

BIOE Team 11: A Modified Syringe Design to Simplify the Preparation of Weight-Based Pediatric Medication

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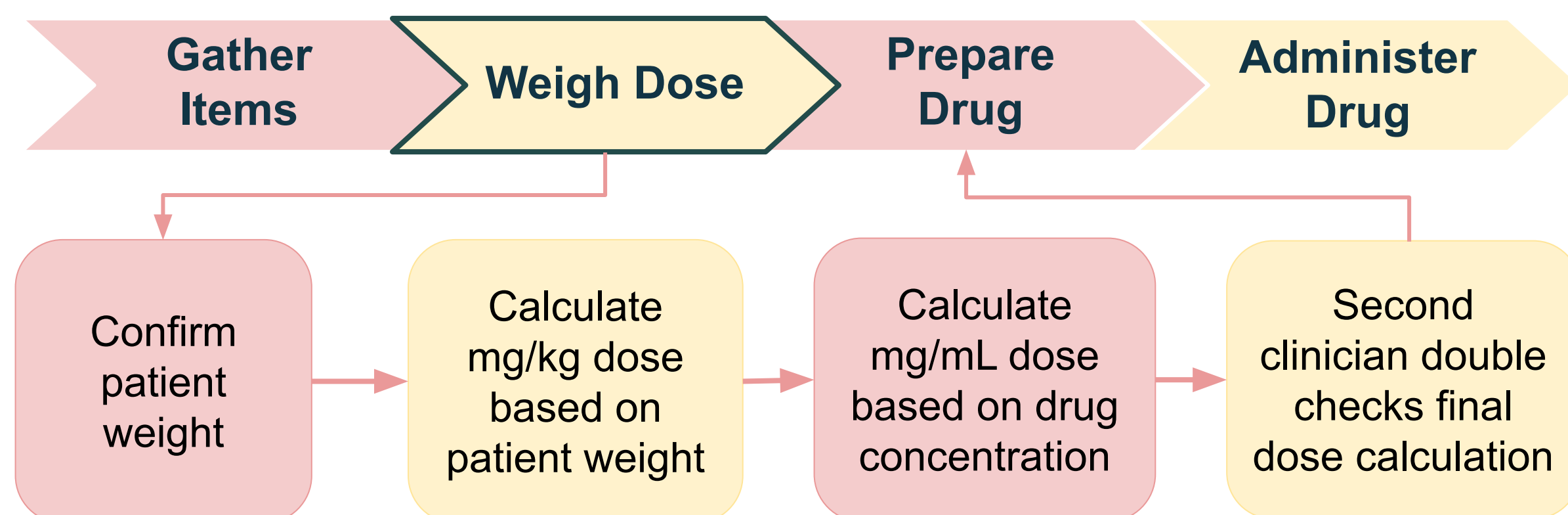
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Objective

