Cremona 20-01-2008

Approccio ai disordini calcemici nella specie canina

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1

Disordini del calcio

- Ipercalcemia
- Ipocalcemia

2

Fisiopatologia

- Calcemia
- Metodi di misura
- Funzioni del calcio
- Bioregolatori della calcemia
- Condizioni patologiche correlate alla iper/ipocalcemia

3

Calcemia

1. 56% Calcio Ionico:Ca^{++}
2. 34% Calcio albuminico:Ca^{++} = Albumine
3. 10% Calcio complessato:Ca^{++} Citrato Lattato Fosfati Solfati

4

Calcemia o calcio totale

5

Metodi di misura

- Calcemia totale
- Calcio ionico
- Calcio albuminico
- Calcio complessato

6

Metodi di misura

- **Calcemia totale**
- **Calcio ionico**
- Calcio albuminico
- Calcio complessato

● Misurabile
○ Calcolabile

7

Calcemia totale

- Spettrofotometria ad assorbimento atomico
- Fotometria a fiamma
- Spettrofotometria: Ortocresolphtaleina e l'Arsenazo

9

Calcemia ionica (56%)

- Elettrodi iono-selettivi

10

Calcio albuminico (34%)

- Calcio di riserva

11

Calcio albuminico

- 34% Calcio totale
- Calcio corretto = Calcio mis. – Alb + 3.5

12

Calcio corretto

- Applicabile solo nel cane
- Applicabile solo in caso di iper/ipoalbuminemie
- Calcio corretto = Calcio mis. – Alb + 3.5

Calcio misurato = 8.5 mg/dl (9.6-11.7 mg/dl)
Calcio corretto = 8.5 – 1.5 + 3.5 = 10.5

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The Simultaneous Measurement of Ionized and Total Calcium and Ionized and Total Magnesium in Intensive Care Unit Patients

Stephen M. Koch, R. David Warters, and Uwe Mehlhorn

Purpose: This study was undertaken to determine the relationship between total magnesium and ionized magnesium in critically ill and injured patients.
Methods: Eighty consecutive intensive care unit (ICU) admissions were evaluated and 34 patients were enrolled in the study. Patients were enrolled who had indwelling arterial catheters and were within 4 days of ICU admission. Six milliliters of blood was collected and assayed simultaneously for total and ionized magnesium, total and ionized calcium, and albumin level. An Acute Physiology and Chronic Health Evaluation (APACHE II) score was calculated at the time of blood collection.
Results: The results of our study show a strong correlation between ionized and total magnesium (R = .903) that was not seen between ionized and total calcium (R = .748). We found total hypomagnesemia in 18% and ionized hypomagnesemia in 21% of ICU patients. We also found that 14.7% (5 of 34) of our patients had ionized hypermagnesemia whereas none displayed total hypermagnesemia. We did not find a correlation between APACHE II, sex, race, albumin level, and any electrolyte level. The mortality rate in the subjects studied was 21% (7 of 34).
Conclusions: Based on our results we would recommend that intensivists directly measure ionized calcium whereas ionized magnesium can be inferred from total magnesium.

NCBI PubMed

Accuracy of methods to estimate ionized and "corrected" serum calcium concentrations in critically ill multiple trauma patients receiving specialized nutrition support.

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Department of Pharmacy, University of Tennessee Health Science Center, 26 South Dunlap St., Room 310, Memphis, TN 38163, USA.

