# BME Design-Fall 2023 - KASIA KLOTZ
# Complete Notebook

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## Table of Contents


Project Information 2
- Team Contact Information 2
- Project Description 3

Team Activities 5
- Client Meetings 5
  - 2023/9/15 - Client Meeting 1 5
  - 2023/9/29 - Client Meeting 2 8
  - 2023/10/27 - Client Meeting 3 9
  - 2023/11/15 - Client Meeting 4 10
  - 2023/12/01 - Client Meeting 5 11
- Advisor Meetings 14
  - 2023/9/13- Advisor Meeting 1 14
  - 2023/9/29 - Advisor Meeting 2 15
  - 2023/10/5 - Advisor Meeting 3 16
  - 2023/10/12 - Advisor Meeting 4 18
  - 2023/10/26 - Advisor Meeting 5 21
  - 2023/11/02 - Advisor Meeting 6 24
  - 2023/11/09 - Advisor Meeting 7 26
  - 2023/11/16 - Advisor Meeting 8 27
  - 2023/11/30 - Advisor Meeting 9 28
- Team Meetings 31
  - 2023/9/13 - Team Meeting 1 31
  - 2023/9/20 - Team Meeting 2 34
  - 2023/9/27 - Team Meeting 3 35
  - 2023/10/5 - Team Meeting 4 36
  - 2023/10/11 - Team Meeting 5 39
  - 2023/10/18 - Team Meeting 6 40
  - 2023/10/25 - Team Meeting 7 41
  - 2023/11/1 - Team Meeting 8 43
  - 2023/11/8 - Team Meeting 9 46
  - 2023/11/15 - Team Meeting 10 47
  - 2023/11/29 - Team Meeting 11 48
  - 2023/12/6 - Team Meeting 12 51
- Design Process 53
  - 2023/09/27 - Team's Initial Design Ideas 53
  - 2023/11/03 - Show and Tell Feedback 60
- Materials and Expenses 63
  - 2023/10/11 - Expenses Master Sheet Midterm 63
  - 2023/10/11 - Expenses Master Sheet Final 66
  - 2023/12/05 - Material Properties of PLA 69
- Fabrication 70
  - 2023/10/31 - The Eye Lash Dropper Initial Prototype 70
  - 2023/11/07 - The Eye Lash Dropper - Nose Piece 73
  - 2023/11/02 - The Eye Lash Dropper Second Prototype 76
  - 2023/11/10 - The Eye Lash Dropper Third Prototype 81
  - 2023/11/17 - Eye Lash Dropper v4 Prototype 89

2023/11/07 - The Eye Lash Dropper - Nose Piece Update 98
2023/12/09 - Final Eye Drop Assist Device 101
Testing and Results 105
Protocols 105
2023/10/23 - IRB Protocol research 105
2023/11/02 - Ease of Use Testing Protocol 106
2023/11/09 - Squeeze Force Testing Protocol 109
2023/12/01 - IRB Application 112
2023/12/03 - Precision Testing Protocol 113
2023/12/11 - Single Drop Testing Protocol 116
Experimentation 119
Single Drop Test 119
2023/11/17 - Single Drop Test Results & Analysis 119
2023/12/01 - Visualization of Single Drop Statistics 122
Squeeze Force Testing 127
2023/11/21 - MTS Testing Meeting with Dr. Wille 127
2023/12/01 - Squeeze Force Testing Results 130
2023/12/05 - Squeeze Force Simulation 135
2023/12/12 - MTS Testing Fixture 140
Precision Testing 143
2023/11/21 - Precision Testing 1 Notes 143
2023/12/04 - Precision Testing 2 Notes 145
2023/12/05 - Precision Testing Results 148
Project Files 152
Final SolidWork Parts 152
Kasia Klotz 153
Research Notes 153
Biology and Physiology 153
2023/9/11 - Relevance of Eye Drop Aids 153
2023/10/8 - Eye Drop Dosage 156
2023/10/8 - Grip Strength, Dexterity, and Age 161
Competing Designs 164
2023/9/12 - Gentle Drop Eye Drop Guide 164
2023/9/12 - Eye Drop Guide Glasses 167
2023/9/26 - Patent Search 170
Fabrication 174
2023/10/24 - Eye Lash Curler Handles 174
Design Ideas 175
2023/9/29 - Initial Design Ideas 175
2023/11/02 - The Eye Lash Dropper Second Prototype 178
Training Documentation 182
Red Permit 182
Green Permit 183
Chemical and Biological Safety Training 184
Anabelle Olson 185
Research Notes 185
Biology and Physiology 185
2023/9/9-Initial Research 185
2023/9/18 - Research on common diseases and uses for eyedrops 188
Competing Designs 189
2023/9/13-Competing design research 189
2023/09/24-Patent search 191
Design Ideas 201
2023/10/04 Anthropometry data for design measurements 201
2023/09/27- Eye Lash Dropper Design initial sketch 208
2023/10/11 Big eye dropper design 211
Eva Coughlin 212
Research Notes 212
Biology and Physiology 212
2023/09/28 - Eye Drop Technique 212
2023/09/29 - Squeezing Force and Dispensing Time among Eyedropper Bottles 213

2023/10/03 - Contamination of the Dropper Tip and Cap of In-Use Eye Drops 217
2023/10/10 - How to Instill Eye Drops and Avoid Contamination 218
2023/10/11 - Beta-Blocker-Induced Complications and the Patient with Glaucoma 219
Competing Designs 220
2023/09/13 GentleDrop Eye Drop Guide 220
2023/09/13 "Droppy" Eye Drop Dispenser 224
2023/10/10 Peermax Eye Drop Guides 226
U.S. Pharmacopeia Standards 229
2023/10/26 - Applying Human Factors and Usability Engineering to Medical Devices 229
2023/11/15 - Ophthalmic Products: Quality Test 231
Design Ideas 234
2023/09/27 The Butterfly - Individual Design #1 234
2023/09/27 The Pliers - Individual Design #2 235
Tevis Linser 236
Research Notes 236
Biology and Physiology 236
20 SEP 2023 - How to Properly Administer Eye drops 236
PDS Research 237
20 SEP 2023 - Motivation for project 237
Competing Designs 240
11 SEP 2023 - Low Tech Competing Designs 240
Design Ideas 243
4 OCT 2023 - Initial Design Idea 243
09 OCT 2023 - Materials for Fab 244
Training Documentation 247
10/10/2023 Safety Training 247
10/10/2023 GreenPass 248
Jenna Krause 249
Research Notes 249
Biology and Physiology 249
2023/09/13 - Study of Eye Drops 249
2023/10/04 - Squeeze Force 250
2023/10/04 - Squeeze Variability 251
2023/12/02 - Variations in Eyeball Diameters 252
Competing Designs 253
2023/09/13 - Global Drop Dispensing Bottles 253
Standards/Specifications/Patents 254
2023/09/19 - Overview of Device Regulation 254
2023/09/19 - ISO 291: Plastics — Standard atmospheres for conditioning and testing 257
2023/10/08 - IRB Information 258
Design Ideas 259
2023/09/27 - Design Idea "Stopper Buddy" 259
2023/10/03 - Redrawn "stopper buddy" 260
Training Documentation 261
2022/03/22 - Green Permit 261
Thomas Kriewaldt 265
Research Notes 265
Biology and Physiology 265
9/12/23 - Disturbed Grip Function in Women with Rheumatoid Arthritis 265
9/12/23 - The Relationship Between Hand Grip and Pinch Strengths and Disease Activity, Articular Damage, Pain, and Disability in Patients with Rheumatoid Arthritis 266
9/20/23 - PDS Research 269
10/4/23 - Bottle Squeeze Force Research 270
12/01/23 - Additional Hand Grip Research 271
Competing Designs 274
9/12/23 - XactDrop Eye Drop Helper 274
Design Ideas 277
9/26/23 - The Clasp Design 277
9/26/23 - The Slider Design 278
10/5/23 - The Slider Design Updated Sketch 279
Training Documentation 280

Red Permit 281
Green Permit 282
Biosafety and Chemical Safety Training 283
2014/11/03-Entry guidelines 284
2014/11/03-Template 285

# Team Contact Information

KASIA KLOTZ - Nov 02, 2023, 12:38 PM CDT

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# Project Description

**Course Number:**

BME 400

**Project Name:**

Eye Drop Assistant

**Short Name:**

Eye Drop Assistant

**Project description/problem statement:**

Administration of eye drops is difficult for patients, especially older adults and those with limiting diseases like arthritis. This results in eye drop waste and tip contamination. The team will design a device to assist patients in squeezing the eye drop bottle, while releasing a consistent amount of solution per drop. This device will improve the administration of eye drops for the patient while minimizing eye drop waste.

**About the client:**

Beth joined the School of Pharmacy in 1998 and was the Director of the Pharmacotherapy Labs for the entry-level Doctor of Pharmacy degree program from 1998 - 2005, where she implemented OSCEs (Objective Structured Clinical Exams - performance based assessments) into the curriculum. She currently co-coordinates the DPH-1 IPPE courses, the Teaching Certificate Program for Pharmacy Residents, and promotes assessment, teaching and learning initiatives in the school.

Current education initiatives Martin is involved with include developing interprofessional practice and education experiences for health sciences students in communications and promoting older adult health and safety. She is serves on several campus committees focused on teaching and learning technologies, promoting student engagement in the classroom and providing peer feedback on teaching.

Her practice experience is in community and managed care pharmacy and she also served as the Director of Educational Affairs for the Pharmacy Society of Wisconsin before transitioning to the School.

Beth Martin's honors include being a Big Ten Academic Alliance Academic Leadership Program Fellow (2020-21), being named an APhA-APRS Fellow in 2018, the UW-Teaching Academy Distinguished Teaching Award in 2017, AACP Excellence in Assessment Award in 2015, the 2011 Wiederholt Prize for Best Paper in JAPhA, AFPE 2004-05 Fellow, the APhA-APRS ESAS postgraduate officer for 2004-05, receiving the 1998-99 and the 2008-09 Teaching Excellence Awards, AACP Innovative Teaching Award 2001, the 1995 Young Pharmacist of the Year Award, and being a 1994 graduate of the SKB/APhA Community Pharmacy Management Program.

Beth's professional affiliations include: PSW, the American Pharmacists Association, the Academy of Communications in Healthcare, the American Association of Colleges of Pharmacy, and the Professional and Organizational Development Network in Higher Education (POD)

# 2023/9/15 - Client Meeting 1

**Title:** Client Meeting 1

**Date:** 9/15/2023

**Content by:** Kasia Klotz

**Present:** Anabelle, Jenna, Eva, Tevis, Kasia

**Goals:** Learn more about what the client is looking for out of this project

**Content:**

Questions for first meeting with client:

- 
- Where did the idea come from?
    - Retired age group complains about eye drops “not lasting the whole month”, the droppers are made of hard plastic, hard to control how much comes out of the dropper
    - Dexterity issues
        - Try to broaden the grip
    - Eyedrops are expensive (hundreds of dollars a month), anything extra comes out of pocket
    - If they run out, could cause macular degeneration
- Are the eye drop bottles refillable or one time use?
- Are all bottles universal in size and shape?
    - No, Antibiotic vs. glaucoma eye drop
- Would you rather us design a new bottle or something to insert the bottle in?
    - Either one, customer would change
- Who is the device specifically catered to? If intended for arthritis patients, what type of arthritis?
    - Elderly
- What is our budget?
    - $300 - $500
- What do you not like about the eye drop guides already on the market? (How can we make our device stand out?)
    - Order some competing devices
    - Do they really fit most eye drops?
        - Antibiotic vs. glaucoma eye drop
    - They may not be sensitive enough for dropping a specific amount of drops
    - Glasses one is bad, should not drop on eyeball
        - Make a pocket with bottom eyelid, drop in pocket, hold eye closed
        - Hold tear duct closed
        - Could create a fall risk problem
        - Glaucoma patients use beta blocker eyedrops
        - This technique should be used for all patients
- Could be automatic dispenser, could be a dispenser that is just easier to use

**Conclusions/action items:**

The team will use the information from the client to structure future research. The main concerns of the client will also be considered when brainstorming ideas for initial designs. This information will also help the team construct the product design specifications. Future client meetings have been scheduled to ensure there is time available for everyone. The next steps for the team will be to create the PDS.

# 2023/9/29 - Client Meeting 2

Jenna Krause - Nov 30, 2023, 11:15 AM CST

**Title:** Client Meeting 2

**Date:** 9/29/2023

**Content by:** Jenna Krause

**Present:** Jenna, Anabelle, Eva, Kasia, Tommy, Tevis

**Goals:** To introduce our client to our initial designs for feedback

**Content:**

- The team was introduced to our pharmacy student: Ryan Smith
  - Talks about his experience with patients not having insurance covering their eyedrops because they run out of solution so far.
  - He was thinking about a cap design at first
    - Some worry about cross contamination
    - Research needs to go into what the proper amount of solution needed in each drop.
  - Does not know about pressure because so many bottle are made with different materials /or different size bottles so the amount of pressure would change with each bottle.
- Client input into the design:
  - Likes that the designs are 3 different
  - Likes the idea of the clamp because of adjustable to fit different size bottles
  - Stability could be a plus but is not a high need.
  - With the spring could the patient feel when they dispersed one drop or would they keep going with if it is a full bottle.
- What she doesn't like about current market designs:
  - Is the difficulty of the patient to hold the device and also getting the precise eye drop into the bottom lip.
  - Does not like the assembly piece.
  - Most market designs just take into account the position instead of drop amount.
- Main goal is to produce the proper amount of solution with each drop so solution is not wasted.

**Conclusions/action items:**

The team was introduced to our pharmacy student Ryan for the semester who will help the team with design feedback and industry information. Client input emphasized a preference for adjustable clamp designs and a focus on efficient and precise solution dispensing to minimize waste. Action items for the team for this next week includes finalizing preliminary presentation and presenting to fellow BME students. Also starting to work on the preliminary report which is due the following week.

# 2023/10/27 - Client Meeting 3

KASIA KLOTZ - Nov 13, 2023, 11:32 PM CST

**Title: Client Meeting 3**

**Date:** 10/27/2023

**Content by:** Anabelle, Kasia

**Present:** Jenna, Anabelle, Eva, Kasia, Tommy, Tevis

**Goals:** To discuss our testing protocol with our client and show her our rough prototype

**Content:**

- Beth says that we can make updates to our device and then make updates to the IRB
- Beth recommends we asking questions to people for the IRB, she says they like it
- Ryan wants to help with the IRB
- Beth mentions that there might be some hipaa training we need to do before we can do the human testing
- Beth mentioned that 75 people showed up last year to another type of training
- Beth mentioned that she liked that it was 2 pieces, in case a user did not have an issue with positioning the eye drop bottle, so they could take off the nose bridge
- Squeezing with your full hand is a marketable point!
- Ryan wants to be a part of the 3D print process, so we will shoot him a message next time
- Eva will update beth and ryan our progress as we move along because we dont have our next team meeting until nov 17th

**Conclusions/action items:**

The team will continue drafting the testing protocol and application for the IRB. The team will also continue pushing through different iterations of prototypes in an attempt to capitalize on all goals for the device. The team will also host Beth and Ryan at the engineering campus to show them around and introduce them to the 3D printing process. The team aims to begin testing before Thanksgiving break.

# 2023/11/15 - Client Meeting 4

Jenna Krause - Dec 06, 2023, 4:47 PM CST

**Title:** Client Meeting 4

**Date:** 11/15/2023

**Content by:** Jenna Krause

**Present:** Jenna, Anabelle, Eva, Kasia, Tevis

**Goals:** To give our client and pharmacist student a tour of engineering and show them the next iteration of prototypes.

**Content:**

- The team met with Dr. Martin and Ryan at the MakerSpace to show them how the device is used in person.
- Feedback on Prototype:
    - Suggested a lego design with hinge to allow for movement to do drops without tipping the head.
    - Dr. Martin does not believe that the team's design does not need a stopper for the design since the device already has some give to it with the bottle.
        - This would mean a person could feel when to stop squeezing
    - One benefit of the device is the eye bottle does not need to leave the device since an individual can screw the top back on with it still being in the device.
        - This would help patients with not losing the eye drop bottle since Dr. Martin said that's a common occurrence.
    - Ryan has a group of people to talk to at the community center to see when the team can come in 2nd semester for testing.
    - Dr. Martin will send the team an information sheet to give the individuals at the retirement community.
        - Dr. Martin recommends that the team doesn't take anyone's signature or contact info from the retirement community.
    - Ryan will share with the team 2 more specific documents from standards
    - Dr. Martin will provide the team with more medicated bottles for testing.
    - Nurses who administer eye drops in hospitals to patients do it at a perpendicular
    - Look into an arthritis lab to figure out measure grip strength

**Conclusions/action items:**

The team took Dr. Martin and Ryan on a tour of the engineering campus to show them the different systems the team uses for prototyping. Action items for the team are continuing to iterate and fix the device prototype. Specifically finding a solution to the nose piece portion. Finalizing the IRB to get feedback from Dr. Martin and IRB contact.

# 2023/12/01 - Client Meeting 5

Jenna Krause - Dec 06, 2023, 4:16 PM CST

**Title:** Client Meeting 5

**Date:** 12/1/2023

**Content by:** Jenna Krause

**Present:** Jenna, Anabelle, Eva, Kasia, Tommy, Tevis

**Goals:** To update our client on the team's findings so far.

**Content:**

- Updated Dr. Martin on the results of MTS Testing with Dr. Wille
    - Talked about the issue with the displacement and force being applied to just one side of the handles.
    - The team is meeting with Dr. Wille again to discuss this problem.
- The team asked Dr. Martin about IRB document specifically about the "Principal Investigator Considerations"
    - Talked about establishing a communication aspect with monthly meetings
- Ryan updated the team on his zoom session with the community center
    - In this meeting he was informing the center about the project as well as the team's testing goal
    - Around 30 individuals were on the zoom.
    - Latanoprost Bottles (rectangle shape) is a commonly used bottle in the community center.
    - About 15 people signed up for the google form
- Updated Dr. Martin about the UW Madison's WARF application
    - Asked about any contacts they might know in the WARF community
        - Her contact is Aimee Arnoldussen (aimee.arnoldussen@wisc.edu)
- Talked about the ideal method for presenting data for the Team's poster. Dr. Martin thinks that box and whisker plot is the best way to go out the data.
- Discussed poster session time and availability for the client. (Team presents at 12:50pm)
- Over winter break, Dr. Martin will share some shark tank information so the team can start working on the pitch to have a draft sooner to work on
- Final prototype for the semester will be printed in the next few days.
    - Biggest change is having the nose piece automatically attached to the handles.
    - One pain point that might need to be addressed later on is the packing issue with a large assembly from the start.
- The community center has both brand and generic brands of eye drops
    - https://www.xalatan.com/
- It is okay to use lubricant solution in the eye droppers for testing compared to just water.
- Discussed more about the information sheet.
    - We will want to keep track of tallies if they are current or former users of eye drops. This can be used as inclusion parameter
    - Can keep track by using "subject 3" as a name to help organize data
    - It is okay to put the community name on the IRB but do not put it on the poster or information sheet. Call it a "local retirement facility"
    - Put one of the Team's contact information on it to have a point of contact
- Informed Dr. Martin later on location testing on individuals faces to have more accurate response.
    - Does the team want subject's to use their own eye drops or a stock of lubricant eye drops.
- https://www.xalatan.com/

**Conclusions/action items:**

The team discussed current testing findings with Dr. Martin and how the team plans on improving the current limitations. Dr. Martin updated the team on shark tank and community center information. Action items for the team are to finish the information sheet given to us from Dr. Martin. Send the initial version of IRB to get feedback from the IRB official. Begin working on the final deliverables.

# 2023/9/13- Advisor Meeting 1

ANABELLE OLSON (amolson27@wisc.edu) - Dec 12, 2023, 3:51 PM CST

**Title: First Advisor Meeting**

**Date:** 9/13/23

**Content by:** Anabelle Olson

**Present:** Tommy, Tevis, Jenna, Eva, Kasia, and Anabelle.

**Goals:** Meet with Prof. Puccinelli to learn about expectations for this semester.

**Content:**

- Dr. P mentioned that we do a full patent work. If we need help we could ask librarians. Google patent is a useful site.

- We informed Dr. P that we are planning on asking out client a lot of questions so we can focus our research in a specific direction.

- Dr. P mentioned she will grade the PDS with preliminary reports so we will get feedback after its turned in, hence there is no need to turn it in early.

- We established with Dr. P that there is no weekly grading, however we can show her the notebooks at meetings to asses them.

- Dr. P would like everyone to say a blurb of what they have done over the week and this will count towards meeting participation

- outreach due April 20th, Dr. P also mentioned about mentoring highschool students next semester on their own design projects, which we all thought sounded super cool.

- Dr. P thinks its beneficial to purchase existing eye drop aids

**Conclusions/action items:**

This meeting met with our advisor to understand the expectations for the design semester. This week the team will start initial research and conduct a patent search. Going forward, the team will meet with client to understand her expectations for the eye dropper aid. We will then explain these expectations to our advisor on next weeks progress report.

# 2023/9/29 - Advisor Meeting 2

Jenna Krause - Oct 04, 2023, 12:02 PM CDT

**Title:** Advisor Meeting 2

**Date:** 9/29/2023

**Content by:** Jenna Krause

**Present:** Jenna, Anabelle, Eva, Kasia, Tevis

**Goals:** To update advisor on progress and get feedback on draft of preliminary presentation.

**Content:**

- The team updated our advisor on the client meeting.
    - Discussed about expectations of the client for the semester
        1. Goal for the client is to focus more on designing a device that accurately administer one drop for client.
    - Presentation feedback
        - Add a description to the background title
        - Change problem statement to bullet points
        - Add a patent page to discuss what are the problems with current solution and how we are going to change it
        - More detailed specs with quantified numbers
        - Spring might be okay since negligible when coming into different bottle sizes
        - Redraw designs to include dimensions, labels need to be in text,
        - Add key words to the design criteria instead of just the word safety.
            - Change words in matrix to be more accurate with our explanation
        - Ask the client again about testing in the nursing home and see if she needs an IRB for it.
        - Future works need to be more accurate to our project with specific dates included.
        - Included stats in the background as well as need for the project
            - Talk about insurance and patient problem
        - 2317 Engineering Hall for advisor meetings.
    - General Feedback:
        - Have the client set up an account in the makerspace to do all the printing so we do not need to worry about it.
        - She likes the idea of having patients look at prototypes

**Conclusions/action items:**

In summary, our advisor meeting emphasized editing preliminary presentation, enhancing design criteria with precise specifications, and seeking clarity on testing protocols. Further, involving patients in the prototyping phase was highlighted as important steps for the project's successful progression. Action items for the team is finalizing preliminary presentation and start working on report.

# 2023/10/5 - Advisor Meeting 3

KASIA KLOTZ - Oct 11, 2023, 11:18 AM CDT

**Title: Advisor Meeting 3**

**Date:** 10/5/2023

**Content by:** Kasia Klotz

**Present:** Anabelle Olson, Kasia Klotz, Jenna Krause, and Eva Coughlin

**Goals:**

- Go over preliminary presentation
- Go over team notebook

**Content:**

- Split first background slide into two slides
- Correct citations on background (location of brackets)
- Problem statement is good
- Describe downfalls of each design for competing designs (delete slide that has this separately)
- Look over grammar
- Increase size of dimensions, take away bullets on design slides and just add labels
    - Tommy use better text colors
- Tommy make videos
    - Make sure to share videos with Dr. P
- Update headers with new design criteria names
- Discuss “Pursuing IRB” for human testing
    - Discuss this with client next meeting
- Future work needs to be more details
    - Select materials
    - IRB approval
    - Approach to 3D model

**Conclusions/action items:**

The team will improve the preliminary presentation based on advisor feedback. Then, the team will practice presenting slides in preparation for preliminary tomorrow. Tommy will be recording his sections and they will be played during the presentation. The main feedback involved expanding upon the ideas on the slides to make the information more clear. There was also discussion about the process or receiving IRB approval for human test subjects. This will be needed in order for our client to test the assistant device by allowing people in the retirement community she works at to use it. Their feedback will be important when determining the success of the device.

# 2023/10/12 - Advisor Meeting 4

**Title: Advisor Meeting 4**

**Date:** 10/12/2023

**Content by:** Tommy Kriewaldt

**Present:** All Members

**Goals:** Meet with Dr. Puccinelli to discuss questions about the IRB process and our future work.

**Content:**

- Dr. P is getting connected with the Engineering Teachers at Brookfield.
    - Lean into engineering over healthcare (more to add about the process).
    - Good sign with communication, just hasn't been scheduled yet.
    - Last year: split into pairs of BME students to match with 1-2 students from the class.. evenly matched and came to campus for a presentation.
    - Dr. P will update us, it will happen around December-March.
- Dr. P has not gotten a chance to look at the PDS → the team didn't change anything for the report.
- IRB: What can we do?
    - Tevis took Beth out to dinner → Beth was planning to talk to people who know about the "device improvement" category.
    - Beth was very insightful and informative about the topic.
    - If we did our own, we would go **through Arrow**.
        - Don't think we could use Beth's existing IRB.
    - We should all do Human Subjects Training.
        - Then write protocols (split up the team - ½ fabrication, ½ protocols).
    - Be careful about being **TOO** negative, don't be too honest.
    - Also, use the right kind of language!
    - Mention that there are no cross-contamination issues with our final design
        - It is safe. **Use saline eyedrops?**
- Have to figure out a few things before we have a physical prototype.
    - Need to start the 3D modeling in SolidWorks.
    - Figure out the stopping mechanism → use spring or something else?
    - Have a preliminary prototype for the October 27th meeting with the client.
        - Good to have a physical model as soon as possible.
        - Dr. Kille switched up on the design during the first semester.
    - The need for the project has been established, which
- We are not meeting with Dr. P next week.
    - Reach out to her via email as needed.
    - Get the IRB started, at minimum a rough draft!

        - The team will likely need some assistance, but Dr. P is willing to help.
- The due date for the Peer Feedback is probably going to be pushed back.
- Won’t get feedback on our papers until the end of next week!
    - Uploaded to Canvas: PDS, Preliminary Presentations, Report, etc.

**Conclusions/action items:**

Finish stuff with the IRB, make a CAD/SolidWorks model, and have a prototype to show Dr. P during our next meeting (October 26th).

# 2023/10/26 - Advisor Meeting 5

**Title:** Advisor Meeting 5

**Date:** 10/26/2023

**Content by:** Jenna Krause

**Present:** All Members

**Goals:** Meet with Dr. P to discuss draft of IRB and prototype model

**Content:**

- Showed Dr. P the first draft of the team's prototype
    - Feedback:
        - Discussed some concerns about material snapping but need to test out material first
        - Mechanical advantage would be the spring mechanism with a peg to allow for one drop.
        - Would like to see calculations needed for the spring and if it would work.
- Asked about the senior year timeline
    - Focus 1st semester on prototyping heavy first semester
    - Little testing for the spring calculations and force calculations would be fine
- Shoed Dr. P the first draft of the teams IRB/Protocol
    - Feedback:
        - Do not need to include exception conditions
        - Do not list in details harm such as mental health problems
        - Very minimal risk associated with the team's design
        - Survey is an observational study
        - Make sure the survey is scale that all the 5's are the positive
        - Make sure to include detail instructions of use in the IRB protocol
        - Sample size:
            - Wouldn't worry about the exact z score sample size
            - Just give a range of people we want to recruit to the survey.
        - Put Dr. P as the "Lead Researcher/PI" and the rest of the team as co-investigator.
            - Ask Dr. Beth if she wants
        - CAD design is fine for protocol
        - Take a photo of someone using the design for better understanding.
        - Add multiple prototype designs to the IRB so the team can work on multiple concepts covered by the IRB

**Conclusions/action items:**

Dr. P provided valuable feedback on the team's prototype, focusing on material concerns and the need for calculations related to the spring mechanism. In the IRB/Protocol draft, she emphasized the importance of clarity, minimal risk assessment, and flexibility in sample size. Action items for the team is to continue the prototyping process for multiple designs to include in the IRB.

# 2023/11/02 - Advisor Meeting 6

Jenna Krause - Dec 06, 2023, 4:33 PM CST

**Title:** Advisor Meeting 6

**Date:** 11/02/2023

**Content by:** Jenna Krause

**Present:** All Members

**Goals:** Showed the team's first 2 iterations of prototype to Dr. P for feedback

**Content:**

- The team showed Dr. P the initial prototypes
    - The team still needs more mechanical advantage
    - Wrap handles with black electrical tape for aesthetic and feel for show and tell
- Recommended doing another iteration of prototypes
- Label prototypes
- Dr. P recommended looking into MTS testing in the ECB lab
    - Need to reach out to Dr. Wille to ask permission for using the machine
    - Also, I need to see if we need an TA or a professor monitoring us while using it.
- Discuss a time that could work to show Dr. Martin and her pharmacy student around the engineering campus.
- Maybe start looking into WARF now to see if we accomplish novel and not obvious aspects.
    - If the team focuses on the one drop aspect of the design that might qualify
    - Need testing and results first before WARF will even work on it.
    - One page for the IDR
- Show and Tell questions
    - How can the team customize the design to fit different variations of drop bottles?
    - How can the team incorporate a stopper mechanism into the design?
- The team will create an instruction manual to go with the device to help educate proper eye drop technique.
- Present the amount of people with glaucoma using the actual number
    - How many of these can we sell based on this market
    - Also, is there an additional market for people that no not have glaucoma

**Conclusions/action items:**

The team presented initial prototypes to Dr. P and received valuable feedback. To enhance the design, further iterations and mechanical advantage are needed, along with aesthetic improvements like wrapping handles. Action items for the team are to explore the possibility of MTS testing at the ECB lab and contacting Dr. Wille for permission is a priority.

# 2023/11/09 - Advisor Meeting 7

EVA COUGHLIN - Nov 09, 2023, 7:56 PM CST

**Title:** Advisor Meeting 7

**Date:** 11/09/2023

**Content by:** Eva Coughlin

**Present:** Eva Coughlin, Jenna Krause, Anabelle Olson, and Thomas Kriewaldt

**Goals:** To discuss the advice we received from show and tell and our future plans with prototyping and testing.

**Content:**

- Discussed several ideas from show and tell
    - Spring loaded like a phone holder (suggested by Prof. Puccinelli)
    - Koozie adjustments
    - Two different devices for different sized bottles
- Talked about plan for prototyping to make the handles of the device angled to create more mechanical leverage
    - Tommy and Tevis are meeting on Friday to make the changes in Solidworks
    - Reprinting will happen on Monday/as soon as possible
    - Team is showing client and pharmacy student the Makerspace from 11-2 on Wednesday
- Questions on MTS testing
    - Need to generate a stress vs. strain curve
    - Email Dr. Wille to ask who we need to supervise
- IRB needs to continue to be worked on
    - Eva will send to contacts at IRB that she received from the client to look it over once the team has a draft

**Conclusions/action items:** We had a short meeting to discuss show and tell feedback as well as prototyping updates. We are going to make necessary changes to the device and reprint it as soon as possible. We are anticipating starting testing with the Single Drop protocol next Friday. We will all attend the Tong lecture tomorrow.

# 2023/11/16 - Advisor Meeting 8

ANABELLE OLSON (amolson27@wisc.edu) - Dec 12, 2023, 3:55 PM CST

**Title:** Advisor Meeting 8

**Date:** 11/16/2023

**Content by:** Anabelle Olson

**Present:** Eva Coughlin, Jenna Krause, Anabelle Olson, Thomas Kriewaldt, Tevis Linser and Kasia Klotz

**Goals:** To inform Prof. Puccinelli about our current testing results and talk about our meeting we had yesterday with our client.

**Content:**

- Mentioned the changes we made to the prototype - added the bottle cap holder
    - Two separate devices for two bottle devices
    - Dr. P asked about if we were gonna make multiple nose pieces or one nose piece with flexible material
- Mentioned shark tank and ryan helping us with the marketing part of our design
- Mentioned our current testing results
    - Standard deviation of drop size smaller with device than with just traditional bottle
- Asked Dr. P about the advisor opportunity that we plan to do in place of the outreach
    - She said she just messaged the teacher, but haven't heard back yet
    - But don't start working on outreach yet
- Risk for the irb - straining hand muscles
    - Dr. P said don't even put this risk on the IRB
- We should apply for a patent right now
    - Need to identify market more
        - We have been very focused on what our client wants
        - Now we need to expand a little more
        - Tell warf
            - Its innovative
            - Its not obvious

**Conclusions/action items:**

In summary: The team had a productive meeting with our advisor, we informed her of the changes made to the current prototype and are now continuing to proceed with our testing. Our client mentioned we should work towards applying for a patent as soon as possible, so going forward, the team will do research on the patent process and identify the market our design is aiming for.

# 2023/11/30 - Advisor Meeting 9

EVA COUGHLIN - Nov 30, 2023, 5:15 PM CST

**Title:** Advisor Meeting 9

**Date:** 11/30/2023

**Content by:** Eva Coughlin, Thomas Kriewaldt

**Present:** Eva Coughlin, Jenna Krause, Anabelle Olson, Thomas Kriewaldt, Tevis Linser and Kasia Klotz

**Goals:** To meet with Prof. Puccinelli and discuss what we've completed these last two weeks.

**Content:**

- Testing is mostly done!
- Measured displacement to elicit one singular drop then measured force.
    - Only pushes on one-half, we're going to adjust this in MATLAB analysis
- Making MATLAB plots of the drops with the use of the device vs. without it to show the statistical significance between these conditions.
- Location testing is something we still have to complete
    - Taking the device on and off and analyzing the location of a drop on mannequin
    - Using an eye drop bottle alone as the control
    - Drawing or image of the eye on the paper
        - ImageJ the paper to see how far drops are from the eye.
- Discussed how to analyze the single drop testing
    - Box and whisker plot for individual data tables
        - DON'T COMBINE DIFFERENT USERS!
    - All did trials, so how many should we include?
        - 2-3, important to show more than one
    - Put all six figures in the report.
- The team has a lot of testing data to include in the report
- Reach out to Dr. Wille to discuss how to analyze the data
    - She will help us a bit further and confirm that we can take the ½ displacement force and double that instead of what we measured today.
    - Ask if this is usable
- We have enough testing to start to talk to WARF.
    - Need to have a super concise version of our final report.
    - She would be happy to look at it for us before we submit it.
    - Pull out the most compelling data → pull from our poster potentially
    - Focus on the shortcomings of competing designs.
        - Don't say ANYTHING positive about them!
    - *Novel and not obvious*

        - Neck size, anatomical data, handle angle, no assembly required (nosepiece will be attached to the rest of the device), etc.
    - Can start this before the report
    - Go through each part of the device when explaining the function
    - Outline is on WARF page - IDR
    - Hear back after about a week or so
    - Send it to Prof. Puccinelli
        - https://www.warf.org/invent/disclose-an-invention/
- We are still working on IRB → need to confirm a few additional things with our client.
- Nose piece will be connected in the final prototype for the poster session.
- Need to start to think about the packaging and manufacturing of our device.
- Future work on our poster is more focused on broad ideas for next semester.
    - The first thing when we come back is to set timelines for this future work.
- 11:30-12:30 office hour on Wednesday - discuss poster to make any changes
    - Bullet points, no abstract, very few words, pictures, anything relevant!

**Conclusions/action items:**

We will reach out to Dr. Wille to ensure that our strategy for determining the squeezing force is okay and ask for advice on how to analyze our data. We will reprint the devices with the nose pieces incorporated into the device, so that we can get the drop location testing done on Monday. We will begin working on the summary for WARF and the final poster presentation and report. Tomorrow is our last meeting of the semester with the client.

# 2023/9/13 - Team Meeting 1

Jenna Krause - Oct 05, 2023, 11:45 AM CDT

**Title: Team Meeting 1**

**Date:** 9/13/2023

**Content by:** Thomas Kriewaldt, Kasia Klotz

**Present:** All members

**Goals:**

- Create a problem statement
- Complete progress report
- Review schedule for the semester

**Content:**

Goal for this semester is to have a faster turn around on deliverables

- Make sure to utilize the fact that we can submit deliverables early and then get feedback on them.

Wait until we have the client meeting until we do the PDS.

- Still need to do more research.

Have to write the problem statement.

- Due THIS WEEK. (Finish today!)

Tevis found 2 in market competing products on Amazon.

- Not sure if we will be ordering it, yet but always can.

Anabelle found that a lot of people who use eyedrops are older.

Contamination of eye drop bottle is also a major problem.

Need to know why this project is so important from the client.

- Write the problem statement then adjust if it doesn’t align with the client’s viewpoint.

Need to add folders to Lab Archives.

Complete 2-3 entries before we submit the progress report.

Tommy researched the amount of Force generated by arthritic patients.

Potentially design a universal bottle to fit eye drops in?

- Could pose a problem to some patients that cannot unscrew the top of the original bottles.

Client is a pharmacy professor (realm of ophthalmology).

Dr. P will not be present next week, no meeting!

- Try to finish PDS by Tuesday night / Wednesday morning.
- Then email to Dr.P well before the deadline!

Should use PDS outline to ask the client questions on Friday.

- After client meeting, we should set up a meeting to discuss PDS work.

**Conclusions/action items:**

The PDS will be due next week, so the teams top priority is gathering all of the required information to successfully complete the PDS. The first step to that will be completing background research to further our knowledge in the area of interest. The next step will be meeting with the client to hear about all of the desired design criteria. After the client meeting, sections of the PDS will be assigned to team members. Completing the PDS early (by Wednesday preferably) will allow the team to receive feedback before handing in the final product.

# 2023/9/20 - Team Meeting 2

KASIA KLOTZ - Sep 21, 2023, 10:42 PM CDT

**Title: Team Meeting 2**

**Date:** 9/20/2023

**Content by:** Kasia Klotz

**Present:** All members

**Goals:**

- Revise and edit PDS
- Create plan for design matrix
- Discuss schedule for client meetings

**Content:**

- Each team member created at least a rough draft for their section of the PDS
- Some of the feedback discussed as a team includes
    - Appropriate pricing for product
    - Consistent language throughout the document
- The team was given the option by the client to create either a device that would fit existing eyedroppers, or to create a device that would include an eyedropper
    - Creating a device to fit existing eye droppers would mean the customer would be anyone who uses eyedrops
    - Creating a device that would include a new eye dropper would mean the customer would be clinicians and/or companies in industry
    - The team decided to move forward with a device that would be marketed to people who use eyedrops, specifically elderly people with dexterity issues
- Eva sent an email to the client to schedule meeting in advance to ensure availability of team members and the client
    - The team tried to schedule meetings that aligned well with deliverable due dates
- The next “deliverable” due is the design matrix
    - Each team member will come up with two unique design ideas to present to the team during the next meeting

**Conclusions/action items:**

The team will meet again on Wednesday to discuss designs. During this time, multiple design ideas will be combined to create three final design ideas that will be put into the design matrix. Over the weekend, team members will come up with design criteria (with definitions) to rank the designs. This will lead to narrowing down a final design.

# 2023/9/27 - Team Meeting 3

EVA COUGHLIN - Sep 28, 2023, 1:51 PM CDT

**Title: Team Meeting 3**

**Date:** 9/27/2023

**Content by:** Eva Coughlin

**Present:** Anabelle Olson, Kasia Klotz, Tevis Linser, Jenna Krause, Tommy Kriewaldt, and Eva Coughlin

**Goals:**

- Decide on three preliminary designs for the design matrix
- Decide on the weights for the different categories of the design matrix
- Rank the three designs for the design matrix
- Complete the design evaluations for the design matrix
- Complete the team contract
- Discuss client questions for Friday meeting

**Content:**

- Tevis brought the eye drop bottles and products on the market that the client bought
- Discussed everyone’s individual design ideas (two for each person)
    - Noticed several overlapping concepts
    - Similar idea with the “pliers” and the wings concept for the handles
- Questions for client:
    - Does the amount of liquid in an eye drop bottle affect the pressure needed to dispense one drop?
    - What are the steps for proper eye drop technique? (we would like to use this for our preliminary presentation)
- Decided on the three designs
    - Anabelle’s design eyelash dropper
    - Tommy’s slider that incorporates an electrical component
    - the stopper buddy which Jenna, Eva, and Tevis all had as an idea
- Discussed our ideas from our individual worksheets to write the team contract
- Completed most of design matrix as a team
    - Winner was the “Eye Lash Dropper”

**Conclusions/action items:**

We decided on the three preliminary designs and completed the design matrix. We need to finish the last question of the team contract and turn it in before the advisor meeting. We also need to work on the rough draft of the preliminary presentation. At the advisor meeting tomorrow, we will ask Dr. P if we should include a patent search in the presentation.

# 2023/10/5 - Team Meeting 4

**Title: Team Meeting 4**

**Date:** 10/4/2023

**Content by:** Tevis Linser

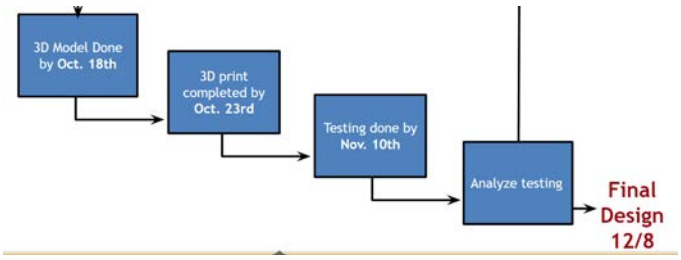
**Present:** Anabelle Olson, Kasia Klotz, Tevis Linser, Jenna Krause, Tommy Kriewaldt (online), and Eva Coughlin

**Goals:**

- To go over and finalize the preliminary design presentation and make sure the team is on the same page
- Split up sections for the prelim report

**Content:**

- Discussing whether the problem statement should be in bullet points.
    - Will ask our advisor
- Focus the problem statement on the eye drop bottle itself not competing designs
    - Flow of logic should be problem statement -> existing designs that also try to solve the problem -> reasons why the existing devices fall short
- Do we need to change the names on the design matrix?
    - Is it sufficient to have a design criteria slide describing them before the matrix
- Ask what size font is acceptable/ if we can use different size on different slides
- Try to get specs for squeeze force in the bottle
- Make sure all the drawings are cleaned up
    - Typed text and dimensions
- Talking split :
    - Client Description - Eva
    - Background-Eva/Kasia
    - Problem Statement-Kasia
    - Competing Designs-Kasia/Tevis
    - Design Specification -Tevis
    - Preliminary Designs
    - Design 1: The Eye Lash Curler-Tommy
    - Design 2: The Slider-Tommy
    - Design 3: Stopper Buddy-Jenna
    - Design Criteria -Jenna
    - Future Work-Anabelle
    - References-Anabelle
- Ask how long we should aim to present for
- Completed the future plans section in depth
    - Deadlines:




**Conclusions/action items:**

Presentation is pretty much done, ask our questions during the advisor meeting.

Finalize and practice presentation after advisor meeting.

# 2023/10/11 - Team Meeting 5

EVA COUGHLIN - Oct 13, 2023, 11:52 PM CDT

**Title: Team Meeting 5**

**Date:** 10/11/2023

**Content by:** Eva Coughlin

**Present:** Anabelle Olson, Kasia Klotz, Tevis Linser, Jenna Krause, Tommy Kriewaldt, and Eva Coughlin

**Goals:**

- To discuss the preliminary report and any final edits that need to be made
- To check progress on LabArchives notebook entries

**Content:**

- Preliminary report looks good
    - Need to create references page and number in-text citations
    - Some research that can be added to the background
    - Discussed design specifications and improvements that need to be made on those
- Almost everyone is done with LabArchives
    - All biology & physiology research, competing designs research, and design sketches have been added
    - Team notebook is updated with all team, client, and advisor meeting notes
- Thought that the preliminary presentation went very well
- Reviewed plan for rest of the semester
    - Writing test protocols for IRB
    - Beginning fabrication process by modeling prototype on SolidWorks

**Conclusions/action items:** The team will finish any remaining edits on the preliminary report by 6 PM tonight and submit it. Jenna will download the team LabArchives notebook and submit that this afternoon. We need to complete Feedback Fruits later in the week. Tomorrow we have an advisor meeting at ECB 1003 at 3:45 PM.

# 2023/10/18 - Team Meeting 6

EVA COUGHLIN - Oct 18, 2023, 7:01 PM CDT

**Title: Team Meeting 6**

**Date:** 10/18/2023

**Content by:** Eva Coughlin

**Present:** Anabelle Olson, Kasia Klotz, Tevis Linser, Jenna Krause, Tommy Kriewaldt, and Eva Coughlin

**Goals:**

- Discuss future plans for testing protocols and 3D modeling/fabrication process
- Discuss funding/Makerspace account for 3D printing

**Content:**

- We decided that Anabelle, Jenna, and Eva will start researching how to write testing protocols for IRB and start writing what we can
- Kasia, Tommy, and Tevis will 3D model the prototype in SolidWorks
- We talked about how we might not have the IRB approved in time to start testing before the end of first semester
    - Idea is to save the human subject testing with the client at retirement home for second semester and just write the protocol for first semester/make sure that the IRB is submitted
- Our client would like to purchase everything for our project with her own funding so no reimbursement is necessary at the end of the year
    - We need to get more information on how the client can make a makerspace account that allows us all to order from it and attach it to her funding
    - Tevis is BPAG and will talk to Dr. P about this to get more information
    - Tevis sent a spreadsheet to Eva regarding Makerspace information that she will send to the client along with another Amazon link
    - Client is out of office through 10/23, so she will not respond to this correspondence until then
- Goal is to have the prototype 3D printed and assembled by 10/27, which is the next client meeting

**Conclusions/action items:** The team split into two groups to be more efficient. Anabelle, Jenna, and Eva will focus on researching how to apply for the IRB and beginning writing testing protocols. Kasia, Tommy, and Tevis will allocate their time towards 3D modeling in SolidWorks. Tevis will get more information on funding with the makerspace and Eva will communicate with the client regarding this information, so the team is ready to print and assemble the prototype within the next two weeks.

# 2023/10/25 - Team Meeting 7

KASIA KLOTZ - Oct 25, 2023, 3:38 PM CDT

**Title:** Team Meeting 7

**Date:** 10/25/2023

**Content by:** Kasia Klotz

**Present:** Anabelle Olson, Kasia Klotz, Tevis Linser, Jenna Krause, Tommy Kriewaldt, and Eva Coughlin

**Goals:**

- Share 3D model and ask for feedback from team members on dimensions
- Make a plan for 3D modeling
- Review progress on IRB application and testing protocols, set goals for completion moving forward

**Content:**

- The team reviewed the 3D model made for the initial designs
    - Possible concerns include:
        - The interface between the nose piece and the rest of the device
        - The versatility of the chosen nose piece
        - The ability to use the device on both sides without having the adjust the nose piece
        - The nosepiece and the device will be printed separately
- The team is in the process of figuring out purchasing issues at the MakerSpace. The team might just pay out of pocket for the initial prototype
- The team reviewed the progress on the IRB proposal
    - A template was found online
    - Testing protocols still need to be made
    - Need to find how many patients are required for successful testing and an accurate confidence interval
- Advisor meeting tomorrow
    - Ask what the expectations are for timelines this semester regarding prototyping and final product
    - Show initial IRB application progress

**Conclusions/action items:**

The team will discuss current progress with the advisor tomorrow. The team will then meet with the client on Friday and update her on the progress made on modeling the device as well as the IRB approval process. This week and next week, the team will continue working on the IRB template as well as drafting detailed and accurate testing protocols, specifically for the ease of use test since that will be required for the IRB application.

# 2023/11/1 - Team Meeting 8

ANABELLE OLSON (amolson27@wisc.edu) - Dec 12, 2023, 3:59 PM CST

**Title:** Team Meeting 8

**Date:** 11/01/2023

**Content by:** Anabelle Olson

**Present:** Anabelle Olson, Kasia Klotz, Tevis Linser, Jenna Krause, Tommy Kriewaldt, and Eva Coughlin

**Goals:** Discuss successes and challenges of our current 3D printed prototype and come up with new testing protocols

**Content:**

- Team discussed possible new iterations of the current prototype
    - Making the arms of the device wider
    - Possible finger grip indent handle
- Team talked about doing cad models for our other designs
    - We think that our current device works well so for now we won't proceed with outer design ideas, however, if we come to a situation where our current design seems to not be working then we can turn to our other designs.
- New testing protocol ideas:
    - Force it takes to dispense one drop
    - Displacement of squeeze (bottle) to dispense one drop
    - Need distance between ends of handles for displacing one drop
        - For stoppers, we can used this distance between the handles when one drop is released and divide by 2 to find stopper dimensions
- The team is going to make a document to have on showcase at show and tell
    - Summarize our project and the problem we are addressing
- Advisor meeting
    - Show our advisor prototypes
    - Ask questions about IRB
    - Tell her our plan about our testing protocols

**Conclusions/action items:**

This week the team got together and addressed everything done during the past week, including iterations to the prototype and testing protocol generation. The team also planned for what is going to be talked about during our advisor meeting, and going

forward the team plans to continue prototyping and start writing the testing protocols, in preparation for testing coming up in the next few weeks

# 2023/11/8 - Team Meeting 9

EVA COUGHLIN - Nov 08, 2023, 6:31 PM CST

**Title:** Team Meeting 9

**Date:** 11/08/2023

**Content by:** Eva Coughlin

**Present:** Anabelle Olson, Tevis Linser, Jenna Krause, Tommy Kriewaldt, and Eva Coughlin

**Goals:** Discuss how we want to modify the prototype to reprint and discuss testing protocols.

**Content:**

- Need to make smaller version of prototype for the smaller eye drop bottles such as the glaucoma bottle
- Need to make version of prototype with angled handles as discussed at prior meetings to add more mechanical leverage
- Connection to nosepiece needs to be at a higher height so that the eye drop bottle is further away from the patient's eye
- Tevis, Tommy, and Kasia will meet Friday this week to change design on SolidWorks
    - Plan to reprint early next week
        - Client and pharmacy student expressed interest in observing this process
- Anabelle, Eva, and Jenna will continue with testing protocols and IRB
    - Single Drop protocol is completed: we want the results of this test to support the fact that the eye drop assistant device can dispense a consistent amount of medication per drop regardless of the user
    - Consistency of drop location protocol has been started: thinking of using food dye to mark location of drop on mannequin and measure displacements
    - MTS compression testing protocol needs to be done: want to test compression force of handles in MTS

**Conclusions/action items:**

Eva will email the client to ask if she or Ryan have availability early next week to come observe 3D printing at the Makerspace, and she will reach out to Dr. Wille to discuss the MTS compression testing. Tevis, Kasia, and Tommy will work on the changes to the Solidworks model and reprinting early next week. Anabelle, Eva, and Jenna will continue to add to the IRB protocol and complete the preliminary testing protocols discussed. The plan is to start our testing from 12-2 next Friday and begin with the Single Drop testing protocol.

# 2023/11/15 - Team Meeting 10

EVA COUGHLIN - Nov 15, 2023, 5:41 PM CST

**Title:** Team Meeting 10

**Date:** 11/14/2023

**Content by:** Eva Coughlin

**Present:** Kasia Klotz, Anabelle Olson, Tevis Linser, Jenna Krause, Tommy Kriewaldt, and Eva Coughlin

**Goals:** To discuss the client meeting at Makerspace and our plans for the week.

**Content:**

- Only constructive criticism from the client meeting was that the device isn't very easy to use when standing up, need to tilt head all the way back to dispense drop into the eye
    - Discussed incorporating a joint on the component that attaches to the nosepiece to allow for adjustability with the angle of administration
    - Client mentioned that perpendicular orientation would be great for bedside nurses to use when administering eye drops to their patients
    - For self-use, it would be convenient to be able to use the device when standing up and while lying down flat
- Decided that we don't need the stopper between the handles
- Discussed the height that the nosepiece lifts off the face
    - Hard to determine how high/low that part needs to be because everyone's eyes are different
    - Decided we are going to leave it as is
- We gave Ryan (pharmacy student) the 3D printed prototypes to show at his pop up meeting in order to get opinions on the concept
- For the IRB, we do not need a consent form with the participants' signatures
    - Instead we need an informational sheet used as the consent form
    - Dr. Martin is going to send that to Eva
- Ryan will send documents for standards for eye drop bottles and arthritis lab grip strength
- Starting with single drop testing as proof of concept

**Conclusions/action items:** Our next step with the project is to start preliminary testing. We will have everyone complete their part of the single drop testing at the biomaterials lab at ECB on either Thursday or Friday depending on individual availability. The data will be sent to Eva to do statistical analysis. The IRB draft will be sent to Dr. Martin's client after the informational sheet is completed.

# 2023/11/29 - Team Meeting 11

KASIA KLOTZ - Nov 29, 2023, 12:42 PM CST

**Title:** Team Meeting 11

**Date:** 11/29/2023
**Content by:** Kasia Klotz
**Present:** Kasia Klotz, Anabelle Olson, Tevis Linser, Jenna Krause, Tommy Kriewaldt, and Eva Coughlin
**Goals:** Update team on progress for testing and discuss plan to finish out the semester.

**Content:**

- Topics to discuss with Professor P. tomorrow during meeting
    - Location testing
    - WARF application
    - PDS grade
    - Mentorship
    - Ask about specifics for presentation and poster
        - Future work
        - Words vs pictures
- MTS machine test fixture as well as altered prototype are printing and should be done by tomorrow morning
    - Holes will be drilled out
- Location test needs to be more specific to prove something
    - Device should removed from “face” after every drop
    - Should be compared to control (eye drops dispensed without device)
    - Goal is to show precision of device in location of drops
        - Accuracy would need to be proven via human testing to prove that the device works for different shaped and sized faces
    - Considering using a piece of paper rather than an eye, multiple pieces of paper with the same size circle
        - User will aim for the middle of the circle, one test with the device and one test with the control
        - ImageJ will be used for analysis
        - The spot furthest from the center of the circle will be set as the radius for the area
        - Areas will be compared
- Another iteration of the device will be printed with the nose piece attached
    - The nose piece is going to be altered to be skinnier to be more comfortable on the nose
- Poster template has been made, team members m

**Conclusions/action items:** The team will conduct MTS testing tomorrow to determine the force taken to displace the device enough to release one drop. Location testing will be conducted early next week to determine the precision of the device. The team will start working on the poster this week and will start the final report next week.

