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ON-THE-MOVE NUTRIENT DELIVERY SYSTEM (NDS): USER ACCEPTABILITY of ROTARY FLOW CONTROL VERSION

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Scott J. Montain, Susan M. McGraw, Matthew R. Ely, Frederick Dupont, William J. Tharion

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14. ABSTRACT

Dismounted operations make it difficult for Warriors to drink and eat enough. The Nutrient Delivery System (NDS) is an add-on to collapsible bladder with drink tube personal hydration systems, and is intended to facilitate fluid and on-the-move nutrient intake. Soldier feedback (n=83) was captured regarding acceptability of NDS form and function, and their opinions regarding the merits of the system. Sixty-eight percent of the Soldiers rated the device as moderately to extremely valuable, and 68% felt it would provide a performance advantage by better sustaining hydration and/or providing energy, and not having to stop to get nutrients. Eighty-three percent would recommend the system to their peers and 76% recommend that the Army invest in the technology. The potential advantage of the NDS technology for the user and logistician in combination with the favorable acceptability scores received, make the NDS a worthy candidate for advanced development.

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ON-THE-MOVE NUTRIENT DELIVERY SYSTEM (NDS): USER ACCEPTABILITY OF ROTARY FLOW CONTROL VERSION

Scott J. Montain[1]
Susan McGraw[1]
Matthew R. Ely[1]
Frederick Dupont[3]
William J. Tharion[2]

[1]Military Nutrition Division, USARIEM
[2]Biophysics and Biomedical Modeling Division, USARIEM

[3]Battle Lab Integration Team, NRDEC, NSC

March 2009

U.S. Army Research Institute of Environmental Medicine
Natick, MA 01760-5007

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Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRMC Regulation 70-25 on the use of volunteers in research.

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EXECUTIVE SUMMARY

Soldiers typically under-eat relative to their energy expenditure during field training and deployments. Maintaining hydration is also a challenge, particularly during hot weather, as there is aversion to the smell and taste of warm water, particularly when chlorine is present. This report summarizes the outcomes of a product evaluation of the fully manufacturable version of the Nutrient Delivery System (NDS), an add-on device to the Soldiers's personal hydration system (PHS) that enables hands-free on-demand access to flavored beverages while maintaining water purity. Product acceptability responses were obtained from 83 Soldiers who used the system during military training. Eighty-three percent would recommend the system to their peers and 76% recommend that the Army invest in the technology. Sixty-eight percent of the Soldiers rated the device as "moderately valuable" to "extremely valuable" and 68% felt if would provide a performance advantage by better sustaining hydration and/or providing energy, and not having to stop to get nutrients. Recommended improvements included covering the two fluid input lines so they become a single tube, reducing stiffness in the rotary valve, and minimizing opportunities for fluid leakage.

INTRODUCTION

Adequate fluid and nutrient intake to during high tempo military operations are difficult to achieve (2; 8). It is well described that dehydration and under consumption of electrolytes and carbohydrate can lead to compromised performance (3). In warm weather, a Soldier's fluid and electrolyte intake requirements can be substantial due to sustained vigorous sweating. Their desire to drink is easily compromised, however, as warm water and water containing purifying agents such as chlorine, impart a negative taste to water and reduce voluntary water intake (1). Similarly, it is operationally challenging to eat enough during mission execution as many food items provided in individual ration packs are difficult to eat on the move and may require preparation before consumption. Moreover, food intake is all too often restricted to eating when time permits. The addition of flavoring and/or carbohydrate to the water supply is a proven method to enhance voluntary fluid intake and provide essential nutrients to sustain performance (6; 7).

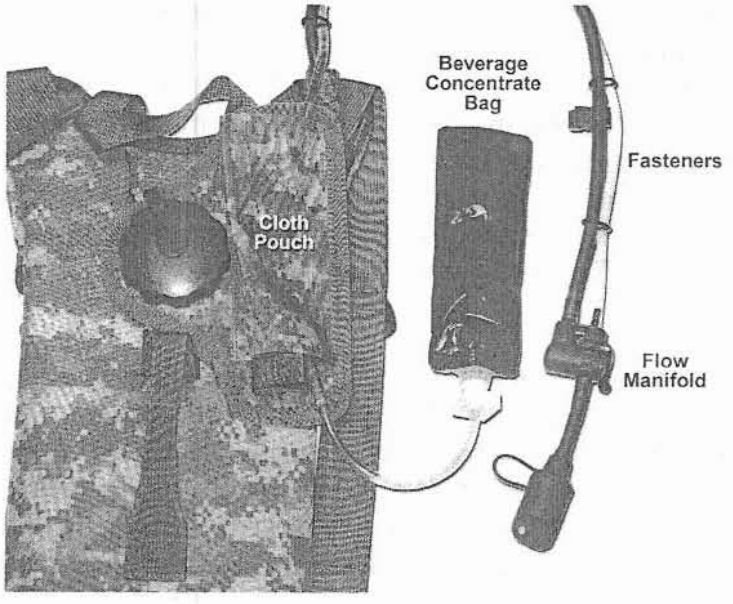
The Nutrient Delivery System (NDS) is a patented device (9), manufactured by Designturn, Inc.,Wellesley, MA, that integrates with the Soldier's Personal Hydration System (PHS). It was developed to provide a simple means of flavoring water and/or providing nutrients to Soldier's operating on-the-move. The current system (Figure 1) consists of 4 Parts: a flow control manifold, a beverage concentrate, a beverage concentrate line that connect s beverage concentrate with the flow manifold, and a cloth carrier for securing the beverage concentrate bag to the PHS during use. To operate the system, the user adjusts a rotary flow controller to turn off flow, select water-only, or select a user-defined blend of the beverage concentrate with water. The flow control lever passes over raised edges over the course of the system gain, providing tactile feel when moving from one selector setting to another. Built into the flow manifold are two one-way valves that prevent movement of beverage concentrate into the water supply line and vice versa; thereby protecting the integrity of the source liquids. Thus, the NDS enables the user to make a plurality of mixed drinks, when desired, in an automated way, using a method that doesn't contaminate the water in the PHS.

