

Skin Applicator

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Client: Dr. Bill Fahl

Outline

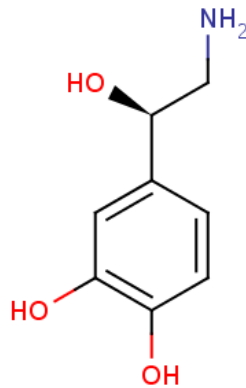
- Problem Statement
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Problem Statement

- A disposable applicator
- Will disperse 8.0 mL of solvent (70:30, ethanol:water) containing drug
- Drug applied to cancer patient receiving radiotherapy for 30 days
- Device will provide cost-effective alternative to current devices

Background

- The drug will be administered to patient's skin prior to radiation therapy
- The drug (norepinephrine) is designed to prevent dermatitis (radiation burns)
- The drug vehicle, as previously mentioned, is a 70:30, ethanol:water solution



Norepinephrine

Source:

http://www.bmrwisc.edu/metabolomics/mol_summary/?molName=Norepinephrine

Background

- The cause of dermatitis:
 - Radiotherapy directly damages tissues by creating oxygen-based free radicals via high energy electron beam
 - Much of this energy is dissipated in the 1st mm of skin
 - Free radicals are formed from the bloodstream, which damage the surrounding tissues
 - e^- (electron beam) + oxygen containing species (H_2O , O_2 , etc.) \rightarrow Reactive Oxygen Species \rightarrow Tissue Damage
 - Radiation burns/dermatitis occurs



Severe dermatitis from radiation targeting throat cancer.

Source: <http://www.cancer-throat.com/index.php?s=lubricate>

Background

- How the drug will work:
 - The drug, norepinephrine, is a vasoconstrictor
 - By restricting blood supply to the treated area, oxygen is removed
 - Free radical formation is limited and (hopefully) dermatitis/radiation burns are avoided
 - Drug trials are underway, and a more efficient and cost-effective means of application is required

Client Requirements

The device should...

- apply 8.0 mL of drug solution to an area of 225 cm²
- deliver the drug solution in a controlled, consistent manner
- be disposable (i.e. one-time use)
- not cause the patient any excessive discomfort or harm
- have a per-unit cost of \$5

Product Design Specifications

- Function
 - A disposable drug applicator
- Design Requirements
 - Safe, must not cause any harm to patient
 - Accurate and reliable
 - User-friendly (i.e. portable, handheld, requires minimal effort to operate)
- Production
 - Initially 1-2 devices, large-scale production long-term
 - Final off the shelf cost of less than \$5

Constant Features of the Design

- Glass ampoule for drug containment
- Reticulated polyurethane foam for drug application



Glass Ampoule,

source:
<http://stores.ebay.com/Element-Sales>



Foam,

Source:
<http://www.superior.ie/cleanroomwipers.htm>

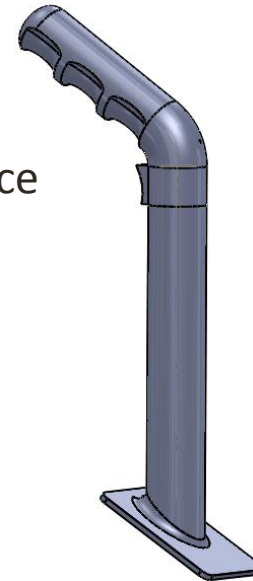
Last Semester

- Two design alternatives
 - 1st device used bending motion to release drug
 - Concern: difficult drug release mechanism
 - 2nd device used spring-activated mechanism
 - Concern: difficult drug application

1st Device



2nd Device



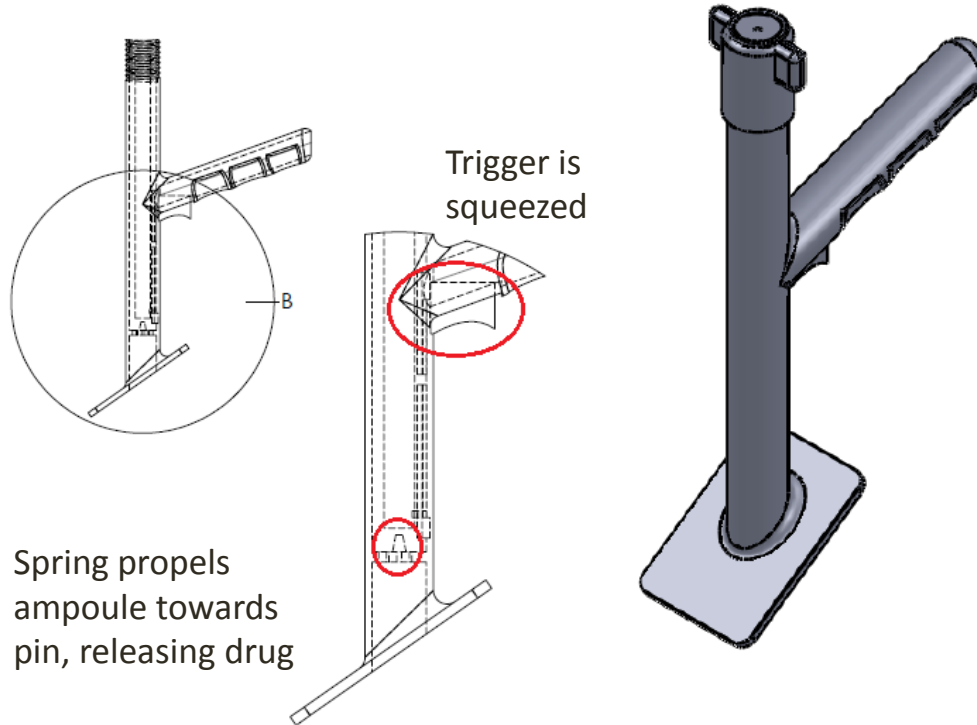
Final Design Alternatives

- This semester we have come up with two final design alternatives
- These designs differ primarily by means of drug release mechanism
 - Design Alternative #1: Spring-Loaded Mechanism
 - Design Alternative #2: Screw-Driven Mechanism

