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Original Article

Water balance management in intensive care: what is conventionally practiced and ideally possible

Gestão de balanço hídrico em terapia intensiva: o convencionalmente praticado e o idealmente possível

Sebastião de Melo Fonseca[1], Eduardo Shimoda[2]

1 Professor, Faculdade de Medicina de Campos (FMC), Campos dos Goytacazes, RJ, Brasil.
2 Professor, Universidade Candido Mendes, Campos dos Goytacazes, RJ, Brasil.
Corresponding Author: Sebastião de Melo Fonseca
Contact: sebastiaomfonseca@gmail.com

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ABSTRACT

The Fluid Balance (FB) is an extremely important tool in the management of critically ill patients, especially in maintaining hydroelectrolytic balance. As it does not require a protocol model, varying according to the institution, it often does not encompass all necessary variables for comprehensive assessment. The study aimed to propose a more comprehensive fluid balance model and quantify the distortion of the sum of daily evaluated fluid variables with the current local model, comparing it with a theoretically ideal model. For this, a crossover comparison was conducted between "practiced" and "calculated" fluid balances. Additional fluid variables were added to the commonly used ones in an attempt to complement the assessment. Two intensive care units were selected, each with distinct profiles, typification, target population, economic condition, and resources. Each patient was compared with themselves, excluding from the study only cases that did not complete 24 hours of hospitalization. The results showed a discrepant cumulative fluid volume between the groups (11,218 mL in the "practiced" group versus 5,512 mL in the "calculated" group), along with a false impression of mortality associated only with excessively high FB (deaths with a cumulative of 20,764 mL in the currently practiced collection compared to 11,560 mL from the proposed model). Moreover, higher mortality was observed in the negative spectrum range of fluid balance in the calculated model. Thus, in the proposed model, FB 50% lower than the "practiced" ones already present poor outcomes and increase the lethality of these patients. Concurrently, the calculated cumulative fluid balance of discharged patients was 2.97 times lower than commonly practiced. The findings had statistical significance and corroborated with current medical literature, associating increased mortality with a more positive fluid balance.

RESUMO

O Balanço Hídrico (BH) é uma ferramenta de extrema importância na condução dos pacientes criticamente enfermos, principalmente na manutenção do equilíbrio hidroeletrolítico. Como não exige um modelo protocolar, variando conforme a instituição, muitas vezes não contempla todas as variáveis necessárias para a sua ampla avaliação. O objetivo do estudo foi propor um modelo de balanço hídrico mais completo e quantificar a distorção do somatório das *variáveis hídricas avaliadas diariamente com o modelo local em vigência, comparando-o com um modelo teoricamente ideal. Para isso, foi realizada uma comparação tipo crossover, entre balanço hídrico "praticado" e o "calculado". Variáveis hídricas adicionais somaram-se às costumeiramente utilizadas, na tentativa de complementar a avaliação. Foram selecionadas duas unidades de terapia intensiva, com perfis, tipificação, público-alvo, condição econômica e recursos distintos. Cada paciente foi comparado consigo mesmo, excluindo-se do estudo apenas casos que não completaram 24h de internação. Os resultados apontaram um discrepante volume hídrico cumulativo entre os grupos (11.218mL no grupo "praticado" versus 5.512mL no "calculado"), além de uma falsa impressão de mortalidade associada apenas aos BH excessivamente altos (óbitos com cumulativo de 20.764mL na coleta atualmente praticada em relação a 11.560mL do modelo proposto). Além disso, observou-se maior mortalidade na faixa de espectro negativo do balanço hídrico, no modelo calculado. Assim, no modelo proposto, BH 50% menores do que os "praticados" já apresentam desfechos ruins e aumentam a letalidade desses pacientes. Concomitantemente, o balanço hídrico cumulativo calculado dos pacientes que tiveram alta, foi 2,97 vezes menor do que o corriqueiramente praticado. Os dados encontrados tiveram significância estatística e corroboraram com a literatura médica atual, associando incremento de mortalidade com um balanço hídrico mais positivo.*

INTRODUCTION

The Fluid Balance (FB) is an important method for measuring the gain and loss of fluids in critically ill patients. There is higher morbidity and mortality in FB that remain continuously positive[1].

Between 1950 and 1970, conceptual evaluations and data measurement became the basis of knowledge on this subject[2,3]. An FB can be more prone to hypervolemia or hypovolemia depending on the studied situation. There is a dichotomy: septic patients are overhydrated[4,5] and cardiac patients have systematically negative FB[6].

Recent techniques for assessing tissue perfusion, including at the microscopic level[7], as well as studies comparing FB oscillations and clinical outcomes, support the maintenance of voluminous equilibrium given the mortality associated with progressively positive fluid balances[8]. Thus, there is an enormous challenge in pursuing this balanced fluid pendulum and proposing solutions to measure it more accurately.

The hypothesis to be tested is that data collection on fluid intake and output over 24 hours in most Brazilian ICUs does not adequately account for the variables that should be measured. Often, data such as the amount of diarrhea, fluid gain in mechanical ventilation and nutritional therapy, water loss in fever episodes, and insensible losses are not computed.

FB is the cornerstone of fluid control in hospitalized patients, serving as a cut-off point in good medical practice, even inferring higher mortality when it is excessive in critically ill patients[1]. According to Boyd et al.[8], there is currently a concern in maintaining isovolemia as excesses in any spectrum significantly contribute to mortality. This information is also corroborated by other authors[4-6].