An advantage of the NDS over other approaches is that it provides a method of mixing in flavor and other additives to the water stream as it is being sipped. The NDS does not require a separate drink container (e.g., canteen cup) to mix drink ingredients; there is no requirement for the user to physically add water to powder or vice versa before consumption (e.g., adding beverage base to canteen); and the NDS does not contaminate the water reservoir or compromise water resistance to contamination.

In previous reports, we have described the outcomes of an initial proof-of-concept evaluation (5) and tests to define NDS mixing attributes and the specifications for a carbohydrate-electrolyte beverage concentrate for use with the NDS (4). This technical report summarizes user feedback regarding the acceptability of the fully manufactured version of the NDS during operational use. Three military populations working in different environmental situations were asked to provide written feedback on the acceptability of current NDS form and function, and most importantly, their opinions

regarding the merits of the system. The Soldiers who participated were infantry trained and had many years of active duty experience.

Figure 1. Nutrient Delivery System configured for use with U.S. Army Personal Hydration System



METHODS

One hundred systems were distributed to Soldiers assigned to the Warrior Training Center and the Ranger Training Brigade. Eighty-five of those Soldiers provided written feedback on the NDS but 2 did not provide ratings of acceptability and were subsequently removed from the dataset. Of the 83 whose comments were kept for analysis, 31 were stationed at Fort Benning, GA, 33 at Camp Rudder, FL and 18 at Camp Merrill, GA. Eighty-two were male and 1 was female. Seventy-five were enlisted (E-3 to E-9) and 8 were officers (O-1 to O-4). Mean time in service was 9 [5] (mean [sd]) years (range 2 to 21 years). Ninety-four percent were assigned to the Infantry.

Each participant was provided with a NDS equipped PHS and 12 to 14 100 ml bags of a carbohydrate-electrolyte beverage concentrate (each capable of blending approximately 1 liter of beverage). Volunteers were briefed regarding system function and system use, and given a written instruction sheet (Appendix 1). They were instructed to wear the NDS+PHS in the vertical position on the upper back during training and patrol missions. The objective was for the volunteers to use the system long enough that they had several opportunities to replace the drink concentrate pouch during the evaluation period and use it during a number of different operational situations (e.g., night and day activities, mounted and dismounted situations, etc). Acceptability was captured by survey (Appendix 2). Questions on the survey were

yes/no responses, ratings on a 9-point Likert scale (1=least acceptable and 9= most acceptable), and open-ended responses.

The NDS system features and beverage composition are summarized in Appendix 3.

This is a descriptive study only. Descriptive statistics of means, standard deviations, median scores and frequency counts are used to describe the results. Mean and standard deviation (sd) are presented as mean [sd].

RESULTS

The overall acceptability results are presented in Table 1 and Figure 2. Sixty-five percent of Soldiers surveyed liked the NDS, whereas 13% did not. The median and most frequent score was a 7 on 9-point scale; equivalent to the anchor phrase "like moderately". Sixty-eight percent felt that the NDS could improve Soldier performance. The most frequently cited reason was better hydration, followed by improved hydration and energy delivery, and not having to stop to obtain nutrients. The 13% who rated it negatively cited concerns about the ease of cleaning/maintaining the system, durability, lack of advantage, and leaks. That said, 79% of those examining the NDS thought it was a valuable device for use by Soldiers and 70% would prefer it over a water-only hydration system. Additionally, 77% would request the NDS if it were made available to them and 83% would recommend it to a friend. Seventy six percent felt the Army should continue to invest in the technology.

Table 1. Acceptability of the NDS – Overall *.

Acceptability Question	Mean	Median	n
Would the NDS be a valuable device for Soldiers in the field?	6.7	7	82
Would the NDS/beverage improve your performance?	6.2	6	78
Overall, how much do you like or dislike the NDS?	6.3	7	78
	Yes	No	n
Would you prefer to use the NDS over a water only hydration system?	70%	30%	82
Would you request the NDS and drink pouches through your supply chain if they were available?	77%	23%	82
Would you recommend the NDS to other Soldiers?	83%	17%	82
If your unit could afford it, and the NDS were commercially available, would you recommend your unit purchase it?	76%	24%	82
Do you recommend the Army invest in the NDS	76%	24%	82

