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ORIGINAL ARTICLE

Early discharge of premature infants < 37 weeks gestational age with nasogastric tube feeding: the new standard of care?

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Abstract

Most premature infants are hospitalised until they no longer need monitoring of vital parameters and are independent of nasogastric tube feeding (NTF). Hospital admission time easily reaches a length of multiple months in extremely preterm infants, but also in late preterms, in whom drinking may be the only problem, hospital admission time can reach weeks. This is a very stressful time for both parents and child. Parents in the Albert Schweitzer Hospital (ASH) are taught to give their child NTF. When monitoring is no longer necessary, the child can be discharged with NTF, with home care by paediatric nurses. In this study duration of NTF at home, safety of the procedure and parental satisfaction with NTF at home were evaluated. Duration of NTF at home was compared to admission time from cessation of monitoring till discharge independent of NTF in infants born in two comparable hospitals where discharge with NTF is not standard care. Median duration of NTF at home in the ASH infants was 9 days. In the control group, median admission time after cessation of monitoring was 9 days. No complications related to NTF at home were noted. Ninety-six percent of parents regarded NTF at home as safe and would repeat it in the future.

Conclusion: NTF at home in premature infants shortens hospital admission time, is safe and results in high parental satisfaction rates.

What is Known:

- *Premature infants are most often hospitalised until they are no longer dependent on NTF. Hospital admission time therefore easily reaches a length of multiple months for the extremely preterm infant. This can be a very stressful time for both parents and child.*

What is New

- *Making discharge with NTF in otherwise stable premature infants possible, by teaching parents the procedure and by providing home care by paediatric nurses.*
- *NTF at home in premature infants is safe, limits hospital admission time and has high parental satisfaction rates.*

Keywords Premature infants · Nasogastric tube feeding (NTF) at home · Hospital admission time

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Abbreviations

ASH	Albert Schweitzer Hospital
BPD	Bronchopulmonary dysplasia
GA	Gestational age
IC	Intensive care
IVH	Intraventricular haemorrhage
MSH	Maasstad Hospital Rotterdam
NHG	Northwest Hospital Group Alkmaar
NICU	Neonatal intensive care unit
NTF	Nasogastric tube feeding

Introduction

Premature infants are most often hospitalised until they no longer need monitoring of vital parameters and are no longer dependent on nasogastric tube feeding (NTF). Hospital admission time therefore easily reaches a length of multiple months in the extremely preterm infant, but also in late preterms, in whom drinking may be the only problem, hospital admission time can reach weeks. This can be a very stressful time for both parents and child.

Earlier discharge is beneficial for the emotional and psychological state of the parents and the attachment to their child. Being in a natural environment can help reducing stress levels of parents and child and promotes formation of a better attachment—an ultimate form of family integrated care [7].

Furthermore, earlier discharge is also cost-effective, since hospitalisation for NTF only is expensive care.

To facilitate an early discharge and to make parents feel more involved with the care-taking of their child, we started teaching parents how to give their child NTF in the Albert Schweitzer Hospital (ASH) in 2002. When monitoring of vital parameters was no longer necessary but the infant was still dependent on NTF, it could be discharged home.

Home care was provided by a transmural team of neonatal and paediatric nurses. They made weekly home visits and could be reached 7 days a week from 7 a.m. until 10 p.m. by mobile phone. During the night, parents could contact the neonatology ward.

Apart from the advantage of early discharge, the possibility of NTF at home also gives the child the opportunity to learn how to drink on its own pace, in a less stressful environment, with less negative stimuli [1]. Overstimulation will likely be prevented and there is more time to support breastfeeding.

Previous studies show that earlier discharge with NTF is associated with longer duration of breastfeeding [7, 5, 2, 6].

Primary outcome of this study was to determine the duration of NTF at home in our study group. Time of NTF at home was compared to the admission time, after cessation of monitoring till discharge independent of NTF, in infants born in two comparable hospitals in which discharge with NTF is not standard of care. Secondary outcomes were safety of the procedure (readmissions due to problems with NTF) and parental satisfaction with the procedure. Growth during the first 3 months after discharge and duration of exclusive breastfeeding were also evaluated.

