Effects of an induced hypoglycemia for 48 hours on metabolism in lactating dairy cows

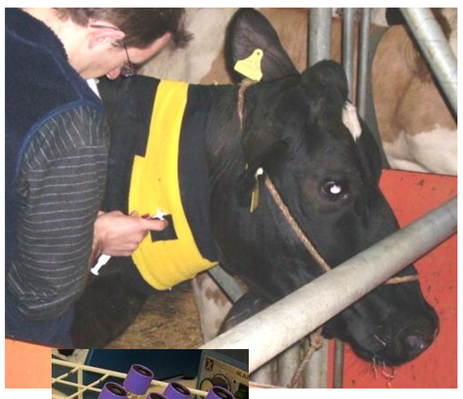
van Dorland, H.A., L. Kreipe, M.C.M.B. Vernay, A. Oppliger, O. Wellnitz & R.M. Bruckmaier

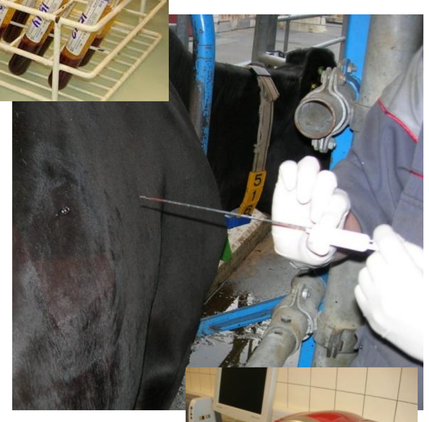
Veterinary Physiology, Vetsuisse Faculty, University of Bern, Bern, Switzerland

Introduction

Characteristic for a cow in negative EB compared to a cow in positive EB is a low plasma concentration of glucose, which is normally accompanied by elevated plasma concentrations of NEFA, and ketone bodies. Each of these metabolites is dependent on and may affect the metabolic regulation in the liver.

The identification of the specific adjustments or failure of hepatic metabolism during the physiological condition of early lactation may increase the understanding of the pathogenesis of metabolic disorders. The investigation of exclusive effects of individual parameters of the complex physiological condition of early lactation may aid in obtaining this understanding.





OBJECTIVE

The aim was to study the effects of an induced hypoglycemia over 48 hours on metabolic parameters in plasma and liver of mid-lactating cows

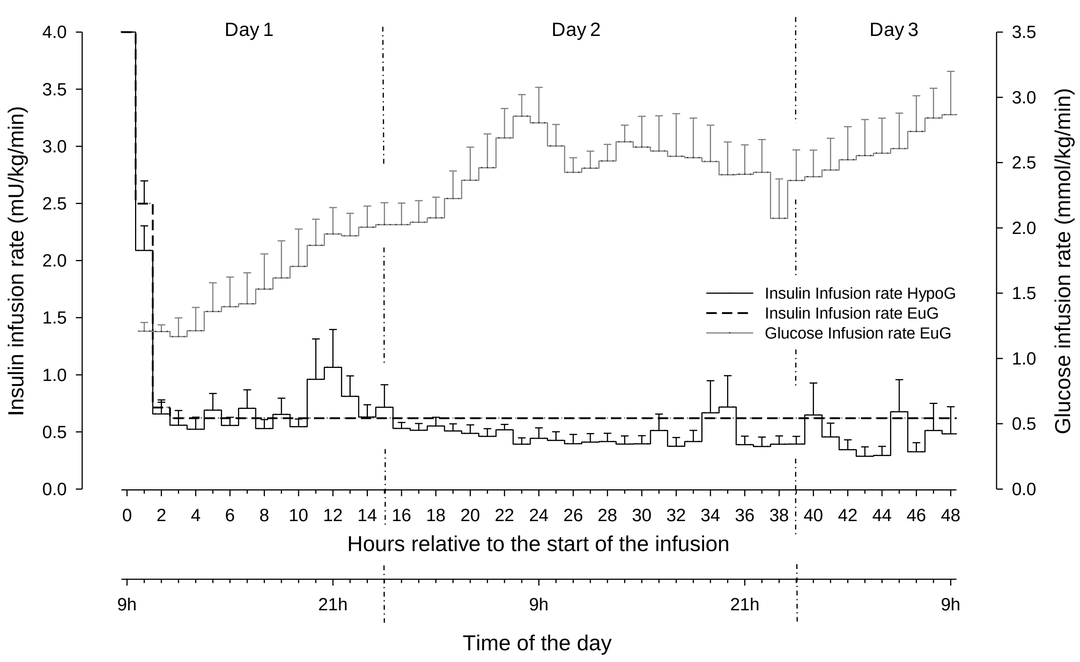
Materials and Methods

- Eighteen dairy cows were randomly assigned to one of three infusion treatments for 48 h (each n=6):
  - Hyperinsulinaemic hypoglycaemic clamp (**HypoG**), to obtain a glucose concentration of 2.5 mmol/L
  - Hyperinsulinaemic euglycaemic clamp (**EuG**) in which the effect of insulin was studied
  - Control treatment with a 0.9 % saline solution (**NaCl**).
- Blood was collected for glucose, insulin, NEFA, and BHBA analysis.
- Liver tissue was taken before and after the treatment, and analyzed for mRNA expression levels by qRT-PCR encoding enzymes related to carbohydrate, lipid and protein metabolism:

