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# Homecare and Healthcare Utilization Errors Post–Neonatal Intensive Care Unit Discharge

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## ABSTRACT

**Background:** High-risk infants transitioning from the neonatal intensive care unit (NICU) to home represent a vulnerable population, given their complex care requirements. Little is known about errors during this period.

**Purpose:** Identify and describe homecare and healthcare utilization errors in high-risk infants following NICU discharge.

**Methods:** This was a prospective observational cohort study of homecare (feeding, medication, and equipment) and healthcare utilization (appointment) errors in infants discharged from a regional NICU between 2011 and 2015. Chi-square test and Wilcoxon rank-sum test were used to compare infant and maternal demographics between infants with and without errors.

**Results:** A total of 363 errors were identified in 241 infants during 635 home visits. The median number of visits was 2. No significance was found between infant and maternal demographics in those with or without errors.

**Implications of Practice:** High-risk infants have complex care needs and can benefit from regular follow-up services. Home visits provide an opportunity to identify, intervene, and resolve homecare and healthcare utilization errors.

**Implications of Research:** Further research is needed to evaluate the prevalence and cause of homecare errors in high-risk infants and how healthcare resources and infant health outcomes are affected by those errors. Preventive measures and mitigating interventions that best address homecare errors require further development and subsequent description.

**Key Words:** discharge planning, healthcare errors, high-risk infants, home care services, NICU, transition of care

High-risk infants are at increased risk for morbidity and mortality after hospital discharge compared with healthy term infants.<sup>1,2</sup> Often these infants are discharged from the neonatal intensive care unit (NICU) requiring individualized feeding regimens, home medical equipment, medications, and a multitude of follow-up appointments.<sup>2,3</sup> Parents of high-risk infants are responsible for carrying out these complex and dynamic care regimens following NICU discharge, and thus have an increased need for support provided by home visitation services.<sup>4-9</sup>

Transitions in care after hospitalization require an active and reliable reception into the next setting of care services, such as ambulatory primary care and specialty care services. Poor execution of care transitions adversely affects patients' health, well-being, and family resources, while unnecessarily increasing healthcare system costs.<sup>10</sup> Accordingly, prior studies demonstrate that providing continuity of patients' medical care, especially during transition from hospital to home, aids in the reduction of preventable medical errors and avoidable readmissions.<sup>10,11</sup> Currently, the healthcare system is focused on reporting and tracking medical errors that occur in the hospital to improve the quality of care delivered to high-risk populations. While home medical errors have been studied in pediatric<sup>12-14</sup> and adult populations, little is known about homecare and healthcare utilization errors during the transition from the NICU to home in high-risk infants.

To address the issues that high-risk infants face during transition of care, in 2011 Santa Clara Valley Health and Hospital Systems (SCVHHS) developed the Babies Reaching Improved Development and Growth in their Environment (BRIDGE) program. This program provides home visits for high-risk infants following NICU discharge. The purpose of this study was to identify and characterize homecare and healthcare utilization errors encountered during BRIDGE home visits.

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The study was conducted at Santa Clara Valley Health and Hospital System, San Jose, California.

The authors declare no conflicts of interest.

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### What This Study Adds

- Identifies and characterizes homecare and healthcare utilization errors in high-risk NICU graduates during their transition to home.
- Establishes that homecare and healthcare utilization errors occur regardless of maternal or infant demographic factors.
- Demonstrates resolution of homecare and healthcare utilization errors through home visits.

## METHODS

### Study Design

This was a prospective observational cohort study of infants discharged from our county safety net hospital's California Regional NICU (equivalent to AAP level IV) between April 2011 and January 2015 who met California Children's Services High Risk Infant Follow up (HRIF) eligibility criteria.<sup>15</sup> The criteria included infants born less than 32 weeks' gestation, with weight 1500 g or less, and/or had a diagnosis that may result in neurologic abnormalities. The study was approved by the institutional review board with waiver of consent. Infants who never received a BRIDGE visit were excluded from the study, such as infants who died within 2 weeks of discharge, moved out of the county, were lost to follow-up, or whose parents declined visits.

### Process of Transitioning Care From NICU to Home

#### *Discharge Preparation*

The NICU discharge process included multiple check lists, protocols, and a multidisciplinary team including medical providers, social worker, family and baby advocates, clinical nurse specialist, physical therapist, nutritionist, public health nurse, and BRIDGE pediatric nurse practitioners (PNPs). The team performed a detailed assessment of family needs during the NICU stay to ensure a smooth transition from hospital to home.