Materials and methods

Patients

Premature infants with a gestational age (GA) < 37 weeks were included in a prospective study between February 2014 and February 2016 in the Albert Schweitzer Hospital (ASH), Dordrecht, the Netherlands. This is a large, secondary care level hospital with a post-intensive care (IC) high care neonatology ward. In the Netherlands, infants < 32 weeks GA are born in a centre with a neonatal intensive care unit (NICU). When they are stable enough (no longer dependent on invasive respiratory or circulatory support) and weigh > 1 kg, they can be transferred to a post-IC unit. Infants ≥ 32 weeks GA can be born in a secondary level hospital where non-invasive respiratory support can be given.

Exclusion criteria were syndromal anomalies which interfere with normal oral feeding, asphyxia with neurological sequelae or (psycho)social problems (including language barrier).

During the study period, 448 infants were admitted to the ASH because of prematurity. Nineteen infants were transferred to other hospitals, mostly because they no longer needed post-IC high care. Thirteen infants were excluded due to one of the above-mentioned exclusion criteria. Of the remaining 416 infants, 133 were discharged with NTF (32%), of which 123 participated in the study (Fig. 1). The other 283 premature infants were discharged home without NTF.

The control group consisted of infants < 36 weeks GA from the Northwest Hospital Group Alkmaar (NHG), included between February 2014 and May 2015, and the Maasstad Hospital Rotterdam (MSH), included between February 2014 and December 2015. Only infants < 36 weeks GA were included in these hospitals because infants > 36 weeks GA do not receive standard follow-up.

These hospitals are also secondary care level hospitals with a post-IC high care neonatology ward.

Two hundred five premature infants were included in these hospitals. Eleven were transferred to other hospitals and two were excluded. Of the total of 192 infants, 103 (54%) stayed in hospital only for NTF after cessation of monitoring of vital parameters. They were all included in the control group (Fig. 2).

For the comparison with the control group, only the ASH infants < 36 weeks GA were analysed.

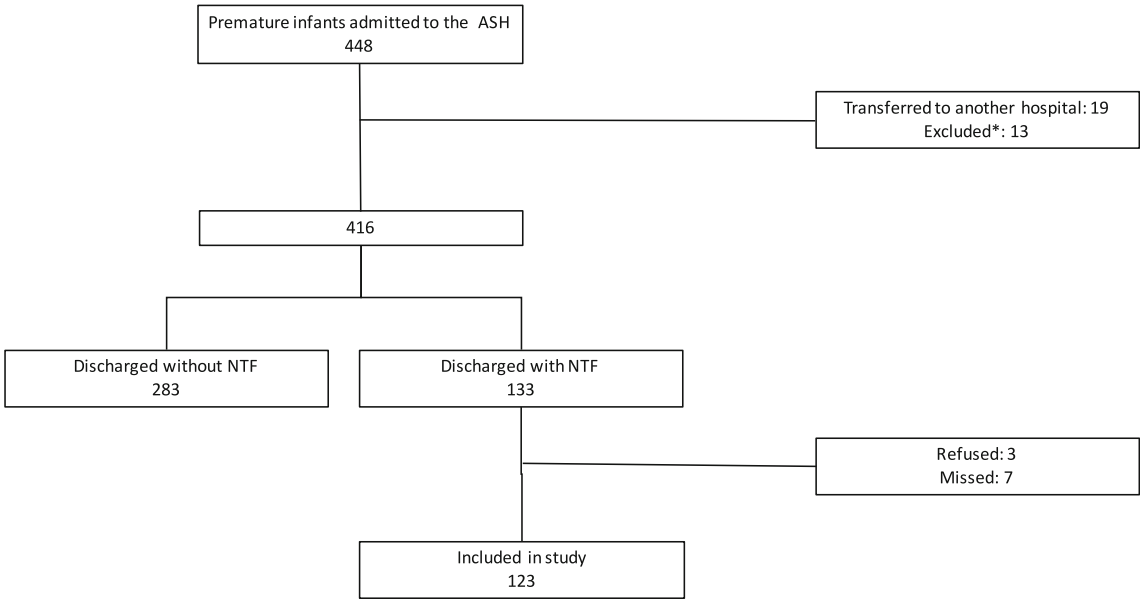

Fig. 1 Flow-chart of patient inclusion in the ASH. *Exclusion criteria: syndromal anomalies which interfere with normal oral feeding, asphyxia with neurological sequelae, or (psycho)social problems (including language barrier)

In all three hospitals, infants' vital parameters were monitored till at least 35 weeks post menstrual age in infants of < 35 weeks GA. Infants ≥ 35 weeks GA are not routinely monitored.