INFLUENCING VARIABLES

FB is a daily assessment of undeniable importance for many decades, as per Doherty Sirl and Ring[9] in 1962.

There are many ways to measure values that should be uniform, causing inaccuracy and significantly compromising this important assessment[10].

Among the variables that make up an effective FB, those that are easy to measure, such as diuresis and administered liquids, are observed because they consist of volumes previously known by the team. Similarly, some values of the negative spectrum of this calculation are quantified by precise measures, such as diuresis collected and measured in graduated containers (in mL).

Among the positive variables are venous, oral, or enteral hydration.

There is also food by oral, enteral, or even parenteral routes with variable quantities (liquid and/or solid). Another point is the water intake present in the food consumed by patients. The water content in these foods is not measured in the FB of most hospitals. The water percentage in each food depends on its weight (portion) and can be obtained from specific tables. The total water value found in all foods offered in 24 hours, using the Brazilian Table of Food Composition (TBCA), is approximately 1,380 mL[11].

Venous hydration provides a volume to be administered in 24 hours. This volume is proportional to the number of calories metabolized, i.e., for a hypothetical caloric expenditure of 2,000 kcal, 2,000 mL of hydration should be administered, which can be fully infused intravenously (if the patient is on a zero diet), orally, or both[12]. Another aspect defines the daily water requirement as 20 mL/kg, assuming the individual has no pathologies that require larger volumes[13]. The body's internal water production is small, about 200-300 mL/day, but directly influences FB[14,15]. The volume of water ingested also varies in the literature on this subject, ranging from 1,600 mL in drinks and 700 mL in various foods[16]. This volume should include transfusions, almost entirely composed of water, the water volume used in the dilution of constantly administered medications, whether intravenously or orally, and the volume from mechanical ventilation due to the humidity formed in the respirator circuit[17].

In the negative variables, the main component is diuresis, which almost always constitutes the largest amount of water loss in hospitalized patients[18]. It is known that the means by which the kidneys optimize the water flow in the human body is the most efficient mechanism for effective endogenous fluid management. The normal diuresis volume is highly variable, depending on factors such as dehydration or excessive intake of ingested liquids, ranging from 500 mL to 2,000 mL at its extremes. Other authors disagree with these values, but their suggestions are very close. McMillen and Pitcher[16] and Ceneviva[14] suggest 1,500 mL of urinary loss per day.

Other volumes are accounted for in drains and tubes installed in such individuals. Sweating debits fluids from the body at around 100 mL/day under normal temperature and physical inactivity conditions, which can rise significantly if there is excessive physical activity or temperature.

Gastrointestinal losses are also conditioning factors for negative FB. In cases of normal stools, about 100 mL or even 200 mL[16] or values between 100-200 mL of water are excreted in 24 hours[14], which can rise considerably if the individual suffers from diarrhea.

In a study on insensible water losses[17], precise calculations of water diffusion in the environment were highlighted, implying a deduction of water gain from air samples in hermetic environments, where air samples were monitored before and after keeping individuals breathing in such locations. These studies maintained controlled environments in temperature (24°C) and relative humidity (40-50%) for a predetermined time. The results showed water loss values to the environment between 35 to 46 g/m3 of air, making it possible to estimate water loss to the environment. In the same study, the author estimates that 60% of insensible losses constitute cutaneous evaporation and 40% pulmonary activity. Also described in this work is a negative variable of 50 mL/day in all patients on mechanical ventilation. Some authors[15,16] suggest the total of insensible losses as 800 mL/day (pulmonary and cutaneous diffusion losses), 420 mL/m2 of body surface area[17], as well as a value of 1,000 mL/day[19].

A factor often improperly accounted for is fever episodes accompanied by water losses. Patients with high fever and visible sweating can lose 500 mL/24h[17]. The human body loses 500-1,000 mL of water every 24 hours of high fever[20], or 4.6 g per hour if the temperature remains >39°C. However, the best management value for the systematic collection of FB[14]: There is a water loss of 500 mL every 24 hours for each degree maintained above 37°C. That is, to evaluate fever episodes during this period, the period/temperature should be provided. An increase of 12% in basal hydration for each 1°C of temperature above 38°C in 24 hours[12]. Thus, an individual with a persistent fever of 39°C and a calculated hydration of 2,000 mL/24h should receive an increase of 240 mL in total. Another author states that a patient should receive a water intake of 10 mL/kg for each degree above 37°C maintained in 24 hours[21].

Small volume evacuations have an approximate water loss of 50 mL, while considerably larger volumes can lose 200 mL[13].

Diarrhea is another important factor among those responsible for maintaining daily losses in such an evaluation. The diarrheal patient may eventually lose up to 6,000 mL of water per day[14], or if the diarrhea volume can be measured, its composition can have 60-85% water[22].

In Tables 1 and 2, positive and negative fluid variables respectively described in the literature for 24-hour periods are presented. Among them are estimated variables with their respective bibliographic references, as well as variables that are necessarily measured in the ICU daily.

MATERIAL AND METHODS

This was an observational study based on data obtained from the FB records of patients admitted to intensive care units (ICU) of two institutions, one accredited to the Unified Health System (SUS) and the other private in the city of Campos dos Goytacazes-RJ. There was no interference in the collected data or the ongoing conduct. A comparison was only made between the models habitually practiced in these institutions and a more faithful and closer to the ideal FB prototype.

