



Original Contribution

Cost-effectiveness of point-of-care testing for dehydration in the pediatric ED☆☆☆★

Rachel E. Whitney, MD^{*}, Karen Santucci, MD, Allen Hsiao, MD, Lei Chen, MD, MHS

Department of Pediatrics, Section of Emergency Medicine, Yale University School of Medicine, New Haven, CT 06510

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ABSTRACT

Objectives: Acute gastroenteritis (AGE) and subsequent dehydration account for a large proportion of pediatric emergency department (PED) visits. Point-of-care (POC) testing has been used in conjunction with clinical assessment to determine the degree of dehydration. Despite the wide acceptance of POC testing, little formal cost-effective analysis of POC testing in the PED exists.

We aim to examine the cost-effectiveness of using POC electrolyte testing vs traditional serum chemistry testing in the PED for children with AGE.

Methods: This was a cost-effective analysis using data from a randomized control trial of children with AGE. A decision analysis model was constructed to calculate cost-savings from the point of view of the payer and the provider. We used parameters obtained from the trial, including cost of testing, admission rates, cost of admission, and length of stay. Sensitivity analyses were performed to evaluate the stability of our model.

Results: Using the data set of 225 subjects, POC testing results in a cost savings of \$303.30 per patient compared with traditional serum testing from the point of view of the payer. From the point-of-view of the provider, POC testing results in consistent mean savings of \$36.32 (\$8.29–\$64.35) per patient. Sensitivity analyses demonstrated the stability of the model and consistent savings.

Conclusions: This decision analysis provides evidence that POC testing in children with gastroenteritis-related moderate dehydration results in significant cost savings from the points of view of payers and providers compared to traditional serum chemistry testing.

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1. Introduction

Few fields of practice are as consistently innovative as the practice of medicine. New technologies of diagnostics and treatments are frequently introduced into practice with the hope of improving patient care. The costs of these changes, however, are not always examined before implementation. The ideal new technology is one that supports a low-spending/high-performance hospital system [1]. Point-of-care (POC) testing for serum electrolytes allows accurate and rapid results at a reduced cost compared with traditional laboratory testing [2]. This technology can be especially useful in the emergency department (ED),

where previous research has shown that the use of POC testing leads to decreased time to medical decision making [3] and decreased length of stay (LOS) [4] in select populations.

Acute gastroenteritis (AGE) accounts for almost 2 million annual visits to pediatric emergency departments (PED) in the United States and incurs a large health care cost [5]. Appropriate treatment of children with dehydration from AGE requires assessment of severity of symptoms and degree of dehydration. Often, the degree of dehydration determines treatment course and disposition, that is, admission vs discharge and oral vs intravenous hydration [6]. Although weight loss is accepted as the most accurate method of determining degree of dehydration, this is not always possible to determine in the emergency setting, where a recent prior weight is usually not available. Consequently, other factors are used to judge the severity of dehydration. These factors often include serum electrolyte measurements [7].

We aim to examine the cost-effectiveness of using POC electrolyte testing vs traditional serum chemistry testing in the PED for children with AGE. We predict that use of POC technology for AGE management results in a cost savings from the points of view of the payer as well as the provider.

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* Corresponding author at: 100 York St, Suite 1F, New Haven, CT 06511. Tel.: +1 203 737 7433.

E-mail address: rachel.whitney@yale.edu (R.E. Whitney).

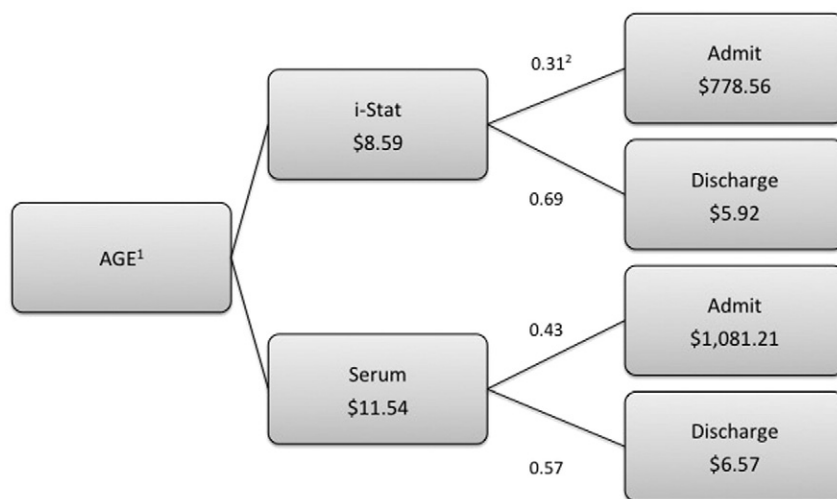


Figure. Cost to individual payer in POC and serum testing groups. ¹Hypothetical cohort of 100 patients in each arm. ²Probability of admission and discharge in each arm as calculated by Hsiao et al [8].

2. Methods

2.1. Decision analysis

We calculated the incremental cost-effectiveness using data from a randomized controlled trial of children with AGE [8]. A model was constructed using parameters obtained in the trial, including cost of testing, admission rates, and cost of admission (Figure). We performed the analysis from 2 points of view. First, we calculated costs based on the point of view of the payer. Next, we looked at costs from the point of view of the provider (ie, the hospital system). Cost data were obtained from various reference sources (Table).