Discharge teaching began on the day of admission and was reinforced throughout the NICU stay and assessed prior to discharge. During regular family conferences, the team assessed family needs, connected parents to social agencies/networks, and provided infant care education. At weekly multidisciplinary rounds, discharge plans were reviewed to ensure families' needs and resources were obtained for the transition from the NICU to home.

Education and infant CPR classes in Spanish, English, or Vietnamese were offered to all families prior to discharge. To effectively address language barriers of non-English-speaking families, medical interpreters and translation phones services were utilized. An education tablet with preselected topics was also used to complement bedside education.

Before discharge, the parents were offered and encouraged to stay in 1 of 2 NICU family rooms to provide full care to their infant with support available if needed. Day of discharge, nurses assessed, confirmed, and reinforced that all education was complete using a check list related to baby care, medication, equipment, and home feeding plan. Initial follow-up appointments were scheduled and written instructional materials were provided.

#### *BRIDGE Program PNPs*

The BRIDGE home visits were performed by PNPs. Each PNP attended a 4-hour didactic orientation with simulated case scenarios, instructions for proper documentation, and practice identifying homecare errors followed by a shadowing experience with the lead PNP for 2 to 4 weeks based on their level of previous experience. The PNPs' performances with regard to identification and reduction of errors were not tied to an increase in pay or any other incentives.

#### *Home Visit*

The first BRIDGE home visit occurred within 2 weeks of NICU discharge. Length of each home visit was based on parental need and generally lasted an hour. Subsequent follow-up visits were scheduled on the basis of PNP evaluation of medical need until no longer required, up to approximately 6 months postdischarge. During each home visit, the PNP performed an initial homecare setting assessment by asking open-ended questions about the infant's general well-being and answered any questions or concerns of the parents. A subsequent more structured assessment of the infant's current plan of care was performed that included both verbal and return demonstrations of appropriate feeding, medication, and equipment use.

When PNPs observed an error in the home, they responded by giving parents immediate, targeted education, writing prescriptions, making referrals, scheduling visits, and arranging for equipment delivery as needed (Table 1). The PNPs were also available to the caregivers by phone to provide guidance and phone triage as needed.

The PNPs' findings including plan-of-care modifications and errors were documented in a standardized patient note. Patient notes were recorded in the electronic health record and accessible to relevant healthcare providers. When clinically necessary, PNPs consulted their supervising physician. In addition, the infant's primary care provider and specialists were notified of the infant's progress and/or concerns by phone, hospital e-mail, or electronic medical record.

#### *Homecare Errors and Healthcare Utilization Errors*

A homecare error was defined as a deviation from the prescribed plan of care after discharge or an

TABLE 1. Process for Error Assessment and Intervention

	Appointment	Medication	Feeding	Equipment
Assessment	Record review Caregiver interview	Record review Caregiver interview Return demonstration	Record review Caregiver interview Return demonstration	Record review Caregiver interview Return demonstration
Error criteria	Scheduled but missed: Parent unaware Parent aware Not scheduled: By parent By provider	Preparation or administration deviation	Preparation or administration deviation	Inappropriate use or lack of equipment such as bulb suction, thermometer, other (eg, G-tube, home oxygen, braces)
Intervention	Scheduled appointments, made referrals, communicated appointments, provided handouts, phone consultations and triage	Demonstrated correct preparation and administration, prescribed medication, provided phone consultation	Demonstrated correct preparation and administration, provided handouts, prescribed formula, customized feeding plans, provided phone consultation	Demonstrated use, coordinated obtaining equipment with suppliers and caregivers, provided phone consultation

ambulatory care visit. These errors included medication, equipment use, and feeding (Table 1). Specifically, medication errors included incorrect dose, failing to obtain or administer a medication. Equipment errors consisted of lack of equipment or incorrect use of bulb syringe, thermometer, oxygen, feeding tube, or other home healthcare equipment. Feeding errors included incorrect fortification of breast milk or formula, administering the wrong type of formula, or inappropriate volume. An inappropriate feeding volume error was defined as any deviation from the current plan of care, which included a detailed volume requirement for specific infants such as small-for-gestational age, intrauterine growth retardation, failure to thrive, or those with a nasogastric tube or gastrostomy tube.

A healthcare utilization error was defined as a lack of compliance with follow-up appointments (Table 1). This included missing a scheduled appointment, missing a referral, or failure to schedule an appointment.