Infants of the ASH were discharged if no significant incidents (apnoea/bradycardia) occurred for 5 days after all respiratory support (including caffeine medication) had been stopped. In the control groups, they could be discharged after 48–72 h without incidents.

Data collection

During admission time, data about pregnancy, birth, morbidity, duration of monitoring, duration of NTF, kind of feeding and growth were noted on precoded forms in all hospitals.

Duration of NTF and growth parameters during NTF at home as well as kind of feeding were registered by the home care nurses during their weekly visits.

Children were seen at the outpatient clinic by a neonatologist (if already discharged from hospital at that time) at term age and at 4 and 12 weeks post term in the ASH, and at 6 weeks and 12 weeks post term in the NHG and MSH. Data on growth, feeding, potential diseases and neurological abnormalities, readmissions and medication use were collected.

Parental satisfaction in the study group was evaluated by a short questionnaire (six questions) developed by a neonatologist of the ASH. Parents were asked how they experienced the processes of learning NTF at the ward and of giving NTF at home, if they felt it was safe and if they would repeat it again in the future if necessary.

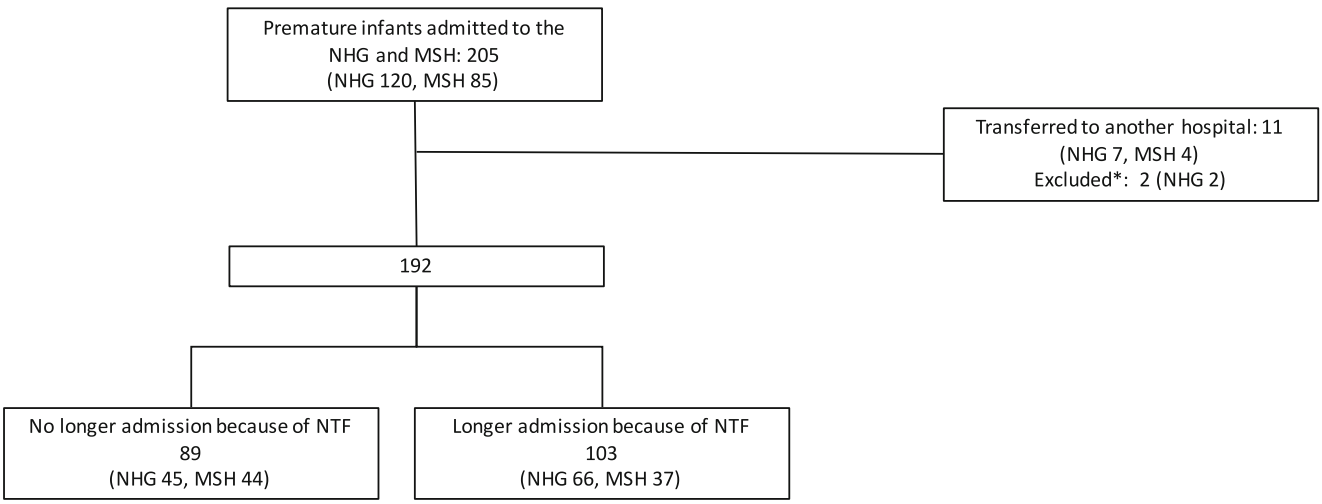

Fig. 2 Flow-chart of patient inclusion in the control group (NHG and MSH). *Exclusion because of discharge with NTF in the control group.

Data analysis

Statistical analysis was performed using SPSS (version 24) and R (version 3.4.3). Patient characteristics between groups were compared using chi-square and nonparametric Mann-Whitney tests, where appropriate. NTF duration was illustrated using Kaplan-Meier curves and compared between groups using the logrank test. Weight(-change) of the infants during the study was analysed using linear mixed-effects models as a function of infant age (days since birth) with infant-specific intercept and slope. Differences in average slope between groups were tested using the test of interaction of infant age and group. A p value of 0.05 or less was interpreted to indicate statistical significance.

Ethical aspects

This study was approved by the Medical Ethics Review Board of the Albert Schweitzer Hospital.

Informed consent was obtained from all parents of the children included in the study group.

Results

ASH infants

Of the total of 416 eligible infants, 133 (32%) were discharged home with NTF, 123 participated in the study.

The number of admissions, exclusions and participating infants according to GA is shown in Table 1.

