**Original Article**

# Evaluation of WHO criteria to determine degree of dehydration in children with acute diarrhea

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## ABSTRACT

*Objective* To evaluate the diagnostic accuracy and agreement between the 1980 and 1990 WHO criteria for determining the degree of dehydration in children with acute diarrhea.

*Methods* This prospective study was conducted in two hospitals from October 2002 to February 2003. Clinical signs of dehydration all patients were recorded. The degree of dehydration based on the 1980 and 1990 WHO criteria was determined and compared with fluid deficit measured by the difference of body weight on admission and on discharge. Chi-square test and kappa value analyses were performed. Sensitivity, specificity, predictive values, and accuracy of each WHO criteria were assessed. The prevalence of dehydration was also determined.

*Results* Sixty-five patients, comprising 40 boys and 25 girls, were studied. There was a significant difference between the two WHO criteria in differentiating between dehydration and non-dehydration (P<0.05). Based on the 1980 WHO criteria the prevalence of dehydration was 62.2%. Its sensitivity, specificity, and accuracy in diagnosing dehydration were 100.0%, 55.5%, and 86.2%, respectively. Based on the 1990 WHO criteria, the prevalence of dehydration was 60.0%. Its sensitivity, specificity, and accuracy in diagnosing dehydration were 94.9%, 46.1%, and 75.4%, respectively. There was also a significant difference between both criteria in determining severe dehydration (P<0.05). Based on the 1980 criteria, the prevalence of severe dehydration was 15.4%. Its sensitivity, specificity, and accuracy in diagnosing severe dehydration were 30.0%, 94.5%, and 84.6%, respectively. Based on the 1990 criteria, these results were 40.0%, 94.5%, and 86.2%, respectively. The prevalence was 15.4%. Kappa value comparing the two WHO criteria was 0.852 in diagnosing dehydration and 0.915 in diagnosing severe dehydration. There was no significant difference between the two criteria in their sensitivity and specificity (P>0.05).

*Conclusion* Both WHO criteria can be applied to determine dehydration in patients with acute diarrhea, although we feel that the 1990 criteria is simpler **[Paediatr Indones 2005;45:76-80].**

*Keywords:* WHO criteria, acute diarrhea, dehydration, fluid deficit, sensitivity, specificity, agreement

Diarrhea is one of the leading causes of morbidity and mortality in children worldwide, causing one billion episodes of illness and 3 – 5 million deaths annually.[1,2] Diarrhea patients may die of dehydration; therefore, the main priority in treating diarrhea is early replacement of fluid and electrolyte to prevent and treat dehydration, as well as to prevent already rehydrated patients from dehydrating again.[3,4,5] The amount of fluid required to replace fluid loss can be measured by the change of body weight during diarrhea, especially in children. If the true pre-illness weight is not known, an estimate of fluid deficit is made on clinical assessment.[4-7]

Maurice King (1974) recommended six clinical signs to determine dehydration i.e., general appearance, skin elasticity, eyes, anterior fontanelle, mouth, and radial pulse.[8] In 1980 WHO recommended 10 clinical signs to determine dehydration based on general appearance and condition, radial pulse, respiration, anterior fontanelle, systolic blood pressure, skin elasticity, eyes, tears, mucous membranes, and urine

production.[9] Both the 1980 WHO criteria and Maurice King's criteria classify dehydration as mild, moderate, or severe.[8] Siregar reported that there was no significant difference between these two criteria in determining the degree of dehydration, except in children less than two years of age and malnourished children.[10] Gorelick[7] found that all 10 clinical signs (general appearance, quality of radial pulse, quality of respiration, skin elasticity, eyes, tears, mucous membranes, urine output, heart rate and capillary refill) in children with diarrhea were significantly associated with the presence of dehydration. The sensitivity of individual findings varied from 0.35 to 0.85, and the specificity ranged from 0.53 to 0.97. Gorelick recommended that the existing criteria for the diagnosis of dehydration in children be modified to reflect the fact that objective signs of dehydration are apparent with a fluid deficit of <5%. Of the 10 findings studied, none is sufficiently accurate to be used in isolation. The presence of fewer than three signs corresponds with a deficit of <5%, whereas children with deficit of 5% to 9% generally have three or more clinical findings. At least six to seven findings should be present to diagnose a deficit of 10% or more.

On the last revision (1990), WHO assessed six clinical signs to determine the degree of dehydration.[11] Despite the enormous advances in recent decades in the treatment of dehydration, especially in the use of oral rehydration therapy, little attention has been focused on the clinical diagnosis of this condition.[7] To our knowledge no study has been conducted on the accuracy of WHO criteria in determining dehydration in children with acute diarrhea.