BACKGROUND: The purpose of this study was to determine the accuracy of 22 published methods to estimate serum ionized calcium (iCa) and "corrected" total serum calcium (totCa) concentrations in critically ill, multiple trauma patients. Seven of these formulas estimated iCa and 15 were directed toward predicting a "corrected" totCa. METHODS: Adult patients admitted to the trauma intensive care unit who received specialized nutrition support were consecutively recruited for study. Patients who received blood products, i.v. calcium, or therapeutic doses of heparin within 24 hours before the laboratory measurements or had a history of cancer, bone disease, parathyroid disease, hyperphosphatemia (> or = 6 mg/dL), hyperbilirubinemia (> 3.5 mg/dL), or renal failure requiring dialysis were excluded. The 22 published methods were analyzed for sensitivity, specificity, percentage false negatives, and percentage false positives for predicting hypocalcemia or hypercalcemia. RESULTS: One hundred patients were studied 4.9 +/- 3.3 days post-injury and were receiving enteral nutrition (n = 81), parenteral nutrition (n = 18), or both (n = 1) at the time of study. Twenty-one patients were hypocalcemic (iCa < or = 1.12 mmol/L) and 6 were hypercalcemic (iCa > or = 1.32 mmol/L). The mean sensitivity of the 22 methods for assessing hypocalcemia was 25% +/- 32% and the specificity was 90% +/- 18%. Although the average percentage of false positives for assessing hypocalcemia was 10% +/- 18%, the mean percentage of false negatives was inordinately high at 75% +/- 32%. The most common method for determination of "corrected" totCa concentration ["corrected" calcium = totCa + (3.8 x (4-serum albumin concentration))] had a sensitivity of only 5%. The McLean-Hastings nomogram method, the most common method for estimating serum iCa concentration, had a sensitivity of 67% but unfortunately also had a significant false-positive rate of 27%. Serum totCa correlated modestly with iCa (r2 = .334, p < .001). Those patients with a serum albumin < or = 2 g/dL (n = 41) had a significantly higher prevalence of hypocalcemia than those with a higher serum albumin concentration (37% incidence of hypocalcemia vs 10%, respectively, p < .002). CONCLUSIONS: Aberrations in calcium homeostasis are frequent (27%) in postresuscitative critically ill multiple trauma patients. Methods for predicting hypocalcemia lack sensitivity and are often associated with an unacceptable rate of false negatives. Predictive methods for estimating ionized or corrected serum concentrations should not be used. Direct measurement of serum iCa concentration is indicated for assessing calcium status for this population.

PMID: 15141404 [PubMed - indexed for MEDLINE]

Excerpta Medica

The American Journal of Surgery

The American Journal of Surgery 189 (2005) 310–314

Scientific paper

A comparison of corrected serum calcium levels to ionized calcium levels among critically ill surgical patients

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Manuscript received September 14, 2004; revised manuscript November 22, 2004

Presented at the 47th Annual Meeting of the Midwest Surgical Association, Mackinac Island, Michigan, August 15–18, 2004

Abstract

Background: Aberrations in calcium homeostasis are common in critically ill patients. The proper method to evaluate this issue in surgical patients has not been completely defined.

Methods: Medical records of patients admitted to a university-affiliated, tertiary-care surgical intensive care unit were retrospectively reviewed. Calcium status was evaluated by ionized levels and as a function of serum calcium levels corrected for albumin aberrations.

Results: Corrected serum calcium values failed to accurately classify calcium status in 36% of cases. The sensitivity and specificity of the corrected serum calcium formula to evaluate hypocalcemia were 53% and 85%, respectively. Corrected serum values underestimated the prevalence of hypocalcemia and overestimated the prevalence of normocalcemia. No factors were able to discern which patients could be evaluated by corrected serum calcium levels.

Conclusions: Calcium homeostasis should be evaluated by ionized calcium levels rather than as a function of serum calcium and albumin levels.

Keywords: Ionized calcium; Electrolytes; Surgical; Critical care

Prediction of serum ionized calcium concentration by use of serum total calcium concentration in dogs.

Schenck PA, Chew DJ

Calcio complessato (10%)

- Fosfati
- Lattati
- Bicarbonati
- Solfati
- Citrati
- Acidi grassi

18

Funzioni del calcio

- Attivita' neuromuscolare
- Secrezione
- Trasduzione di segnale
- Attivita' procoagulante

19

Calcio ionico (Ca++)