As can be seen in Table 1, the percentage of infants discharged with NTF decreased with GA. In our study population, 75% of infants born at 24–29 weeks of GA were discharged with NTF, decreasing to 6% at 36 weeks GA.

Characteristics of the studied population according to GA are shown in Table 2.

As can be expected, infants of lower GA had lower 5-min Apgar scores and were more frequently diagnosed with bronchopulmonary dysplasia (BPD) and IVH (intraventricular haemorrhage).

Median duration of NTF at home was 9 days. Infants of 24–29 weeks of GA had a median of 23 days of NTF at home (95% CI 7.3–38.7), infants of 30–33 weeks 9 days (95% CI 5.1–12.9 days) and infants of 34–36 weeks 7 days (95% CI 5.8–8.2).

The cumulative NTF duration distributions according to GA categories are shown in Fig. 3.

Parental evaluation of the process of learning how to give NTF and give NTF at home was highly positive. 82/123 questionnaires were completed (67%). Ninety-six percent of the parents regarded the procedure as safe and 93% would repeat it again in the future if necessary.

No complications were noted; none of the 123 infants had to be readmitted because of problems due to NTF at home.

Nurses of the transmural team made on average 4.8 house visits per infant (range 2–12). The mean duration of a visit was 47 min (range 15–90 min). They had 0.6 telephone contacts per infant (range 0–4) which lasted 11 min on average (range 5–40 min).

Comparison with the control group

Since the NHG and MSH did not include infants of 36 weeks GA in the study, ASH infants of 36 weeks GA were excluded for the comparison ($n = 10$).

Table 1 Number of admissions, exclusions, and inclusions according to gestational age in the ASH

GA (weeks)	Admissions (n)	Transfers (n, %*)	Exclusions ** (n, %*)	Available for study (n, %*)	Discharge without NTF (n, %^)	Discharge with NTF (n, %^)	Included in study (n, %**)
24–26	12	–	–	12 (100)	3 (25)	9 (75)	8 (89)
27–29	21	8 (38)	1 (5)	12 (57)	3 (25)	9 (75)	8 (89)
30–32	64	9 (14)	3 (5)	52 (81)	16 (31)	36 (69)	34 (94)
33–34	83	2 (2)	6 (7)	75 (90)	30 (40)	45 (60)	42 (93)
35	93	–	2 (2)	91 (98)	67 (74)	24 (26)	21 (88)
36	175	–	1 (1)	174 (99)	164 (94)	10 (6)	10 (100)
Total	448	19 (4)	13 (3)	416 (93)	283 (68)	133 (32)	123 (92)

*Percentage of admissions

**Exclusion criteria: syndromal anomalies which interfere with normal oral feeding, asphyxia with neurological sequelae or (psycho)social problems (including language barrier)

^Percentage of infants available for study

**Percentage of infants discharged with NTF

Table 2 Patient characteristics of the ASH infants according to GA

	24–29 weeks GA ($n = 16$)	30–34 weeks GA ($n = 76$)	35–36 weeks GA ($n = 31$)	Total group ($n = 123$)	p*
Female	7 (49%)	40 (52%)	14 (45%)	61 (50%)	0.7
Caucasian	12 (75%)	61 (80%)	26 (84%)	99 (80%)	0.2
Singleton	13 (81%)	46 (61%)	20 (65%)	79 (64%)	0.3
Antenatal steroids	13/15 (87%)	47/74 (64%)	2/31 (6%)	62/120 (52%)	< 0.001
Birthweight (grams, mean (minimum–maximum))	1039 (630–1680)	1946 (1120–2982)	2395 (1565–3416)	1941 (630–3416)	< 0.001
Apgar 5 min (mean (SD))	7 (1.5)	8.4 (1.7)	9.5 (1.0)	8.5 (1.6)	< 0.001
BPD^	10 (62%)	4 (5%)	–	14 (11%)	< 0.001
IVH**	3/16 (19%)	6/56 (11%)	No ultrasound	9/72 (13%)	

*Chi-square or One way ANOVA

^Bronchopulmonary dysplasia: mild, moderate or severe BPD combined (WHO criteria)

**Intraventricular haemorrhage: grade 1 or more. In infants of 34–36 weeks GA cerebral ultrasounds are not routinely made in the ASH

Patient characteristics of the infants of ASH, NHG, and MSH are shown in Table 3.