## Methods

This prospective study was conducted in the Gastroenterology Departments of H. Adam Malik and Pirngadi Hospitals, Medan from October 2003 to February 2003. Eligible subjects were all infants/children with acute diarrhea treated in these departments as in- or outpatients. This study was approved by the H. Adam Malik and Pirngadi Medan Hospital Medical Ethics Committee. Patients included were those with less than five days of acute diarrhea without any severe underlying disease such as severe pneumonia, encephalitis, or meningitis, who had received no medication for 12 hours prior to the diagnosis, and were well-nourished or mildly malnourished based on the National Center for Health Statistics (NCHS) standards. They were excluded if they received incomplete monitoring. All patients were recorded for age, weight, height, body temperature, and signs of dehydration based on the 1980 and 1990 WHO criteria. Assessment was done before rehydration. Fluid therapy was given based on the degree of dehydration according to the 1990 WHO criteria. Dehydration was defined as a fluid deficit of 5% or greater. Before medication, each patient's weight without slippers or shoes was measured using a Mic-Health scale which had been calibrated with an accuracy of 0.1 kg. Infants less than one year of age were weighed unclothed using a Tanita scale which had been calibrated with an accuracy of 0.05 kg. Patients were weighed twice daily until discharge at 7 AM and 7 PM by an investigator or senior resident. For outpatients, home visits were done twice daily until the patient recovered. A patient's weight was considered stable if the two consecutive measurements differed by <2%; the mean of these weights was the final weight. The gold standard was fluid deficit measured by difference between body weight on admission and discharge. A patient was discharged if symptoms such as vomiting, diarrhea, fever, or abdominal pain had resolved. The person calculating the percentage of fluid deficit was kept blind to the patient's dehydration level at initial assessment.

Due to differences in the dehydration classification between the two WHO criteria, we evaluated the ability of each criterion to distinguish between dehydration and non-dehydration and between severe dehydration and non-severe dehydration. Data was analyzed with the chi-square test to seek the difference between proportions. A P value of <0.05 was considered significant. Agreement between both criteria was assessed by calculating the kappa value. Data was processed using SPSS for Windows version 10.0. The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of each criterion was calculated. The prevalence of dehydration and severe dehydration based on each criterion was also determined. Finally, sensitivity and specificity were compared between both WHO criteria.

## Results

Out of 65 patients studied, there were 40 boys and 25 girls. There was significant difference between the two criteria in distinguishing dehydration from non-dehydration (P<0.05). The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the 1980 WHO criteria in diagnosing dehydration were 100.0%, 55.5%, 83.3%, 100.0%, and 86.2%, respectively. The prevalence of dehydration based on this criteria was 69.2%. Meanwhile, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the 1990 WHO criteria were 94.9%, 46.1%, 72.5%, 85.7%, and 75.4%, respectively. The prevalence of dehydration was 60.0%. There was also significant difference between the two criteria in distinguishing severe from non-severe dehydration (P<0.05). The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the 1980 criteria in diagnosing severe dehydration were 30.0%, 94.5%, 50.0%, 88.1%, and 84.6%, respectively, with a prevalence of 15.4%. On the other hand, using the 1990 criteria, these results were 40.0%, 94.5%, 57.1%, 89.6%, and 86.2%; respectively, with a prevalence of 15.4%. Kappa value between the two criteria in diagnosing dehydration and severe dehydration measured by were 0.852 and 0.915, respectively. In determining dehydration and severe dehydration, sensitivity and specificity values between the two criteria were not significantly different (P>0.05).

## Discussion

In diagnosing dehydration, we found that sensitivity was high for both the 1980 and 1990 WHO criteria (100% and 94.9%, respectively). Both criteria showed significant difference between the proportion of patients with dehydration and that of those without dehydration (P<0.05). We also obtained high accuracy for both criteria (86.2% and 75.4%, respectively) in determining dehydration.

