

Evaluation of a Continuous Glucose Monitoring System for Use in Goats and Calves

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Introduction

Hospitalized goats with pregnancy toxemia and calves with diarrhea require frequent glucose monitoring. Current glucose monitoring options are either expensive or inaccurate¹, so an affordable and accurate continuous glucose monitoring system (CGMS) is desirable.

Test	Price
Chemistry analyzer	\$55/test
ICU machine	\$40/test
POC glucometer	\$7/test
Freestyle Libre (CGMS) Sensor	\$94/14 days → \$7/day
Freestyle Libre (CGMS) Reader	\$0 or \$107

Figure 1. UC Davis Veterinary Medical Teaching Hospital prices for tests used for glucose measurements in goats.

CGMSs have previously been evaluated in dogs, cats, adult cattle², and horses³. Freestyle Libre is a CGMS with a small filament that inserts under the skin and measures interstitial glucose concentrations, which is at equilibrium with blood glucose concentrations. Glucose measurements can be read using a mobile phone app or handheld scanner.

Benefits of Freestyle Libre include:

- 14 day application to animal
- Unlimited glucose readings
- No physical restraint or blood draw required
- Reusable handheld scanner

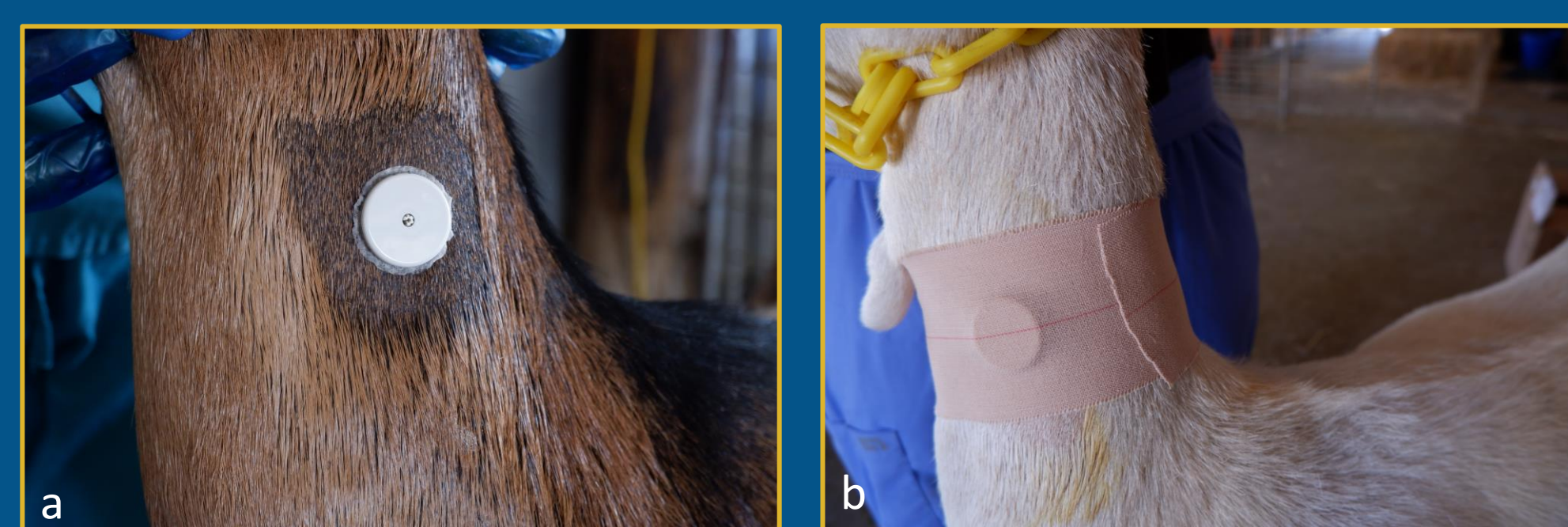


Image 1.
a. CGMS applied to a goat's lateral neck.
b. Bandage material wrapped over CGMS on a goat's neck.
c. CGMS applied to a calf's lateral neck.

Hypothesis

Glucose measurements determined by a continuous glucose monitoring system will be similar to those determined by a chemistry analyzer (reference method)

Aim

To determine the accuracy of a CGMS by comparing glucose concentrations measured over time by the CGMS, the chemistry analyzer, the ICU machine, and the POC glucometer in normoglycemic, hyperglycemic, and hypoglycemic healthy goats and calves

Methods

Randomized cross-over study design

Animals:

7 healthy goats	7 healthy calves
• Female	• Male
• 13-14 months old	• <2 weeks old