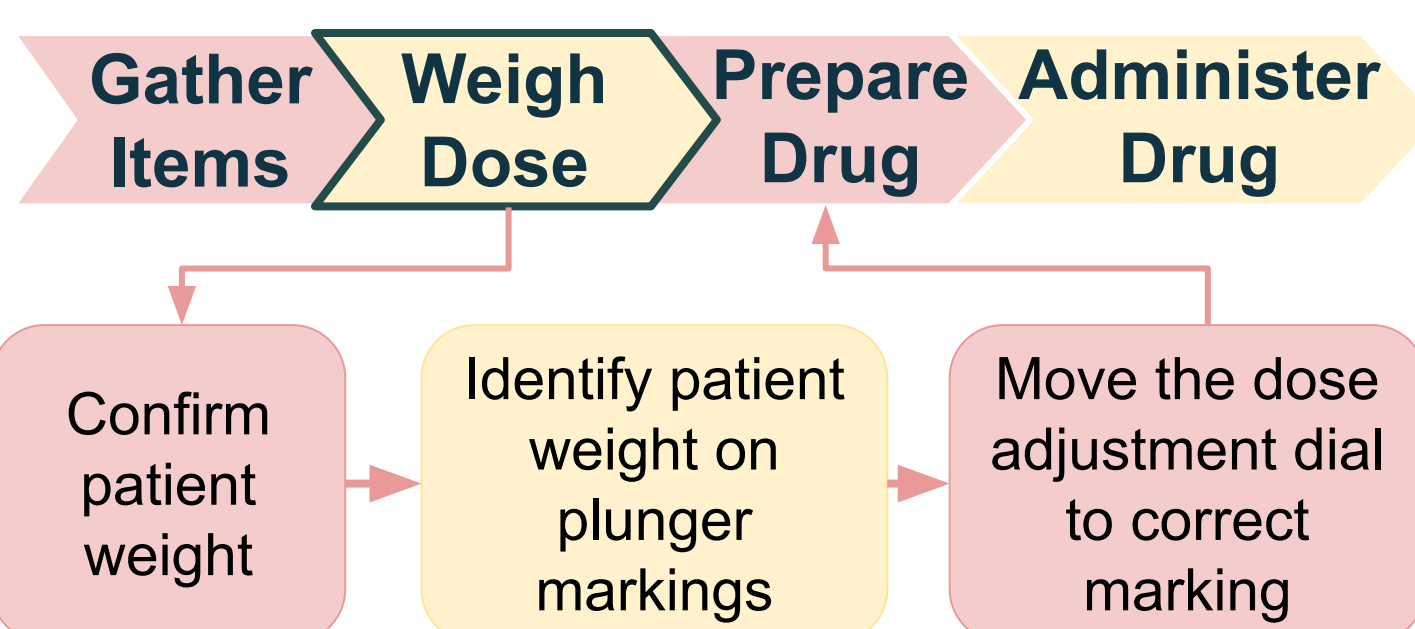
Adverse Drug Effects (ADEs): unintended, harmful effects attributed to medicine use, including dosage errors

- Can result in ineffectiveness of treatment, toxicity, or death
- Dosage errors are **3x** more common in children than adults¹
- Reported incidence of ADEs in hospitals is **6.5 per 100 admissions**²

“Simplify current workflow by eliminating hand calculations, and instead use our modified syringe and dose adjustment dial to determine the correct dose”



Methods



- **Dose Conversion Analysis:**
 - Epinephrine as the main drug focus
 - Calculated dose → 0.01 mg/kg of body weight³
- **Time of Use Assessment:**
 - Time trials to compare preparation time between workflow and syringe
 - Calculate the average time to adjust the syringe and estimate final time

Table 1. Appropriate dosage of 1:10000 Epinephrine in mg and mL given patient weight

Weight (kg)	mg	mL
5	0.05	0.5
7	0.07	0.7
10	0.1	1
12	0.12	1.2
15	0.15	1.5
18	0.18	1.8
20	0.2	2
22	0.22	2.2
25	0.25	2.5
27	0.27	2.7
30	0.3	3