# 2023/12/6 - Team Meeting 12

Jenna Krause - Dec 06, 2023, 4:33 PM CST

**Title:** Team Meeting 12

**Date:** 12/6/2023

**Content by:** Eva Coughlin and Jenna Krause

**Present:** Eva Coughlin, Jenna Krause, Anabelle Olson, Thomas Kriewaldt, Tevis Linser and Kasia Klotz

**Goals:** To discuss the IRB, poster feedback, outreach opportunity, and next steps with finishing the semester.

**Content:**

- Did zoom meeting with Prof. Puccinelli
- Do we have an advisor meeting tomorrow? no
- Outreach opportunity is confirmed? yes
- Poster feedback:
    - Problem statement first before other motivation
    - Figure 2: not clear which one is the proper technique. So make it clear that it is the proper steps to the technique
    - Put “figure 2” next to the text as well. Add in numbers to illustrate the flow of technique
    - Design Criteria is a little wordy but not a huge deal. Solution eliminate words and enlarge text size
    - Final design images need a figure caption. Turn text below of “features” into a caption title “Figure 5: Features of Final Design”
    - Changes in the design or iterations of the design instead of “design process”
    - Box plot lines are really faint and the title headings are too small.
    - For the box plot section when the team presents they need to clearly explain the labels of the graph and the difference between device and no device
    - Edit precision test for font size and eliminate title
    - Do not need the whole table of the displacement and force just need the summary of the small and large bottle force.
    - Fill in the space with images from the other testing
    - Make sure to go through and default to no periods on bullet points
    - Do not include the outreach seminar on the final report
- Make sure the team gets an “IRB certification of exemption”
- Can the team resubmit this application with slight changes to represent using the prototype with saline on human trials.

**Conclusions/action items:**

The team met with Prof. Puccinelli on Zoom and went over our poster. The team edited the poster with the provided feedback and is sending Prof. Puccinelli the draft. Prof. Puccinelli recommended that the team email IRB to ask for a certification of exemption for the consumer preference testing. The team will split up the final report soon and edit our LabArchives after the poster presentation.

# 2023/09/27 - Team's Initial Design Ideas

ANABELLE OLSON (amolson27@wisc.edu) - Dec 12, 2023, 4:14 PM CST

**Title:** Team's Initial Design Ideas

**Date:** 09/27/2023

**Content by:** Team

**Present:** Jenna Krause, Eva Coughlin, Tevis Linser, Tommy Kriewaldt, Kasia Klotz, Anabelle Olson

**Goals:** For each team member to come up with a design concept and choose which to include in the design matrix

**Content:**

Team's Design Ideas:

## Anabelle's designs: Eye Lash Dropper & Giant Bottle

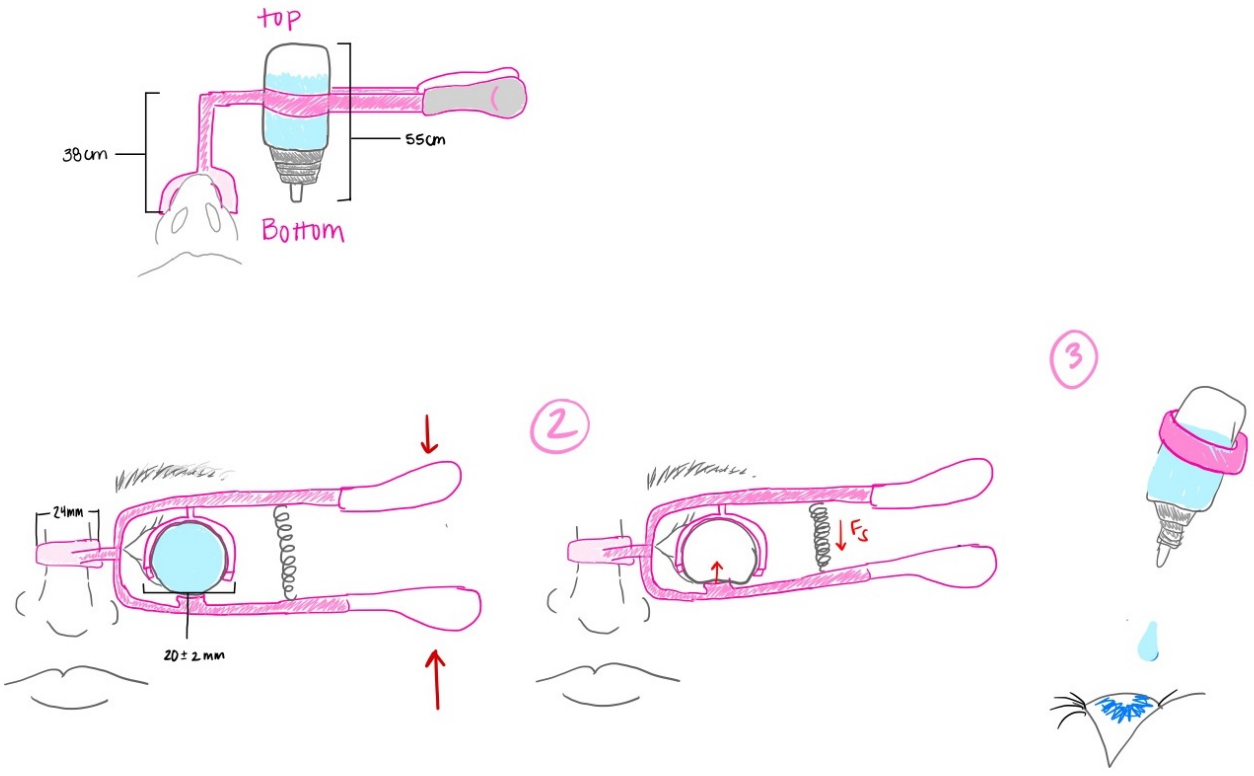



Figure 1. Eye lash dropper sketch

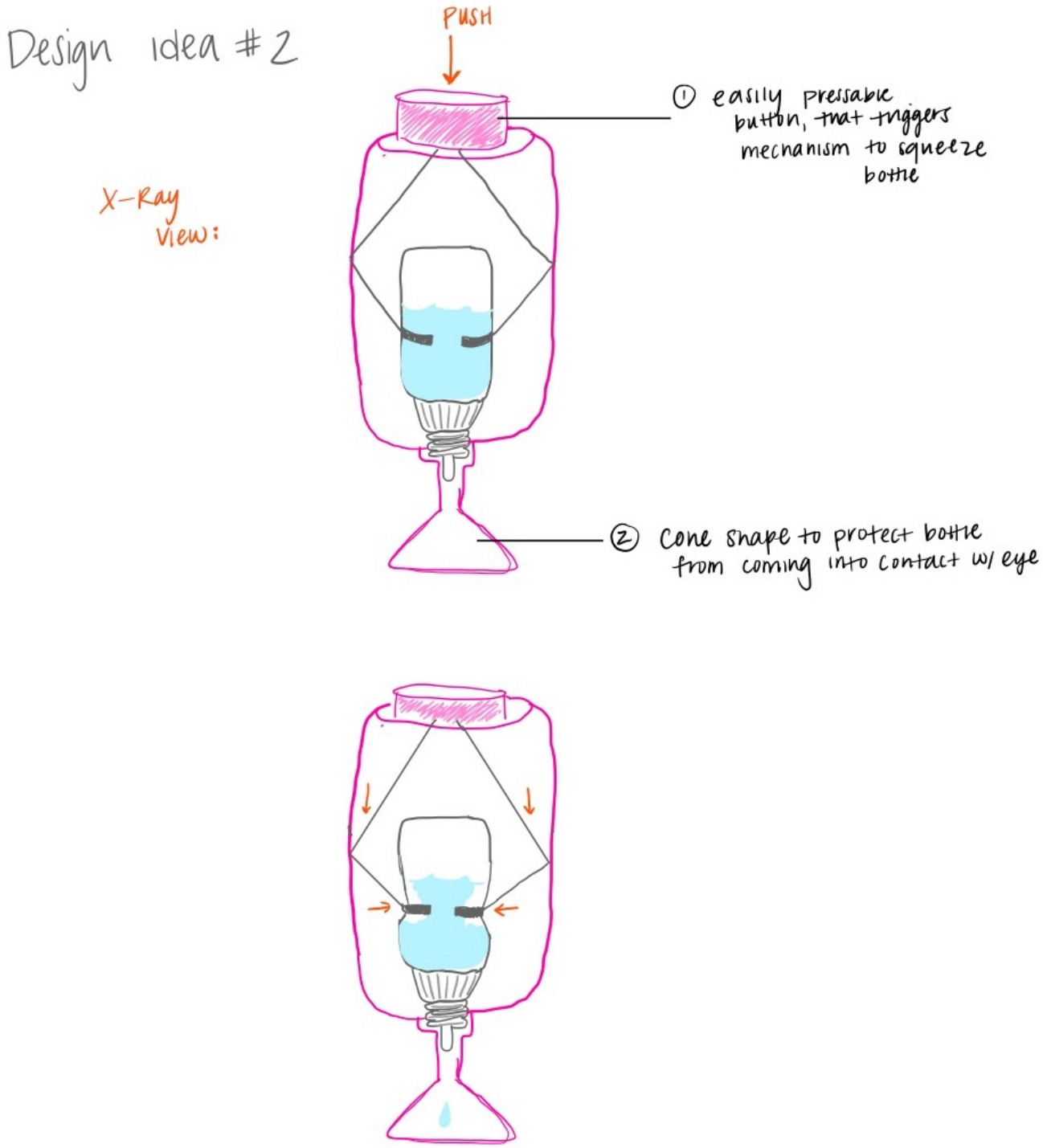



Figure 2. Giant Bottle Sketch

**Tommy's Designs: The slider & The Clasp**

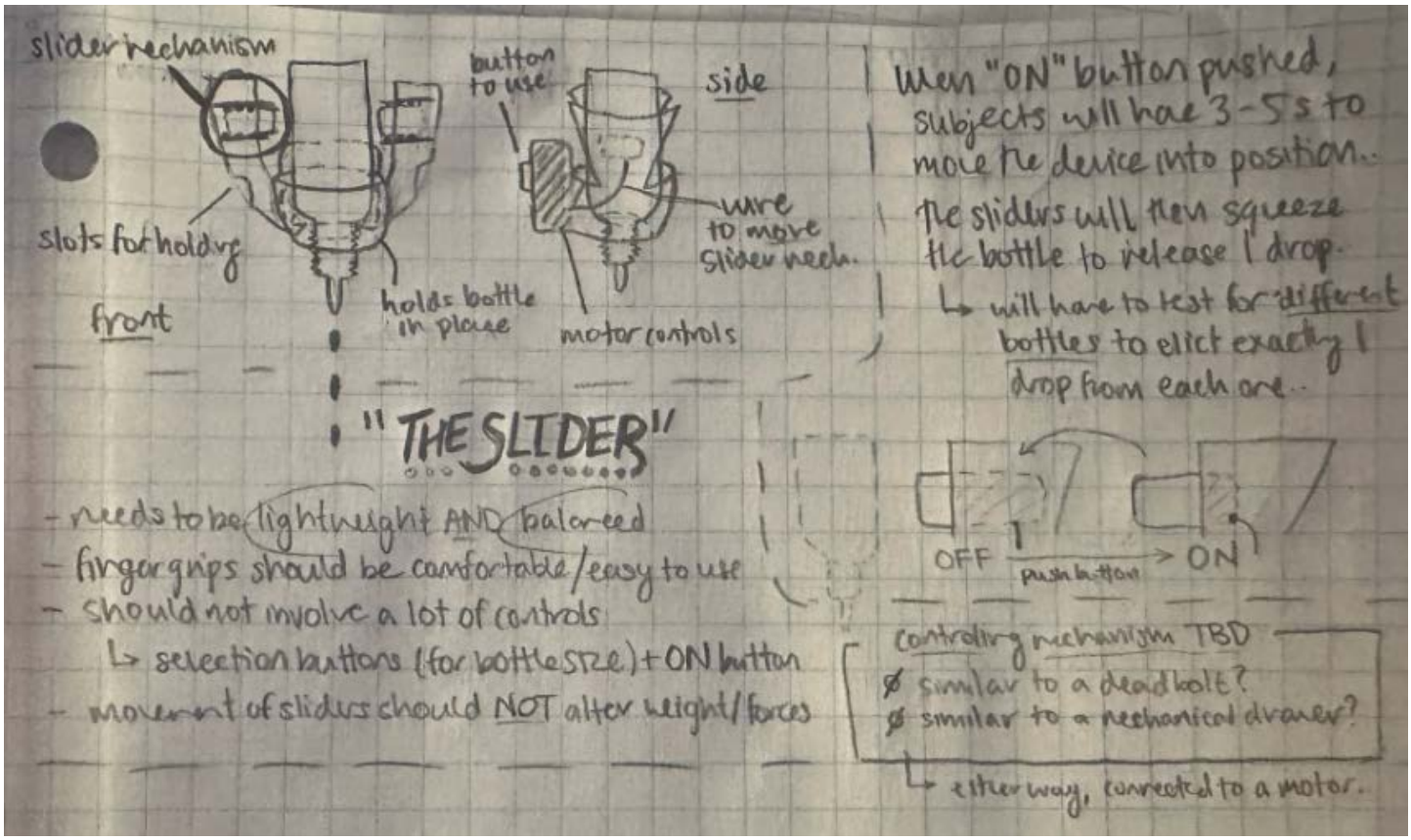



Figure 3. The slider sketch

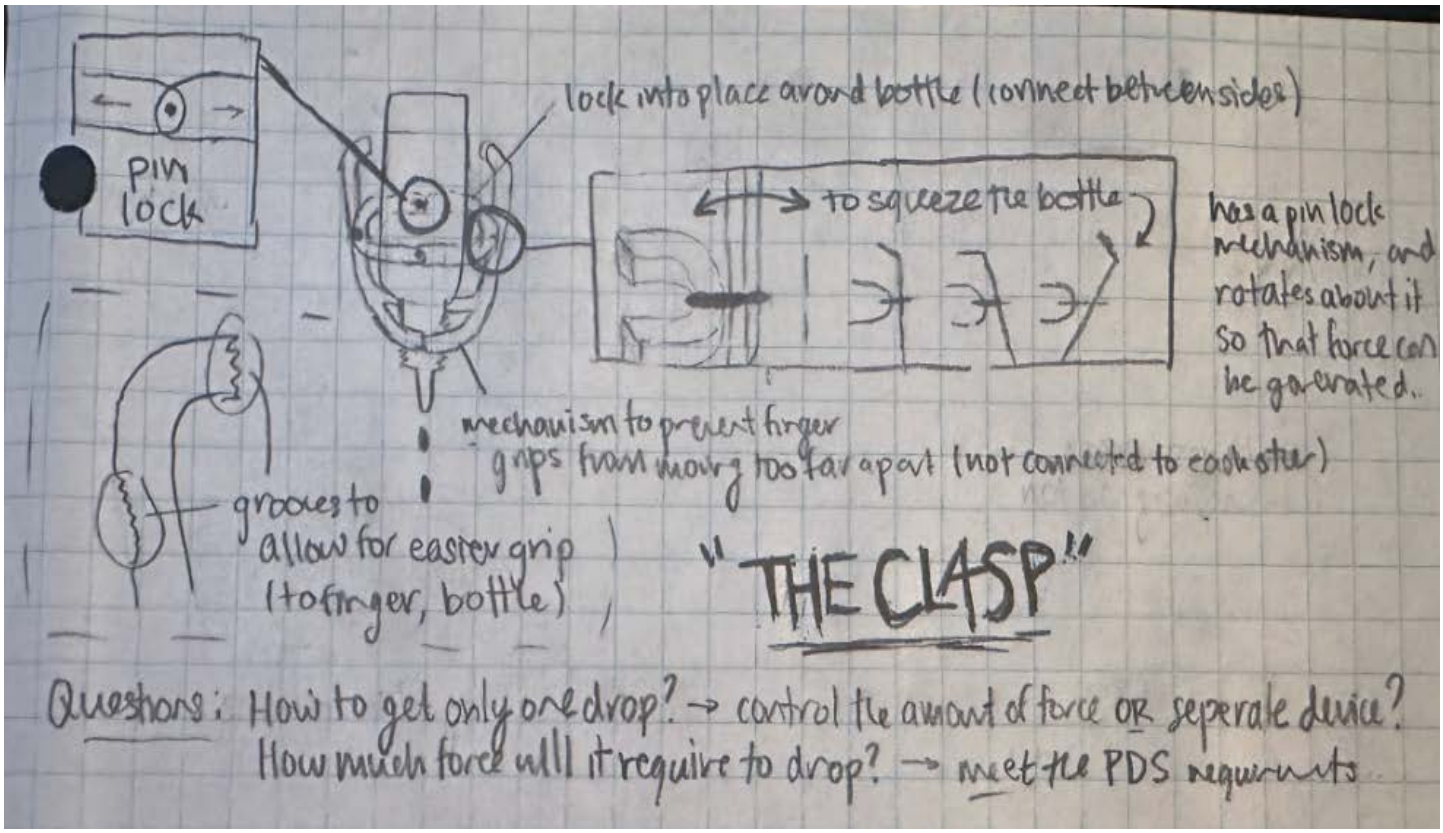



Figure 4. The clasp design sketch

**Jenna's designs: Stopper Buddy & flexible wiring**

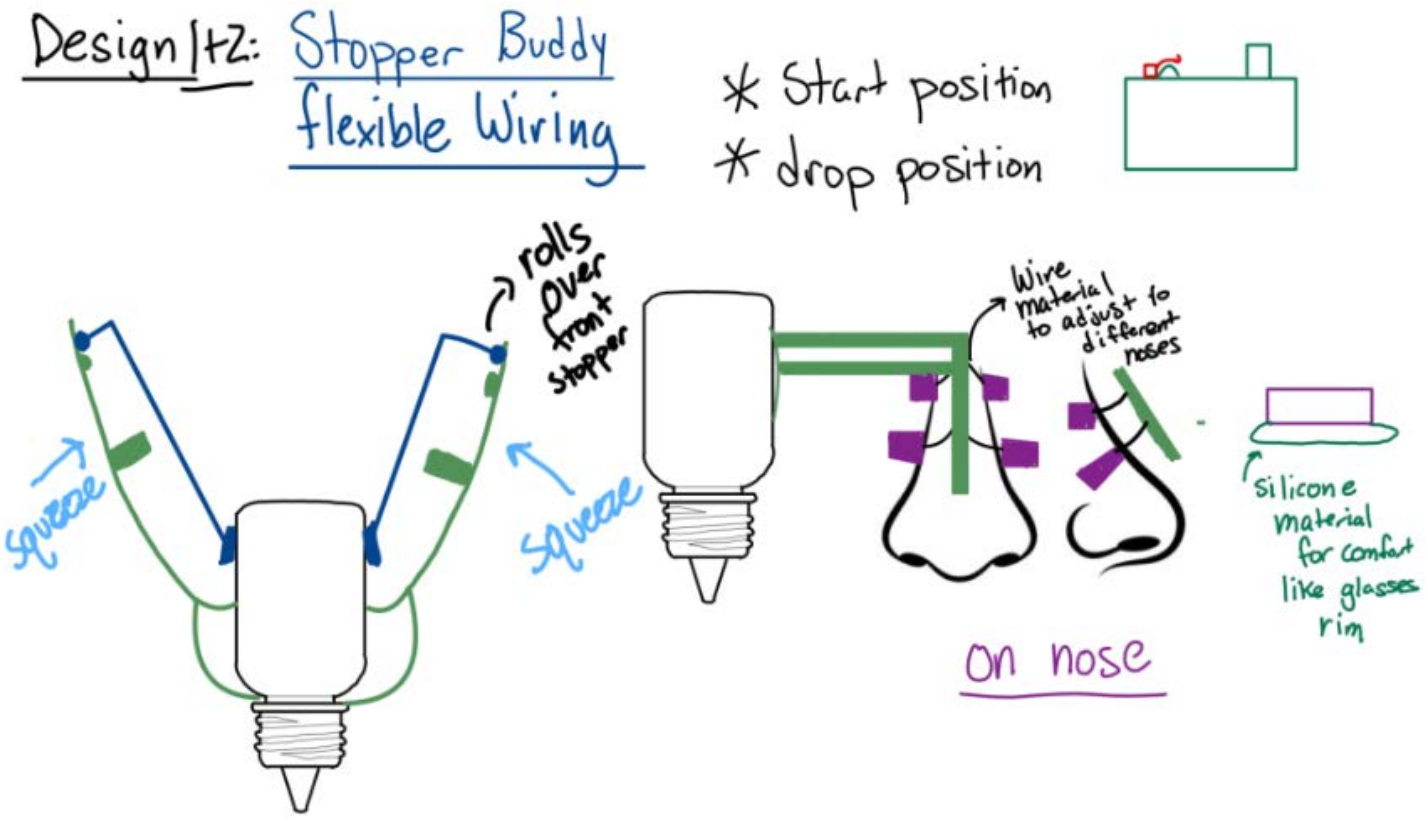



Figure 5. The stopper buddy and flexible wiring design sketch

**Kasia's design: Plier's & Pencil Grip**

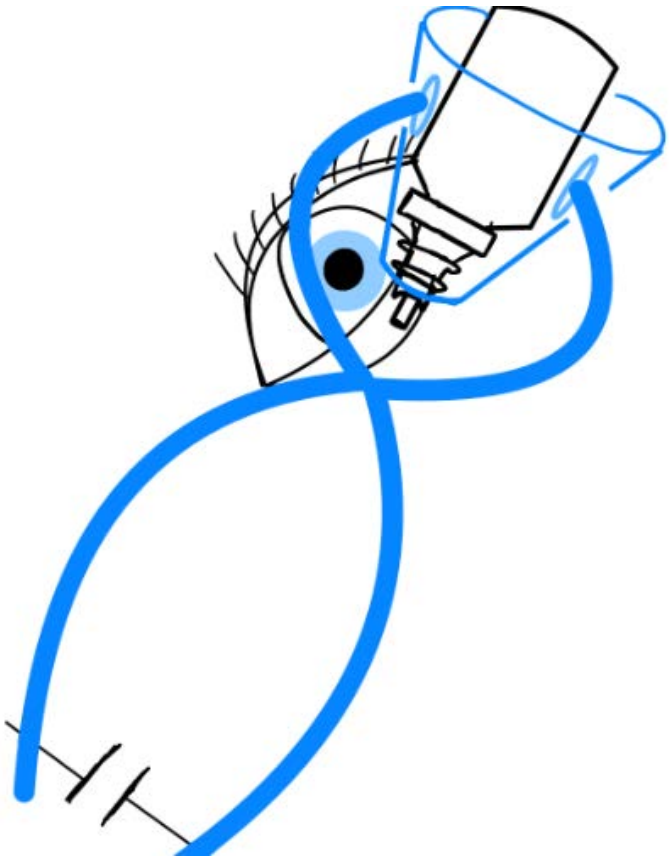


Figure 6. The plier design sketch

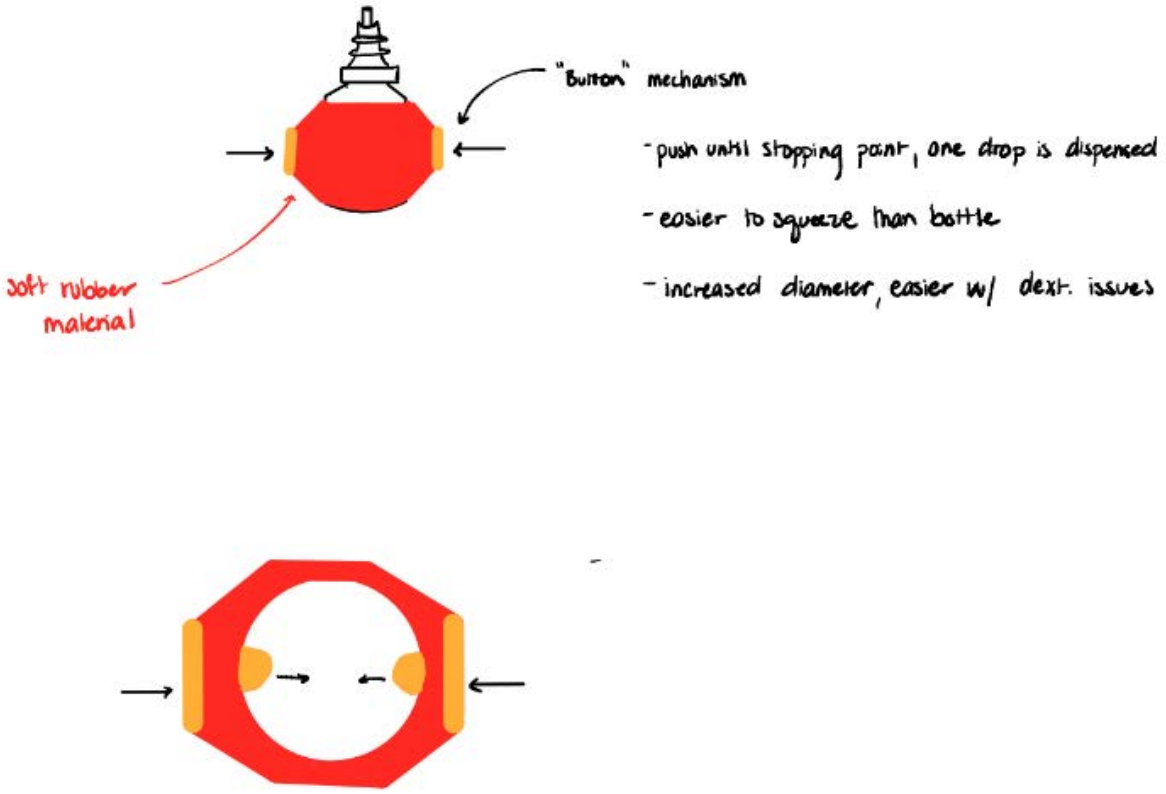



Figure 7. the pencil grip design sketch

**Tevis's Design:**

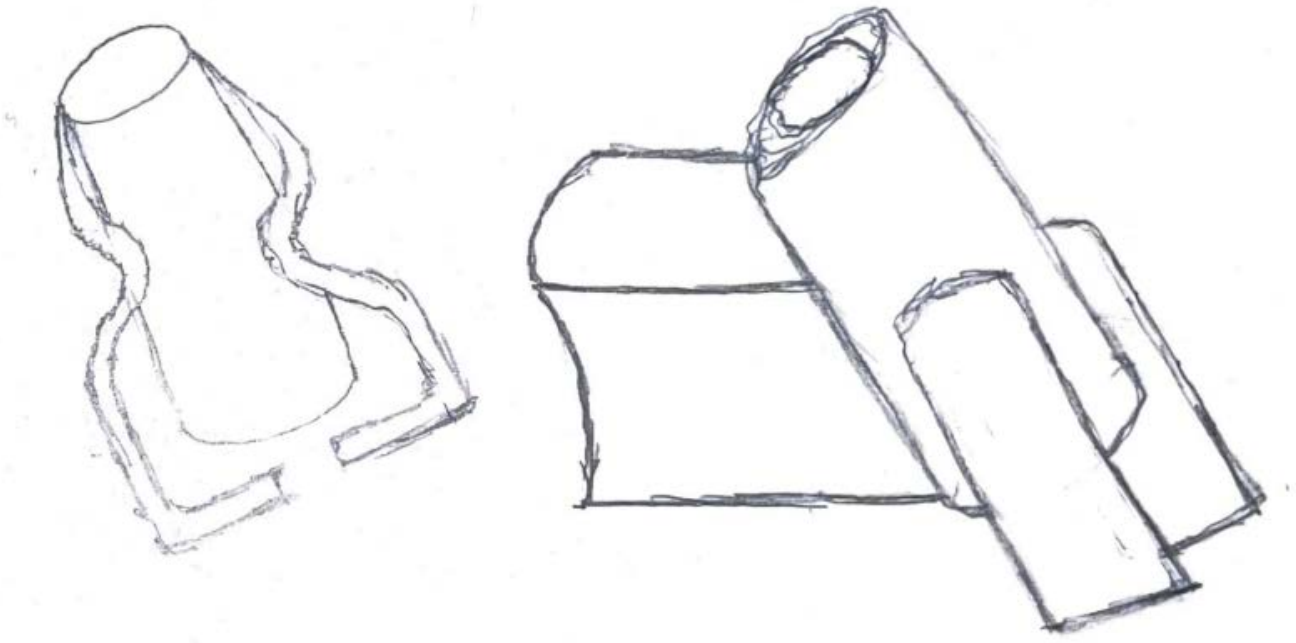


Figure 8. Tevis's design sketch.

**Conclusions/action items:**

The team got together to review everyone's initial design ideas. For the design matrix, three pitches were selected from the team. Anabelle's eyelash dropper design is labeled as Design 1, Tommy's slider design is Design 2, and Jenna's stopper buddy design is Design 3. These designs will form the basis for the upcoming design matrix, which is due later this week.

# 2023/11/03 - Show and Tell Feedback

Jenna Krause - Nov 08, 2023, 12:20 PM CST

**Title:** Show and Tell

**Date:** 11/03/2023

**Content by:** Anabelle Olson, Jenna Krause, Tommy Kriewaldt

**Present:** All Members

**Goals:** To receive feedback on the team's design from fellow BME peers at show and tell

**Content:**

- Show and Tell questions
    - How can the team customize the design to fit different variations of drop bottles?
    - How can the team incorporate a stopper mechanism into the design?
    - How can the team test the device to ensure only one drop is released
- Show and Tell feedback
    - O - ring attachment
        - Some sort adaptor is needed
    - Screw on the outside to allow for adjustment of the bottle holder
        - Can bring the holder more in or more out
    - Slider into the design → change the ring size for different bottles
        - Can easily change for different bottle sizes
        - It might be easier to just make different sized devices for each different bottle size!
    - Screw on outside to bring the internal components closer or farther apart
    - Foam or squishy material (rubber) that can adjust to the size of the bottle
        - Stretches to fit larger bottles, but can still fit the smaller bottles
    - Doesn't look scary, looks accessible to use!
    - Could add hand grips, but honestly doesn't need it.
    - Bendy bottle attachment fo you can bend it to fit smaller bottles
    - Multiple nose bridge attachments to fit other nose anatomies
    - Electronic component to have a light flash when drop is administered
        - Tommy idea: Put sensors in the nose bridge, and relay to mechanical components in the handles → need to study fabrication and hollow out the inside of the design.
    - Likes the rotation mechanism to allow for people with right hand left hand to use it with no difficulty.
    - Spring to stretch out for bottle attachment for each bottle size - example she gave was the phone holder in car that can stretch for different size phones
- Can koozie ideas. Different levels on the inside:


- Make the bottle holder completely enclosed as a circle so you can just squeeze it in till it fits the bottle size you need.
- Form fitting nose piece that works with universal nose sizes like jenna’s nose piece mechanism
- Do not think we need the eyelash handles now
- Jenna idea: Choose your own adventure vibe.
    - Create your own device so can pick custom nose piece size, and eye drop holder to fit different size bottles
- Tommy idea: pull springs tight based on the bottle size → different modes to ensure eliciting only one drop.
- Idea from group: create a sleeve to accommodate different bottle sizes, also threading the cap into the device

**Conclusions/action items:**

The feedback suggests incorporating an adaptable design with features like a screw-on mechanism, slider, and foam material for flexibility to accommodate various bottle sizes. The concept of a customizable device, allowing users to choose nose piece size and bottle holder configurations, emerged, along with considerations for an electronic component signaling drop administration. The overarching theme emphasizes user-friendly adaptability. Action items incorporate this feedback into our initial prototype.

# 2023/10/11 - Expenses Master Sheet Midterm

**Title:** Expenses Master Sheet

**Date:** 10/11/2023

**Content by:** Tevis Linser

**Present:** N/A

**Goals:** To record and track the expenses associated with the project

**Content:**

| Item | Description | Manufacturer | Part Number | Date | QTY | Cost Each | Total | Link |
|---|---|---|---|---|---|---|---|---|
| **Existing Devices** | | | | | | | | |
| **Droppy Eye Drop Dispenser** | Competing Design | Droppy, Amazon | DR001 | TBD | 1 | 9.99 | 9.99 | **Link** |
| **GentleDrop Eye Drop Guide** | Competing Design | GentleDrop, Amazon | ASIN: B0BQBHRKV1 | TBD | 1 | 17.99 | 17.99 | **Link** |

# Competing Designs To Purchase:

GentleDrop Eye Drop Guide | Aid to Help Aim Most Eye Drop Bottles | Dispenser Invented by Doctors


Droppy Eye Drop Dispenser

**Conclusions/action items:**

This is an ongoing list that should continue to be updated.

# 2023/10/11 - Expenses Master Sheet Final

**Title:** Expenses Master Sheet

**Date:** 12/11/2023

**Content by:** Tevis Linser

**Present:** N/A

**Goals:** To record and track the expenses associated with the project

**Content:**

| Item | Description | Manufacturer | Part Number | Date | QTY | Cost Each | Total | Link |
|---|---|---|---|---|---|---|---|---|
| **Existing Devices** | | | | | | | | |
| **Droppy Eye Drop Dispenser** | Competing Design | Droppy, Amazon | DR001 | 9/25 | 1 | 9.99 | 9.99 | Link |
| **GentleDrop Eye Drop Guide** | Competing Design | GentleDrop, Amazon | ASIN: B0BQBHRKV1 | 9/25 | 1 | 17.99 | 17.99 | Link |
| **Prototyping** | | | | | | | | |
| **Silicone Eyelash Curler** | Prototype Materials (Handle Grips) | PETUNIA SKINCARE, Amazon | ASIN: B00UVLNDVQ | 10/25 | 1 | 7.49 | 7.49 | Link |
| **MakerSpace Print** | Prototype v1 | UW Makerspace Ultimaker 3D Print | N/A | 10/31 | 1 | 4.96 | 4.96 | N/A |
| **MakerSpace Print** | Prototype v2 | UW Makerspace Ultimaker 3D Print | N/A | 11/10 | 1 | 5.07 | 5.07 | N/A |
| **MakerSpace Print** | Prototype v3 | UW Makerspace Bambu Labs 3D Print | N/A | 11/13 | 1 | 4.5 | 4.5 | N/A |
| **MakerSpace Print** | Prototype v3 | UW Makerspace Bambu Labs 3D Print | N/A | 11/14 | 1 | 4.96 | 4.96 | N/A |
| **MakerSpace Print** | Prototype v3 | UW Makerspace Ultimaker 3D Print | N/A | 11/15 | 1 | 8.16 | 8.16 | N/A |
| **MakerSpace Print** | Prototype v4 | UW Makerspace Ultimaker 3D Print | N/A | 11/17 | 1 | 10.08 | 10.08 | N/A |
| **MakerSpace Print** | Test Fixture | UW Makerspace Ultimaker 3D Print | N/A | 11/29 | 1 | 13.78 | 13.76 | N/A |
| **MakerSpace Print** | Final Prototype | UW Makerspace Ultimaker 3D Print | N/A | 12/1 | 1 | 7.36 | 7.36 | N/A |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MakerSpace Print** | Multiple Final Prototypes | UW Makerspace Ultimaker 3D Print | N/A | 12/8 | 1 | 11.6 | 11.6 | N/A |

**Conclusions/action items:**

The team spent $106, the bulk of prototyping is done so we will likely stay in budget.

# 2023/12/05 - Material Properties of PLA

THOMAS KRIEWALDT - Dec 12, 2023, 8:03 PM CST

**Title: Summary of PLA Material Properties**

**Date:** 12/05/2023

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To characterize the material properties of PLA to use in the SolidWorks simulation.

**Sources:**

[1] Ryan Dix, “Material Considerations in Fused Filament Fabrication,” United States Merchant Marine Academy, Kings Point Department of Engineering, 2018. [Online]. Available: https://drive.google.com/file/d/1-Rk4UL_jVFBVn9pm14jypMBkYNrGs0wW/view

[2] PolyFluor, PLA Datasheet. https://www.polyfluor.nl/assets/files/datasheet-pla-filament-uk.pdf

[3] L. Kuentz, A. Salem, M. Singh, M. C. Halbig, and J. A. Salem, “Additive Manufacturing and Characterization of Polylactic Acid (PLA) Composites Containing Metal Reinforcements”. https://ntrs.nasa.gov/api/citations/20160010284/downloads/20160010284.pdf

**Content:**

As a result of the shortcomings of our MTS testing, the team was unsure whether or not the data from that testing was valid.

- We consulted a SolidWorks simulation to ensure that these results would be similar to what we did experimentally.

-

The 40% infill PLA we used to create the final physical prototypes are not in SolidWorks software.

The following material properties were found in literature, and will be used to create a custom material in SolidWorks.

- 40% infill PLA has an **elastic modulus of 324 MPa** [1].
- 40% infill PLA has a **yield strength of 11.1 MPa** [1].
- 40% infill PLA has an **ultimate strength of 12.6 MPa** [1].
- 100% infill PLA has a density of 1.25 g/cm^3 [2].
    - Calculating for 40% infill, PLA has a **density of 0.5 g/cm^3**.
- PLA material has a Poisson's Ratio of ~0.33 [3].

We can model the PLA material as linear isotropic elastic, as it is homogeneous and displays no non-linear traits.

-

**Conclusions/action items:**

Use these material properties to characterize PLA plastic in SolidWorks as it doesn't have a preset material for PLA.

Carry out the SolidWorks simulation for the small and large eye drop assistants.

# 2023/10/31 - The Eye Lash Dropper Initial Prototype

THOMAS KRIEWALDT - Oct 31, 2023, 3:27 PM CDT

**Title: Eye Lash Dropper Initial Prototype**

**Date:** 10/24/2023 & 10/31/2023

**Content by:** Thomas Kriewaldt, Tevis Linser, Kasia Klotz

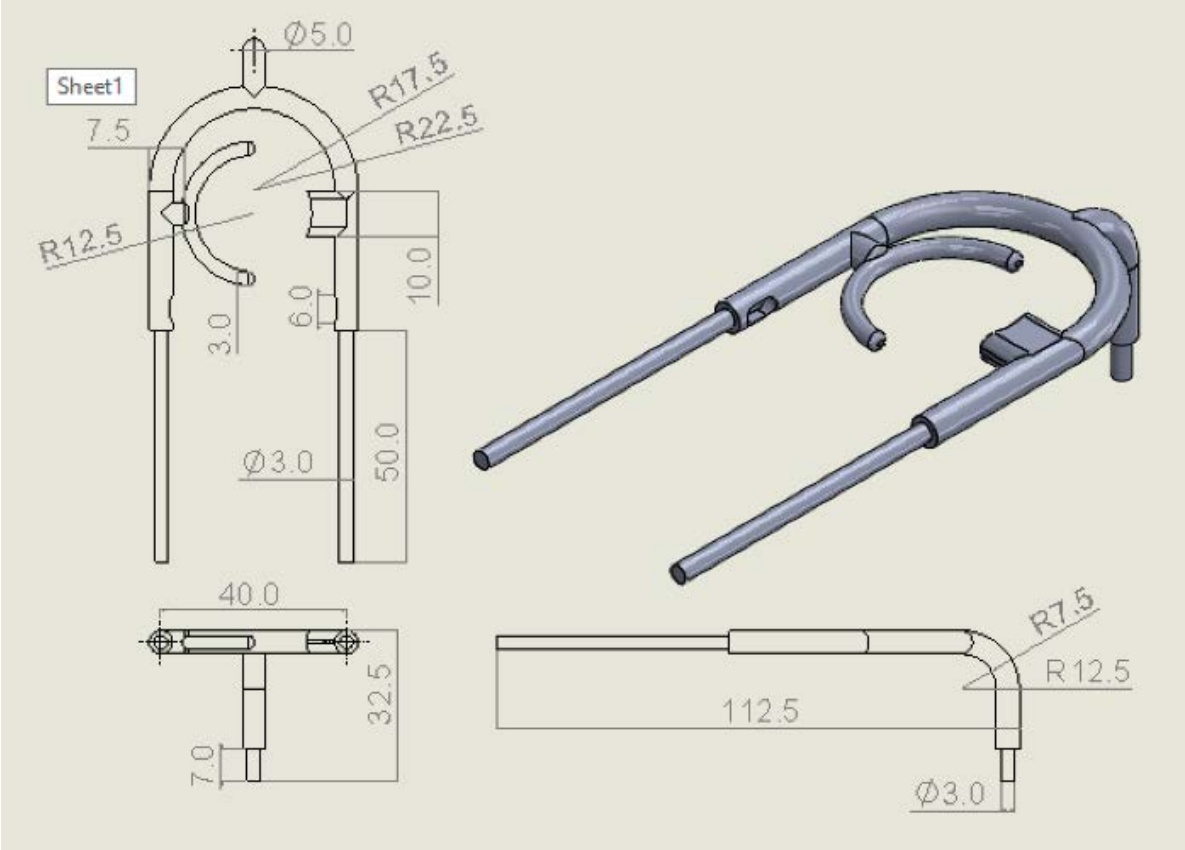
**Present:** Thomas Kriewaldt, Tevis Linser, Kasia Klotz

**Goals:** To create an initial model and 3D print of the Eye Lash Dropper; To refine our design before show and tell.

**Content:**

The initial model was created on 10/24

- Dimensions and the overall layout are shown in the SolidWorks sketch below. Part files for the body, nose clip, and assembly are also linked to this document.




Changes to be made on the printed prototype on 10/31

- Tip the device slightly to match the facial anatomy and elicit eye drops into the eye.
    - Do this on the nose piece connection
- Thicken the squeezing mechanism of the device --> reduce any chance of plastic deformation.
- Lengthen the handle to give more room to the hand squeezing of the device.
- Add a secondary layer to support the neck of the bottle (pre-standardized diameter).
- Add a joint between the nose piece and the body to ensure it doesn't rotate when the patient doesn't want it to.

Need to nail a testing build that maximizes the easy squeeze of one drop before we focus on the stopper (for one drop) mechanism.

Get feedback on the spring or stopping mechanism at Show and Tell.

**Conclusions/action items:**

Create a new Solidworks model that fixes some of the observations we made on Halloween.

Plan to print this model before Show and Tell and begin drafting testing protocols to test the optimal length of the squeezing mechanism.

After this optimal length is found, need to add a stopping mechanism to only elicit one drop!

KASIA KLOTZ - Nov 13, 2023, 9:48 PM CST


Download

**V1_400_BodyPiece.SLDPRT (268 kB)**

KASIA KLOTZ - Nov 13, 2023, 9:48 PM CST


Download

**400_NosePiece.SLDPRT (1.68 MB)**

KASIA KLOTZ - Nov 13, 2023, 9:50 PM CST


Download

**V1_Body_Eye_Lash_Dropper.SLDDRW (314 kB)**

# 2023/11/07 - The Eye Lash Dropper - Nose Piece

**Title: Eye Lash Dropper Initial Prototype**

**Date:** Part creation: 10/24/2023 Notebook Entry: 11/7/2023

**Content by:** Thomas Kriewaldt, Tevis Linser, Kasia Klotz

**Present:** Thomas Kriewaldt, Tevis Linser, Kasia Klotz

**Goals:** To create an initial model and 3D print of the Eye Lash Dropper; To refine our design before show and tell.

**Content:**

The initial model was created on 10/24

- Dimensions and the overall layout are shown in the SolidWorks sketch below.


Methods:

An STL file for a generic nose piece was acquired from UVEX (https://www.printables.com/en/model/284816-uvex-sportstyle-802-vario-nose-piece/files). Additional features were added to make the nose piece more robust and compatible with the rest of the prototype.

Potential Changes:

Make the nose piece compatible for both sides of use so the body won't have to twist around the nose piece.

Add an angle to the connector so the user doesn't have to tilt their head back so far.

**Conclusions/action items:**

For now the nose piece remained the same throughout both prototype versions. Future work (if needed) will likely be conducted after refining the body piece.

TEVIS LINSER - Nov 07, 2023, 3:57 PM CST


Download

**UVEX.stl (1.12 MB)**

TEVIS LINSER - Nov 07, 2023, 3:57 PM CST


Download

**400_NosePiece.SLDDRW (861 kB)**

TEVIS LINSER - Nov 07, 2023, 3:57 PM CST


Download

**400_NosePiece.SLDPRT (1.84 MB)**

# 2023/11/02 - The Eye Lash Dropper Second Prototype

KASIA KLOTZ - Nov 02, 2023, 1:19 PM CDT

**Title: The Eye Lash Dropper Second Prototype**

**Date:** 11/2/2023

**Content by:** Kasia Klotz, Thomas Kriewaldt, Tevis Linser

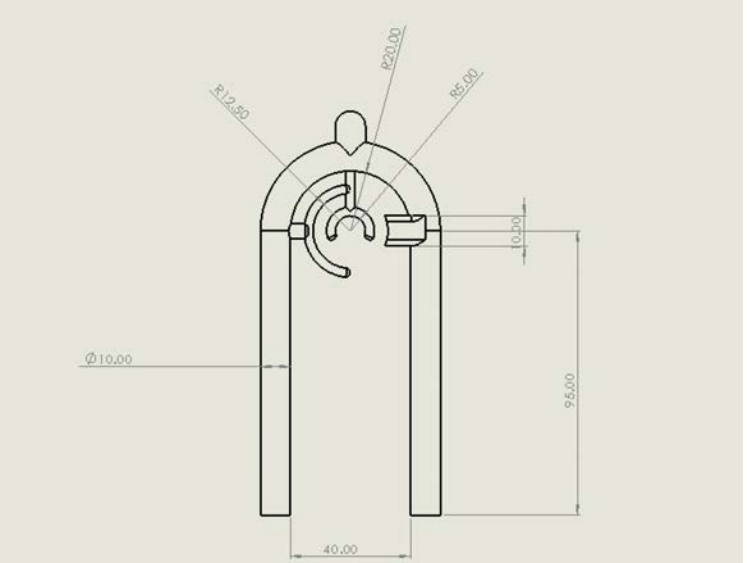
**Present:** Kasia Klotz, Thomas Kriewaldt, Tevis Linser

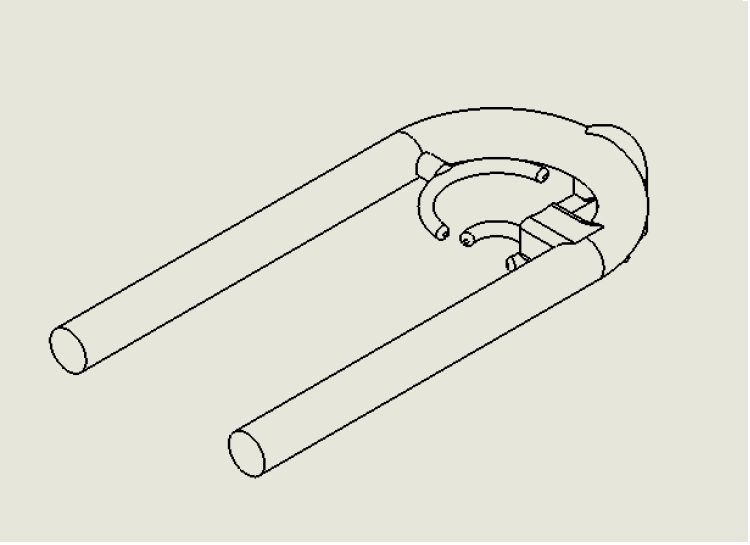
**Goals:** Modify initial prototype and reprint

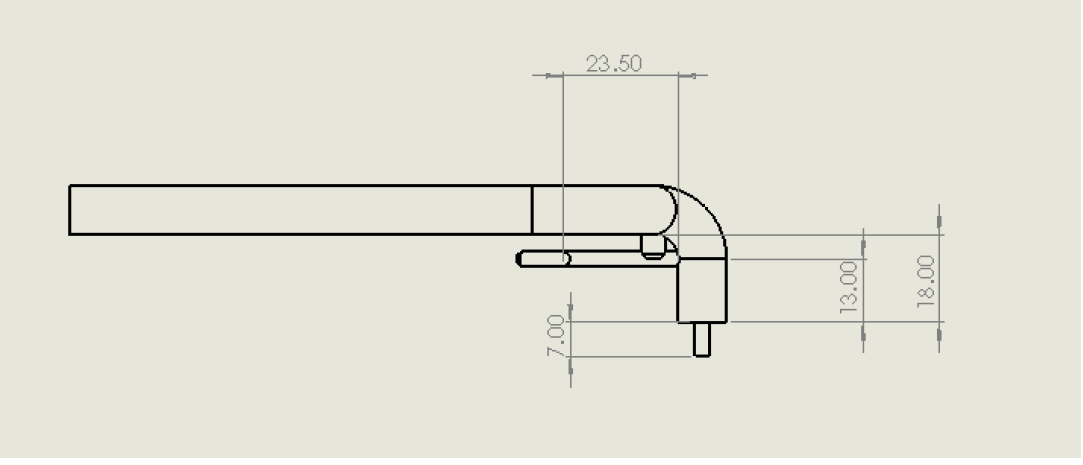
**Content:**

- The second iteration of this prototype is larger than the initial. There was a second suppoer added that wraps around the neck of the eye drop bottle to ensure the bottle sits in the correct place and does not come into contact with the eye. The places initially set for the grips was removed and the diameter of the handles was held constant throughout
- By inspection, it is clear that the smaller support for the bottle neck is too small. It was removed in the middle picture shown above. Overall, compared to the first print, the second print is more successful in squeezing the bottle to dispense a single drop of solution.

- Some possible changes to this prototype that should be considered in the next print include:
  - extending the length of the handles
  - widening the grip to increase mechanical advantage
  - either remove or improve second support
  - increase length of attachment piece to nose piece






- The provided dimensions are in mm.

**Conclusions/action items:** The team will continue to analyze current prototypes and improve the 3D models. The team will also use feedback received from peers during show and tell to make alterations to the current model. So far, the team is very pleased with the results of initial prints. The main edit for the next iteration will be to widen the grip of the device.

KASIA KLOTZ - Nov 13, 2023, 9:49 PM CST


Download

**V2_BME400_Body_Piece_.SLDPRT (382 kB)**

KASIA KLOTZ - Nov 13, 2023, 9:49 PM CST


Download

**BME400_NosePiece.SLDPRT (1.82 MB)**

KASIA KLOTZ - Nov 13, 2023, 9:51 PM CST


Download

**V2_BME400_Body_Piece_.SLDDRW (297 kB)**

# 2023/11/10 - The Eye Lash Dropper Third Prototype

THOMAS KRIEWALDT - Nov 21, 2023, 10:46 AM CST

**Title: Eye Lash Dropper Initial Prototype**

**Date:** Part Creation: 11/10/2023; Notebook Entries: 11/10/2023, 11/13/2023

**Content by:** Thomas Kriewaldt, Tevis Linser, Kasia Klotz

**Present:** Thomas Kriewaldt, Tevis Linser, Kasia Klotz

**Goals:** To refine our design based on team brainstorming and show-and-tell feedback.

**Content:**

The (v3) models were created on 11/10

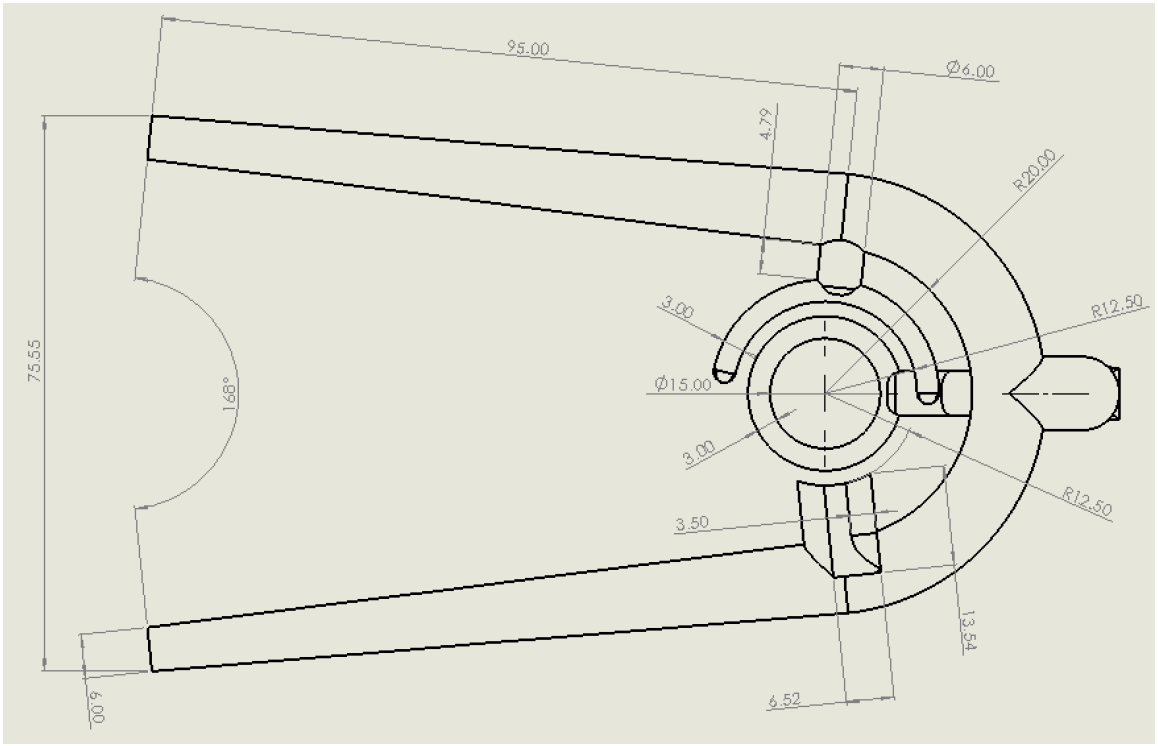
- Dimensions and the overall layout are shown in the SolidWorks sketch below. Part files for the body, nose clip, and assembly are also linked to this document.

Changes to be made on the printed prototype (v2) on 11/02

- Added a 6-degree angle to the arms and lofted the arms down to an ellipse for ease of use/ergonomics.
    - Adjusted the squeezing mechanism to match this angle, so that they remained parallel with the handles
    - Math to justify angle change magnitude while keeping the grip length below 8cm (as per previous research/calculations)
- Increased the post height that interfaces with the nose piece to ensure the bottle tip is the correct distance from the user's eye (when the middle of the bottle is in the squeeze plane). We lofted the post to mate with the nosepiece for aesthetics.
    - Ask Beth if this distance matters - if yes, adjust this length for future prototypes
- Increased radius of the piece that stabilizes the bottle below the squeeze plane.
    - Now a full circle rather than a half circle as well.. Should match the bottle better now.
- Created a separate device size that is able to hold the smaller glaucoma medicine bottle.
    - The diameter of the squeezing mechanism decreased from 2.5 to 2 cm.
    - Extrusions towards the holding mechanism were lengthened to adjust for the aforementioned change.
- Altered the support beam to be at a 60-degree angle rather than purely vertical
    - Previous trouble with 3D printing, this change should support the piece better during the 3D print (and when in use).

