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Nasogastric Hydration for Bronchiolitis: Sustaining Change in Practice

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The success of a quality improvement (QI) project depends not only on the implementation of the initiative but also on the sustainability of the changes.[1] While there is large body of literature showing the successful implementation of QI initiatives in hospitals across the nation, reports showing sustainability in follow-up periods are often not available.[1] We implemented a QI initiative to increase the rate of nasogastric (NG) hydration in children with bronchiolitis from January to April 2016.[2] The rationale for the initiative was that NG hydration, compared with intravenous (IV) hydration, can provide better nutrition since breast milk or formula can be given via NG tube. Decreased nutritional intake early in the hospital course has been associated with a longer length of stay in infants with bronchiolitis.[3,4] Increased protein energy intake in critically ill infants with bronchiolitis promotes anabolism, an important goal of nutritional support of sick children.[5] Our initiative was successful in increasing rates of NG hydration in eligible children from 0% to 58% in 6 months.[2] We sought to determine if this change could be sustained without further interventions.

Methods

The sustainment phase of the QI initiative was conducted in the emergency department (ED) and inpatient units at a 280-bed tertiary care, freestanding children's hospital with about 11 000 annual admissions. The QI initiative implementation was from January 5, 2016, to March 29, 2016, and the sustainment phase was from October 1, 2016, to April 18, 2016. Chart review of patients admitted with bronchiolitis was performed to determine rates of NG hydration and identify complications as per methodology described previously.[2] Our inpatient clinical database (KIDDOS) was queried to identify children 1 to 23 months old admitted with a diagnosis (International Classification of Diseases, Tenth Revision [ICD-10]) of acute bronchiolitis (J21.9, J21.0, J21.1, J21.8, J20.9, J11.1), respiratory distress (J80, R06.00), wheezing (R06.2, J98.8), respiratory syncytial virus (RSV)-related infections (B97.4, J12.1, J20.5, B97.4, J02.9), and viral pneumonia (J12.9, J12.89). Chart review data were entered into REDCap (Research Electronic Data Capture), a secure web-based data capture application hosted at Washington University in St Louis.[6] Three study team members reviewed the charts, and the team leader audited 20% of charts reviewed by each team member.

The primary outcome was the rate of NG hydration in eligible children admitted with bronchiolitis needing supplemental hydration. Physicians chose IV or NG hydration at the time of presentation using their clinical discretion, personal preference, and education received during the implementation phase of the QI initiative.[2] Criteria used during retrospective chart review that define children not eligible for NG hydration are shown in Figure 1. Balancing measures were complications such as aspiration, epistaxis, accidental placement of NG tube in airway, or worsening of disease severity that could be potentially attributed to NG hydration.

Monthly rates of NG hydration in eligible children were plotted over time in a statistical process control *P* chart using established rules for identifying special cause variation.[7,8] Characteristics and hospital course of patients that received IV or NG hydration were compared. Categorical variables were analyzed with exact χ^2 tests of independence, and continuous variables with the Kruskal-Wallis test. All analyses were performed with SAS/STAT software Version 9.3 of the SAS System for Windows (Copyright 2010 SAS Institute Inc, Cary, NC).

Results

There were 545 patients, 1 to 23 months of age, admitted to our hospital with bronchiolitis, RSV infection, or a first

