



Update on tests used to diagnose insulin dysregulation in the field

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Dedicated expert care

ANZCVS
VET SCIENCE WEEK
2025

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Disclosure Statement

Presenter: Brianna Clark

Disclosure:
I do not have any relevant financial or non-financial relationships with industry or commerce to disclose

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Overview

- ID and EMS definition
- Testing and testing consideration
 - Recent research
- Current recommendations
- Future research



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Recommendations for the Diagnosis and Management of Equine Metabolic Syndrome (EMS)

2022 EQUINE ENDOCRINOLOGY GROUP

2024 EQUINE ENDOCRINOLOGY GROUP

Recommendations for the Diagnosis and Treatment of Equine Metabolic Syndrome (EMS)

2020 EQUINE ENDOCRINOLOGY GROUP

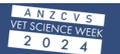
Recommendations for the Diagnosis and Management of Equine Metabolic Syndrome (EMS) and Insulin Dysregulation

Revised June 2024

Prepared by the 2024 EMS/ID Working Group

François-René Bertin (Group Lead; Purdue University)
Simon Bailey (The University of Melbourne)
Teresa Burns (The Ohio State University)
Melody de Laat (Queensland University of Technology)
Andy Durham (Liphook Equine Hospital)
Nicholas Frank (Mississippi State University)
Janice Kritchevsky (Purdue University)
Nicola Menzies-Gow (Royal Veterinary College)

<https://equineendocrinologygroup.org/>



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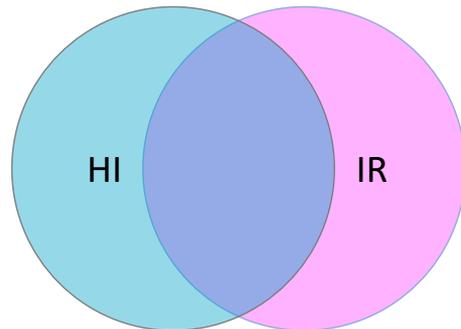
Insulin dysregulation

- Central to EMS development
- EMS
 - Collection of metabolic and clinical features
 - → increased risk **HAL** (hyperinsulinaemia-associated laminitis)
 - ID consistent component
 - ± altered adipokines, incretins, hypertriglyceridaemia, hypertension



Insulin dysregulation

- Hyperinsulinaemia (HI)
 - Basal
 - Dynamic (oral challenge)
 - Excess insulin secretion β -cells
 - Potentially decreased hepatic clearance
- Insulin resistance (IR)
 - Hepatic
 - Peripheral tissue
 - Inadequate response of insulin-sensitive tissues



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Evaluation of field-testing protocols to diagnose insulin dysregulation in ponies using a Bayesian approach