The data were considered jointly regardless of the evaluated hospital since they presented the same clinical profile and similar FB models. The first hospital (SUS) had 14 beds and

Table 1 – Positive Variables for Estimating Water Gains for ICU Patients

Positive Variable	Value	References
Hydration	Measurable	--
Oral/NE Hydration	Measurable	--
	1600mL	(15,16)
Oral Diet	700mL	(15,16)
	700-1500mL (liquid)	-14
	600-700mL (solid)	-14
Enteral Diet	Measurable	--
NPT	Measurable	--
Endogenous Water	200-300mL	-14
	400mL	-31
Transfusion	Measurable	--
Medication Dilution	Measurable	--
Mechanical Ventilation	50mL	-17

the second (private) had 10 beds. Both were for adult patients but differed in terms of average age, socioeconomic profile, prognosis, and most frequent pathology. In addition to the information normally collected in the current FB form, other non-constant data were obtained from this data source to create the FB model proposed in this study, comparing the data used in the norm with a hypothetical situation. The project was approved by the Ethics and Research Committee under number CAAE 03689818.8.0000.5244.

Patients admitted for more than 24 hours, regardless of their condition and severity, with monitored fluid status in their own forms, were included. There was no distinction in collection between age, gender, or comorbidity, as positive FB is an isolated factor of worse prognosis regardless of the patient's condition. Additionally, as a crossover study, each patient's data were readjusted in the proposed model and compared with themselves. Those who did not complete 24 hours of hospitalization were excluded.

Table 2 - Negative Variables for Estimating Water Losses for ICU Patients

Negative Variable	Value	References
Diuresis	Measurable	(14)
	700-1500mL/24h	--
Drains/tubes/aspirates	Measurable	(19)
Normal Stools	100-200 mL, 70% water	(14,17,19)
Excessive Sweating	1000 mL, 4-6h = 600 mL	
Gastrointestinal	100-200 mL	(14)
Respiration	300-400 mL, 300 mL, 170 mL/m² SC / 24h	(17)
	800 mL	(14,15,17)
	420 mL/m² SC	(19)
	250 mL/m² SC	(17)
Insensible Losses*	800 mL + [20% x 800 (max axillary temp - 37)] if on mechanical ventilation: divide total by 2	(25)
	800mL	(31)
	Weight X 10	(23)
Hyperthermia	101° F (38,33°C) = 500mL	(19)
	For each degree maintained > 37°C = 500 mL every 24h	(14)
	46 g/h >39°C and 175 m² SC (500-1000 mL/24h of hyperthermia)	(20)
	Each degree maintained above 37.8°C = 100 mL/hour of hyperthermia	(31)
Diarrhea	Up to 6 L/day, 60-85% H_2O	(14,22)

The variables observed in the individual FB were arranged in a spreadsheet after collection in the studied hospitals or indirectly attributed/calculated based on current literature. Thus, the total analyzed variables will be the sum of the routinely collected data and those not routinely used but impacting the fluid status.

Entries and exits were computed in the table, counting the daily calculated FB in each ICU. These values were compared with those found in the effective calculation proposed by the work. For each item not directly collected, an average of the values found in the medical literature (**Tables 1 and 2**) was assigned. Each item was calculated as described below:

Positive Variables

a) Venous hydration; Oral/enteral hydration; Enteral diet; NPT; Transfusion and Medication dilution – Measured values.

b) Oral diet – value attributed to the water percentage according to the TBCA table according to the informed menu by the studied institutions. The average total water content found in the oral diet of this menu (common to both institutions) is 1,381 mL/24h.

c) Endogenous water– Average value found in the literature (3166 mL/24h).

d) Mechanical ventilation – Average value found in the literature (50 mL/24h).

Negative Variables

a) Diuresis; Drains/tubes/aspirates- Measured values.

b) Normal stools - Average value found in the literature (150 mL/24h)

c) Diarrhea – Due to the enormous difficulty of measurement, the subjectivity of observation by nursing technicians, and inconsistency of values in the literature, a strategy for its estimation was created.

In both institutions, the nursing staff computes diarrhea in a number of "crosses," ranging from 1 to 6 "crosses" according to their subjective observation. This generated significant variation from different observers, requiring the standardization of this measure. Thus, for each sample, the number of "crosses" that the nursing technician deemed consistent was assigned. They were then weighed on a digital scale, discounting the weight of the diaper. All patients were under vesical catheterization without mixing diarrheal stools and urine. After weighing 100 samples, an average of the total "crosses" and the total sample weight revealed that on average each "cross" (+) equals approximately 444 g of stools, here represented by the variable "a." According to current literature (**Table 2**), 60-80% (average of 72.5%) of this composition is water. The total water lost by diarrhea in 24 hours equals the sum of "crosses" multiplied by the average weight (in grams) of the stools and multiplied by 0.725 (which corresponds to 72.5%).

$$\sum a*44{,}4*0{,}725$$

d) Sweating – There is an average loss of 120 mL of water per hour when the patient presents sweating (**Table 2**). The number of sweating episodes will be represented by "n" and the number of hours contained in each measurement period will be represented by "h." The total water lost by sweating in 24 hours equals 120 multiplied by the num-

Table 3 – Table of correlation between measured temperature and hyperthermia coefficient

Measured temperature (in °C)	Hyperthermia coefficient (Points per episode)
37,1-38,1	1
38,2-39,1	2
39,2-40,1	3
>40,1	4

ber of sweating episodes recorded and multiplied by the number of hours in each measured period.