### Data Collection and Analysis

Errors identified by PNs during the home visit were documented in the patients' electronic medical record. Data were validated by an independent analyst not involved with the BRIDGE program, who read every error description in the PNs' home visit note to ensure accuracy and conformity of error identification. Infant demographics, including gestational age, birth weight, gender, and NICU length of stay, and maternal demographics, including age, marital status, parity, primary language, race/ethnicity, and level of education, were obtained from the NICU and HRIF database. The categorical variables of infant and maternal demographics between infants with and without errors were

compared using chi-square test with the Yates correction. The Wilcoxon rank-sum test was used to evaluate birth weight, gestational age, length of stay, and day of life at discharge comparing infants with and without errors. For the Wilcoxon rank-sum test, infants were categorized into high-risk infants born less than 32 weeks' gestation or 1500 g or less and high-risk infants born more than 32 weeks' gestation and more than 1500 g. Statistical analyses were done using R version 3.1.2 (cran.r-project.org).

## RESULTS

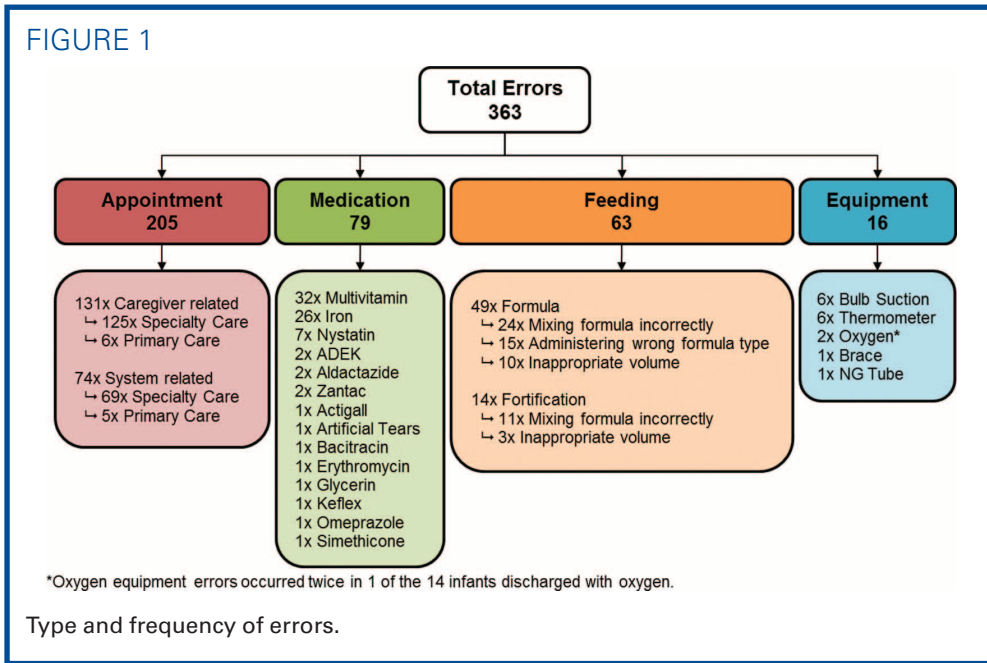
### Study Population

Of the 241 high-risk infants, 163 (68%) were born less than 32 weeks' gestation or with weight 1500 g or less. The remaining 78 infants were born more than 32 weeks' gestation and with weight more than 1500 g and had other California Children's Services HRIF eligible diagnoses,<sup>15</sup> which could result in neurologic abnormalities.

### Errors

A total of 635 visits were conducted for 241 high-risk infants with a median of 2 visits (range, 1-8) per infant. Of the 241 infants, 152 infants (63.1%) encountered at least 1 homecare or healthcare utilization error. A total of 138 infants (57.1%) had at least 1 error identified during the first visit.

A total of 363 errors were identified in the 152 infants (Figure 1). Of the 363 errors, 205 (56.5%) were appointment errors, 79 (21.8%) were medication errors, 63 (17.4%) were feeding errors, and 16 (4.4%) were equipment errors.



Errors were observed throughout the home visits (Figure 2). Sixty-four percent of the total errors were identified at the first home visit and there was one error on the last visit for 24 infants. The majority of encountered errors did not reoccur in patients who had subsequent visits with the exception of 38 physical therapy appointment errors. The median number of visits until no new errors were observed was 2.

