

PRELIMINARY CHARACTERIZATION OF ENTERADE® REHYDRATION KINETICS FOLLOWING INTRA- AND EXTRA- CELLULAR DEHYDRATION



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ABSTRACT

Two distinct types of dehydration occur when body water loss is accompanied by small or large solute losses. Small solute losses result in shared water losses between the intra- (ICF) and extracellular (ECF) fluid spaces (intracellular dehydration, ID) while large solute losses primarily reduce volume of the ECF (extracellular dehydration, ED). The distinction between the two has therapeutic implications for rehydration. Enterade® is a commercial beverage blend of amino acids and electrolytes designed to improve gut function and enhance body water restoration. **PURPOSE:** To compare the rehydration kinetics of Enterade® following two types of dehydration. **METHODS:** Thirteen healthy, non-heat acclimatized volunteers participated in this study [mean ± SD; 23 ± 8 yr, 78.5 ± 14.2 kg, 1.8 ± 0.1 m, total body water (TBW), 41.1 ± 7.1 L]. A euhydration baseline was established over three days using standardized fluid intakes (≥ 3 L/d). On day four volunteers were acutely dehydrated using 80 mg furosemide (ED; n = 6) or exercise-heat stress (ID; n = 7). Volunteers were then rehydrated by replacing 100% of TBW losses with Enterade® over 90 minutes. Blood, urine, and sweat were sampled throughout. Rehydration kinetics were assessed over 4 hours, including plasma volume (PV) restoration, compartmental fluid shifts and drink volume retention. **RESULTS:** ID (- 4.1 ± 0.5% body mass) produced a hyper-osmotic (10 ± 4 mmol/kg) hypovolemia (-10 ± 5% PV). Losses in TBW (-3.0 ± 0.6 L) and solute (-583 ± 120 mmol) were shared between the ICF (25%) and ECF (75%). ED (-3.0 ± 0.2% body mass) produced an iso-osmotic (0 ± 2 mmol/kg) hypovolemia (-11 ± 4% PV). TBW (-2.4 ± 0.2 L) and solute losses (-719 ± 98 mmol) came primarily from the ECF (98%). PV was restored to baseline by 1.5 hours in ID and by 2.5 hours in ED, but after 4.5 hours ID was 5% above baseline while ED was 3.5% below. Enterade® retention was 75 ± 8% in ID and 70 ± 13% in ED. The ICF and ECF were restored by 47% and 80% in ID, while in ED restoration was 115% and 58% for ICF and ECF, respectively. **CONCLUSION:** Enterade® rehydrated volunteers to within ~1% of euhydrated TBW baseline after 4.5 hours in both ID and ED. However, PV was restored more rapidly and recovery of the ECF volume was more complete in ID.

Opinions herein are the private views of the authors; citations of commercial products are not an endorsement by the DOA.

INTRODUCTION

- Total body water (TBW) losses produce cell desiccation (intracellular dehydration, ID) when solute losses are smaller and lead to osmotic sharing of the TBW deficit among body fluid compartments; larger accompanying losses of solute affect primarily the extracellular fluid space (extracellular dehydration, ED).
- The distinction between ID and ED has many important medical implications including fluid replacement therapy.
- Enterade® is a proprietary commercial beverage blend of amino acids and electrolytes designed to optimize rehydration via enhanced gut transport and improved beverage retention.

PURPOSE

The purpose of this study was to provide a preliminary characterization of the rehydration kinetics and retention profile of Enterade® following two distinct types of dehydration (ID, ED).

METHODS & MEASUREMENTS

- ID was achieved by large losses of sweat and small losses of urine during exercise-heat stress and fluid restriction over ~6 hours.
- ED was achieved by large losses of urine following an acute 80 mg Furosemide dose and ~ 6 hours of fluid restriction.
- Direct compositional measurements of blood, urine, and sweat were used to estimate fluid space loss and recovery in accordance with plasma volume^{1,2} and osmometric mass balance³ calculations.
- Rehydration was achieved by replacing 100% of TBW losses with Enterade® over 1.5 hours in three equal boluses (additional details see Figure 1).

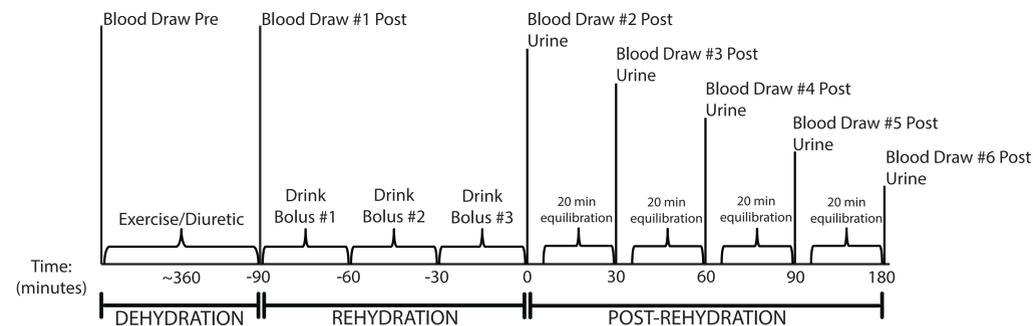


Figure 1. Rehydration design schematic following ID and ED.

RESULTS

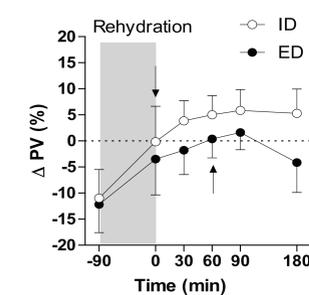


Figure 2. Percentage change in plasma volume (PV) after ID or ED (-90 min) and recovery kinetics. Arrows indicate group mean return to baseline.

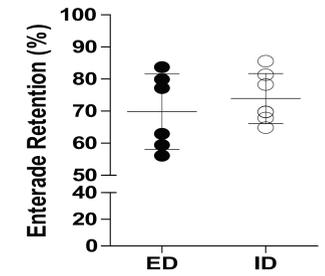


Figure 3. Retention of Enterade® 3 hours post-absorptive.

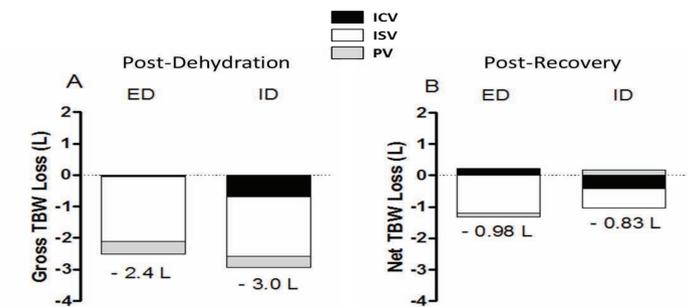


Figure 4. Distribution of compartmental TBW losses (intracellular volume, ICV; interstitial volume, ISV; plasma volume, PV) after ID or ED (A) and their recovery 3 hours post-absorptive (B).

DISCUSSION & CONCLUSIONS

- Enterade® fluid replacement rehydrated volunteers to within ~1% of euhydrated baseline body weight after 4.5 hours (3 hours post-absorptive) in both ID and ED.
- PV was restored more rapidly and recovery of the ECF volume was more complete in ID than in ED.



REFERENCES

1. Dill DB and Costill DL. J Appl Physiol 37: 247-248, 1974.
2. Sawka MN et al. Med Sci Sports Exerc 24: 447-453, 1992.
3. Wolf AV. Am J Physiol 153: 499-502, 1948.