



# Drain Tube

## Team Members:

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## Client:

Samuel Poore, Dental and Plastic Surgery, UW School of Medicine and Public Health

## Advisor:

Professor John Webster, Department of Biomedical Engineering, UW Madison

# Background

- 200,000 patients are diagnosed with breast cancer every year<sup>[1]</sup>
- Many have to undergo a mastectomy
- After a mastectomy the patients have to wear a surgical drain tube



**Figure 1:** Diagram of a surgical drain tube.  
<[http://www.cancer.sutterhealth.org/information/bc\\_notebook/postoperative\\_care.html](http://www.cancer.sutterhealth.org/information/bc_notebook/postoperative_care.html)>

# Background

- Surgical drain tubes are used to drain fluid from the wound
- Drain tubes are worn for 14 days following a mastectomy
- Patients clean and record how much fluid was drained



**Figure 2:** Close up view of a fluted drain tube.  
<<http://www.ctsnet.org/peterssurgical>>

# Background

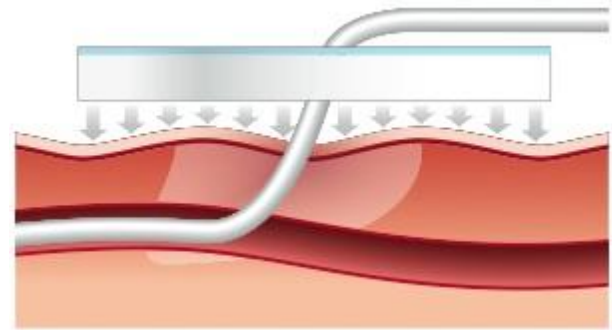
- 20% of Dr. Poore's patients develop an infection
- 5% have to get the drain removed and undergo another surgery
- Extra operations= longer recovery, more complications, more medical bills



**Figure 3:** Skin Bacteria  
<<http://www..brighamandwomens.org>>

# Competition

- **Biopatch**
  - Releases CHG up to 7 days [2]
  - Successfully fights infection
- **Issues:**
  - Hinders surgeon's procedure
  - Provides additional work for the surgeon
  - Does not function for the optimal amount of time



**Figure 4:** Diagram of a biopatch.  
<http://www.ethicon360.com/products/biopatch-protective-disk-chg>

# Competition

- Microcidal Catheters
  - Micropores in the catheter release microcidal agent<sup>[3]</sup>
- Issues:
  - Cannot function as an ideal drain tube
  - Has agent in regions unassociated with the wound cite
  - Potential to slide in and out

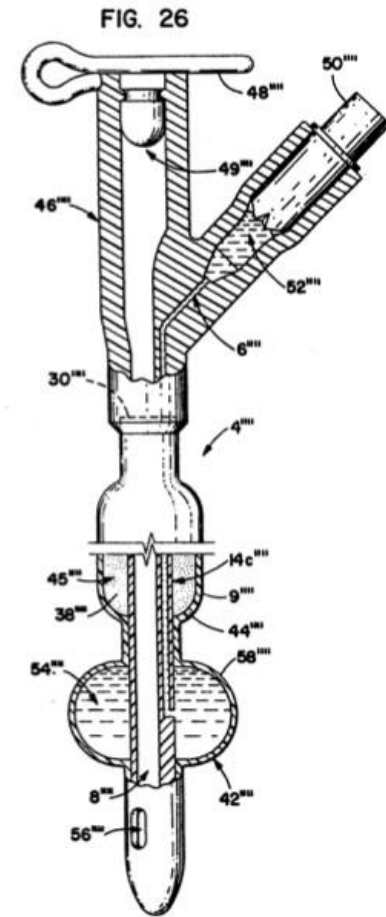


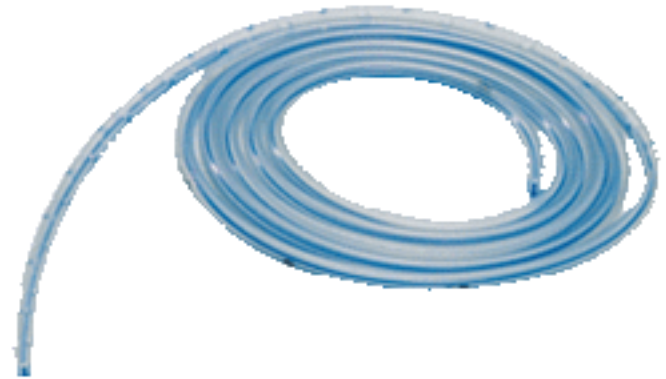
Figure 5: U.S. Patent #5,269,770

# Client Specifications

- Small and flexible
  - Fit through a 5 mm incision
- Operate *in vivo* for up to 2 weeks
- Microcidal agent should be a part of tube
- Reduce wound dressing needed
- Must be biocompatible
- Economical enough to be mass produced
- Release microcidal agent at wound site