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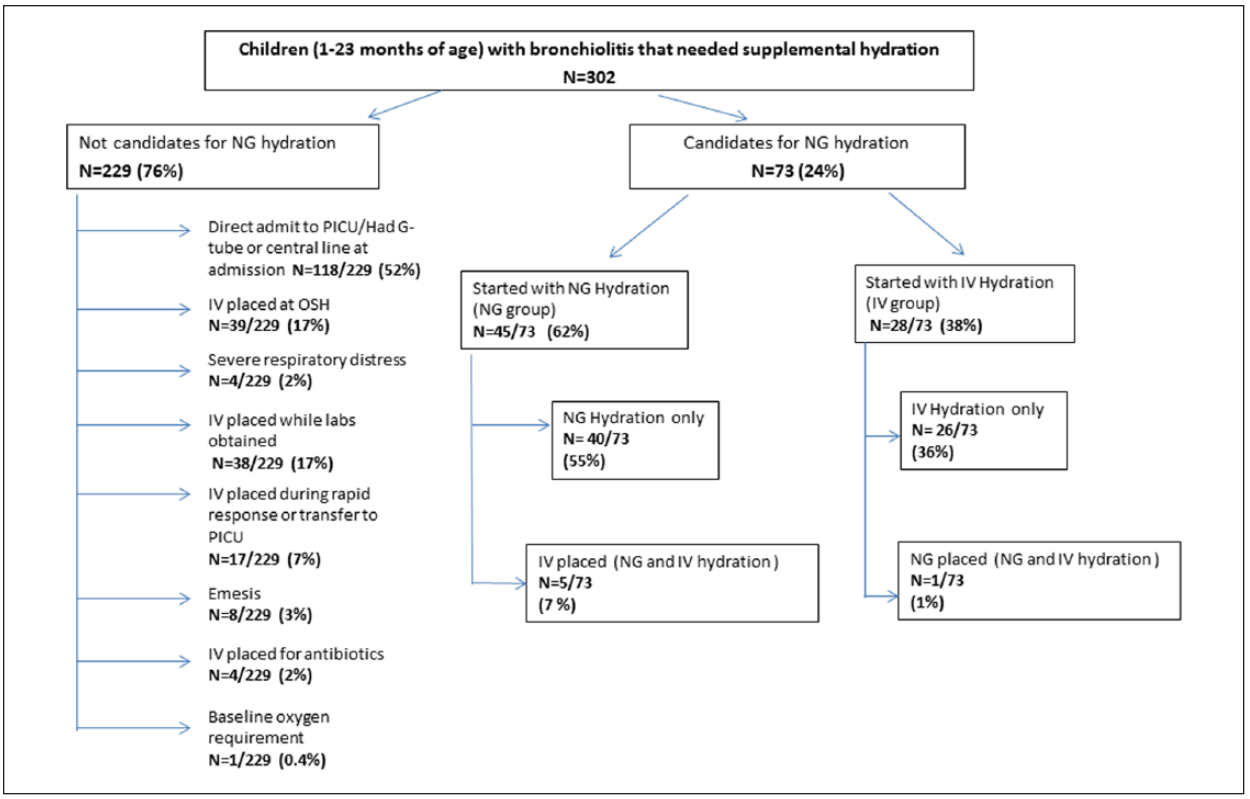

Figure 1. NG and IV hydration groups.
Abbreviations: NG, nasogastric; IV, intravenous; PICU, pediatric intensive care unit; G-tube, gastric tube; OSH, outside hospital.
Some patients have more than one reason for not being a candidate for NG.

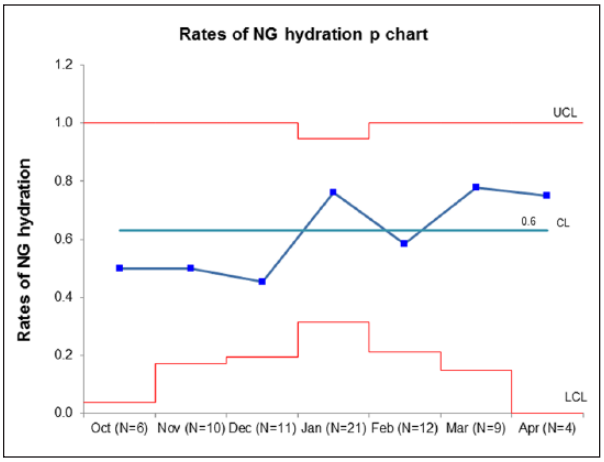

Figure 2. Rates of NG hydration *P* chart.
Abbreviations: NG, nasogastric; CL, control limit; UCL, upper control limit, LCL, lower control limit.

episode of wheezing from October 1, 2016, to April 18, 2017. Of these, 302 (55%) received supplemental hydration. Two hundred and twenty-nine (76%) patients were not candidates for NG hydration for reasons described in Figure 1. Seventy-three (24%) patients were eligible for NG hydration, of whom 45 (62%) received NG hydration as the initial choice for hydration (NG group) and 28 (38%) received IV hydration (IV group). Five (7%) patients in the NG group subsequently received IV hydration, whereas only 1 (1%) patient in the IV group subsequently received NG hydration (Figure 1).