B.L. Clark^{a,*}, A.J. Stewart^a, K.L. Kemp^a, N.J. Bamford^b, F.-R. Bertin^a

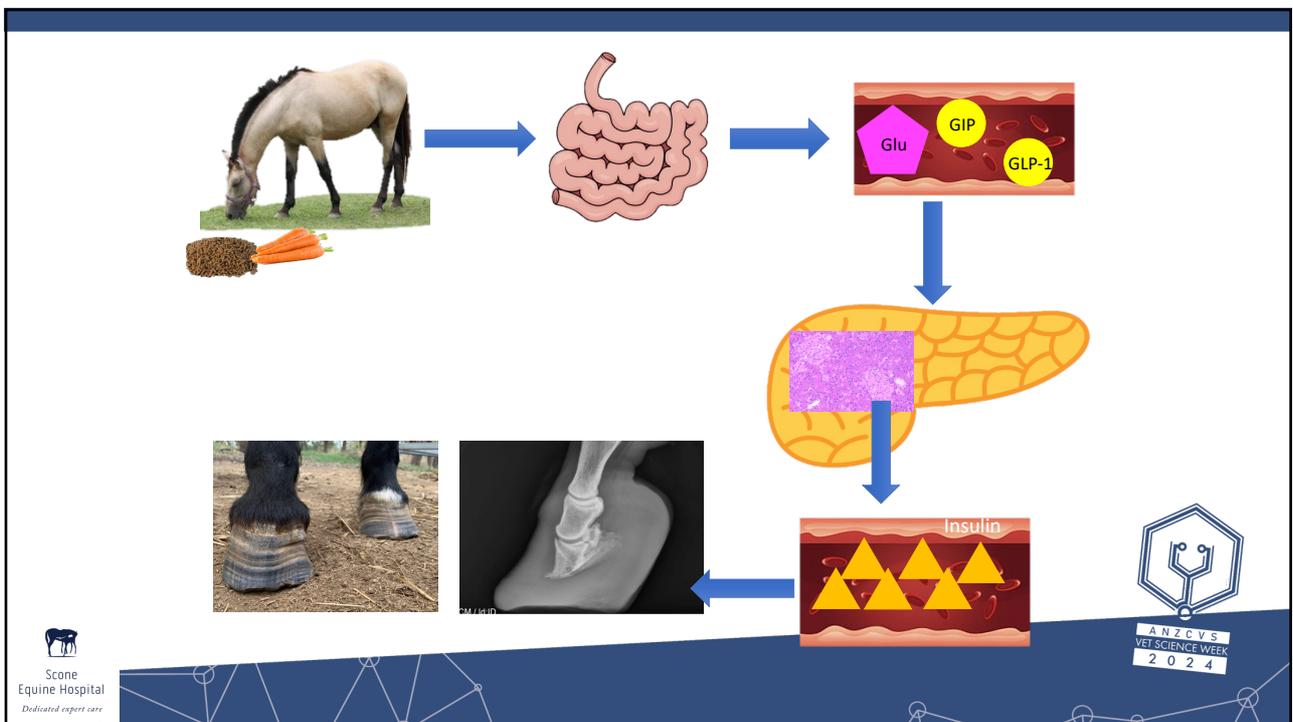
^a The University of Queensland, 5391 Warrago Hwy, Gatton, QLD 4343, Australia
^b The University of Melbourne, Park Drive, Parkville, VIC 3010, Australia

Region	Count
Dynamic HI only	7
IR only	32
Basal HI only	0
Dynamic HI & IR	29
Dynamic HI & Basal HI	4
IR & Basal HI	2
All three (Dynamic HI, IR, Basal HI)	16

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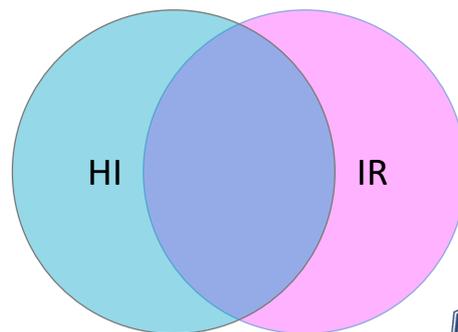
When to test?

