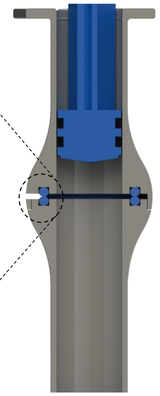


Figure 2: O-ring compression before and after barrier removal (δ = o-ring strain)

Data

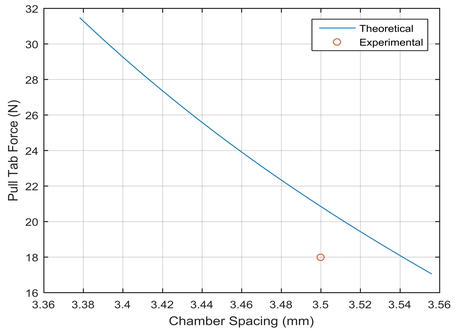


Figure 3: Plot of calculated pull tab force vs. chamber spacing with data found through experimentation

$$F_{pull} = \mu_{static} P_{contact} A_{contact}$$

Equation 1: Used to determine the pull force based on the contact area with the o-ring

$$A_{contact} = \frac{3}{2}\left(\frac{ID_{oring} + OD_{oring}}{2}\right)\pi D\delta^{\frac{2}{3}}$$

Equation 2: Used to determine the contact area of the o-ring based on its compression

Impact

Conclusion

- Appropriate flange spacing
  - Provides air and water tight seal with pull tab
  - Remains air and water tight upon removal of pull tab
- Device that appropriately meets requirements
  - Easy to use
  - Compact and durable

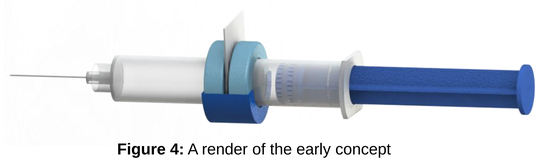


Figure 4: A render of the early concept

Contribution

- What was developed
  - A functional device
  - The purpose of the project was achieved
- Improvements over current kit
  - Significant time saved
  - Potential human errors minimized

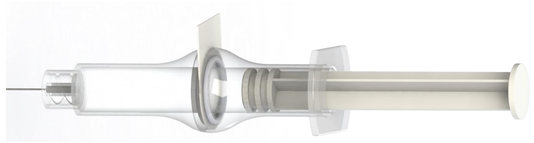


Figure 5: A render of the final design

*Provisional Patent Application Filed with the United States Patent and Trademark Office