May also try to fuse the cap with the bottom of the device, so that it could be screwed into place easily. This will be looked at in future prototypes.

**Large Bottle Size: (mm, degrees)**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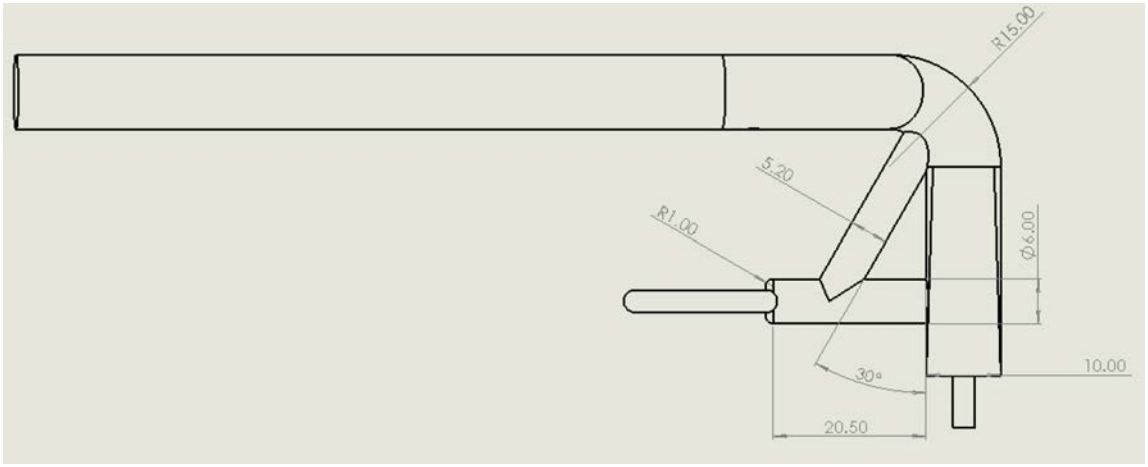
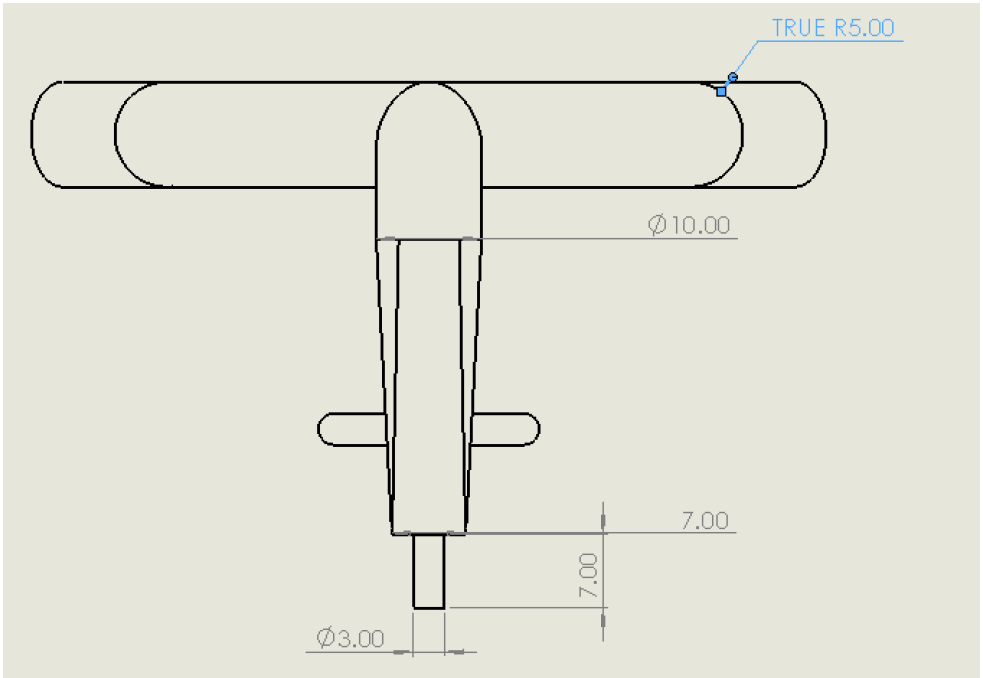
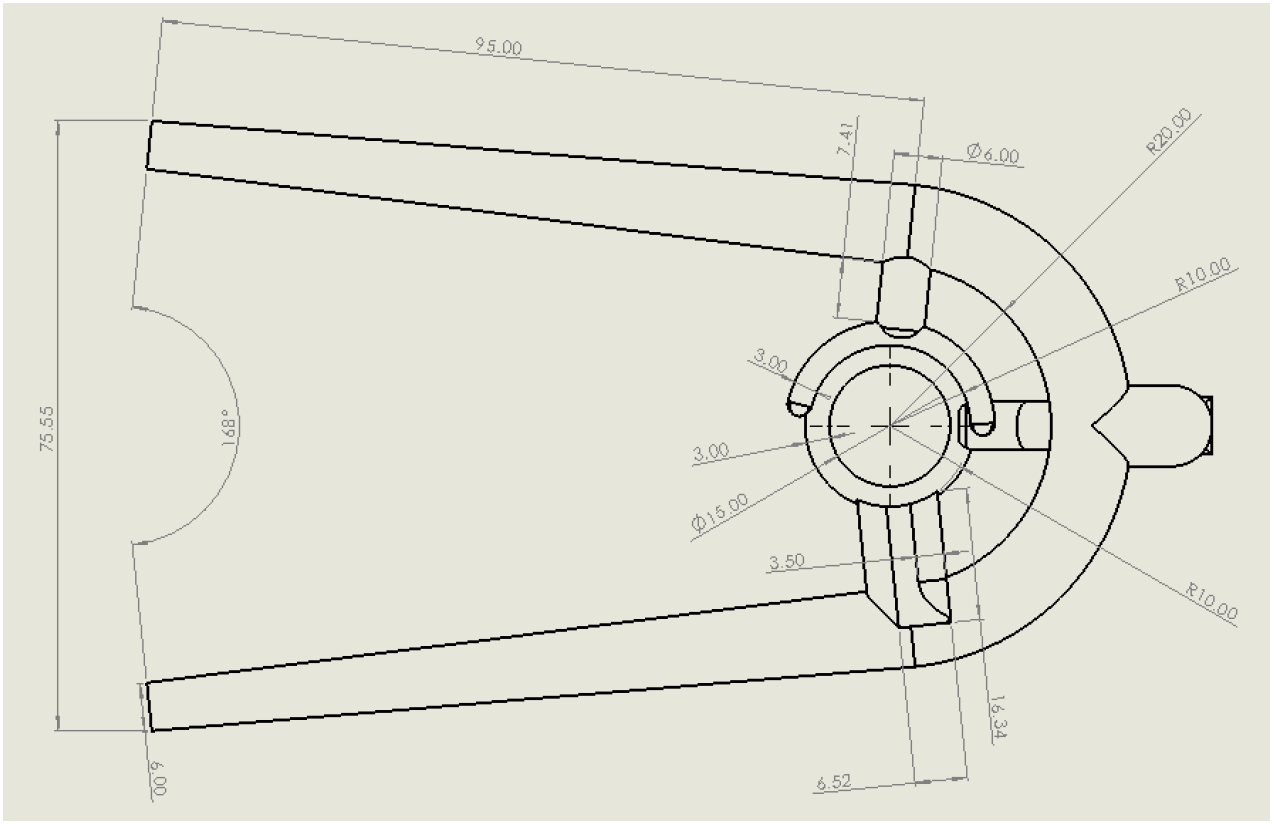
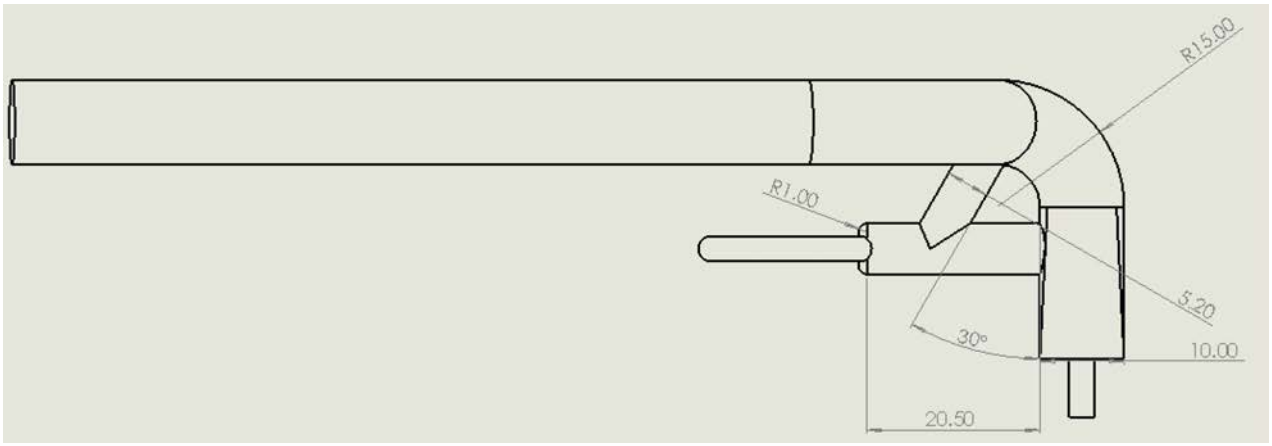
75.55
168°
6.00

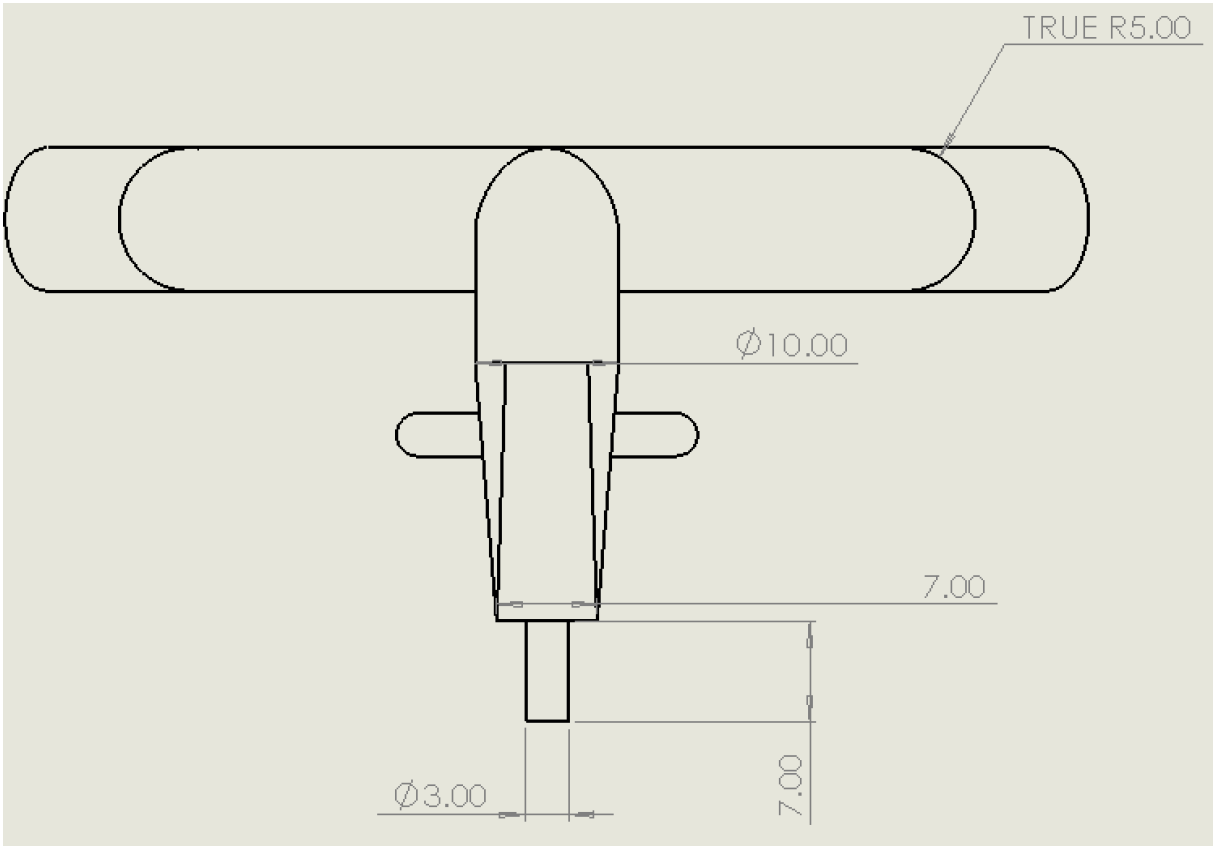

R15.00
5.20
R1.00
Ø6.00
10.00
30°
20.50


TRUE R5.00
Ø10.00
7.00
7.00
Ø3.00

**Small Bottle Size: (mm, degrees)**






The designs were printed and picked up on November 13th. The team's observations are below:

- Printed using BambuLabs instead of Ultimaker PLA
  - This caused the design to be much lighter and not as strong
  - The nose piece connection sheared off when attempting to assemble the device.
  - Need to reprint using Ultimaker PLA, as there were no previous issues with this material.
    - After speaking to makerspace employees, the team decided to attempt to reprint using BambuLabs but with increased the infill for the print in hopes of improving strength. The BambuLabs material is higher quality than Ultimaker PLA. However, if there is still a problem with sheering, the team will revert back to Ultimaker PLA for the next print.
- The bottom support ring is the perfect size and encompasses the proper region referenced above.
- The squeezing mechanism is perfectly centered on the larger saline bottle and smaller glaucoma bottle.
  - The bottle is held in place well by this design.

The two different-sized 3D prints of the models are shown above. Both hold their respective bottle size very well.

**Conclusions/action items:**

11/10: The changes made should increase the usability and safety of the device. Two different-sized devices were saved so that we could accommodate the size of the small bottle. Print and test the new prototypes, continue to iterate and based on results.

11/13: Reprint the designs with increased infill percentage in BambuLabs PLA so that the connection to the nose piece is more stable. If this issue becomes more prominent, then try printing in Ultimaker PLA and make design changes to this portion to ensure the stability of the device if necessary!

KASIA KLOTZ - Nov 13, 2023, 11:20 PM CST

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**BME400_Body_v3.SLDDRW (440 kB)**

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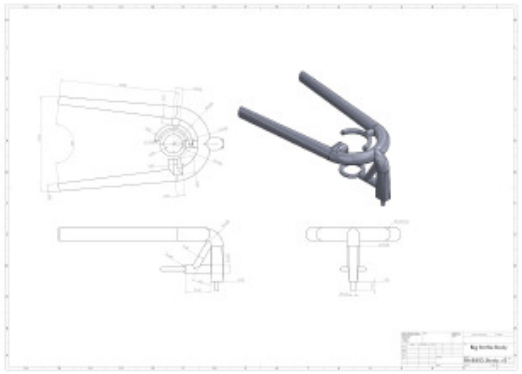

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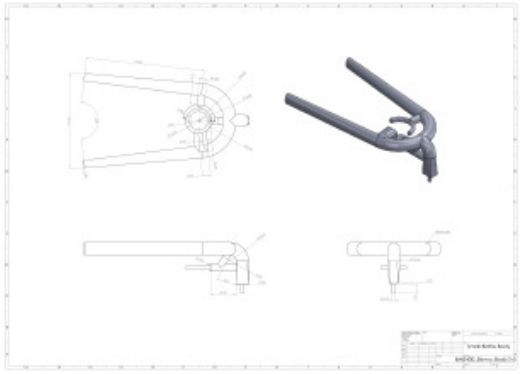

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KASIA KLOTZ - Nov 13, 2023, 11:20 PM CST

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**BME400_Skinny_Body_v3.SLDPRT (541 kB)**

# 2023/11/17 - Eye Lash Dropper v4 Prototype

THOMAS KRIEWALDT - Dec 12, 2023, 6:06 PM CST

**Title: Eye Lash Dropper v4 Prototype**

**Date:** Part Creation: 11/17/2023, Notebook Entries 11/17/2023, 11/20/2023

**Content by:** Thomas Kriewaldt, Kasia Klotz, Tevis Linser

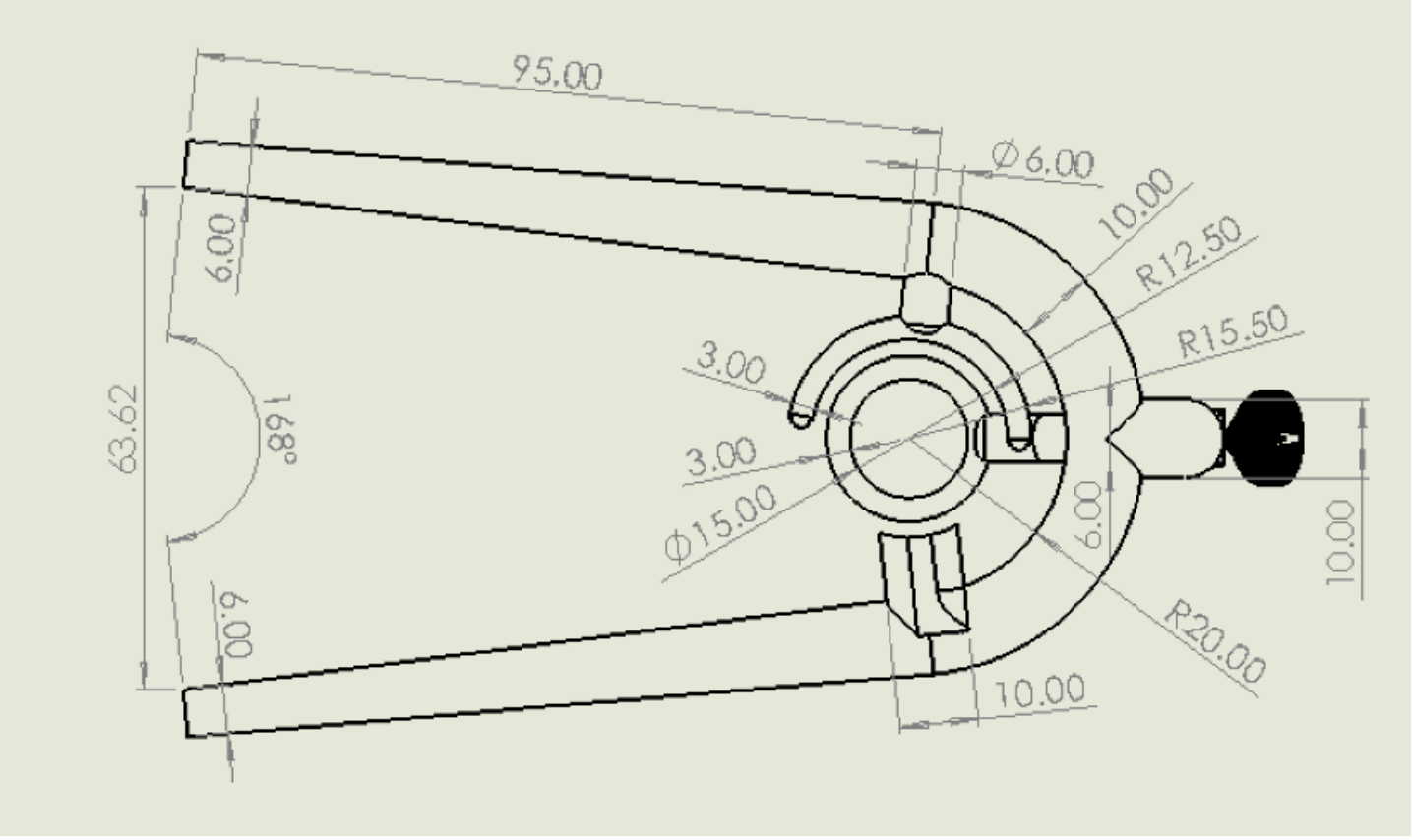
**Present:** All members

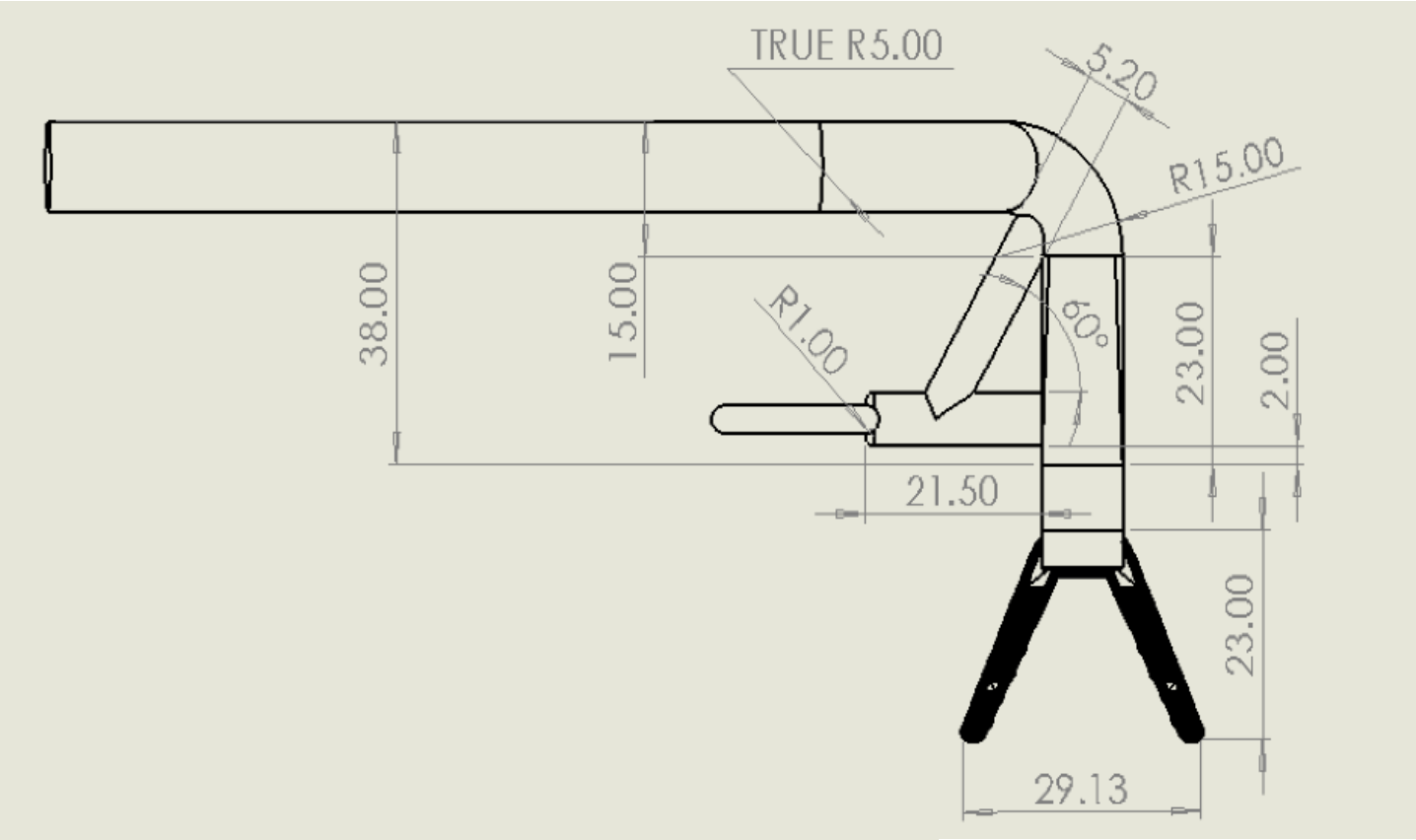
**Goals:** To adjust small portions of our device to better accommodate our patients

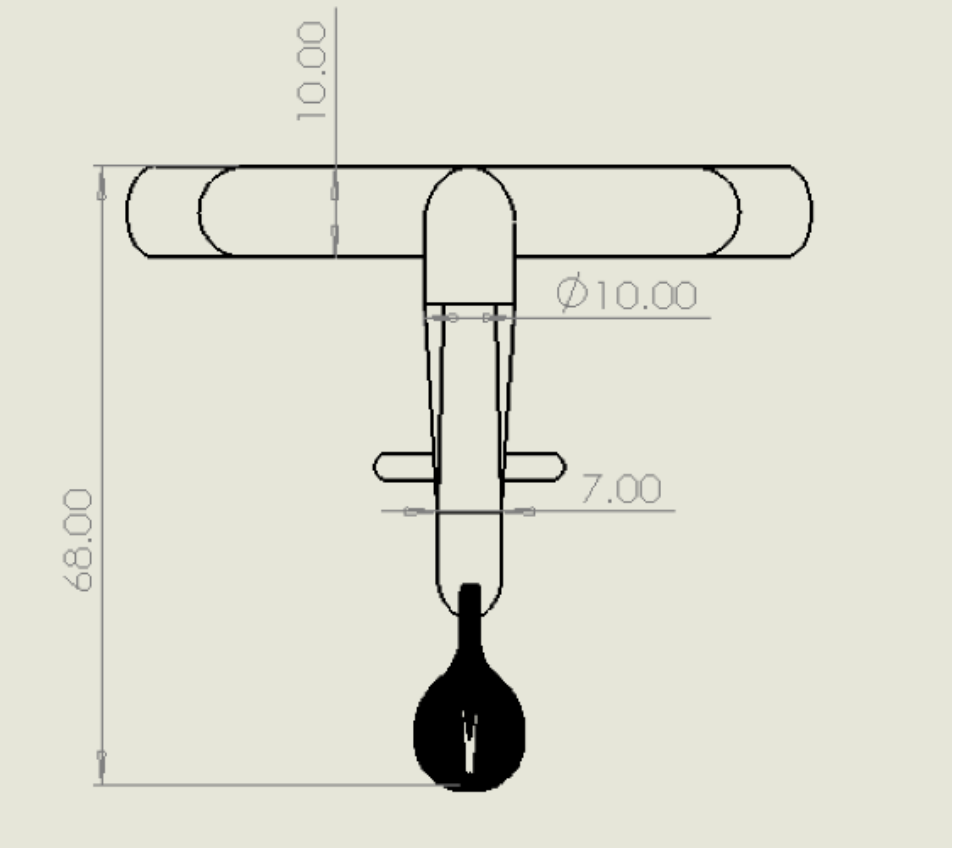
**Content:**

**November 17th:** The device was slightly altered in Solidworks to adjust the height of the bottle relative to the eye and to get rid of the rotation of the nose piece.

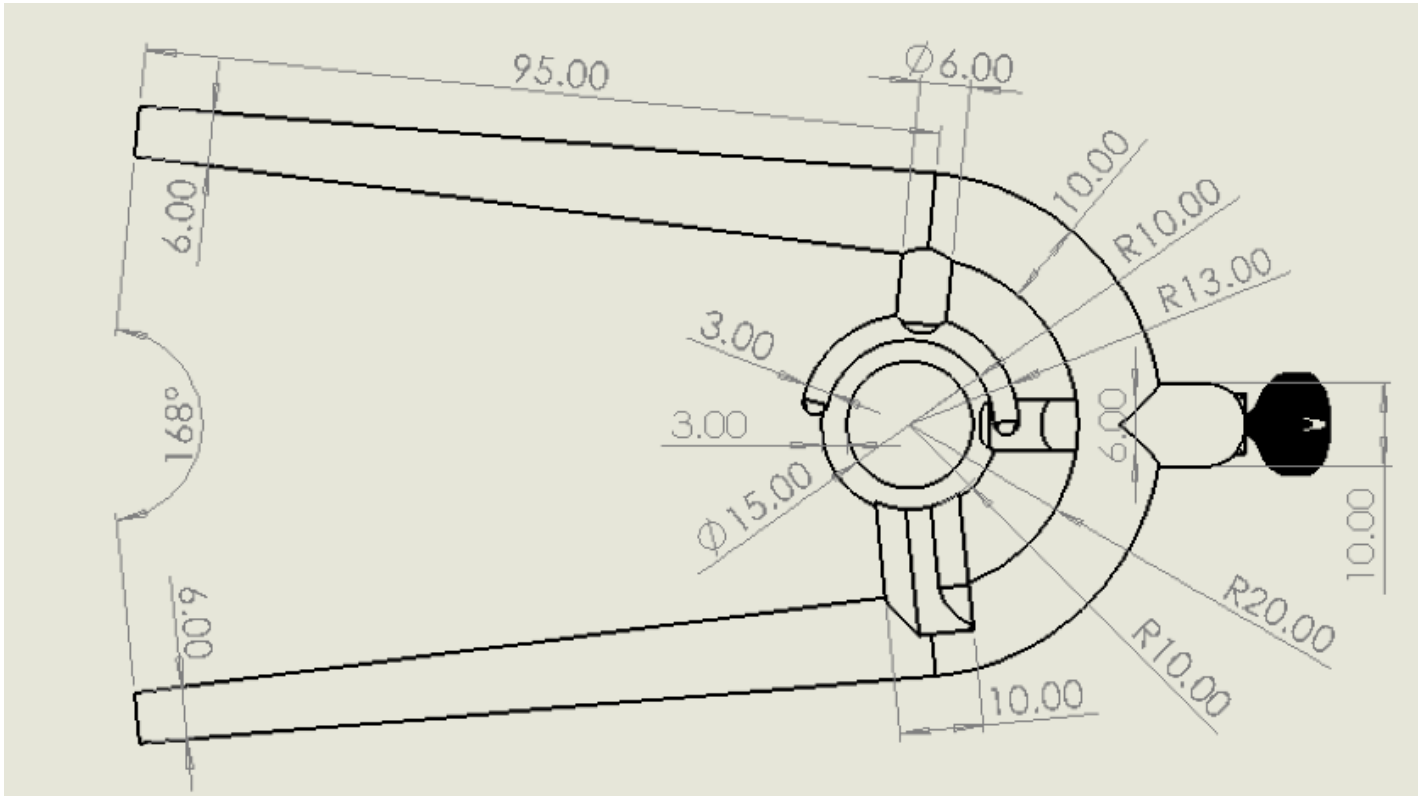
- Besides this height change, the body of the device remained unaltered. All dimensions that are not in the vertical dimension remain the same.
  - Updates to the part are linked below, and a dimensioned sketch is also below.
  - **For the small bottle, this height was changed to:**
    - **5 mm** *from the top of the nose piece to the center of the lower support*
    - **20 mm** *from the center of the squeezing handles to the center of the lower support*






- 
  - **For the large bottle, this height was changed to:**
    - **<u>5 mm</u>** *from the top of the nose piece to the center of the lower support*
    - **<u>28 mm</u>** *from the center of the squeezing handles to the center of the lower support*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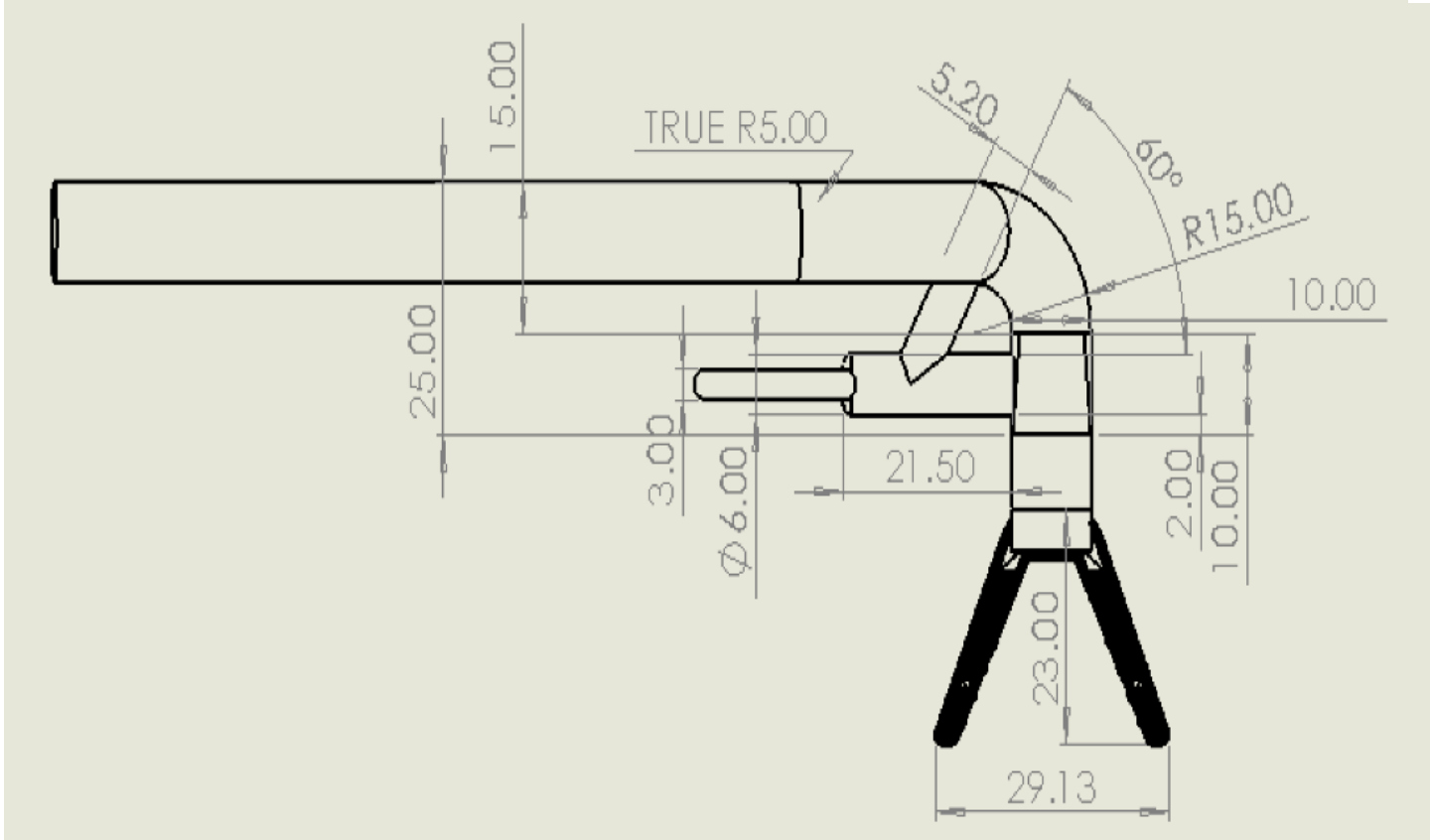
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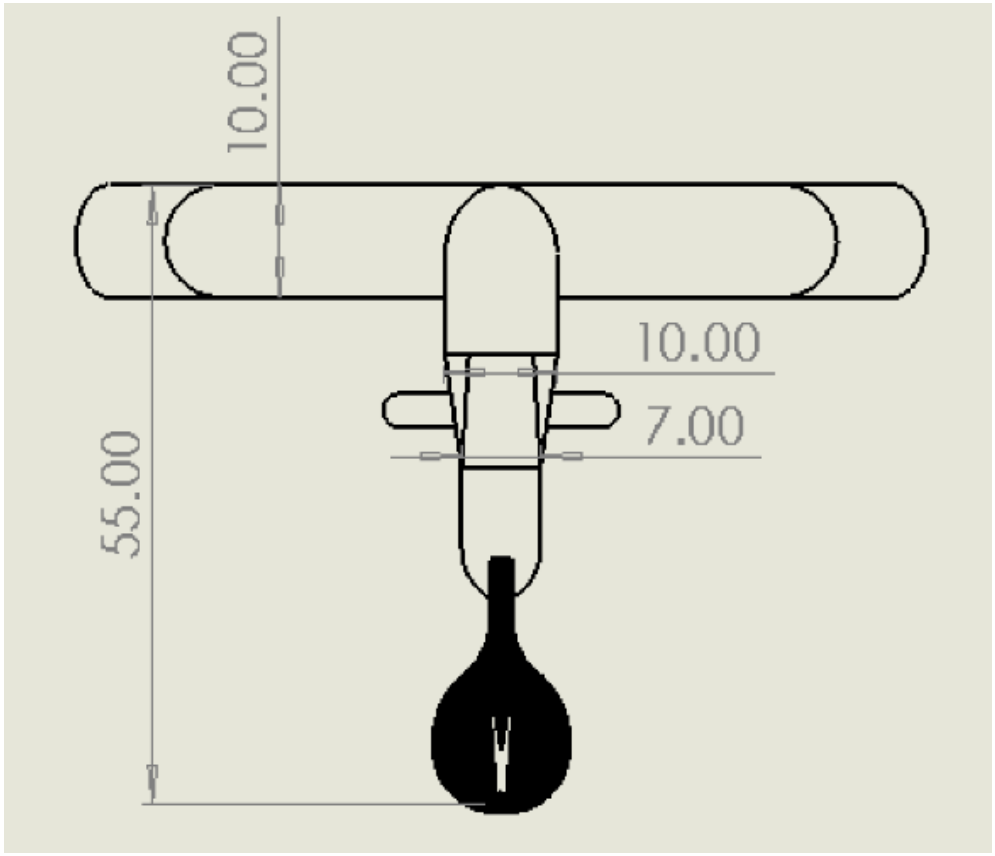
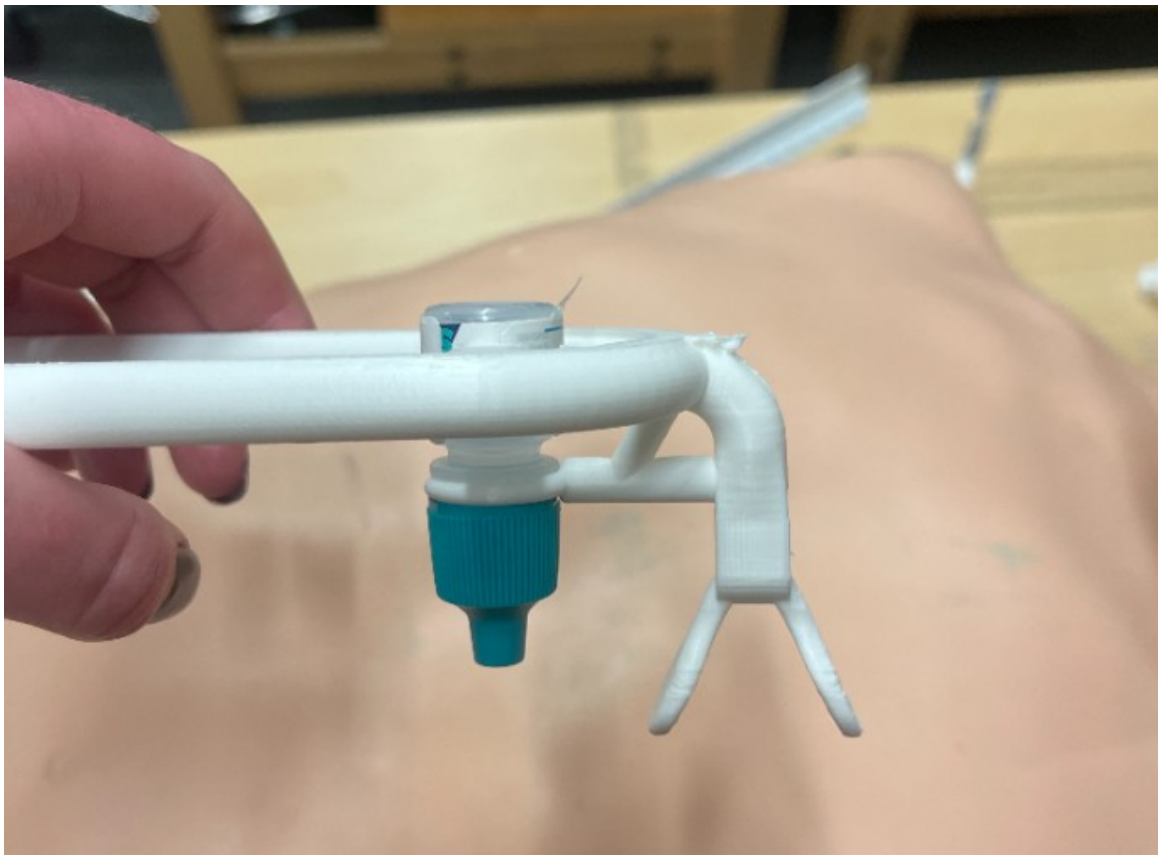



- The nose piece was mirrored in the middle plane to be symmetric with a 180 degree rotation on the frontal plane
    - **When switching between the left and the right eye!**

**November 20th:** The designs were reprinted in Ultimaker PLA, and as a full assembly rather than two separate parts

- The nose piece was also redesigned to accommodate flipping the device rather than rotating the two parts.
    - Made it so both sides are symmetrical and it does not matter if you are dropping on the right or left eye.
    - The connection to the nose support is a bit thin, and the nose supports themselves are a bit thick
        - **Adjust this in a v4.5 model.**
- Heights also work much better and are more consistent between bottle sizes than in the previous prototypes.
- The fact that the nosepiece is already connected to the main portion of the device makes it a bit less work
    - This allows for better stability and ease of connection without the hassle of taking out supports from the inside hole.
    - Also the seamless transition looks more aesthetically pleasing than our earlier prototypes.



**Conclusions/action items:**

Attend the client meeting to discuss testing the device.

Think of a new, marketable name for our device.

Discuss how we can better accommodate the vast potential users of this device (kids vs. elderly etc).

Adjust the nose piece of the model to better fit our patients!

THOMAS KRIEWALDT - Nov 21, 2023, 11:09 AM CST

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**BME400_Body_v4.SLDPRT (557 kB)**

THOMAS KRIEWALDT - Nov 21, 2023, 11:09 AM CST

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**BME400_NosePiece_New.SLDPRT (36.7 MB)**

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**BME400_Small_Bottle_v4.SLDASM (6.19 MB)**

THOMAS KRIEWALDT - Nov 21, 2023, 11:58 AM CST

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**BME400_large_Bottle_v4.SLDASM (6.2 MB)**

THOMAS KRIEWALDT - Nov 21, 2023, 12:44 PM CST

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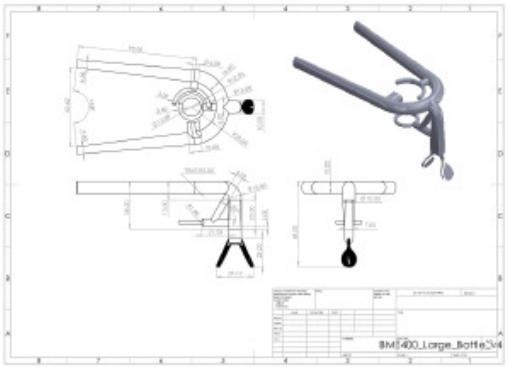
**BME400_Large_Bottle_v4.SLDDRW (8.44 MB)**

THOMAS KRIEWALDT - Nov 21, 2023, 12:44 PM CST



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THOMAS KRIEWALDT - Nov 21, 2023, 12:44 PM CST

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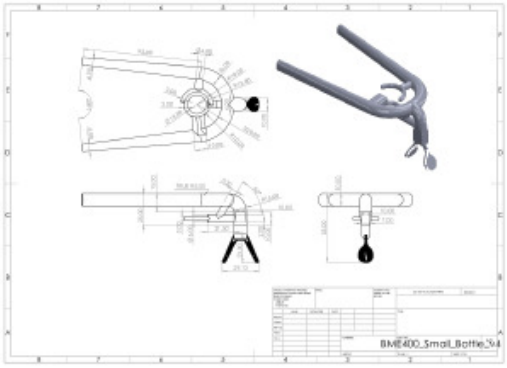
THOMAS KRIEWALDT - Nov 21, 2023, 12:44 PM CST



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**BME400_Small_Bottle_v4.pdf (379 kB)**

# 2023/11/07 - The Eye Lash Dropper - Nose Piece Update

TEVIS LINSER - Dec 13, 2023, 11:53 AM CST

**Title: New nose piece**

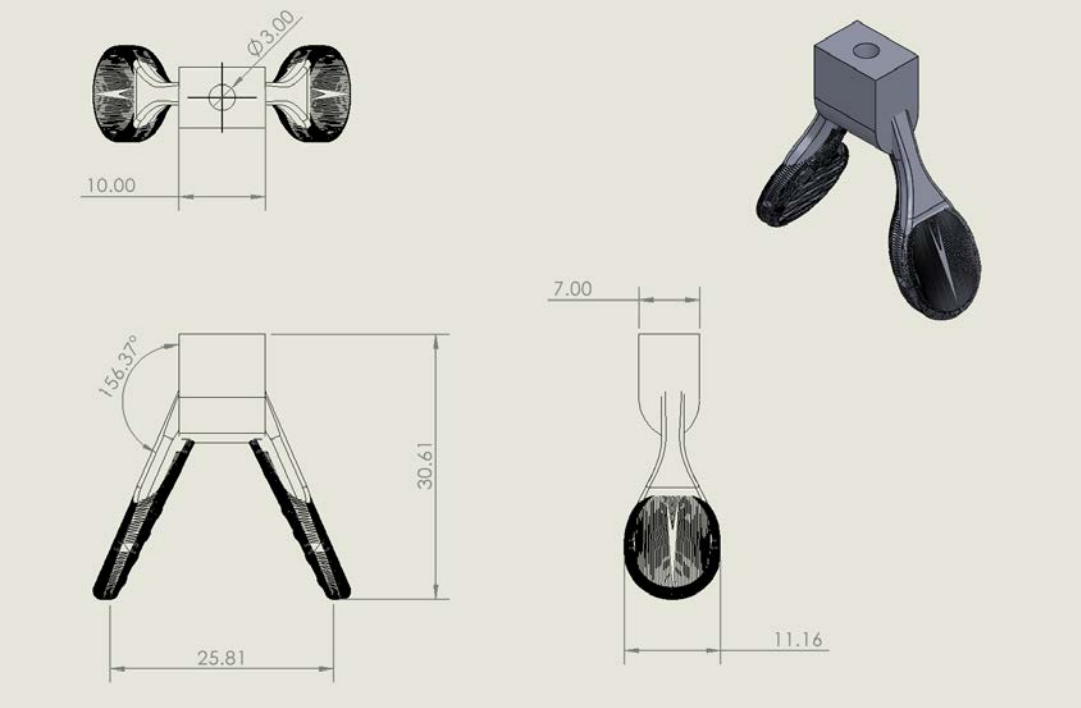
**Date:** Part creation: 12/1/2023 Notebook Entry: 12/13/2023

**Content by:** Tevis Linser

**Present: N/A**

**Goals:** To adjust the nose piece so that it can be connected to the body as one part. The nosepiece needs to be symmetrical to allow for comfort during administration of both sides.

**Content:**




Methods:

The original nose piece was cut and mirrored, the part that interfaces with the body remained the same.

Potential Changes:

The material used might change to conform to more nose types

**Conclusions/action items:**

This nosepiece will allow for the device to be one solid piece with no assembly. The final prototype will be made into an assembly and printed

TEVIS LINSER - Dec 13, 2023, 11:41 AM CST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**BME400_NosePiece_New.SLDDRW (10.3 MB)**

TEVIS LINSER - Dec 13, 2023, 11:41 AM CST


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**BME400_NosePiece_New.SLDPRT (32.3 MB)**

# 2023/12/09 - Final Eye Drop Assist Device

KASIA KLOTZ - Dec 11, 2023, 11:30 AM CST

**Title: Final Eye Drop Assist**

**Date:** 12/09/2023

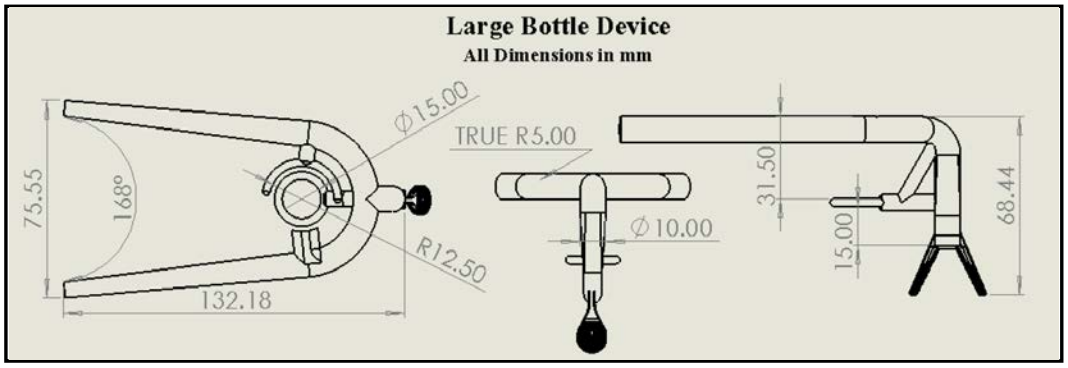
**Content by:** Tevis, Kasia, Tommy

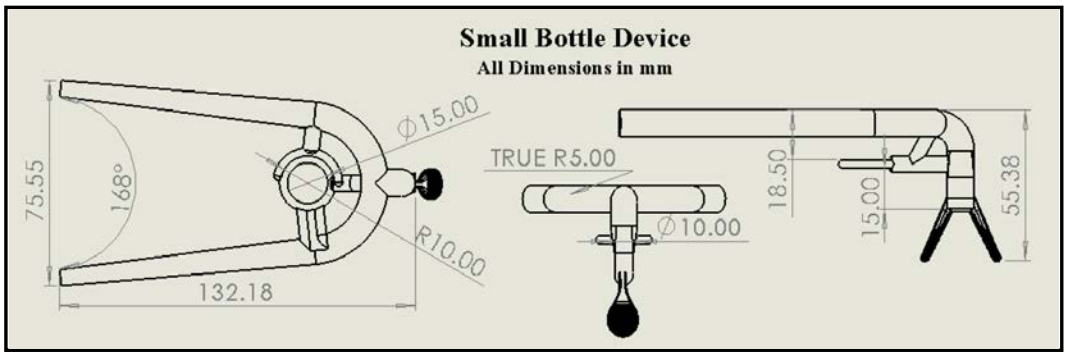
**Present:** Tevis, Kasia, Tommy

**Goals:** Finalize prototypes to maximize success of product

**Content:**

- The final device has the following key features:
  - a nose piece that provides stability for users
  - a squeezing mechanism that applies force to the eye drop bottle
  - a bottle neck holder that holds the eye drop bottle at the correct location
    - also allows for the cap to be placed onto the bottle
  - wide grip handles with increased diameter compared to previous model
    - increased mechanical advantage
- The figures below show the following
  - Key device features
  - Engineering drawing of large bottle device with dimensions in mm
  - Engineering drawing of small bottle device with dimensions in mm




**Conclusions/action items:**

As of right now, the team considers this final device a final product. They key features account for all of the design criteria. Future changes will be made as necessary once reviewing patents more in detail. The team would like to patent this product, so the next steps include sitting down with someone who is experienced in reading patents and making sure we are allowed to have all of the features we have included. Overall, the team is very happy with the final device and the testing results it has produced.

KASIA KLOTZ - Dec 11, 2023, 11:06 AM CST

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**BME400_FinalDevice_Large.SLDASM (5.93 MB)**

KASIA KLOTZ - Dec 11, 2023, 11:06 AM CST

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**BME400_FinalDevice_Small.SLDASM (5.93 MB)**

KASIA KLOTZ - Dec 11, 2023, 11:07 AM CST

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**BME400_NosePiece_New.SLDPRT (32.3 MB)**

KASIA KLOTZ - Dec 11, 2023, 11:07 AM CST

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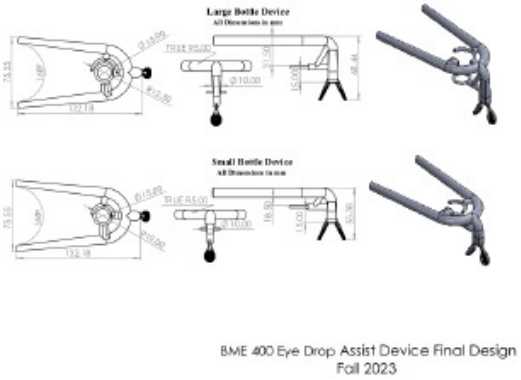
**Final_Device_Drawings.SLDDRW (19.6 MB)**

KASIA KLOTZ - Dec 11, 2023, 11:07 AM CST




BME 400 Eye Drop Assist Device Final Design
Fall 2023

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**Final_Device_Drawings.pdf (508 kB)**

# 2023/10/23 - IRB Protocol research

EVA COUGHLIN - Dec 11, 2023, 9:47 AM CST

**Title:** IRB Protocol Information

**Date:** 2023/10/23

**Content by:** Anabelle Olson

**Goals:** learn about what is necessary for submitting an IRB application for approval and document that steps I take while making protocol application.

**Content:**

- Application type for our project: Protocol-Based Application
  - studies investigating a drug or device
  - I am using the protocol #503 from the IRB UW site - Biomedical protocol

**Conclusions/action items:**

We are still in the process of finishing the IRB so this section will be updated when we are finished

# 2023/11/02 - Ease of Use Testing Protocol

**Title:** Ease of Use Testing Protocol

**Date:** 11/02/23

**Content by:** Anabelle Olson, Eva Coughlin, Jenna Krause

**Goals:** To have a written documentation outline for our ease of use test.

**Content:**

THE UNIVERSITY of WISCONSIN MADISON

## Ease of Use Testing Protocol

Date of testing: TBD - one day duration

- Scope
  To perform testing to evaluate the effectiveness of the eye drop assistant device in making the administration of eye drops easier than the traditional eye drop bottle.
- Purpose
  The purpose of this study is to determine if the proposed device is one that should be commercially distributed and available to consumers.
- Test Samples
  Residents of the Oakwood Village University Woods Retirement Community, located in Madison, Wisconsin. A total of 30 residents or more.
- Materials and Equipment
  - Eye drop assistant device
  - Eye drop solution bottles
  - Saline solution (70 microliters)
  - Cloth to dispense eye drop solution onto
  - Post test survey
- Methods
  The participant of the study will be shown a demonstration by a lead investigator on how to use the device. Once the participant receives this demonstration, the device wi eye drops. It should be noted that the participant should not administer eye drops into their own eyes, rather they should hold the device above a cloth and administer the e participant will be instructed to complete a survey about the difference in difficulty in the two methods.
- Acceptance Criteria
  - Adults with ophthalmic conditions treated by eye drops.
  - Experience difficulties when using the conventional eye drop bottle.
  - Ability to hold and manipulate a hand held device with one hand.
  - English-speaking (able to provide consent and complete questionnaires).
- Data Analysis and Documentation Requirements
  - The participants will be given a survey that will record how they felt the device affected their ability to distribute the eye drop solution compared to dispensing without the

**Survey:**

On a scale from 1-10, with 1 being extremely difficult and 10 being extremely easy, rank the following:

Dispensing a singular drop out of the eye drop bottle without the assistive device: _____

Dispensing a singular drop out of the eye drop bottle with the assistive device: _____

Ease of handling and holding the assistive device: _____

How straightforward was it to grasp the device's usage?: _____

What changes, if any, would make the assistive device easier to use? Consider how it would feel to use this device while dispensing eye drops into the lower eyelid pocket.

