HOW ACCURATE ARE GLUCOMETERS REALLY?

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OUTLINE

1. Review the importance of blood glucose measurements

2. Provide an overview of available veterinary glucometers and how to use them

3. Provide recommendations for best practices

BLOOD GLUCOSE CONCENTRATION

- Important for
  - Establishment of diagnoses
  - Therapeutic decisions
- Situations
  - Monitoring diabetes/endocrine disease
  - Anorexic patients
  - Hospitalized patients
  - Intoxicated patients
  - Emergency procedures

MEASUREMENT

- Most clinicians
  - Access to automated biochemical analyzers
  - Quantify blood glucose: hexokinase vs glucose oxidase
- Automated analyzers
  - Gold standard
  - Disadvantages: blood sample volume, slower turnaround time

PORTABLE BLOOD GLUCOSE METERS

- Small, handheld devices with reagent strips
- Multiple versions
- Most PBGMs designed:
  - To use capillary blood
  - Drop of blood on test strip
- Test Strips:
  - Porous membrane
  - Separates RBCs

PURPOSE OF PBGMS

- Quick, easy and cost-effective BG measurement
- Serial BG measurement in diabetics
- Allow monitoring:
  - Liver dz
  - Sepsis
  - Neoplasia
  - Hypoadrenocorticism
  - Insulinoma
  - Weak neonates
  - Neurologically unstable

ADVANTAGES OF PBGMS

Characteristic	Patients/situations that benefit
Results within seconds	Emergency situations
Small amount blood used	Small or anemic patients
Fairly inexpensive	Serial monitoring
Can be used at home	Diabetic dogs and cats

GLUCOMETER USE

- First reports in vet med: 2000
- Different PBGM's frequently available
- Challenging to choose appropriate meter
- Very few meters validated for animals
- Veterinary glucometers: 2010

VETERINARY GLUCOMETERS

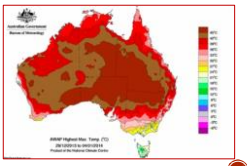
- AlphaTrak2
- Advocate PetTest
- iPet PRO
- EverPaw
- VetMate
- Cera-Pet
- FastCare Pet

ACCURACY OF PBGM'S

- Aids clinical management of hypo- and hyperglycemia
- Environmental
- Physiologic
- Operational

ENVIRONMENT

- Do not operate outside of manufacturer's recommendations
- Humidity extremes (>85%)
- Temperature extremes (>40°C)
- Altitude extremes



PHYSIOLOGICAL FACTORS

Factor	Effect
Glucose	Performance changes at extremes
Hematocrit	↑ HCT, ↓ BG and vice versa
Lipemia	Can cause false elevations
Bilirubin	Can cause up to 21% inaccuracy

OPERATIONAL

- Units of measurement: know the units!
- Accurate records must be kept

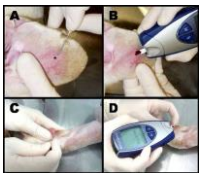
CAPILLARY VS. VENOUS

- PBGMs developed for capillary blood
- In vet practice, venous samples frequently used

Borin et al; **Capillary Blood Glucose and Venous Blood Glucose Measured with Portable Digital Glucometer in Diabetic Dogs**. Braz J Vet Pathol, 2012, 5(2), 42 - 46

Samples of diabetic dogs group	Mean ± SE mean	Maximum Value	Minimum Value
Venous Glycemia – colorimetric enzymatic assay	220.40±25.17	618.70	37.28
Venous Glycemia– Glucometer	242.00±25.94	591.00	40.00
Pinna Glycemia – Glucometer	230.00±27.38	591.00	32.00
Carpal pad Glycemia– Glucometer	245.10±26.06	549.00	36.00

- No significant difference between sites



PERFORMANCE

- Classified based on analytical vs clinical accuracy
- Analytical
  - Quantitative approach
  - Measurement method compared to reference method
- Clinical
  - Qualitative approach
  - Describes clinical outcome based off measurement method

ARE HUMAN PBGMS ACCURATE IN ANIMALS?

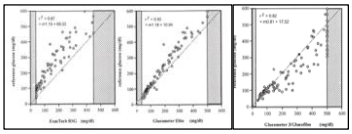
- Not all PBGMs accurate in dogs
- Dogs and cats have higher % glucose in plasma

Assessment of five portable blood glucose meters, a point-of-care analyzer, and color test strips for measuring blood glucose concentration in dogs

JAVMA, Vol 216, No. 2, January 15, 2000

Leah A. Cohn, DVM, PhD, DACVIM; Dudley L. McCaw, DVM, DACVIM; Deborah J. Tate; Jane C. Johnson, MA

- One of the first studies looking at PBGMs in dogs



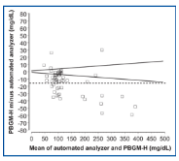
- Results from these PBGM could lead to erroneous clinical decisions.

