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Review Article

Causes, management and complications of severe adult dehydration in the emergency room

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ABSTRACT

This literature review aims to highlight the possible causes, complications, and management of this event from previously published studies discussing dehydration in critically-ill patients admitted to the emergency room (ER). In general, the administration of fluids has been used in the ER for critically-ill patients for many purposes. These include the optimization and adjustment of body fluids and electrolytes, increase renal protection against contrast, enhance uric acid, globins, caloric intake, and as an adjuvant to ameliorate the potentiality of certain medications or to dilute them. Many etiologies have been accused to cause dehydration in critically-ill patients. These include the fasting strategy that patients are obliged to whenever undergoing a surgical operation. Kidney, heart, and liver injuries have also been associated with patients' dehydration. Old age and the presence of other co-morbidities diabetes insipidus and uncontrolled diabetes can also aggravate the condition. Mental affection is the main complication that patients with severe dehydration might complain about. Other complications might include aggravation of heart failure, and skin diseases, and deterioration of the kidney functions and other cellular processes that require adequate nourishment for their daily normal functions. Mortality is also a serious common complication, especially within elderly patients. Although the management of dehydration can be easily achieved by fluid administration, fluid overload can aggravate the underlying complications and develop others. Therefore, the main challenge here would be to frequently monitor patients during fluid administration and resuscitation to prevent this side effect.

Keywords: Dehydration, Emergency; Complication, Management

INTRODUCTION

Preoperative fasting before performing surgeries has been prescribed for patients undergoing surgeries to prevent any possible complications that may result from aspiration of food particles intraoperatively.[1] Consequently, patients are more prone to develop a dry mouth and be hungry perioperatively. Preoperative management of these events can be easily achieved by intravenous supportive care, and by optimizing the preoperative fasting time which seems to be variable among the different healthcare systems globally.[2] Based on the shortage of present scientific evidence for evaluating the theory of preoperative fasting, many approaches have been made to reevaluate this phenomenon and adjust it based on the possible outcomes.[1] The relevant societies in the United States and most European countries have led such approaches to adjust the preoperative fasting guidelines and suggested that clear fluids can be orally allowed until 2-3 hours preoperatively except when a procedure for evaluating gastric emptying was planned.[3]

In general, strategies following restrictive fluid management approaches are encouraged during certain procedures as those involving patients with severe respiratory distress undergoing major surgical operations as they are thought to decrease the time spent on mechanical ventilation and frequency of any potential cardiopulmonary complications.[4,5] Malbrain et al.[6] conducted a meta-analysis to study the effect of frequency of fluid overhydration and resuscitation of critically ill patients. The authors reported that positive fluid balance was significantly associated with better outcomes regarding the patients' survival rates among the included studies. The results also demonstrated that the restrictive strategy was more significantly efficacious in reducing the mortality rates than the liberal one.[6]

The administration of fluids has been used in the emergency room (ER) for critically-ill patients for many purposes. These include the optimization and adjustment of body fluids and electrolytes, increase renal protection against contrast, enhance uric acid, globins, caloric intake, and as an adjuvant to ameliorate the potentiality of certain medications or to dilute them.[7-11] It should be noted that the re-hydration process is a fine one and should be carefully approached. If misused, serious complications may arise as a result which is mainly attributable to overhydration that can be fatal sometimes causing cerebral edema and cardiopulmonary complications.[12] In this review, we aim to discuss the different aspects of dehydration in patients admitted to the ER. We will try to highlight the possible causes, complications, and management of this event from previously published studies.

METHODS

We performed an extensive literature search of the Medline, Cochrane, and EMBASE databases on 14th December 2020 using the medical subject headings (MeSH) or a combination of all possible related terms. Studies reporting the causes, complications, and management of severe adult dehydration in the ER were screened for relevant information. We did not pose any limits on date, language, or publication type.