**Conclusions/action items:**

The client for this project works with Oakwood Village University Woods and is allowing the team the opportunity to completing testing at this location. This testing is inte
will be helpful for making improvements to the device. This protocol will be incorporated in the IRB application.

# 2023/11/09 - Squeeze Force Testing Protocol

**Title:** Squeeze Force Testing Protocol

**Date:** 2023/11/09, 2023/12/11

**Content by:** Eva Coughlin, Anabelle Olson, Thomas Kriewaldt (updated)

**Goals:** To document our plans for testing the force required to squeeze the handles of the device using the MTS machine.

**Content:**

**Squeeze Force Testing Protocol**

Date of testing: 11/21/23 & 12/1/23

- Scope
  - To perform testing to evaluate the force required to compress the handles of the eye drop assistant device together.
- Purpose
- To understand the squeezing force required by the user to dispense one eye drop using the eye drop assistant device.
- Reference Documents
- Test Samples
- Eye drop Assistant devices (include all prototypes)
- Materials and Equipment
  - Eye drop assistant device
  - MTS machine
  - Device holder
    - used to stabilize the device on its side while using the MTS machine
- Methods
  - The team will design a device holder using SolidWorks and 3D print it with PLA plastic. The holder will conform to the shape of the device, leaving the handles free of any constraint. This fixture will support the device to ensure it cannot rotate, slip, or move during the test. Before using the MTS machine, the team will measure and record the distance between the two handle edges, which is consistent between the two sizes of the device. The team will then insert the 2.5 mL and 15 mL bottles into the small and large devices and squeeze the handles of each device until a single drop is released. The distance between the handles will be recorded, and then subsequently used to calculate the net displacement used for the MTS machine. The 3D-printed test fixture will be placed on the bottom portion of the MTS machine, and the eye drop assistant device will be secured into the test fixture on the MTS machine. 2.5 mL and 15 mL bottles will be inserted into the squeezing mechanism of small and large devices and placed into the testing fixture so that the plane between the device handles points vertically and the nozzle of the bottle faces the observer. A testing setup with a strain rate of 0.002 mm/sec will be loaded into the MTS software. The

MTS machine will then be lowered manually to the first point of contact with the device handles. The compression test on the MTS machine will be performed and the handles of the device will get closer together until the displacement reaches the previously calculated value of displacement. The MTS test will record a graph of Force vs displacement. The graph generated on the MTS software will be saved and exported to MATLAB. The MTS test will be conducted six times, three trials for each bottle size.

- Data Analysis and Documentation Requirements
    - The team will analyze the data using the graphs created by the MTS software. The maximum squeezing force required to use the eye drop assistant device will be determined by the peak of force on the graph. The precalculated displacement value will be located on the graph, and the corresponding force value will represent the amount of force required to squeeze and administer one eye drop with the device. The study aims to show that the eye drop assistant device requires less force to release an eye drop than the traditional device. The endpoint of this study will be the required force to drop an eye drop with the device is smaller than with the bottle.

**Conclusions/action items:** The MTS machine will be used to test the force required to squeeze the handles of the device. The team needs to meet with Dr. Wille to help plan the testing and the computer setup. The team is planning on using the BME 201 compression protocol. The goal is for the squeezing force of the handles to be less than 35 N.

# 2023/12/01 - IRB Application

EVA COUGHLIN - Dec 11, 2023, 9:49 AM CST

**Title:** IRB Application

**Date:** 2023/12/01

**Content by:** Eva Coughlin, Anabelle Olson, Jenna Krause

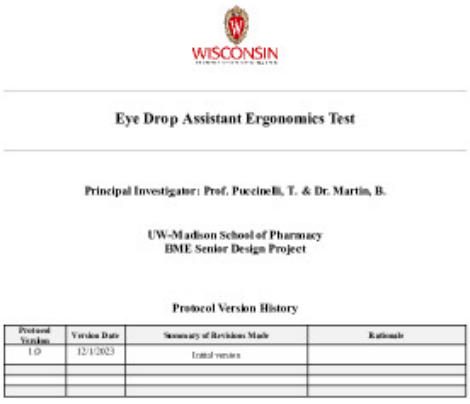
**Goals:** Apply for an IRB, so that the team can go to the retirement community that the client works at to test the device.

**Content:**

File is attached below

**Conclusions/action items:** We started working on this IRB after the preliminary presentations and finished it this past week. We sent the document to our client's contact at the IRB for feedback. We were told that the IRB may not be needed, so we are waiting on an IRB exemption certificate. The application is linked below.

EVA COUGHLIN - Dec 02, 2023, 3:39 PM CST



WISCONSIN

Eye Drop Assistant Ergonomics Test

Principal Investigator: Prof. Puccinelli, T. & Dr. Martin, B.

UW-Madison School of Pharmacy
BME Senior Design Project

Protocol Version History

| Protocol Version | Version Date | Summary of Revisions Made | Rationale |
|---|---|---|---|
| 1.0 | 12/1/2023 | Initial version | |
| | | | |
| | | | |
| | | | |

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**IRB_Eye_drop_Assistant_Protocol_2023.docx.pdf (483 kB)**

# 2023/12/03 - Precision Testing Protocol

Jenna Krause - Dec 13, 2023, 12:12 PM CST

**Title:** Precision Testing Protocol

**Date:** 12/03/2023

**Content by:** Jenna Krause

**Goals:** To document out plans for testing precision of device and analysis procedure.

**Content:**

**Drop Precision Testing Protocol**

Date of testing: 12/04/23

- Scope
  - To perform testing to evaluate the precision of the eye drop dispensing
- Purpose
  - To understand the effectiveness of the eye drop assistant device in consistently delivering a drop into the same location every time dispensed.
- Test Samples
  - To ensure consistency in technique during data collection, one team member will conduct trials using both small and large eye drop bottles, facilitating a direct 1-to-1 comparison between the different trial conditions.
- Materials and Equipment
  - Eye Drop Assistant Device
  - 2.5 mL Eye Drop Bottle
  - 15 mL Eye Drop Bottle
  - Tin Foil and Paper
  - Sharpie
  - Light
- Methods
  - A testing setup will be created on a flat surface with a rolled up tin foil acting as a nose anatomy next to the piece of paper with a round circle on it.
    - Circle dimensions should be 24.2 mm (transverse) × 23.7 mm (sagittal) [1].
  - The subject will perform four tests with 10 drop trials each on the following conditions:
    - 15mL without the device
    - 15mL with the device
    - 2.5mL without the device
    - 2.5mL with the device

    - The experiment involves dispensing a single drop onto a piece of paper, marking it with a sharpie, and then replacing the paper. This sequence is repeated until ten drops are marked on ten different pieces of paper. Subsequently, using a light, the ten marked papers are transferred onto a single master page, capturing all drops from that trial.
    - This process will be the same for all the conditions listed.
        - In the scenario involving the device, the tin foil will serve as its stabilizing point, analogous to how it would utilize the nose in a typical human anatomy setup.
- Data Analysis and Documentation Requirements
    - The team will conduct a thorough analysis of the data using ImageJ on the master pages. Each piece of paper, featuring a calibrated line of 10.54 mm, will be used for ImageJ calibration. Initially, the team will measure the entire area of the circle, representing the eye, followed by measuring the areas covered by the 10 drops. To determine the total area covered by the drops, the team will divide the area of 10 drops by the total circle area. This process will be iterated for each condition, allowing the team to assess the precision difference between the device and no device. The precision differential will be calculated by dividing the total area covered by drops for the device by the total area covered by drops for no device, multiplied by 100, providing the percentage difference in precision.
- References

[1] I. Bekerman, P. Gottlieb, and M. Vaiman, “Variations in eyeball diameters of the healthy adults,” *Journal of Ophthalmology*, vol. 2014, pp. 1–5, 2014. doi:10.1155/2014/503645

**Conclusions/action items:**

The Precision Testing Protocol outlines the team's comprehensive plan to evaluate the effectiveness of the eye drop assistant device in consistently dispensing drops into the same location. Through a systematic testing setup, utilizing different eye drop conditions and employing ImageJ analysis, the team aims to assess and quantify the precision difference between the device and no device, providing valuable insights into its performance.

# 2023/12/11 - Single Drop Testing Protocol

**Title:** Single Drop Testing Protocol

**Date:** 2023/11/8

**Content by:** Eva Coughlin, Anabelle Olson

**Goals:** To document our plans for single drop testing and analysis.

**Content:**

**Single Drop Testing Protocol**

Date of testing: 11/17/23

- Scope
  - To perform testing to quantify the amount of eye drop solution released from the bottle for each squeeze of the handles.
- Purpose
  - To understand the effectiveness of the eye drop assistant device in minimizing eye drop waste per use and delivering a consistent dosage of medication.
- Test Samples
  - Multiple teammates will perform trials, so that our data collected is more representative of a variety of users, such as male and female.
- Materials and Equipment
  - Eye drop assistant devices
  - Scale
  - Weight Boats
- Methods
  - 6 total subjects will participate in the testing
  - Each subject will perform four tests with 10 trials each:
    1. 15mL without the device
    2. 15mL with the device
    3. 2.5mL without the device
    4. 2.5mL with the device
  - For each trial the weight boat will be set on top of the scale and the scale will be zeroed out. After the scale reads zero, the user will handle the device and hold it above the weight boat. Next the user will squeeze the handles of the eye drop assistant device together to administer one drop. Once there is a visual indication

that a drop has dropped, the user will set the device down away from the scale. Then the scale measurement will be recorded. Ten trials are performed, so there are ten measured drops for the use of the eye drop assistant device. Each test participant will complete these ten trials.

- Data Analysis and Documentation Requirements
    - The weight of eye drop solution dispensed per trial will be recorded for each of the four tests. For each individual subject, the average and standard deviation of the ten trials will be calculated for each of the four tests. These will be used to create box plots of each individual subject's data to visually compare use of the device with not using the device for both of the bottle sizes. Then, the averages and standard deviations will be combined to calculate the overall average and overall standard deviation across subjects for each of the four tests. These overall averages and standard deviations will be used for a statistical test.
    - A t-test will be run to compare the overall average eye drop size when using the device compared to not using the device for both the 15 mL bottle size and the 2.5 mL bottle size.
        1. The goal is for the average drop size when using the device to be statistically significantly lower than without using the device. This result will indicate that our device effectively minimizes eye drop waste compared to regular eye drop bottles.
    - A f-test will be run to compare the overall variance in eye drop size when using the device compared to not using the device for both the 15 mL bottle size and the 2.5 mL bottle size.
        1. The goal is for the variance in drop size when using the device to be statistically significantly lower than without using the device. This result will indicate that our device delivers a more consistent dose of eye drop medication compared to regular eye drop bottles.

**Conclusions/action items:** The whole team will participate in single drop testing. This is arguably the most important testing because it assesses the accuracy and precision of dispensing one drop when using the device, which is the client's main objective with the device. We plan on creating box plots in MatLab to display our results. We will use an t-test and f-test to analyze the statistical significance of our results.

# 2023/11/17 - Single Drop Test Results & Analysis

EVA COUGHLIN - Dec 11, 2023, 10:06 AM CST

**Title:** Single Drop Test Results & Analysis

**Date:** 2023/11/17

**Content by:** Eva Coughlin

**Goals:** To analyze the results of the single drop test using statistics.

**Content:**

- all six members of the group completed testing
- tests were done using the two different eye drop assistant devices: 15 mL bottle size and 2.5 mL bottle size
  - control = eye drop bottle without the device
- each test participant did ten trials for each group for a total of 60 trials to analyze

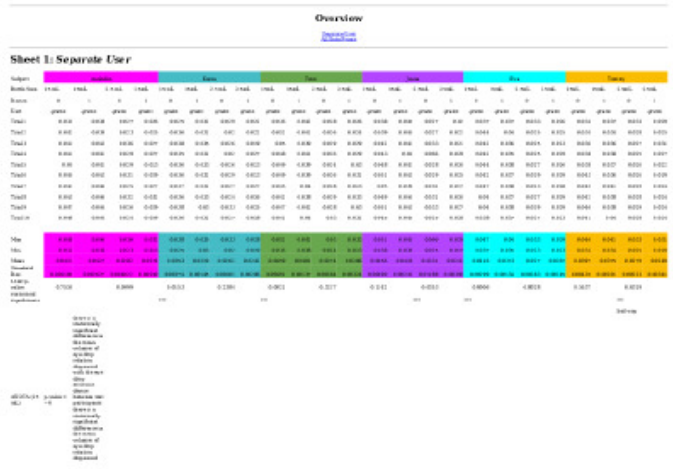
| | 15 mL bottle | 15 mL bottle with device |
|---|---|---|
| Mean (g) | 0.04172 | 0.03872 |
| SD (g) | 0.005443 | 0.004187 |
| **t-test p-value** | 0.000988 | |
| **f-test p-value** | 0.04601 | |

| | 2.5 mL bottle | 2.5 mL bottle with device |
|---|---|---|
| Mean (g) | 0.02828 | 0.02598 |
| SD (g) | 0.005843 | 0.003427 |
| **t-test p-value** | 0.009677 | |
| **f-test p-value** | 0.00006598 | |

- performed a t-test to compare the mean mass of a single drop dispensed from the eye drop bottle alone vs. the eye drop bottle with the device
  - the goal is for the mean mass of the drop with the device to be lower than the mean mass of the drop without the device because this indicates that the device is minimizing eye drop waste
  - the p-values for both eye drop bottles were less than alpha of 0.05, indicating that there is a statistically significant difference between the mean drop size when using the device compared to not using the device
    - **The eye drop assistant device effectively minimizes eye drop waste**
- performed a f-test to compare the variances of the drop sizes dispensed from the eye drop bottle alone vs. the eye drop bottle with the device
  - the goal is for the variance of the drop size with the device to be lower than the variance of the drop size without the device because this indicates that the device increases the consistency of eye drop administration
  - the p-values for both eye drop bottles were less than alpha of 0.05, indicating that there is statistically significant difference between the variability of the drop size with the device compared to without the device
    - **The eye drop assistant decreases the variability of eye drop size dispensed**

**Conclusions/action items:** The Single Drop Test successfully demonstrated the device's effectiveness at minimizing eye drop waste and making eye drop administration more consistent. These conclusions were confirmed by statistically significant results of the t-test and f-test. The other test we need to perform before the end of the semester is testing for the location of the eye drop administration. The location drop testing will be performed within the next week.

EVA COUGHLIN - Dec 11, 2023, 10:28 AM CST




Download

**Single_Drop_Test.xlsx (13.4 kB)**

# 2023/12/01 - Visualization of Single Drop Statistics

ANABELLE OLSON (amolson27@wisc.edu) - Dec 12, 2023, 3:49 PM CST

**Title: Visualization of Single Drop Data - Graphs**

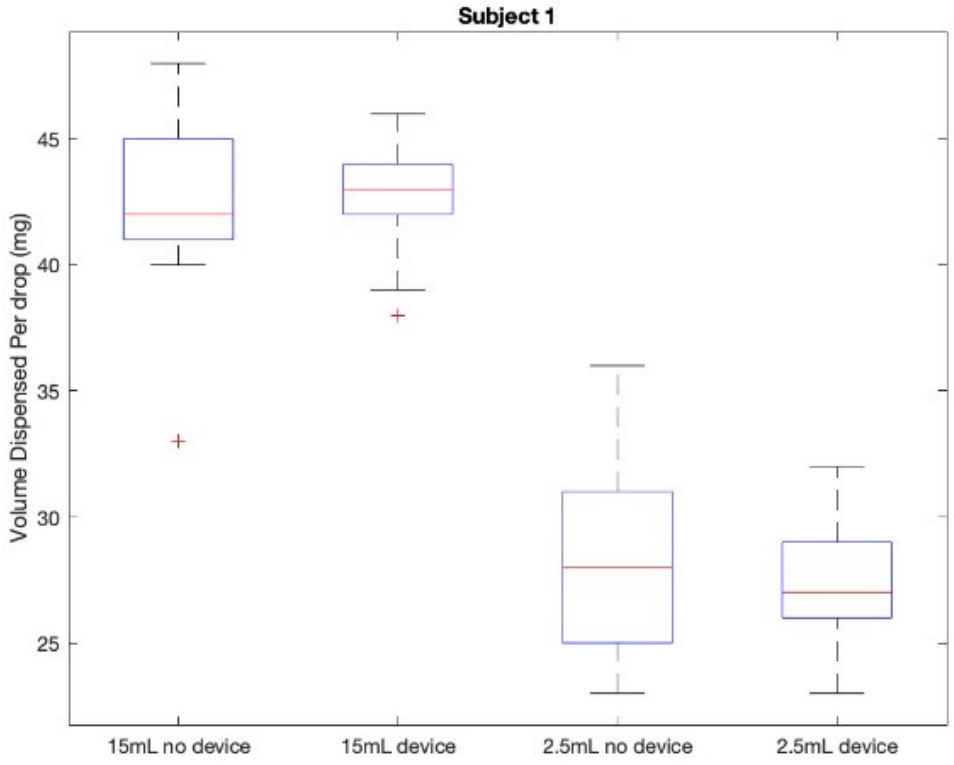
**Date:** 12/01/23

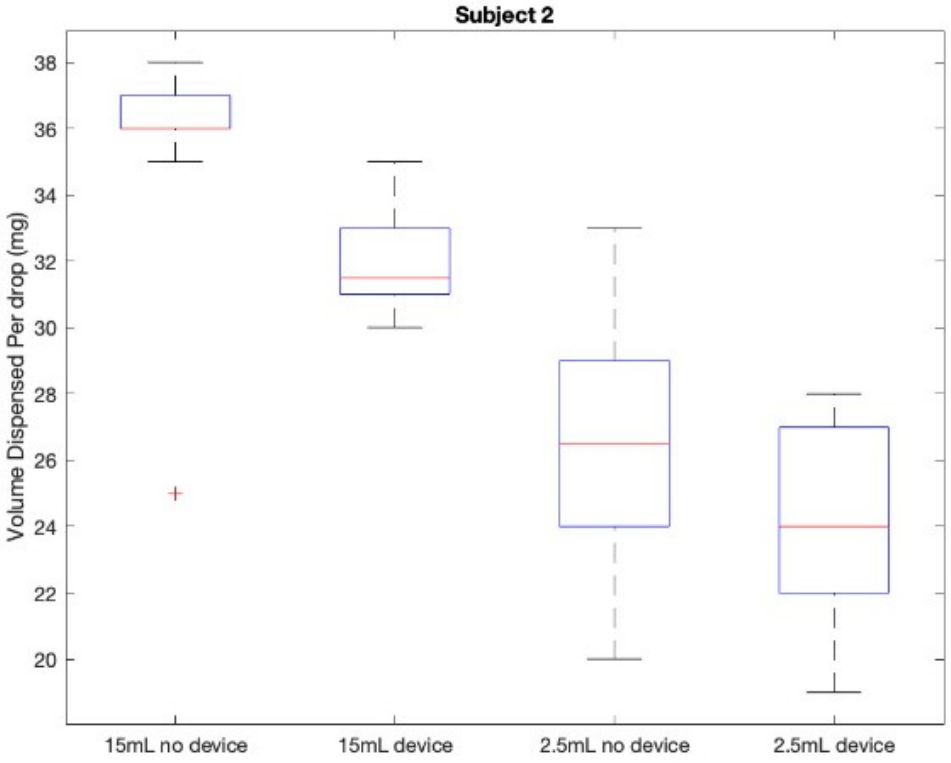
**Content by:** Anabelle Olson

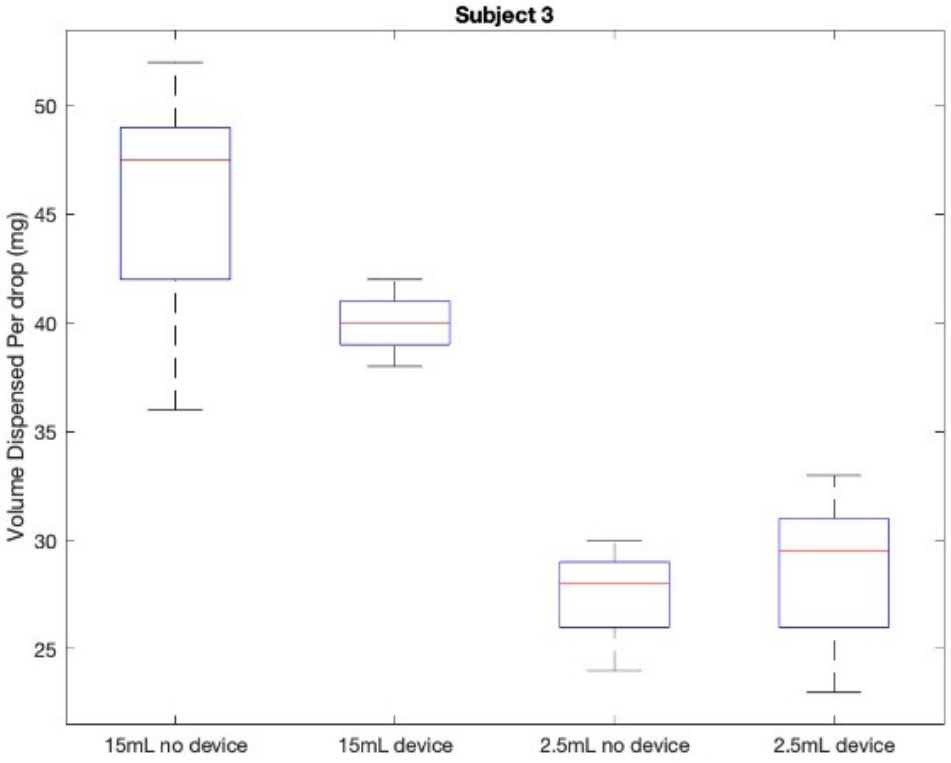
**Goals:** To visually depict the data we gathered during the single drop trials for presentation and final poster.

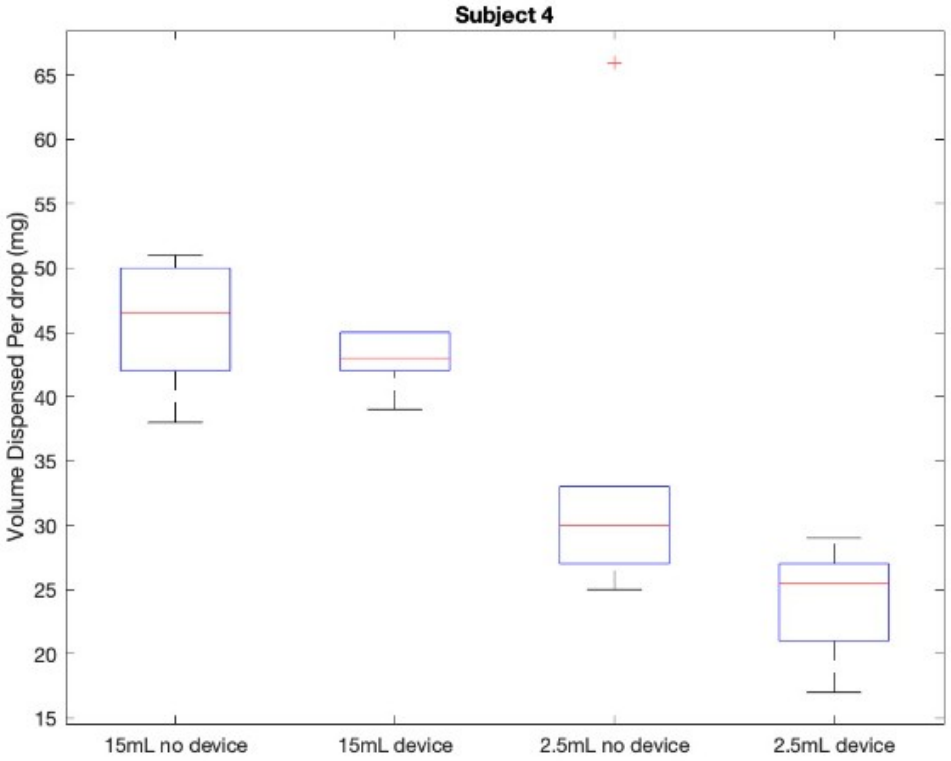
**Content:**

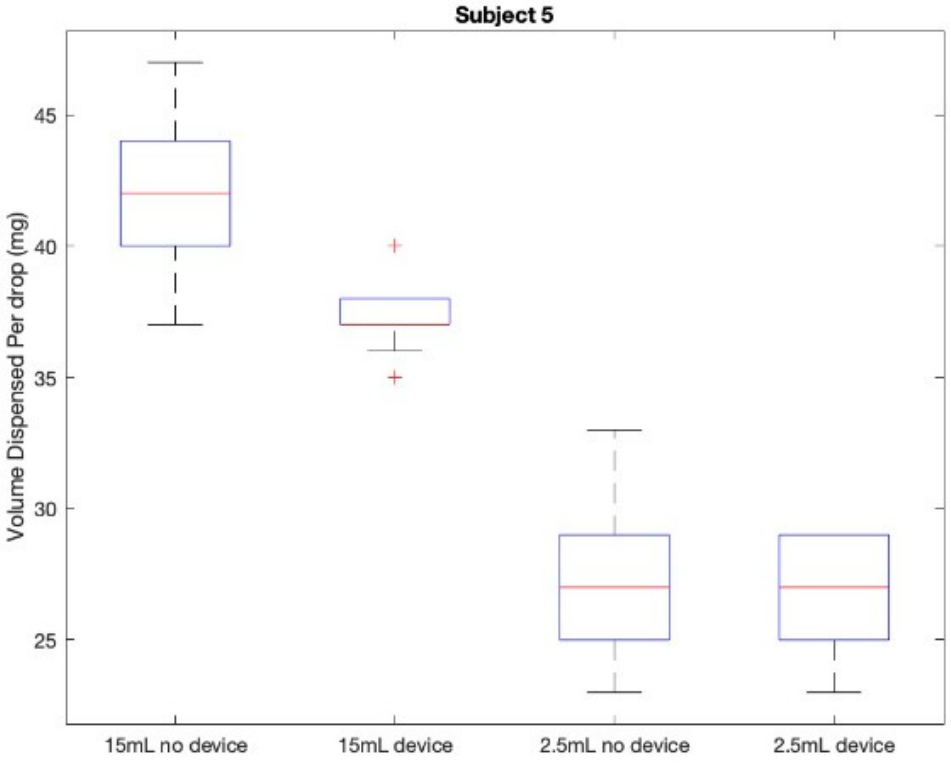
The following graphs are box and whisker graphs to compare the amount of eye drop solution dispensed per squeeze of the bottle. Each subject preformed 4 tests with 10 trials per. The first comparison is between the size of the drop dispensed from the 15mL bottle when the device is used and the control, being the use of eye drop bottle without the device. The second camparison is the same two tests but with the 2.5mL bottle. There are 6 graphs, each corresponding to a different subjects data. All 6 of the group members preformed the tests. These graphs compare the volume dispensed under the four conditions only among the trials done by the subject. There is not comparison on these graphs among the different subjects, as it is not as applicable the compare the change over each subject. The endpoint of this study is to show that the device dispenses more consistent amount of solution per drop than the traditional eye drop bottle. Additional findings include a reduced average drop size when the device was used in comparison to the control.

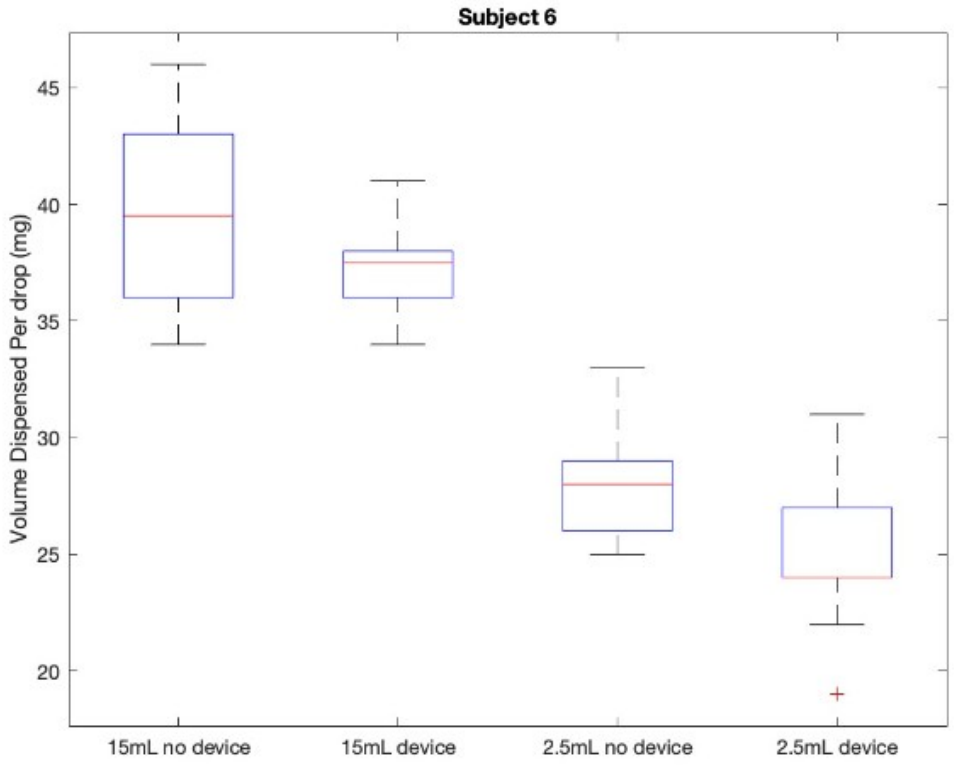



Subject 2
Volume Dispensed Per drop (mg)
38
36
34
32
30
28
26
24
22
20
15mL no device
15mL device
2.5mL no device
2.5mL device


Subject 3
Volume Dispensed Per drop (mg)
50
45
40
35
30
25
15mL no device
15mL device
2.5mL no device
2.5mL device


Subject 4
Volume Dispensed Per drop (mg)
65
60
55
50
45
40
35
30
25
20
15
15mL no device
15mL device
2.5mL no device
2.5mL device


Subject 5
Volume Dispensed Per drop (mg)
45
40
35
30
25
15mL no device
15mL device
2.5mL no device
2.5mL device




**Conclusions/action items:**

Through our testing we found that the standard deviation for the amount dispensed with the 15mL bottle decreased with the device when compared to the control for all six subjects. For the smaller 2.5mL bottle, the standard deviation of the drop size decreased with the device compared to the control for five out of the six subjects. These findings suggest that the device promotes less variability and more consistency in the size of the dispensed eye drops. Additionally, the data shows that the max size of the drop dispensed from the 15mL bottle decreased with the device in comparison to the control for all 6 subjects. For the smaller 2.5mL bottle, the max size of the drop dispense with the device was smaller than the max drop size for the control trial for five out of six subjects. This data further shows that our device allows for a smaller size eye drop than the traditional bottle. This is crucial as our target audience struggle using the eye drop bottle and consequently waste a lot of medicine.

# 2023/11/21 - MTS Testing Meeting with Dr. Wille

EVA COUGHLIN - Dec 11, 2023, 10:04 AM CST

**Title**: MTS Testing Meeting 1

**Date**: 11/21/2023

**Content by:** Thomas Kriewaldt

**Present**: Kasia Klotz, Tommy Kriewaldt, and Eva Coughlin

**Goals**: To get feedback from Dr. Wille on how we should do displacement and force testing for our device.

**Content:**

- Explained the background of the device
    - Beta-blocker into the pocket of the eye
- Force to dispense a singular drop (using the MTS machine)
    - Measure displacement to squeeze one drop
    - Measure the force to get to that displacement
    - Dr. Wille agrees that this would be a good plan of action
- Digital newton meter NOT hand dynamometer
    - hand dynamometer doesn't measure displacement
    - hold in place with a testing apparatus (a mold)
    - support to the thick squeezing mechanism
    - attach the digital Newton meter to the other end and pull down
        - might have to make a specific testing device to attach the Newton meter
- Using the MTS machine can control the displacement better
    - Set the displacement level based on previous studies
    - We can achieve this by also using a mold to keep it **flat and level**
        - With enough displacement, we probably would reach that
        - We don't care about the stress, but the load won't change.
        - Still should make a mold to ensure it remains stable during testing!
- We don't need to do a full stress test using the MTS machine
    - Use an FEA analysis in Solidworks → estimate of the force
        - Won't be a true failure test, because of the displacement conditions.
        - Will still tell us where the weak points of the design are, which would be super useful to test for durability and shelf life in the future.

    - A bit overkill, but will still be accurate, and tell us what we'd need to know
- Have to build the mold regardless, so might as well do it with the MTS machine
    - Dr. Wille recommends we use the MTS machine!
- Wille would help us set up the test for the first time
    - BME 201 protocol → goes to failure
    - Need to adjust the stopping point to be the set distance
        - From displacement value used when we do the one drop test.

**Conclusions/action items:**

- Make the testing platform mold for MTS machine testing.
- Make the nose piece thickness of the bridge thicker
- Make the nose part of the nose clip thinner
- Only print the assembly moving forward, as it works way better!

# 2023/12/01 - Squeeze Force Testing Results

THOMAS KRIEWALDT - Dec 09, 2023, 3:57 PM CST

**Title: MTS Testing Results**

**Date:** 12/01/2023

**Content by:** Thomas Kriewaldt

**Present:** All members

**Goals:** To characterize the force required to elicit a single drop from each device.

**Content:**

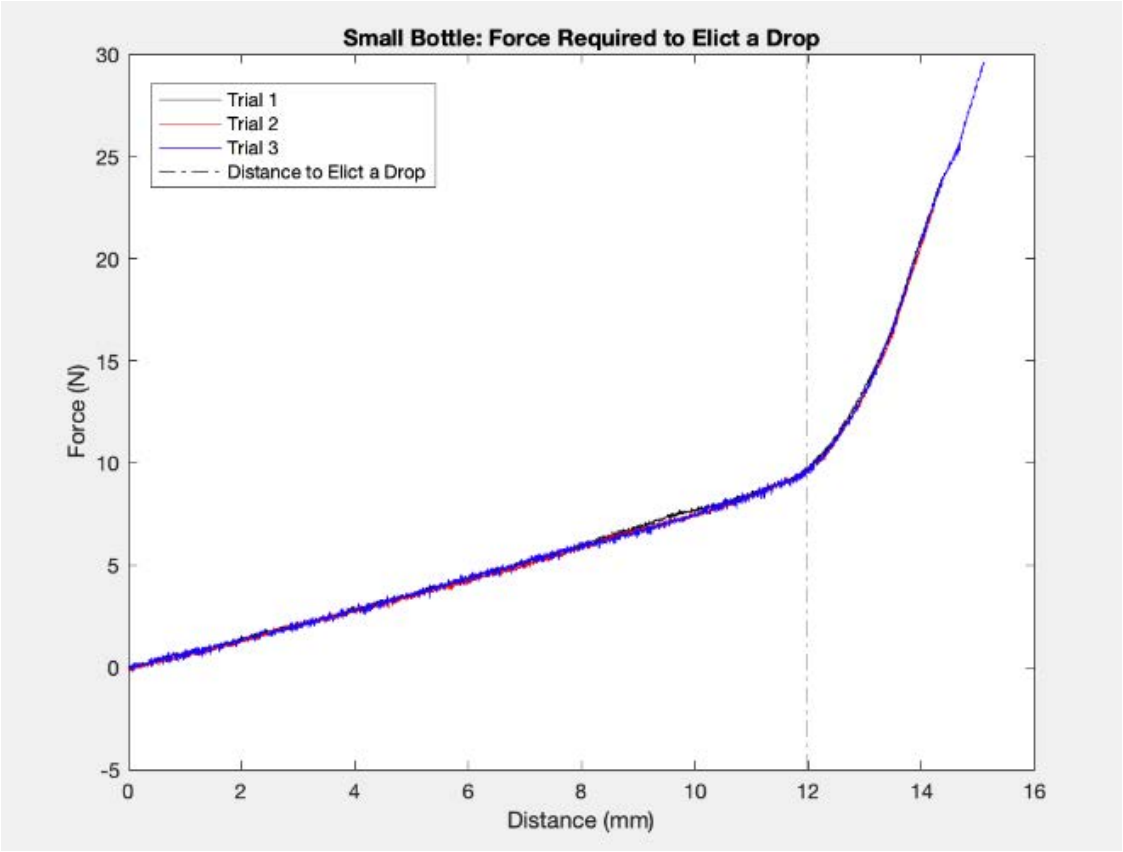
Prior to placing the sample in the MTS machine, the displacement for each device size to release a drop was found

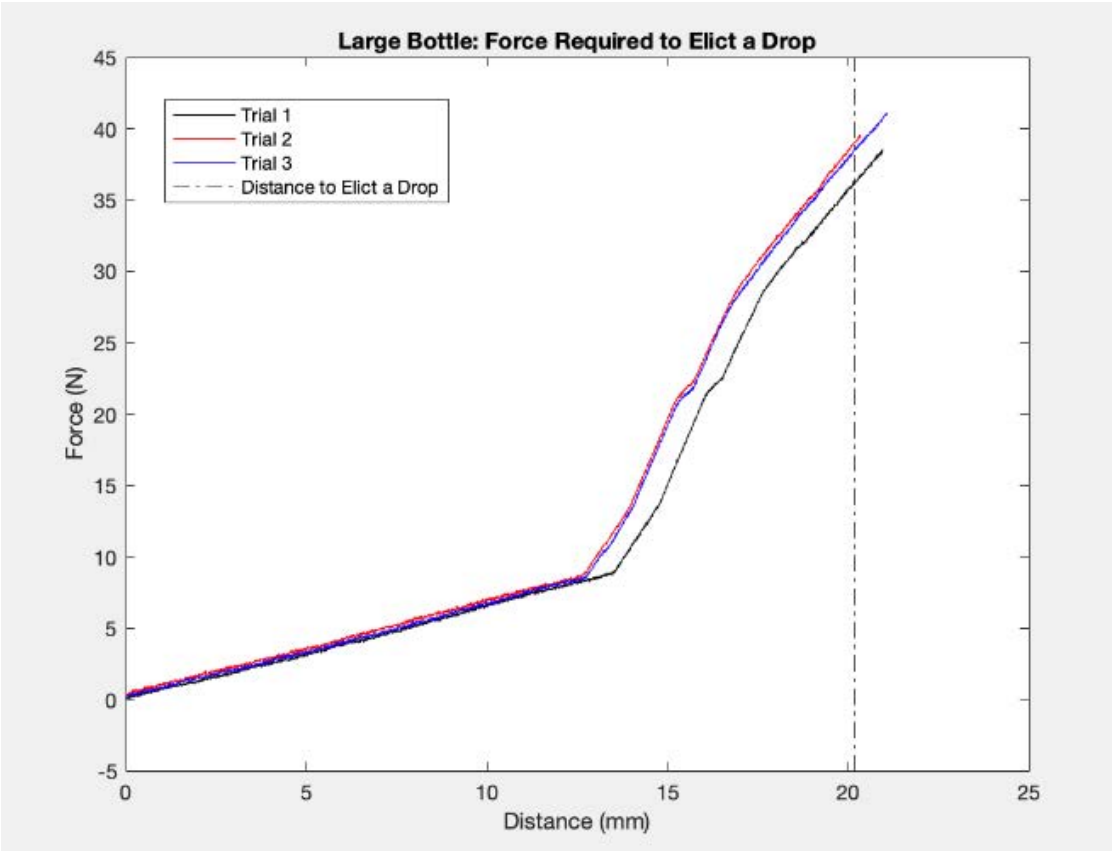
- Small Bottle: 11.973 mm
- Large Bottle: 20.184 mm

From this, the displacement was set on the MTS machine, and the test was carried out three times for each device.

- For this test, we created a test figure to hold the bottom of the device in place.
    - These part files are linked below.
- During this initial test, the bottle was not placed in the device, so the team disregarded this data and redid the six trials.
    - These results are linked in a .zip file below, but were not used here.

The MTS testing was carried out using the MTS Machine and analyzed using MATLAB, linked below.




The graphs for the three trials of the small and large bottle sizes showing the force required to reach their specific handle displacements.

***From this testing we found:***

- Small Bottle Force: 9.6499 +/- 0.1325 N
  - [9.6707, 9.7707, 9.5082 N]
  - Well below the worst-case grip strength group of 35 N

- Large Bottle Force: 37.9039 +/- 1.4663 N
  - [36.2396, 39.0055, 38.4667 N]
  - Slightly above the worst-case grip strength group of 35 N, but still within limits for 95% of the grip strength sample (83 N).

However, the graphs of between force and displacement look very different for the different bottle size. This is likely because of the flat head of the MTS machine first started as a point load, and then as the displacement passed a certain point (~13 mm), it became a distributed load, then another point load, but much closer to the bottle. This definitely affected our results and we should alter this procedure or add an additional test fixture to ensure consistent loading moving forward. We should also carry out additional testing to see if these values are truly the force required to release a single drop.

**Conclusions/action items:**

Discuss these results with the team, and carry out a FEA analysis of the part that matches the loading condition we were hoping to test.

THOMAS KRIEWALDT - Dec 09, 2023, 3:39 PM CST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**BME400_SmallBottle_Testing.SLDPRT (572 kB)**

THOMAS KRIEWALDT - Dec 09, 2023, 3:39 PM CST


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**BME400_LargeBottle_Testing.SLDPRT (579 kB)**

THOMAS KRIEWALDT - Dec 09, 2023, 3:37 PM CST


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**Old_MTS_Data.zip (398 kB)**

THOMAS KRIEWALDT - Dec 09, 2023, 3:37 PM CST


Download

**New_MTS_Data.zip (488 kB)**

```
%% MTS Machine Results - HydroPED
% By Tommy Kriewaldt

%% Importing the Small Bottle Data:
[file, path] = uigetfile('*', 'Select the file to Open');
SB_1 = importdata([path,filesep,file]);

[file, path] = uigetfile('*', 'Select the file to Open');
SB_2 = importdata([path,filesep,file]);

[file, path] = uigetfile('*', 'Select the file to Open');
SB_3 = importdata([path,filesep,file]);

% Importing the Large Bottle Data:
[file, path] = uigetfile('*', 'Select the file to Open');
LB_1 = importdata([path,filesep,file]);

[file, path] = uigetfile('*', 'Select the file to Open');
LB_2 = importdata([path,filesep,file]);

[file, path] = uigetfile('*', 'Select the file to Open');
LB_3 = importdata([path,filesep,file]);

%% Setting Variables
SB_distance = 11.673; % distance to elicit a drop in mm
LB_distance = 20.184; % distance to elicit a drop in mm

%% Calculating Force and SD of trials!
% Finding the index
SB_idx = find(round(SB_1.data(:, 1), 3) == SB_distance); % rounding to meet the
distance we measured in 3 decimal places
LB_idx = find(round(LB_1.data(:, 1), 3) == LB_distance);
% Given the strain rate is consistent between trials for the small and large
% bottle, this index will be the same for Trials 1-3 for both scenarios.

% Force to reach this displacement for each trial:
% Small Bottle
SB_1_F = SB_1.data(SB_idx, 2);
SB_2_F = SB_2.data(SB_idx, 2);
SB_3_F = SB_3.data(SB_idx, 2);
% Large Bottle
LB_1_F = LB_1.data(LB_idx, 2);
LB_2_F = LB_2.data(LB_idx, 2);
LB_3_F = LB_3.data(LB_idx, 2);

% Averages and Standard Deviation:
% Small Bottle
SB_F = [SB_1_F(:), SB_2_F(:), SB_3_F(:)];
SB_F_avg = mean(SB_F);
SB_F_sd = std(SB_F);
% Large Bottle
LB_F = [LB_1_F(:), LB_2_F(:), LB_3_F(:)];
LB_F_avg = mean(LB_F);
LB_F_sd = std(LB_F);

%% Plotting the Data - Small Bottle
figure(1);
plot(SB_1.data(:, 1), SB_1.data(:, 2), "k");
title("Small Bottle: Force Required to Elicit a Drop")
xlabel("Distance (mm)")
ylabel("Force (N)")
hold on
plot(SB_2.data(:, 1), SB_2.data(:, 2), "r");
```

Download

**MTS_Force_Code.m (2.61 kB)**

# 2023/12/05 - Squeeze Force Simulation

THOMAS KRIEWALDT - Dec 12, 2023, 3:03 AM CST

**Title: Squeeze Force SolidWorks Simulation**

**Date:** 12/05/2023

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To characterize the force required to displace the device, to see if it lines up with our physical testing data.

**Sources:**

[1] Ryan Dix, “Material Considerations in Fused Filament Fabrication,” United States Merchant Marine Academy, Kings Point Department of Engineering, 2018. [Online]. Available: https://drive.google.com/file/d/1-Rk4UL_jVFBVn9pm14jypMBkYNrGs0wW/view

[2] PolyFluor, PLA Datasheet. https://www.polyfluor.nl/assets/files/datasheet-pla-filament-uk.pdf

[3] L. Kuentz, A. Salem, M. Singh, M. C. Halbig, and J. A. Salem, “Additive Manufacturing and Characterization of Polylactic Acid (PLA) Composites Containing Metal Reinforcements”. https://ntrs.nasa.gov/api/citations/20160010284/downloads/20160010284.pdf

**Content:**

As a result of the shortcomings of our MTS testing, the team was unsure whether or not the data from that testing was valid.

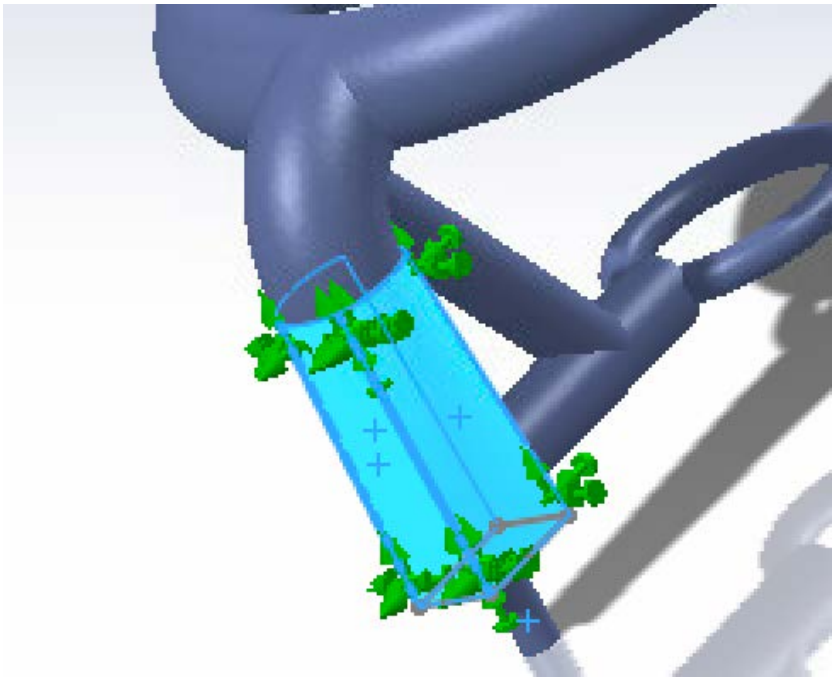
- We consulted a SolidWorks simulation to ensure that these results would be similar to what we did experimentally.

To find the proper material properties of PLA material, the team consulted multiple sources:

- The team used a 40% infill PLA print [1]:
  - E = 324 MPa (elastic modulus)
  - Sy = 11.1 MPa (yield strength)
- Density of 100% infill PLA is about 1.25 g/cm^3 [2].
  - So for 40% infill, this is 0.5 g/cm^3
  - ro = 500 kg/m^3 (density)
- Poisson's Ratio is about 0.33 for PLA [3].

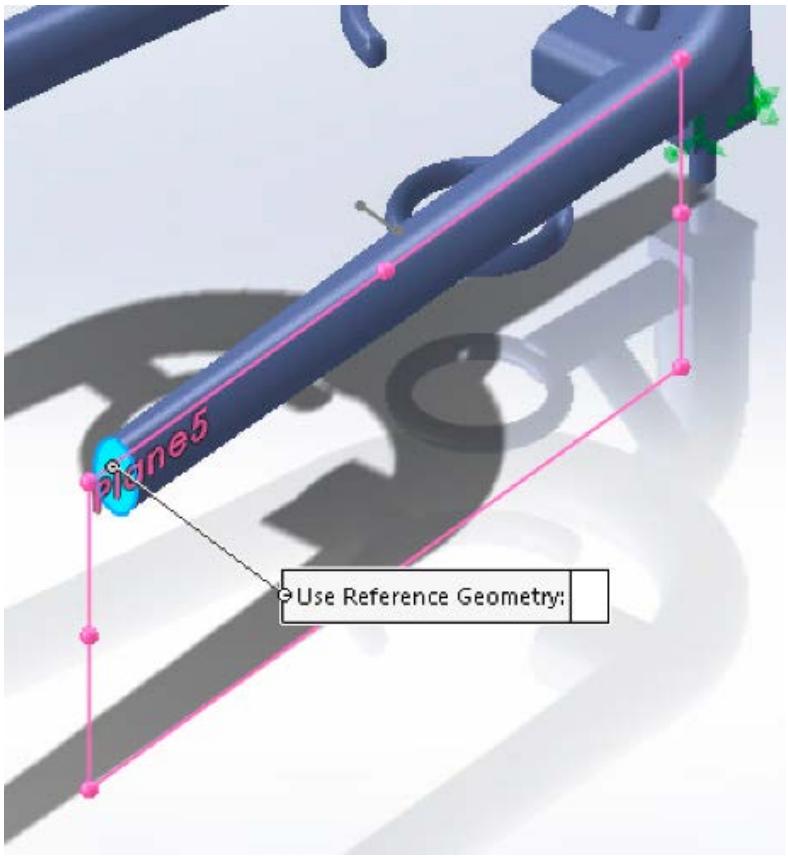
All of these material properties were inputted into SolidWorks as a new material, as PLA is not a default option for the software.

In Solidworks, the final device models were used, and fixed at the connection between the nose piece as shown below.



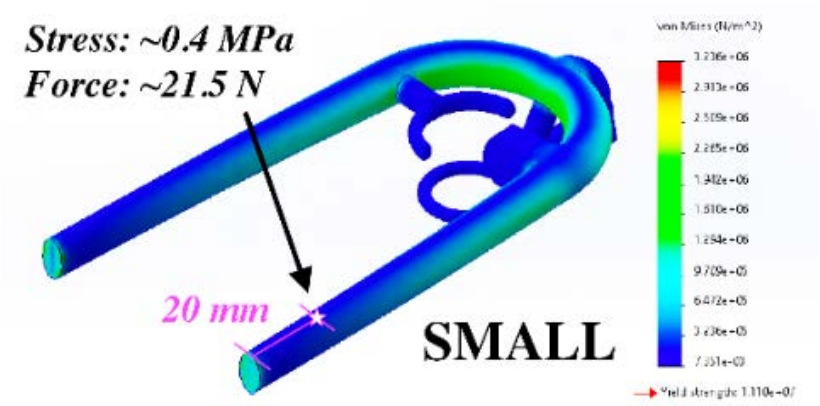
Then from "External Loads" the "Prescribed Displacement" option was selected.

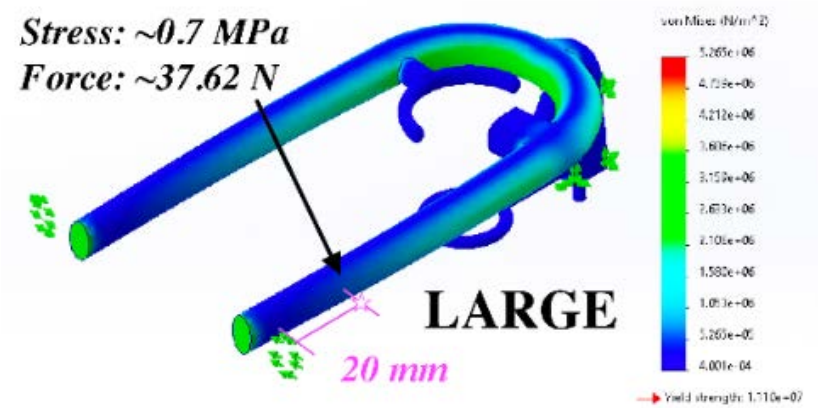
- The furthest face of each handle was selected, along with the vertical plane used to create the handles as shown below.




- A displacement normal to this plane was inputted as 11.973 / 2 mm for the small size, and 20.184 / 2 mm for the large size, respectively.
- Note: this simulation was done for both handle edges for both device sizes, which is why these values are divided by two (to match total displacement)

The simulation was then ran for each bottle size and the resulting stresses are shown in the Figures below.




The team noticed that there was much less stress, and therefore force, near the edges of the handles compared to closer to the squeezing mechanism.

We decided to calculate the force at around 20 mm from the edge of the handles (75 mm from the central connection point) for both devices.

- This is about where a user would apply the force onto each device.

Calculation of Force from Stress:

Since these handles are an elliptical shape, the area can be calculated from the formula: A = r1 * r2 * pi

- The height is a consistent 10 mm tall
- The width is not consistent, ranging from 6 to 10 mm.
  - At 20 mm from the edge of the device, this distance is about 6.8421 mm.
- Therefore the A = (6.8421 * 10 * pi) mm^2 for both bottle sizes

***AREA:*** *53.73776 mm^2*

-

At 20 mm from the edge of the small bottle, the stress was measured to be ~0.4 MPa.

At 20 mm from the edge of the large bottle, the stress was measured to be ~0.7 MPa.