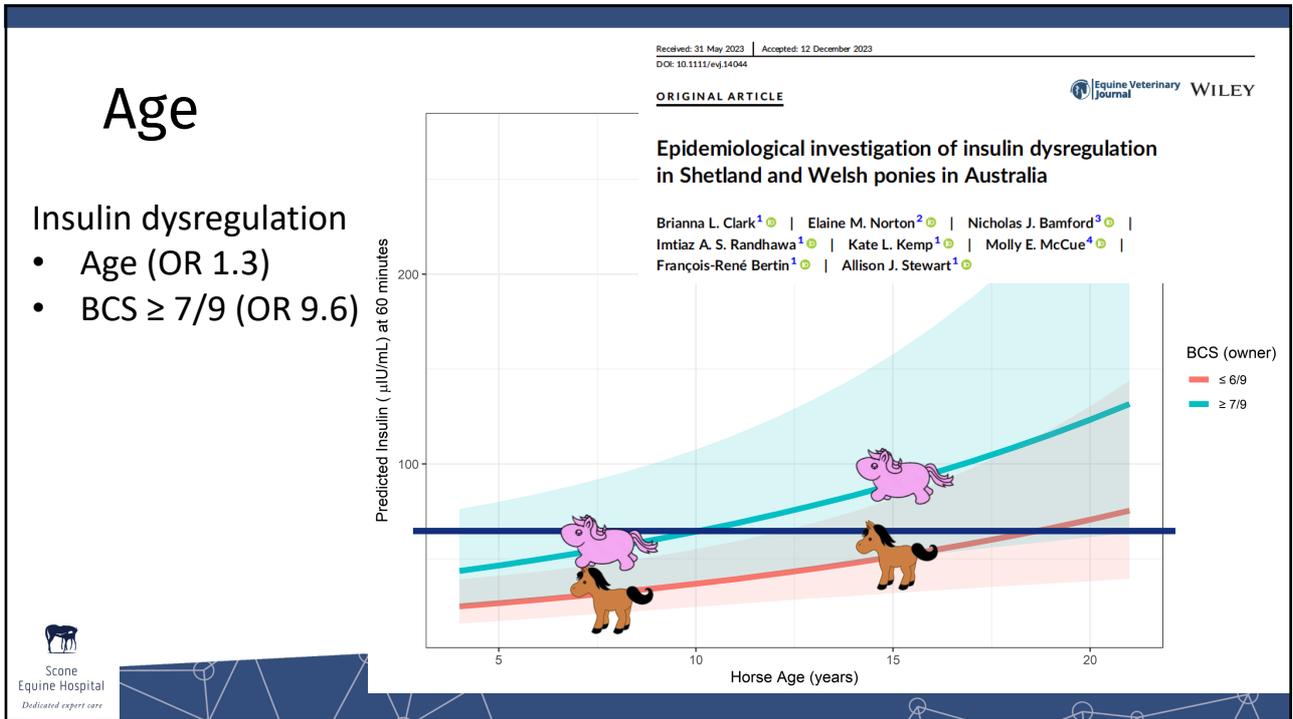
- Predisposed breeds
 - Ponies, Arabs, Spanish breeds, Morgans, WBs
- Obesity
 - Generalised and regional (CNS)
 - Not all are obese
- Hx of laminitis
 - Growth rings
- Current laminitis
- Corticosteroid use in at risk breeds
- PPE?
- Concurrent PPID?
- Other?