- Responsabile delle azionji biologiche
- Regolazione endocrina
- pH

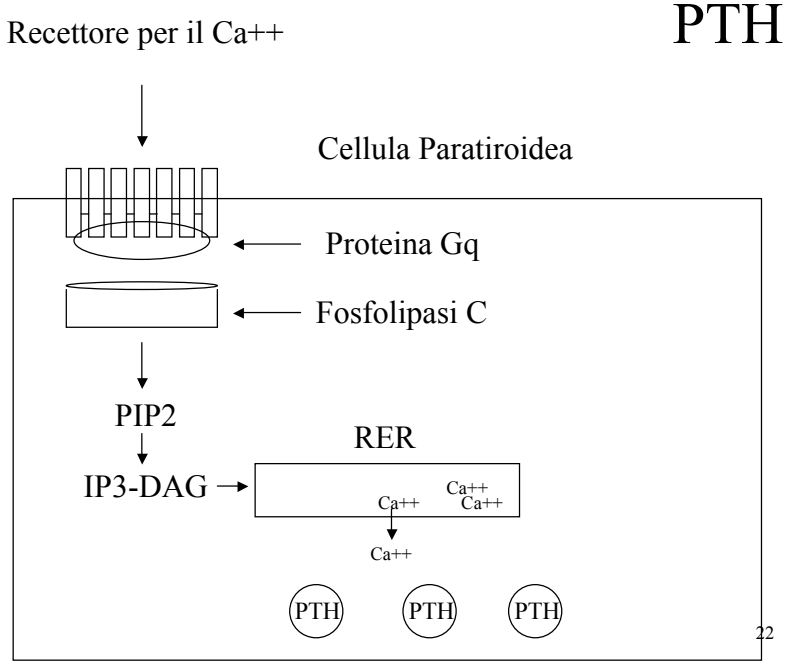
20

Bioregolatori

- PTH (minuto per minuto)
- Vit. D (1-25 OH) Diidrossicolecalciferolo (giorno per giorno)
- Pi
- Calcitonina (emergenza)

21

PTH



22

PTH

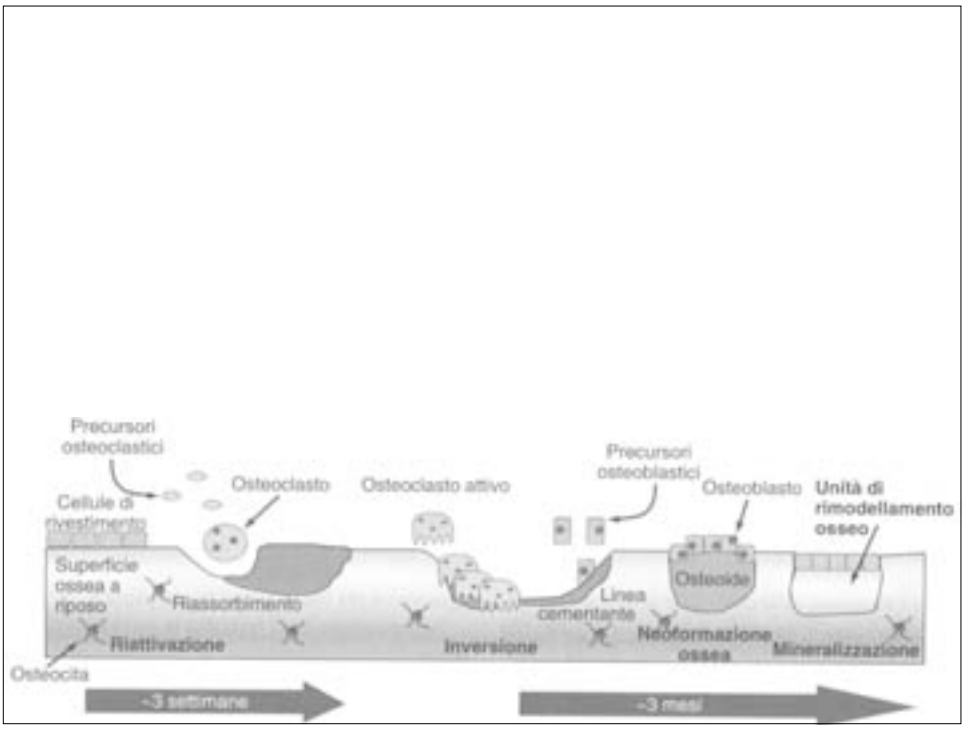
- 84 aa
- 9300 D
- Pre-pro-paratormone
- Emivita di 2-4 min.
- Clearance epato-renale 33-34 36-37

23

Azione biologica

- Osso
- Rene
- Intestino

24



Riassorbimento renale Ca++

- Meccanismo Passivo (paracell.): 65% TCP
- Meccanismo Passivo (paracell.): 20% cTAL
- Meccanismo Attivo (transcell.): 10% TCD