- Given that T = F/A, we can solve for the force by multiplying the stress times the area.
- F(small) = 0.4 N/mm^2 * 53.73776 mm^2
- F(large) = 0.7 N/mm^2 * 53.73776 mm^2

***FORCE (Small Device)****: 21.4951 N*

***FORCE (Large Device)****: 37.6164 N*

-

The force of the small bottle device was much larger than we found experimentally, however, the force for the large bottle was almost identical. One drawback of this simulation is that we did not account for the bottle being present in the device during this displacement, as we could not find

material properties for either size referenced. It is possible that this played a role in these different values. The Solidworks files are linked to the MTS physical testing above this entry.

**Conclusions/action items:**

Finish the poster, and discuss the results and complications with the MTS machine and how they compare to the SolidWorks simulation.

Conduct additional physical testing to see if we can replicate these results or prove they are incorrect.

# 2023/12/12 - MTS Testing Fixture

KASIA KLOTZ - Dec 12, 2023, 12:59 PM CST

**Title: MTS Testing Fixture**

**Date:** 12/12/2023

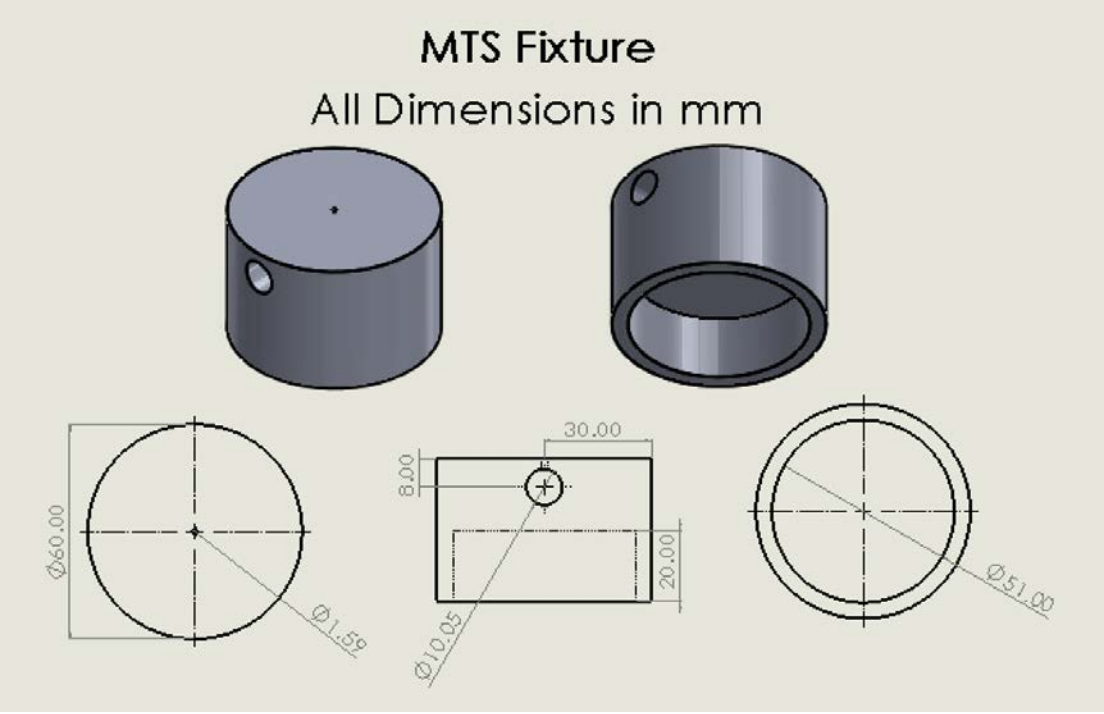
**Content by:** Kasia Klotz

**Present:** N/A

**Goals:** Create a fixture to place onto the MTS machine that is capable of holding the prototype in place during compression

**Content:**

- Due to the geometry of the eye drop assist device, a testing fixture was needed to secure it during compression testing on the MTS machine
- This fixture fits over the bottom compression block
- The small hole running all the way through the fixture is where the handle of the device can be inserted
- There is a small hole at the top of the fixture where a pin can be inserted to ensure the device does not spin at all during compression
    - This did not end up being needed during testing



**Conclusions/action items:** The testing fixture successfully held the device in place during compression testing. There was a point where the fixture tilted off of the compression block, but this was fixed by simple holding the fixture onto the block manually. The other issue with this test was the distribution of loading onto the device. Initially, the force is applied via a point load, then a distributed load, and then back to a point load. This is due to the angle of the device. In the future, the team would like to test with a consistent distributed load.

KASIA KLOTZ - Dec 12, 2023, 12:59 PM CST

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**MTS_Holder.SLDPRT (98.3 kB)**

KASIA KLOTZ - Dec 12, 2023, 12:59 PM CST

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**MTS_Holder.SLDDRW (146 kB)**

# 2023/11/21 - Precision Testing 1 Notes

Jenna Krause - Dec 10, 2023, 5:05 PM CST

**Title:** Precision Testing 1 Notes

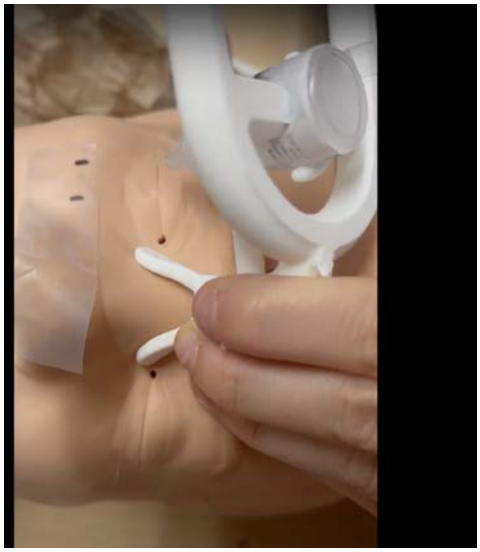
**Date:** 11/21/2023

**Content by:** Jenna Krause

**Present:** Jenna Krause and Eva Coughlin

**Goals:** To determine using a prototype allows for higher precision of eye drops then no device.

**Content:**

- For testing, version 4 of the prototype was used.
- The mannequin from the green room of ECB was used and tape was put on the mannequin's cheek with one inch mark in sharpie for calibrating later on in ImageJ.
- Below is an image of what the testing step up looks like.
- 
- The set up was extremely useful to see how the prototype fits on a human facial structure.
- 10 drops were tested on the mannequin.
- The goal was to see where repeated drops hit on the mannequin's eye
- Downsides to this testing method:
    - Since the drops are clear, it was difficult to determine where the drops landed on the mannequin.
    - In order to capture an image of the drop the prototype had to be tilted backwards. However, this is not the proper technique in using the device and the majority of the drops were landing in the incorrect place.
    - There was no way to overlay the drops in imagej so comparing drop to drop was more difficult.
    - Prototype was held in the same position between drops and not reset after each drop so did not accurately represent an individual reapplying each drop.

**Conclusions/action items:**

The testing session above led to many protocol drawbacks and did not achieve the exact testing the team was looking for. Action items are to develop a better testing method for precision testing to accurately compare drop to drop of each of the bottle sizes. In addition a better one to one comparison of eye drops with the device and eye drops with NO device.

# 2023/12/04 - Precision Testing 2 Notes

Jenna Krause - Dec 11, 2023, 11:38 AM CST

**Title:** Precision Testing 2 Notes

**Date:** 12/4/2023

**Content by:** Jenna Krause

**Present:** Jenna Krause, Tevis Linser, Kasia Klotz

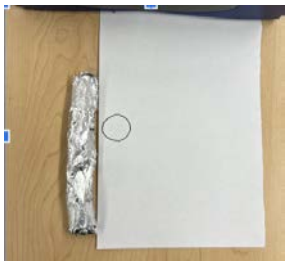
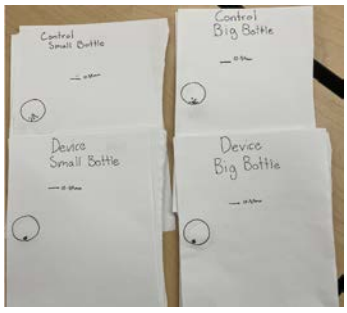
**Goals:** To determine using a device allows for higher precision of eye drops then no device.

**References:**

I. Bekerman, P. Gottlieb, and M. Vaiman, “Variations in eyeball diameters of the healthy adults,” *Journal of Ophthalmology*, vol. 2014, pp. 1–5, 2014. doi:10.1155/2014/503645

**Content:**

- Used the following journal article to determine the accurate size of circle that was needed to represent a human eye.
    - 24.2 mm (transverse) × 23.7 mm (sagittal)
    - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4238270/
- Figure of precision testing setup with a large bottle in the device is provided below.
- 
- Figure of precision testing setup with large bottle and NO device is provided below
- 
- Overhead photo of testing set up. Foil is used as a reference to the nose. The device sits on the foil when in use.

- 
- 10 drops were done with each of the methods which were the following:
  - Big Bottle NO Device and Big Bottle Device
  - Small Bottle NO Device and Small Bottle Device
- Between each drop the bottle and device are both reposition it show use on different days.
- Example of 10 drop trials is given below.
- 
- The 10 drops were than copied over with a light to a master sheet where it will be later analyzed in ImageJ. Examples of each of the methods is shown below. A 10.54 mm mark is made on all the sheet for calibration in ImageJ
- 


**Conclusions/action items:**

Utilizing dimensions from a journal article, a test was conducted with a precision setup involving large and small bottles, with and without the device, for 10-drop trials, and the results were transferred to a master sheet for subsequent ImageJ analysis. Action items are then to analyze each of the method areas in ImageJ to see if the device meets the goal of being more precise than no device.

# 2023/12/05 - Precision Testing Results

Jenna Krause - Dec 11, 2023, 11:34 AM CST

**Title:** Precision Testing Results

**Date:** 12/5/2023

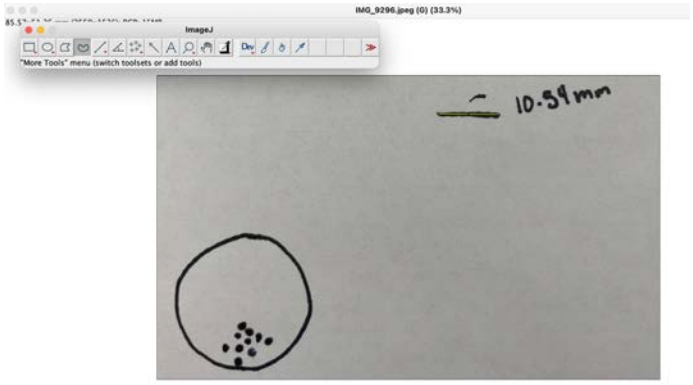
**Content by:** Jenna Krause

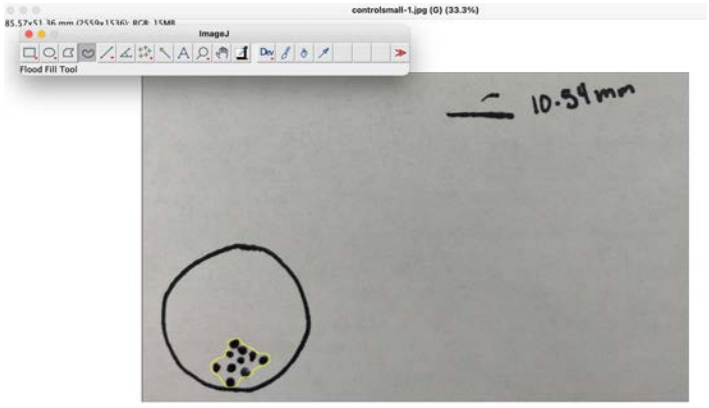
**Present:** Jenna Krause

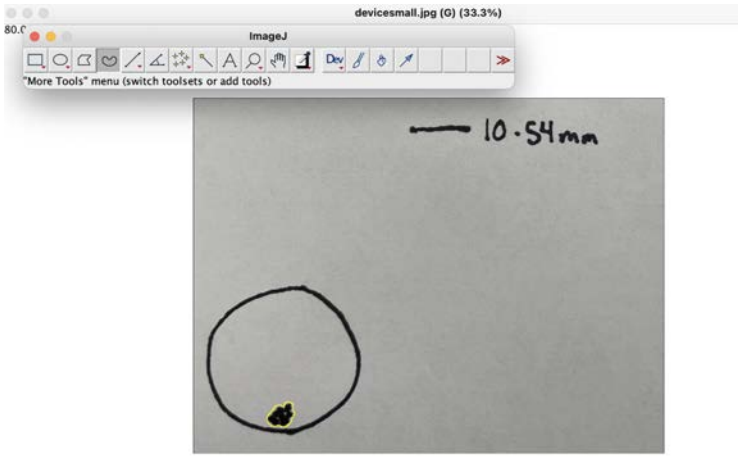
**Goals:** To analyze the results of the precision testing in ImageJ

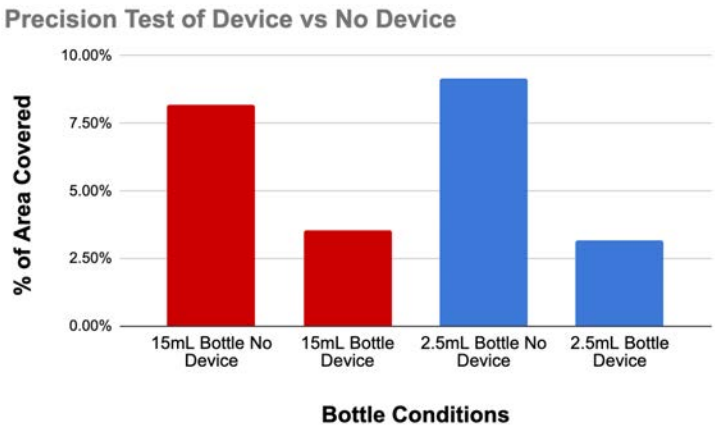
**Content:**

- Analysis of each of the drop areas in ImageJ.
    - Calibrated each of the new images to 10.54 mm based on the calibration line I made.
    - First took the area of the large circle and then took the area of the cluster of dots.
    - Divide these two numbers to get the area covered by the dots.
    - Then the area covered percentage of no device vs device is compared and the percentage decreased is calculated
    - This happens for both small (2.5mL) and large (15mL)bottles
- No device small bottle:
    - Area whole: 433.365 mm^2
    - Area drops: 39.660 mm^2
    - Area covered percentage = 9.152%
- Device small bottle:
    - Area whole:  434.532 mm^2
    - Area drops: 13.881 mm^2
    - Area covered percentage = 3.194%
- Difference between device and no device is an **34.90% decrease**
- No device big:
    - Area whole: 434.206 mm^2
    - Area drops: 35.632 mm^2
    - Area covered percentage =  8.206%
- Device big bottle:
    - Area Whole: 435.754 mm^2
    - Area Drops: 15.491 mm^2
    - Area covered percentage = 3.555 %
- Difference between device and no device is an **43.32% decrease**
- Figures below are examples of how images were analyze ImageJ for areas:

- 

- 

- 

- Bar Graph and Table comparison for both small (2.5 mL) and large (15mL) bottles with device vs No device.
- 

| 15 mL Bottle | |
|---|---|
| **Device Condition** | **% of Ares Covered** |
| **NO Device** | 8.21% |
| **Device** | 3.56% |
| **2.5 mL Bottle** | |
| **Device Condition** | **% of Ares Covered** |
| **NO Device** | 9.15% |
| **Device** | 3.19% |

**Conclusions/action items:**

Based on the ImageJ results, for both small (2.5mL) and large(15mL) the device allows for more precision from drop to drop compared to no device meeting the goal of the precision test. Small bottle size area coverage decreased 34.90 % with the device. Large bottle size area coverage decreased 43.32% with the device. Action items is to get an IRB approval for testing the device on individuals with lubrication or saline solution to get a better idea of accuracy and precision on different eye anatomies.

# Final SolidWork Parts

THOMAS KRIEWALDT - Dec 12, 2023, 6:27 PM CST

Download

**BME400_FinalDevice_Large_MainBody.SLDPRT (553 kB)**

THOMAS KRIEWALDT - Dec 12, 2023, 6:27 PM CST

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**BME400_FinalDevice_Large.SLDASM (5.93 MB)**

THOMAS KRIEWALDT - Dec 12, 2023, 6:27 PM CST

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**BME400_FinalDevice_Small_MainBody.SLDPRT (773 kB)**

THOMAS KRIEWALDT - Dec 12, 2023, 6:27 PM CST

Download

**BME400_FinalDevice_Small.SLDASM (5.93 MB)**

THOMAS KRIEWALDT - Dec 12, 2023, 6:27 PM CST

Download

**BME400_NosePiece_New.SLDPRT (32.3 MB)**

# 2023/9/11 - Relevance of Eye Drop Aids

**Title: Improving Compliance with Medical Treatment Using Eye Drop Aids**

**Date:** 9/11/2023

**Content by:** Kasia Klotz

**Present:** N/A

**Goals:** Determine the need and relevance for eye drop aids in healthcare

**Link:** [https://www.mdpi.com/2673-8392/3/3/65](https://www.mdpi.com/2673-8392/3/3/65)

**Citation:**

[1] A. Biran, M. Goldberg, N. Shemesh, and A. Achiron, “Improving compliance with medical treatment using eye drop aids,” *Encyclopedia*, vol. 3, no. 3, pp. 919–927, 2023. doi:10.3390/encyclopedia3030065

**Content:**

- This article discusses the importance of eye drop aids when administering treatment for glaucoma, specifically in the elderly population
- Treatment plans often include administering a specific amount of eyedrops into the patients eye. Too little or too much of the solution can not only cause further complications, but is also wasteful and could lead to the patient spending more money on excessive supplies
- Main populations impacted include: elderly, sick, and visually handicapped
- Providers would like to ensure that patients are receiving the "full benefits" of their treatment. The addition of an eye drop aid to the treatment plan can help.
- This article focuses on primary open-angle glaucoma
    - "Primary open-angle glaucoma is a chronic and progressive optic neuropathy characterized by a gradual loss of vision, which often goes unnoticed until the later stages of the disease. The proposed explanations for optic neuropathy include direct pressure on nerve fiber layer axons, local pressure on optic nerve axons at the lamina cribrosa (the “mechanical theory”) and vascular insufficiency of the optic nerve head (the “vascular theory”)."
- The difficulty of administering eye drops can cause patients to skip scheduled applications. Irregularities in administration of eye drops throughout the day can cause patients to become more forgetful, leading to delayed healing and further nerve damage.

**Table 1.** Summary of the main problems limiting patients' adherence to the treatment schedule.

| Expected Challenge | Risk Factors for Difficulty |
|---|---|
| Difficulty in bottle pinching | Lack of physical power, neuropathy |
| Difficulty in bottle placement | Tremor, rigidity, poor coordination, fear of corneal touch |
| Difficulty in timing | Reduced mental ability, poor memory |
| Local side effects | Conjunctival reaction, discomfort, dryness |
| Systemic side effects | Compromised pulmonary function, cardiac |
| Systemic medication | Confusion about the overall medical treatment regimen |

- Research has been conducted using existing eye drop aids. The results and a list of company names are shown below.

**Table 2.** A summary of the reports and their findings.

| Publication | Type | No of Patient | Patients | Product | Conclusions | Strength/Quality of Evidence (*) |
|---|---|---|---|---|---|---|
| Saiyami et al. [29] | Prospective, comparative | 93 | POAG patients | Eye drop guide | Aid use lessens compliance | high |
| Davies et al. [24] | Prospective, comparative | 40 | POAG patients | Upright eye-drop bottle | No change in placement, fewer drops, less touch | high |
| Davies et al. [18] | Meta-analysis | 14 publications 1194 patients | | 14 different aids | Better pinch power, better coordination | very high |
| Gomes et al. [25] | Prospective | 23 | naive | Xal-ease | No reduction in drops, less touch and no difference in general use | low |
| Strungaru et al. [26] | Prospective, comparative | 30 | POAG | Mirror hat device | No change in time, number of drops and placement. Less touch and better vision of drops | medium |
| Averns et al. [27] | Prospective, comparative | 30 | RA patients | Opticare | Better pinch power. Less Fewer drops | medium |
| Connor et al. [20] | Comparison of physical properties | none | none | Xal-ease, Opticare, Eyot, Opticare | Increased power is needed in the first three cases, decreased in the last | N/A |
| Zhu et al. [28] | Prospective, comparative | 39 | POAG patients | Autodrop, autosqueeze, simplitouch | Fewer drops missed in Autodrop, increased patient satisfaction | low |
| Sharma et al. [30] | Prospective, comparative | 72 | POAG patients | Application strips | Less eye contact, fewer drops missed | medium |

(*) The report's strength and the quality of evidence presented were evaluated based on the GRADE system for evaluating studies [31].

- When designing an eye drop aid, some important aspects to consider are as follows:
  - force needed to expel a drop
  - drop placement
  - bottle tip contact and contamination risk
  - the number of drops expelled
- Administering eyedrops without an aid comes with the risk of causing inflammation and irritation in the eye, as well as contamination which may lead to infection

**Conclusions/action items:** Based off of this article, there is a clear need to eyedrops aids in healthcare. Many people struggle to administer a precise amount of eyedrops on their own for problems as simple as dry eyes. Glaucoma is a much more serious problem and it tends to impact the older populations who have less control and function of their hands. This article mentions many existing devices. However, the client presented this problem because there is still not a perfect solution. The next steps will be to investigate the competing devices further.

KASIA KLOTZ - Sep 11, 2023, 9:30 PM CDT

encyclopedia

Entry

# Improving Compliance with Medical Treatment Using Eye Drop Aids

Download

**encyclopedia-03-00065.pdf (598 kB)**

# 2023/10/8 - Eye Drop Dosage

**Title: Eye Drop Dosage**

**Date:** 9/30/2023

**Content by:** Kasia Klotz

**Present:** N/A

**Goals:** Investigate what one dosage of eye drop solution is equivalent to

**Link:** https://www.sciencedirect.com/science/article/pii/S0039625703001838

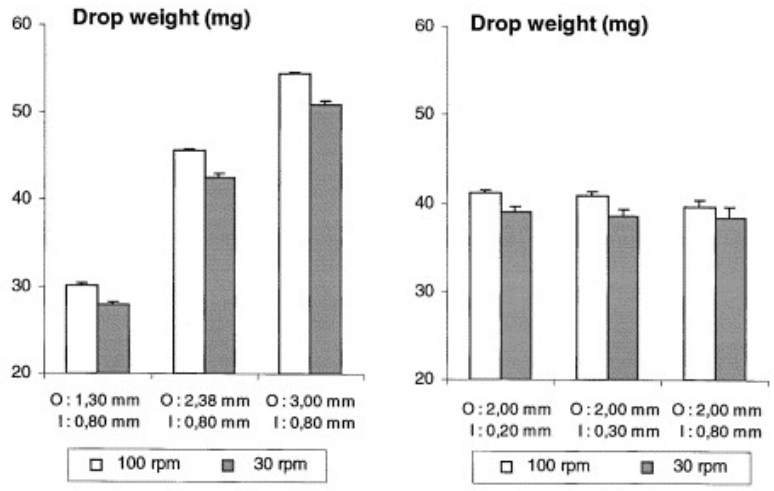
**Citation:**

[1] L. Van Santvliet and A. Ludwig, “Determinants of Eye Drop Size,” Survey of Ophthalmology, vol. 49, no. 2, pp. 197–213, Feb. 2004. doi:10.1016/j.survophthal.2003.12.009

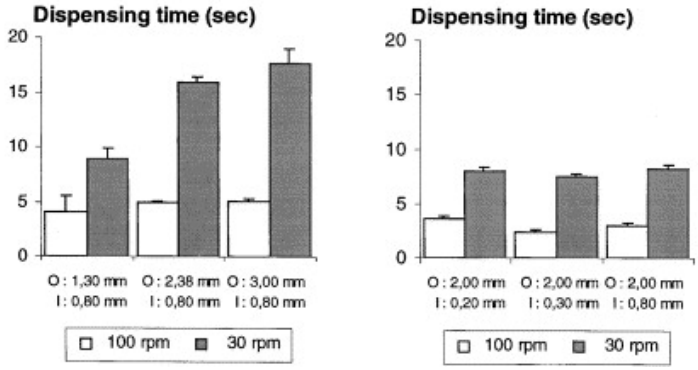
**Content:**

- research suggests that eye drop bottles only really need to adminisotr 5 ul- 15 ul of solution
    - still enough to effectively treat patient
    - reduces the amount drainage from the eye
        - eye reflexively waters after administering eyedrops, often times washes out medication
            - palpebral fissure can contain aout 30 ul before overflowing
    - reduces cost of treatment by making the eye drops last longer
- current bottles release about 21.5 ul - 69.4 ul on average
    - very inconsistent between bottles
    - in general, much more than needed
- although our goal is not to change existing eye drop bottles, this just further proves how important it is that patients do not administer more drops than needed
- the figures below show the results of a study that was done to assess the consistency of eye drops being dispensed

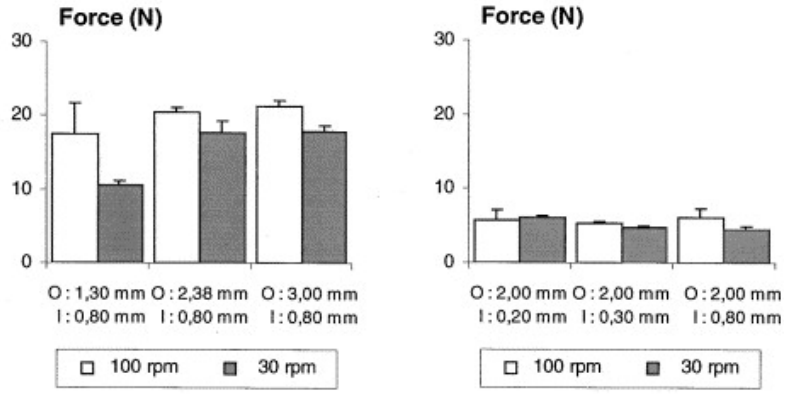
(A)


Drop weight (mg)
60
50
40
30
20
O : 1,30 mm
I : 0,80 mm
O : 2,38 mm
I : 0,80 mm
O : 3,00 mm
I : 0,80 mm
100 rpm
30 rpm
Drop weight (mg)
60
50
40
30
20
O : 2,00 mm
I : 0,20 mm
O : 2,00 mm
I : 0,30 mm
O : 2,00 mm
I : 0,80 mm
100 rpm
30 rpm

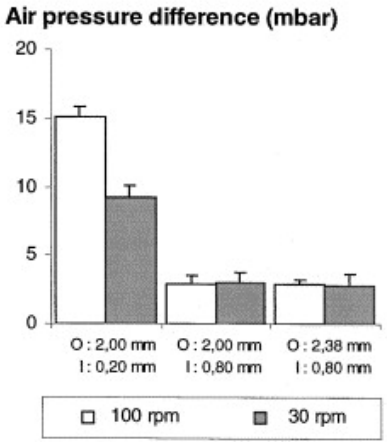
(B)


Dispensing time (sec)
20
15
10
5
0
O : 1,30 mm
I : 0,80 mm
O : 2,38 mm
I : 0,80 mm
O : 3,00 mm
I : 0,80 mm
100 rpm
30 rpm
Dispensing time (sec)
20
15
10
5
0
O : 2,00 mm
I : 0,20 mm
O : 2,00 mm
I : 0,30 mm
O : 2,00 mm
I : 0,80 mm
100 rpm
30 rpm

(C)




(D)




**Conclusions/action items:**

The information in the article can be used to explain the importance of this project. While the alteration of drop sizes from the dropper itself would be ideal, the team can have a direct impact by creating an assistive device that ensures the administration of a singular drop. This article also introduced the important of considering tears and how reflexes like blinking impact the administration of medicated eye drops. The team will consider this information while moving forward in the design process.

SURVEY OF OPHTHALMOLOGY

THERAPEUTIC REVIEWS

JOEL MINDEL, EDITOR

# Determinants of Eye Drop Size

**Luc Van Santvliet, PhD, and Annick Ludwig, PhD**

*University of Antwerp (U.I.A.), Laboratory of Pharmaceutical Technology and Biopharmacy, Antwerp, Belgium*

**Abstract.** Ophthalmic solutions are available for multidose or single-dose administration in a wide variety of glass and plastic dropper bottles which deliver drops with a volume between 25 and 75 µl. From a biopharmaceutical and economic point of view, however, smaller volumes of 5 to 15 µl should be instilled. In this review, the technical, pharmaceutical, and therapeutic aspects of eye drop formation and delivery are presented. The different types of containers are described and the determinants of eye drop size are discussed, such as the design and physical characteristics of the dropper tip and bottle, the physicochemical properties of the solution, and the manner in which the patient dispenses the drops. Preferred and alternative instillation techniques and aids to facilitate the administration of eye drops by elderly patients are described. (**Surv Ophthalmol 49:197–213, 2004.** © 2004 Elsevier Inc. All rights reserved.)

**Key words.** administration aids • drop dispensing • eye drop administration • eye drop size • ophthalmic solutions • packaging

An aqueous ophthalmic solution, instilled as a drop in the lower conjunctival sac, remains the preferred dosage form for an ocular medication.[1–3,4–6] Such a solution is formulated for multidose or single-dose administration in a wide variety of glass and plastic dropper bottles. Until recently, the average drop size of ophthalmic solutions was assumed to be 50 to 70 µl.[3,7,8] Lederer et al, however, determined that the average drop size of many commercially available topical medications was actually 39 µl with a range of 25.1 to 56.1 µl.[9] Ophthalmologists and hospital pharmacists performing studies to determine the cost per dose and per bottle of eye medication, reported eye drop volumes ranging from 26.4 µl up to 69.4 µl.[10–12,13,14,15,16,17,18] From bioavailability and toxicological points of view, even smaller volume drops, of 5 to 15 µl, should be instilled.[19,20,21] The size of drops delivered from plastic dropper bottles is influenced by three major factors: the design and characteristics of the dropper tip and bottle, the physicochemical properties of the solution to be dispensed, and the patient's manner of handling the dropper bottle (Van Santvliet L: Optimization of eye-drop administration. Antwerp, PhD thesis 1999). Many patients, especially the elderly, experience physical difficulties in administering eye drops, which can lead to poor compliance.[22]

In this review article, the pharmaceutical and clinical aspects of eye drop size, formation, and administration will be outlined. The correct instillation of drops will be emphasized and alternative instillation techniques and aids to facilitate their administration, for example, for arthritis patients, will be discussed.





0039-6257/04/$–see front matter
doi:10.1016/j.survophthal.2003.12.009

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**1-s2.0-S0039625703001838-main.pdf (741 kB)**

# 2023/10/8 - Grip Strength, Dexterity, and Age

**Title: Grip Strength, Dexterity, and Age**

**Date:** 10/8/2023

**Content by:** Kasia Klotz

**Present:** N/A

**Link:** https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0117598

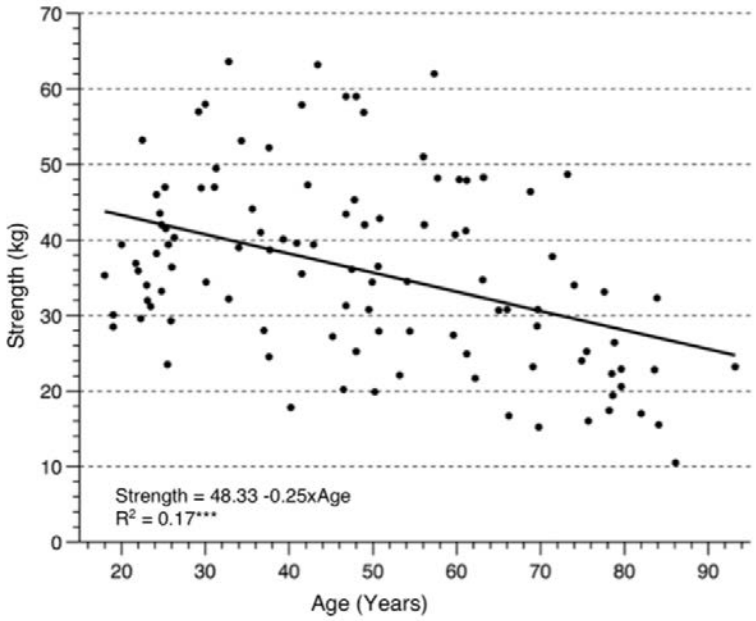
**Citation:**

[1] J. A. Martin, J. Ramsay, C. Hughes, D. M. Peters, and M. G. Edwards, “Age and grip strength predict hand dexterity in adults,” *PLOS ONE*, vol. 10, no. 2, 2015. doi:10.1371/journal.pone.0117598

**Goals:**

- Investigate the relationship between grip strength, dexterity, and age

**Content:**

- The goal of this study was to investigate the relationship between aging, reduced grip strength, and dexterity issues
- This study had 107 participants, ages ranging from 17-93, 57 female and 60 male
- 

- This study found that grip strength decreases by about 1-1.5% per year of aging
- Grip strength is linked to reductions in muscle mass
  - age associations with changes in muscle mass also affects rate of activation in muscles as well us muscle recruitment, all of which would impact hand dexterity
- With aging also comes reduced stability in joints, including the wrist
- Weaker grip strength is directly related to reduced dexterity
- Used dexterity tests such as steadiness and line tracking
- Tremors are also common in the elderly population, and should be considered in conversations about reduced hand capabilities

- Testing aiming and tapping (more targeted, coordinated, and goal directed actions) was impacted more by grip strength rather than age.
    - Steadiness and line tracing, however, were more impacted by age than strength
- Physical activity may improve certain aspects of reduced dexterity

**Conclusions/action items:**

This article discusses the relationships between dexterity, grip strength, and age. The tests that were used included line tracing, steadiness, aiming, and tapping. It was found that line tracing and steadiness were more affected by the age of the person rather than strength. However, aiming and tapping, which are more coordinated movements, were more impacted by strength. These results are important to consider when selecting our target audience. Although reduced dexterity and grip strength is more common among the elderly population, anyone with low grip strength will have trouble properly administering eye drops.

KASIA KLOTZ - Oct 10, 2023, 9:33 PM CDT

PLOS ONE

Age and Grip Strength Predict Hand Dexterity in Adults

Abstract

Download

**file.pdf (740 kB)**

# 2023/9/12 - Gentle Drop Eye Drop Guide

**Title: Gentle Drop Eye Drop Guide**

**Date:** 9/12/23

**Content by:** Kasia Klotz

**Present:** Kasia Klotz

**Goals:** Investigate competing designs

**Link:**https://www.amazon.com/GentleDrop-Eyedrop-Bottles-Dispenser-Invented/dp/B0BQBHRKV1/ref=sr_1_1_sspa?keywords=eye+drop+dispenser+for+elderly&qid=1694576041&sr=8-1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&psc=1

**Citation:**

[1] “Amazon.com: Eye drop dispenser for elderly,” Amazon.com, https://www.amazon.com/eye-drop-dispenser-elderly/s?k=eye+drop+dispenser+for+elderly (accessed Sep. 13, 2023).

**Content:**

Product details:

- Soft silicone sleeve safely aims your eye drop bottle
- Clinically shown to improve success, safety, & satisfaction
- Fits 5, 10, & 15 ml TRADITIONALLY shaped bottles
- DOES NOT FIT Visine, Rohto, and Latanoprost
- DOES NOT FIT: 2.5 ml bottles, PRESERVATIVE-FREE vials, NON-TRADITIONALLY SHAPED bottles (ex. Latanoprost, Travoprost, Rhopressa, Rocklatan, Vyzulta, Travatan-Z, Lumigan, Diclofenac by Sandoz, Brimonidine by Sandoz, Visine, Rohto, Pataday, Similasan, iVizia, Nevanac, and others)

| | GentleDrop | AutoDrop | Remedic | Droppy | Peermax Drop Smart |
|---|---|---|---|---|---|
| Does NOT cover eye | ✓ | | | | |
| Does NOT touch skin around eye | ✓ | | | | |
| Does NOT point bottle tip straight at eye | ✓ | | | | |
| Rests on nasal bridge | ✓ | | | | |
| Material | Silicone | Plastic | Plastic | Plastic | Plastic |

Drawbacks based on reviews:

- does not properly grip the bottle; allows for slippage
- still required manual positioning due to twisting of the bottle and slippage of the device on the nose

**Conclusions/action items:**

This device is unique because it uses the bridge of the nose to help position the eyedropper rather than resting around the outside of the eye. This can decrease the likelihood of contamination. However, based off of customer reviews, this eyedropper still is not very easy to hold in place. Some customers reported the drops dripping down their cheek. However, this is likely due to the user not tipping their head back far enough. This device also does not ensure a precise amount of drops are dispensed. Overall, this idea is an improvement from usual method, but is not a perfect solution.

# 2023/9/12 - Eye Drop Guide Glasses

**Title: Eye Drop Guide Glasses**

**Date:** 9/12/2023

**Content by:** Kasia Klotz

**Present:** N/A

**Goals:** Investigate competing products

**Link:** **https://www.amazon.com/Eye-Bottles-Pipettes-Dispenser-Applicator/dp/B0BRDFVRZB/ref=psdc_3760941_t2_B0BQBHRKV1**

**Citation:**

[1] “Amazon.com: Eye drop aid for bottles, pipettes, and vials | eye drop ...,” Amazon, https://www.amazon.com/Eye-Bottles-Pipettes-Dispenser-Applicator/dp/B0BRDFVRZB (accessed Sep. 13, 2023).

**Content:**

- eye dropper becomes "stuck" in glasses, locks in place
- three different sized holes for different sized droppers

**HOW IT WORKS:**
1. ATTACH: Place the eye drop bottle, pump or vial in one of the openings and gently push and turn till it is stuck securely.
2. WEAR: Put the glasses on with the eye drop bottle, pipette or vial attached in one of the three holes. It will not fall out when picking up the glasses.
3. DROP: Tilt your head back, pull your lower eyelid down with one hand to create a pocket, look up and drop. Or alternatively have the drop land directly on the open eye.
4. DONE: Consistently EASY, effective and comfortable. Thanks to the glasses with the holes.

Based off of customer reviews, some areas for improvement include

- hole sizes do not fit most prescription eye drops (specifically for cataract surgery)
- holes did not line up correctly with some peoples eyes
- holes were hard to see

**Conclusions/action items:**

This was the first idea I thought of after hearing about this project. However, based off of customer reviews, there is a wide variety of sizes for eyedrops. Also, because not every face shape is the same, the holes do not always line up where they are supposed to. This device also does not control the amount of eyedrops that are dispensed.

Added Info: After discussing this product with the client, the team found out that the biggest drawback to this design is the placement of the eyedrops. This product guides the drops into the center of the eye which can cause problems with blood pressure in patients with glaucoma. The device must support proper eye drop technique.

# 2023/9/26 - Patent Search

**Title: Patent Search**

**Date:** 9/26/2023

**Content by:** Kasia Klotz

**Present:** N/A

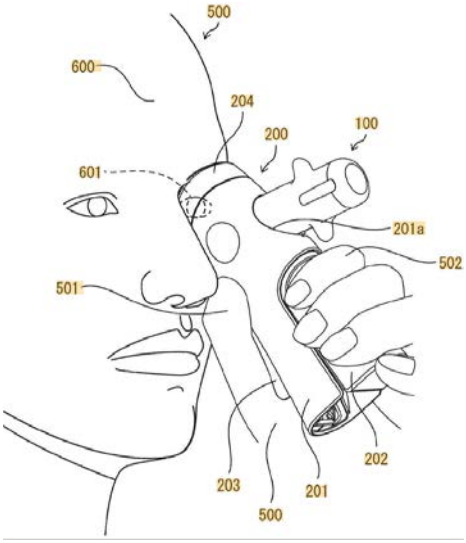
**Goals:** Find existing patents for eye drop assistants to ensure avoiding existing designs

**Content:**

**Eye Drop Assistor**

https://patents.google.com/patent/CN110072502B/en?q=(eyedrop+assist)&oq=eyedrop+assist

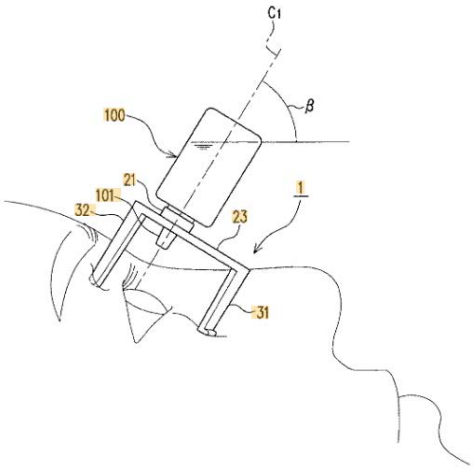
- This device uses a trigger like design
- Although it is hard to tell by the photos, it appears that this device sprays the eye drop into the eye
    - The description discusses the patient not having to tip back their head, and the place where the eyedrops are dispensed appears similar to a spray nozel
- This device also looks like it would dispense the drops directly into the eye, which is problematic.




**Instillation Assist Tool and Instillation Container Having the Same**

https://patents.google.com/patent/JP2020081321A/en?q=(eyedrop+assist)&oq=eyedrop+assist

- I chose to make note of this patent because it seems the team will have to avoid designing anything that holds the eye open, or encompasses the eye.
- This should not be too big of a problem, as many of these devices do not allow for proper eye drop technique.
- The other problem with these designs is although they may make eyedrops easier to administer, they do not ensure that the accurate dosage is dispense.




**Bandolier cartridge sterile eyedrop delivery system with eyelid retracting legs and eyedrop delivery confirmation**

https://patents.google.com/patent/US9549847B2/en?q=(automatic+eyedrop+dispense)&oq=automatic+eyedrop+dispense

- This device automatically dispenses a dosage of eyedrops
- It appears that this device includes it's own eyed drop bottle, so it may not be compatible with many prescription eye drops
- The electronics portion of this designs is explained as follows
    - "A sprocket drive motor directs the advancement of a loop cartridge band containing eyedrop solution ampoules, moving each one at a time into position for dispensing. A motor rotates a cam to strike a push rod to compress each ampoule. The system includes an eyelid retracting leg assembly. The cartridge automatically advances the next full ampoule into position for dispensing and pushes the ampoule tip aside."
- This device, like many others, drops the eyed drop directly onto the eye which is not desirable.

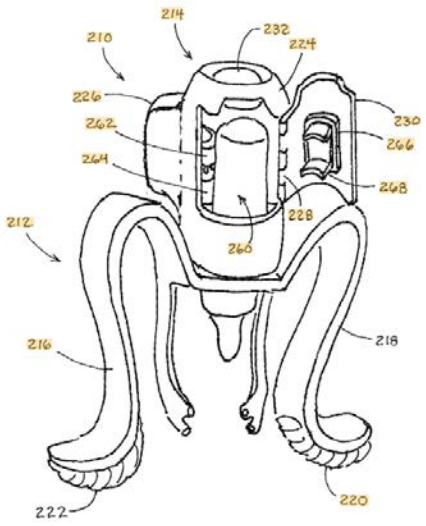



Fig. 14

**Conclusions/action items:**

The team will consider these designs, as well as ones other team members found while brainstorming ideas for our design. There are many existing devices on the market, so it will be important to avoid using any ideas that are already patented. The team will

continue to do research on patents. Next, the team will ask the client what she does not like about the existing devices.

# 2023/10/24 - Eye Lash Curler Handles

**Title: Eye Lash Curler Handles**

**Date:** 10/24/2023

**Content by:** Kasia Klotz

**Present:** N/A

**Goals:** Find the dimensions of existing silicone handles used on eyelash curlers

**Content:**

https://www.amazon.com/Petunia-Skincare-Silicone-Designed-Pinching/dp/B00UVLNDVQ/ref=asc_df_B00UVLNDVQ/?tag=hyprod-20&linkCode=df0&hvadid=312065699933&hvpos=&hvnetw=g&hvrand=3966918063294545296&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9018948&hvtargid=pla568864793200

- The link above is for an eye lash curler that the team is having the client purchase. The team plans to use the silicone handles found on this device in time consuming, so for now the team plans to use existing devices.
- In order for the team to use the existing handles, we will need to find dimensions for the silicone handles in order to properly create a 3D model for the
- Dimensions of entire device: 4.45 x 2.32 x 1.42 inches (LxWxH) = 113.03 mm x 58.928 mm x 36.068 mm (LxWxH)
- Unfortunately, there are no dimensions listed for the part of the handle that is inserted into the silicone handle. However, I can see that the metal is cyl
- Amazon describes the silicone handles as follows:
  - QUALITY NON-SLIP SILICONE RUBBER THUMBPRINT HANDLES - Specifically improved to create a comfortable, anti slip and easy grip curl
  - 

**Conclusions/action items:**

The team will have to wait to measure the necessary dimensions until the product has arrived. It will be important to model the device in a way that is easily

# 2023/9/29 - Initial Design Ideas

**Title: Initial Design Ideas**

**Date:** 9/29/23

**Content by:** Kasia Klotz

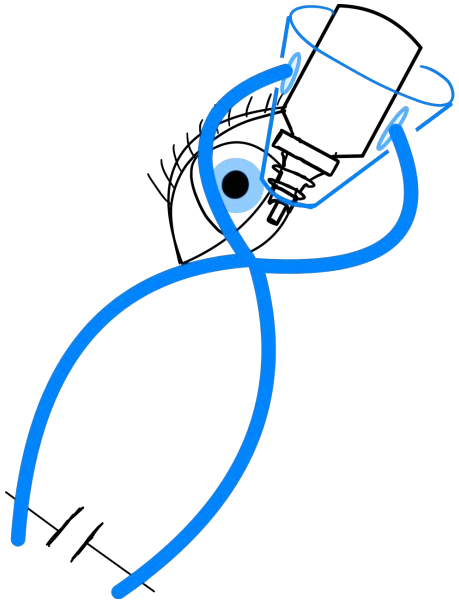
**Present:** N/A

**Goals:** Brainstorm initial design ideas

**Content:**

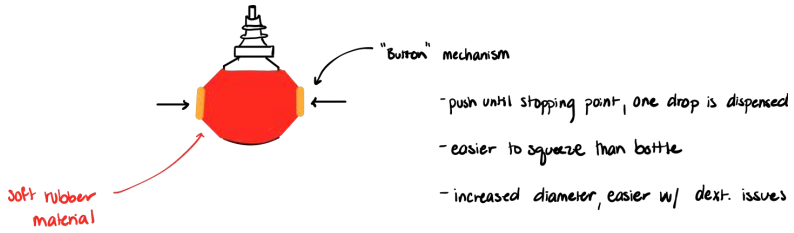
#1) Plier Grip

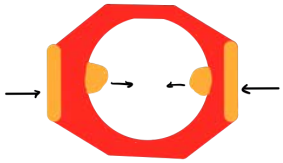
- This designs provides a widened grip compared to just squeezing a eye drop bottle
- The bottle is held in a cone like structure. I chose a cone because I think it could acomodate multiple sized bottles
- The handles have a stopper in between them to ensure that only enough pressure is applied to dispense one drop



#2) Pencil Grip

- This design fits tightly around the bottle, and would likely be fabricated with some type of silicone
- The "button" would push inward toward the bottle, adding pressure and releasing a drop
    - The idea is that the button would be easier (take less effort) to squeeze than the bottle
- There would need to be some sort of stop point included



**Conclusions/action items:**

The team members shared their design ideas with one another, and moved forward with three designs to use in the design matrix. While the designs chosen have strong potential to solve the clients problem, it will be important to continue brainstorming ideas for ways to improve the current designs. Asking the client detailed questions about what she is looking for will help with this process. The design matrix will be presented to the client for feedback.

# 2023/11/02 - The Eye Lash Dropper Second Prototype

**Title: The Eye Lash Dropper Second Prototype**

**Date:** 11/2/2023

**Content by:** Kasia Klotz, Thomas Kriewaldt, Tevis Linser

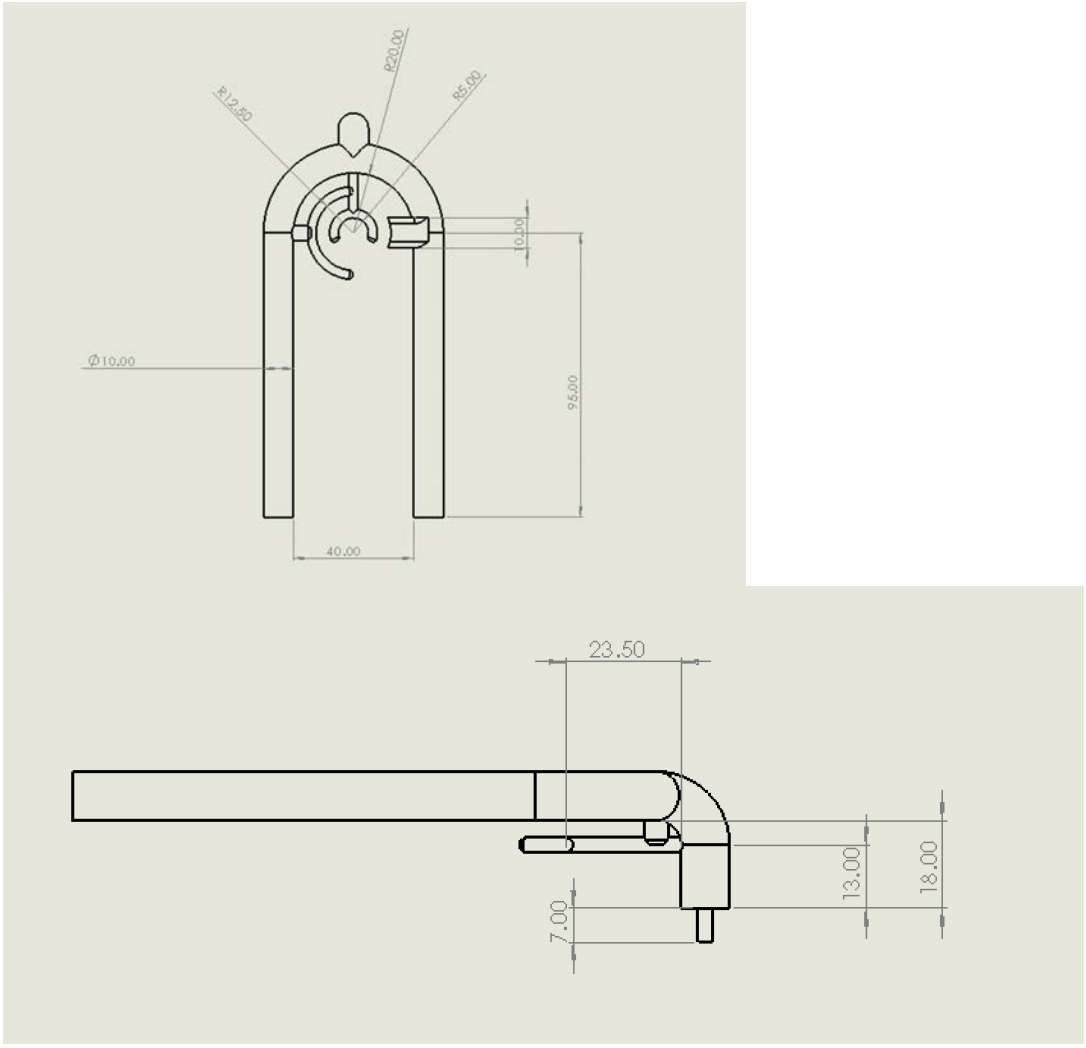
**Present:** Kasia Klotz, Thomas Kriewaldt, Tevis Linser

**Goals:** Modify initial prototype and reprint

**Content:**

- The second iteration of this prototype is larger than the initial. There was a second suppoer added that wraps around the neck of the eye drop bottle to ensure the bottle sits in the correct place and does not come into contact with the eye. The places initially set for the grips was removed and the diameter of the handles was held constant throughout
- By inspection, it is clear that the smaller support for the bottle neck is too small. It was removed in the middle picture shown above. Overall, compared to the first print, the second print is more successful in squeezing the bottle to dispense a single drop of solution.

- Some possible changes to this prototype that should be considered in the next print include:
  - extending the length of the handles
  - widening the grip to increase mechanical advantage
  - either remove or improve second support
  - increase length of attachment piece to nose piece




- The provided dimensions are in mm.

**Conclusions/action items:** The team will continue to analyze current prototypes and improve the 3D models. The team will also use feedback received from peers during show and tell to make alterations to the current model. So far, the team is very pleased with the results of initial prints. The main edit for the next iteration will be to widen the grip of the device.

# Red Permit

KASIA KLOTZ - Feb 21, 2022, 9:51 PM CST

**Title: Red Permit**

**Date:** 2/21/22

**Content by:** Kasia Klotz

**Present:** Kasia Klotz

**Goals:** complete red permit

**Content:**

**See pdf of proof of red permit completion below.**

**Conclusions/action items:**

**Complete green permit.**

KASIA KLOTZ - Feb 21, 2022, 9:52 PM CST


Download

**Red_Permit.pdf (207 kB)**

# Green Permit

KASIA KLOTZ - Mar 08, 2022, 9:07 PM CST

**Title: Green Permit**

**Date:** 03/08/2022

**Content by:** Kasia Klotz

**Present:** N/A

**Goals:** learn how to use a lathe and mill

**Content:**

proof of completion below

**Conclusions/action items:**

KASIA KLOTZ - Mar 08, 2022, 9:06 PM CST


Download

**Green_Permit.png (254 kB)**

# Chemical and Biological Safety Training

KASIA KLOTZ - Mar 28, 2022, 10:59 PM CDT

**Title: Chemical and Biological Safety Training**

**Date:** 03/08/2022

**Content by:** Kasia Klotz

**Present:** N/A

**Goals:**

**Content:**

Proof of completion shown below

**Conclusions/action items:**

KASIA KLOTZ - Mar 08, 2022, 9:04 PM CST


WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

This certifies that Kasia Klotz has completed training for the following course(s):

| Course | Assignment | Completion | Expiration |
|---|---|---|---|
| Biosafety Required Training | Biosafety Required Training Quiz 2022 | 1/19/2022 | |
| Chemical Safety: The OSHA Lab Standard | Final Quiz | 1/19/2022 | |

Data Last Imported: 03/08/2022 08:50 PM

Download

**Screen_Shot_2022-03-08_at_8.57.15_PM.pdf (141 kB)**

# 2023/9/9-Initial Research

ANABELLE OLSON (amolson27@wisc.edu) - Sep 10, 2023, 9:16 AM CDT

**Title: Initial Research**

**Date:** 9/9/23

**Content by:** Anabelle Olson

**Present:**

**Goals:**

Citations:

Brand, Gali, et al. “Comparison of the usability of Eye Drop AIDS and the conventional bottle.” *Journal of Clinical Medicine*, vol. 10, no. 23, 2021, p. 5658, https://doi.org/10.3390/jcm10235658.