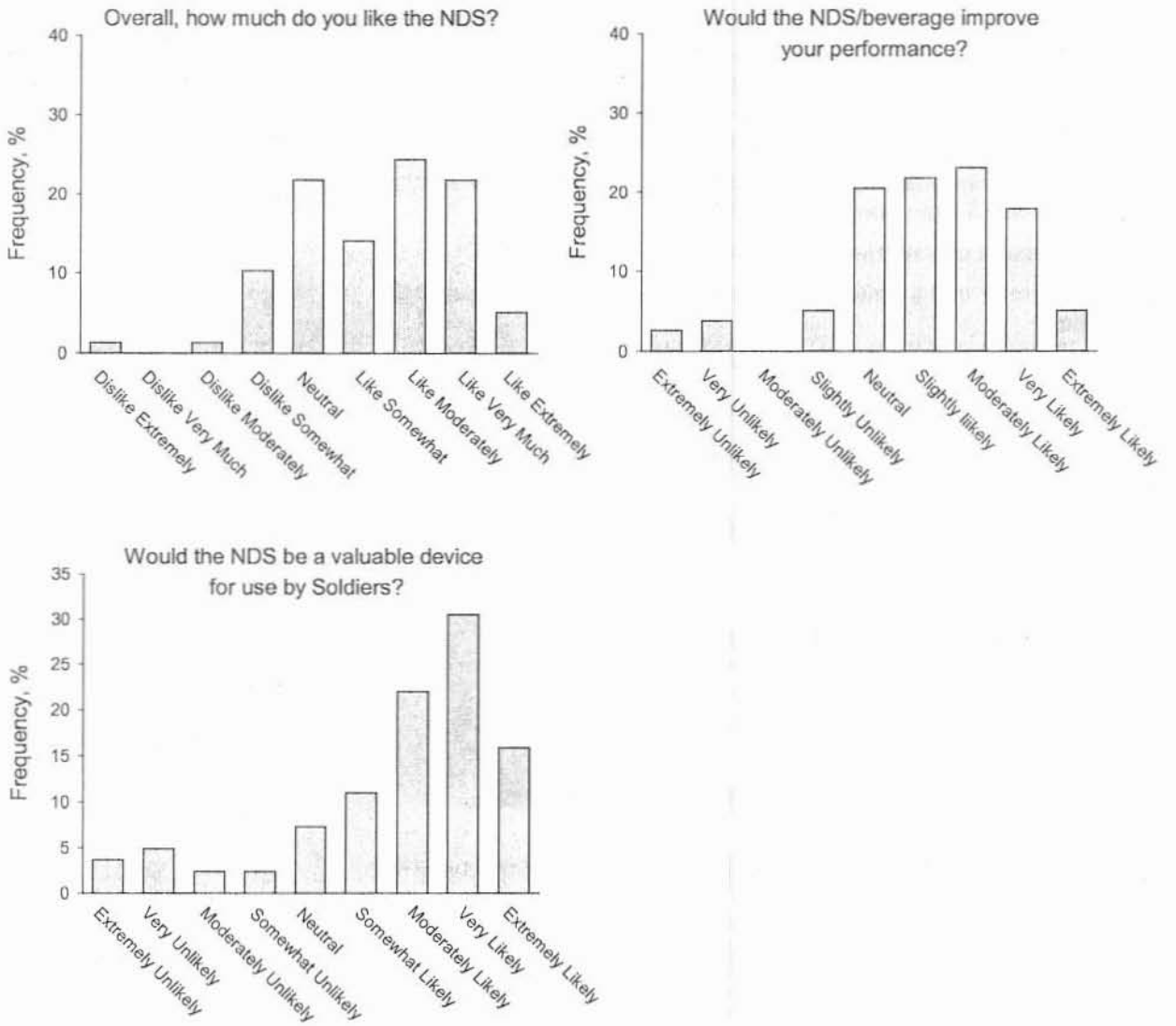
*Except where indicated, the questions utilized a 9-point scale, with the higher number being more acceptable.

Anchor words whether NDS would be a valuable device were: 1= Extremely Unlikely, 2= Very Unlikely, 3= Moderately Unlikely, 4=Somewhat Unlikely, 5= Neutral, 6= Somewhat Likely, 7= Moderately Likely, 8= Very Likely, and 9= Extremely Likely.

Anchor words for opinion regarding ability to improve performance were: 1= Extremely Unlikely, 2= Very Unlikely, 3= Moderately Unlikely, 4=Somewhat Unlikely, 5= Neutral, 6= Somewhat Likely, 7= Moderately Likely, 8= Very Likely, and 9= Extremely Likely.

Anchor words for Overal like/dislike were: 1= Dislike Extremely, 2= Dislike Very Much, 3= Dislike Moderately, 4=Dislike Somewhat, 5= Neutral, 6= Like Somewhat, 7= Like Moderately, 8= Like Very Much, and 9= Like Extremely

Figure 2. Frequency distribution of responses regarding how much the respondents liked the NDS, the likelihood NDS would mprove performance, and value for use by Soldier.



Soldier satisfaction with NDS form and function is presented in Table 2 and Figure 3. The cloth carrier appeared to be satisfactory in terms of size and it's adequacy as a carrier, as 99% rated the dimensions as acceptable, 93% felt the carrier pouch adequately stabilized the drink pouch during use, and 88% reported that the beverage concentrate remained secure during use. The respondents did recommend refinements to the system, however. For example, a majority of users suggested that the two beverage lines be integrated into a single drink tube. There were also written comments stating that the Velcro fastener used to secure the beverage bag to the carrier needed improvement. The preferred color for the beverage concentrate drink line drew a mixed response, with 55% preferring a clear tube, 33% army green, and 12% some other color. In response to query regarding how many spare beverage

concentrates they preferred to carry, the mean response was 2.6 [1.1] bags, with a median response of 3 (n=82 responses).

Table 2. Acceptability of NDS form and function *

Acceptability Question	Yes, %	No, %	n
Were the dimensions of the cloth carrier pouch acceptable?	99	1	83
Did the cloth carrier attachment sites adequately stabilize the beverage concentrate bag & cloth pouch to the PHS?	93	7	83
Did the beverage concentrate bag remain secure during use?	88	6	78
Would you prefer that the two beverage lines be integrated into a single drink tube?	62	38	82
Were you able to operate the flow manifold with one hand?	90	10	82
Were you able to mix the beverage to the strength that you wanted?	61	39	82
Were the intermediate stops helpful for positioning the valve to desired drink strength?	66	34	82
Did you experience any system leaks or spills?	30	70	80
Did the system break during use?	8	92	82
Did the NDS perform to your satisfaction?	81	19	82

	Mean	Median	n
How acceptable were the fasteners used to hold the beverage concentrate line to water line	6.3	7	69
How difficult or easy was it to select/switch receiving water and receiving the flavored beverage?	6.4	7	81

* Except where indicated, the questions utilized a 9-point scale, with the higher number being more acceptable.