DISCUSSION

Etiology of dehydration among adult patients

It has been reported that the human kidneys lose efficacy as patients get older which is attributable to the fact that kidneys lose 33-50% of their nephrons in patients that exceed 30 years of age which affects the absorbing capacities of the kidneys.[13,14] Studies also estimated that kidney function tests become heavily impaired by the age of 80 as creatinine clearance becomes 30% and serum creatinine might be elevated 300 mL/min.[15] The same study also reported that the kidneys of older patients secrete fewer amounts of renin which affects the levels of aldosterone secretions, and consequently, the physiology of sodium and water secretion.[15] In the same context, adult patients' kidneys are more prone to be less likely respondent to vasopressin which is attributable to the resistance of the osmoreceptors which increases with age.[15-18] These events affect the kidneys' ability to concentrate or dilute the urine in a consequence that meets the metabolic and fluid status of the body. This increases the risk of developing hyponatremia and dehydration which is attributable to many relevant complications. As it is widely known, factors as diarrhea, diuretics, fever, heat exhaustion and cathartics are responsible for losing many metabolites and body fluids that can contribute to dehydration. In addition to these factors, organ damage, especially heart, liver, and kidney injuries and other disorders causing hormonal imbalance as inappropriate antidiuretic hormone secretion, uncontrolled diabetes, and angiotensin-converting enzyme inhibitors, contribute mainly to the process of dehydration and the disturbance in body fluids balance. Intact organ functions and appropriate hormonal secretions are responsible for body fluids and electrolyte balance within the human body. Therefore, disorders affecting this normal balance can easily cause disturbances, especially in sodium levels, which can cause a shift of fluids extracellularly and edema which can aggravate dehydration. The release of atrial natriuretic peptide (which is secreted from patients with myocardial injuries) can also aggravate dehydration by reducing the release of renin, and consequently, the activation of the renin-angiotensin cascade, causing more fluid loss. These events, in addition to other conditions as vomiting and diarrhea that seriously-ill patients, usually have, are the main causes of hypovolemia and dehydration. Drug-induced diuresis is also another factor for fluid floss and the subsequent complications in adult patients.

Sepsis is another contributing disorder to the process of dehydration. In sepsis, the body exhibits more frequent

spells of sympathomimetic agents as adrenaline and noradrenaline which cause arteriolar vasoconstriction, including those afferent arterioles of the kidneys, which reduces the glomerular filtration rate and the kidney functions to dilute and concentrate. This will result in a state of oliguria, azotemia, and concentrate urine that is similar to that of dehydration which is also related to being infected with severe illnesses and infections. Perioperative blood loss is also a contributing factor that can be aggravated by the aforementioned etiologies. A previous study by Mukand et al reported that a significant cohort of their patients, that underwent total hip and/or knee replacement procedures, were prone to develop dehydration, azotemia, and orthostasis which was responsible for delayed healing of these patients due to the relevance of possible complications.[19] Furthermore, the presence of certain comorbidities may lead to more fluid loss and complications than others. These include, in addition to renal, liver, and heart injuries, aging (as it is frequently associated with the loss of thirst sensation), dysphagia, and the underlying neurological disorders (as parkinsonism, cognitive impairment, amyotrophic lateral sclerosis) that may affect the habituation of drinking.[20,21]

Complications and burdens of dehydration

Many complications have been associated with the development of dehydration which affects cellular functioning and causes serious damage to many organs especially, the brain tissues. Studies showed that dehydration is accused of acute onsets of acute confusion and delirium states especially in the elderly population which lacks the synthesis of nitric oxide.[22-25] The process of dehydration is responsible for increased osmolality of the plasma and the concentration of electrolytes as sodium which leads to the development of hypernatremia, and hyperosmolality. This process affects the mentality of the diseased patients as they affect the functions and release of acetylcholine which is a strong mediator for all the neurological processes. Previous studies showed that dehydration-induced complications can also aggravate more dehydration running in a vicious circle.[26,27] To maintain adequate hydration is an essential need to pursue the metabolic and healing processes of an injured body. In the same context, absorption of the administered drugs also needs the availability of adequate hydration to complete the process. Chronic dehydration, therefore, would aggravate the underlying patients' conditions and delay the process of healing, and would also prolong the hospital stay. Studies showed that this can complicate many conditions and can even increase the rate of mortality, especially in the elderly. [28,29] Reduced body fluids lead to reduced plasma volume which stimulates the heart to exert more efforts to increase the stroke volume to maintain adequate tissue perfusion. Disturbed thermo-regulation is another consequence as redistribution of the body fluids to the most important organs in need of adequate perfusion makes the skin vessels more liable to severe vasoconstriction causing peripheral cyanosis.[30] Xiao et al.[31] also reported that dehydration might complicate other pre-existing conditions like infections, kidney stones, constipation, mitral valve prolapse, pneumonia, urinary tract infections, gastroenteritis, uncontrolled diabetes, ulcers, metabolic disturbances, and cancers. The cumulative effect of such complications will affect the patients' quality of life, especially the elderly ones which may exhibit more complications than can even cause death. A high range of 15-50% for mortality rates has been noticed among studies in the literature for institutionalized elderly patients. Mahowald and Himmelstein reported that up to 59% of their patients died as a result of dehydration-induced pneumonia and/or urinary tract infection. Dehydration can lead to various life-threatening events as evidence shows that the rate of patients' hospitalization that is attributable to dehydration is rapidly increasing among patients within the United States.