1. https://www.owenmumford.com/us/medical-devices/eye-care/autodrop-autosqueeze

2. https://guldenophthalmics.com/product/opticare-eye-drop-dispenser/

**Content:**

Background:

- eye drops are the most common route of administration for ophthalmic medications
- using eye drop bottles can be hard for patients, potentially resulting in noncompliance and treatment failure
- 25% or patients report missing doses due to difficulty using the eye drop bottle
- Opthalmic diseases are more prevalent in the elderly population, where other diseases such as hand tremor, arthritis, poor coordination and peripheral neuropathy present further challenges to successful eye drop use.

Study objective:

- To assess the effectiveness of two current eye bottle assisters on the market in comparison to the conventional eye bottle
- the patients in this study were healthy people without any diseases that could compromise drop instillation

Current Eye Dropper Aids on the Market in this study:

- The Autodrop - Owen  Mumford [1]
    - the eye drop bottle clips into place, and the body of the device prevents blinking by keeps the lower eyelid open. A small pinhole directs the eyesight upward and away from the descending drops. Patients apply pressure directly onto the bottle to expel drops.
    - study showed may lead to multiple drops and medication wastage
- Opticare Eye Drop Dispenser [2]
    - the eye drop bottle is placed inside the device, allowing for a better grip. The device is placed on the eye and the eyepiece holds the upper lid, which helps prevent the blinking reflex.
    - showed more challenging to use and could only fit small, round bottles.

Study Results

- the conventional eye dropper showed contamination 46% of the time, while the eye drop assistors showed no contamination
    - contact with the bottle tip and their canthus, eyelid, cornea or conjunctive when using the conventional bottle
    - this contamination and potential trauma from the tip of the eye drop bottle is a concern for patients taking topical treatments
    - eye infections can result from contaminated bottles
    - 61% glaucoma patients contaminated the bottle tip
- Opticare aid reduced the difficulty controlling the number of drops
- To use the opticare aid, force is to be applied to the device and not to the eye drop bottle, resulting in some subjects overestimating the force needed to release a signle drop, leading to multiple drops being expelled

Other Studies

- 50% of glaucoma patients dropped 2 drops or more (instead of one drop).
    - it is speculated that excess medication in the eye is draned by the lacrimal apparatus and can increase absorption and possibly the liklihood of unwanted systemic side effects
    - Medication wastage also can decrease a patient's compliance, due to more frequent prescription refills due to the drops running out faster
        - also becomes more expensive

**Conclusions/action items:**

This study showed some background of why eye drop aids are used. Bottle tip contamination seems to be one of the most prevalent downfalls of using only the bottle dropper to administer eye drops. Also, this article provided some current eye dropper aids on the market and studied their downfalls and selling points that make them better than the conventional bottle. This article will be used for our project to not only assess some of the driving points for needing the eyedropper aid, but also evaluate eye droppers already on the market

# 2023/9/18 - Research on common diseases and uses for eyedrops

ANABELLE OLSON (amolson27@wisc.edu) - Sep 18, 2023, 1:58 PM CDT

**Article Title: How can eye drops help?**

**Date:** 09/18/2023

**Content by:** Anabelle Olson

**Goals:** To learn more about the common diseases and other uses for eye drops

Citation:

> “Eyedrops: An Ocean of Uses.” *WebMD*, WebMD, www.webmd.com/eye-health/eyedrops-an-ocean-of-uses. Accessed 18 Sept. 2023.

**Content:**

- eye drops are real medicine just like tablets and injections
- Common uses of eyedrops:
    - Cataract surgery: use of eye drops before surgery to prevent infection, make your pupil larger, and numb the area
        - drops administered after the surgery can lower the chances of infection
    - Conjunctivitis (pink eye): drops can treat this infection
    - contact lens rewetting: self explanatory
    - Infected cornea (keratitis): receive antibiotic eye drops for a minor problem, for a more severe infection, you might need fortified antibiotic drops
    - Corneal transplant surgery: drops help with healing and prevent rejection of the donor tissue
    - Glaucoma
        - often associated with increased fluid pressure inside the eyes
        - can cause serious optic nerve damage and vision loss if you don't treat it
        - in early stages - eye drops can reduce the amount of fluid your eye makes and help more liquid drain from it
        - eye drops may also prevent people with high eye pressure from getting glaucoma

**Conclusions/action items:**

This research provided me with common uses for eyedrops, and helped me understand a little bit about all of the uses.

# 2023/9/13-Competing design research

ANABELLE OLSON (amolson27@wisc.edu) - Oct 11, 2023, 11:24 AM CDT

**Title: Remedic Eyedrop Bottle Dispenser**

**Date:** 9/13/23

**Content by:** Anabelle Olson

**Goals:** To learn about a current eye dropper aid that is on the market, while also identifying its strong and weak points

**Citation:** https://www.amazon.com/Remedic-Eyedrop-Bottle-Dispenser-Easier/dp/B08B632R4Y/ref=psdc_3760941_t1_B0010NLNF2#customerReviews

**Content:**

**Brand: Remedic**

Found on amazon for $14.99 per aid.

Product Description:

The product helps to ensure the drops go directly into the eye. The website says that it is an "arthritis-friendly" dispenser, and has soft rubber that holds the eye open to aid in dropping into eye. This product doesn't specifically fit our clients specifications, as it does not promote the proper eye drop technique. The proper eye drop technique requires the drop to be administered in the bottom pocket of the eye and not directly centered in the middle of the eye ball. This design does however help prevent bottle tip contamination. The design also does acommodate for multiple bottle sizes, which is something we are trying to incorporate into our design.


**Conclusions/action items: This design has some aspects we would like to incorporate into our design, but it also doesn't allow for the proper eye drop technique.**

# 2023/09/24-Patent search

ANABELLE OLSON (amolson27@wisc.edu) - Sep 24, 2023, 5:22 PM CDT

**Title: Patent Search**

**Date:** 2023/09/24

**Content by:** Anabelle Olson

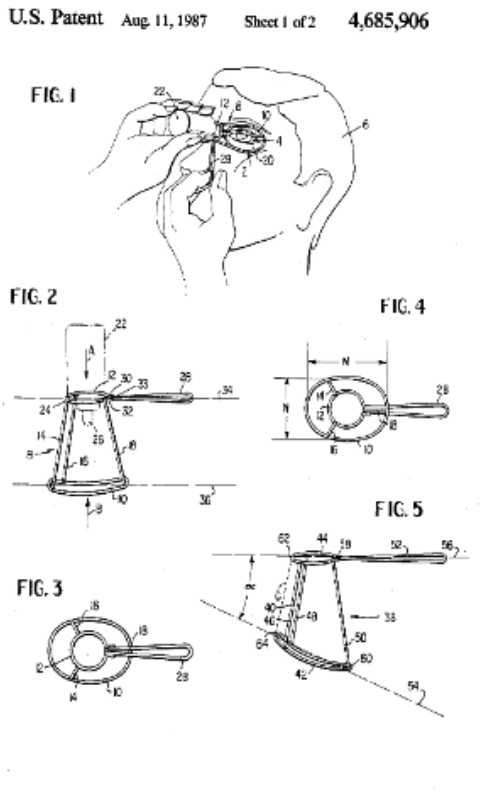
**Goals:** Completing patent searches to understand and learn about devices that already exist and are patented

**Content:**

Eye-Drops application device:

patent: US4685906A

This device utilizes a frame with 2 rings, the first ring fits around the eye of the person and the second ring supports the eye drop bottle. This device helps to reduce the risk of contaminating the eye drops.




citation:

> Franklin, Murphy Wiliam. *Eye-Drops Application Device*. 11 Aug. 1987.

Eye Drop applicator and drop transfer method:

patent US10758407B2

This device is a handheld applicator in which you transfer the eye drop onto the applicator and then into the pocket of the eye.

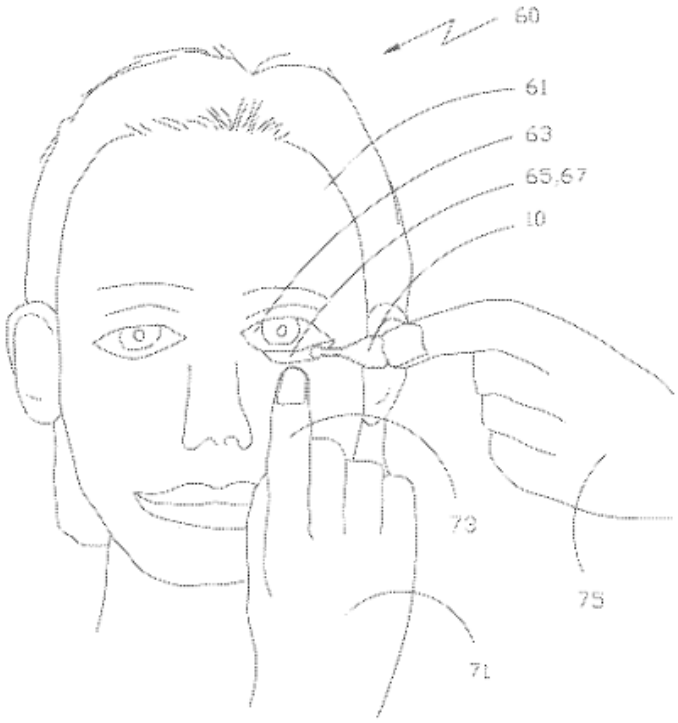
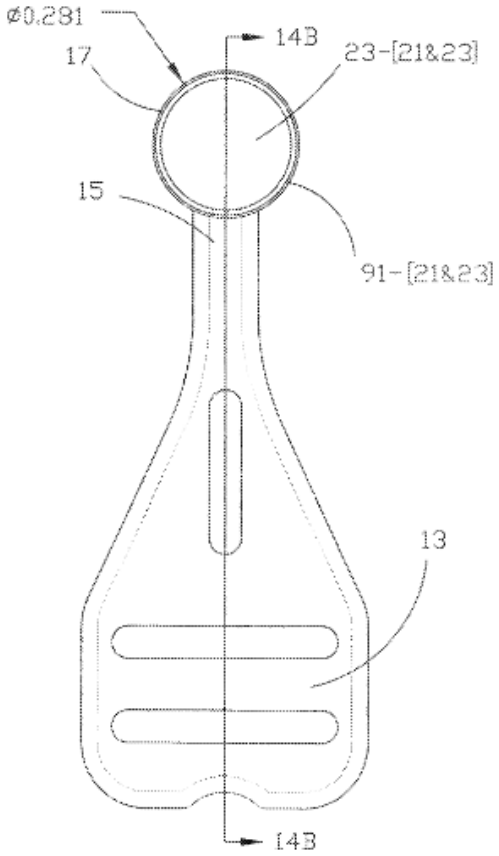



FIG. 5A




Citation:

Mansfield, Harold D. *Eye Drop Applicator and Drop Transfer Method*. 1 Sept. 2020.

Unit dose drug delivery platform

Patent US8579856B

This delivery system works to administer either single-dose or multiple-doses of a substance to a user. it has a user activation mechanism that engages a drug delivery mechanism comprising a piston driveable into at least one dosage form contained in the housing.

"the combined actuation approach of the delivery systems may allow the force applied by the user to actuate the device such that it reaches a pre-defined minimum threshold level to dispense the substance contained in the unit dosage form. This feature ensures that sufficient force is applied to fully dispense the dose. Once the pre-defined minimum threshold level is reached, the system is mechanically advantaged such that administration requires minimal effort. This approach is designed to increase ease of administration of the disclosed delivery systems, which is particularly important for elderly or incapacitated users, who typically find it difficult to administer a substance, for example to administer eye drops, because of a physical infirmity such as arthritis, or other disabling conditions." - interesting, seems like what we are trying to do

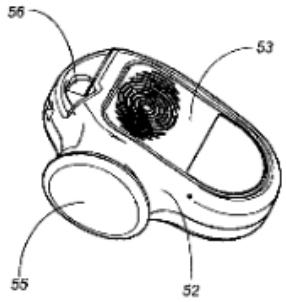



*Fig. 22*

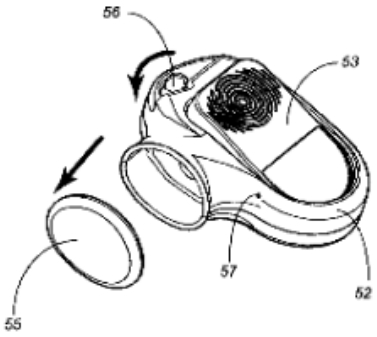



*Fig. 23*

Citation:

> Sullivan, Timothy R, and Jeffrey Nelson. *Unit Dose Drug Delivery Platform*. 12 Nov. 2013.

Bandolier cartridge sterile eyedrop delivery system with eyelid retracting legs and eyedrop delivery confirmation

Patent: US9549847B2

this system uses electronics, and includes an eyelid retracting leg assembly. This system helps to assure that a known number of drops are dispensed, the dispensed drops fall on the eyeball (by providing eyelid retracting legs to keep the eye open), and the eyedrops landing on the surface of the eye are confirmed using a drop dispensor sensor pair.

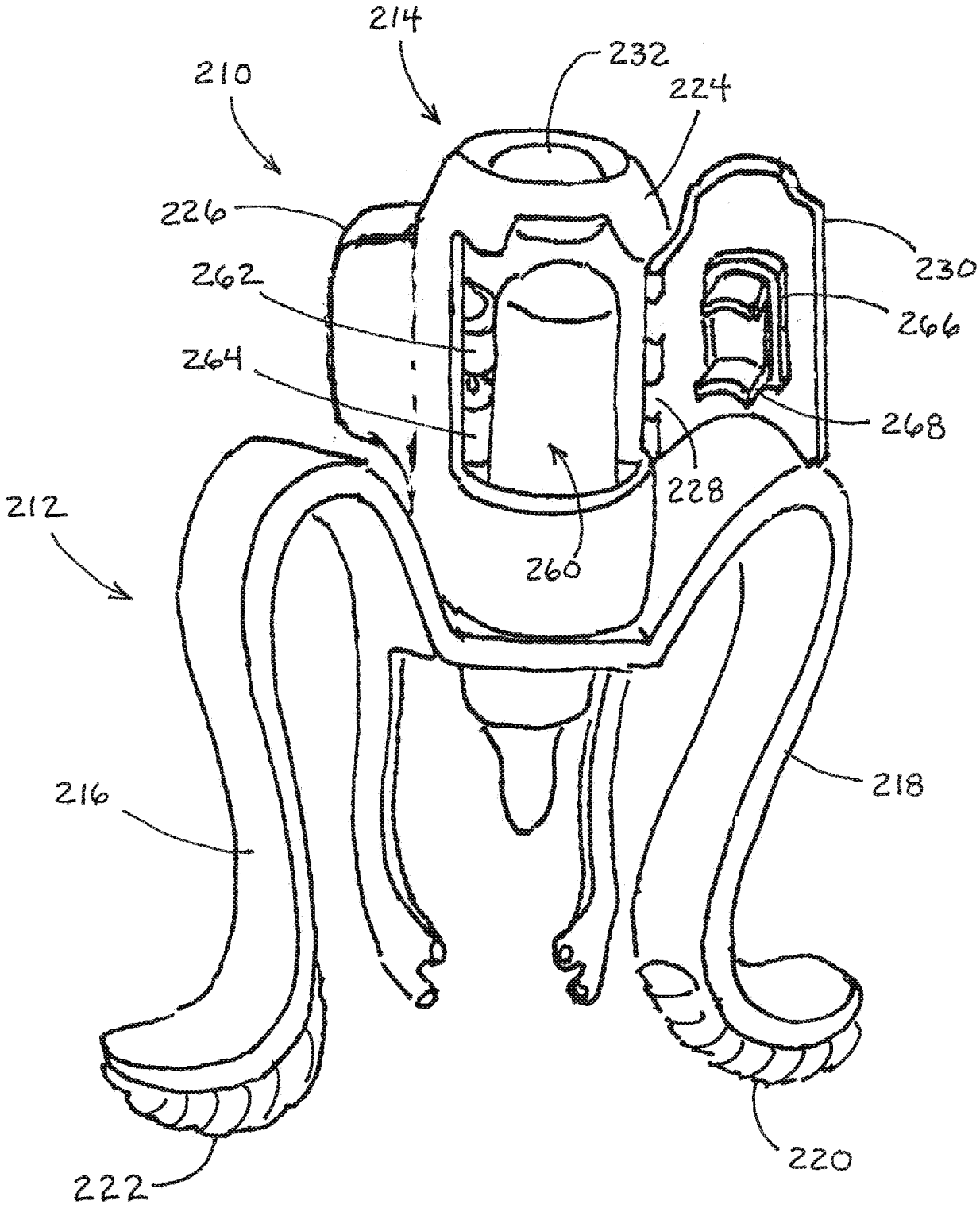

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Fig. 14

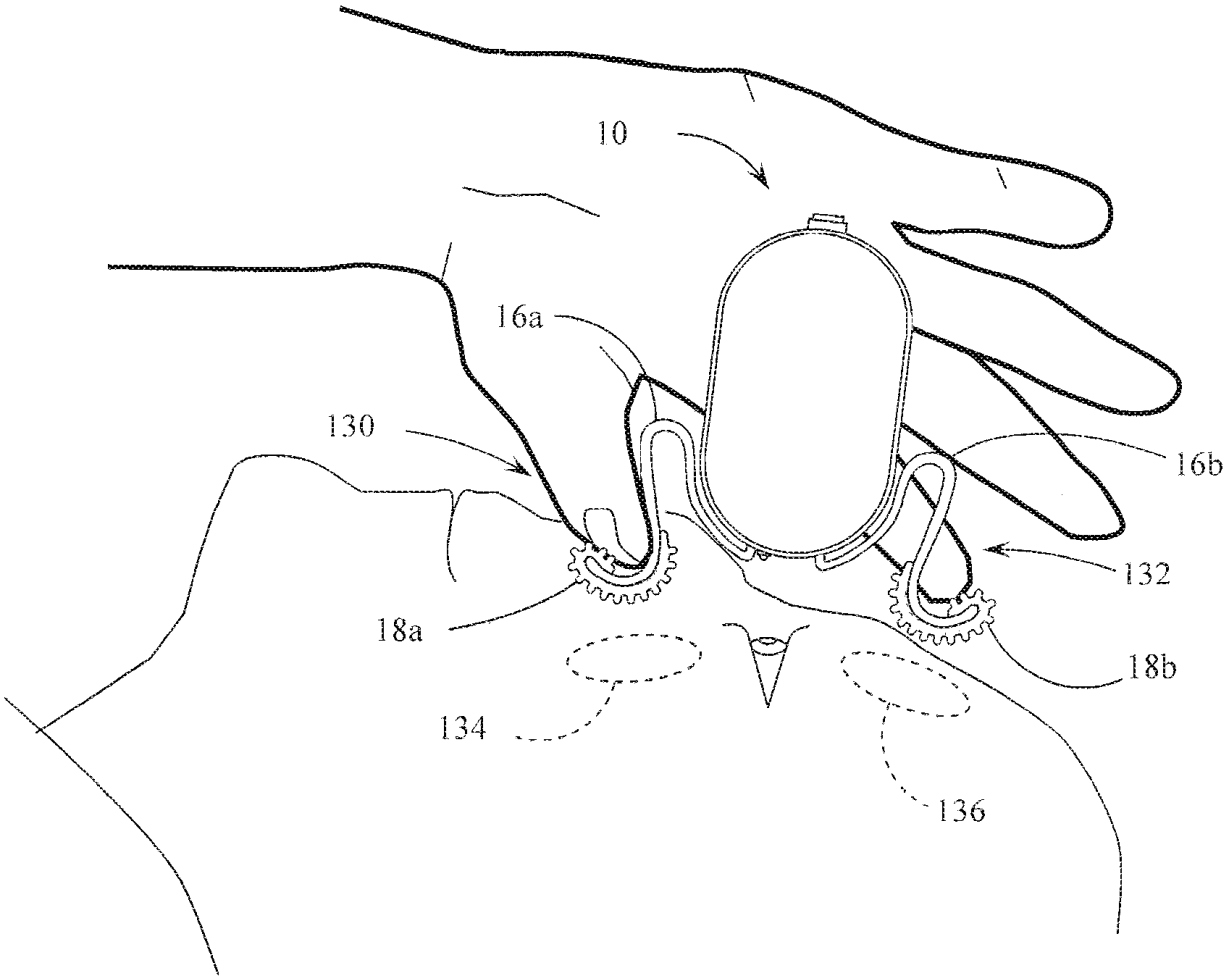



Fig. 12

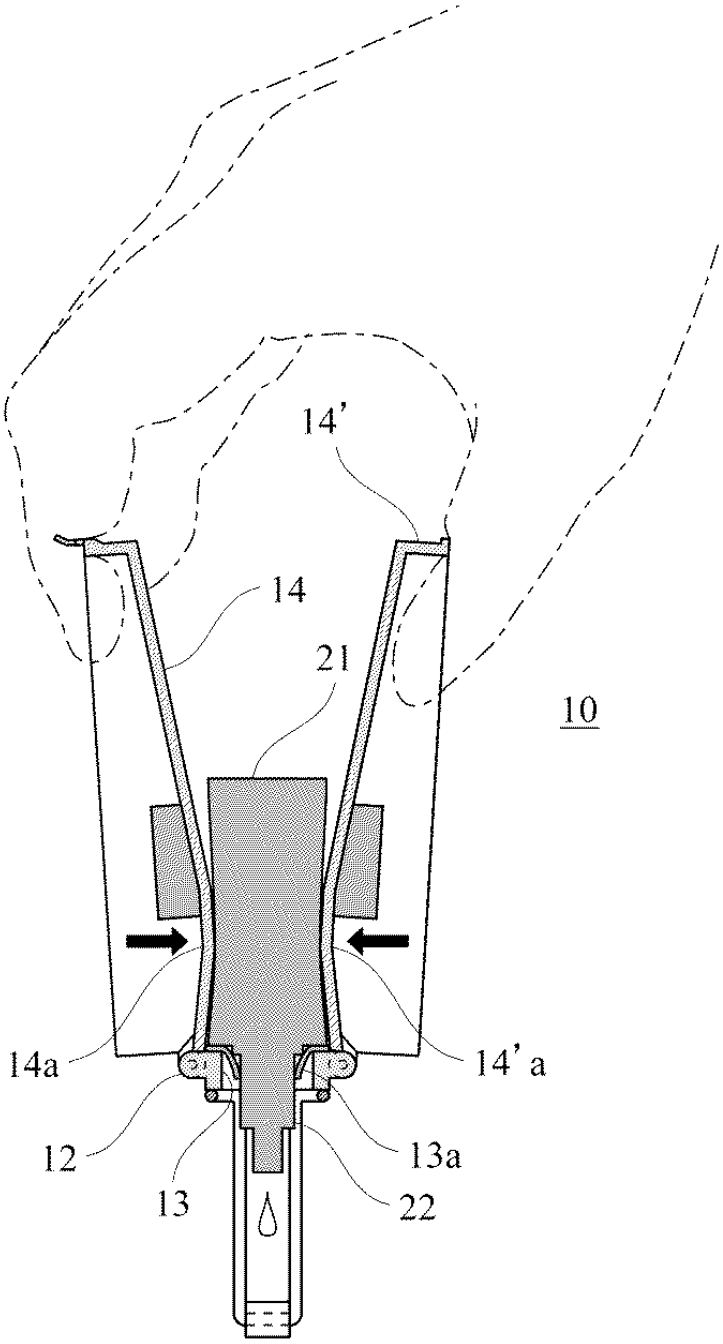
Citation:

Marx, Alvin J. *Bandolier Cartridge Sterile Eyedrop Delivery System with Eyelid Retracting Legs and Eyedrop Delivery Confirmation*. 24 Jan. 2017.

Eye drop aid

Patent : JP2019187540A - Japan

eye drop aid that facilitates fine eye drop operation, even for elderly, by the "principle of leverage" using a storage case as pressing means of a medical solution bottle, and enables force adjustment by the whole hand (palm) of which wraps it up




Citation:

Sullivan, Timothy R, and Jeffrey Nelson. *Unit Dose Drug Delivery Platform*. 12 Nov. 2013.

**Conclusions/action items:**

**All of these patents take a very different approach to either eliminating bottle tip contamination or administering only one dose of eye drops, however no device that is patented has shown to do both.**

# 2023/10/04 Anthropometry data for design measurements

ANABELLE OLSON (amolson27@wisc.edu) - Oct 11, 2023, 12:26 PM CDT

**Title: Anthropometry data used for design measurments**

**Date:** 2023/10/04

**Content by:** Anabelle Olson

**Goals:** To understand measurements of the face to be used for my designs

Citation:

Young, Joseph W. *Head and Face Anthropometry of Adult U.S. Civilians*. Federal Aviation Administration, Office of Aviation Medicine, 1993.

**Content:**

I am using the bizygomatic breadth measurement to figure out the length of the arms of the eye lash dropper device. The bizygomatic breadth is defined by this anthropometry resource as the greatest bilateral distance between the most lateral surfaces of the zygomatic arch, and is represented as number 12 in figure 9 below. I am dividing this measurement by two because my device is only on one side of the face. I am averageing the mean of the female and male measurement:

Female mean = 65.9 mm

Male mean = 70.3 mm

average = 68.1 mm

**FIGURE 9. FACE & HEAD MEASUREMENTS.**

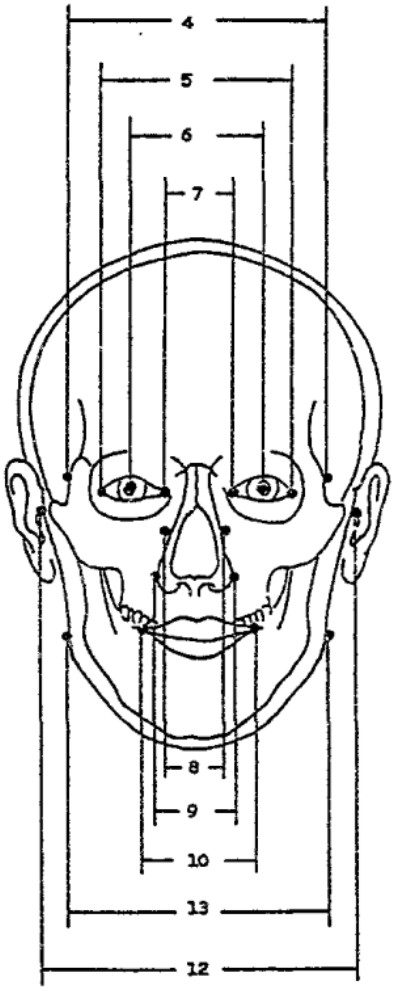
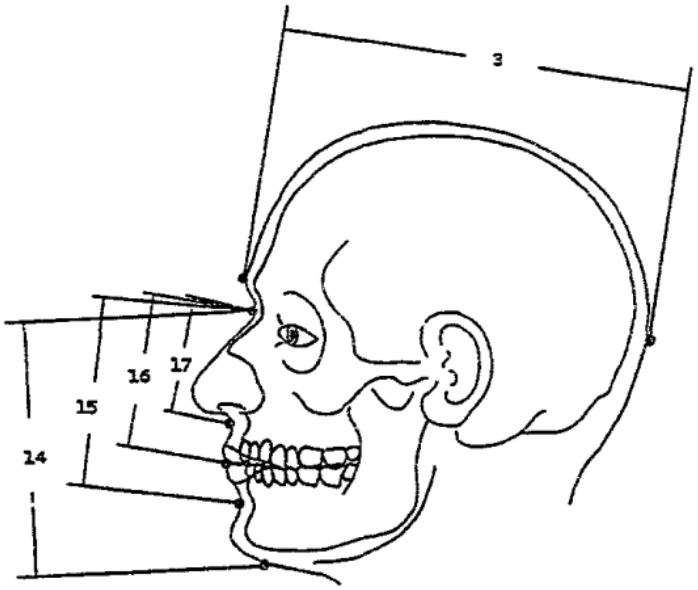



**FIGURE 10. FACE BREADTH MEASUREMENTS.**



## TABLE 13. BIZYGOMATIC BREADTH

### FEMALE

SUMMARY STATISTICS

| MILLIMETERS | | INCHES |
|---|---|---|
| 131.81 | MEAN | 5.18 |
| Ø.36 | STD ERROR(MEAN) | Ø.Ø1 |
| 5.Ø9 | STD DEVIATION | Ø.2Ø |
| 119.12 | MINIMUM | 4.68 |
| 148.Ø8 | MAXIMUM | 5.83 |
| COEFF. OF VARIATION(%) | | 3.85 |
| SYMMETRY | | Ø.12 |
| KURTOSIS | | 3.11 |
| NUMBER OF SUBJECTS | | 195 |

PERCENTILES

| MILLIMETERS | | INCHES |
|---|---|---|
| 119.89 | 1 ST | 4.72 |
| 122.94 | 5 TH | 4.84 |
| 124.97 | 1Ø TH | 4.92 |
| 128.Ø2 | 25 TH | 5.Ø4 |
| 132.Ø8 | 5Ø TH | 5.2Ø |
| 134.87 | 75 TH | 5.31 |
| 137.92 | 9Ø TH | 5.43 |
| 139.95 | 95 TH | 5.51 |
| 145.Ø3 | 99 TH | 5.71 |

### MALE

SUMMARY STATISTICS

| MILLIMETERS | | INCHES |
|---|---|---|
| 14Ø.67 | MEAN | 5.54 |
| Ø.46 | STD ERROR(MEAN) | Ø.Ø2 |
| 6.Ø2 | STD DEVIATION | Ø.24 |
| 125.98 | MINIMUM | 4.96 |
| 152.91 | MAXIMUM | 6.Ø2 |
| COEFF. OF VARIATION(%) | | 4.26 |
| SYMMETRY | | -Ø.Ø8 |
| KURTOSIS | | 2.53 |
| NUMBER OF SUBJECTS | | 171 |

PERCENTILES

| MILLIMETERS | | INCHES |
|---|---|---|
| 127.ØØ | 1 ST | 5.ØØ |
| 13Ø.Ø5 | 5 TH | 5.12 |
| 133.1Ø | 1Ø TH | 5.24 |
| 135.89 | 25 TH | 5.35 |
| 139.95 | 5Ø TH | 5.51 |
| 145.Ø3 | 75 TH | 5.71 |
| 149.1Ø | 9Ø TH | 5.87 |
| 15Ø.11 | 95 TH | 5.91 |
| 151.89 | 99 TH | 5.98 |

BIZYGOMATIC BREADTH: The greatest bilateral distance between the lateral cheek surfaces of the zygomatic arch (ZYGION landmarks).

Next, I am using the bipupil breadth to find the distance at which the eye drop bottle should be inserted in from the nose bridge. The bipupil breadth can be seen in figure 9 represented as number 6. The bipupil breath is defined as the bilateral distance between the right and left pupil centers of the eye when looking straight ahead. Since the measurement I need is only from the nose brdige to the pupil I will divided the means for each gender in half and then average them to find the distance to use for the design.

Female = 29.22 mm

Male = 30.7mm

average = about 30 mm

TABLE 7. BIPUPIL BREADTH

| FEMALE | | | MALE | | |
|---|---|---|---|---|---|
| SUMMARY STATISTICS | | | SUMMARY STATISTICS | | |
| MILLIMETERS | | INCHES | MILLIMETERS | | INCHES |
| 58.44 | MEAN | 2.30 | 61.39 | MEAN | 2.42 |
| 0.28 | STD ERROR(MEAN) | 0.01 | 0.36 | STD ERROR(MEAN) | 0.01 |
| 3.32 | STD DEVIATION | 0.13 | 3.63 | STD DEVIATION | 0.14 |
| 52.07 | MINIMUM | 2.05 | 54.99 | MINIMUM | 2.17 |
| 68.07 | MAXIMUM | 2.68 | 70.99 | MAXIMUM | 2.80 |
| COEFF. OF VARIATION(%) | | 5.66 | COEFF. OF VARIATION(%) | | 5.88 |
| SYMMETRY | | 0.50 | SYMMETRY | | 0.55 |
| KURTOSIS | | 2.85 | KURTOSIS | | 2.99 |
| NUMBER OF SUBJECTS | | 136 | NUMBER OF SUBJECTS | | 102 |
| PERCENTILES | | | PERCENTILES | | |
| MILLIMETERS | | INCHES | MILLIMETERS | | INCHES |
| 52.07 | 1 ST | 2.05 | 54.99 | 1 ST | 2.17 |
| 54.10 | 5 TH | 2.13 | 56.01 | 5 TH | 2.20 |
| 54.61 | 10 TH | 2.15 | 57.00 | 10 TH | 2.24 |
| 55.88 | 25 TH | 2.20 | 59.00 | 25 TH | 2.32 |
| 57.91 | 50 TH | 2.28 | 61.01 | 50 TH | 2.40 |
| 59.94 | 75 TH | 2.36 | 62.99 | 75 TH | 2.48 |
| 62.99 | 90 TH | 2.48 | 65.99 | 90 TH | 2.60 |
| 64.01 | 95 TH | 2.52 | 68.00 | 95 TH | 2.68 |
| 68.07 | 99 TH | 2.68 | 70.99 | 99 TH | 2.80 |

BIPUPIL BREADTH: The bilateral distance between the right and left pupil centers of the eyes when looking straight ahead.

Lastly, I need to determine a measurement for the height of the arms from the nose bridge rest. There are alot of important factors that need to be considered here, first being that the arms should be in line with the center of the squeezeable bottle part, to be able to squeeze the bottle most efficiently. This means that the second half of the squeezable part of the bottle and the tip part need to be below the arms on the eye side of the device. Therefore I am using the average sellion height from medial canthus plane line measurement to understand how high the nose bridge rest will be positioned in relation to the eye ball. This is represented as number 21 in figure 12.

Female average = 11.42mm

Male average = 12.87 mm

average = 12.1 mm

**FIGURE 12. NASAL BRIDGE HEIGHT MEASUREMENTS FROM REFERENCE PLANE LINES.**

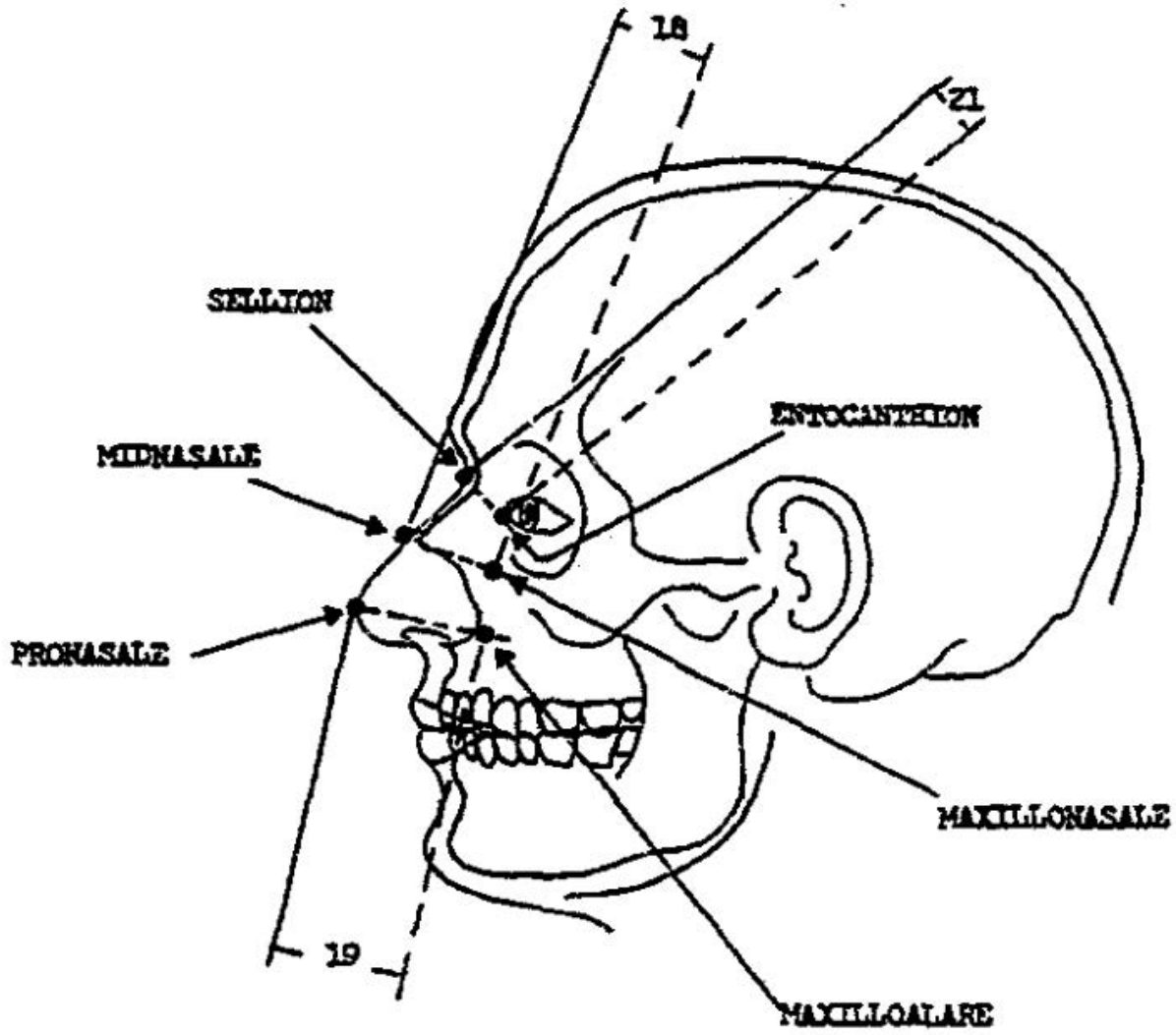


TABLE 22. SELLION HEIGHT FROM MEDIAL CANTHUS PLANE LINE

| FEMALE | | | MALE | | |
|---|---|---|---|---|---|
| SUMMARY STATISTICS | | | SUMMARY STATISTICS | | |
| MILLIMETERS | | INCHES | MILLIMETERS | | INCHES |
| 11.42 | MEAN | Ø.45 | 12.87 | MEAN | Ø.51 |
| Ø.28 | STD ERROR(MEAN) | Ø.Ø2 | Ø.31 | STD ERROR(MEAN) | Ø.31 |
| 3.13 | STD DEVIATION | Ø.12 | 3.21 | STD DEVIATION | Ø.13 |
| 6.1Ø | MINIMUM | Ø.24 | 7.ØØ | MINIMUM | Ø.28 |
| 22.1Ø | MAXIMUM | Ø.87 | 26.ØØ | MAXIMUM | 1.Ø2 |
| COEFF. OF VARIATION(%) | | 27.11 | COEFF. OF VARIATION(%) | | 24.85 |
| SYMMETRY | | Ø.48 | SYMMETRY | | Ø.88 |
| KURTOSIS | | 3.37 | KURTOSIS | | 4.93 |
| NUMBER OF SUBJECTS | | 121 | NUMBER OF SUBJECTS | | 111 |
| PERCENTILES | | | PERCENTILES | | |
| MILLIMETERS | | INCHES | MILLIMETERS | | INCHES |
| 6.1Ø | 1 ST | Ø.24 | 7.Ø1 | 1 ST | Ø.28 |
| 7.11 | 5 TH | Ø.28 | 8.ØØ | 5 TH | Ø.31 |
| 7.87 | 1Ø TH | Ø.31 | 8.99 | 1Ø TH | Ø.35 |
| 8.89 | 25 TH | Ø.35 | 11.ØØ | 25 TH | Ø.43 |
| 1Ø.92 | 5Ø TH | Ø.43 | 13.ØØ | 5Ø TH | Ø.51 |
| 13.97 | 75 TH | Ø.55 | 14.ØØ | 75 TH | O.55 |
| 14.99 | 9Ø TH | Ø.59 | 16.99 | 9Ø TH | Ø.67 |
| 16.ØØ | 95 TH | Ø.63 | 18.Ø1 | 95 TH | Ø.71 |
| 2Ø.Ø7 | 99 TH | Ø.79 | 23.Ø1 | 99 TH | Ø.91 |

SELLION HEIGHT FROM MEDIAL CANTHUS PLANE LINE: A perpendicular projection distance of the SELLION landmark away from a line coincident with both bilateral areas just medial of the ENTOCANTHION landmarks.

**Conclusions/action items:**

I used these two average measurements to determine the length of the arms of the eye lash dropper and the length between the nose bridge rest and the middle point of the insertion of the bottle to ensure that the bottle would hover over the eye in the correct spot.

# 2023/09/27- Eye Lash Dropper Design initial sketch

ANABELLE OLSON (amolson27@wisc.edu) - Oct 10, 2023, 8:41 PM CDT

**Title: Initial sketch for the eye lash dropper design**

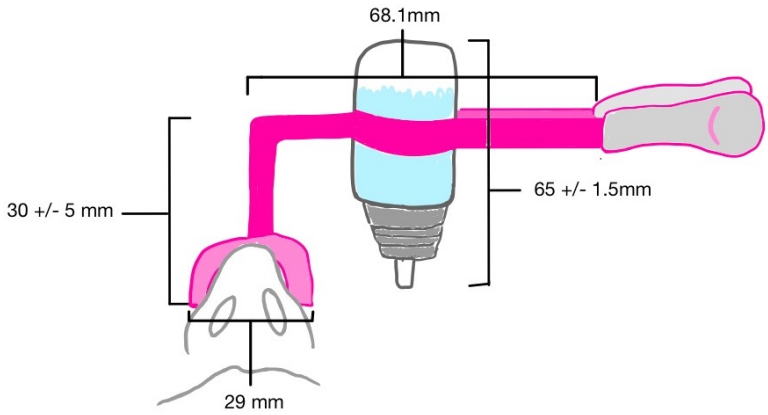
**Date:** 2023/09/27

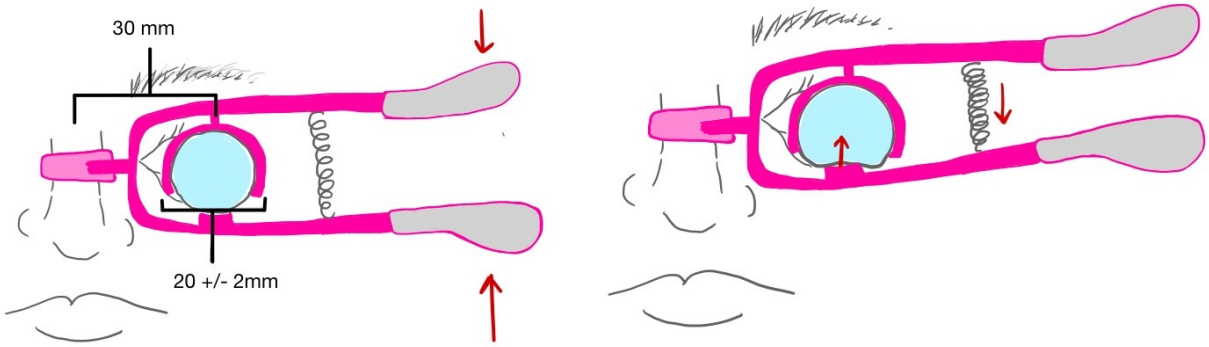
**Content by: Anabelle Olson**

**Goals:**

**Content:**

Our first design is the eye lash design which encompasses multiple components. The first component is the bridge rest, which allows the user to position this rest on their nose bridge and support the device in the correct position. The handles are inspired by the comfy handles on some eyelash curlers. These handles provide a larger surface area of grip than the eye drop bottle, allowing the user to use multiple fingers to squeeze the handles together.




**Conclusions/action items:**

The Eye Lash Dropper design contains four components to make the dispensing of an eye drop easier. First, the handles, which will be soft and shaped comfortably to fit the hand, provide a larger surface area to squeeze than the traditional dropper. The next component is the nose bridge rest. This rest provides support for the device and allows the user to position the device over their eye, such that the proper eye drop technique is used. The next component is the spring stopper mechanism, which will have a spring constant such that when the correct amount of force is applied to the handles, the spring will apply force against the user and the handles will separate. This ultimately ensures that only one drop of eye drop medication is dispensed, and the user does not willingly dispense too much. In the case that the medication dose requires two drops, the user will have to squeeze the handles a second time to dispense the second drop. This final component is the bottle insert, which can fit multiple bottle sizes, allowing this device to be more universal and reach a larger audience. Together, these components of the eye lash dropper design allow for ease and accuracy of eye drop administration.

# 2023/10/11 Big eye dropper design

ANABELLE OLSON (amolson27@wisc.edu) - Oct 11, 2023, 11:41 AM CDT

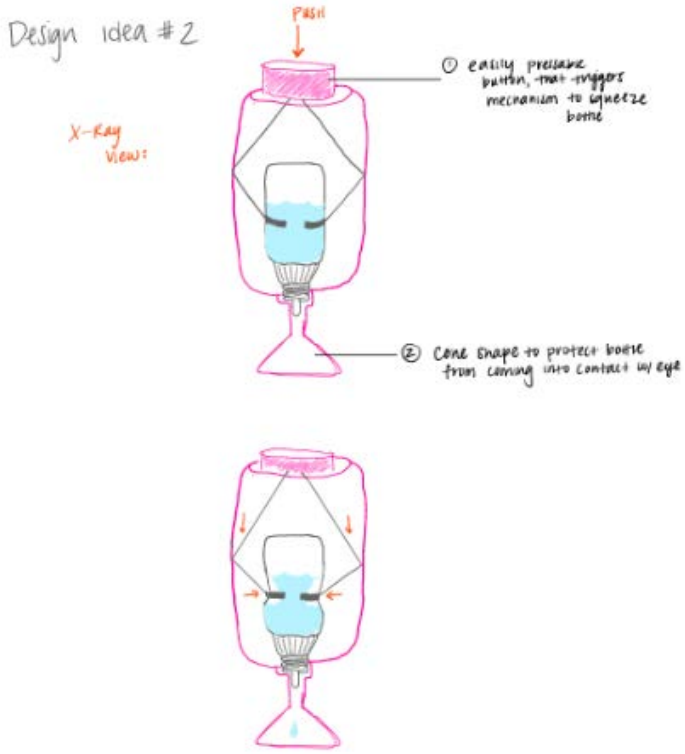
**Title: The big eye dropper design**

**Date:** 10/11/23

**Content by:** Anabelle Olson

**Goals:** explain my second design idea

**Content:**




**Conclusions/action items:**

This is my second design idea. The idea behind this design is that the eye dropper bottle is inserted into a larger device, that makes the surface area for grip much larger than the traditional eye drop bottle. Additionally, the stopper mechanism is the two arms inside of the device. when the top button is pushed, the two arms translate down and translate in to squeeze the bottle. These arms will only be permitted to translate down so far, to release only one drop. There is also a cone at the bottom of the design to prevent the possibility of tip of the bottle coming into contact with the eye ball. The downfall of this design is that it does not do anything to promote the proper eye drop technique.

# 2023/09/28 - Eye Drop Technique

EVA COUGHLIN - Sep 29, 2023, 1:12 PM CDT

**Title:** Proper Eye Drop Technique

**Date:** 2023/09/29

**Content by:** Eva Coughlin

**Goals:** Research the steps for properly administering eye drops.

**Sources:**

"How to put in Eye Drops," National Eye Institute, https://www.nei.nih.gov/Glaucoma/glaucoma-medicines/how-put-eye-drops (accessed Sep. 29, 2023).

**Content:**

- proper eye drop technique is essential for disease like glaucoma
  - if you don't use them correctly, you could lose your vision
- Steps to put in eye drops:
  - 1. Tilt your head back and look up
  - 2. With one hand, pull your lower eyelid down and away from your eyeball
  - 3. With the other hand, hold the eye drop bottle upside down with the tip above the pocket
  - 4. Squeeze the prescribed number of eye drops into the pocket
  - 5. For at least one minute, close your eye and press your finger lightly on your tear duct to prevent the eye drop from draining into your nose
- never touch the tip of the eye drop bottle with your hands and don't touch it to your eye
  - this helps prevent infection

**Conclusions/action items:** Understanding proper eye drop technique is essential for this project. The device must be compatible with this technique because it can be dangerous if the eye drops are delivered incorrectly. Some devices on the market deliver the drops directly to the center of the eye, which is incorrect. This is useful information for the preliminary design presentation.

# 2023/09/29 - Squeezing Force and Dispensing Time among Eyedropper Bottles

EVA COUGHLIN - Oct 04, 2023, 5:54 PM CDT

**Title:** Wide Variation of Squeezing Force and Dispensing Time Interval among Eyedropper Bottles

**Date:** 2023/10/03

**Content by:** Eva Coughlin

**Goals:** To better understand how the squeezing force of an eye dropper bottle changes as the solution in the bottle decreases.

**Source:** K. Kashiwagi, “Wide variation of squeezing force and dispensing time interval among Eyedropper bottles,” Journal of Ophthalmology, https://www.hindawi.com/journals/joph/2019/7250563/ (accessed Oct. 4, 2023).

**Content:**

Intro

- eye drop administration requires one drop of solution placed in the conjunctival sac
- problems with eye drop administration:
    - eye drops don't enter conjunctival sac properly (improper technique)
        - Solomon et al. demonstrated that up to 80% of patients use an incorrect technique
    - multiple eye drops are dropped into the eye (waste --> leads to increasing cost for more drops and decreased therapeutic efficacy)
    - bottle tip makes contact with surface of eye/eyelashes (bacterial contamination)
- many patients do not have necessary squeezing power for proper eye drop administration

Methods

- squeezing force measuring system: syringe pump, digital force gauge, test stand
- syringe pump used to apply constant pressure to eyedropper bottle, mimicking squeezing
- sensor was centered on eyedropper bottle
- applied 0.5 mm/sec displacement speed (similar to patient speed in preliminary experiment)
- recorded squeezing force for first and second eye drop and time interval between the drops
- used ANOVA test for analysis

Results & Discussion

- 86 total eye dropper bottles, most commonly for glaucoma
    - 53 of the bottles were round shaped
- some bottles had built in filter membranes
    - squeezing forces of first and second drops were significantly greater with filter membrane compared to without filter membrane
- Without filter membranes: first drop - mean squeezing force was 8.3 +/- 3.0 N, second drop - mean squeezing force was 10.4 +/- 3.2 N
    - second drop requires significantly more squeezing force
    - mean time interval between drops was 3.1 +/- 1.2 seconds
- round-shaped eyedroppers required much greater squeezing force for the first drop than square-shaped/other shaped bottles

Discussion

- 40% of patients in the study had maximum pinch strength lower than the ne essary maximum squeezing force of the eyedropper bottles
    - patients experienced difficulty and uncomfortableness
- 10 out of the 87 eyedropper bottles required 14.7 N+ squeezing force (contained filter membranes)
- volume of conjunctival sac is about 20 microliters
    - one eye drop is sufficient
- 22% of paitnets adminsiterd two or more eye drops in an attempt
- factors influencing squeezing force: viscosity of solution, surface tension of solution, design of eyedropper tip, shape of eyedropper bottles, tilting angle of eyedropper bottles, **remaining amount of eye drops in bottles**
- single-dose containers are becoming more popular but may be more difficult to handle because they're smaller

**Conclusions/action items:** There is a large variation of squeezing force among eyedropper bottles and several factors affect this force. The older the patient is, the more difficult it is for them to administer their eye drops with proper technique while preventing eye drop waste.  I predict that this concept will be one of the greatest difficulties with our project as we need our device to administer one drop, despite the shape of the bottle and the amount of solution in the bottle. I think this information will be necessary to refer to while we are in the fabrication and testing process.

# 2023/10/03 - Contamination of the Dropper Tip and Cap of In-Use Eye Drops

EVA COUGHLIN - Oct 10, 2023, 1:58 PM CDT

**Title:** Highlighting the Microbial Contamination of the Dropper Tip and Cap of In-Use Eye Drops

**Date:** 2023/10/4

**Content by:** Eva Coughlin

**Sources:**

K. Iskandar, L. Marchin, L. Kodjikian, M. Rocher, and C. Roques, “Highlighting the microbial contamination of the dropper tip and cap of in-use eye drops, the associated contributory factors, and the risk of infection: A past-30-years literature review,” Pharmaceutics, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9611205/.

**Goals:** To learn about the causes and effects of eye drop contamination on patients.

**Content:**

- eye drops are sterile topical ophthalmic formulations
    - account for 90% of marketed ophthalmic solutions
- handleability of eye drops may pose an important risk of microbial contamination
- potential causes of microbial contamination at the dropper tip: squeezability, missing the eye during instillation, variable duration of use, improper administration techniques, and age-related physical difficulties
- contact of the dropper tip and eye or ocular annexes leads to microbial contamination
- studies were performed worldwide, including both high-income and low-income countries
- overall 29% microbial contamination in eye drop bottles used by patients for at least two months
- for glaucoma medications, the rate of bacterial contamination was 28% for at least three months of use
- microbial contamination for eye drops used for less than four weeks: 19% and microbial contamination for eye drops used for more than 12 weeks: 40%
- gram-positive bacteria (GPB) were the only type of bacteria isolated from the drops, residual contents, and dropper tips
- a contaminated dropper tip can come in contact with the ocular surface, eyelids, and eyelashes during instillation of eye drops
    - primarily occurs in the elderly
- eye dropper tip is source of ocular infections and eye injuries

**Conclusions/action items:** Contamination of the eye dropper tip and cap is prevalent and dangerous for patients. Improper eye drop administration technique and age-related physical difficulties increase the risk of contamination. This contamination is caused by the eye drop bottle contacting any parts of the eye and surrounding facial area. Our device must ensure that the eye drop bottle does not come in contact with the patient's eye or face in order to minimize contamination risk.

# 2023/10/10 - How to Instill Eye Drops and Avoid Contamination

EVA COUGHLIN - Oct 10, 2023, 11:21 PM CDT

**Title:** How to Instill Eye Drops and Avoid Contamination

**Date:** 2023/10/10

**Content by:** Eva Coughlin

**Sources:**

> C. Karen Bachman, “How to instill eye drops and avoid contamination,” Optometry Times, https://www.optometrytimes.com/view/how-instill-eye-drops-and-avoid-contamination.