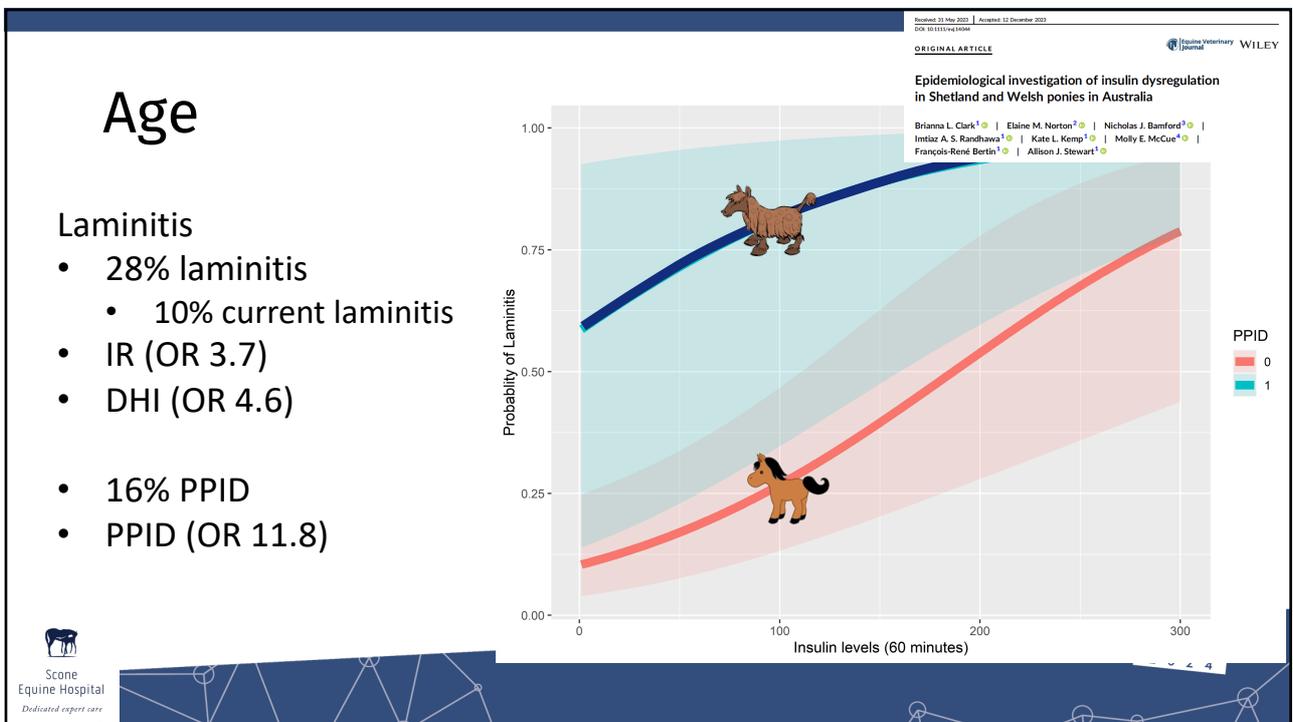
Testing considerations

- Assessment of HI
 - Oral glycaemic challenge
 - Mimics what occurs naturally
- Assessment of IR
 - ITT
- Pre-testing considerations
 - Age
 - Other diseases/illness?
 - Transportation
 - Current laminitis





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Transportation

Received: 14 March 2024 | Accepted: 8 August 2024
DOI: 10.1111/evj.14403

ORIGINAL ARTICLE

The impact of short-term transportation stress on oral sugar responses in insulin dysregulated and non-dysregulated horses

Erica T. Jacquay¹ | Patricia A. Harris² | Amanda A. Adams¹

- Increase in HR and cortisol
- Variable response for insulin and ID status
- Post transport insulin higher in ID and non-ID post OST
- No difference baseline
- Clinical considerations?

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Current laminitis

- No evidence that testing causes laminitis
 - OST
 - ITT
- Acute episode still recommend testing
 - Unless laminitis caused by SIRS etc

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Measuring insulin

- Chemiluminescent assay
 - Immulite 1000
 - Immulite 2000 (XPI)
- RIA
- ELISA
- Different cut-offs



Article
Development of a Web App to Convert Blood Insulin Concentrations among Various Immunoassays Used in Horses

Julien Delarocque ^{1,*}, Karsten Feige ¹, Harry B. Carslake ², Andy E. Durham ³, Kerstin Fey ⁴ and Tobias Warnken ^{1,†}

<https://www.equine-insulin-converter.org/>



Insulin

- Stallside
- CV 11-15.7%
- Limit of detection
 - 20 – 99.9 µIU/mL

Journal of Veterinary Diagnostic Investigation
 Volume 35, Issue 2, March 2023, Pages 124-131
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<https://doi.org/10.1177/10966872231142268>



Full Scientific Reports

Validation and method comparison for a point-of-care lateral flow assay measuring equine whole blood insulin concentrations

Emily H. Berryhill ^{1,†}, Naomi S. Urbina ², Sam Marton ³, William Vernau ⁴, and Flavio H. Alonso ^{5,6}



Insulin

- Stability
- Serum within 3d at 20°C and 8 days 4°C
- No need to separate if short delay
- Not EDTA (lower insulin concentration)

Received: 25 February 2019 | Accepted: 20 September 2019
DOI: 10.1111/jvim.15629

STANDARD ARTICLE

Journal of Veterinary Internal Medicine **ACVIM**
American College of Veterinary Internal Medicine

Immunoreactive insulin stability in horses at risk of insulin dysregulation

Dakota H. Leschke¹ | Genevieve S. Muir¹ | Jack K. Hodgson¹ | Mitchell Coyle² | Remona Horn¹ | François-René Bertin¹



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Oral glycaemic challenges

- Corn syrup (Karo®)
- Glucose/dextrose pNGT
- Other non-standardised products – validation?