120 * n * h

e) Insensible losses – he average value from various research in own literature was 750 mL in 24 hours.

f) Hyperthermia – There is a loss of 500 mL of water for each degree above 37°C maintained in 24 hours. Most often, the temperature is measured every 6 hours (4 times a day). When hyperthermia was present, it was inserted in the FB at a standardized time. As the next measure would be done in 6 hours, an empirical number of hours between each period was assigned to this episode multiplied by the number of periods in which hyperthermia was maintained, in addition to a coefficient that relates the number of degrees above 37°C with multiples of 500 mL of water loss[14] (**Table 3**).

Thus, the formula developed for hyperthermia cases was: the total water loss in 24 hours (500 mL) for each degree above 37°C divided by the number of periods (p) where the fever was detected. This total should be multiplied by the sum of the fever coefficient (c) for each observed period (**Table 3**).

$$(500/p) * \Sigma c$$

Statistical Analyses

For the obtained fluid balances, means and standard errors were calculated regarding the practiced and calculated stratifying the results concerning the outcome (death or discharge). The means were compared using the paired t-test of Student. When the data had a non-normal distribution, the medians were compared through the non-parametric Mann-Whitney Test. Data related to the frequency of deaths according to the FB range were also presented, as well as Pearson correlation coefficients between the percentage of deaths with the practiced and calculated fluid balances and with the overestimated value relative to the calculated. Statistical analyses were processed in the R program, adopting a 5% significance level.

This manuscript was translated with the assistance of ChatGPT, an AI language model developed by OpenAI.

RESULTS AND DISCUSSION

The mean practiced fluid balance was substantially higher than the calculated one (**Figure 1**), even though the groups were rigorously

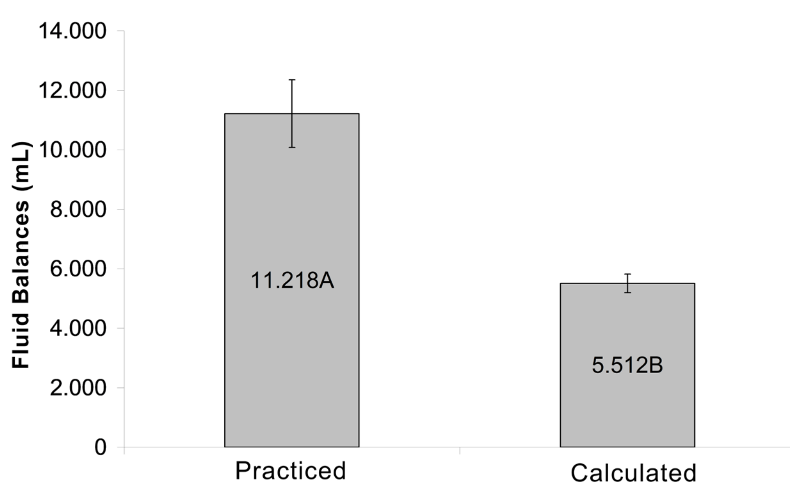

Figure 1 – Fluid Balances (means and standard errors) practiced and calculated

(A)

(B)

