



## ORIGINAL

# Continuous tissue glucose monitoring correlates with measurement of intermittent capillary glucose in patients with distributive shock



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Received 22 June 2014; accepted 22 September 2014

Available online 12 December 2014

### KEYWORDS

Glucose monitoring;  
Tissue glucose;  
Capillary glucose;  
Distributive shock;  
Critical illness;  
Hypoglycemia

### Abstract

**Background:** Intermittent glycemic measurements in patients admitted to the intensive care unit (ICU) can result in episodes of severe hypoglycemia or in a poor control of glycemia range. We designed a study to assess accuracy and reliability of continuous monitoring of tissue glucose for patients with distributive shock.

**Methods:** Consecutive patients admitted to the ICU with a diagnosis of distributive shock and the need of insulin infusion for glycemic control were included in the study. These patients were implanted a Continuous Glucose Control Monitoring System (CGMS) with the sensor inserted subcutaneously into the abdominal wall. CGMS values were recorded every 5 min. Capillary glucose (CG) was monitored for adjusting insulin perfusion according to the ICU protocol. Correlation between both methods was assessed.

**Results:** A total of 11,673 CGMS and 348 CG values were recorded. In five patients, CGMS failed to detect tissue glucose. A glucose value  $<3.33$  mmol/l ( $<60$  mg/dl) was observed in 3.6% of CGMS and in 0.29% CG values. 295 pairs of measurements were included in the statistical analysis for correlation assessment. The intraclass correlation coefficient was 0.706. The Pearson correlation coefficient was 0.71 ( $p < 0.0001$ , 95% CI 0.65–0.76). The mean of differences between both measurement methods was 0.22 mmol/l (3.98 mg/dl) (95% CI 0.66–7.31).

**Conclusions:** When the Continuous Glucose Control Monitoring System (CGMS) is able to obtain data (75% of the patients), there is correlation between the values obtained by this method and capillary blood glucose in patients with distributive shock. CGMS can detect more episodes of glycemic excursions outside the normal range than intermittent capillary glucose monitoring. Variables that may impair glucose metabolism and peripheral soft tissues perfusion could impair CGMS measurements.

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**PALABRAS CLAVE**

Monitorización de la glucosa;  
 Glucosa tisular;  
 Glucosa capilar;  
 Shock distributivo;  
 Enfermo crítico;  
 Hipoglucemia

## La monitorización continua de la glucosa de tejido se correlaciona con la medición de glucosa capilar intermitente en pacientes con shock distributivo

**Resumen**

**Antecedentes:** las medición de glucemia intermitente pueden provocar episodios de hipoglucemia severa o un mal control glucémico en los pacientes ingresados en la Unidad de Cuidados Intensivos (UCI). Diseñamos un estudio para evaluar la exactitud y fiabilidad de la monitorización continua de glucosa tisular en pacientes con shock distributivo.

**Métodos:** Se incluyeron en el estudio todos los pacientes ingresados consecutivamente en la UCI con el diagnóstico de shock distributivo y la necesidad de insulina en perfusión para el control glucémico. A estos pacientes se les implantó un Sistema de Monitorización Continua de la Glucosa Tisular (CGMS) con un sensor insertado en tejido subcutáneo de la pared abdominal. CGMS valores se registraron cada cinco minutos. La glucosa capilar (GC) fue monitorizada para ajustar la perfusión de insulina de acuerdo con el protocolo de la UCI. Se evaluó la correlación entre ambos métodos.

**Resultados:** Se registraron un total de 11.673 valores de CGMS y 348 valores de GC. En cinco pacientes, la CGMS no pudo ser detectada. Un valor de glucosa  $<3,33$  mmol/l ( $<60$  mg/dl) se observó en 3,6% de los valores de CGMS y en el 0,29% de los valores de GC. 295 pares de mediciones se incluyeron en el análisis estadístico para la evaluación de la correlación. El coeficiente de correlación intraclass fue de 0,706. El coeficiente de correlación de Pearson fue de 0,71 ( $p < 0,0001$ ; IC 95% 0,65–0,76). La media de las diferencias entre los dos métodos de medición fue de 0,22 mmol/l (3,98 mg/dl) (IC 95% 0,66 a 7,31).

**Conclusiones:** Cuando el sensor de medición de glucosa tisular continua es capaz de obtener datos (75% de los pacientes), existe correlación entre los valores obtenidos mediante este método y la glucemia capilar en los pacientes que presentan shock distributivo. CGMS puede detectar más episodios de excursiones glucémicas fuera del rango de normalidad que la monitorización intermitente de glucosa capilar. Variables que pueden perjudicar el metabolismo de la glucosa y la perfusión periférica de los tejidos blandos podrían afectar las mediciones CGMS. © 2014 Elsevier España, S.L.U. y SEMICYUC. Todos los derechos reservados.

**Introduction**

Hyperglycemia is common in critically ill patients, appearing in 90% of them during serious illness, were diabetic or not before admission. It occurs as an adaptive response to aggression to ensure delivery of glucose to the tissues in serious situation.<sup>1–3</sup> The most recent reports have shown that uncontrolled hyperglycemia has an adverse effect on mortality of critically ill patients.<sup>4–9</sup> In this setting there is a resistance to insulin action of multifactorial origin, which makes difficult the control of blood glucose. For this reason, high doses of insulin can be needed, with the resultant risk of hypoglycemia.

In 2001, Van den Berghe et al. described as the strict control of blood glucose decreased morbidity and mortality in critically ill surgical and, in subsequent studies, also in medical patients.<sup>10–12</sup> The benefits obtained with this control need to maintain blood glucose in the range of 4.44–6.1 mmol/l (80–110 mg/dl), administering insulin intravenously in most cases.

More recent studies shown that strict control of blood glucose may not be beneficial or may even get worse in the prognosis of patients, due to an increase in late mortality. The main difference in complications that appeared in the strict control group compared to the control group of less strict glycemic is the occurrence of severe hypoglycemia,

which may be associated with severe morbidity and mortality.<sup>13–15</sup>

Monitoring of capillary blood glucose has been customary in the ICU for adjustment of insulin requirements of patients, until recently. It is a simple procedure with few complications for the patient and is economical, with a good correlation with blood glucose in most patients. Studies of glycemic control in critically ill patients have been performed by measuring CG intermittently, with the risk of the existence of periods of hypoglycemia and hyperglycemia undetected between measurements. Besides the difficulty of detecting large glucose excursions, intermittent control of CG requires multiple punctures and an increase in the nurse staff workload.

Currently, continuous glucose monitoring is performed in diabetic outpatients by sensors positioned in the subcutaneous tissue, but these devices have not been incorporated into the routine monitoring in the ICU. The development of these devices of subcutaneous continuous glucose monitoring system emerged as a need for close monitoring of blood glucose concentrations in patients with metabolic instability or insulin pumps carriers, thereby reducing the risk of complications. These devices were first developed in the 1980s and its operation is based on subcutaneous implantation of a sensor carrying an enzyme electrode measuring interstitial glucose concentration. The device security is

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