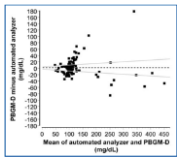
Comparison of a human portable blood glucose meter, veterinary portable blood glucose meter, and automated chemistry analyzer for measurement of blood glucose concentrations in dogs

Beth M. Johnson, DVM, DACVIM; Michael M. Fry, DVM, MS, DACVP; Bente Flatland, DVM, MS, DACVIM, DACVP; Claudia A. Kirk, DVM, PhD, DACVIM, DACVN

JAVMA, Vol 235, No. 11, December 1, 2009

- First study to investigate veterinary glucometer accuracy





- Correlation noted; disagreement greater than can be explained by instrument imprecision

Evaluation of six portable blood glucose meters for measuring blood glucose concentration in dogs

JAVMA, Vol 235, No. 3, August 1, 2009

Todd A. Cohen, DVM; Richard W. Nelson, DVM, DACVIM; Philip H. Kass, DVM, PhD, DACVPM; Mary M. Christopher, DVM, PhD; Edward C. Feldman, DVM, DACVIM

- Investigate newer human and one vet PBGM accuracy

Meter	Glucose concentration obtained with reference analyzer (mg/dL)				
	< 100 (n = 29)	100–199 (n = 31)	200–299 (n = 36)	300–400 (n = 36)	> 400 (n = 26)
AlphaTrak[a]	8 (0–28)	12 (1–44)	18 (0–99)	31.5 (3–110)	57.5 (2–179)
Precision[b]	22 (2–37)	30 (6–53)	52 (4–112)	85 (24–152)	133.5 (48–234)
Elite[c]	20 (12–32)	34 (18–50)	46 (0–97)	64 (1–144)	82 (30–155)
Contour[a]	30 (22–52)	54 (38–76)	81 (7–141)	94.5 (5–182)	101.5 (5–197)
Accu-Chek[a]	21 (10–52)	34 (20–54)	47 (9–104)	71.5 (1–136)	120.5 (44–196)
OneTouch[f]	13 (2–29)	22 (4–43)	16.5 (0–80)	30.5 (1–113)	44.5 (2–118)

- For all, results differed from reference; difference increased as plasma glucose increased

Correlation between glucose concentrations in serum, plasma, and whole blood measured by a point-of-care glucometer and serum glucose concentration measured by an automated biochemical analyzer for canine and feline blood samples

JAVMA, Vol 246, No. 12, June 15, 2015

Barbara S. Tauk, DVM, Kenneth J. Drobatz, DVM, MSCE, Koranda A. Wallace, DVM, Rebecka S. Hess, DVM

- First study comparing whole blood, plasma and serum accuracy on a human PBGM

Species	Sample analyzed by POCG	ρ_c (95% confidence interval)	Bias correction factor
Dog	Serum	0.981 (0.98–0.99)	0.993
	Plasma	0.983 (0.98–0.99)	0.997
	Whole blood	0.624 (0.54–0.71)	0.697
Cat	Serum	0.990 (0.986–0.994)	0.997
	Plasma	0.992 (0.989–0.995)	0.997
	Whole blood	0.900 (0.88–0.93)	0.913

Strength-of-agreement	Continuous variables
Almost perfect	>0.99
Substantial	>0.95–0.99
Moderate	0.90–0.95
Poor	<0.90

- Glucose concentrations in serum and plasma by PBGM more strongly correlated with analyzer than whole blood

ALPHATRAK2 STUDY

- Objective:
  - Investigate agreement between glucose concentrations in canine serum, plasma, and whole blood measured by the AlphaTrak2 and glucose concentration measured by a biochemical analyzer

CONCLUSIONS

Method	Glucose concentration (mg/dL)	Bias	P_c
Lab	107 (39-464)	--	--
Whole blood	121 (47-632)	14 mg/dL	0.93
Plasma	200 (65-751)	124 mg/dL	0.62
Serum	211 (84-751)	130 mg/dL	0.61

- With AlphaTrak2, whole blood better
- Opposite of Aviva

CONCLUSIONS

- Need to assess accuracy and precision of every PBGM
- Inappropriate therapeutic decisions can be made
- Is serum, plasma or whole blood better?

QUESTIONS?


Stop raising your hand Alligator.
You don't know the answer to my questions. You are an Alligator.