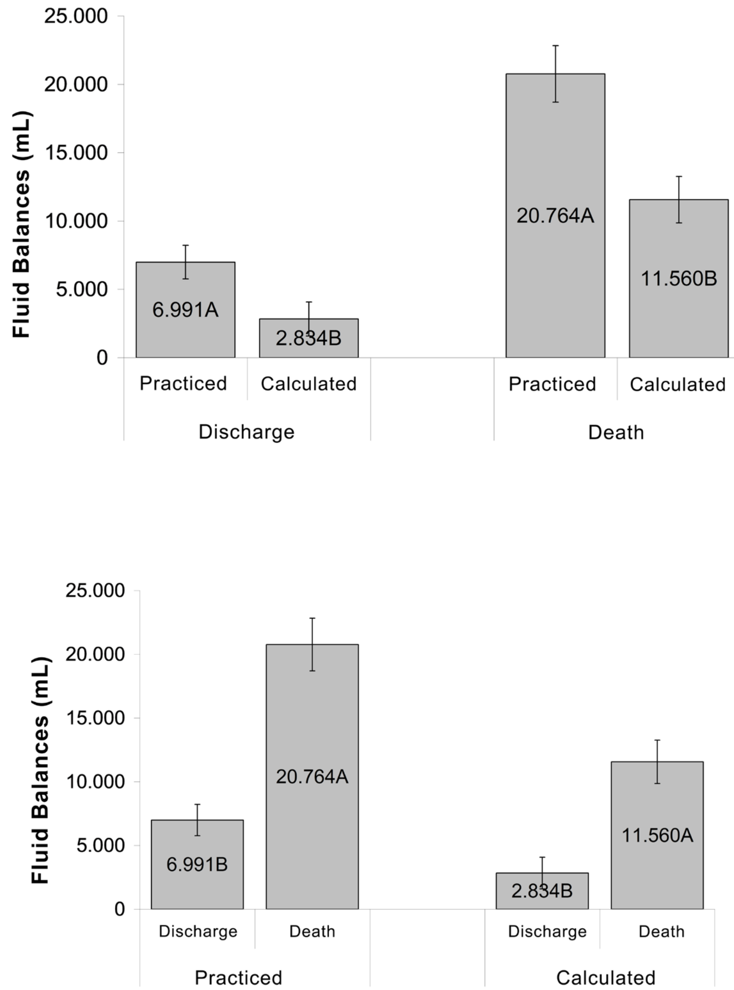

Figure 2 – Comparison of Practiced and Calculated Fluid Balances in Relation to Clinical Outcome (Death or Discharge). A) Fluid balances (means and standard errors) practiced and calculated related to the outcome (death or discharge). B) Fluid balances (means and standard errors) with discharge and death outcomes inserted into the main evaluated groups (practiced and calculated)

the same, the results were quite distinct (11,218 mL versus 5,512 mL), both being considerably positive. Many patients had a significant fluid accumulation. It was not evident whether the difference was due to the difficulty in negative the FB or the clinical severity in these groups. At best, there was a 5.5 L fluid increase, worsening the prognosis and recovery.

In both groups, mortality was associated with very positive fluid balances, with overestimation of FB in the "practiced" group (20,764 mL) compared to the "calculated" (11,560 mL) (**Figures 2A and B**). There is significant statistical significance, endorsing the direct relationship between mortality and overhydration. High readings in the "practiced" group (6,991 mL) had a cumulative FB 2.47 times higher than the "calculated" group (2,834 mL). The second group presented lower cumulative values closer to neutral, corroborating the expected outcome. This may have generated judgment errors, overestimating values in the "practiced" group.

The "practiced" fluid balance means were significantly higher in deaths (20,764 mL) com-

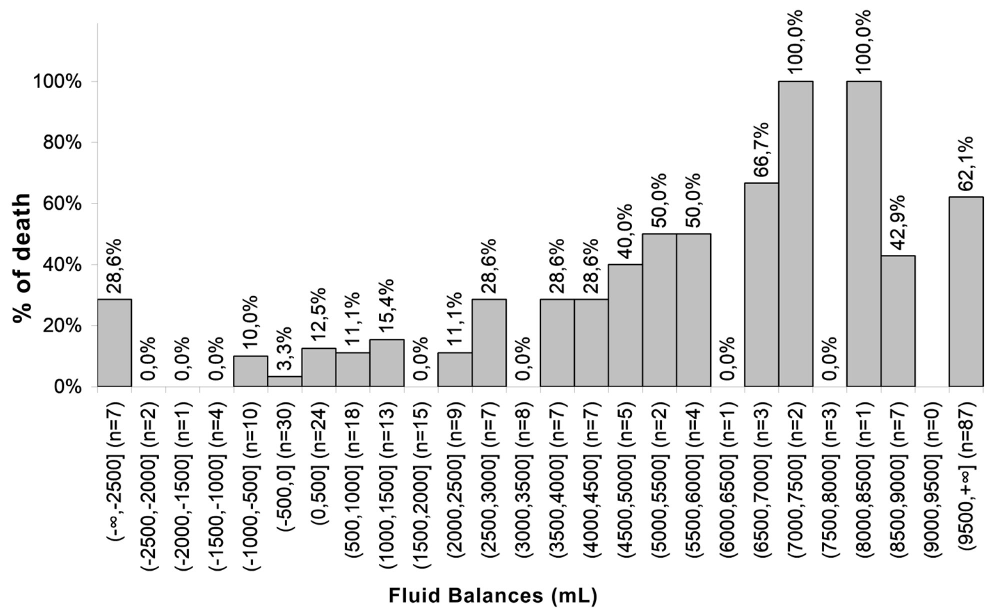

Figure 3 – Percentage of Deaths by Subgroup (FB ranges with limits every 500 mL) in the practiced group.

pared to discharges (6,991 mL). In the "calculated" group, the FB means related to deaths were considerably higher than the means related to discharges, proportionally greater when compared to the practiced group.

The average fluid balance in the "Practiced" group was 6,991 mL in patients with "Discharge" outcome and 20,764 mL for "Death". There is a 2.97 times more positive FB in deaths.

In the "Calculated" group, this relationship was much greater (4.08 times), increasing the margin between the outcomes (2,834 mL with "Discharge" outcome and 11,560 mL with "Death").

In the "practiced" group, there was an upward trend in deaths as the fluid balance was more positive, peaking at deaths (100%) in the