Rates of NG hydration during the sustainment phase (62%) were not significantly different ($P = .74$) than rates of hydration during the preceding QI initiative (58%).[2] The monthly rate of NG hydration during the sustainment phase was stable with no special cause variation detected during the study period (Figure 2). There were no significant differences in gender, RSV infection rates, presenting history or exam, any oxygen requirement (by nasal cannula or face mask) at time of admission, hospital course, length of stay, or discharge diagnosis between the patients who received NG versus IV hydration (Table 1). There were no aspiration events, death, or epistaxis in children receiving either IV or NG hydration. There was no significant difference ($P = .30$) in proportion of IV catheter versus NG tube dislodgement or removal. Twenty (44%) NG tubes were displaced or removed, 5 were replaced with an NG tube, 4 with an IV, and 11 were not replaced with an NG or IV. Nine (32%) IVs were displaced or removed, 1 was

Table 1. Characteristics, Clinical Presentation, and Hospital Course of IV and NG Groups.

	NG Group, N = 45	IV Group, N = 28	*P*
Median age in months (IQR 25th-75th)	6 (3-8)	6 (3-9)	.65
Gender			
Female	27 (60)	14 (50)	.40
Virus detected			
RSV	36 (80)	24 (86)	.75
Non-RSV viral infections	12 (27)	9 (32)	.62
Presenting symptoms			
Respiratory	45 (100)	28 (100)	NA
Emesis	22 (49)	12 (43)	.62
Dehydration	43 (96)	24 (86)	.20
Presenting exam			
Rhinorrhea	22 (49)	10 (36)	.27
Wheezing	29 (64)	16 (57)	.53
Tachypnea	10 (22)	9 (32)	.35
Retractions	39 (87)	25 (89)	1.00
Oxygen requirement at time of admission	5 (11)	5 (18)	.49
Hospital course			
Oxygen by NC	16 (36)	9 (32)	.77
IV antibiotics	1 (2)	0 (0)	1.00
Albuterol treatment	9 (20)	7 (25)	.62
Transferred to PICU	4 (9)	0 (0)	.29
Noninvasive ventilation	4 (9)	0 (0)	.29
Intubated	1 (2)	0 (0)	1.00
Discharge diagnosis			
Bronchiolitis	41 (91)	25 (89)	1.00
Dehydration	15 (33)	9 (32)	.92
LOS (hours), median (IQR)			
ED LOS (hours)	5 (5-6)	5 (4-6)	.18
Inpatient LOS (hours)	41 (25-59)	40 (33-68)	.64
Total LOS (hours)	47 (34-68)	45 (36-71)	.91
Day of illness at presentation median (IQR)	4 (4-6)	4 (3-5)	.12

Abbreviations: IV, intravenous; NG, nasogastric; IQR, interquartile range; RSV, respiratory syncytial virus; NC, nasal cannula; PICU, pediatric intensive care unit; ED, emergency department; LOS, length of stay.

replaced with an NG, 1 with an IV, and 7 were not replaced with an IV or NG.

Of the 45 patients who received NG hydration, 18 (40%) patients received either breast milk or formula; the remaining patients received Pedialyte only.

Five patients in the NG group had progression of disease requiring NPO (nil per os) status and placement of an IV. Four were subsequently transferred to the pediatric intensive care unit (PICU) and received noninvasive ventilation. One of these children was subsequently intubated. None of the children in the IV group were transferred to PICU. The median age of children transferred to PICU was 6.5 months (IQR = 4.8-7.68), median day of illness at time of presentation to hospital was 4.5 days (IQR = 3.8-5.5), and median day of illness at time of transfer to PICU was 6.0 days (IQR = 5.5-6.5). All 4 patients had wheezing and retractions at presentation. None of the patients had documented aspiration or were treated with antibiotics for aspiration pneumonia. The NG tube remained in place in 2 of the patients transferred to the PICU. The patient who was intubated (a 7-month-old child with a history of neurofibromatosis-1 and a prior history of bronchiolitis) was treated for status asthmaticus with albuterol, prednisolone, IV magnesium sulfate, and IV terbutaline in the PICU.