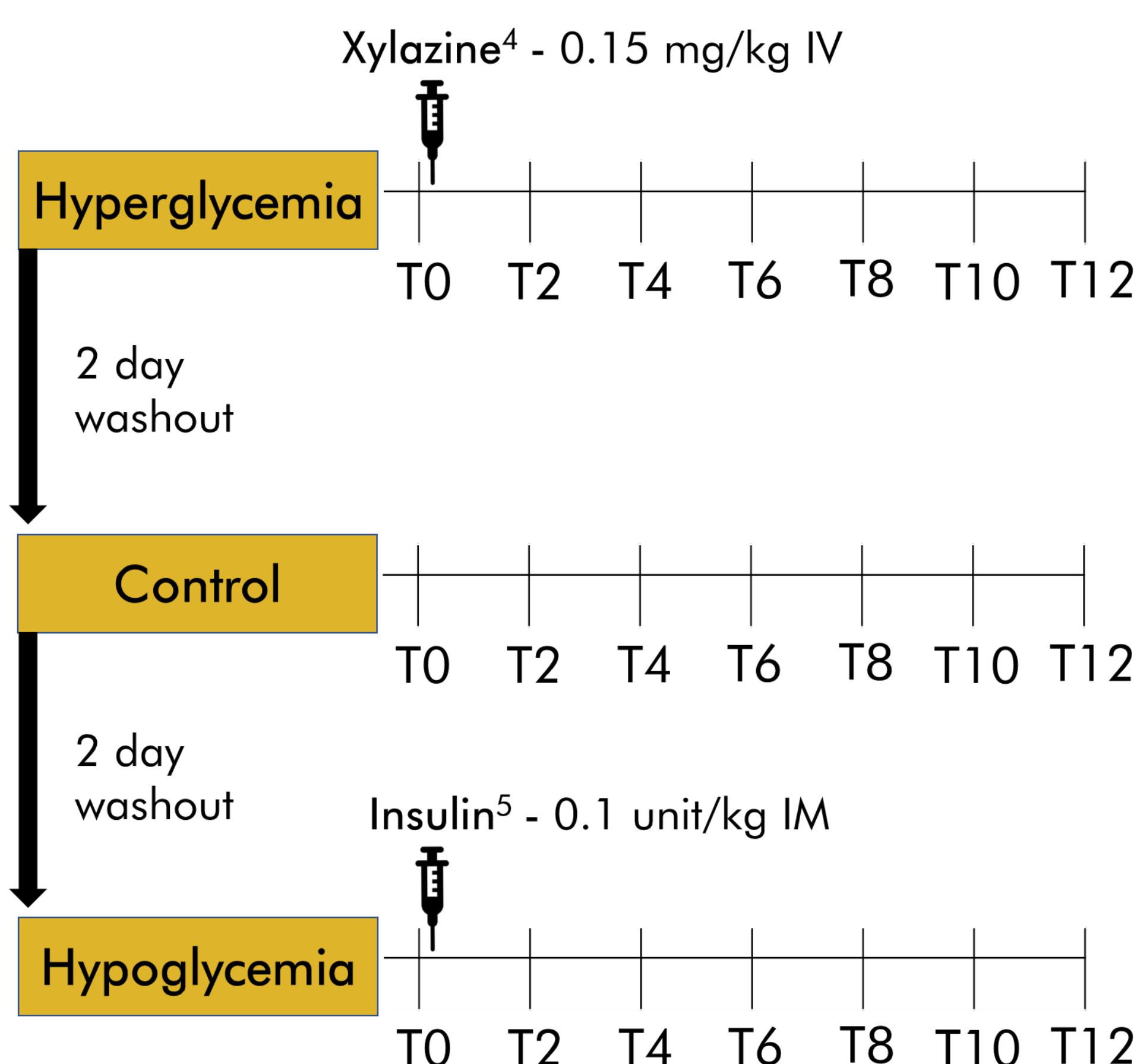


Figure 2. Timeline of 3 glycemia states the cohort of goats progressed through, showing 12 hours of glucose concentration measurement timepoints.

Measurement Timepoints:

- Every 2 hours for a total of 12 hours
 - CGMS
 - POC glucometer
 - ICU Machine
 - Freeze plasma → Chemistry analyzer

