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Impact of restrictive fluid protocol on hypoxemia after aneurysmal subarachnoid hemorrhage☆,☆☆

Claire-Marie Drevet, MD [a,1], Nicolas Opprecht, MD [a,1], Abdelouaïd Nadji, MD [a,1], Sebastien Mirek, MD [a,1], Serge Aho, MD [b,2], Frederic Ricolfi, MD, PhD [c,3], Claude Girard, MD, PhD [a,3], Bélaïd Bouhemad, MD, PhD [a,*,3]

[a] Service d'Anesthésie Réanimation, CHU de Dijon, Dijon, France, BP 77908, 21709 Dijon Cedex, France
[b] Service d'Epidémiologie et d'Hygiène Hospitalières, CHU de Dijon, Dijon, France, BP 77908, 21709 Dijon Cedex, France
[c] Service d'imagerie diagnostique et thérapeutique Neuroradiologie et Urgences CHU de Dijon, Dijon, France, BP 77908, 21709 Dijon Cedex, France

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ABSTRACT

Purpose: In patients with aneurysmal subarachnoid hemorrhage (aSAH), acute cardiac dysfunction and triple-H-therapy, can lead to hypoxemia. Our aim was to assess impact of a protocoled fluid restrictive approach on hypoxemia in these patients.
Methods: We included prospectively ICU patients with aSAH admitted within 24 h after the bleed. The study was divided into 2 phases. The first phase, from January to December 2012, was designated as control group (group C). The second phase, from February 2014 to January 2015, was designated as study group (group S). Between these periods, a protocoled fluid intake approach was implemented to maintain as low as possible the cumulative fluid balances.
Results: Effective fluid restriction was obtained: at day 3 cumulative fluid balances were respectively for group C and group S, 1559 ± 2402 ml and 759 ± 1855 ml ($p = 0.04$); and 2211 ± 4918 ml vs 529 ± 2806 ml ($p = 0.04$) at day 7. We observed reduction in proportion of hypoxemic patient in group S compared to group C, at day 3 (22% vs 40%, $p = 0.047$) and at day 7 (28% vs 57%, $p = 0.007$).
Conclusions: Fluid restrictive management of patients with aSAH decreases number of hypoxemic patients at day 3 and day 7.

1. Introduction

In patients with Aneurysmal Subarachnoid Haemorrhage (aSAH) prevention of cerebral vasospasm, responsible of delayed cerebral ischemia (DCI) and poor outcome classically relied on triple-H-therapy. This could be a matter of concern since acute cardiac dysfunction occurs frequently in patients with aSAH [1-3] and may result in hypoxemia with its deleterious effects on recovery. The liberal fluid approach did not show any superiority in preventing DCI [4]. Moreover aggressive fluid administration may be detrimental [5] especially using colloids [6]. Thus recent guidelines recommend maintenance of euvolemia and normal circulating blood volume associated to oral nimodipine to prevent DCI [4]. In practice, during the acute phase, the euvolemia is only achieved by a protocoled fluid restrictive approach. This approach could decrease cardiac output and worsen organs perfusion (in particular renal and cerebral perfusion). It was shown in ARDS patients that restrictive fluid approached improved lung function and shortened the duration of mechanical ventilation and intensive care without increasing organ failures [7]. The restrictive fluid approach in aSAH should have more dramatic respiratory effect in these patients prone to cardiac dysfunction.

Relationship between positive fluid balance and cardiopulmonary complications during ICU stay is not clearly demonstrated.

~~So we conducted an observational controlled study~~. The aim of our investigation was to assess the impact of protocoled fluid restrictive approach on respiratory outcome of patient admitted in ICU for aSAH. As a secondary goal, we examined the impact on cerebral and renal complications.

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* Corresponding author at: Service d'Anesthésie Réanimation CHU Dijon and Université Bourgogne Franche-Comté, LNC UMR866, F-21000 Dijon, France, BP 77908, 21709 Dijon Cedex, France.
E-mail address: belaid_bouhemad@Hotmail.com (B. Bouhemad).
[1] Collected the data, analyzed the data and prepared the manuscript.
[2] Performed the statistical analysis.
[3] Analyzed the data and prepared the manuscript.

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2. Methods

2.1. Patients and protocol

This observational controlled study was performed in a 17-bed neurosurgical, and trauma ICU in Dijon University hospital. Inclusion criteria were: age > 18 years, admission to ICU within 24 h after the initial bleed and for at least 3 consecutive days; aSAH proven by CT scan or angio CT scan.

Exclusion criteria were: non-aneurismal SAH (trauma, arteriovenous malformation or undetermined); pregnancy; presence of COPD, pulmonary embolism.

The study was divided into 2 phases. The first phase was from January 2012 to December 2012 and was designated as the control group (group C). The second phase of the study was from February 2014 to January 2015 and was designated as the study group (group S). Between these periods a protocoled fluid intake approach was progressively implemented following strictly AHA/ASA guidelines [4]. In particular, specific computer prescribing routine were created to increase medical adherence to protocol. The aim of this protocol was to maintain as low as possible the Cumulative fluid balances. Input fluids (IV and enteral) were limited to 30 ml/kg/day for the study group. According to the neurologic status of patients (able to drink by themselves or not) medications were given per os or IV. At the initial phase, volume expansion was decided by bedside physicians and was only performed if respiratory changes in pulse pressure variation were >13% for ventilated patients [8] or CVP < 5 mmHg in spontaneous breathing patients [9,10].