No statistically significant differences between the two groups were noted.

The median duration of NTF at home was 9 days in the ASH infants; infants of the control group (MSH + NHG) had a median of 9 days admission time (95% CI 7.8–10.2) after cessation of monitoring of vital functions until drinking all feeds themselves ($p = 0.56$). Duration of NTF at home/days in hospital after cessation of monitoring according to GA is shown in Table 4.

The median admission time was 20 days in the ASH infants (range 2–126) and 23 days in the control group (range 5–142) ($p = 0.14$). Hospital admission time according to GA is shown in Table 4.

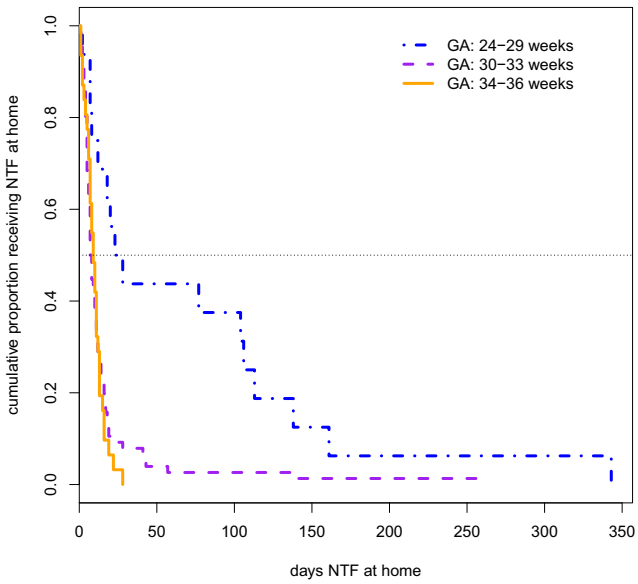

Fig. 3 Proportion of infants receiving NTF at home after discharge according to GA

Fifteen infants were rehospitalised during the follow-up period in the ASH compared to 11 infants in the control group ($p = 0.72$). Most rehospitalisations were caused by viral upper airway infections or gastro-oesophageal reflux. None of the rehospitalisations in the ASH group were due to problems caused by NTF.

Growth between the two groups during follow-up until 3 months corrected age did not significantly differ.

The percentage of mothers who gave breastfeeding during the time their infant was hospitalised did not significantly differ between the ASH and control group: 65% vs 72%, $p = 0.2$.

At the age of three months, these percentages also did not differ significantly: 23% (25/110) in the ASH group, 30% (21/69) in the control group ($p = 0.25$).

Discussion

This study demonstrates that discharge with NTF in premature infants is safe and results in high parental satisfaction rates regarding the procedure.

Compared to a control group of infants admitted to comparable hospitals who do not offer NTF at home as standard of care, the infants are not more frequently readmitted to hospital after discharge, no problems with giving NTF at home were noted.

Median duration of NTF at home was 9 days in the ASH group, so in the study group, admission time was shortened by 9 days. Infants of the control group had a comparable median admission time of 9 days after cessation of monitoring of vital parameters till discharge independent of NTF.

The discharge criteria were unfortunately not completely equal between the ASH and control group hospitals. In these hospitals, infants are discharged after 48–72 h of no

Table 3 Comparison of patient characteristics of the ASH, NHG and MSH infants

	ASH ($N = 113$)	NHG ($N = 66$)	MSH ($N = 37$)	p*
Female	57 (50%)	23 (35%)	19 (51%)	0.10
Caucasian	89 (79%)	53 (84%)	24 (65%)	0.08
Singleton	69 (61%)	52 (79%)	23 (64%)	0.05
Antenatal steroids	62 (56%)	29 (45%)	13 (36%)	0.072
Gestational age (weeks, mean (SD))	32.6 (2.8)	32.8 (2,5)	32.4 (2.5)	0.71
24–29 weeks	16 (14%)	11(17%)	9 (24%)	
30–33 weeks	49 (43%)	26 (39%)	11 (30%)	
34–35 weeks	48 (42%)	29 (44%)	17 (46%)	
Birthweight (grams, mean)	1873 (539)	1934 (522)	1716 (542)	0.14
Apgar 5 min (mean (SD))	8.5 (1.7)	8.8 (1.4)	8.1 (1.7)	0.16
BPD	14 (12%)	3 (5%)	5 (14%)	0.19
IVH	9 (12%)	5 (20%)	2 (6%)	0.29

*Chi-square or One way ANOVA

significant apnoea/bradycardia incidents, in the ASH, this period is longer, 5 days. In the control hospitals, the above-mentioned 9-day median admission time after cessation of monitoring till discharge independent of NTF therefore could be 2–3 days shorter if the same criteria were used. However, if NTF at home was possible in these hospitals, their admission time could also be shortened by about a week.