Discussion

Changes in rates of NG hydration achieved during the QI initiative were sustained during the follow-up period without any additional interventions. We attribute this success to the following reasons:

1. *Improved awareness*: Previously, a survey of physicians and nurses showed that most physicians (74%) and nurses (72%) in our institution were unaware that NG hydration was an option for bronchiolitis. After the QI initiative, the majority of nurses (73%) and physicians (79%) were aware of the NG hydration option.[2]
2. *Familiarity with NG hydration*: After the initiative, the majority of physicians (78%) and nurses (64%) surveyed reported that they had used or placed an NG tube for hydration.[2]
3. *Positive parent feedback*: Parental feedback obtained during the initiative was positive.[2] Sharing this information with providers helped change attitudes about NG hydration.
4. *Accessibility of information*: We made the NG hydration protocol clear and readily available via posters/pocket cards in all units.
5. *System-based changes*: The creation of a new order set for NG hydration, as well as the placement of NG tube supplies in the ED reduced barriers to using NG hydration.
6. *Change in culture*: All the aforementioned reasons led to a change in culture among the providers. This was evidenced by a post-QI survey in which majority of nurses (63%) and physicians (95%) stated that they are more likely to consider NG hydration in children with bronchiolitis for the next bronchiolitis season.[2]

There was also peer pressure for the change. There were anecdotal reports of residents in the inpatient team requesting ED providers to start NG hydration prior to admission, and of IV therapy nurses suggesting NG tube placement for appropriate patients when consulted for IV placement. Ultimately, our goal was to improve nutrition by hydrating with formula or breast milk via NG tube, yet the majority of children were given Pedialyte. Further provider education is needed in future bronchiolitis seasons to encourage residents to hydrate using formula or breast milk via NG tube.

Similar to findings during the QI initiative (during which 6 patients in the NG group were transferred to the PICU, compared with none in the IV group) in the sustainment phase, 4 patients in the NG group were transferred to the PICU, compared with none in the IV group. Our chart review did not show documented aspiration or any other direct evidence that NG hydration contributed to PICU admission, and PICU providers removed the NG in only half of these patients. Thus, intensive care unit (ICU) transfers in these patients appear to be due to worsening of the underlying disease process. While this study is part of our QI initiative and is not designed or powered to compare adverse events between IV and NG hydration, several published reports support the safety of NG hydration. A large randomized control trial by Oakley et al comparing IV versus NG hydration in infants hospitalized with bronchiolitis did not show any significant differences in adverse events between the 2 groups including ICU admission rates or need for ventilator support.[9] A retrospective cohort study comparing IV versus NG hydration in infants 0 to 2 months of age hospitalized with bronchiolitis showed a positive association of IV hydration with ICU admissions and ventilator support.[10] A prospective randomized controlled pilot study by Kugelman et al comparing infants receiving IV or gastric tube feedings showed no significant difference in the hospital course of the 2 groups, and gastric tube feeding was not associated with worsening of respiratory status of the infants.[11]

Limitations

This study was done in a single freestanding children's hospital and the results may not be generalizable to other institutions. In addition, the number of patients receiving NG versus IV hydration was not large enough to compare serious adverse events between the 2 groups. The sustainment phase was during a single RSV season and continued measurements of rates of NG hydration during subsequent seasons are needed to ensure that changes are sustained through time.

Conclusion

Our study shows that the change in NG hydration rates effected during the QI initiative was successfully sustained during the follow-up period without any interventions.

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Author Contributions

MS: Contributed to conception and design; contributed to acquisition, analysis, and interpretation; drafted manuscript; critically revised manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.
TJC: Contributed to acquisition, analysis, and interpretation; critically revised manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

Declaration of Conflicting Interests

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