Kappa between the two WHO criteria was 0.852 for diagnosing dehydration and 0.915 for diagnosing severe dehydration. Kappa values of >0.8 are generally considered as indicating good agreement.[12]

Gorelick[7] found that sensitivity and specificity in determining dehydration of clinical findings ranged from 0.35 to 0.85 and 0.53 to 0.97; respectively. In contrast to our study, Gorelick's assessed each clinical finding separately. Of the 10 findings studied, none was sufficiently accurate to be used in isolation. To determine the presence of dehydration, three signs or more are required. In the study of Mackenzie *et al* [13] clinical assessment was compared to actual weight change. Mackenzie's study showed that house officers commonly overestimated the degree of dehydration in children hospitalized for gastroenteritis. Of the 13 specific findings studied, decreased skin turgor, decreased peripheral perfusion, and deep (acidotic) breathing were found to be the best clinical indicators of dehydration. Serum urea of >6.5 mmol/l and pH <7.35 were positive signs associated with dehy-

TABLE 1. ASSESSMENT WITH DIAGNOSTIC TEST AND GOLD STANDARD BASED ON DEHYDRATION AND NO DEHYDRATION ACCORDING WHO CRITERIA 1980

| Gold standard (% fluid deficit) | | | |
| --- | --- | --- | --- |
| WHO criteria 1880 | dehydration | no dehydration | N |
| dehydration | 45 | 9 | 54 |
| no dehydration | 0 | 11 | 11 |
| N | 45 | 20 | 65 |

$x^2$ = 29.792 ; df = 1 ; P = 0.000

TABLE 2. ASSESSMENT WITH DIAGNOSTIC TEST AND GOLD STANDARD BASED ON DEHYDRATION **AND NO DEHYDRATION** ACCORDING WHO CRITERIA 1990

| Gold standard (% fluid deficit) | | | |
| --- | --- | --- | --- |
| WHO criteria 1990 | dehydration | no dehydration | N |
| dehydration | 37 | 14 | 51 |
| no dehydration | 2 | 12 | 14 |
| N | 39 | 26 | 65 |

$x^2$ = 15.537 ; df = 1; P = 0.000

TABLE 3. AGREEMENT BETWEEN CRITERIA OF WHO 1980 AND WHO 1990 TO DETERMINE **DEHYDRATION AND NO DEHYDRATION**

| | WHO criteria 1990 | | |
| --- | --- | --- | --- |
| WHO criteria 1980 | dehydration | no dehydration | N |
| dehydration | 51 | 3 | 54 |
| no dehydration | 0 | 11 | 11 |
| N | 51 | 14 | 65 |

*ppa* = 0.852

**TABLE 4.** Assessment with diagnostic test and gold standard based on severe dehydration and non severe dehydration according WHO criteria 1980

| Gold standard (% fluid deficit) | | | |
|---|---|---|---|
| WHO criteria 1990 | dehydration | no dehydration | N |
| severe dehydration | 3 | 3 | 6 |
| non severe dehydration | 7 | 52 | 59 |
| N | 10 | 55 | 65 |

$x^2$ = 6.084 ; df = 1; P =0 .014

**TABLE 5.** Assessment with diagnostic test and gold standard based on severe dehydration and non severe dehydration according WHO criteria 1990

| Gold standard (% fluid deficit) | | | |
|---|---|---|---|
| WHO criteria 1990 | dehydration | no dehydration | N |
| severe dehydration | 4 | 3 | 7 |
| non severe dehydration | 6 | 52 | 58 |
| N | 10 | 55 | 65 |

$x^2$ = 10.508 ; df = 1; P = 0.014

dration. However, the sensitivity and specificity of these signs were low.

In a prospective cohort study of children between 3 and 18 months of age in Egypt, Duggan and colleagues[15] found that prolonged skinfold, dry oral mucosa, sunken eyes, and altered neurological status were the best clinical signs correlated with dehydration as determined by post-rehydration weight gain. Children with clinical signs of mild and moderate dehydration had fluid deficits of 3% and 5% body weight, respectively.[15]

In the studies of Duggan[15] and Mackenzie,[13] mild to moderate dehydration on clinical assessment was found to be represented by 3 to 5% of weight loss. Those with severe signs (circulatory collapse) had weight loss of 9-10%. These studies agreed with the WHO guidelines on dehydration assessment.

The severity of dehydration is most accurately assessed in terms of weight. This was the gold standard against which other tests are measured.[14] In this study, we did not analyze the amount of fluid intake (oral, intravenous, intake from food) and fluid loss (vomiting, urine, feces).

We did not include patients with severe malnutrition because it is difficult to estimate dehydration status accurately in severely malnourished children using clinical signs alone.[17] Since the

WHO criteria does not consider nutritional status in determining the degree of dehydration, further studies need to be done to determine whether these criteria can be used for patients with severe malnutrition.

In conclusion, both the 1980 and the 1990 WHO criteria can be used to determine the degree of dehydration in patients with acute diarrhea. The investigators feel that the 1990 criteria is simpler.

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