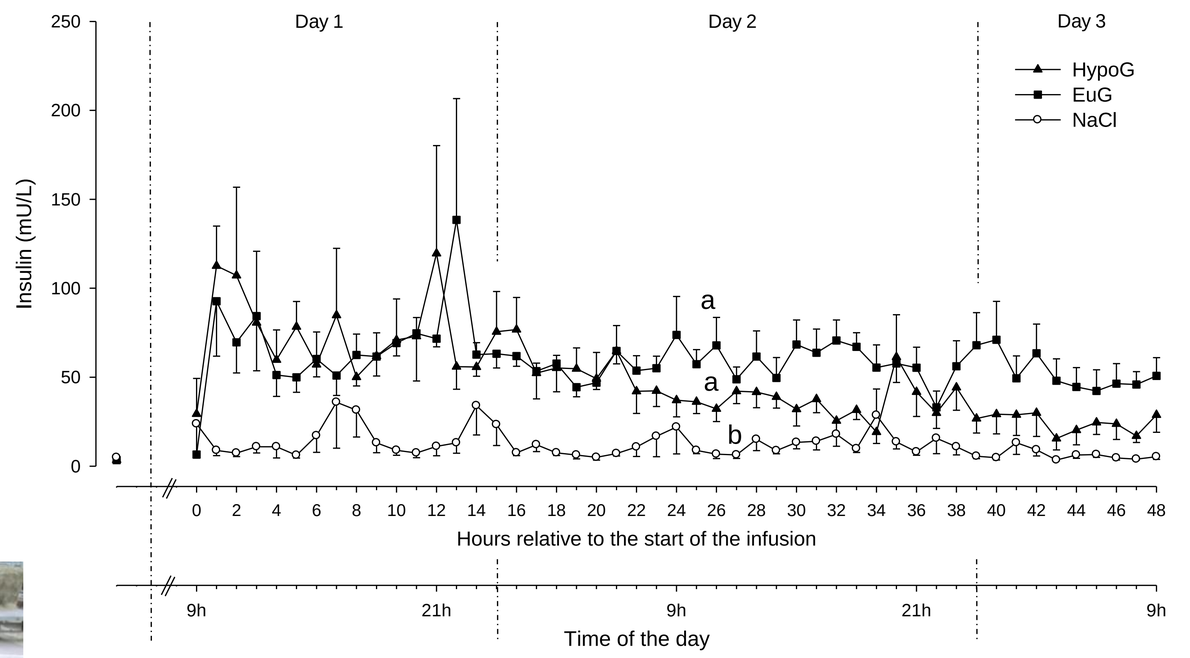
  Acyl-coenzyme A dehydrogenase very long chain (ACADVL), acyl-CoA synthetase long-chain 1 (ACSL1), carnitine palmitoyltransferase 1A (CPT1A), carnitine palmitoyltransferase 2 (CPT2), fatty acid synthase (FASN), glycerol-3-phophate acyltransferase (GPAM), glucose-6-phosphatase (G6PC), 3-hydroxy-3-methylglutaryl-coenzyme A synthase 2 (HMGCS2), pyruvate carboxylase (PC), cytosolic phosphoenolpyruvate carboxykinase (PEPCKc), mitochondrial phosphoenolpyruvate carboxykinase (PEPCKm).

Results

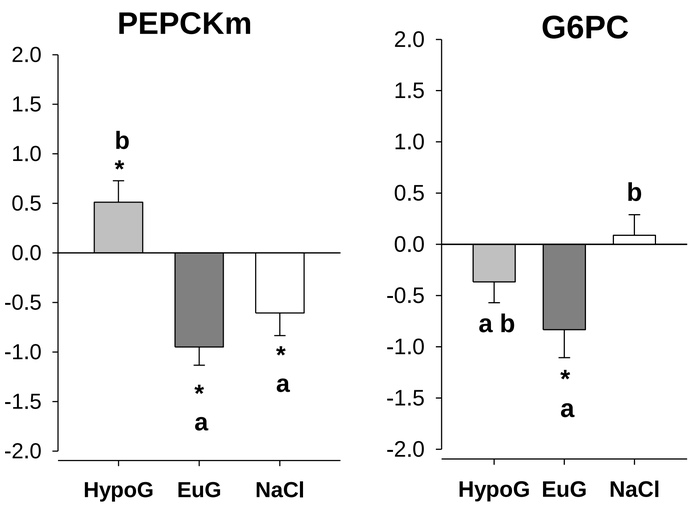
Insulin and glucose infusion rates (MEAN ± SEM) during 48 h infusion of insulin and glucose in a hypoglycemic (HypoG) and euglycemic (EuG) clamp.