Results - Goats

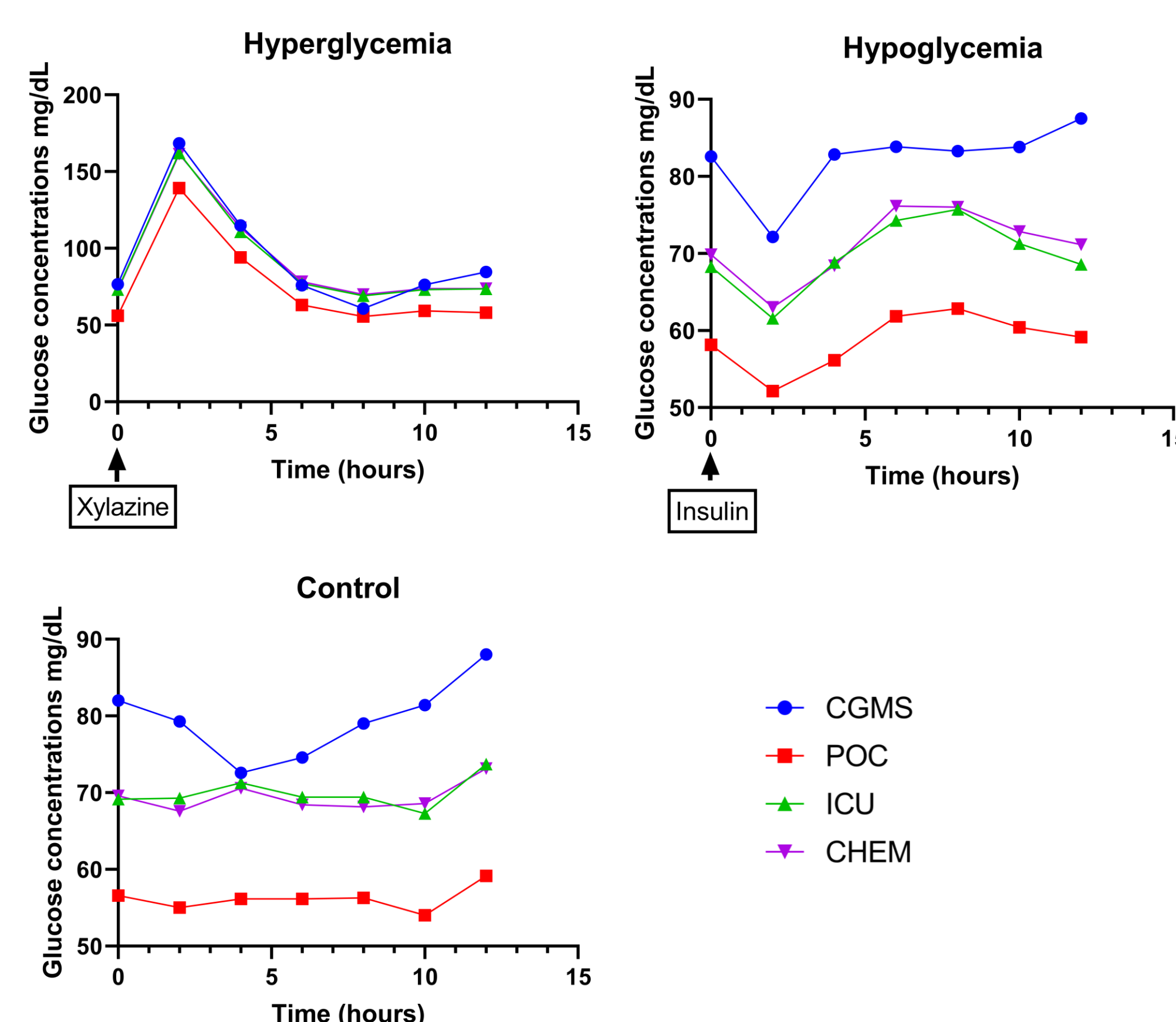


Figure 3. Average glucose concentrations of cohort of goats as determined by CGMS, POC glucometer, ICU machine, and chemistry analyzer over time.

Hyperglycemia		Control		Hypoglycemia	
Bias	95% Limits of Agreement	Bias	95% Limits of Agreement	Bias	95% Limits of Agreement
1.7 mg/dL	-43.5 to 46.8	10.2 mg/dL	8.9 to 29.2	8.8 mg/dL	-13.8 to 31.2

Figure 4. Bias and 95% limits of agreement for CGMS in each glycemia state as determined by Bland-Altman plots for repeated measures.