**Infant Demographics**

There was no significant difference in birth weight, gestational age, length of hospital stay, day of life at discharge, or gender between infants with and without errors in the overall cohort and in the subgroups (Table 2).

**Maternal Demographics**

Demographic data were obtained for all the parents. There was no difference in the primary caregiver’s level of education, marital status, primary language, parity, age, race, and ethnicity between infants with and without errors (Table 3).

**DISCUSSION**

This study identified the majority of high-risk infants visited experienced at least 1 homecare or healthcare utilization error despite a comprehensive standardized discharge teaching process. Supporting high-risk infants and their parents during the transition from the NICU to home provided an opportunity to

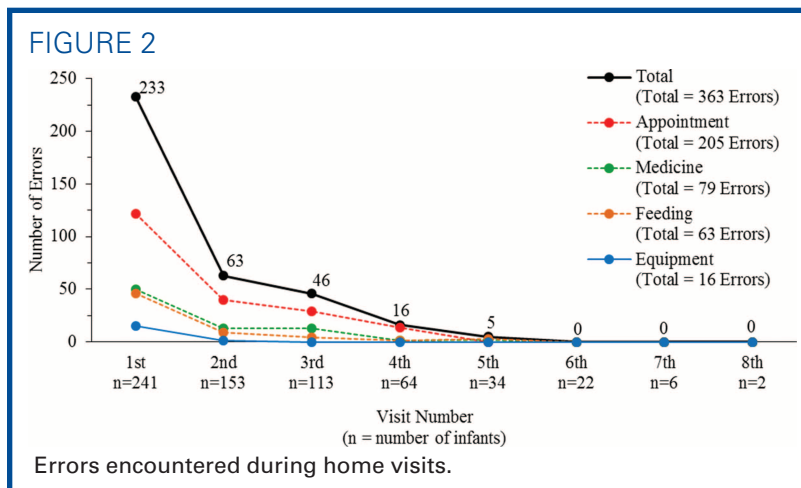


TABLE 2. Infant Demographics of Infants With and Without Errors

	<32-wk Gestation or ≤1500-g Weight				≥32-wk Gestation and >1500-g Weight			
	Study	Errors	No Errors	P	Study	Errors	No Errors	P
n	163	108	55		78	44	34	
Birth weight, g Median (range)	1260 (430-2170)	1275 (470-2170)	1230 (430-2010)	.5	3065 (1520-4060)	3085 (1731-4060)	3027.5 (1520-4060)	.6
Gestational age, wk Median (range)	29.86 (23.71-36.71)	29.43 (23.71-36.71)	30.00 (24.14-34.71)	.6	37.86 (32-42.43)	37.71 (32.29-41.14)	38.21 (32-42.43)	.8
Length of stay, d Median (range)	43 (7-167)	43.5 (7-167)	43 (7-147)	.5	13 (3-112)	13 (4-112)	13 (3-75)	.6
Day of life at discharge Median (range)	44 (7-168)	44 (7-168)	43 (7-147)	.6	13.5 (3-112)	14 (4-112)	13 (3-75)	.3
Male sex, %	62	68	51	.057	50	48	53	.8

improve their care. Several different types of errors were identified with the most frequent being appointment errors, due to either parents missing appointments or failure of discharging team to schedule an initial follow-up appointment. Common reasons for parents missing appointments were lack of transportation, no childcare, or the parent not remembering the scheduled appointment.

Common reasons why healthcare system–related appointment errors occurred included initial appointment not made prior to discharge, no referral placement by providers, insurance-related problems, and/or lack of NICU administrative staff availability to schedule appointments.

In addition, errors were more often related to specialty care appointments than primary care appointments because specialty appointments required prior authorization. Parents became responsible for

scheduling these appointments after receiving authorization from their insurance provider via mail, but were often unsuccessful due to lack of resources such as inadequate mobile phone minutes or numbers, inconsistent mailing address, and inability to obtain necessary patient medical record number or insurance information. This explains the 38 physical therapy errors identified in subsequent visits.