# Three Designs

- Cuff Design
- Chlorohexidine-Impregnated Tube
- Suture Tab Design



**Figure 6:** Drain Tube

[http://images1.hellotrader.com/data2/AI/FH/HELLOTD-1867255/15\\_1\\_1\\_roundsiliconedrainsjackson-250x250.gif](http://images1.hellotrader.com/data2/AI/FH/HELLOTD-1867255/15_1_1_roundsiliconedrainsjackson-250x250.gif)



# Cuff Design

- Silicone tube
- Cuff around tube at surface of skin
- Made out of polymer foam
- Chlorohexidine is microcidal agent

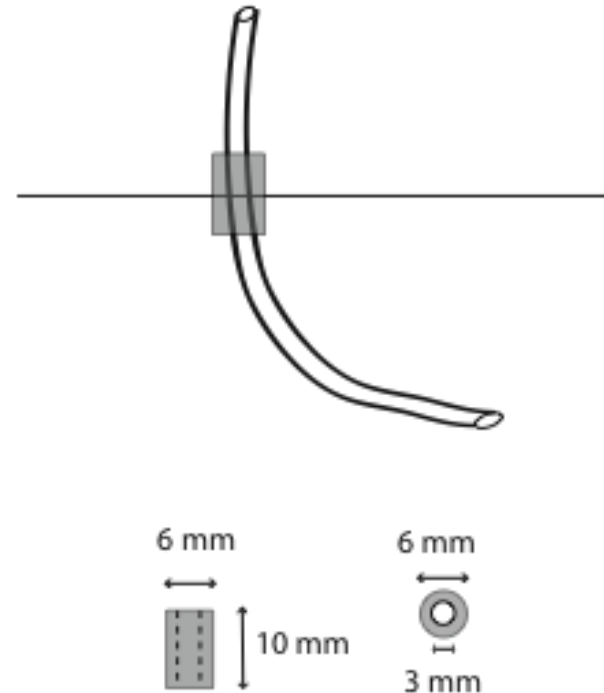


Figure 7: Cuff Design

# Chlorohexidine-Impregnated Tube

- Silicone tube impregnated with chlorohexidine
- No chlorohexidine after set point

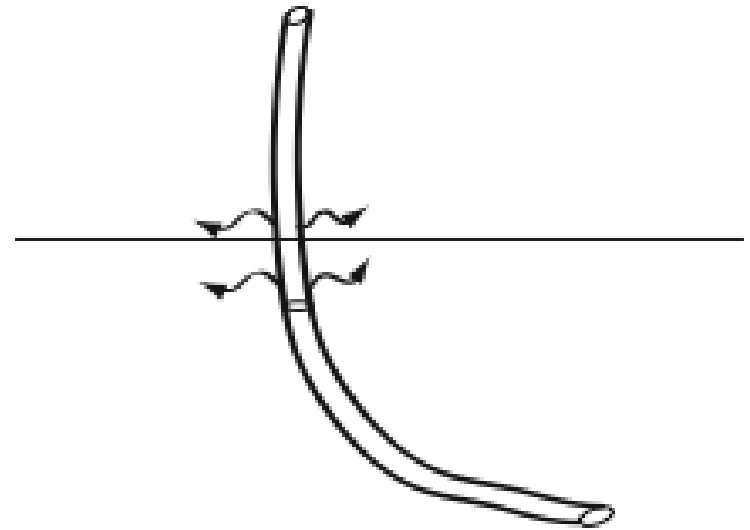


Figure 8: Tube design

# Suture Tab Design

- Disk attached to tube
- Acts as tab to suture better to skin
- Tab must be able to fit through incision
- Tab is a type of foam
- Chlorohexidine