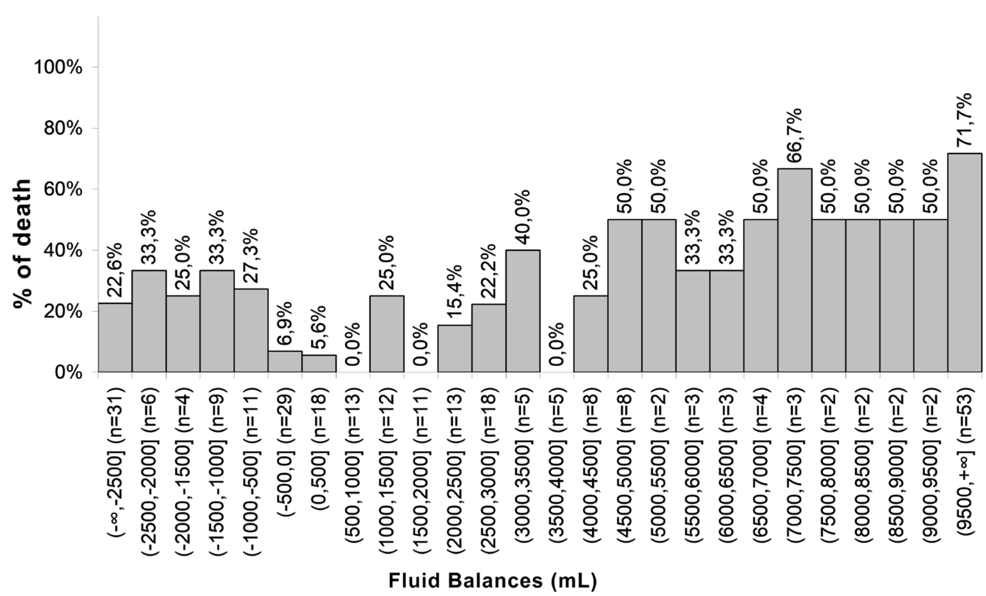

Figure 4 – Percentage of Deaths by Subgroup (FB ranges with limits every 500 mL) in the calculated group.

7,000-7,500 mL and 8,000-8,500 mL subgroups. However, the "n" was very small in these subgroups (**Figure 3**). In the >9,500 mL subgroup, the "n" of deaths is quite significant, with a mortality rate of 62.1% (n=87).

Mortality was proportionally inverse, even absent between -1,000 mL to -2,500 mL, but with many deaths in <-2,500 mL (28.6%). The death rate is much higher in the surplus FB ranges (**Figure 4**), with approximately 50% deaths between 4,000 to 9,500 mL and in the more negative subgroups than -500 mL (22.6 to 33.3% deaths).

Comparing the two groups, the underestimated mortality in the negative spectrum of the FB in the "practiced" group and the overestimation of deaths in the submaximal evaluation range are visible. The calculated group showed more solid results, making the deleterious effects at the ends of the evaluation evident, without failing to corroborate with current literature (deaths above 9,500 mL = 71.7%). The "calculated" fluid balance valued the mortality relationship in the negative spectrum of the measurement (in > -1,000 mL: 50 against 7 deaths respectively in the calculated and practiced groups). In other words, mortality is bimodal, either in the very "wet" or very "dry" patient. However, there was a higher prevalence in the more positive FB spectrum. The more overestimated the values, the higher the mortality.

Most subgroups with larger "n" are close to fluid balance or at opposite extremes. This behavior may reside in the fact that a considerable part of patients can be minimally satisfactorily managed regarding fluid balance. Those at the extremes may be of extreme severity and/or difficult fluid management.

There is also a number between -500 mL to 500 mL (mortality of 15.8% in the "practiced" group and 12.5% in the "calculated"; n = 54 in both). The most plausible explanation is the heterogeneity of cases, as there are pathologies with a bleak outcome despite the FB. In Table 4, the number of death observations in the two groups (practiced and calculated), the correlation between them, and the "Z" (standardized score), as well as the same values for the practiced FB overestimated in relation to the calculated with significance (P < 0.0001), are shown.

When evaluating the results, the employed methodology should be observed, as the reference articles evaluated the parameters differently. FB contains weight, administrations (oral and venous) of fluids, and losses (vomiting, excretions, drains, and hemodialysis)[23]. Although there was concern with hyperthermia and mechanical ventilation, these variables were not used. Thus, the results obtained in the present study, including nutrition data, mechanical ventilation, and fever episodes, showed significant differences in the accumulated FB.

In the evaluated institutions, there was concern in computing the data, but technological resources were lacking, contrasting with other realities, discussing whether the methodology of daily weight measurement in ICU patients predicts real fluid gain[24,25]. In the Brazilian reality, daily fluid

Table 4 – Number of death observations in the practiced, calculated groups, and practiced FB overestimated in relation to the calculated, their correlation values, and standardized scores (P-value < 0.0001)

Variable	Variable	Observations	Correlation	Z	P-value
Practiced	% óbito	277	0,4777	7,9365	<0,0001
Calculated	% óbito	277	0,3640	6,0467	<0,0001
Practiced balance overestimated in relation to the calculated	% óbito	277	0,3598	5,9776	<0,0001

chart data collection prevails. The electronic scale is not yet mandatory in Brazilian ICUs according to RDC n° 07[26]. Other efficient technologies for fluid assessment, such as Bioimpedance[27,28] or EVLW – evaluation of extravascular lung water[29], are not available in most Brazilian ICUs.

In both evaluated hospitals, some variables proposed by this study were not collected, with 1/3 of the collected FBs being inaccurate[30]. There is a lack of a pre-defined model for evaluating the water quantity in the measured items. The weight of the food, its water percentage, nor the daily water gain from mechanical ventilation were computed. Blood transfusion data were erratic and irregularly recorded.

Moreover, factors contributing to consistent water loss, such as fever and diarrhea, are underestimated or neglected due to the subjectivity of measurements. In the evaluated FB records, this fact was evident. This measure should have considerable importance in the daily routine, both for its frequency and the magnitude of water loss (60-85% water/sample of diarrhea)[22]. This variable significantly impacted the negative spectrum of the calculated FB.