↑

PTH

26

Assorbimento intestinale Ca++

- Meccanismo Passivo (paracell.): 5%
- Meccanismo Attivo (transcell.): 20-70%

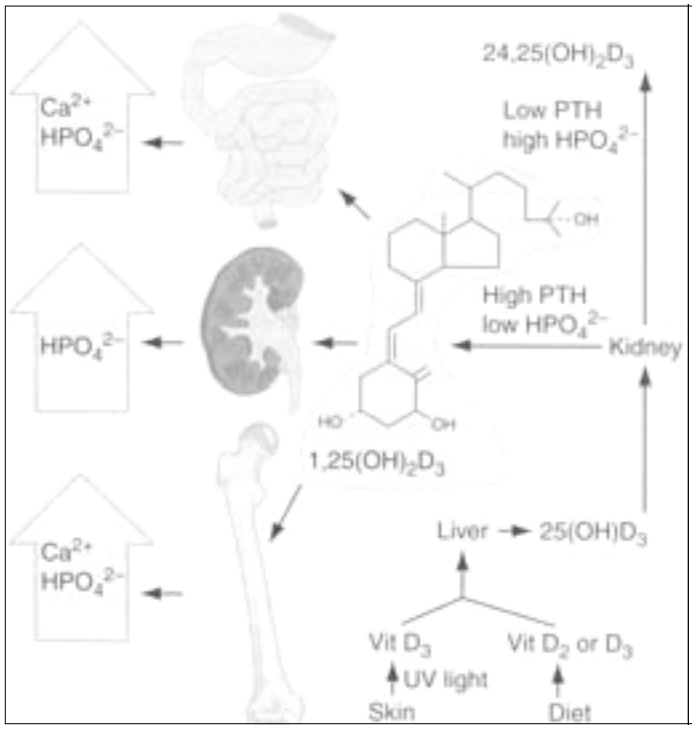
1,25 (OH) D

27

Vitamina D

- Depositi cutanei
- Raggi UV
- I Tappa idrossilativa Fegato
- II Tappa idrossilativa Rene

28



Regolatori dell'1 alfa idrossilasi

- PTH
- Pi
- 1-25 Colecalciferolo
- GH
- Prolattina
- Glucocorticoidi

30

Metabolismo

- 1-25 Colecalciferolo
- 24-25 Colecalciferolo
- Coniugazione
- Ossidazione catena laterale

31

Azione biologica

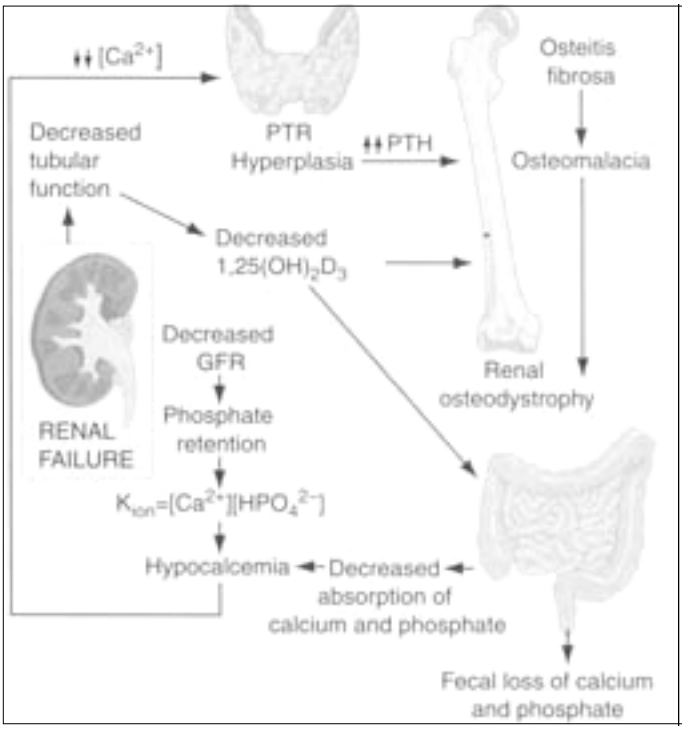
- Intestino
- Osso
- Rene

32

Calcitonina

- Blocca il riassorbimento osseo

33



Epidemiologia dell'ipercalcemia

- 07-01-2005 / 07-01-2008
- 5248 pazienti canini
- 104 pazienti ipercalcemici (> 11.7 mg/dl)
- 15 pazienti < 12 mesi di età
- 104-15 = 89 casi di ipercalcemia
- 89/5248 = 1.69% (prevalenza)