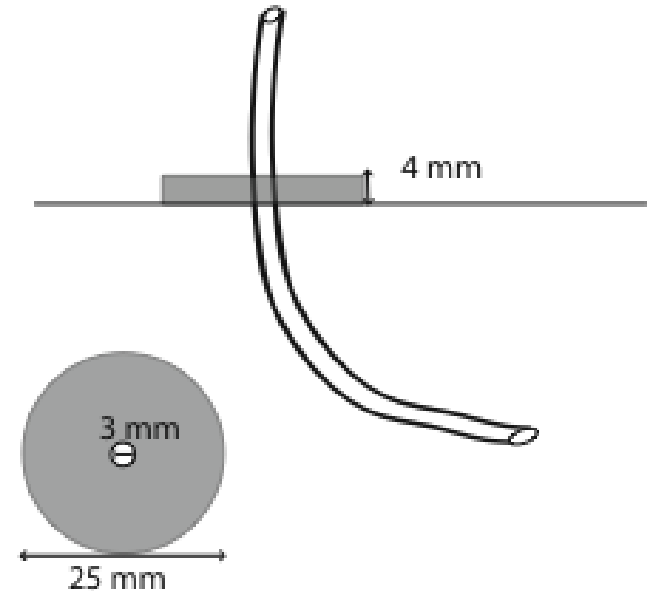


Figure 10: Suture tab design

# Design Matrix- Shapes

	Weight	Tube	Cuff	Disc
Feasibility	0.50	1	3	4
Cost	0.10	2	2	2
Durability	0.70	4	3	2
Safety	1.00	1	3	4
Ergonomics	0.85	1	2	4
Surface Area	0.40	1	2	4
Flexibility	0.90	4	3	2
<b>Total</b>		<b>9.35</b>	<b>12</b>	<b>14.4</b>

# Design Matrix- Materials

	Weight	Silicone	Polyurethane
Feasibility	0.50	2	2
Cost	0.10	2	3
Durability	0.70	4	3
Safety	1.00	4	4
Absorbency	0.85	2	4
Flexibility	0.70	2	3
Manufacturability	0.50	3	3
Bonding	0.90	4	3
<b>Total</b>		<b>15.7</b>	<b>17.1</b>

# Final Design

- Combines cuff and disc designs
- Has most surface area
- Will not slip back into incision

\*not to scale

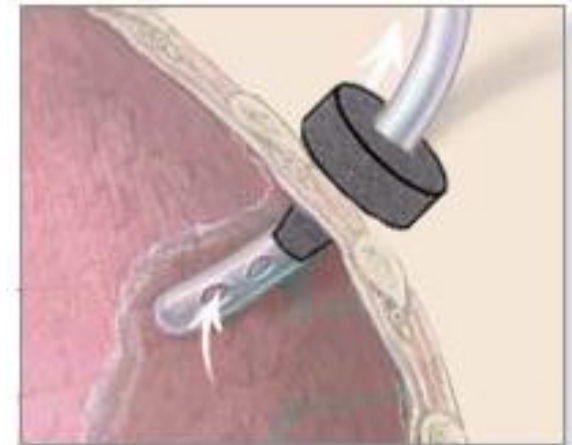
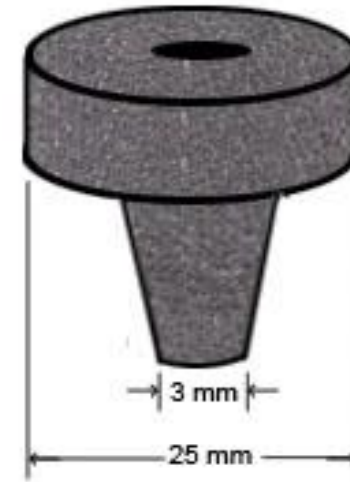
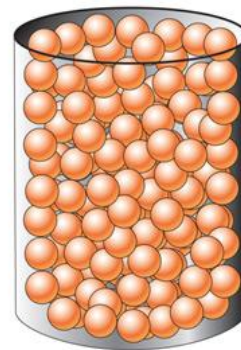


Figure 11 & 12: Final design

# Final Design Continued

- **Obstacles**
  - Fitting foam piece through incision
    - Compact or fold
  - Releasing mechanism
    - Matrix or reservoir
    - Foam type
    - Testing



Matrix Configuration



Reservoir Configuration

**Figure 13:** Drug delivery configuration.  
<http://www.mdtmag.com/uploadedImages/MDT/Articles/2010/06/NuSil1%20Preview.jpg>

# Future Work

- Determination of Material (Silicone vs. Polyurethane)
  - Adherence to Silicon Tube
  - Flexibility
  - Absorbency of microcidal agent



# Future Work Continued

- Testing
  - Multiple simple prototypes
  - Simulated environment
  - Animal Testing
  - Effective duration of use
- Final design
- Product Development

# Acknowledgements

- Professor John Webster – Advisor
- Samuel Poore – Client
- Greg Gion – Polymers Specialist



Questions?

# References

- [1] American Cancer Society. (2009). *Facts and Figures 2010*. Retrieved January 2011, from <http://www.cancer.org/Research/CancerFactsFigures/BreastCancerFactsFigures/breast-cancer-facts--figures-2009-2010>
- [2] Biopatch: Protective disk with CHG. *Ethicon 360*. [online] Referenced Feb. 27, 2011. <http://www.ethicon360.com/products/biopatch-protective-disk-chg>.
- [3] Conway, L. J., Conway, P. J., Fryar, D. 1992. *Microcidal Agent Releasing Catheter*. US Patent 5,269,770.