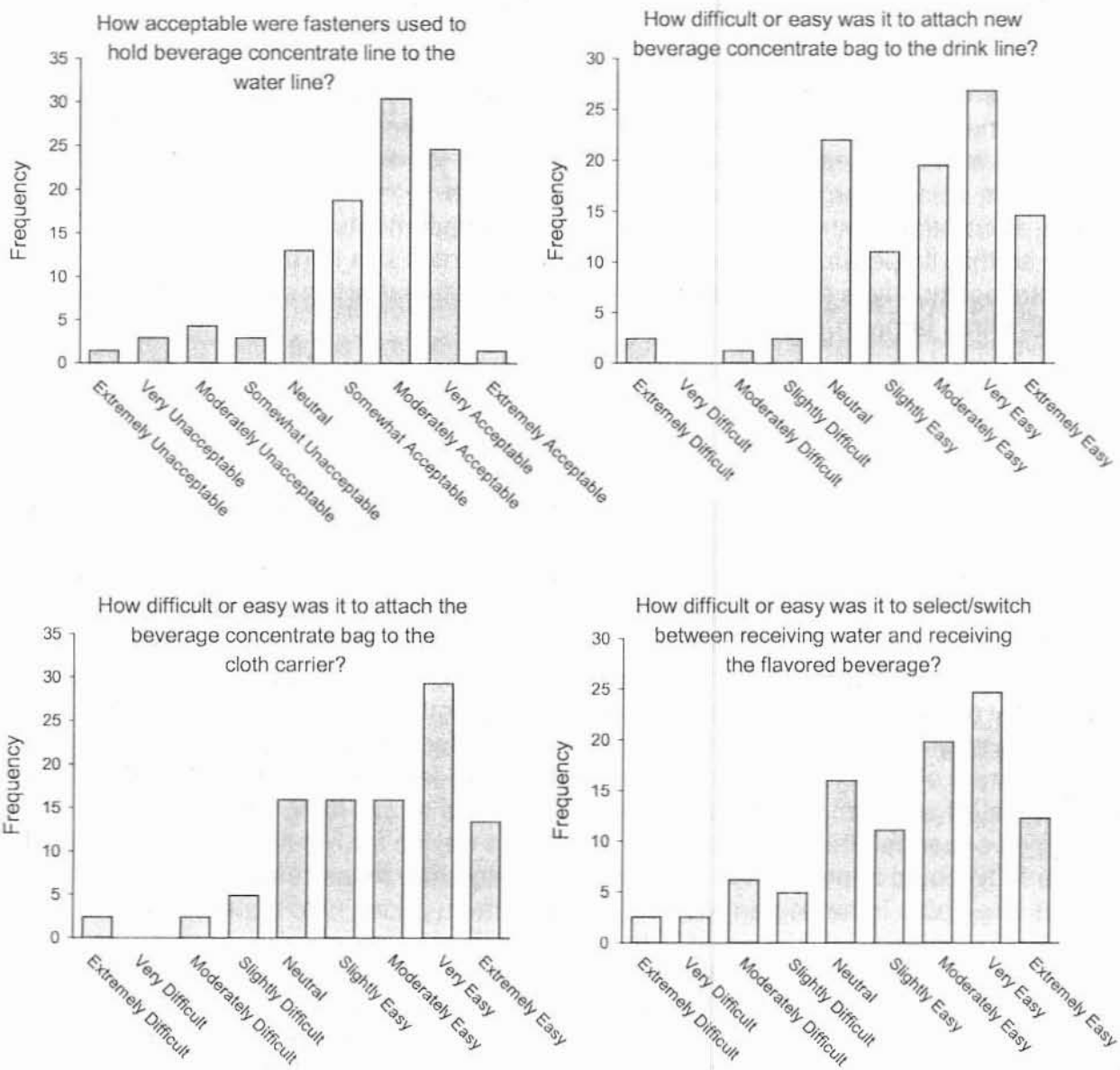
Anchor words for acceptability of fasteners were: 1= Extremely Unacceptable, 2= Very Unacceptable, 3= Moderately Unacceptable, 4=Somewhat Unacceptable, 5= Neutral, 6= Somewhat Acceptable, 7= Moderately Acceptable, 8= Very Acceptable, and 9= Extremely Acceptable.

Anchor words regarding how Unacceptable or easy it was to select beverage were: 1= Extremely Unacceptable, 2= Very Unacceptable, 3= Moderately Unacceptable, 4=Somewhat Unacceptable, 5= Neutral, 6= Somewhat Easy, 7= Moderately Easy, 8= Very Easy, and 9= Extremely Easy.

The majority of users found the system easy to use. Ninety percent reported they could operate the flow control on the manifold with one hand, and 68% reported that it was easy to select/switch between receiving water and receiving the flavored beverage, with the most frequent response being "very easy". Sixteen percent did

report some difficulty, however, with the written suggestion to make the lever less stiff. The majority of users found it relatively easy to attach a new beverage concentrate bag onto the system. Seventy-two percent reported that it was easy to attach the beverage concentrate bag onto the beverage concentrate line, whereas 6% had some difficulty. Similarly, 74% reported that it was easy (most frequent "very easy") to attach the beverage concentrate bag to the cloth carrier.

Figure 3. Frequency distribution of responses regarding NDS ease of use



The NDS performance was acceptable to the user, with 81% reporting that it performed to their satisfaction. There were, however, signs that performance could be improved. Forty eight (39%) reported that they had difficulty obtaining the drink blend

they desired; with 66% reporting the drink was too strong, 25% too weak; and 9% both. Thirty percent of users reported either a system leak or spill sometime during the evaluation period. Eleven of these 24 (46%) reported a system leak and a separate 6 (25%) reported both leaks and spills. The spills or leaks occurred at the beverage bag (n=4), the connection between the concentrate bag and beverage line (n=8), at the connection between the beverage concentrate line and flow manifold (n=8), manifold (n=7), and/or bite valve (n=6). When asked if the leak or spill was a problem, 16 of 24 (70%) marked slightly (n=15) or not at all (n=1); whereas 4 marked "moderately" and 3 "very." Seven of 82 (8%) reported that the system broke during the evaluation period. Unfortunately, data are incomplete regarding what broke and how it was broken. However, it is known that at least 4 failures were attributable to problems with the bite valve rather than the NDS.