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89 Casi di ipercalcemia

- 34/89 = 38.2% Insufficienza renale
- 15/89 = 16.9% Linfoma T
- 13/89 = 14.6% Neoplasie varie
- 12/89 = 13.5% Glucocorticoidi
- 7/89 = 7.9% Emoconcentrazione
- 4/89 = 4.5% Addison
- 2/89 = 2.2% Iperparatiroidismo primario
- 1/89 = 1.1% Osteomielite
- 1/89 = 1.1% Idiopatica

36

Insufficienza Renale

- 60% normocalcemia
- 20% ipercalcemia
- 20% ipocalcemia

37

Linfoma/Neoplasie varie

- PTH-rp
- Vit D ?

38

Glucocorticoidi

- Iperalbuminemia

39

Emoconcentrazione

- Iperalbuminemia/Stimolazione PTH

40

Addison

- Emoconcentrazione
- Stimolazione PTH
- Riduzione della escrezione calcica corticosteroideo-mediata

41

Iperparatiroidismo Primario

- PTH

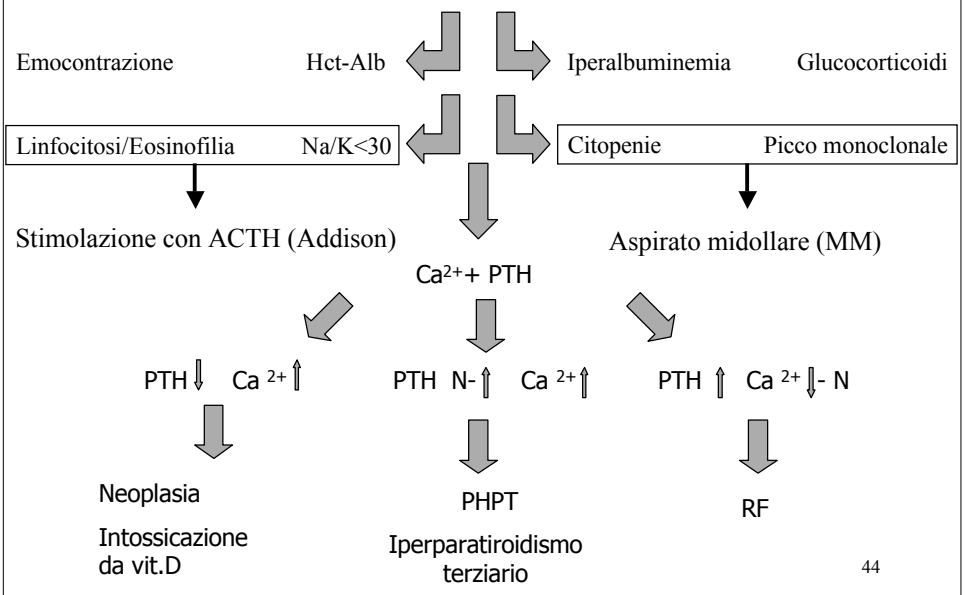
42

Osteomielite

- Citochine proinfiammatorie che cagionano lisi ossea

43

Ipercalcemia



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Cremona 20-01-2008

Ipocalcemia nel cane

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Case Report

Journal of Veterinary Emergency and Critical Care 15(2) 2005, pp 136–142

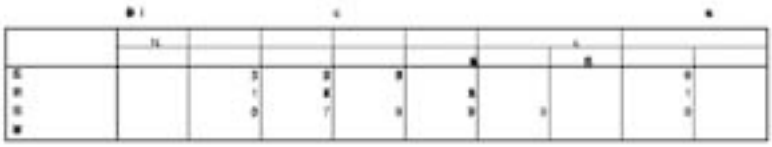
Hypocalcemia in a critically ill patient