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Glycaemic challenges

Received: 12 April 2022 | Accepted: 14 December 2022
DOI: 10.1111/jvim.16621

STANDARD ARTICLE

Journal of Veterinary Internal Medicine  American College of Veterinary Internal Medicine

Carbohydrate pellets to assess insulin dysregulation in horses

Melody A. de Laat¹ | Tobias Warnken^{2,3} | Julien Delarocque³ |
Dania B. Reiche² | Anne J. Grob³ | Karsten Feige³ | Harry B. Carslake⁴ |
Andy E. Durham⁵ | Martin N. Silience¹ | Kristen E. Thane⁶ |
Nicholas Frank⁶ | Johan Brojer⁷ | Sanna Lindase⁷ | Johanna Sonntag²

- Correlation to OGT
 - GC pellets $r = 0.72$ ($P < 0.001$)
 - GC syrup $r = 0.91$ ($P < 0.001$)
- Good palatability (5min)



Received: 2 March 2022 | Accepted: 8 December 2022
DOI: 10.1111/jvim.16614

STANDARD ARTICLE

Journal of Veterinary Internal Medicine  American College of Veterinary Internal Medicine

Palatability, glycemic, and insulinemic responses to various carbohydrate formulations: Alternatives for the diagnosis of insulin dysregulation in horses?

Tobias Warnken¹ | Claudia Schaub¹ | Julien Delarocque¹ | Florian Frers¹ |
Karsten Feige¹ | Johanna Sonntag² | Dania Birte Reiche²



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Comparison of one novel and four established diagnostic tests for insulin dysregulation in ponies

H.B. Carslake^{a,*}, G.L. Pinchbeck^a, C.M. Argo^b, A.H.A. Dugdale^c, C.M. McGowan^a

- OST, OGT, novel Weetabix (1g/kg NSC equivalent)
 - To CGIT
- Good correlation oral challenges
- Poor palatability



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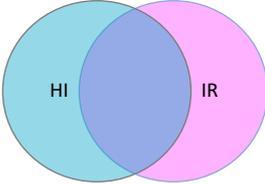


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^aThe University of Queensland, 5391 Warrego Hwy, Gatton, QLD 4343, Australia
^bThe University of Melbourne, Park Drive, Parkville, VIC 3010, Australia

- 146 ponies
- Basal insulin, OST, ITT
- Laminitis history
- Bayesian analysis (lack of GS)





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Estimates and 95% Bayesian Credible Intervals (CI) for sensitivity and specificity for insulin dysregulation for the insulin tolerance test (ITT), basal hyperinsulinaemia (BHI; serum insulin >20 µIU/mL) and dynamic hyperinsulinaemia 60 min post administration of corn syrup orally (DHI; serum insulin >65 µIU/mL).

Test	Sensitivity	95% CI	Specificity	95% CI
ITT	0.85	0.68 – 0.96	0.88	0.75 – 0.97
BHI	0.52	0.35 – 0.79	0.97	0.91 – 1.00
DHI	0.84	0.70 – 0.94	0.60	0.49 – 0.71



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Receiver operator characteristic (ROC) curve analysis of baseline and dynamic hyperinsulinaemia (insulin concentration 60 and 90 min after oral sugar test [OST]), percent glucose reduction after insulin tolerance test (ITT) and measures of adiposity, with current laminitis as the outcome.

	AUC (accuracy)	P	Cut-off	Sensitivity	95% CI	Specificity	95% CI	Positive likelihood ratio
Baseline insulin	0.75	0.003	> 20 µIU/mL	0.46	0.23 – 0.71	0.88	0.81 – 0.92	1.63
			> 9.6 µIU/mL ^a	0.69	0.42 – 0.87	0.76	0.68 – 0.82	2.47
OST insulin 60 min	0.71	0.015	> 65 µIU/mL	0.62	0.36 – 0.82	0.70	0.62 – 0.77	1.82
			> 193 µIU/mL ^a	0.46	0.23 – 0.71	0.89	0.83 – 0.94	1.67
OST insulin 90 min	0.69	0.022	> 65 µIU/mL	0.62	0.36 – 0.82	0.66	0.58 – 0.74	1.72
			> 96 µIU/mL ^a	0.62	0.36 – 0.82	0.71	0.63 – 0.78	1.86
ITT % glucose reduction	0.53	0.706	b	b	b	b	b	b
BCS	0.69	0.0002	> 6/9 ^a	0.77	0.58 – 0.89	0.60	0.52 – 0.77	2.61
CNS	0.59	0.260	b	b	b	b	b	b
Baseline glucose	0.61	0.180	b	b	b	b	b	b
OST glucose 60 min	0.63	0.138	b	b	b	b	b	b
OST glucose 90 min	0.64	0.096	b	b	b	b	b	b

AUC, area under the curve; BCS, body condition score; CI, confidence interval; CNS, Cresty neck score.
^a Optimal cut-off as determined with the calculated Youden index.
^b Not applicable with no statistical significance.