The advantage of shorter admission time due to discharge with NTF seems most relevant for the older premature infants of 34–35 weeks. Looking at total hospital admission time in the 34–35-week-old infants, the ASH infants had a highly significant shorter admission time of 6 days median. Had NTF at home not been possible, these infants would have had a comparable admission time to the infants in the control group (16 days vs 15 days median). In the moderately preterm infants of 34–35 weeks GA, who form a large group, NTF at home therefore makes earlier discharge by almost a week possible. The differences were not significant in the infants of younger GA.

Although not significant, the ASH infants of 24–29 weeks had a 30-day longer admission time. This might be caused by the fact that no 24–25-week-old children were included in the control group during the study period. However, repeating the analysis without the 24–25-week ASH infants ($n = 4$), admission time was still 13 days longer in the ASH group. This is probably caused by a higher percentage of 26–29 weeks infants with BPD in the ASH than in the control group: 71 vs 46% ($p = 0.02$). Infants with BPD had a longer admission time than infants without BPD: 106 days vs 63 days.

This study did not show a significant difference in the percentage of infants who were breastfed at discharge or at the corrected age of 3 months between the study and control groups. This is in contrast to earlier studies which showed a significant difference in the percentage of infants who were breastfed between an early discharge group and a control group [7, 5, 2, 6]. These studies however did follow the infants for a longer period (4–6 months); it could be that with a longer follow-up period, a difference

Table 4 Comparison of total hospital admission time between the ASH and the control group (NHG and MSH) and of duration of NTF at home in the ASH infants versus hospital admission time for NTF only after cessation of monitoring in the control group

	ASH	NHG and MSH	p*
Total hospital admission time (median, days (range))			
24–29 weeks GA	93 (47–126)	63 (47–142)	0.11
30–33 weeks GA	33 (9–83)	27 (15–67)	0.46
34–35 weeks GA	9 (3–27)	15 (5–53)	< 0.001
Duration of NTF at home/days in hospital for NTF after cessation of monitoring (median, days (95% CI))			
24–29 weeks GA	23 (7.3–38.7)	8 (6.9–9.1)	0.002
30–33 weeks GA	9 (5.1–12.9)	9 (7.0–11.0)	0.36
34–35 weeks GA	7 (5.5.-8.5)	10 (8.9–11.1)	0.03

*logrank test

between the percentage of infants who received breastfeeding would have been noted.

NTF by parents at home can be seen as an ultimate form of family integrated care, which is in the current opinion the best form of neonatal care [7].

Currently, most neonatal intensive care units are turned into single unit rooms, where parents can stay 24 h a day with their prematurely born child. In this way, parents are more closely involved in the care-taking of their child. Parents and medical staff share responsibility for the wellbeing of the child.

In our hospital, after discharge with NTF, care at home was continued by nurses who were familiar with the child and their family. They provided the necessary care for the infant (replacement of tube when necessary, measurements) but also gave guidance to the parents, who found this to be very reassuring.

In conclusion, NTF in premature infants at home is safe, results in high parental satisfaction rates and leads to shorter admission time, particularly in the premature infants of older GA (34–35 weeks). Shorter admission time is not only desirable for parents, but also leads to greater admission capacity and is likely to be financially favourable [6]. Prolonging hospital admission time by on average 9 days in the 123 ASH infants would cost around 266.000 Euros. The home care by the paediatric nurses would cost around 92.000 Euros, resulting in a cost saving of 174.000 Euros.

NTF at home fits within the Dutch vision document Medical Specialist 2025 [4]. This document promotes a change of practice from integrated care to network-based medicine in which the patients/parents take control of their own/their child's health with the help of their relatives and health care workers. This includes looking at which procedures need to be done by medical staff, and which can be done by the patients' network. NTF at home fits into this vision.

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Amerik de Mol: design study, data collection, co-author.
Jacqueline Korstanje: data collection, co-author.
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Gerlinde Stoelhorst: study coordination, data collection, last author.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained.

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