Several recommendations were provided to improve the product. In addition to the recommendations provided above, there were recommendations to consider quick connectors to make it easier to take the system apart for cleaning, reduce the number of connections as an approach to limit potential for leaks, to improve ruggedness of the system, to consider using snaps instead of Velcro attachments, and to modify the system so that it operates more effectively when oriented in a horizontal position. The horizontal position was the orientation the PHS was placed when some Soldiers used the PHS with a larger rucksack.

DISCUSSION

The primary finding of this field evaluation was that the ~75% of the Soldiers who tested the NDS felt that it would be a valuable device and they would use it if it were made available to them. Forty-six percent who provided written comments regarding why they liked the system described the NDS as a "good" or "great" system and an additional 29% wrote that the NDS would be a very "helpful" for staying hydrated. The ease by which users were able to consume nutrients and water on-the-move, the time and energy savings not spent mixing drinks in a separate reservoir, and the likelihood they would stay better hydrated, were reasons given for rating the system favorably. The outcomes of this investigation are consistent with feedback received from Soldiers who evaluated an initial prototype version (5). Sixteen of 22 (73%) who evaluated the prototype version felt the NDS would be a valuable device for Soldier use, and 73% felt that the NDS could improve their performance. Together, these results indicate that Soldiers see value in having an NDS available to them during field operations.

There was a subset of evaluators (~13%) who rated the NDS unfavorably. Within this subgroup, there were individuals who stated that they were satisfied with a water-only hydration system and didn't see a need for an NDS-type device (n= 4); and there were others who acknowledged the potential utility of NDS, but were concerned that the purchase and upkeep costs (and/or time and effort) might be too much relative to the performance advantages offered (n= 5). Both responses were also received during our initial NDS prototype evaluation. Thus, while the majority of users

appreciated the opportunities that the NDS offers for sustaining performance, there will always be Soldiers that will prefer a water-only hydration platform and will most likely not modify their hydration systems even if the NDS were made available to them.

The system used for this evaluation was the product of earlier feedback obtained from Army and Navy personnel who tested a prototype push button system (5). In response to their desire for a smaller manifold with positive stops to assist with setting intermediate flow control settings, a rotary flow control system was tooled and manufactured. The rotary flow control manifold appeared to be an acceptable design, as 90% reported that they were able to operate the flow control with one-hand, and 66% found the positive stops helpful for setting drink mix blend. Bench tests of this system's performance revealed a sip-to-sip repeatability of 2 [1.5]% (4). Adjusting the lever from lowest to highest setting produces a 4-5% up to ~10% carbohydrate drink.

When designing the current system, an underlying goal was to produce a simple system, consisting of relatively few parts, with sufficient durability to withstand military use. A tradeoff in building a simple system, however, is the need to rely on human use controls to obtain the best operational performance. It was clear from informal system performance tests that PHS and PHS+NDS performance is compromised when the PHS is oriented such that water and beverage concentrate lines are not at the base of their source fluid's reservoir (e.g., horizontal position). When such is the case, air is able to enter the drink line(s) and interfere with fluid flow. Therefore, as part of the pre-evaluation orientation, the Soldiers were instructed to carry the PHS+NDS in the vertical position, i.e., as the carrier was designed. Post-hoc examination of the user feedback revealed that many of the users who rated NDS system performance poorly, chose to wear the system with the collapsible bladder positioned horizontal relative to the ground for at least part of the evaluation period. Therefore, some of their negativity might reflect their attempt to use the NDS (and PHS) in an orientation where performance will be compromised. Human controls are also necessary to overcome a negative attribute caused by the bite valve. At the termination of a sip, the bite valve closes automatically leaving the drink line pressurized and the desirable effect of preventing water from flowing back into the water reservoir between drinking episodes. In the NDS+PHS configuration, this performance attribute also prevents the one-way valves built into the flow manfold from closing fully. As a result, if human controls are not implemented, beverage concentrate can move from the beverage concentrate line into the manifold and into the water line between drinks. Thus, the bite valve properties interfere with the measures built into the NDS to preserve system cleanliness. Fortunately, cross-contamination can be preventing by adopting a very simple human use control step during system use. Briefly, the pressure can be removed and one-way valves can be returned to fully-closed position by very briefly biting open the bite valve upon termination of drinking. For this evaluation, all users received instructions (both oral and written) about this attribute, and most users appear to have adjusted their behavior accordingly (based on satisfaction and acceptability scores), however, it is evident from some of the written comments that some of the negative feedback received was consequent to not following instructions for optimizing NDS system performance.

There are several modifications to NDS design that will be necessary in order to harden the system for military operational use. For example, the NDS utilized o-rings to intermittently anchor the beverage concentrate line to the water line between exit from PHS carrier and the flow manifold. This approach effectively bound the two lines together, but didn't remove potential snag hazards during operational use. Moreover, the cloth carrier used to position the beverage concentrate bag during use had never received user feedback. Regardless, the vast majority of Soldiers evaluating the system were satisfied with the form & function of the fasteners and cloth carrier. Seventy-five percent of respondents gave the fasteners favorable ratings and greater than 90% of respondents were satisfied with the cloth pouch dimensions and how well it was stabilized during use. Thirty percent, however, reported either spills or leaks at some point during the evaluation. Several of the leaks or spills were reported to have occurred at the attachment site where the beverage concentrate bag is attached to the beverage line, suggesting that improvements to the connection process should be considered. While specific causes of the leak at this location were not queried as part of this acceptability test, increasing the pitch of the thread pattern so less degrees of rotation are necessary to thread the beverage bag onto the beverage line might be beneficial for reducing spillage. Durability and maintenance were also brought up as areas for improvement. Suggestions were made to incorporate quick connectors to make it easier to dismantle the system. Similarly, recommendations were made to make the rotary valve easier to move from one flow setting position to another. This could be solved by reducing friction during rotation and/or by modifying the design of the lever so that it is easier to grasp and turn. Importantly, the deficiencies identified above, are all readily addressable in the advanced development process.