Tamara B. Wills, DVM, Andrea A. Bohn, DVM, PhD, DACVP and Linda G. Martin, DVM, MS, DACVECC

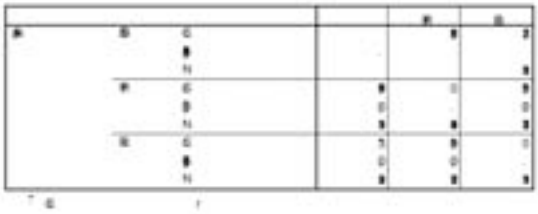
Abstract

Objective: To present a case of clinical hypocalcemia in a critically ill septic dog.
Case summary: A 12-year old, female spayed English sheepdog presented in septic shock 5 days following hemilaminectomy surgery. *Streptococcus canis* was cultured from the incision site. Seven days after surgery, muscle tremors were noted and a subsequent low serum ionized calcium level was measured and treated. Intensive monitoring, fluid therapy, and antibiotic treatment were continued because of the sepsis and hypocalcemia, but the dog was euthanized 2 weeks after surgery.
New or unique information provided: Low serum ionized calcium levels are a common finding in critically ill human patients, especially in cases of sepsis, pancreatitis, and rhabdomyolysis. In veterinary patients, sepsis or streptococcal infections are not commonly thought of as a contributing factor for hypocalcemia. Potential mechanisms of low serum ionized calcium levels in critically ill patients include intracellular accumulation of calcium ions, altered sensitivity and function of the parathyroid gland, alterations in Vitamin D levels or activity, renal loss of calcium, and severe hypomagnesemia. Pro-inflammatory cytokines and calcitonin have also been proposed to contribute to low ionized calcium in the critically ill. Many veterinarians rely on total calcium levels instead of serum ionized calcium levels to assess critical patients and may be missing the development of hypocalcemia. Serum ionized calcium levels are recommended over total calcium levels to evaluate critically ill veterinary patients.

Descriptives



Nonparametric Correlations (SONO 1937)



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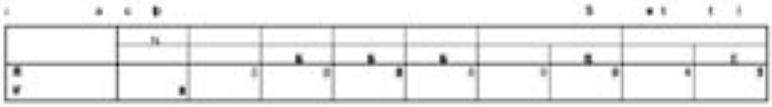
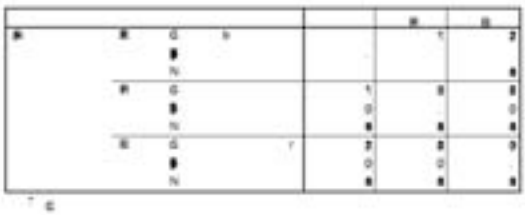
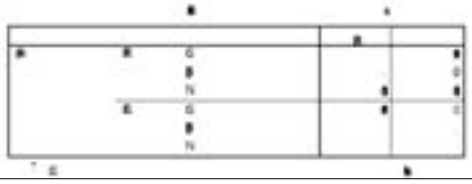
Descriptives



Nonparametric Correlations (SONO 1304)



Nonparametric Correlations



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Ipocalcemia

- Ipoparatiroidismo
- Insufficienza renale acuta e cronica
- Malassorbimento
- Ipovitaminosi D
- Ipomagnesiemia
- Iperparatirodismo nutrizionale
- Diabete mellito

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Ipocalcemia

- Eclampsia
- Avvelenamento da Glicole Etilenico
- Rabdomiolisi
- Pancreatite
- Trauma acuto
- Sindrome da lisi tumorale
- Sepsi

50

Epidemiologia dell'ipocalcemia

- 07-01-2005 / 07-01-2008
- 5248 pazienti canini
- 1300 pazienti ipocalcemici (< 9.6 mg/dl)
- 1300/5248 = 24.8% (prevalenza)

51

Fisiopatologia dell'ipocalcemia

- Alterazioni distributive
- Insufficienza e/o soppressione paratiroidea
- Carenza o alterata risposta alla Vit. D
- Elevazione dei precursori della calcitonina
- Ipoparatiroidismo e/o deficit recettoriali secondari a citochine proinfiammatorie
- Acidosi lattica ed Alcalosi respiratoria
- Acidi grassi liberi secondari a ipercatcolaminemie