In both hospitals, the practiced FB did not associate water loss with fever. There is a loss of 100 mL of water per hour per degree of temperature maintained above 37.8°C[31]. In the present study, it was chosen to infer a water loss of 500 mL for each degree above 37.8°C maintained in 24h[14].

In both practiced or calculated FBs, there was fluid excess as a component of the outcome. The average gain was 5.5 kg. In addition to mortality associated with positive FB, there are surgical, ventilatory, renal, and cardiac complications, greatly hindering the recovery of such patients[32,33]. Disorders related to body fluids and electrolytes are among the most common problems in ICUs[10], with substrates like sepsis, burns, heart failure, and neurological injuries. Such conditions associated with incorrect fluid management can have fatal consequences.

There is a thin line between starting fluid administration and the correct moment to stop it[34]. This inconsistency leads to fluid overload, greatly worsening the clinical outcome.

Another relevant point is the correct preparation of the daily FB chart. There is enormous variation in the components that make up this document, considering each unit. There is no rigid standard to follow or effective monitoring of the values in these tables. If this documentation is prepared incorrectly, it can be counterproductive and even dangerous due to the enormous variation[10]. In the units evaluated in the present study, many data were subjectively collected.

For example, the values assigned to diarrhea, arbitrated individually by each professional. Some variables in the practiced FB in the evaluated hospitals are of inconsistent capture. Blood transfusions were often not accounted for in daily data collections. Many professionals do not consider blood transfusion as a positive variable in FB. This understanding of hemotransfusion therapy is not exclusive to countries like Brazil and can also be observed in developed countries. This shows the lack of training and qualification[35].

Despite being a crossover study, one must consider as a limitation the lack of stratification of patients by weight, age, sex, and underlying pathology.

There is an important variation between the currently practiced FB quantities in many of our ICUs and those effectively calculated based on more complete variables found in various medical literatures. The suggested hypothesis of significant differences in the computation of this information was confirmed, showing that the fluid target of such patients is poorly regulated.

The discrepancy in the daily per capita balance sums between the practiced and calculated groups was confirmed, with differences corresponding to double the calculated group. There is overestimation in the practiced group deaths and underestimation of the more negative FB spectra in the calculated group. However, there is a direct relationship of mortality with accumulated fluid volume, and it should not be so positive for the outcome to be lethal. Neutral balances have better outcomes.

The implications of the current study are relevant, as it can contribute to fluid measurement, especially in units lacking technological resources. The gain, however, was the confirmation of a skeptical suspicion that the preparation of the fluid chart for intensive care patients, especially in the profile of the evaluated ICUs, is erratic. The results are quite robust when comparing a traditionally accepted data collection modus operandi in this reality and a more detailed proposal closer to a scientific reality.

However, some methodological issues in the current study should be considered. Some measurements were impossible due to the lack of specific material and/or staff availability. Lack of precision scales, daily weight assessment of patients, service commitment, and subjectivity hindered certain measurements. The current Brazilian scenario lacks the uniformity of available resources. Thus, the data collection design was based on its reality, with adjustments supported by current medical literature, and may not offer an absolute precision measure. In this case, an approximate evaluation is preferable to not evaluating these variables. It is important to consider that the studied units have a similar data collection profile but with very different material realities. The current study can draw comparisons with institutions sharing the same material and economic reality.