Prototyping and Results

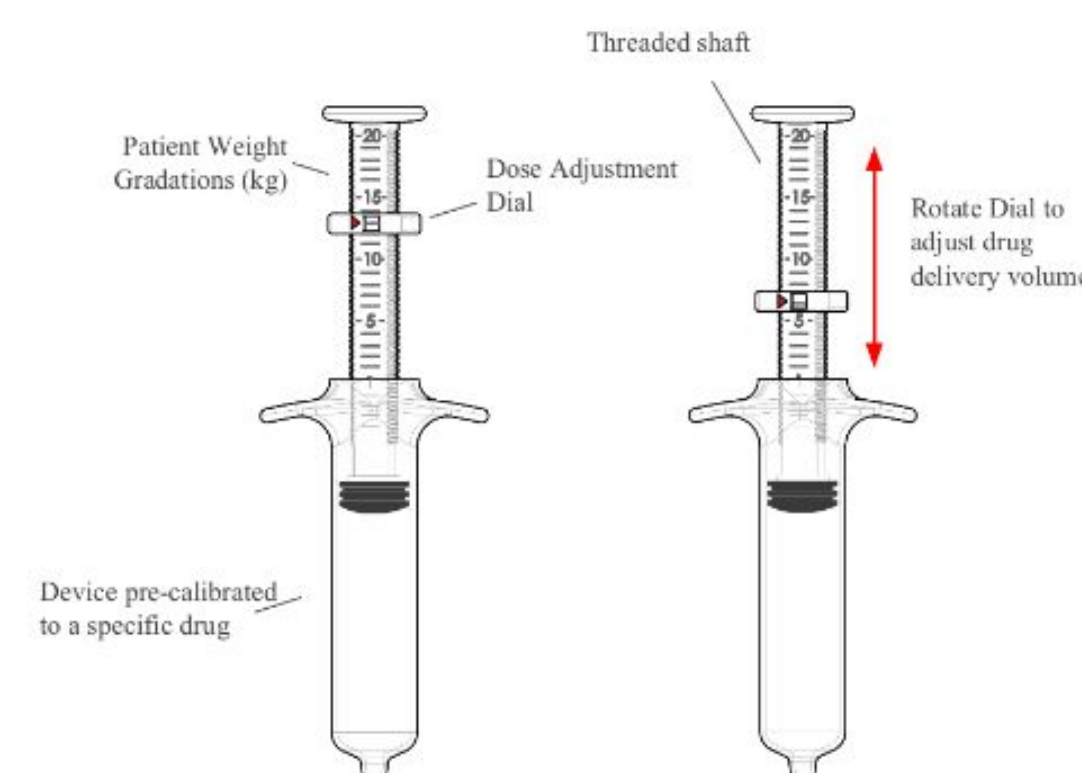


Figure 1. Computer rendered model of preliminary syringe design

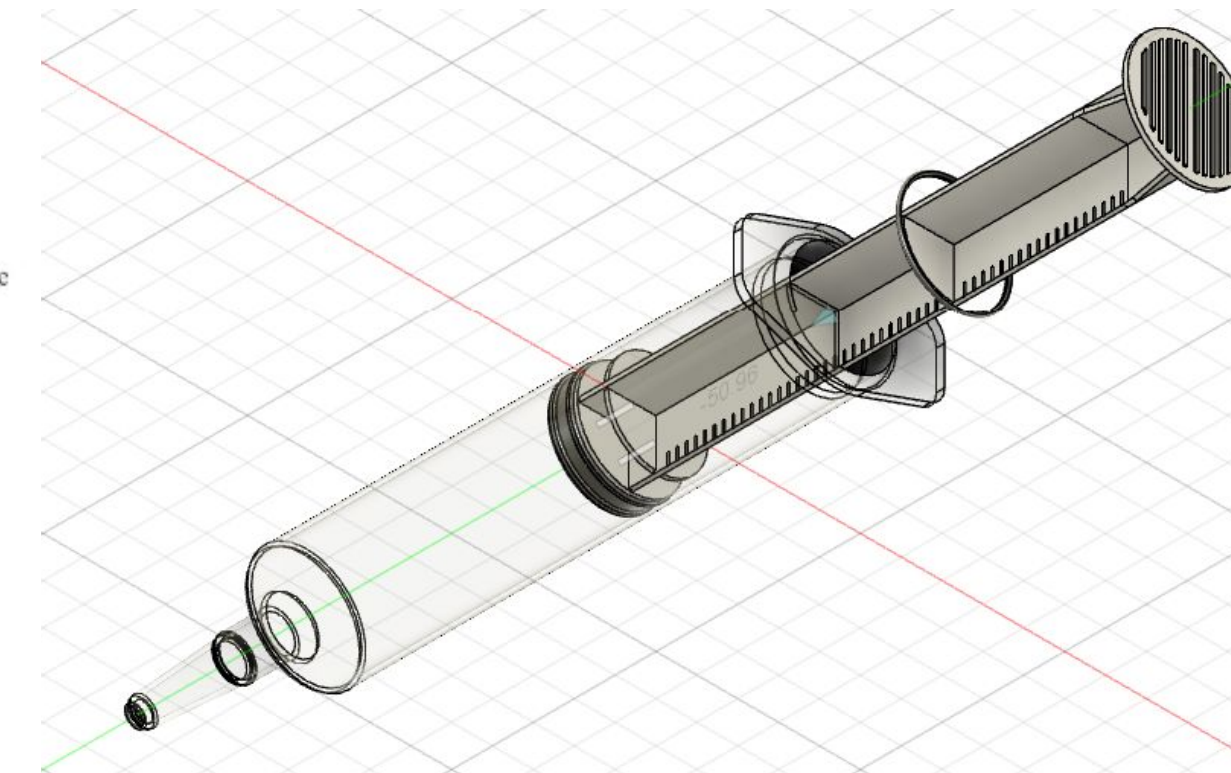


Figure 2. CAD assembly of first prototype of modified syringe

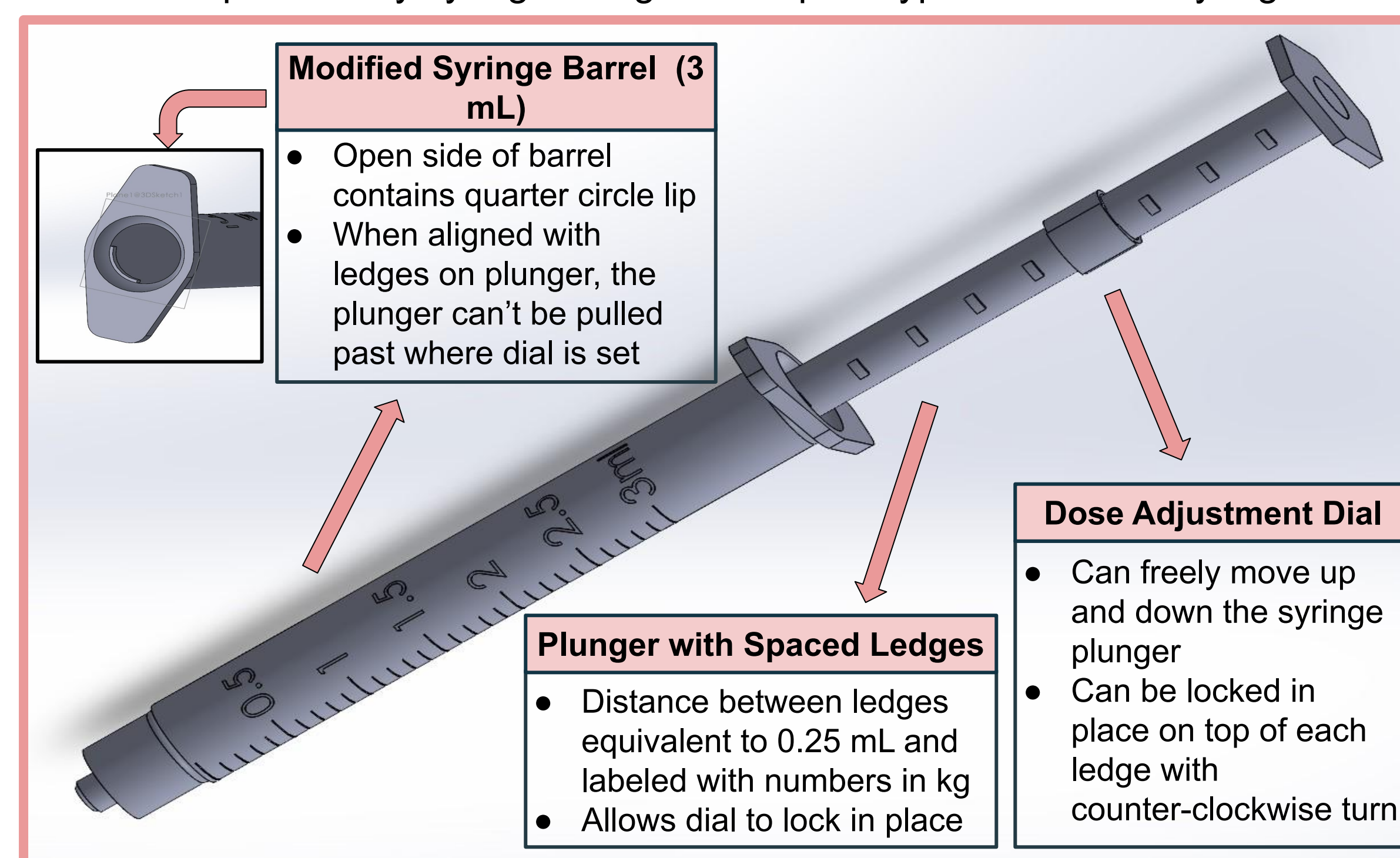


Figure 3. CAD Assembly of modified syringe design

Innovative Approach to Syringe Design:

- Cylindrical plunger with weight based markings
- Dose adjustment dial for smooth sliding, rotating, and locking in place

Results:

- Typical time to dose is ~1 minute⁴
- Reduced time to draw and administer drug by 40%