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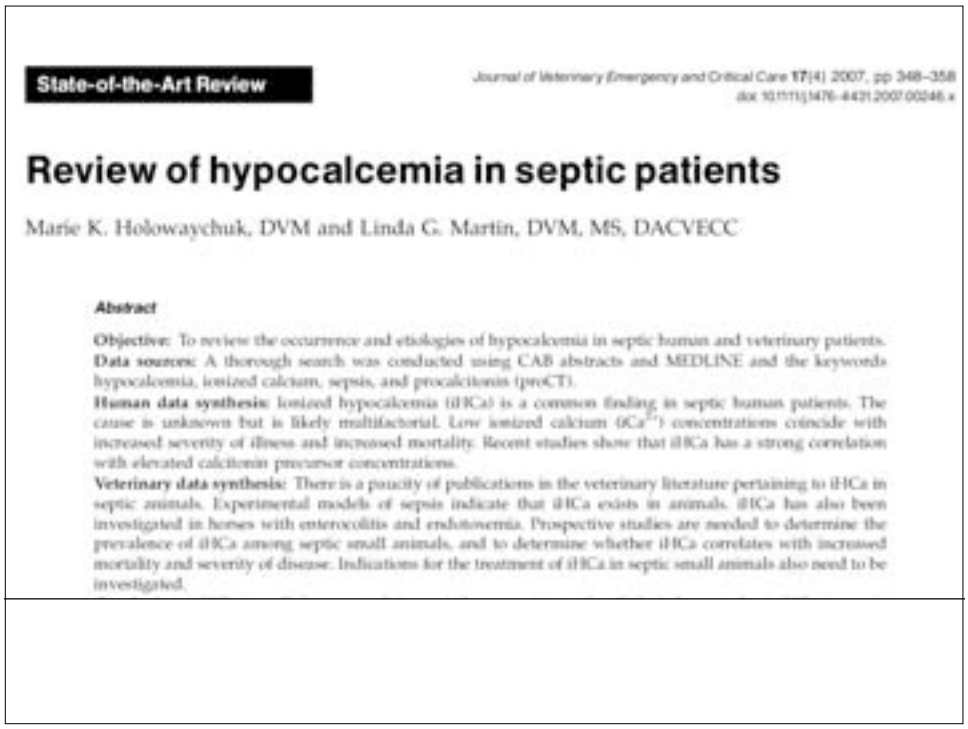

State-of-the-Art Review

Journal of Veterinary Emergency and Critical Care 17(4) 2007, pp 348–358
doi: 10.1111/j.1476-4431.2007.00246.x

Review of hypocalcemia in septic patients

Marie K. Holowaychuk, DVM and Linda G. Martin, DVM, MS, DACVECC

Abstract

Objective: To review the occurrence and etiologies of hypocalcemia in septic human and veterinary patients.
Data sources: A thorough search was conducted using CAB abstracts and MEDLINE and the keywords hypocalcemia, ionized calcium, sepsis, and procalcitonin (proCT).
Human data synthesis: Ionized hypocalcemia (iHCa) is a common finding in septic human patients. The cause is unknown but is likely multifactorial. Low ionized calcium (iCa^{2+}) concentrations coincide with increased severity of illness and increased mortality. Recent studies show that iHCa has a strong correlation with elevated calcitonin precursor concentrations.
Veterinary data synthesis: There is a paucity of publications in the veterinary literature pertaining to iHCa in septic animals. Experimental models of sepsis indicate that iHCa exists in animals. iHCa has also been investigated in horses with enterocolitis and endotoxemia. Prospective studies are needed to determine the prevalence of iHCa among septic small animals, and to determine whether iHCa correlates with increased mortality and severity of disease. Indications for the treatment of iHCa in septic small animals also need to be investigated.