Spring-Loaded Mechanism

- Drug release mechanism similar to that employed in 2nd device from last semester
 - Trigger is pressed and stored energy in spring propels glass ampoule towards pin
 - Ampoule fractures on impact releasing contents
- Pros: One-handed drug release mechanism, user-friendly handle
- Cons: drug-release mechanism difficult to implement/construct

Spring-Loaded Mechanism

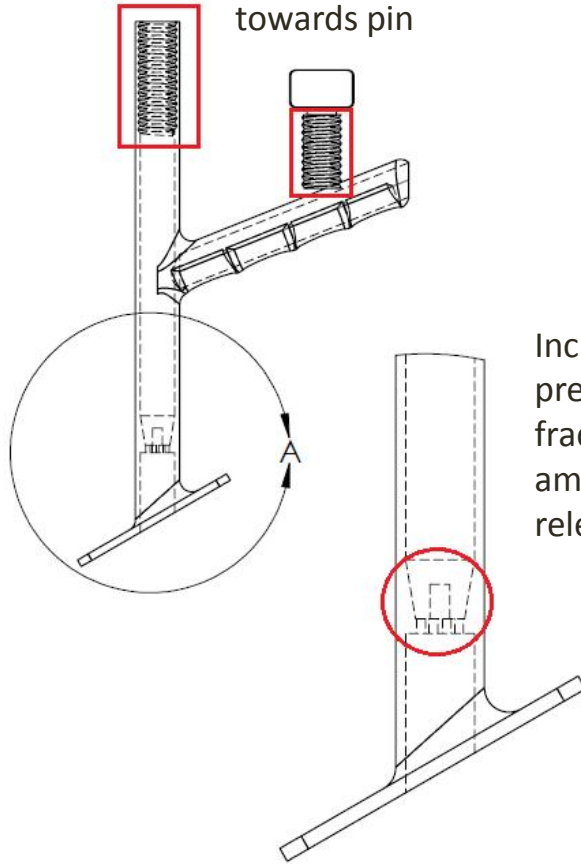


Screw-Driven Mechanism

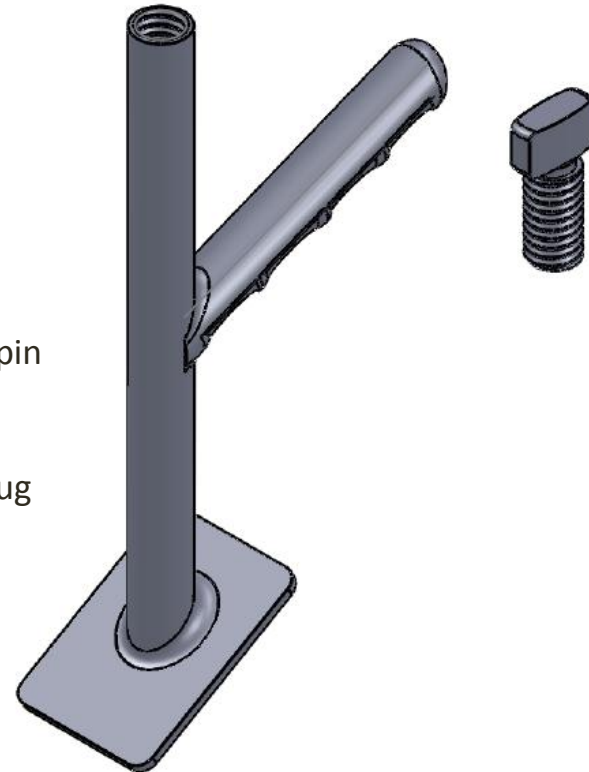
- Drug released by tightening of threaded cap
 - Pros: Simple, effective drug release mechanism, user-friendly handle
 - Cons: Two-handed activation required

Screw-Driven Mechanism

Cap is threaded on,
pushing ampoule
towards pin



Increasing
pressure at pin
fractures
ampoule,
releasing drug



Future Work: Testing

- Develop several testing protocols to compare final designs
 - Weigh device before/after drug release
 - Effectiveness of drug release mechanism
 - User surveys/questionnaires
 - Compare 'user-friendliness' between devices
 - Develop further, more quantitative testing protocols

Future Work: Large-Scale Manufacturing

- After completion of testing, select one device for potential large-scale manufacturing
- Will require material selection of either:
 - HDPE
 - Polypropylene
 - ABS
- Create mold and use injection molding to manufacture several devices

Acknowledgements

- Dr. Wan-Ju Li
- Dr. Bill Fahl

Questions