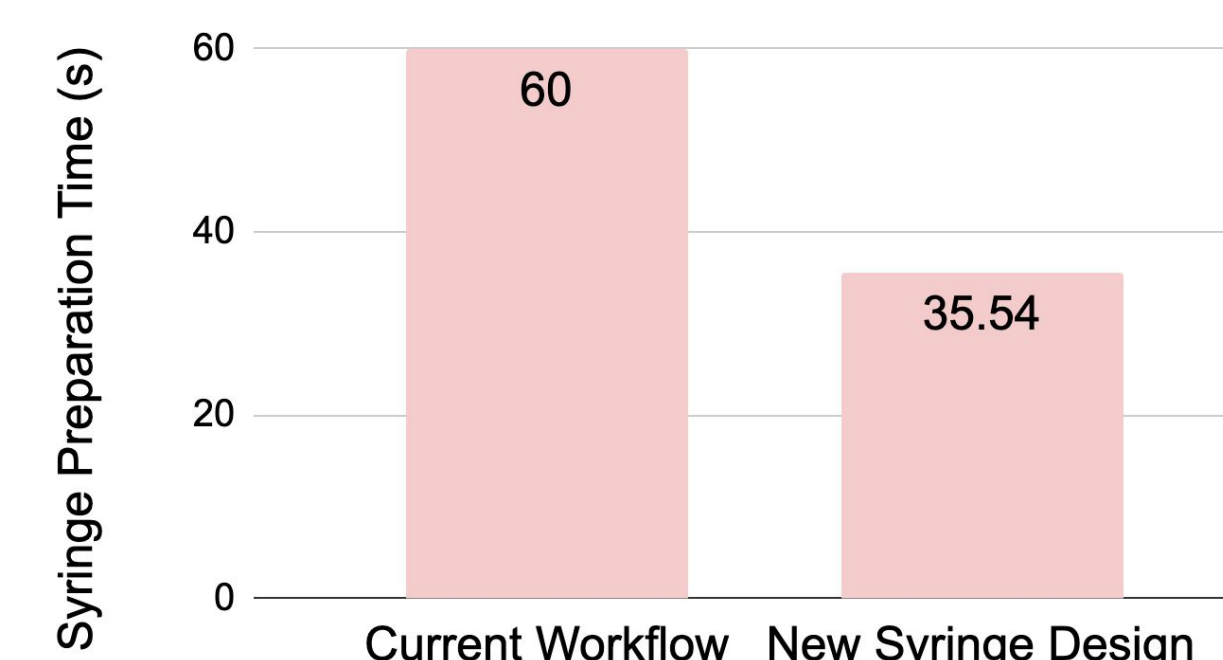


Figure 2. Estimated syringe preparation time with modified design vs. current workflow

Bioethical Implications



Patients

- Receive accurate doses tailored to weight, reducing the risk of under and overdosing



Clinicians

- Reduced risk of calculation error
- Improved patient safety



Hospital Administration

- Cost savings
- Reduced liability for the hospital

Conclusions

- **Cost effective device** that addresses the biomedical problem of medical dosage errors
- **Prevents improper medication dose** from being administered to patients
 - Underdosing, overdosing, and adverse reactions
- **Simplifies the dosing process**
 - Setting the appropriate dosage vs. patient's weight
 - Reduces the risk of manual calculation errors
 - Streamlines the medication administration process

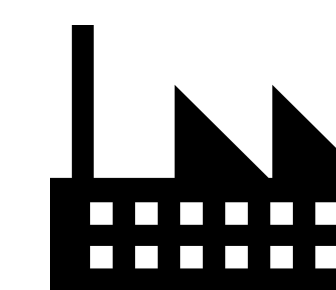
Future Work



Usability Testing

Clinician Experience

- Conduct user testing with clinicians
- Gather feedback on ease of use, and overall satisfaction with the device



Scaling and Manufacturing

- Evaluate scalability of syringe manufacturing
- Obtain necessary regulatory approvals

References

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 2) Oyebode F. Clinical errors and medical negligence. *Med Princ Pract*. 2013;22(4):323-333. doi:10.1159/000346296
 3) Dreborg, S., Walter, G., & Kim, H. (2022). International recommendations on epinephrine auto-injector doses often differ from standard weight-based guidance: a review and clinical proposals. *Allergy, asthma, and clinical immunology: official journal of the Canadian Society of Allergy and Clinical Immunology*, 18(1), 102. https://doi.org/10.1186/s13223-022-00736-5
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