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Oral sugar test (OST)

- Karo® Light corn syrup
- Initially developed by Schuver et al 2014
 - Close correlation with FSGITT
- Good predictability future laminitis risk (Knowles et al. 2023)
- Dose 0.15 or **0.45** mL/kg PO
- Poor repeatability (binary OK)



Equine Veterinary Journal ISSN 0425-1644
 DOI: 10.1111/evj.12826

Effect of varying the dose of corn syrup on the insulin and glucose response to the oral sugar test
 N. A. JOCELYN^{1*}, P. A. HARRIS² and N. J. MENZIES-GOW¹




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Oral sugar test (OST)

- Fast 3-6 h prior
 - Required? Macon et al 2021
- Administer Karo® Light corn syrup
- Collect blood at 0/60/90 min
- **ID > 65 μ IU/mL** (Immulite1000)
- Alternative test \rightarrow OGT (0.75-1g/kg)
 - pNGT/small amount chaff
 - 120min > 80 μ IU/mL

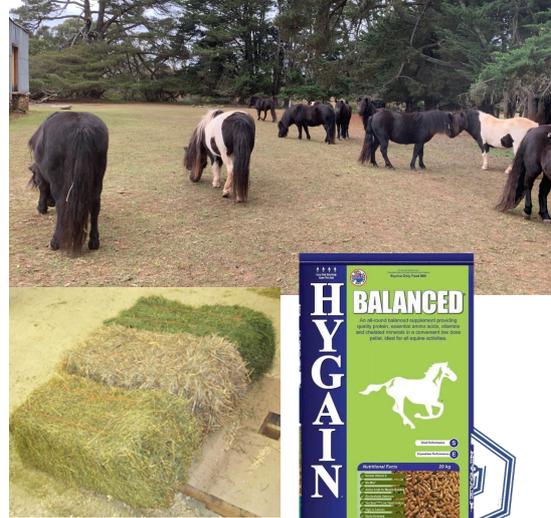


Basal insulin

- Single sample collection
- Poor sensitivity (dynamic \gg basal)
- If positive \rightarrow diagnostic
- If negative \rightarrow dynamic
- **ID > 45 μ IU/mL**
- **Suspicious of ID 20-45 μ IU/mL** (Immulite1000)

Basal insulin

- Post-prandial current diet
 - Evaluate insulinaemic response with current diet
 - → laminitis risk
 - ~ 2h after meal finished/taken off pasture
 - No specific cut-offs



Insulin tolerance test (ITT)

- No fast
- Ease of testing (POC)
- Collect blood measure BGL 0 min
- Administer 0.1IU/kg regular insulin
- Collect blood measure BGL 30 min
- **IR <50% decrease BGL from baseline**
- Risk of hypoglycaemia
 - Low with suspicious cases
 - Monitor
 - Feed grain/molasses at end



Not currently recommended

- Glucose : insulin ratio
- Proxy measures of insulin
- Research setting
 - CGIT
 - FSIGTT
 - Euglycaemic hyperinsulinaemic clamp



Current recommendations

- OST and ITT
- Yearly testing > 5yo



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Other tests for EMS

- Blood glucose
 - Not specific. Weak correlation with CNS
- Leptin
 - Associated with obesity, not ID
- Adiponectin
 - $< 7.9 \mu\text{g}/\text{mL}$ supportive of EMS and increased risk HAL
- Incretins
 - Research setting
- Triglycerides
 - In association with with ID and obesity can consider ($>0.64\text{mmol}/\text{L}$)



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Questions?



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