**Goals:** To learn more about contamination risk in eye drop administration and obtain ideas for how to avoid it.

**Content:**

Steps for Eye Drop Administration:

1. Position the patient in a sitting position with head tilted back.

2. Remove the cap from the bottle and hold dropper over the eye.

3. Ask the patient to look up while gently pulling down the lower lid.

4. Squeeze the dropper to release one drop into the lower cul-de-sac and avoid applying pressure to the globe.

5. Release the eyelid and have patient close their eye for 30 seconds to contain the drop.

- having the patient close their eye after administering the eye drop helps ensure even distribution of the medication
  - blinking causes the medication to clear which we don't want
- placing more than one drop is a waste of solution
  - total capacity of the cul-de-sac is 1/6 of a drop
- do not touch the dropper to the conjunctiva, eyeball, eyelid, eyelashes or face
  - if contact is made, the bottle is contaminated and should be disposed of
- it is important that healthcare providers instruct the patient on eye drop administration, so it is done properly
- 30% of patients miss their eye by dropping the solution on their eyelids or cheeks
- over 70% of patients touch the tip of the eye drop bottle to their eyelashes
- 25% of patients comply with closing their eyes after instillation to allow distribution of the drop
- many patients squeeze out up to eight drops instead of one with each instillation
- physical impairments such as tremors or arthritis may impact patient compliance with proper eye drop administration technique

**Conclusions/action items:** The key takeaway from this article is that teaching the patient the proper technique is necessary for proper eye drop administration. For example, I didn't know that the patient should keep their eye closed for 30 seconds after for even distribution. Learning that the cul-de-sac is only 1/6 of a drop emphasizes the fact that our device needs to ensure only one drop of solution is released. This article provided useful statistics on eye drop waste and contamination.

# 2023/10/11 - Beta-Blocker-Induced Complications and the Patient with Glaucoma

EVA COUGHLIN - Oct 11, 2023, 4:23 PM CDT

**Title:** Beta-Blocker-Induced Complications and the Patient with Glaucoma

**Date:** 2023/10/11

**Content by:** Eva Coughlin

**Source:**

> W. C. Stewart and P. M. Garrison, “β-Blocker–Induced Complications and the Patient With Glaucoma,” JAMA Network , https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/191336.

**Goals:** Our client told us that if patients drop glaucoma medications directly in the center of their eye it can cause drops in blood pressure, so I want to look into why this happens.

**Content:**

- glaucoma is optic nerve degeneration that deteriorates vision and may lead to blindness
- more than 1 million Americans are being treated for glaucoma and 80000 are legally blind because of it
    - 3% in those between the ages of 70 and 80 years and more than 9% in those older than 80 years
- glaucoma eye drops are topical beta-adrenergic antagonists that reduce aqueous humor formation
- topical medication may enter the systemic circulation via the nasolacrimal ducts, where it can be absorbed through the nasal, oropharyngeal, and gastrointestinal mucosa
- small amounts of systemically absorbed beta-blockers can produce significant adverse effects
    - topical timolol maleate therapy was suspected of contributing 32 deaths within 7 years of initial production
- cardiovascular effects: case reports relate the use of topical beta-blockers to syncope, bradycardia, systemic hypotension, palpitation, arrhythmia, and heart block
    - reduce maximum tachycardia and cardiac output
    - reduced oxygen uptake and decreased exercise tolerance
    - peripheral vasodilation
- CNS and endocrine effects: beta-blockers can cross the blood-brain barrier and inhibit central beta-receptors, can block serotonin receptors
    - adverse effects: depression, fatigue, weakness, confusion, memory loss, headaches, and anxiety
- pulmonary effects: has been associated with worsening of reactive airway disease and bronchitis

**Conclusions/action items:** Glaucoma eye drops are beta-adrenergic antagonists and if they are systemically absorbed, they can be dangerous. For example, they can cause hypotension (low blood pressure), potentially resulting in syncope. These eye drops are absorbed systemically via the nasolacrimal ducts (tear ducts). If the patient administers their eye drops correctly into the conjunctival sac of their eye, they won't enter the tear ducts.

# 2023/09/13 GentleDrop Eye Drop Guide

EVA COUGHLIN - Sep 13, 2023, 9:56 PM CDT

**Title:** GentleDrop Eye Drop Guide

**Date:** 9/13/2023

**Content by:** Eva Coughlin

**Goals:** To research other eye drop guides on the market.

**Sources:**

“A revolutionary new way to use your eye drops,” GentleDrop, https://www.dropbetter.com/ (accessed Sep. 13, 2023).

**Content:**



- the device is called GentleDrop and is designed to rest on the patient's nose
- made of non-toxic silicone
- optimizes bottle position
- reduces trauma and improves hygiene
- compatible with cylindrical bottles of 5, 10, and 15 mL sizes
- not compatible with less than 5 mL bottles, irregular shaped bottles, or preservative free drops
- a study of 50 glaucoma patients was performed to determine patient satisfaction with GentleDrop:

    - reduces the average number of drops used from 2.2 to 1.7 per eye
    - 46% reduction of eye trauma (eye drop bottle touching the eyes and eyelid)
    - 49/50 patients felt it was comfortable to use
- Dr. Robert Kinast and Dr. Ashley Hayden created Gentle Drop
    - these doctors have encountered many patients who struggle to put in their eye drops at home and that was their motivation behind designing this product
- advertised to help assist glaucoma patients in administering their eye drops as well as post-op patients who struggle with post procedure medications
- cost = $15 excluding sales tax
- How to use GentleDrop (as advertised on their website):
    - 1. Lie flat
    - 2. Insert the bottle into the GentleDrop sleeve
    - 3. Remove cap
    - 4. Squeeze bottle or the bottom edge of GentleDrop to deliver eye drop

**Conclusions/action items:** GentleDrop is a low cost device created by physicians to ease the administration of eye drops. The physicians who created GentleDrop did clinical research to assess the effectiveness of GentleDrop and patient feedback was positive. This device seems like it fulfills the requirement of making it easier to administer eye drops, but it does not ensure that the eye drops are consistent in size. One of our client's requests was to ensure that a single drop of eye drop solution is administered with every squeeze, so I think this would be a way to make our device stand out compared to this competing design.

# 2023/09/13 "Droppy" Eye Drop Dispenser

EVA COUGHLIN - Sep 29, 2023, 12:21 PM CDT

**Title:** Droppy Eye Drop Dispenser

**Date:** 2023/09/13

**Content by:** Eva Coughlin

**Goals:** To explore various eye drop dispensers on the market and determine their strengths and shortcomings.

**Sources:**

Amazon.com: Droppy eye drop dispenser : Health & Household, https://www.amazon.com/Universal-Eye-Drop-Dispenser-Droppy/dp/B07RLYHT4N (accessed Sep. 14, 2023).

**Content:**

- Product description: Droppy comes with two clamps and a pipette module. Droppy is easy to assemble and use with most dropper bottles. However, Droppy does not fit bottles with flat noses or Hylo Care bottles.
- advertisements from the company:
    - applies eyedrops easily and precisely
    - clamps with ergonomic grip for easier use of bottles
    - great for arthritis and dexterity issues
    - pinhole reduces chance of blinking
- reusable and hand wash only
- rated 3.4 stars for ease of use
- only fits one bottle size
- some reviews say that the device didn't line up correctly with their eye
- reviews complaining that the device requires assembly with multiple components


**Conclusions/action items:** The concept of the Droppy eye drop dispenser seems reasonable. Disadvantages are that it isn't compatible with all bottle sizes and requires assembly. We could create a device that has a similar concept with the handles but is adjustable and is already assembled for customers. I am going to look into more devices online that are patented.

# 2023/10/10 Peermax Eye Drop Guides

EVA COUGHLIN - Oct 10, 2023, 11:12 PM CDT

**Title:** Peermax Eye Drop Guides

**Date:** 2023/10/10

**Content by:** Eva Coughlin

**Sources:**

[1] “Eyedrop guides,” Peermax, https://peermaxcare.com/collections/eyedrops-guides.

[2] Amazon.com: Peermax Eye Drop Aid, autosqueeze eye drop Bottle Squeezer ..., https://www.amazon.com/Peermax-AutoSqueeze-Squeezer-Microfiber-Cleaning/dp/B09K4KV33G.

[3] A. D. SAVAGE, “Peermax Drop Direct Eye Drop Dispenser,” Amazon, https://www.amazon.com/dp/B096HKFHSS/ref=emc_b_5_t.

[4] A. D. SAVAGE, “Peermax Drop Right 2 in 1,” Amazon, https://www.amazon.com/dp/B08HR5MBF9/ref=emc_b_5_t.

[5] A. D. SAVAGE, “Peermax Eye Drop Guide,” Amazon, https://www.amazon.com/dp/B09K4JMGTH/ref=emc_b_5_t.

**Goals:** To explore various eye drop assistant devices on the market, focusing on their downfalls.

**Content:**


- Peermax advertises several eye drop guides for inserting eyedrops "more easily and quickly"
- **AutoSqueeze** is described as "ideal for those who have arthritis and struggle to squeeze their eye drop bottle" and "easy to place on the bottle and now the patient can squeeze the eye drops themselves"
    - made of plastic
    - $13.99
    - 4.3 out of 5 stars on Amazon Reviews
        - Example of 5 star review: "I got this for my 80 year old mother to put glaucoma drops in her eyes. Before, she was wasting more drops than she was getting in her eyes. Great for someone that has limited strength in their hands and coordination."
        - Example of 3 star review stated that the device helped her mother administer the eye drops, but is overpriced. The reviewer wrote, "What a same some companies appear to take advantage of the elderly and handicapped by overpricing their products just because they can."
- **Drop Direct** "holds the eye open to prevent blinking, ensuring accurate placement of the medication with less spilling"
    - made of plastic
    - $14.99
    - 3 out of 5 stars on Amazon reviews
        - Example of 5 star review: "This is saving me a lot of wasted eye drops that did not get into my eye. Eye drops are expensive so it is saving me some money."
        - Example of 1 star review: "...parts do not stay together in order to function properly. In addition even the smallest eye drop bottles do not fit within the canister itself.
- **Drop Right**: "2 in 1, converts the eye drop guide into an eyewash cup", insert the yellow plug supplied to convert the eye drop guide into an eye wash cup
    - holds the eye open to prevent blinking
    - made of silicone
    - $13.99

    - 3.7 out of 5 stars on Amazon reviews
        - Example of 5 star review: "...only have to do it one time and the drop goes right in my eye...I recommend this for anybody who has trouble getting eyedrops in their eyes."
        - Example of 1 star review: "I could not get the cup to fit over my eye tight enough to make the drops go in just right! Missed my eye at times so just gave up!"
- **AutoDrop**: clips onto most eye drop bottles, holds bottle at correct angle over eye, special cup prevents blinking by keeping lower eyelid open, pinhole directs eyesight upwards and away from descending drops
    - made from polypropylene, easy for cleaning
    - $13.99
    - 3.4 out of 5 stars on Amazon reviews
        - Example of 5 star review: "allows me to drop the right amount of drops in my eye"
        - Example of 1 star review: "Not operator friendly to use, the home health aid could not get this item to work properly consistently. Much waisted eye drops."

**Conclusions/action items:** The Peermax company supplies several different eye drop assistant devices. The AutoSqueeze was the device with the highest ratings, and it resembles the Droppy eye dropper by widening the grip for squeezing the eye drop bottles. A few of these devices make contact with the patients eye and surrounding face, which is something we are definitely going to avoid. With all of these competing designs, the team will need to work hard to make our device novel and unique.

# 2023/10/26 - Applying Human Factors and Usability Engineering to Medical Devices

**Title:** Applying Human Factors and Usability Engineering to Medical Devices

**Date:** 2023/10/26

**Content by:** Eva Coughlin

**Source:**

> "Applying Human Factors and Usability Engineering to Medical Devices," U.S. Department of Health and Human Services, https://open.fda.gov/apis/downloads/.

**Goals:** To better understand FDA standards for human testing and medical devices.

**Content:**

- focus of human factors engineering (HFE) and usability engineering (UE): understand how people interact with technology and study how user interface design affects the interactions people have with technology
- human factors considerations: device users, device use environments, and device user interfaces
- use-related hazard examples:
    - device use is inconsistent with the user's expectations about the device operation
    - device use requires physical, perceptual, or cognitive abilities that exceed the abilities of the user
    - the use environment affects operation of the device and this effect is not recognized or understood by the user
- steps for performing successful **HFE/UE analysis**:
    - 1. identify anticipated use-related hazards and initially unanticipated use-related hazards and determine how hazardous use situations occur
    - 2. develop and apply measures to eliminate or reduce use-related hazards that could result in harm to the patient or the user
    - 3. demonstrate whether the final device user interface design supports safe and effective use by conducting human factors validation testing
- **simulated-use testing**: study users interacting with the device user interface and performing actual tasks
    - collection of data from test participants using a device, device component or system in realistic use scenarios but under simulated conditions of use
        - ex: device is used on a manikin rather than an actual patient
    - allows participants to use the device more independently and naturally
    - data can be obtained by observing participants interacting with the device and interviewing them
    - participants can be asked questions or encouraged to "think aloud" while they use the device
    - participants should be interviewed after using the device to obtain their perspectives on device use, particularly related to any use problems that occurred
    - observation data collection can include instances of hesitation or confusion
- **elimination or reduction of use-related hazards**: should be identified through preliminary analyses and evaluations
    - these haxards should be controlled through elimation or reduction in the likelihood or reduction in the severity of resulting harm before human factors validation testing
    - risk management options: (1) inherent safety by design, (2) protective measures in the medical device itself or in the manufacturing process, (3) information for safety
- **human factors validation testing**: demonstrate that the device can be used by intended users without serious problems
    - test participants should represent the intended users of the device
    - all critical task are performed during the test
    - the device user interface represents the final design
    - test conditions are sufficiently realistic to represent actual conditions of use

**Conclusions/action items:** This document was educational in regards to human factors engineering and usability engineering. I learned that there are several different protocols in regards to testing and a particular order in which these different testing methods should be performed. This is helpful as the team is applying for an IRB and will be performing human testing with the residents of the retirement community that the client works at. I believe the testing we are planning on doing at the retirement community will be simulated-use testing, and we will use the interview and observation strategies discussed in this document.

# 2023/11/15 - Ophthalmic Products: Quality Test

**Title:** Ophthalmic Products: Quality Tests

**Date:** 2023/11/15

**Content by:** Eva Coughlin

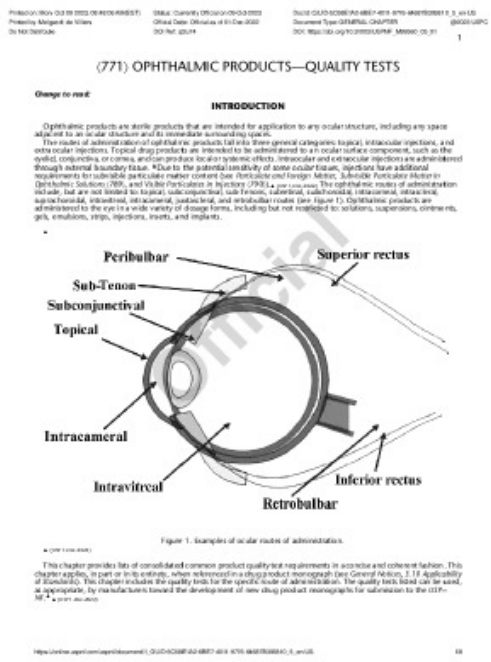
**Goals:** To better understand regulations regarding ophthalmic products.

**Content:**

- ophthalmic products: sterile products intended for application to any ocular strcuture
- three routes of administration: (1) topical, (2) intraocular injections, (3) extraocular injections
    - topical: administered to eyelid, conjunctiva, or cornea
    - intraocular and extraocular: administered through external boundary tissue
- ophthalmic routes of administration: suprachoroidal, intravitreal, intracameral, juxtascleral, and retrobulbar
- opthalmic products: solutions, suspensions, ointments, gels, emulsions, strips, injections, inserts, and implants
    - eye drops are an example of a suspension
- multi-dose products must contain a suitable antimicrobial preservative and the effectiveness of the preservative over the shelf life of the product must be verified
- information specific to ophthalmic solutions:
    - corneal contact time of topical ophthalmic solutions increases with the viscosity of the formulations
        - viscosity enhancers such as polyvinyl alcohol, polyethylene glycol (PEG), poly(acrylic acid), and other synthetic polymers are used
    - also can increase corneal contact time via liquid formulation with semisolid consistency when the solution is placed in the conjunctival or corneal area
        - viscoelastic properties
        - formed hydrogel: 3D networks of polymer chains containing water, can be physically or chemically crosslinked
        - water content of hydrogels can be adjusted by degree of crosslinking and composition of polymers
- information specific to ophthalmic suspensions:
    - after topical instillation, particles are retained in the cul-de-sac and the drug slowly dissolves or is released from the polymeric structures by diffusion, dissolution, polymer degradation, or ion-exchange
- quality tests: assess the integrity of the dosage form vs. performance tests: ensure the identity, strength, quality, purity, and efficacy of the drug product
- quality tests are broken down into two subcategories: universal tests and specific tests
- universal tests: applicable to all ophthalmic products regardless of the dosage form type
    - description: must include clarity and color of dosage form
    - identification
    - assay: determine strength of the drug product
    - impurities:
    - pH: normal tears = pH of 7.4, eye can tolerate products pH 3.0-8.6, depending on buffering capacity
    - osmolarity: hypotonic solutions are better tolerated than hypertonic solutions
    - particulate and foreign matter
    - sterility
    - antimicrobial preservatives
    - bacterial endotoxins
- specific tests:
    - viscosity: increase in viscosity increases residence time of ocular formulations
    - antioxidant content
    - resuspendability
    - particle size
    - drop size:
        - may typically range from 20-70 µL
        - can be controlled by weight or by volume and is evaluated during product development

**Conclusions/action items:** There are several different routes of ophthalmic administration and ophthalmic product forms. Eye drops are an example of an ophthalmic suspension. Eye drops are retained in the cul-de-sac of the eye and the drug slowly diffuses into the eye. The recommended eye drop size is 20-70 µL.

EVA COUGHLIN - Dec 11, 2023, 10:31 AM CST



⟨771⟩ OPHTHALMIC PRODUCTS—QUALITY TESTS

Change to read:

**INTRODUCTION**

Ophthalmic products are sterile products that are intended for application to any ocular structure, including any space adjacent to an ocular structure and its immediate surrounding spaces.

The routes of administration of ophthalmic products fall into three general categories: topical, intraocular injections, and extra ocular injections. Topical drug products are intended to be administered to an ocular surface component, such as the eyelid, conjunctiva, or cornea, and can produce local or systemic effects. Intraocular and extraocular injections are administered through external boundary tissue. *Due to the potential sensitivity of some ocular tissues, injections have additional requirements for subvisible particulate matter content (see *Particulate and Foreign Matter, Subvisible Particulate Matter in Ophthalmic Solutions* ⟨789⟩, and *Visible Particulates in Injections* ⟨790⟩).▲ The ophthalmic routes of administration include, but are not limited to: topical, subconjunctival, sub-Tenon, subretinal, suprachoroidal, intracameral, intravitreal, suprachoroidal, intracameral, juxtascleral, and retrobulbar routes (see Figure 1). Ophthalmic products are administered to the eye in a wide variety of dosage forms, including but not restricted to: solutions, suspensions, ointments, gels, emulsions, strips, injections, inserts, and implants.




Figure 1. Examples of ocular routes of administration.

This chapter provides lists of consolidated common product quality test requirements in a concise and coherent fashion. This chapter applies, in part or in its entirety, when referenced in a drug product monograph (see *General Notices*, 3.10 *Applicability of Standards*). This chapter includes the quality tests for the specific route of administration. The quality tests listed can be used, as appropriate, by manufacturers toward the development of new drug product monographs for submission to the USP–NF.▲

[Download]

**GUID-5C58E1A2-6BE7-4011-9776-64687B306810_5_en-US.pdf (512 kB)**

# 2023/09/27 The Butterfly - Individual Design #1

EVA COUGHLIN - Oct 11, 2023, 5:59 PM CDT

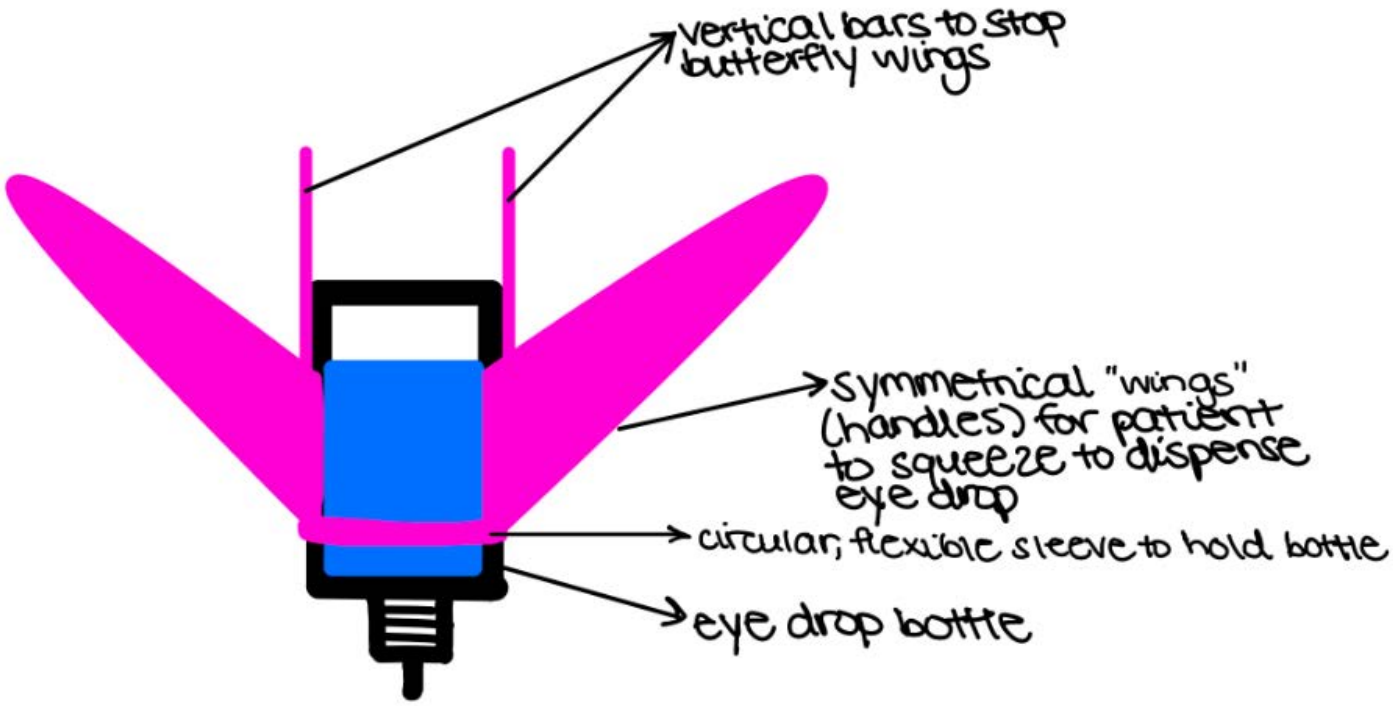
**Title:** The Butterfly

**Date:** 2023/09/27

**Content by:** Eva Coughlin

**Goals:** To design a device that widens the grip in the y-plane compared to the traditional eye drop bottle.

**Content:**




**Conclusions/action items:** The butterfly design is named after the two flapping handles which mimic two wings. This device increases the leverage and would be functional, however it isn't very innovative. It's similar to the Droppy eye drop dispenser, but it will incorporate a stopper that ensures only a single drop is dispensed. I think that I could come up with a more unique design than this.

# 2023/09/27 The Pliers - Individual Design #2

EVA COUGHLIN - Oct 11, 2023, 6:17 PM CDT

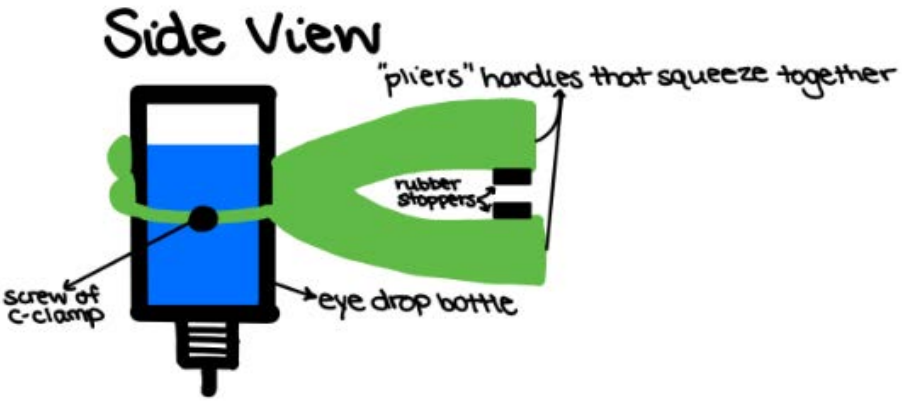
**Title:** The Pliers

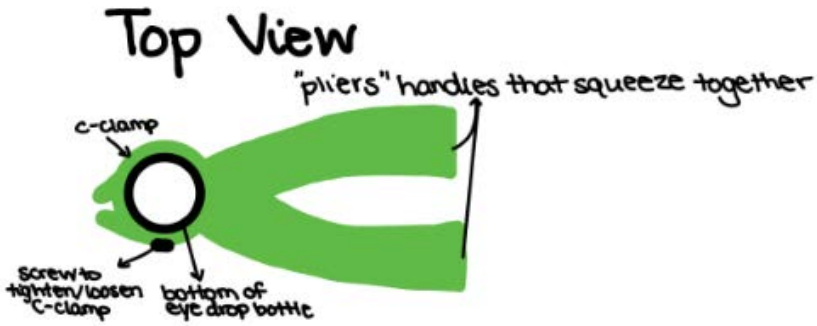
**Date:** 2023/09/27

**Content by:** Eva Coughlin

**Goals:** To design a device that increases the grip in the x-plane compared to the traditional eye drop bottle for those with reduced dexterity.

**Content:**




**Conclusions/action items:** The Pliers design is named after the fact that it mimics an actual pliers and is intuitive for patients to squeeze. The wider grip will increase the squeezing force capability for patients. There is a stopper between the pliers handles, so that the patient dispenses a consistent dose of medication with every squeeze. The biggest disadvantage to this design is that it incorporates a c-clamp, and it would be difficult for people with reduced dexterity to tighten and loosen the screw.

# 20 SEP 2023 - How to Properly Administer Eye drops

TEVIS LINSER - Oct 04, 2023, 11:30 AM CDT

**Title:** American Academy Of Ophthalmology eye drop administration method

**Date:** 9/20/2023

**Content by:** Tevis Linser

**Goals:** To explore eye drop administration and come up with a solid set of design specs

**Content:**

The source gives a detailed list of items to follow when administering eye drops;

- Tilt your head back slightly and look up. Some people find it helpful to focus on a specific point on the ceiling. It might help to tape a photo or clipping from a magazine to the ceiling, so that your eyes can focus on it.
- Use one hand to pull your lower eyelid down, away from the eye. This forms a pocket to catch the drop.
- Hold the dropper tip directly over the eyelid pocket.
- Don’t touch the bottle to your eye or eyelid. This can give bacteria or other contaminants a chance to grow in your eye drops.
- Squeeze the bottle gently and let the eye drop fall into the pocket.

This list follows what our client describes as proper eye drop administration technique.

**Citation:**

[ ] “How to Put in Eye Drops,” *American Academy of Ophthalmology*, May 05, 2023. https://www.aao.org/eye-health/treatments/how-to-put-in-eye-drops (accessed Sep. 20, 2023).

**Conclusions/action items:**

Our device needs to be compatible with these steps.

Action:

Share this with the team and double check the validity of this source with the client.

# 20 SEP 2023 - Motivation for project

**Title:** Current state of glaucoma eye drop administration and success, cost associated with taking latanoprost

**Date:** 9/20/2023

**Content by:** Tevis Linser

**Goals:** To explore why this device is truly needed

**Content:**

1. Between 18.2 and 80% of patients contaminate their eye drop bottle by touching their eye or face [1]
2. 11.3–60.6% do not instill exactly one drop [1]
3. 6.8–37.3% miss the eye with the drop [1]
4. Glaucoma affects over two million Americans, and about one-sixth of cases eventually result in blindness [1]
5. The average wholesale price is $142.90 for Pfizer's branded latanoprost (the drug that treats glaucoma), $19.44 for Akorn, $24.38 for Bausch & Lomb, and $95.00 for Sandoz.
6. Estimated cost per year for patients on latanoprost [2]

| Variable | Manufacturer | | | | *P* Value |
|---|---|---|---|---|---|
| | Pfizer | Akorn | Bausch & Lomb | Sandoz | |
| Fill volume (mL) | 2.91 (±0.03)[a] [2.86–2.96] | 2.50 (±0.11)[c] [2.30–2.64] | 2.68 (±0.04)[a] [2.61–2.73] | 2.56 (±0.04)[a] [2.50–2.60] | Levene: .002 Welch: <.001 |
| Drops/bottle | 87.3 (±3.9)[a] [81–94] | 77.6 (±4.1)[b] [70–84] | 88.7 (±2.3)[a] [86–93] | 76.6 (±2.07)[b] [72–79] | Levene: .14 F: <.001 |
| Drops/mL | 30.0 (±1.4)[b] [28–32] | 31.0 (±1.2)[b] [29–33] | 33.1 (±0.6)[a] [32–34] | 30.0 (±0.9)[b] [29–31] | Levene: .10 F: <.001 |
| Yearly cost ($) | 1198 (±54)[a] [1111–1289] | 184 (±10)[c] [169–203] | 201 (±5)[c] [192–207] | 907 (±25)[b] [879–964] | Levene: .003 Welch: <.001 |

**Citation:**

[1] S. A. Davis, B. Sleath, D. M. Carpenter, S. J. Blalock, K. W. Muir, and D. L. Budenz, “Drop instillation and glaucoma,” *Curr Opin Ophthalmol*, vol. 29, no. 2, pp. 171–177, Mar. 2018, doi: 10.1097/ICU.0000000000000451.

[2] J. H. Queen, R. M. Feldman, and D. A. Lee, “Variation in Number of Doses, Bottle Volume, and Calculated Yearly Cost of Generic and Branded Latanoprost for Glaucoma,” *Am J Ophthalmol*, vol. 163, pp. 70-74.e1, Mar. 2016, doi: 10.1016/j.ajo.2015.11.021.

**Conclusions/action items:**

The motivation for this project has to do with the lack in ability to safely and reliably administer the correct amount of medicine through an eye drop. If the medicine is wasted, patients are spending a lot of money to cover the costs out of pocket.

Action: Present this info to the team and include these stats in the background info section.

# 11 SEP 2023 - Low Tech Competing Designs

**Title:** Multiple Low Tech Options In Market

**Date:** 9/11/2023

**Content by:** Tevis Linser

**Goals:** To explore in market devices and highlight design limitations that have to do with intellectual property

**Content:**

There are three categories of low tech eye drop aids in market.

**Bottle Managers:**

The eye dropper bottle is snapped into, or other wise encased in a plastic device that acts to hold open the eyelids and positions the dropper tip above the eye when the head is tilted back.


Downfalls:

The most obvious problems are that the patient still has to tilt his head back, and there's no guarantee that the drop will land on the eye. Furthermore, the patient may squeeze out multiple drops by mistake.

### Using Capillary Action:

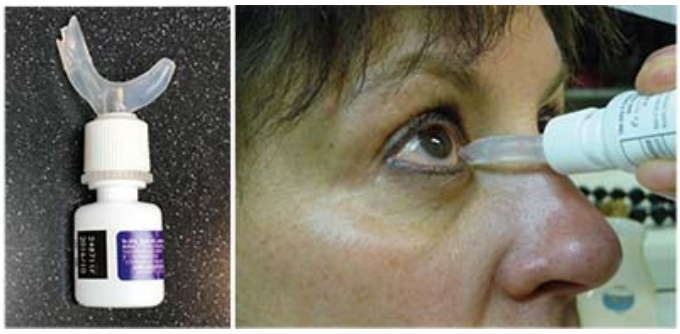
Placing a single drop into a holder and then bringing the holder close to the eye, allowing the drop to "jump" onto the eye from the device.


Downfalls;

Potential drawbacks include the need to keep the device clean, and possible contacts between the device and the eye could cause injury

### A Targeted Approach:

An arched tube that screws onto the dropper bottle, It references the nose so the tip can be comfortably and steadily placed in the medial canthal area. Once the tip is properly placed, the bottle is squeezed; the drop leaves the aperture, slides down and off the little ramp onto the delivery tip and into the eye.



Downfalls:

Some patients who lack manual dexterity or have weak hands still may find it difficult or impossible to meter a drop by squeezing accurately. They still waste drops and occasionally miss, so they’re less happy with it

**Citation:**

[1]

C. K. Editor Senior, “Getting Drops Onto the Eye: Low-tech Solutions.” https://www.reviewofophthalmology.com/article/getting-drops-onto-the-eye-lowtech-solutions (accessed Sep. 11, 2023).

**Conclusions/action items:**

There are a few in market designs that address some of the aspects of the design. A lot of them do not address exactly what our client is looking for. It couild be very helpful to glean design ideas from some of the solutions.

Actions:

Share with the team and Include this information in our preliminary design report and presentation.

# 4 OCT 2023 - Initial Design Idea

TEVIS LINSER - Oct 04, 2023, 11:39 AM CDT

**Title: Design to bring to design brainstorm meeting**

**Date:** 10/4/2023

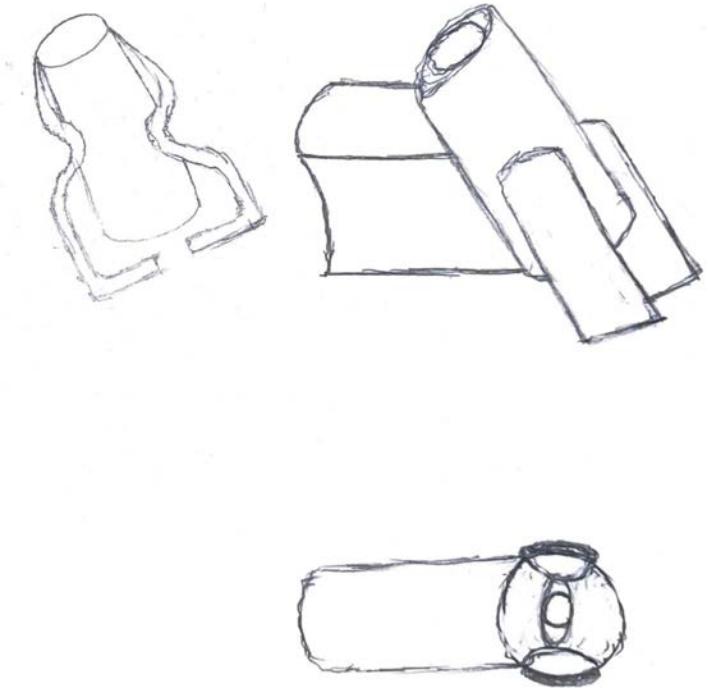
**Content by:** Tevis Linser

**Present:** N/A

**Goals:** To brainstorm ideas to share with the team

**Sources**: N/A

**Content:**



This design includes a cross over of what exists in market. Mechanical leverage from the wings allows for an easy drop and the wings running into each other after dispensing one drop. This design mostly only incorporates ideas that tackle the issue of one drop dispense.

**Conclusions/action items:**

Action: Share this with the team to help brainstorm the final design.

# 09 OCT 2023 - Materials for Fab

**Title:** Materials for fabrication

**Date:** 10/9/2023

**Content by:** Tevis Linser

**Goals:** To explore feasible prototyping material options.

**Content:**

Corrosion-Resistant Extension Springs with Hook Ends

Made of stainless steel, these springs are more corrosion resistant than steel springs. They're also easier to extend than steel springs. As you stretch an extension spring, it gets harder to pull. Minimum load is the amount of force required to start to extend the spring. Maximum load is the amount of force required to fully extend the spring. Spring rate is the amount of force required for every inch of extension or, for metric springs, millimeter of compression.

**302 stainless steel** springs have good corrosion resistance.

**316 stainless steel** springs have excellent corrosion resistance.

CAD For technical drawings and 3-D models, click on a part number.

**Inch**

| OD | Wire Dia. | Extended Lg. @ Max. Load | Load, lbs. Min. | Load, lbs. Max. | Spring Rate, lbs./in. | Material | Pkg. Qty. | | Pkg. |
|---|---|---|---|---|---|---|---|---|---|
| **0.25" Lg.** | | | | | | | | | |
| 0.063" | 0.007" | 0.54" | 0.02 | 0.27 | 0.833 | 302 Stainless Steel | 3 | 9433K001 | $12.39 |
| 0.063" | 0.008" | 0.46" | 0.04 | 0.45 | 2 | 316 Stainless Steel | 3 | 1942N1 | 17.65 |
| 0.063" | 0.009" | 0.4" | 0.05 | 0.52 | 3.082 | 302 Stainless Steel | 3 | 9433K013 | 11.72 |
| 0.063" | 0.011" | 0.34" | 0.08 | 0.91 | 9.246 | 302 Stainless Steel | 3 | 9433K02 | 12.39 |
| 0.063" | 0.011" | 0.344" | 0.1 | 1.14 | 11.1 | 316 Stainless Steel | 3 | 1942N14 | 17.77 |
| 0.078" | 0.008" | 0.54" | 0.04 | 0.39 | 1.21 | 316 Stainless Steel | 3 | 1942N18 | 17.17 |
| 0.078" | 0.011" | 0.399" | 0.09 | 1.03 | 6.3 | 316 Stainless Steel | 3 | 1942N22 | 17.30 |
| **0.31" Lg.** | | | | | | | | | |
| 0.063" | 0.007" | 0.73" | 0.02 | 0.27 | 0.583 | 302 Stainless Steel | 3 | 9433K002 | 11.64 |
| 0.063" | 0.009" | 0.52" | 0.05 | 0.52 | 2.249 | 302 Stainless Steel | 3 | 9433K014 | 11.64 |
| **0.313" Lg.** | | | | | | | | | |
| 0.063" | 0.008" | 0.603" | 0.04 | 0.45 | 1.4 | 316 Stainless Steel | 3 | 1942N11 | 17.69 |
| 0.063" | 0.011" | 0.445" | 0.1 | 1.14 | 7.9 | 316 Stainless Steel | 3 | 1942N15 | 17.84 |
| 0.078" | 0.008" | 0.759" | 0.04 | 0.39 | 0.79 | 316 Stainless Steel | 3 | 1942N19 | 17.26 |
| 0.078" | 0.011" | 0.536" | 0.09 | 1.03 | 4.21 | 316 Stainless Steel | 3 | 1942N23 | 17.26 |
| **0.375" Lg.** | | | | | | | | | |
| 0.063" | 0.008" | 0.745" | 0.04 | 0.45 | 1.1 | 316 Stainless Steel | 3 | 1942N12 | 17.72 |
| 0.063" | 0.011" | 0.551" | 0.1 | 1.14 | 5.9 | 316 Stainless Steel | 3 | 1942N16 | 17.94 |
| 0.078" | 0.008" | 0.973" | 0.04 | 0.39 | 0.59 | 316 Stainless Steel | 3 | 1942N2 | 17.32 |
| 0.078" | 0.011" | 0.671" | 0.09 | 1.03 | 3.17 | 316 Stainless Steel | 3 | 1942N24 | 17.32 |
| 0.094" | 0.01" | 0.673" | 0.05 | 0.36 | 0.104 | 302 Stainless Steel | 1 | 9433K256 | 4.70 |
| 0.094" | 0.012" | 0.559" | 0.1 | 0.61 | 2.78 | 302 Stainless Steel | 1 | 9433K259 | 4.70 |
| 0.094" | 0.012" | 0.655" | 0.1 | 1 | 3.2 | 316 Stainless Steel | 3 | 1942N26 | 17.69 |
| 0.094" | 0.014" | 0.5" | 0.17 | 0.96 | 6.17 | 302 Stainless Steel | 1 | 9433K241 | 4.56 |
| 0.094" | 0.016" | 0.521" | 0.19 | 2.26 | 14.2 | 316 Stainless Steel | 3 | 1942N3 | 17.83 |
| 0.109" | 0.012" | 0.77" | 0.09 | 0.92 | 2.1 | 316 Stainless Steel | 3 | 1942N34 | 17.26 |
| 0.109" | 0.014" | 0.659" | 0.13 | 1.46 | 4.69 | 316 Stainless Steel | 3 | 1942N38 | 17.26 |
| **2.375" Lg.** | | | | | | | | | |
| 0.25" | 0.026" | 5.58" | 0.3 | 2.4 | 0.643 | 302 Stainless Steel | 1 | 9433K484 | $7.79 |
| 0.312" | 0.026" | 7.68" | 0.2 | 1.9 | 0.323 | 302 Stainless Steel | 1 | 9433K485 | 7.98 |
| 0.375" | 0.054" | 3.48" | 3 | 14 | 9.314 | 302 Stainless Steel | 1 | 9433K486 | 8.51 |
| 0.5" | 0.062" | 3.822" | 3 | 16 | 9 | 302 Stainless Steel | 1 | 9433K489 | 8.07 |
| **2.437" Lg.** | | | | | | | | | |
| 0.75" | 0.105" | 2.84" | 13.12 | 32.16 | 47.19 | 302 Stainless Steel | 1 | 9433K406 | 4.63 |
| **2.5" Lg.** | | | | | | | | | |
| 0.125" | 0.022" | 3.63" | 0.37 | 1.37 | 2.541 | 316 Stainless Steel | 2 | 1942N122 | 8.95 |
| 0.18" | 0.018" | 7.27" | 0.12 | 1.29 | 0.25 | 302 Stainless Steel | 5 | 9433K131 | 15.86 |
| 0.18" | 0.022" | 5.36" | 0.17 | 2.17 | 0.75 | 302 Stainless Steel | 5 | 9433K153 | 15.86 |
| 0.18" | 0.034" | 3.36" | 0.67 | 7.47 | 7.914 | 302 Stainless Steel | 5 | 9433K32 | 15.86 |
| 0.188" | 0.022" | 5.32" | 0.25 | 0.88 | 0.65 | 316 Stainless Steel | 2 | 1942N291 | 9.98 |
| 0.24" | 0.018" | 11.33" | 0.09 | 0.98 | 0.083 | 302 Stainless Steel | 5 | 9433K361 | 15.86 |
| 0.24" | 0.026" | 6.06" | 0.25 | 2.75 | 0.666 | 302 Stainless Steel | 5 | 9433K385 | 15.86 |
| 0.24" | 0.029" | 5.19" | 0.33 | 3.75 | 1.25 | 302 Stainless Steel | 5 | 9433K53 | 15.86 |
| 0.25" | 0.022" | 8.44" | 0.17 | 0.74 | 0.267 | 316 Stainless Steel | 2 | 1942N297 | 10.59 |
| 0.25" | 0.026" | 6.05" | 0.33 | 1.09 | 0.633 | 316 Stainless Steel | 2 | 1942N298 | 10.59 |
| 0.25" | 0.029" | 5.24" | 0.46 | 1.51 | 1.141 | 316 Stainless Steel | 2 | 1942N299 | 10.59 |
| 0.25" | 0.031" | 4.64" | 0.61 | 4.32 | 1.74 | 302 Stainless Steel | 3 | 9433K31 | 5.34 |
| 0.25" | 0.034" | 4.36" | 0.71 | 2.38 | 2.666 | 316 Stainless Steel | 2 | 1942N302 | 11.24 |
| 0.25" | 0.037" | 3.97" | 1.89 | 5 | 4.248 | 316 Stainless Steel | 2 | 1942N303 | 11.24 |
| 0.25" | 0.041" | 3.39" | 1.05 | 7.95 | 7.734 | 302 Stainless Steel | 1 | 9433K269 | 5.19 |
| 0.25" | 0.041" | 3.7" | 0.87 | 4.1 | 7.414 | 316 Stainless Steel | 2 | 1942N304 | 11.55 |
| 0.3" | 0.031" | 6.17" | 0.32 | 3.66 | 0.916 | 302 Stainless Steel | 5 | 9433K662 | 15.86 |
| 0.3" | 0.037" | 4.85" | 0.54 | 6 | 2.332 | 302 Stainless Steel | 5 | 9433K675 | 16.89 |
| 0.3" | 0.049" | 3.61" | 1.17 | 12.99 | 10.662 | 302 Stainless Steel | 5 | 9433K687 | 15.91 |
| 0.36" | 0.039" | 5.5" | 0.52 | 5.85 | 1.749 | 302 Stainless Steel | 5 | 9433K766 | 15.86 |
| 0.36" | 0.041" | 5.08" | 0.58 | 6.58 | 2.249 | 302 Stainless Steel | 5 | 9433K779 | 15.86 |

Compression Springs

As you squeeze a compression spring, it pushes back to return to its original length. Spring rate is the amount of force required for every inch of compression or, for metric springs, millimeter of compression. The higher the spring rate, the harder it is to compress the spring.

**Chrome-silicon steel** springs have a high tensile strength for reliable operation over a long lifetime.

**Zinc-plated** springs have mild corrosion resistance.

Springs **with closed and ground ends** sit flat, so they won't buckle.

CAD For technical drawings and 3-D models, click on a part number.

**Inch**

| OD | ID | Wire Dia. | Wire Wd. | Wire Thick. | Compressed Lg. @ Max. Load | Max. Load, lbs. | Spring Rate, lbs./in. | Material | End Type | Pkg. Qty. | | Pkg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.19" Lg.** | | | | | | | | | | | | |
| 0.088" | 0.064" | 0.012" | — | — | 0.116" | 1.07 | 14.5 | Music-Wire Steel | Closed | 6 | 9657K236 | $20.27 |
| **0.25" Lg.** | | | | | | | | | | | | |
| 0.12" | 0.08" | 0.02" | — | — | 0.16" | 4.14 | 46 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K256 | 6.13 |
| 0.12" | 0.088" | 0.016" | — | — | 0.14" | 1.93 | 17.5 | Zinc-Plated Music-Wire Steel | Closed and Ground | 5 | 9434K12 | 5.43 |
| 0.125" | 0.093" | 0.016" | — | — | 0.11" | 2.65 | 18.9 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K257 | 6.13 |
| 0.148" | 0.106" | 0.021" | — | — | 0.156" | 3.2 | 34 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K603 | 6.33 |
| 0.148" | 0.112" | 0.018" | — | — | 0.16" | 1.13 | 12 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K602 | 6.33 |
| 0.148" | 0.12" | 0.014" | — | — | 0.098" | 1 | 6.6 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K601 | 6.33 |
| 0.18" | 0.132" | 0.024" | — | — | 0.159" | 3.9 | 43 | Zinc-Plated Music-Wire Steel | Closed and Ground | 12 | 9657K605 | 13.10 |
| 0.18" | 0.144" | 0.018" | — | — | 0.1" | 2.01 | 13.5 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K258 | 6.13 |
| 0.18" | 0.152" | 0.014" | — | — | 0.1" | 0.9 | 6 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K604 | 6.33 |
| 0.21" | 0.158" | 0.026" | — | — | 0.148" | 4.2 | 41 | Zinc-Plated Music-Wire Steel | Closed and Ground | 12 | 9657K608 | 13.40 |
| 0.21" | 0.166" | 0.022" | — | — | 0.129" | 2.6 | 21.5 | Zinc-Plated Music-Wire Steel | Closed and Ground | 12 | 9657K607 | 13.10 |
| 0.21" | 0.174" | 0.018" | — | — | 0.124" | 1.5 | 11.9 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K606 | 6.33 |
| 0.24" | 0.196" | 0.022" | — | — | 0.128" | 2.3 | 18.9 | Zinc-Plated Music-Wire Steel | Closed and Ground | 12 | 9657K609 | 13.10 |
| 0.24" | 0.2" | 0.02" | — | — | 0.09" | 1.94 | 12.5 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K259 | 6.13 |
| 0.25" | 0.21" | 0.02" | — | — | 0.09" | 2.13 | 13.2 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K261 | 6.13 |
| **0.31" Lg.** | | | | | | | | | | | | |
| 0.18" | 0.152" | 0.014" | — | — | 0.139" | 0.84 | 4.9 | Music-Wire Steel | Closed | 6 | 9657K239 | 18.30 |
| **0.375" Lg.** | | | | | | | | | | | | |
| 0.12" | 0.088" | 0.016" | — | — | 0.17" | 2.32 | 11.2 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K262 | 6.13 |
| 0.125" | 0.093" | 0.016" | — | — | 0.15" | 2.43 | 11 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K263 | 6.13 |
| 0.148" | 0.106" | 0.021" | — | — | 0.223" | 3.2 | 21 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K613 | 6.33 |
| 0.148" | 0.112" | 0.018" | — | — | 0.22" | 1.45 | 9.6 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K612 | 6.33 |
| 0.148" | 0.12" | 0.014" | — | — | 0.183" | 1 | 5.2 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K611 | 6.33 |
| 0.18" | 0.132" | 0.024" | — | — | 0.225" | 3.9 | 26 | Zinc-Plated Music-Wire Steel | Closed and Ground | 12 | 9657K615 | 13.40 |
| 0.18" | 0.144" | 0.018" | — | — | 0.12" | 2.3 | 9.15 | Zinc-Plated Music-Wire Steel | Closed | 12 | 9657K264 | 6.13 |

**Extension/Compression springs with CAD files for design purposes.**

**Exact dimensions and properties will need to be roughly calculated before purchasing.**

**Plastics:**

ABS Plastic is a thermoplastic copolymer that serves as an exceptional substitute for metal parts of medical devices. ABS plastic is rigid, durable, and provides an appealing aesthetic quality that is perfect for the medical field due to its easy coloration. Aside from this, it can undergo various molding processes to form different medical plastic parts.

Further, ABS can withstand medical sterilization techniques like gamma radiation or chemical sterilant such as ethylene oxide (EO). Hence, ABS plastic sheets are ideal for manufacturing non-absorbable sutures, tendon prostheses, tracheal tubes, and other drug-delivery systems.

**Citation:**

[ ] “McMaster-Carr.” Accessed: Oct. 09, 2023. [Online]. Available: https://www.mcmaster.com/

[ ] “Medical Plastics Guide: Types and Applications of Medical Polymers,” Rapid Prototype Manufacturing in China - WayKen. Accessed: Oct. 10, 2023. [Online]. Available: https://waykenrm.com/blogs/medical-plastic-material/

**Conclusions/action items:**

Many types of torsion, compression, extension springs exist with many different sets of properties.

Action: Complete prototype design on CAD with files on McMaster Carr and purchase correct items for prototyping.

# 10/10/2023 Safety Training

TEVIS LINSER - Oct 10, 2023, 4:18 PM CDT

**Title: Safety Training**

**Date:** 10/10/23

**Content by:** Tevis

**Present:** N/A

**Goals:** Document Safety Training

**Content:**

Training Information Lookup Tool — University of Wisconsin-Madison

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

This certifies that Tevis Linser has completed training for the following course(s):

| Course | Assignment | Completion | Expiration |
|---|---|---|---|
| Biosafety Required Training | Biosafety Required Training Quiz 2022 | 3/10/2022 | |
| Chemical Safety: The OSHA Lab Standard | Final Quiz | 3/10/2022 | |

Data Last Imported: 03/10/2022 12:21 PM

**Conclusions/action items:**

**N/A**

# 10/10/2023 GreenPass

TEVIS LINSER - Oct 10, 2023, 4:19 PM CDT

**Title: Green Pass**

**Date:** 10/10/23

**Content by:** Tevis

**Present:** N/A

**Goals:** Document Green Pass

**Content: see attached**

**Conclusions/action items:**

**N/A**

TEVIS LINSER - Mar 30, 2022, 12:45 AM CDT


Download

**IMG_0068_1_.jpg (3.48 MB)**

# 2023/09/13 - Study of Eye Drops

Jenna Krause - Oct 11, 2023, 12:32 PM CDT

**Title:** Eye drop technique and patient-reported problems in a real-world population of eye drop users

**Date:** 09/13/2023

**Content by:** Jenna Krause

**Goals:** Aims to evaluate eye drop technique and identify patient-reported problems in a primary care sample of eye drop users

**Sources:**

E. Mehuys *et al.*, "Eye drop technique and patient-reported problems in a real-world population of Eye Drop Users," *Eye*, vol. 34, no. 8, pp. 1392–1398, 2019. doi:10.1038/s41433-019-0665-y

**Content:**

- This cross-sectional study took place in 136 community pharmacies in Belgium.
- It involved 678 participants aged 18 years or older who had been using eye drops for at least one month.
- Participants demonstrated their eye drop technique, and a questionnaire collected data on their experiences.
- Key findings:
    - Almost everyone (98%) successfully instilled at least one drop in the eye, but 14% required multiple attempts.
    - Only 3% exhibited perfect drop technique, while common errors included touching the bottle to the eye or eyelid (40.7%) and failing to close the eye (67.8%).
    - Important steps like nasolacrimal occlusion were often overlooked.
    - 20% of ophthalmic suspensions were not shaken before use.
    - 40% of patients reported problems with eye drop instillation, such as difficulties in getting drops in the eye and excessive drops coming out of the bottle.
- Many patients had never received education on proper eye drop instillation techniques.
- The study suggests a need for improvements in patient education and the use of dispensing aids to enhance eye drop administration.

**Conclusions/action items:**

The goal of this article is to highlight common errors and issues in eye drop administration, emphasizing the need for improvements in patient education and the use of dispensing aids to enhance treatment effectiveness and safety. Action items for the team is looking into more into customer needs, ergonomic considerations, and preventing contamination. All of this information will be captured in the team's PDS.

# 2023/10/04 - Squeeze Force

Jenna Krause - Oct 11, 2023, 12:48 PM CDT

**Title:** Wide variation of squeezing force and dispensing time interval among Eyedropper bottles

**Date:** 10/04/2023

**Content by:** Jenna Krause

**Goals:** To learn more about the squeezing force needed for eye droppers

**Sources:**

K. Kashiwagi, “Wide variation of squeezing force and dispensing time interval among Eyedropper bottles,” Journal of Ophthalmology, vol. 2019, pp. 1–7, 2019. doi:10.1155/2019/7250563

**Content:**

- The study compared squeezing force and interval for first and second drops in ophthalmic eye drop bottles using various prescription solutions.
- There's a significant 3-fold difference in squeezing force for the first drop, with the interval between first and second drops positively correlated with the force of the first drop.
- Shape of the eyedropper bottle and presence of a filter membrane significantly influence squeezing force and interval.
- Eyedropper bottles requiring greater force may lead to instillation of multiple drops in a single attempt.
- The usability decreased along with the increasing squeezing force among eyedropper bottles having the squeezing force of 14.7 N or more
- Shape influences force differences between the first and second drops, aiding in preventing multidrop instillation.
- Eyedropper bottles should have lower squeezing force and longer intervals for proper eye drop medication, especially for aging patients.
- Factors like viscosity, surface tension, tip design, and bottle shape affect squeezing force, necessitating further investigation.
- Recommendations include dimple-shaped bottles with specific pinch strengths and longer intervals between drops for future eye drop bottles, essential for effective treatment.