REFERENCES

1. Brotfain E, Koyfman L, Toledano R, Borer A, Fucs L, Galante O, et al. Positive fluid balance as a major predictor of clinical outcome of patients with sepsis/septic shock after ICU discharge. Am J Emerg Med. 2016;34(11):2122-6.
2. Andersson B. Regulation of body fluids. Annu Rev Physiol. 1977;39:185-200.
3. Edelman IS, Leibman J. Anatomy of body water and electrolytes. Am J Med. 1959;27:256-77.
4. Durairaj L, Schmidt GA. Fluid therapy in resuscitated sepsis: less is more. Chest. 2008;133(1):252-63.
5. Van Biesen W, Yegenaga I, Vanholder R, Verbeke F, Hoste E, Colardyn F, et al. Relationship between fluid status and its management on acute renal failure (ARF) in intensive care unit (ICU) patients with sepsis: a prospective analysis. J Nephrol. 2005;18(1):54-60.
6. Barretto ACP, Drumond Neto C, Mady C, Albuquerque DCd, Brindeiro Filho DF, Braile DM, et al. Revisão das II Diretrizes da Sociedade Brasileira de Cardiologia para o Diagnóstico e Tratamento da Insuficiência Cardíaca. Arquivos Brasileiros de Cardiologia. 2002;79(suppl 4):1-30.
7. De Backer D, Creteur J, Preiser JC, Dubois MJ, Vincent JL. Microvascular blood flow is altered in patients with sepsis. Am J Respir Crit Care Med. 2002;166(1):98-104.
8. Boyd JH, Forbes J, Nakada TA, Walley KR, Russell JA. Fluid resuscitation in septic shock: a positive fluid balance and elevated central venous pressure are associated with increased mortality. Crit Care Med. 2011;39(2):259-65.
9. Doherty MK, Smith WB, Lew YL, Sirl MB, Ring OI. Modern practical nursing procedures / by M.K. Doherty, M.B. Sirl [and] O.I. Ring ; revised by W.B. Smith [and] Y.L. Lew. 9th ed., rev. ed. Sydney, N.S.W: Dymocks Book Arcade; 1962.
10. Tang VCY, Lee EWY. Fluid balance chart: do we understand it? Clinical Risk. 2010;16(1):10-3.
11. Tabela Brasileira de Composição de Alimentos (TBCA) São Paulo: Food Research Center (FoRC); 2023 [cited 2024 06-12]. Versão 7.2:[
12. Feitosa-Filho GS, Firmo UR, Miranda LB, Oliveira SAd. Guia de Prescrição Hospitalar. São Paulo: Atheneu; 2013. 292 p.
13. Caldeira FM, Westphal G. Manual Prático de Medicina Intensiva. 10a edição ed. São Paulo: Segmento Farma; 2013. 480 p.
14. Ceneviva R, Andrade Vicente YAdMV. EQUILÍBRIO HIDROELETROLÍTICO E HIDRATAÇÃO NO PACIENTE CIRÚRGICO. Medicina (Ribeirão Preto). 2008;41(3):287-300.
15. McGloin S. The ins and outs of fluid balance in the acutely ill patient. Br J Nurs. 2015;24(1):14-8.
16. McMillen R, Pitcher B. The balancing act: body fluids and protecting patient health. British Journal of Healthcare Assistants. 2011;5(3):117-21.
17. Cox P. Insensible water loss and its assessment in adult patients: a review. Acta Anaesthesiol Scand. 1987;31(8):771-6.
18. Moore T, Woodrow P. High dependency nursing care : observation, intervention, and support for level 2 patients. 2nd edition ed. New York: Routledge; 2009. 484 p.
19. Wilson M, Tovey GH. Graphic fluid-balance chart. Lancet. 1961;1(7188):1207-8.
20. Reithner L. Insensible water loss from the respiratory tract in patients with fever. Acta Chir Scand. 1981;147(3):163-7.
21. Biesalski HK, Bischoff SC, Boehles HJ, Muehlhoefer A, Working group for developing the guidelines for

parenteral nutrition of The German Association for Nutritional M. Water, electrolytes, vitamins and trace elements - Guidelines on Parenteral Nutrition, Chapter 7. Ger Med Sci. 2009;7:Doc21.
22. Powell DW. Approach to the Patient with Diarrhea. In: Yamada T, editor. Principles of Clinical Gastroenterology. Oxford, UK: Willey-Blackwell; 2008. p. 304-59.
23. Netto SM, Victoria ZTP, Guerreiro LF, Gomes Gc, Vaghetti HH, editors. Análise dos registros referentes ao balanço hídrico em unidade de terapia intensiva2015.
24. Roos AN, Westendorp RG, Frolich M, Meinders AE. Weight changes in critically ill patients evaluated by fluid balances and impedance measurements. Crit Care Med. 1993;21(6):871-7.
25. Schneider AG, Baldwin I, Freitag E, Glassford N, Bellomo R. Estimation of fluid status changes in critically ill patients: fluid balance chart or electronic bed weight? J Crit Care. 2012;27(6):745 e7-12.
26. Brasil. Resolução no 7, de 24 de fevereiro de 2010. In: Saúde Md, editor. Brasilia: Diário Oficial da União; 2010. p. 1-2.
27. Ellis KJ. Human body composition: in vivo methods. Physiol Rev. 2000;80(2):649-80.
28. Samoni S, Vigo V, Resendiz LI, Villa G, De Rosa S, Nalesso F, et al. Impact of hyperhydration on the mortality risk in critically ill patients admitted in intensive care units: comparison between bioelectrical impedance vector analysis and cumulative fluid balance recording. Crit Care. 2016;20:95.
29. Jozwiak M, Teboul JL, Monnet X. Extravascular lung water in critical care: recent advances and clinical applications. Ann Intensive Care. 2015;5(1):38.
30. Abd El Hamid H. Fluid Balance Monitoring Accuracy in Intensive Care Units. IOSR Journal of Nursing and Health Science. 2016;05:53-62.
31. Cunha AR, Lobo SM. What happens to the fluid balance during and after recovering from septic shock? Rev Bras Ter Intensiva. 2015;27(1):10-7.
32. Elofson KA, Eiferman DS, Porter K, Murphy CV. Impact of late fluid balance on clinical outcomes in the critically ill surgical and trauma population. J Crit Care. 2015;30(6):1338-43.
33. Neyra JA, Li X, Canepa-Escaro F, Adams-Huet B, Toto RD, Yee J, et al. Cumulative Fluid Balance and Mortality in Septic Patients With or Without Acute Kidney Injury and Chronic Kidney Disease. Crit Care Med. 2016;44(10):1891-900.
34. Malbrain M, Van Regenmortel N, Saugel B, De Tavernier B, Van Gaal PJ, Joannes-Boyau O, et al. Principles of fluid management and stewardship in septic shock: it is time to consider the four D's and the four phases of fluid therapy. Ann Intensive Care. 2018;8(1):66.
35. Ferreira O, Martinez EZ, Mota CA, Silva AM. Avaliação do conhecimento sobre hemoterapia e segurança transfusional de profissionais de enfermagem. Revista Brasileira de Hematologia e Hemoterapia. 2007;29