The NDS technology offers the user the advantage of plurality of mixed drinks without cumbersome mixing in a more-or-less hands-free manner. It offers the logistician several advantages over current mode of operations as: 1) it creates less trash weight and volume compared to plastic bottles pre-filled with beverages, 2) it creates little or no additional trash burden compared to disposable drink pouches available in individual field rations while removing the necessity of the user to stop and mix drink before use, and 3) it will cost considerably less to ship a given volume of beverage to an area of conflict as 100 ml of a sports drink concentrate for NDS is less than $1/10^{th}$ the weight and/or volume than a pre-mixed ready-to-drink beverage. The potential advantages of NDS technology for both user and logistician in combination with the favorable customer acceptability scores it has received, together make the NDS a worthy candidate for advanced development.

CONCLUSIONS

The NDS is an add-on to a Soldiers personal hydration system and provides the individual Soldier the capability to improve hydration and better sustain performance while operating on-the-move. In this evaluation, Soldiers rated the NDS technology favorably and feel it would be a valuable device for operational use. Eighty-three percent thought favorably enough of the technology that they would recommend it to

their friends. Seventy-six percent recommended that the Army invest in the NDS technology.

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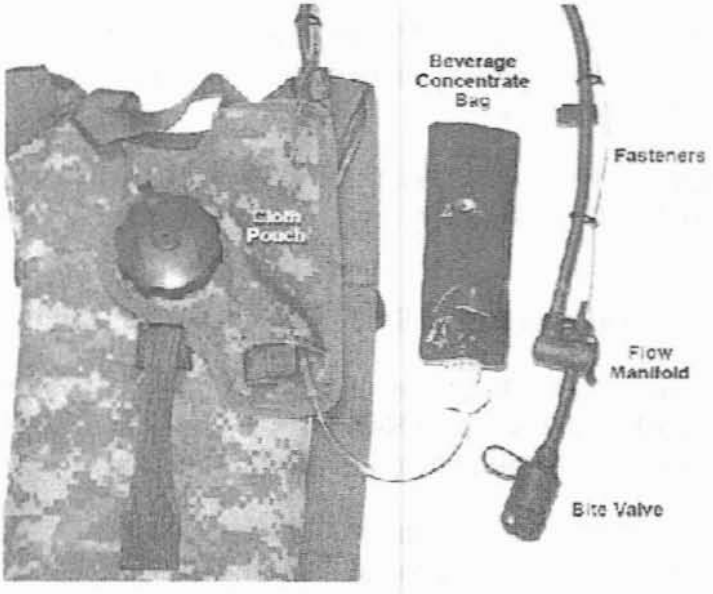
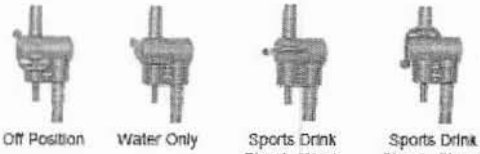
APPENDIX 1. NDS INSTRUCTIONS FOR USE

Nutrient Delivery System: Instructions for Use



Manifold Flow Control Settings



Exchanging Beverage Concentrate Bags

1. Adjust manifold to "off" position
2. Open Velcro fastener holder bag to cloth carrier. Withdraw concentrate bag from carrier.
3. Unscrew empty concentrate bag from beverage concentrate line; set aside.
4. Holding new beverage concentrate bag so spout is upright, unthread cap. Set cap aside.
5. Still holding new beverage concentrate bag upright, thread it onto beverage concentrate line.
6. Insert new bag, spout down, into cloth carrier sleeve until neck of spout is adjacent to Velcro strap.
7. Secure in place by wrapping Velcro strap around neck of beverage concentrate bag.
8. Thread loose cap onto used bag and store away until ready to discard.

Priming the system to deliver Sports drink "on-demand"

1. Adjust manifold flow control lever to full open position.
2. Suck on bite valve to pull beverage concentrate and water from their reservoirs to manifold.
3. Shut off manifold until ready for use.

Tip: pinch off water line during step 2 to pull concentrate-only to manifold.

Recommended Usage

1. Select setting for drink mixture on flow manifold.
2. Bite and suck drink mixture from bite valve.
3. When you are finished drinking, bite the bite valve again to release pressure in the system. Then close flow manifold until next use. Following this step prevents system leakage and water tube contamination.

Important Notes

It is strongly recommended that the user turn the manifold flow control lever to the "off" position when system is not in use (i.e., between drinks) to avoid possible spillage if the bite valve were to open during movement.

When system use will be discontinued for protracted time period, turn the manifold flow control lever to "water only" and take several sips to flush any residual beverage from the manifold. Then, briefly open bite valve to release system pressure. Turn manifold control lever to "off" position. These three steps will help keep system clean.

Evaluation of On-the-Move Nutrient Delivery System, Phase V

The U.S. Army Research Institute for Environmental Medicine is conducting limited user field evaluations of a Nutrient Delivery System (NDS) for possible rapid fielding to forces supporting operations Enduring Freedom and Iraqi Freedom. The findings associated with this field evaluation are not an endorsement of the product or manufacturer and is not authorized for publication or use in advertisement without the consent of the U.S. Army Research Institute for Environmental Medicine.

• Do not put your name on this survey.