**Conclusions/action items**

This study emphasized the differences in squeezing force and time intervals for dispensing eye drops from various bottles. The bottle's shape and the presence of a filter significantly affect these aspects. The team's device must bridge this gap between squeezing force of elderly people/individuals with conditions like arthritis and normal squeezing force of eye bottles.

# 2023/10/04 - Squeeze Variability

Jenna Krause - Oct 11, 2023, 12:33 PM CDT

**Title:** Squeeze me if you can: Variability in force requirements to extract a drop from common glaucoma bottles

**Date:** 10/04/2023

**Content by:** Jenna Krause

**Goals:** To understand the different force requirements for eye drop bottles.

**Sources:**

D. B. Moore *et al.*, “Squeeze me if you can: Variability in force requirements to extract a drop from common glaucoma bottles,” *Journal of Glaucoma*, vol. 25, no. 9, pp. 780–784, 2016. doi:10.1097/ijg.0000000000000506

**Content:**

- Conducted tests on 84 bottles representing 21 bottle designs for glaucoma medications.
    - Glaucoma is a group of eye diseases that can cause vision loss and blindness by damaging a nerve in the back of your eye called the optic nerve.
- Testing involved mimicking ballpoint fingertip contact with a bottle tip using a customized force gauge apparatus.
- Tested two bottle orientations: vertical and horizontal.
- Recorded the force and displacement required for each of the first 10 dispensed drops for all bottles.
- Subsequent tests were conducted in increments of 10 drops until the bottle was empty.
- Pinch strength measured in 53 glaucoma patients, revealing a mean pinch strength of 5.05 kgf (right hand) and 4.82 kgf (left hand).
- Pinch strength ranged from 1.23 to 10.67 kgf, showing variability in hand strength among patients.
- Significant force variability observed across bottle designs: 7-fold (vertical) and 4-fold (horizontal).
- Findings highlight potential challenges patients may face due to varying force requirements.
- Suggested the need for standardization in topical glaucoma drug delivery and bottle design.
- Identified the difficulty in instilling drops as a crucial factor affecting glaucoma medication adherence.
- Patient surveys emphasized the importance of enhancing bottle characteristics for easier and reliable drop dispensing.
- Highlighted the absence of standardization in bottle design concerning drop instillation dynamics.
- Established a correlation between bottle design and force requirements, impacting effective medication use.

**Conclusions/action items**

The research study aimed to comprehensively evaluate the force requirements associated with dispensing a single drop from various glaucoma medication bottles, considering different bottle designs and orientations. Furthermore, the study sought to correlate these force requirements with patients' pinch strength.  The team will consider this information and research when designing

# 2023/12/02 - Variations in Eyeball Diameters

Jenna Krause - Dec 11, 2023, 10:14 PM CST

**Title:** Variations in Eyeball Diameters of the Healthy Adults

**Date:** 12/02/2023

**Content by:** Jenna Krause

**Goals:** To understand the different variations in eye ball diameters among a diverse demographic

**Sources:**

- I. Bekerman, P. Gottlieb, and M. Vaiman, “Variations in eyeball diameters of the healthy adults,” *Journal of Ophthalmology*, vol. 2014, pp. 1–5, 2014. doi:10.1155/2014/503645

**Content:**

- The research aimed to reevaluate normative data on eyeball diameters through a prospective cohort study, analyzing CT data from 250 healthy adults.
- Measurements of sagittal, transverse, and axial diameters were conducted on both eyes, with subsequent comparison between left and right eyes.
- No statistically significant differences were found based on gender, age, or ethnic background, with the right eyeball slightly smaller than the left.
- The average adult eye size was determined to be approximately 24.2 mm (transverse) × 23.7 mm (sagittal) × 22.0–24.8 mm (axial), with variations in the transverse diameter ranging from 21 mm to 27 mm.
- Precise knowledge of eyeball dimensions is crucial for ophthalmological, oculoplastic, and neurological practices
- The study emphasized the considerable variability in eyeball dimensions among subjects, with practical suggestions for ophthalmologic and neurologic clinics, particularly in estimating the transverse diameter.
- Further research is recommended to explore possible ethnic variations in eyeball dimensions and ocular shape.

**Conclusions/action items**

The study aimed to reevaluate normative data on eyeball diameters through a prospective cohort study, analyzing CT data from 250 healthy adults. The precise measurements conducted on sagittal, transverse, and axial diameters, along with the identification of variations in eye size, provide essential insights for the development of an eye drop assistant device, ensuring accurate dispensing into the proper location of the eye.

# 2023/09/13 - Global Drop Dispensing Bottles

Jenna Krause - Oct 11, 2023, 9:15 AM CDT

**Title:** Global Drop Dispensing Bottles Market Size By Product (Glass, Plastic), By Application (Pharmaceuticals, Cosmetics), By Geographic Scope and Forecast

**Date:** 09/13/2023

**Content by:** Jenna Krause

**Goals:** To learn more different dispensing bottles on the market.

**Sources:**

“Drop dispensing bottles market size, share, trends and forecast,” Verified Market Research, https://www.verifiedmarketresearch.com/product/drop-dispensing-bottles-market/ (accessed Sep. 13, 2023).

**Content:**

- The Drop Dispensing Bottles Market has been growing at a CAGR of 5.6% from 2024 to 2030, driven by the demand for precise liquid dispensing in various industries.
- Factors Contributing to Growth:
    - Expansion of the pharmaceutical and healthcare sectors.
    - Increasing consumer interest in beauty and personal care products.
    - Rising popularity of DIY (Do-It-Yourself) projects.
- Drop dispensing bottles are designed to dispense controlled amounts of liquid substances, commonly made of plastic or glass, with dropper caps that allow precise drop-by-drop dispensing.
- The pharmaceutical and healthcare industries are major users of drop dispensing bottles for packaging medications, eye drops, nasal sprays, and other healthcare products, given the need for precise dosing.
- The beauty and personal care industry has also witnessed a surge in demand for these bottles, particularly for packaging cosmetic oils, serums, and essential oils.
- The market is highly competitive, with manufacturers focusing on product innovation, customization, and sustainability to meet customer demands.
- The report segments the market by product (glass and plastic) and application (pharmaceuticals, cosmetics, personal care, industrial chemicals and lubricants, and others).
- North America is a significant market for drop dispensing bottles, with the United States and Canada being key contributors due to a well-established pharmaceutical industry and a focus on patient safety.
- Key players in the market include Akey, Lameplast, Bormioli Rocco, Roma International, and others, with a focus on service features, scalability, and industry coverages.

**Conclusions/action items:**

Overall, the market is expected to continue growing as industries recognize the benefits of precise and controlled liquid dispensing. From this research the team will start outlining the specific requirements for the eye dispenser holder, considering factors like material, size, and compatibility with different eye drop bottle sizes and shapes. These specific requirements will be captured in the Product Design Specification.  The PDS will be completed next week by the team.

# 2023/09/19 - Overview of Device Regulation

Jenna Krause - Oct 11, 2023, 9:14 AM CDT

**Title:** Overview of Device Regulation

**Date:** 09/19/2023

**Content by:** Jenna Krause

**Goals:** To learn more FDA process for medical devices.

**Sources:**

C. for D. and R. Health, “Overview of Device Regulation,” FDA, Sep. 04, 2020. https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance/overview-device-regulation (accessed Sep. 19, 2023).

**Content:**

- Regulatory Scope:
    - FDA's Center for Devices and Radiological Health (CDRH) oversees regulation of medical devices and radiation-emitting electronic products, ensuring safety and efficacy.
- Medical Device Classification:
    - Classifies medical devices into Class I, II, and III based on regulatory control levels.
- Regulatory Requirements:
    - Manufacturers must comply with establishment registration, medical device listing, premarket notifications (510(k)), quality system regulation, labeling, and medical device reporting.
- Establishment Registration:
    - Manufacturers and distributors, both domestic and foreign, must register their establishments with the FDA.
    - All registration information must be verified annually between October 1st and December 31st.
    - Foreign manufacturers must designate a U.S. Agent.
- Medical Device Listing:
    - Manufacturers must list their devices, including various types of establishments involved in device distribution.
- Premarket Notification 510(k):
    - A regulatory requirement for most Class II devices to demonstrate substantial equivalence to legally distributed devices.
    - A 510(k) must show substantial equivalence to a device commercially available before certain dates.
- Premarket Approval (PMA):
    - Required for Class III devices, involving a more rigorous process and submission of clinical data.
- Investigational Device Exemption (IDE):
    - Allows investigational device use in clinical studies to collect safety and effectiveness data.
- Quality System Regulation:
    - Enforces requirements related to methods, facilities, and controls for designing, manufacturing, and servicing medical devices.
- Labeling:
    - Includes device labels and accompanying descriptive and informational literature.
- Medical Device Reporting:
    - Mandates reporting of incidents where a device may have caused or contributed to death, serious injury, or malfunction, aiding in identifying and addressing problems.

**Conclusions/action items:**

These comprehensive regulations not only set a standard for manufacturers and distributors but also prioritize the protection of patients and users. Compliance with the FDA's regulatory framework ensures that medical devices undergo thorough evaluation, reducing potential risks and fostering innovation with confidence. Action items is to pull this information into the product specification document (PDS).

# 2023/09/19 - ISO 291: Plastics — Standard atmospheres for conditioning and testing

Jenna Krause - Oct 11, 2023, 9:30 AM CDT

**Title:** ISO 291: Plastics — Standard atmospheres for conditioning and testing

**Date:** 09/20/2023

**Content by:** Jenna Krause

**Goals:** To learn about ISO that are involved with our project.

**Sources:**

“ISO 291:2008(en), Plastics — Standard atmospheres for conditioning and testing.” https://www.iso.org/obp/ui/#iso:std:iso:291:ed-4:v1:en (accessed Sep. 20, 2023)

**Content:**

- ISO standards define specific atmospheric conditions for conditioning and testing plastics and test specimens.
- Standard atmospheres have defined air temperature, humidity values, atmospheric pressure, and air-circulation velocity.
- Conditioning operations aim to achieve equilibrium in temperature and humidity for samples or test specimens.
- The standards stress the importance of maintaining a consistent atmosphere during testing for reliable and comparable results.
- In the context of an eye dropper container, adherence to these standards is crucial for validating the container's material properties and performance under varying atmospheric conditions.
- Compliance with these standards ensures the container's quality, durability, and functionality, particularly in handling temperature and humidity fluctuations during storage and use.

**Conclusions/action items:**

Since the team is interested in producing a eye drop holder prototype with plastic. The standard found gives the precise atmospheric conditions for conditioning and testing plastics. This helps the team ensure consistent and reliable testing of plastic samples.

# 2023/10/08 - IRB Information

Jenna Krause - Oct 11, 2023, 9:14 AM CDT

**Title:** Institutional Review Board

**Date:** 10/08/2023

**Content by:** Jenna Krause

**Goals:** To learn about the IRB process at UW for team's project.

**Sources:**

Institutional Review Board, https://irb.wisc.edu/about-us/ (accessed Oct. 8, 2023).

**Content:**

- Before any testing begins, the team must prioritize obtaining Institutional Review Board (IRB)
- University of Wisconsin-Madison's HRPP includes Institutional Review Boards (IRBs) to oversee human subjects research.
- ARROW (Application Review for Research Oversight at Wisconsin) is the online system for submission and review of IRB applications used by all IRBs at UW-Madison.
- IRBs ensure ethical research practices and compliance with federal regulations, state laws, and university policies.
- All research involving human subjects at the university, including off-site conducted by university staff, requires IRB review.
- The Institutional Review Boards (IRBs) at our institution oversee research involving human subjects, ensuring compliance with relevant laws and policies.
    - The Health Sciences IRB assesses medical research requiring specialized medical evaluation, while the Minimal Risk Research IRB handles studies with minimal risk, encompassing medical and social-behavioral research.
- Approval to ensure that the research involving human subjects complies with ethical guidelines and safeguards the participants' rights, safety, and well-being.

**Conclusions/action items:**

The team must obtain Institutional Review Board (IRB) approval through the ARROW system at the University of Wisconsin-Madison. This approval is essential in demonstrating the team's commitment to conducting responsible and ethical research and moving forward in the testing process. The team wants to start IRB approval right away, so testing protocols need to be developed to submit with ARROW.

# 2023/09/27 - Design Idea "Stopper Buddy"

Jenna Krause - Oct 05, 2023, 11:25 AM CDT

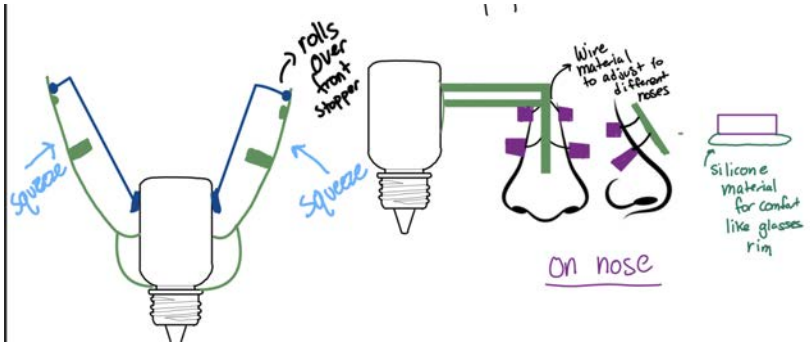
**Title:** Design Idea 1 - "Stopper Buddy"

**Date:** 09/27/2023

**Content by:** Jenna Krause

**Goals:** To come up with an initial design solution to our project.

**Content:**




**Conclusions/action items:**

This design addresses two primary client requirements. Firstly, it enhances patient stability through a nose stabilization mechanism, featuring a four-piece silicone structure resting on the nose. The wires connecting these silicone pieces allow for individualized adjustments based on anatomy. Secondly, the eye dropper design incorporates a stopper mechanism, preventing patients from excessive solution usage by allowing only one drop into each eye. The design integrates a built-in wall to halt any excess force.

# 2023/10/03 - Redrawn "stopper buddy"

Jenna Krause - Oct 11, 2023, 8:52 AM CDT

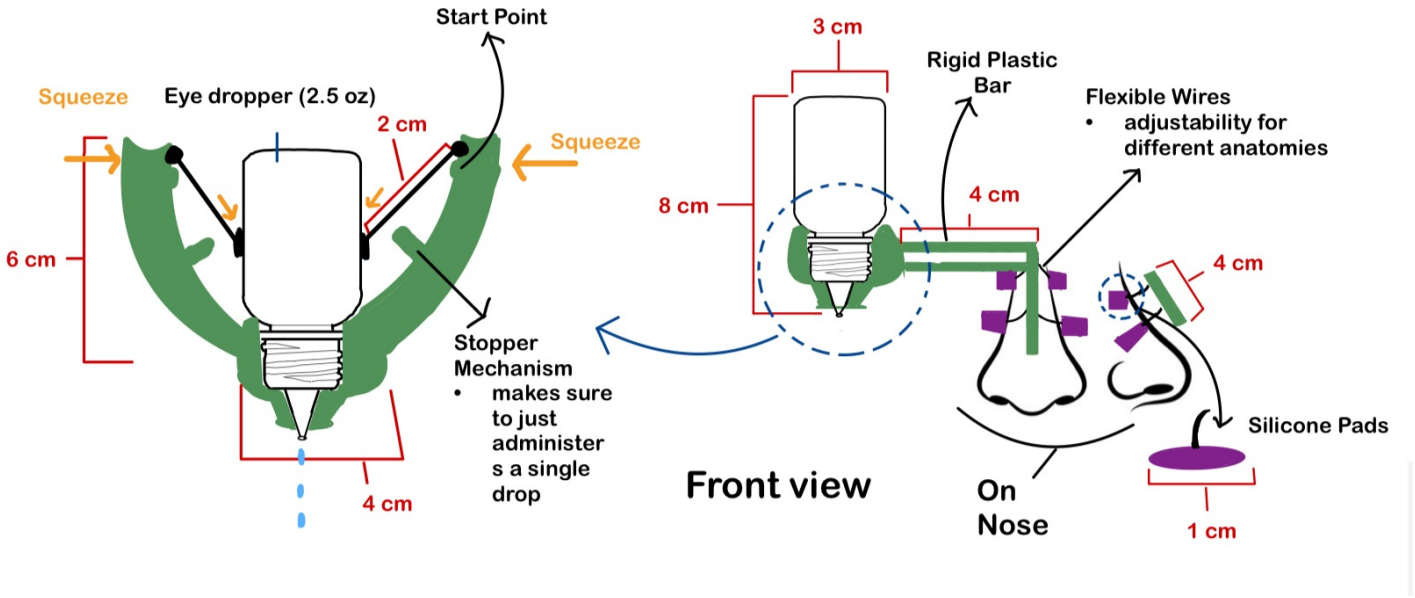
**Title:** Redrawn Design Idea 1

**Date:** 10/03/2023

**Content by:** Jenna Krause

**Goals:** To redraw initial design to include more details.

**Content:**




**Conclusions/action items:**

In this revised iteration of the initial device, I focused on enhancing the design based on a standard 2.5 oz eye drop bottle. The key improvement lies in the meticulous sketch, which now includes detailed dimensions and labeled components of the bottle, offering a clearer and more precise representation. Notably, I emphasized a larger and more secure holder for the eye drop bottle, a critical aspect to ensure stability during the administration process. Next steps would be including this new drawn sketch in the team's preliminary report and presentation.

# 2022/03/22 - Green Permit

Jenna Krause - Oct 05, 2023, 11:24 AM CDT

**Title:** Green Pass Training

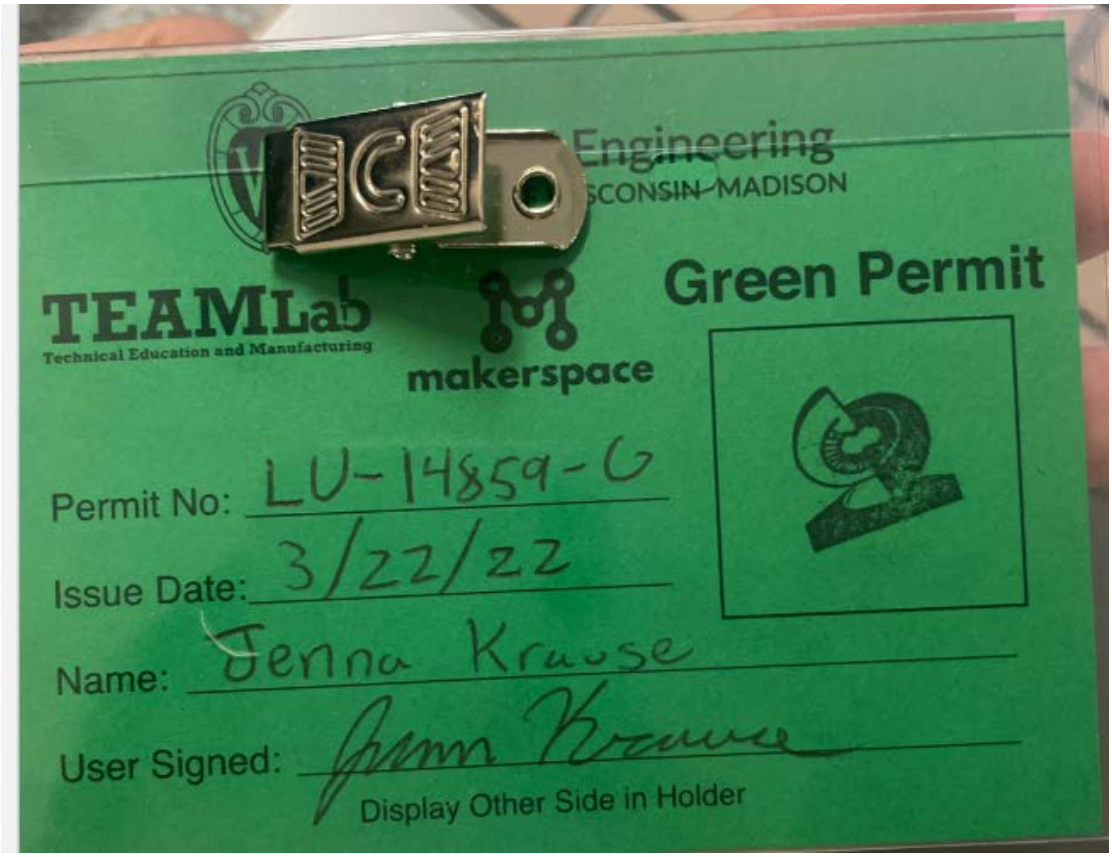
**Date:** 03/22/2022

**Content by:** Jenna Krause

**Present:** N/A

**Goals:** To complete the TeamLab Training that is needed for the Green Permit.

**Content:**



# You have the following permits and upgrades:

| Name | Date |
|---|---|
| Green Permit | 03/22/2022 |
| Lab Orientation | 09/26/2020 |
| Red Permit | 02/26/2022 |
| Laser 1 | 10/06/2020 |

## Virtual Green Permit Seminar Quiz

**Due** No due date **Points** 20 **Questions** 20 **Time Limit** None
**Allowed Attempts** 3

### Instructions

For the Virtual Green Seminar, please watch the first the lathe video, followed by the mill video, and then successfully pass the quiz in order to reserve a machine to complete your training.

The Lathe

The Mill

In order to complete the Virtual Green Permit Seminar, you will need to watch both videos and successfully complete a following quiz. It is twenty questions, multiple choice and you will have three attempts to receive a minimum of 90% correct.

**Last Attempt Details:**

| | |
|---|---|
| **Time:** | 49,950 minutes |
| **Current Score:** | 20 out of 20 |
| **Kept Score:** | 20 out of 20 |

2 More Attempts available

Take the Quiz Again

(Will keep the highest of all your scores)


**Conclusions/action items:**

For the design process I also completed the green permit training through the Team Lab. The training included 2 parts one for the Lathe and one for the Mill. Each section took me about 2 hours to complete for the alpha part. The Lathe part I had little difficulty in with operating the machinery. However, the mill portion was slightly more difficult with having to move in the x, y, and z directions. However, I got the hang of it and completed the section. For future action our team will look into getting the next level of permit for the mill since majority of our fabrication will take place on this machine.

# 9/12/23 - Disturbed Grip Function in Women with Rheumatoid Arthritis

THOMAS KRIEWALDT - Sep 12, 2023, 11:17 PM CDT

**Title:** Disturbed Grip Function in Women with Rheumatoid Arthritis

**Date:** 9/12/23

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To begin to generate baseline values for design inputs that we will be following this semester.

**Citation**:

[1] B. Dellhag, N. Hosseini, T. Bremell, and P. E. Ingvarsson, “Disturbed Grip Function in Women with Rheumatoid Arthritis,” The Journal of Rheumatology, vol. 28, no. 12, 2001.

**Content:**

This source details the effects of Rheumatoid Arthritis (RA) in women below the age of 60.

- This population is not representative of our entire population, as men and women over 60 can have RA as well.
- More research should be put into finding data for these populations.

Of the 23 women with RA, only 8 showed decreased hand function, which was indicated by a GAT (Grip Ability Test) score above 20 [1].

- A GAT score is the "sum of weighted time" taken to perform three simple tasks using the dominant hand:
  - Placing flexible hosiery over the non-dominant hand.
  - Placing a paper clip on the outer edge of an envelope.
  - Pouring water out of a picture.
- Any score below 20 seconds concludes that hand function is normal [1].

In subsequent testing, these 8 women with decreased hand function had a much lower "pinch grip strength" than those with normal hand function.

- Pinch grip strength is defined as the compressive tip-to-tip strength between the thumb and the index finger.
- **Decreased Function (RA)**: median of 26 N.
- **Normal Function (RA)**: median of 42 N.
- **Control Group (no RA)**: median of 40 N.

(RA Group as a whole had a median of 33 N).

It is interesting and unusual that the normal function RA group had a higher median PGS than the control group, however, it is obvious that the *diseased RA group has a significantly lower PGS than the others.*

**Conclusions/action items:**

This is a good start to define some of the design controls we will need this semester.

Still need to research more data about the grip strength of patients with RA that significantly inhibits their hand function.

# 9/12/23 - The Relationship Between Hand Grip and Pinch Strengths and Disease Activity, Articular Damage, Pain, and Disability in Patients with Rheumatoid Arthritis

**Title:** The Relationship Between Hand Grip and Pinch Strengths and Disease Activity, Articular Damage, Pain, and Disability in Patients with Rheumatoid Arthritis

**Date:** 9/12/23

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To find additional pinch grip strength values for a more representative population.

**Citation**:

[1] M. Dedeoğlu, Ü. Gafuroğlu, Ö. Yilmaz, and H. Bodur, “The Relationship Between Hand Grip and Pinch Strengths and Disease Activity, Articular Damage, Pain, and Disability in Patients with Rheumatoid Arthritis,” Arch Rheumatol, vol. 28, no. 2, pp. 069–077, 2013, doi: 10.5606/tjr.2013.2742.

[2] I. Thyberg, U. A. M. Hass, U. Nordenskiöld, and T. Skogh, “Survey of the use and effect of assistive devices in patients with early rheumatoid arthritis: a two-year followup of women and men,” Arthritis Rheum, vol. 51, no. 3, pp. 413–421, Jun. 2004, doi: 10.1002/art.20410.

**Content:**

This study has a much larger sample size than the previous article I reviewed.

- 102 total patients with RA; 78 female and 24 male subjects [1].
    - Mean age of 52.8 +/- 10.5 years; Mean disease duration of 13.55 +/- 9.03 years [1].

Pinch strengths were measured using using a hydraulic gauge.

- Lateral, tip-to-tip, and three point pinch strengths were measured in this study.
    - Lateral: Grip strength using the radial side of the index finger and ulnar side of the thumb.
    - Tip-to-tip: Grip strength using the fingertips of the index finger and thumb.
    - Three-point: Grip strength using the tip-to-tip technique, but using both the index and middle fingers.
- All of these pinch strengths involve a specific setup procedure, distinct from one another.
    - Didn't include it here, because I am not certain the setups are relevant to our project, but they can be found in the **Patients and Methods** section.

*Mean grip strength results (and standard deviations) from these experiments are as follows:*

**Lateral Pinch Strength**: 5.9 +/- 2.2 kg (57.9 +/- 21.6 N) for entire population [1].

- *Female*: 5.2 +/- 1.8 kg (51 +/- 17.7 N) --- *Minimum*: **1.6 kg** (15.7 N).
- *Male*: 8.1 +/- 2.1 kg (79.5 +/- 20.6 N) --- *Minimum*: 3.4 kg (33.4 N).
    - Note: I used the fact that 1 kg = 9.81 N of force to find these values in N (rounded to tenth place). The paper only includes these values in kg.

**Tip-to-Tip Pinch Strength**: 3.9 +/- 1.7 kg (38.3 +/- 16.7 N)

- *Female*: 3.4 +/- 1.4 kg (33.4 +/- 13.7 N) --- *Minimum*: **0.9 kg** (8.8 N)
- *Male*: 5.4 +/- 1.5 kg (53 +/- 14.7 N) --- *Minimum*: 1.8 kg (17.7 N)

**Three-Point Pinch Strength**: 5 +/- 2 kg (49.1 +/- 19.6 N)

(No min/max data was included for this test)

- *Female*: 4.3 +/- 1.6 kg (42.2 +/- 15.7 N)
- *Male*: 7 +/- 1.5 kg (68.7 +/- 14.7 N)

"Males and females show some differences regarding the progression and results of RA. Similar to the healthy population, the mean grip and pinch strengths of males with RA are greater than that of females." [1, 2]

- This tells us that we should be looking at the minimum values (female population) instead a true unbiased population, in order to be inclusive of people with RA who have super severe arthritis, and the most minimal grip strength.

**Conclusions/action items:**

We should make the requirements for force to use our device below the minimum grip strengths that are found in this study. In short, we model our design inputs after female grip strengths, as they are lower than male grip strengths in the two articles I researched.

We should also look into getting/borrowing a hydraulic gauge so we can ensure we meet these inputs later in the design process.

# 9/20/23 - PDS Research

THOMAS KRIEWALDT - Sep 20, 2023, 1:43 PM CDT

**Title: PDS Research**

**Date:** 9/20/23

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To conduct research into specific parameters that are required to be outlined. in the PDS.

**Sources**:

[1] “ISO 291:2008(en), Plastics — Standard atmospheres for conditioning and testing.” https://www.iso.org/obp/ui/#iso:std:iso:291:ed-4:v1:en (accessed Sep. 20, 2023).

[2] S. Mirmohammadi, A. Mehrparvar, M. Mostaghaci, M. H. Davari, M. Bahaloo, and S. Mashtizadeh, “Anthropometric Hand Dimensions in a Population of Iranian Male Workers in 2012,” International journal of occupational safety and ergonomics: JOSE, vol. 22, pp. 1–17, Dec. 2015, doi: 10.1080/10803548.2015.1112108.

[3] “Eye Dropper Bottles.” https://adelphi-hp.com/product-range/eye-dropper-bottles (accessed Sep. 20, 2023).

**Content:**

The first source tells us that the ambient temperature conditions for testing must fall into the range of 18-28 degrees C (62.4 to 82.4 degrees F) to meet ISO testing standards [1].

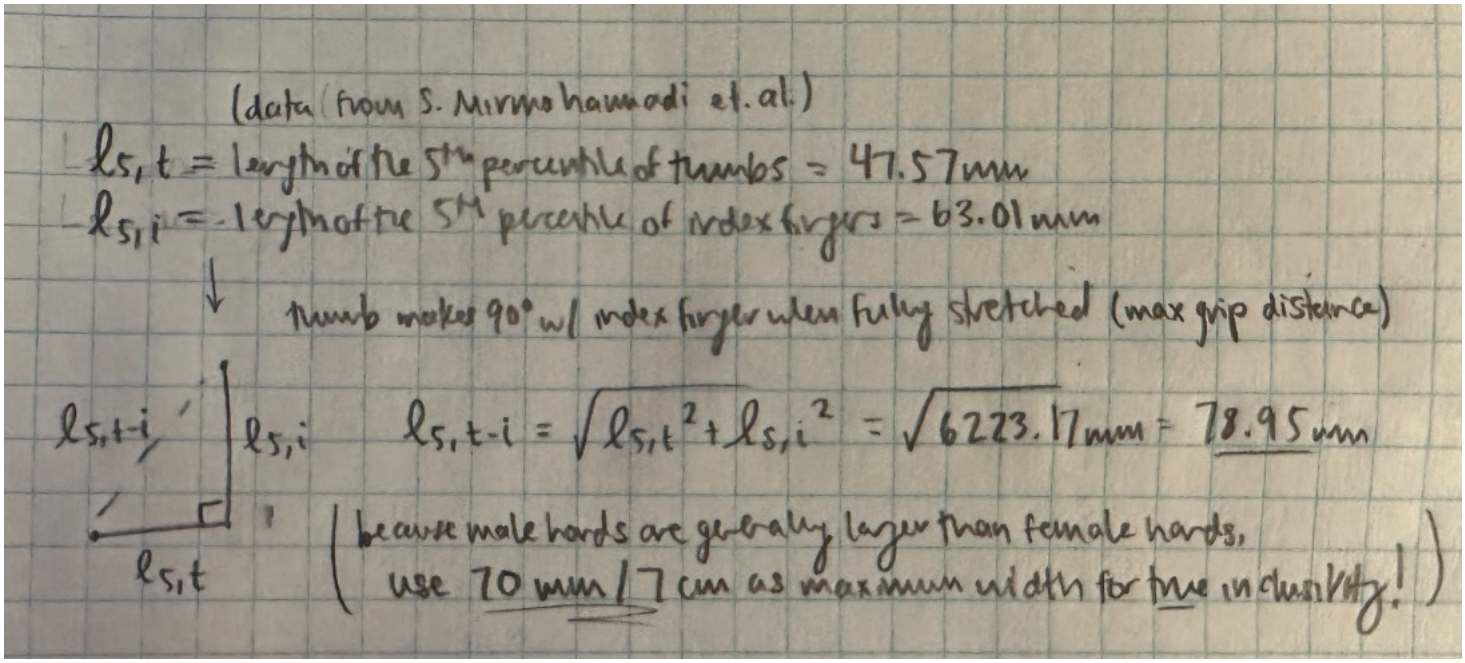
- Our device should be functional under ambient temperature conditions in testing and outside of it.

The second source is an anthropometric table that shows hand lengths and widths of different percentiles of Iranian Male workers [2].

- Note that this population is not representative of the minimum hand sizes, as women tend to have smaller hands than men.
- We can still take the 5th percentile (closest to minimum) values from this dataset and import a bit of wiggle room into these measurements to meet the requirements of most human finger lengths.

***Calculation of width: ~<u>70 mm or 7 cm</u>*** [3]

- Assuming that a user grips the device with their thumb and index finger, this is the largest distance (width) that the squeezing mechanism can be to be inclusive of all prospective patients that will use it.




Lastly, the group needs information about eye dropper bottles that will be used in our device.

- The following information is from a specific manufacturer, Adelphi, that produces bottles that hold 5 - 50 mL of solution [3].
  - There will likely be some bottles that fall outside of this range, but it is a good start to define the inner clasp dimensions to hold such bottles in our device.

**Conclusions/action items:**

Use these in the PDS to define our device and outline its future design process.

# 10/4/23 - Bottle Squeeze Force Research

THOMAS KRIEWALDT - Oct 04, 2023, 2:48 PM CDT

**Title: Bottle Squeeze Force Research**

**Date:** 10/4/23

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To classify the amount of force to release a singular drop from an eye bottle.

**Sources:**

[1] K. Kashiwagi, “Wide Variation of Squeezing Force and Dispensing Time Interval among Eyedropper Bottles,” J Ophthalmol, vol. 2019, p. 7250563, Apr. 2019, doi: 10.1155/2019/7250563.

[2] “Force Requirements to Squeeze a Drop From Glaucoma Bottles Is Highly Variable,” PracticeUpdate. Accessed: Oct. 04, 2023. [Online]. Available: https://www.practiceupdate.com/content/force-requirements-to-squeeze-a-drop-from-glaucoma-bottles-is-highly-variable/43420

**Content:**

The first source details the average force to release one drop from 87 different eye dropper bottles [1].

- The study used a custom squeeze measuring system (this might not be consistent) made from a syringe pump, digital force gauge, and testing stand.
    - Inserted/tested vertically (good, as this is how eye drops will be used)
- 0.5 mm/s was used as the rate of the force gauge.

The most common eye drop bottle was used for glaucoma medicine delivery (good, as this is what the client is also using it for.)

- **First Drop (mean)**: 8.3 ± 3.0 N of Force (*Minimum*: 4.2 N, *Maximum*: 15.7 N)
- **Second Drop (mean)**: 10.4 ± 3.2 N of Force (*Minimum*: 5.6 N, *Maximum*: 18.1 N)

This is interesting because it concludes that about 2 N more are required to release a second drop.

- The team should also verify this experimentally so that we can adjust the design for this factor (if it is true).

Also, the force to release one drop is super variable, and not consistent at all. This could be a factor of the many different bottles that were involved in this study, but also could prove to be an issue for our design inputs (as there would be no way to truly quantify how much force is required from the device.)

-

The second source details the force requirements to release drops from different glaucoma-specific bottles [2].

- Detailed both the horizontal and vertical positions of the eye drop bottles (The team only is concerned with the vertical orientation).
- Tested 84 different bottles (21 different designs), results stem from the release of 10 drops from each different bottle.

Results:

- **Vertical Position**: 0.67 to 4.49 kgf (6.57 to 44.032 N)
- *Horizontal Position*: 0.81 to 3 kgf (7.943 to 29.42 N)

This source, like the first one, concludes that the release of one drop from different bottles is wildly inconsistent, and may require a significantly higher force than arthritic patients can generate.

**Conclusions/action items:**

The force to elicit exactly one drop from various eye drop bottles is very inconsistent. We should continue to move forward with designs that can generate additional force to assist the force that arthritic patients can exert.

# 12/01/23 - Additional Hand Grip Research

**Title: Hand Grip Strength Research**

**Date:** 12/01/2023

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To characterize the minimum and average hand grip strength of arthritic patients.

**Source**:

[1] G. Sferra da Silva, M. de Almeida Lourenço, and M. R. de Assis, “Hand strength in patients with RA correlates strongly with function but not with activity of disease,” Advances in Rheumatology, vol. 58, no. 1, p. 20, Aug. 2018, doi: 10.1186/s42358-018-0020-1.

[2] Shiratori AP, Iop R, Borges Júnior NG, Domenech SC, Gevaerd MS. Protocolos de avaliação da força de preensão manual em indivíduos com artrite reumatoide: uma revisão sistemática. Rev Bras Reum. 2014;54(2):140–7

**Content:**

This study looks into 242 subjects, half of which were evaluated to have rheumatoid arthritis and the other half being a control group [1].

- Evaluated for: disease by DAS-28, functional capacity by HAQ, and extremity function by CHFS and DASH questionnaires.
- Includes different characteristics in Table 1, but does not analyze any of the strength metrics with them.

In this study, they detail hand-grip strength, 2 point pinch strength, 3 point pinch strength, and lateral pinch strength.

- We will be focusing on hand-grip strength, as it is the method of application for our device!
    - This was done by using a Jamar hydraulic dynamometer at hand position 2 as defined by the ASHT [2].

(B) Position 2

*The hand grip was determined for the left and right hands for both the RA and control groups:*

- Calculated the N force using the equation: Force (N) = Force (kg) * 9.81 (m/s^2)

**Left Hand:**

- RA: 170.11 ± 87.01 N (17.34 ± 8.87 kgf)
- Control: 253.59 ± 81.62 N (25.85 ± 8.32 kgf)

**Right Hand**:

- RA: 174.03 ± 90.55 N (17.74 ± 9.23 kgf)
- Control: 254.47 ± 81.72 N (25.94 ± 8.33 kgf)

This means that in the RA groups, the average hand grip strength is about **172 N**, compared to 254 N for the control group.

- Focus on the lower bound to be inclusive of all potential users of this device.
- The device should be able to accomodate this range, which has a lower bound of **83 N**.
    - **We need to ensure that our testing of the device allows patients to elicit drops using a force less than 83 N.**
- Also note that this minimum force decreases with age, as expected.
    - The lowest value in this study was about 35 N for the highest age in the left hand.
    - We should try to meet ***this*** value if possible!

**Conclusions/action items:**

Test our device using the MTS machine

- Figure out the displacement required to release one drop from each bottle size.
- Use the MTS machine to find the force required to move the device to this deformation.
- Analyze results, ensure the force is below 83 N.
    - Below 35 N would be better, as it accommodates *EVERY* patient would be more ideal!
- Make changes to the device as needed to meet this condition!

# 9/12/23 - XactDrop Eye Drop Helper

THOMAS KRIEWALDT - Sep 13, 2023, 12:15 AM CDT

**Title:** XactDrop Eye Drop Helper

**Date:** 9/12/23

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To see what this existing product does, and how it compares to what we hope to do.

**Citation:**

[1] “Amazon.com: XactDrop Eye Drop Helper- with Free Travel Pouch $9.95: Health & Household.” https://www.amazon.com/XactDrop-Helper-Travel-Pouch-Shipping/dp/B07ZZDLQ17 (accessed Sep. 12, 2023).

**Content:**


This is a picture of the XactDrop as shown on Amazon. A link to it is embedded into the picture [1].

This design seems pretty innovative and useful to a population that struggles with gripping eye drops.

- Particularly, I think this would be super useful for those with Parkinson's or related diseases.

- However, I don't think this design would be super helpful for those with arthritis, as it does not offer any additional grip support.

***Reviews on Amazon are mixed:***

- The $9.95 price point seems a bit expensive for what it does.
    - This also serves as a good reminder to keep cost in mind for this project.
- Does not fit the nose bridge of many users; "not a one-size-fits-all design."
- 42% of reviewers gave it a 5-star review.

I think this design could be a good place to start, but a lot of future modifications would have to be made to make it viable for our client.

- The semi-circular nose bridge will likely not fit *every* nose size and shape.
    - Could use an adjustable mechanism here.
        - This could be a bit much, but a rigid and flexible material could work too.
- The bottle holder again will probably not fit *every* bottle size and shape.
    - For both the nose bridge and bottle holder aspects, two sizes are nice, but likely not enough.
    - Again, could use an adjustable apparatus to fit into every bottle.
- There is no additional support for the targeted, arthritic, population in this design.

Overall, this device seems useful, but only in specific instances.

**Conclusions/action items:**

Something similar to this could be used, although it seems a bit ineffective, as different-sized bottles and noses could impact certain users.

We should start drafting design ideas for this project.

# 9/26/23 - The Clasp Design

THOMAS KRIEWALDT - Sep 26, 2023, 8:17 PM CDT

**Title: The Clasp Design**

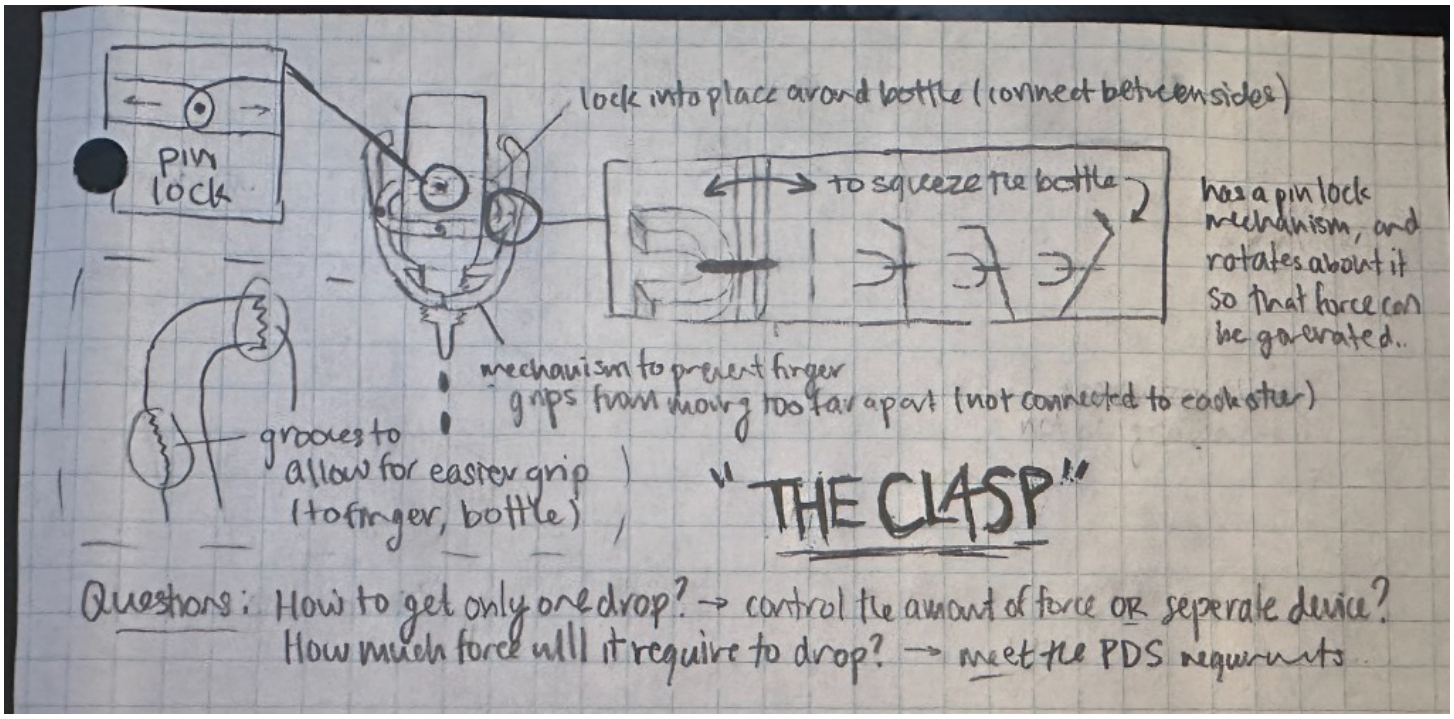
**Date:** 9/26/23

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To create a design idea that relies on a simple mechanical principle.

**Content:**




**Conclusions/action items:**

I believe that this design will work, but it will need a separate mechanism or an additional mechanism to this one for ensuring that only one drop is administered.

# 9/26/23 - The Slider Design

THOMAS KRIEWALDT - Sep 26, 2023, 8:28 PM CDT

**Title: The Slider Design**

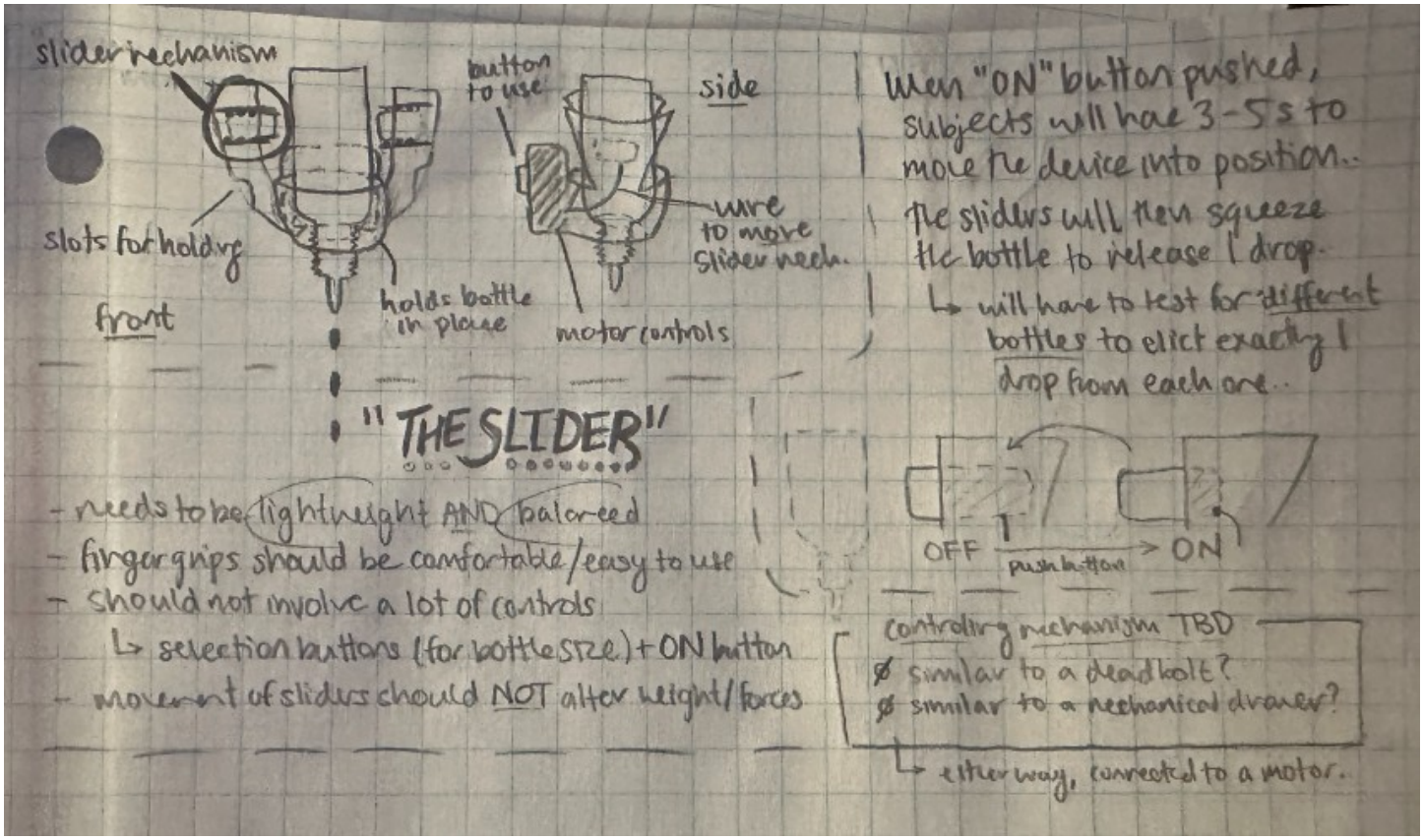
**Date:** 9/26/23

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To create a more complex design that involves electrical components so that arthritic patients do not have to squeeze the eye drop bottles.

**Content:**




**Conclusions/action items:**

This design would fit the criteria outlined by the client however, it would be difficult to fabricate.If we could simplify aspects of this design, it could prove to be more effective with less moving parts.

# 10/5/23 - The Slider Design Updated Sketch

THOMAS KRIEWALDT - Oct 10, 2023, 11:03 PM CDT

**Title: The Slider Design**

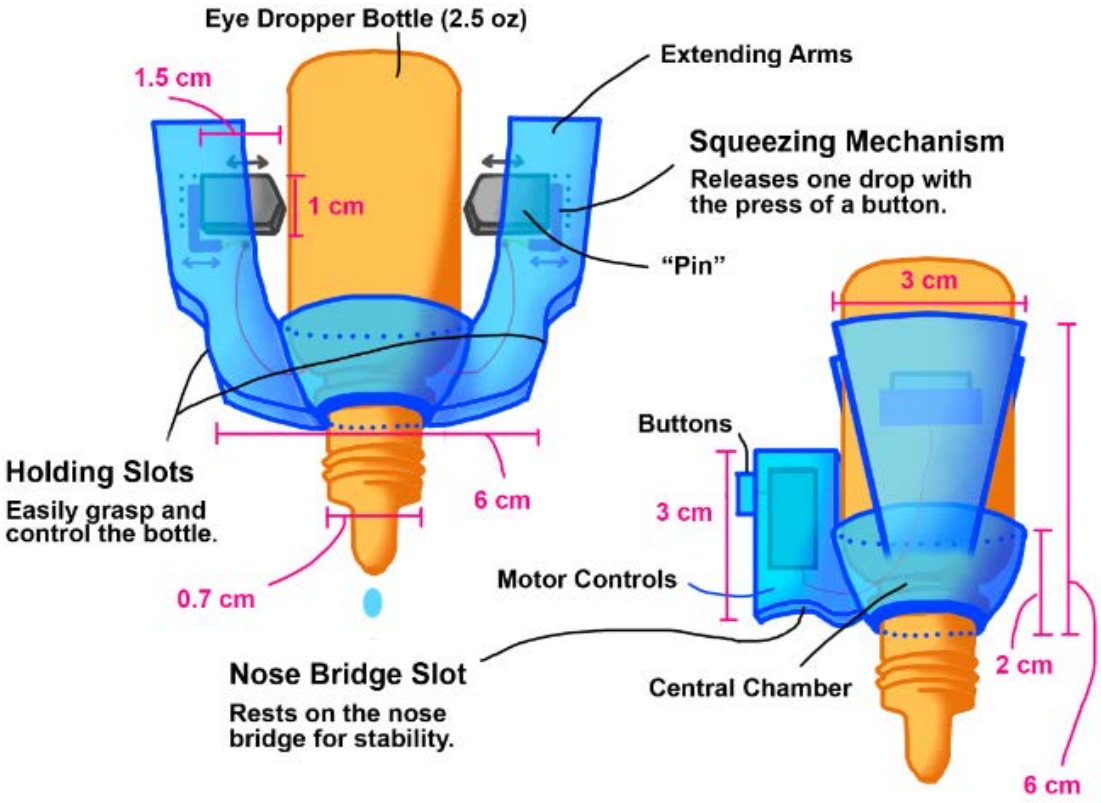
**Date:** 10/5/23

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Goals:** To create a better sketch of the Slider design so that it can be visually understood.

**Content:**




**Conclusions/action items:**

This sketch will be used in the preliminary presentation and preliminary report and shows enough information for the viewer to understand.

Finish the presentation slides using this sketch, and start work on the preliminary report.

# Red Permit

THOMAS KRIEWALDT - Mar 09, 2022, 7:01 PM CST

**Title: Red Permit**

**Date:** 2/17/22

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Content:**

THOMAS KRIEWALDT - Feb 18, 2022, 12:08 PM CST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**Red_Permit_-_Thomas_Kriewaldt.jpg (61.1 kB)**

THOMAS KRIEWALDT - Feb 18, 2022, 12:09 PM CST

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**IMG_3624.jpg (1.61 MB)**

# Green Permit

THOMAS KRIEWALDT - Apr 06, 2022, 1:52 PM CDT

**Title: Green Permit**

**Date:** 3/9/22

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Content:**

THOMAS KRIEWALDT - Mar 09, 2022, 7:01 PM CST


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THOMAS KRIEWALDT - Mar 09, 2022, 7:01 PM CST


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**Green_Permit_-_Thomas_Kriewaldt.jpg (280 kB)**

# Biosafety and Chemical Safety Training

THOMAS KRIEWALDT - Apr 06, 2022, 1:52 PM CDT

**Title: Biosafety and Chemical Safety Training**

**Date:** 3/12/22

**Content by:** Thomas Kriewaldt

**Present:** N/A

**Content:**

THOMAS KRIEWALDT - Mar 14, 2022, 2:53 PM CDT


Training Information Lookup Tool University of Wisconsin-Madison

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This certifies that Thomas Kriewaldt has completed training for the following course(s):

| Course | Assignment | Completion | Expiration |
|---|---|---|---|
| Biosafety Required Training | Biosafety Required Training Quiz 2022 | 3/7/2022 | |
| Chemical Safety: The OSHA Lab Standard | Final Quiz | 3/7/2022 | |

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**Biosafety_and_Chemical_Training_Kriewaldt_Thomas.pdf (165 kB)**

# 2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

**Title:** Descriptive title (i.e. Client Meeting)

**Date:** 9/5/2016

**Content by:** The one person who wrote the content

**Present:** Names of those present if more than just you (not necessary for individual work)

**Goals:** Establish clear goals for all text entries (meetings, individual work, etc.).

**Content:**

Contains clear and organized notes (also includes any references used)

**Conclusions/action items:**

Recap only the most significant findings and/or action items resulting from the entry.

# 2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

**Title:**

**Date:**

**Content by:**

**Present:**

**Goals:**

**Content:**

**Conclusions/action items:**