2.2. Equipment costs

The POC device used for this study was the i-Stat Analyzer (Abbott Point of Care, East Windsor, NJ), a handheld, cartridge-driven device capable of performing basic electrolyte and blood gas tests in less than 2 minutes. Each cartridge requires less than 0.1 mL of blood. Tests used during the course of the study included basic electrolytes (sodium, potassium, chloride, and bicarbonate), glucose, blood urea nitrogen, creatinine, ionized calcium, hematocrit, and basic blood gas analysis. The cost of an i-Stat 7 cartridge to the payer is \$8.59. These data were obtained from our university health center.

A basic metabolic panel, which includes sodium, potassium, chloride, bicarbonate, blood urea nitrogen, creatinine, and calcium, costs the payer \$11.54 and has a result time of 1 hour for STAT orders and 4 hours for routine orders. These data were obtained from our university health center.

2.3. Payer costs

We used an average admission cost of \$1158.76 per day for an otherwise healthy patient admitted for dehydration in the setting of AGE (unpublished hospital data). We then multiplied this cost by 2.16 days, the average LOS for AGE admission at our university health center (unpublished data), for a total admission cost of \$2502.92. The cost and LOS are on par with data from Pediatric Health Information System (PHIS) data. The total cost of the hospital stay was multiplied by the probability of admission for patients in the POC and serum testing groups [8]. Cost data were obtained from our university health center. The sentinel PED visit was not included in the cost. All costs are expressed in US dollars.

2.4. Provider costs

We calculated the opportunity cost for the hospital based on decreased LOS in the POC group as measured by nursing hours saved. The hourly wage for nursing staff in our university ED ranges from \$35 to \$70 per hour, based on experience and specific shift. The median LOS for the POC group was 38.5 minutes, 95% confidence interval (14.3–55.0), shorter than the traditional serum testing group.

2.5. Sensitivity analysis

We performed 1-way sensitivity analyses to determine the stability of our model. We used the 95% confidence interval cutoffs [8] for ED LOS, varied the rate of admission by 20% bidirectionally, and used the low and high range of nursing salary.

3. Results

From the point of the view of the payer, the average cost per patient using iSTAT was \$784.48. The average cost using serum electrolytes was \$1087.78. Results of our decision model suggest that using POC testing rather than traditional serum testing results in a cost savings of \$303.30 per patient (Figure). Sensitivity analysis for admission rate shows stability of the model and consistent savings. Varying admission rate by 20% bidirectionally gives a savings range of \$225.99 to \$378.40.

From the point-of-view of the provider, the time saved with POC testing factored by average nursing salary shows a mean cost savings of \$33.60 per patient. Performing the sensitivity analysis with low and high range of nursing salaries, the savings had a range of \$8.40 to \$64.40 per patient.

Table
Assumptions for decision analysis

Assumption	Rate	Reference
i-Stat cost	\$8.59	University data
Serum cost	\$11.54	University data
Admission cost	\$1158.76	PHIS data
Admission LOS for AGE	2.16 d	PHIS data
Admission rate for i-Stat testing	31%	Hsiao et al
Admission rate for serum testing	43%	Hsiao et al
Nursing hourly wage range	\$35–70/h	University data
ED LOS difference for i-Stat group	38.5 min/patient	Hsiao et al

4. Discussion

Although widely studied in adult populations, scant data exist on cost-effectiveness for POC testing in the pediatric population. We have shown that using POC testing rather than traditional serum testing for children presenting with gastroenteritis may result in cost savings from the points of view of the payer as well as the provider.

The American Academy of Pediatrics set weight measurement as the standard of dehydration assessment [9]. However, this parameter continues to be debated [10], and several measures have been offered as adjunct evaluation tools [11]. Perhaps, most widely supported in literature is electrolyte testing to help evaluate degree of dehydration in children. Although conflicting results exist for blood urea nitrogen and creatinine as markers for dehydration, bicarbonate is consistently shown to be decreased in moderate to severe dehydration [10,12,13] with a cutoff value of less than 15 to 17 mmol/L indicative of moderate to severe dehydration [7,14,15]. These laboratory markers, in addition to the overall clinical picture of the patient, are often incorporated to determine the need for intravenous hydration. Given that earlier result time has been linked to decreased time to medical decision making [4], it is possible that intravenous fluids were started earlier and more appropriately in the POC testing group.

Our data also show that use of POC testing can lead to decreased cost for the hospital by decreasing LOS and creating revenue potential through bed and nursing availability. Decreased LOS and time to treatment with use of POC testing have been shown consistently in adult populations [4,16,17]. The same properties lead to increased throughput and bed turnover in pediatric patients, as demonstrated in the study by Hsiao et al [8].

5. Limitations

Our decision model is based on data from a single randomized control trial set in an urban tertiary care children's hospital and is therefore not necessarily generalizable to all PED settings.

A major contributor to overall cost savings in our model was the decrease in admission rates for the POC testing group. Admittedly, this is not a consistent finding in the available literature. One possible explanation for this is that shorter time to institute appropriate treatment based on laboratory data leads to more prompt improvement in clinical condition during the ED stay, thereby leading to decreased admission rates.

The cost data for laboratory testing and result time for testing are specific to our university health center. The relatively small sample size of the randomized control trial model tempers our conclusions. The original study was performed before the widespread availability of low-cost generic ondansetron [18]. As previously mentioned, cost savings from the

hospital perspective is subject to numerous variables that affect bed availability and nursing hours. Although this is challenging to quantify, decision model analysis has been proven as a reasonable assessment tool, and our cost-savings results were found to be consistent after careful sensitivity analysis.

6. Conclusion

This decision analysis provides evidence that POC testing in children with moderate dehydration from gastroenteritis results in significant cost savings from the points of view of payers and providers.

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