MARKING INSTRUCTIONS
• Use a No. 2 pencil only. • Do not use ink, ballpoint, or felt tip pens. • Make solid marks that fill the response completely. • Erase cleanly any marks you wish to change. • Make no stray marks on this form. CORRECT: ● INCORRECT: ⊘ ⊠ ◒ ◔

SITE
LOCATION
Camp Rudder Dahlonega Fort Benning Other_____

DATE	
MONTH	
DAY	
YEAR	0 8

1. Gender:

Male
Female

2. What is your rank?

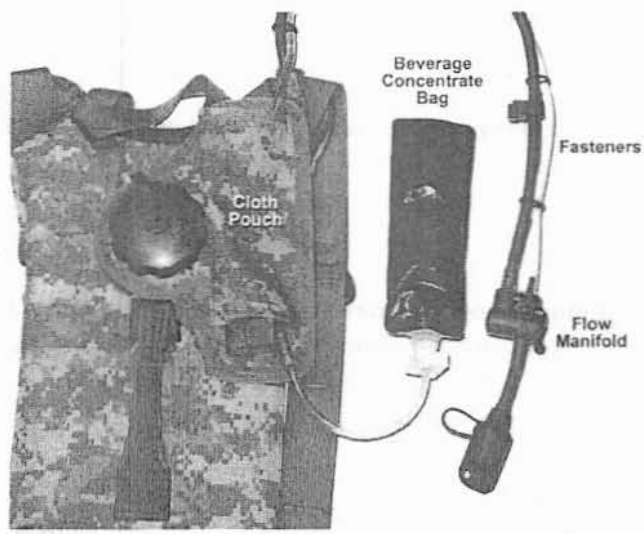
Enlisted
Officer

3. How many years have you been in the service?

Less than one year - OR - if one year or more.

Years

SYSTEM PARTS



4. What is your "primary MOS" or current Duty Position?

Infantry	Transportation	Signal	Artillery
Medical	Cavalry	Supply	Food service
Administration	Military intelligence	Engineer	Other _____

5. Do you currently use a collapsible bladder-type hydration system?

Yes
No

6. Did you receive adequate training on the use of the Nutrient Delivery System?

Yes
No

PLEASE DO NOT WRITE IN THIS AREA

[SERIAL]

7. **What type of tasks were you participating in when you evaluated the Nutrient Delivery System? Check all that apply.**

Road march
Battle drills
Sentry duties
Other:_____
Dismounted patrol
Mounted patrol
Desk work

8. **How many hours did you wear the system?**

Less than two hours - OR - if 2 hours or more.

Hours	

9. **What time(s) of the day did you use the Nutrient Delivery System?**

Daytime
Nighttime
Both

10. **How many concentration bags did you consume?**

11. **Indicate how you carried the personal hydration system during the evaluation. Check all that apply.**

Worn on back using PHS shoulder straps (vertical position)
Bag in horizontal position on top of rucksack
Bag in horizontal position in small of back
Other:_____

FORM / FIT

12. **Were the dimensions of the cloth carrier pouch acceptable?**

Yes
No If no, why not?_____

13. **Did the cloth carrier attachment sites adequately stabilize the beverage concentrate bag & cloth pouch to the personal hydration system?**

Yes
No If no, suggestions for improvement:_____

14. **Did the beverage concentrate bag remain secure during use?**

Did not use cloth carrier attachment site.
Yes
No If no, suggestions for improvement:_____

15. Rate the acceptability of the fasteners used to hold the beverage concentrate line to the water line:

EXTREMELY UNACCEPTABLE	VERY UNACCEPTABLE	MODERATELY UNACCEPTABLE	SLIGHTLY UNACCEPTABLE	NEITHER UNACCEPTABLE OR ACCEPTABLE	SLIGHTLY ACCEPTABLE	MODERATELY ACCEPTABLE	VERY ACCEPTABLE	EXTREMELY ACCEPTABLE

Did not use

Suggestions for improvement:_____

_____

16. What color tubing would you prefer for beverage concentrate line?
    - Clear
    - Army Green
    - Other color_____

17. Would you prefer that the two beverage lines be integrated into a single drink tube?
    - Yes
    - No

18. Would you prefer the beverage concentrate line to be?
    - Longer
    - Shorter
    - The same length

19. How many spare concentrate bags would you want to carry?

None	One	Two	Three	Four or more

20. How difficult or easy was it to attach new beverage concentrate bag(s) to the drink line?

EXTREMELY DIFFICULT	VERY DIFFICULT	MODERATELY DIFFICULT	SLIGHTLY DIFFICULT	NEITHER EASY OR DIFFICULT	SLIGHTLY EASY	MODERATELY EASY	VERY EASY	EXTREMELY EASY

21. How difficult or easy was it to attach the beverage concentrate bag to the cloth carrier?

EXTREMELY DIFFICULT	VERY DIFFICULT	MODERATELY DIFFICULT	SLIGHTLY DIFFICULT	NEITHER EASY OR DIFFICULT	SLIGHTLY EASY	MODERATELY EASY	VERY EASY	EXTREMELY EASY

22. How difficult or easy was it to select/switch receiving water and receiving the flavored beverage?

EXTREMELY DIFFICULT	VERY DIFFICULT	MODERATELY DIFFICULT	SLIGHTLY DIFFICULT	NEITHER EASY OR DIFFICULT	SLIGHTLY EASY	MODERATELY EASY	VERY EASY	EXTREMELY EASY

23. Were you able to operate the flow manifold with one hand?
    - Yes
    - No

24. Were you able to mix the beverage to the strength that you wanted?
    - Yes
    - No → 24b. If NO, was the drink too?
        - Strong
        - Weak

25. Were the intermediate stops helpful for positioning the valve to desired drink strength?

Yes
No

26. Did you experience any system leaks or spills when connecting the beverage concentrate bag to the drink line or during use?