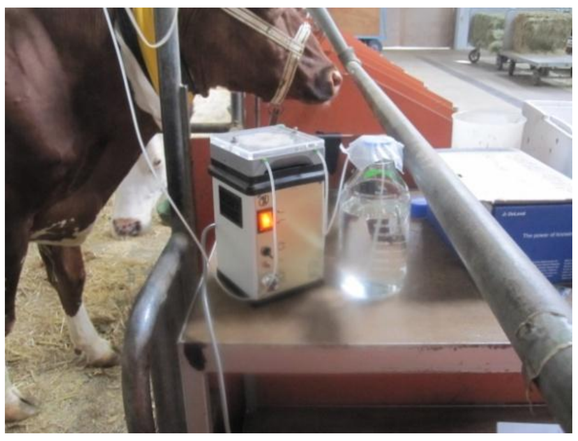
Insulin concentration (MEAN ± SEM) in blood plasma before the start of the infusion (d0) and during 48 h infusion. Different letters (a, b) indicate differences (P < 0.05) between the means of the 3 treatment groups.



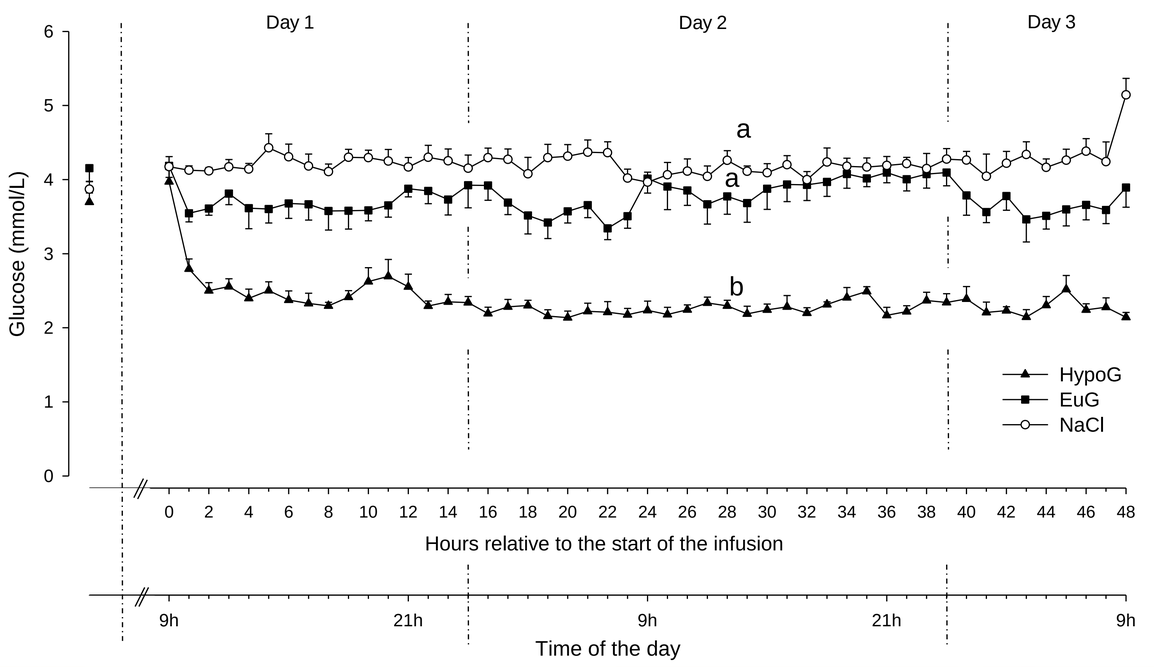
Differences in mRNA abundance (Δ CT, log2) of hepatic candidate genes after 48 h of infusions normalized for the housekeeping genes GAPDH and ubiquitin. An '*' represents means are different from 0 (P < 0.05). Different letters (a, b) indicate differences (P < 0.05) between the means of the 3 treatment groups. (G6PC, glucose-6-phosphatase; PEPCKm, mitochondrial phosphoenolpyruvate carboxykinase).



No significant treatment differences were observed for genes related to lipid metabolism, and plasma NEFA remained unaffected, likely due to the infusion of insulin.



Glucose concentration (MEAN ± SEM) in blood plasma before the start of the infusion (d0) and during 48 h infusion. Different letters (a, b) indicate differences (P < 0.05) between the means of the 3 treatment groups.



CONCLUSION

The results suggest that metabolic regulatory events in the liver are directed, apart from hormones, by the level of metabolites, either in excess (e.g. free fatty acids) or in shortage (e.g. glucose)