Management of dehydration and related concerns

Although dehydration can be prevented, it is frequently reversible.[32] Therefore, efforts should be directed to primarily preventing the condition by continuously monitoring patients at risk which can dramatically decrease the rate of the condition and the associated burdens. It has been reported that perioperative adequate rehydration is much more efficacious than managing post-operative dehydration.[31] Although previous studies demonstrated many concerns about the screening and assessment of dehydration, recent studies have demonstrated reliable approaches for early detection and continuous monitoring of patients.[33-35] History and physical examination, electrocardiogram, chest radiograph, and the serum levels of type-B natriuretic peptide (BNP) can detect the presence of severe complications that require adjusting the plan of management and resuscitation accordingly.[36-39] Previous protocols were designed to decrease the preoperative fasting interval to reduce the risks of dehydration. Another approach to minimize surgery-induced stressful situations has also been approached by Fearon et al.[40] namely the enhanced recovery after surgery (ERAS) aiming to reduce the demerits of perioperative fasting. Nygren et al.[41] also reported that perioperative administration of fluids and carbohydrates can decrease the anxiety and the subsequent feeling of thirst and hunger that may result from perioperative fasting. Carbohydrate administration can also reduce the postoperative anticipated insulin resistance. Oral rehydration therapy (ORT) is considered one of the most efficacious modalities for the management of dehydration in such patients. As recommended by the world health organization, it can be used to compensate fluids, electrolytes, and carbohydrates which may be superior to intravenous compensation and are favored in many European countries and the United States.[42] Taniguchi et al.[43] conducted a cohort study to decide whether ORT is an efficacious modality for the management of dehydration in terms of efficacy and complications. The authors reported that rehydration, which means providing fluid, carbohydrates, and electrolytes could be safely

achieved in their patients with improvements regarding the fractional excretion of Na, kidney function tests, and volume of esophageal-pharyngeal fluid and gastric fluid. No serious complications were noticed among the study population, however, only one patient suffered from vomiting.[43]

Another aspect of complications that should be considered is those complications resulting from the management of patients with dehydration. For instance, fluid overload can aggravate the underlying complications and develop others. Bouchard et al. reported that the rate of recovery from a kidney injury was significantly lower in patients that suffered from fluid overload. [44] In addition to the brain, the lungs are also one of the heavily affected organs by fluid imbalance. Volume overload can lead to complications as acute respiratory distress syndrome and acute pulmonary edema which can be fatal.[45] Murphy et al. showed that adequate fluid therapy after resuscitation can reduce the mortality rates among hospitalized patients.[46] Fluid and electrolyte balance together with a central venous pressure >12 mmHg are associated with better outcomes as reported by the vasopressin in septic shock trial.[47] On the other hand, a previous systematic review showed that central venous pressure should not be used to decide the effectiveness of fluid management and other methods of evaluation should be approached.[48]

CONCLUSION

Pre-existing evidence shows that dehydration can be easily managed. However, many concerns are to be considered, especially when managing patients suffering from critical illnesses. These include the frequent monitoring of patients during fluid administration and resuscitation to prevent any possibility of adverse events causing overhydration and subsequent pulmonary and cerebral edema that can be fatal. For proper management of dehydration, special attention should be given to the etiology which should be primarily prevented to essentially eliminate the condition. Special care should also be provided for elderly patients, patients with uncontrolled diabetes, and those with underlying chronic conditions as heart, liver, or kidney diseases, and patients suffering from diabetes insipidus.

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