Patients of the study group were enrolled prospectively and data were collected on medical charts. ~~Data collection of the study part was made prospectively.~~ The intensivists were unaware of the ongoing data collection to reduce provider bias. Data collection of control phase was made retrospectively. Data collection was done by ICU attendants (NO, AN, CMD).

For all patients the following data were collected: age, gender, simplified acute physiology score II, cardiac and pulmonary history, aneurism treatment (embolization or surgical clipping), WFNS SAH grading scale, occurrence of symptomatic cerebral vasospasm, mortality and neurologic outcome. We considered as symptomatic vasospasm, new focal neurological deficits, abnormal drowsiness, delirium or acute confusional state associated with vasospasm seen on perfusion CT scan or angiography. Neurologic outcome was assessed by the modified Rankin Scale (mRS). The mRS, was retrieved from the electronic patient record or from the primary care physician and assessed at 3 months after SAH. Poor outcome was defined as an mRS score of 4, 5, or death.

The following data were collected at day 3 and day 7: PaO_2/FiO_2 ratio, creatinine clearance rate, norepinephrine treatment, mechanical ventilation duration, occurrence of hypoxemia, defined as a PaO_2/FiO_2 ratio ≤ 200.

For each patient, we calculated the daily fluid balance. Input fluids were all the IV fluids plus feeding (oral, enteral or parenteral). Output fluids were the sum of diuresis, enteral residuals and external ventricular drain. Day 3 and day 7 cumulative fluid balances were also calculated.

2.2. Statistical analysis

Quantitative variables were given as mean, standard deviations. Study of their distribution (Gaussian or otherwise) was carried out using histograms followed by normality tests. Categorical variables were described using percentages. 95% confidence intervals for the proportions were estimated using the exact binomial method.

Comparisons were made between groups C and S, and in hypoxemic and non-hypoxemic patients in group C. Means were compared using Student's *t*-test or Kruskal-Wallis test, as appropriate. Percentages were compared using Chi-square test or Fisher exact test, as appropriate. In order to identify risk factors for hypoxemia in group C, multivariate logistic regression was performed with a robust variance estimate or an exact logistic regression to take into account potential confounding variables. Multinomial variables were coded as dummy variables. Variables with a p value <0.2 in the univariate analysis were included in the multivariate analysis. A p value <0.05 was considered significant. All statistical analysis was performed using Stata software (Version 12).

3. Results

3.1. Clinical and demographic data

The flow chart is given fig. 1. Main clinical characteristics are given Table 1. No statistical difference was found between the 2 groups. Day 3 and day 7 cumulative fluid balances were significantly decreased between group C and group S and were respectively 1559 ± 2402 ml vs

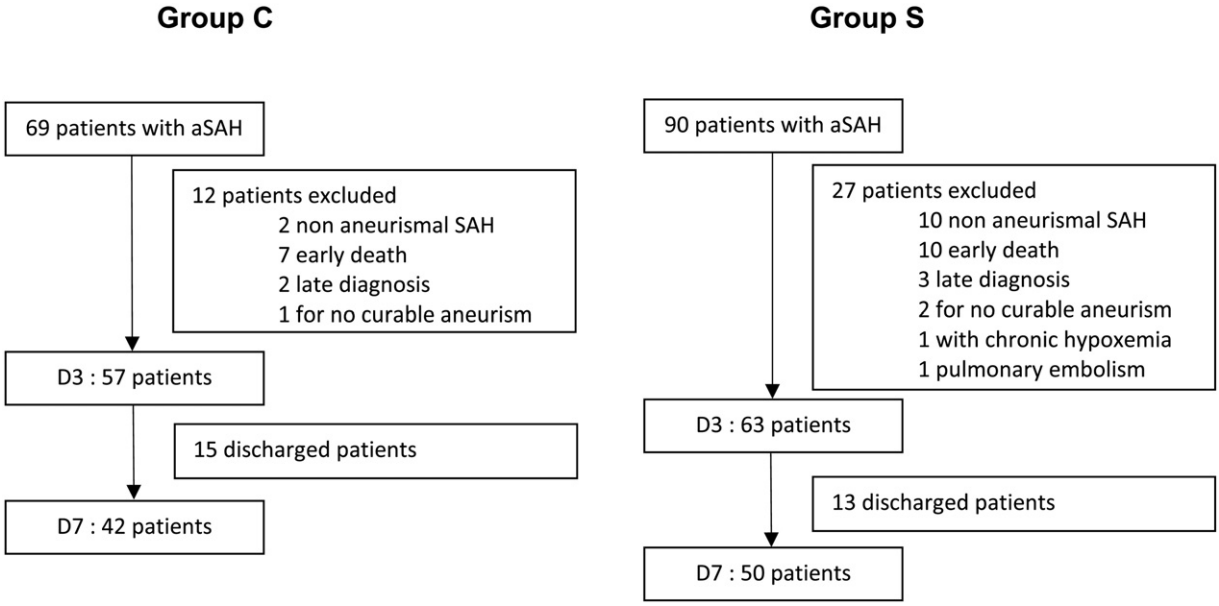

Fig. 1. Flow chart of the study.