No leaks or spills (go to question #29) System leaks Spills during attachment Both

27. If you experienced system leaks, where did they occur? Pick all that apply.

Beverage bag
Connection between beverage concentration bag and beverage line
Connection between beverage concentration line and flow manifold
Flow manifold
Bite valve

28. If system leaks or spills occurred was this a problem?

Not at all
Slightly
Moderately
Very

29. Did the system break during use?

Yes → 29b. What broke?_____
No 29c. How did it break?_____
29d. What activity were you doing when it broke?_____

30. What modifications to the NDS would you recommend?_____
_____
_____

Do not write in this box

31. Did the NDS perform to your satisfaction?

Yes
No modify

31b. Why or why not?_____
_____

ACCEPTABILITY

32. Would the NDS be a valuable device for use by Soldiers in the field?

EXTREMELY UNLIKELY	VERY UNLIKELY	MODERATELY UNLIKELY	SLIGHTLY UNLIKELY	NEITHER UNLIKELY OR LIKELY	SLIGHTLY LIKELY	MODERATELY LIKELY	VERY LIKELY	EXTREMELY LIKELY

Comments:_____
_____

ACCEPTABILITY

33. Would the NDS/beverage improve your performance?

EXTREMELY UNLIKELY	VERY UNLIKELY	MODERATELY UNLIKELY	SLIGHTLY UNLIKELY	NEITHER UNLIKELY OR LIKELY	SLIGHTLY LIKELY	MODERATELY LIKELY	VERY LIKELY	EXTREMELY LIKELY

[_____]

33b. If likely to improve performance, why? (check all that apply)

Better hydrated
More energy
Better hydrated and more energy
Don't have to stop to get nutrients
Other, Please specify_____

34. Overall, how much do you dislike or like the NDS?

DISLIKE EXTREMELY	DISLIKE VERY MUCH	DISLIKE MODERATELY	DISLIKE SLIGHTLY	NEITHER LIKE NOR DISLIKE	LIKE SLIGHTLY	LIKE MODERATELY	LIKE VERY MUCH	LIKE EXTREMELY

[_____]

34b. If you dislike the NDS, what factors caused you to rate the system poorly? Check all that apply.

System leaks
Poor durability
Too difficult to operate
Too hard to clean/maintain
No advantages over current methods
Other_____

35. Would you prefer to use the NDS over a water only hydration system?

Yes
No

36. Would you request the NDS and drink pouches through your supply chain if they were available?

Yes
No

37. Would you recommend the NDS to other Soldiers?

Yes
No

38. If your unit could afford it, and the NDS were commercially available, would you recommend your unit purchase it?

Yes
No

39. Do you recommend the Army invest in the NDS?

Do not write in this box

Yes

No

Q39b

39b. Regardless, of answer, please comment_____

_____

Any additional feedback_____

_____

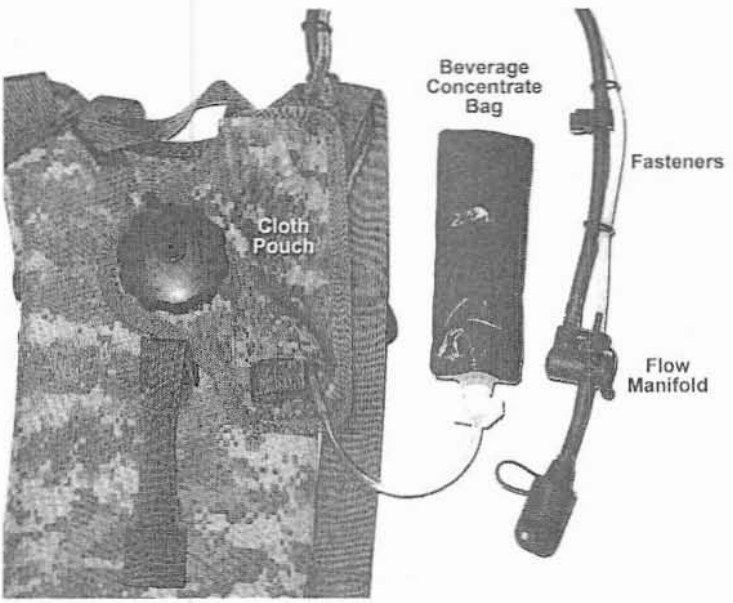
PLEASE DO NOT WRITE IN THIS AREA

[SERIAL]

APPENDIX 3. NDS FEATURES AND SPECIFICATIONS

Features:

- On-the-Move Access to Mixed Beverage
- Ability to mix drink to personal taste
- No contamination of water line or reservoir
- Lightweight (~25g)
- Efficient. 100 ml beverage concentrate bag will make ~ 1 liter of sports drink
- Easy to clean and sanitize



Physical Characteristics:

Flow Manifold: polypropylene. Flow settings include off, water-only, and 3 discrete settings for blending beverage concentrate into water stream (dilution factor: 7, 9.5, and 11)

Tubing: PVC; approved to NSF 61 Section 9 clean drinking water standard.

Beverage Conc. Bag:: foil laminate

Beverage Concentrate Ingredients: : Sugar, Water, Dextrose, Citric Acid, Natural & Artificial Flavors, Contains Less Than 2% Of The Following: Salt, Sodium Citrate, Monopotassium Phosphate, Sodium Benzoate, Potassium Sorbate, FD & C Yellow #5.

Package Net Weight: 126.00 g (4.44 oz-wt.). Serving Size: 126.00 g (4.44 oz-wt.)

Nutrition Facts			
Calories		260	
Calories from Fat		0	
Total Fat		0g	0%
Saturated Fat		0g	0%
Cholesterol		0mg	0%
Sodium	440mg	18%	
Potassium		125mg	4%
Total Carbohydrate		68g	23%
Dietary Fiber		0g	0%
Sugars		63g	
Protein		0g	
Vitamin A			0%
Vitamin C			0%
Calcium			0%
Iron			0%
Phosphorus			10%

The NDS is manufactured by Designturn, Inc., Wellesley, MA. Beverage concentrate component is made for Designturn, Inc. by Jel Sert Company. This food manufacturer is inspected at least annually by FDA against both food and medical food regulations. They are also inspected yearly by an independent QA auditor (AIB) and maintain a 'superior' rating.