Results - Calves

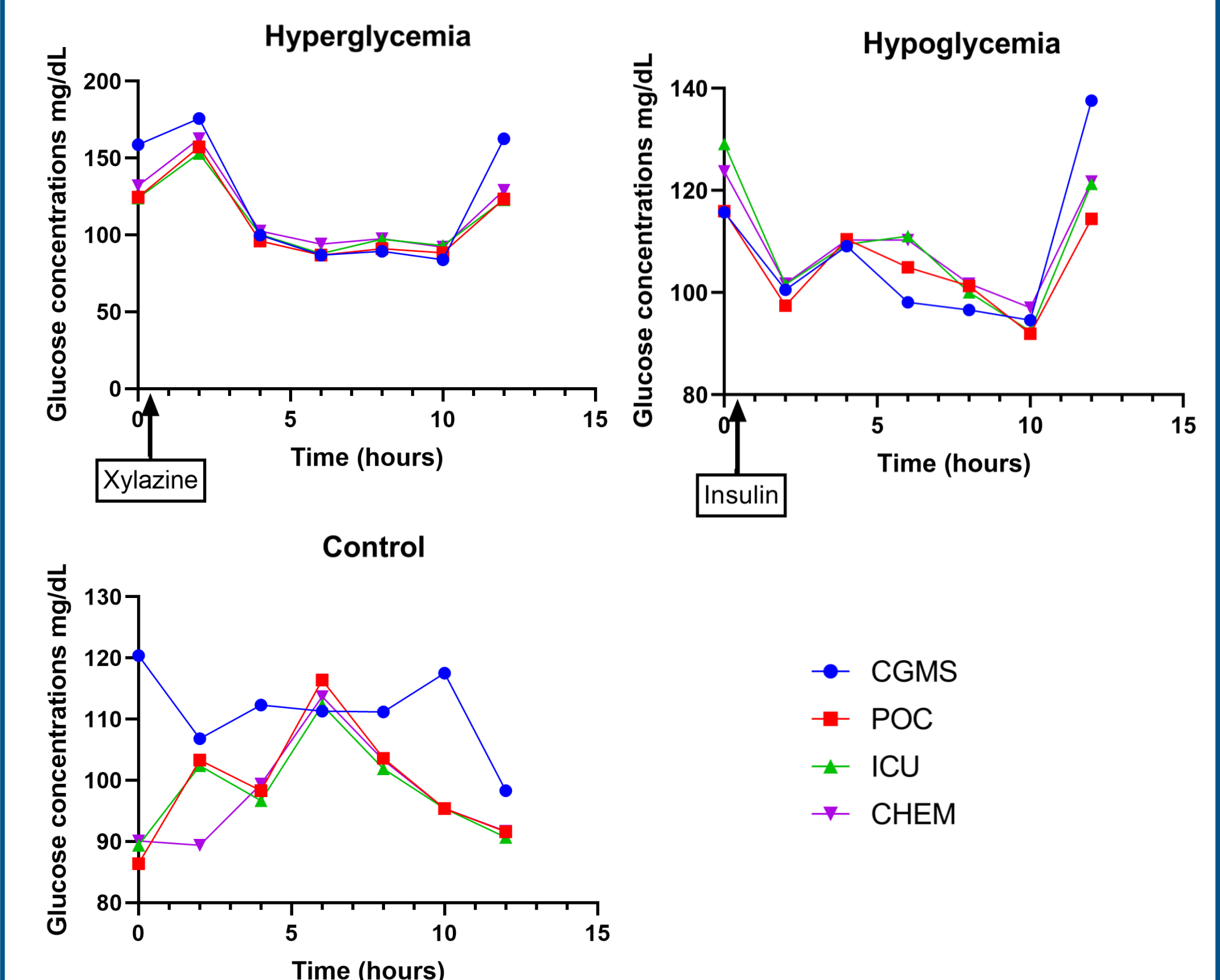


Figure 5. Average glucose concentrations of cohort of calves as determined by CGMS, POC glucometer, ICU machine, and chemistry analyzer over time.

Hyperglycemia		Control		Hypoglycemia	
Bias	95% Limits of Agreement	Bias	95% Limits of Agreement	Bias	95% Limits of Agreement
6.7 mg/dL	-54.0 to 67.3	8.1 mg/dL	-29.4 to 45.5	-2.1 mg/dL	-56.7 to 52.3

Figure 6. Bias and 95% limits of agreement for CGMS in each glycemia state as determined by Bland-Altman plots for repeated measures.

Discussion

Conclusions

- CGMS has acceptable accuracy in healthy goats and calves for potential clinical use
- CGMS is most accurate in hyperglycemic goats and hypoglycemic calves

Future Direction

- Test accuracy of CGMS in sick goats and calves

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References

1. Quandt, Jane E., et al. "Evaluation of a Point-of-Care Blood Glucose Monitor in Healthy Goats." *Journal of Veterinary Emergency and Critical Care*. 2018;28(1):45-35
2. Wiedmeyer, Charles E., et al. "Evaluation of a Continuous Glucose Monitoring System for Use in Veterinary Medicine." *Diabetes Technology & Therapeutics*. 2005;6(7):885-895
3. Wong, David, et al. "Evaluation of a Continuous Glucose Monitoring System in Neonatal Foals." *Journal of Veterinary Internal Medicine*. 2021;35(4):1995-2001
4. Hsu, Walter, and Sharon Hummel. "Xylazine-Induced Hyperglycemia in Cattle: A Possible Involvement of A2-Adrenergic Receptors Regulating Insulin Release." *Endocrinology*. 1981;109(3):825-829
5. Giri, J.K., et al. "Insulin-dependent diabetes mellitus associated with presumed autoimmune polyendocrine syndrome in a mare." *Canadian Veterinary Journal*. 2001;52(5):506-512