Cremona 20-01-2008

Alterazioni della fosforemia

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54

Fosforo

- 300-400 g.
- 80-85% Scheletrico
- 15% ICF

55

Fosforo

- Fosfati organici IC
- Fosfati inorganici EC

56

Fosforo inorganici

- H_2PO_4
- $NaHPO_4$
- HPO_4

57

Fosforo organici

- Fosfolipidi
- Acidi nucleici
- ATP

58

Fosforo inorganico o Pi

- $H_2PO_4^-$ $HPO_4^{=}$ 55%
- $HPO_4^{=}$ Na Ca Mg 35%
- HPO$^{=}$ Pr 10%

59

Funzione dei fosfati

- Pi-Cristalli di idrossiapatite
- Acidi nucleici RNA DNA
- ATP NADP
- 2-3 DPG Trasporto dell'ossigeno

60

Assorbimento intestinale

- Tenue 65%

1,25 (OH) D

61

Escrezione renale

- Tubulo contorto prossimale

NaPi-2

PTH-FGF23

62

Ipofosforemia

- Ridotto assorbimento intestinale
- Aumentata escrezione renale
- Ridistribuzione dei Fosfati

63

Ridotto assorbimento intestinale

- Enteropatie proteino-disperdenti
- IBD
- Malassorbimento

64

Aumentata escrezione renale

- Dieta carnea
- Acidosi
- Iperparatiroidismo
- Ipertiroidismo
- PTH-rp
- Corticosteroidi
- Calcitonina
- Vitamina D
- Fosfatonine (FGF-23)
- Aumento del volume effettivo

65

Redistribuzione dei fosfati

- Alcalosi
- Terapia diabetica
- Infusione di glucosio
- Alimentazione

66

Segni dell'ipofosforemia

- Neuromuscolari
- Gastroenterici
- Ematologici

67

Iperfosforemia

- Ridotta escrezione renale
- Ridistribuzione dal LIC

68

Ridotta escrezione renale

- Riduzione del GFR
- Ipoparatiroidismo
- Acromegalia
- Iperinsulinismo

69

Ridistribuzione dal LIC

- Rabdmiolisi
- Sindrome da lisi tumorale
- Grave acidosi metabolica e respiratoria

70

1: J Am Vet Med Assoc. 2007 Nov 15;231(10):1545-9.

Evaluation of total and ionized calcium status in dogs with blastomycosis: 38 cases (1997-2006).

Department of Veterinary Clinical Sciences, College of Veterinary Medicine, University of Minnesota, Saint Paul, MN 55108, USA.

OBJECTIVE: To determine blood ionized calcium (iCa) and serum total calcium (tCa) concentrations in dogs with blastomycosis and to evaluate whether serum tCa concentration, albumin-adjusted serum calcium concentration (AdjCa-Alb), and total protein-adjusted serum calcium concentration (AdjCa-TP) accurately predict iCa status. DESIGN: Retrospective case series. ANIMALS: 38 client-owned dogs with a cytologic diagnosis of blastomycosis. PROCEDURES: Dogs were classified as hypocalcemic, normocalcemic, or hypercalcemic on the basis of blood iCa concentration, serum tCa concentration, AdjCa-Alb, and AdjCa-TP; classification on the basis of serum tCa concentration, AdjCa-Alb, and AdjCa-TP was compared with blood iCa concentration. RESULTS: Except for 2 hypercalcemic dogs, all dogs had blood iCa concentrations within the reference interval. Use of serum tCa concentration overestimated hypocalcemia in 57.9% (22/38) of dogs and underestimated hypercalcemia in 1 dog. Use of AdjCa-Alb correctly reclassified all dogs as normocalcemic that were classified as hypocalcemic on the basis of serum tCa concentration, but failed to predict hypercalcemia in 1 dog. Use of AdjCa-TP correctly reclassified all but 2 dogs as normocalcemic that were classified as hypocalcemic on the basis of serum tCa concentration, and failed to predict hypercalcemia in 1 dog. No correlation was found between blood iCa concentration and serum concentrations of tCa, total protein, and albumin; AdjCa-Alb; or AdjCa-TP. CONCLUSIONS AND CLINICAL RELEVANCE: High blood iCa concentration was uncommon in dogs with blastomycosis. Hypoalbuminemia contributed to a low serum tCa concentration despite a blood iCa concentration within reference limits. The use of serum tCa concentration, AdjCa-Alb, and AdjCa-TP may fail to identify a small number of dogs with high blood iCa concentrations.