If appointment errors had not been identified and addressed in a timely manner, infants might have missed valuable follow-up opportunities with the potential to prevent morbidities such as blindness, cerebral palsy, respiratory syncytial virus infection, neurodevelopmental delay, or failure to thrive.<sup>16</sup> In addition, appropriate early follow-up can potentially prevent improper utilization of healthcare resources such as urgent care services and rehospitalization.<sup>17</sup>

TABLE 3. Maternal Demographics of Infants With and Without Errors

Sociodemographic (n = 232)	Primary Care Giver, %	Infants With Errors, %	Infants Without Errors, %	P
Ethnicity, Hispanic	62	61	62	.9
Race (n = 223) <sup>b</sup>				
Caucasian	78	80	76	.5 <sup>a</sup>
Black	4	3	6	
Asian	14	15	13	
Age < 19 y	9	7	11	.3
Parity, primigravida	36	32	44	.09
Language (n = 140), English <sup>b</sup>	61	66	51	.1
Education (n = 158), high school graduate <sup>b</sup>	34	32	37	.5
Marriage (n = 136), married <sup>b</sup>	29	25	36	.2

<sup>a</sup>Caucasian versus non-Caucasian.  
<sup>b</sup>Missing data.

## Summary of Recommendations for Practice and Research

<b>What we know:</b>	<ul style="list-style-type: none"> <li>• Homecare errors and healthcare utilization errors often occur in high-risk infants during the transition from the NICU to home.</li> <li>• Errors occur regardless of underlying reasons for NICU care, length of NICU stay, or demographic status.</li> <li>• Home follow-up visits were helpful to identify, intervene, and resolve home care errors.</li> </ul>
<b>What needs to be studied:</b>	<ul style="list-style-type: none"> <li>• Development and implementation of system-based interventions to prevent and mitigate errors.</li> <li>• Comparison of resource utilization and health outcomes between infants with errors and without errors.</li> </ul>
<b>What we can do today:</b>	<ul style="list-style-type: none"> <li>• Anticipate errors in high-risk infants with complex care plans following NICU discharge.</li> <li>• Perform home follow-up visits to identify, intervene, and resolve errors.</li> <li>• Utilize information acquired through follow-up visits to employ effective pre- and postdischarge interventions to better address anticipated errors.</li> </ul>

Optimal nutrition of high-risk infants after NICU discharge represents a unique challenge for parents. In addition to breast milk feeding or breastfeeding, these infants often require supplements of formula or fortification of breast milk, resulting in complex feeding regimens prone to mistakes. Timely identification and correction of feeding errors were critical for growth and to help prevent unnecessary office visits and rehospitalizations for weight loss, constipation, electrolyte imbalance, and failure to thrive.

Multiple medications are often prescribed for NICU graduates. The majority of observed medication errors in this study were missed doses of multivitamins and iron. Omitting 1 or 2 doses of these medications may not be significant; however, correction of other medication dosing errors such as diuretics, antibiotics, may be important to optimize infant health and prevent complications.

The majority of equipment errors related to misuse of thermometer and bulb syringe; it is important to note that improper use could result in unnecessary visits to the emergency room or urgent care. Even though discharge with home oxygen equipment was infrequent in this study cohort, errors related to improper use of oxygen equipment could potentially cause serious morbidity and mortality.

In pediatric populations, maternal race, ethnicity, level of education, and language have been reported as barriers to access of healthcare utilization.<sup>18-21</sup> Although limited, similar findings have been reported in infants discharged from the NICU.<sup>16,22</sup> However, this study found no association between maternal or infant demographic factors and errors. This difference between study findings may be attributed to the standardized comprehensive NICU discharge process and BRIDGE PNPs.

This study demonstrated that the majority of homecare and healthcare utilization errors were identified by a single home visit within 2 weeks following NICU discharge. Once identified, the same error did not reoccur in the same infant in subsequent

follow-up visits with the exception of physical therapy appointments. New errors were identified in subsequent visits. Although the number of home visits in this study was based on medical need, at least 2 follow-up home visits were necessary to sufficiently address the majority of errors for the patient.

### Limitations

This is a single-center study and hence the generalizability of the study results is limited to similar populations and healthcare systems. Identification of homecare and healthcare utilization errors is institution-specific due to the different needs of patient populations, available resources, and the different types of systems. Given the sensitive nature of maternal demographic data, some mothers chose not to disclose information with regard to marital status, level of education, race, and language. In addition, attrition of sample size occurred in subsequent follow-up visits because they were scheduled on the basis of PNP evaluation of medical need.

### CONCLUSION

This study advances an understanding of the presence and types of errors encountered by high-risk infants in their home after NICU discharge. Anticipating these errors and the challenges parents face in their home assists caregivers in identifying and employing effective interventions that are essential to optimizing the care of high-risk infants during this transitional period.

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