

SHORT COMMUNICATION

Nutrition and Growth

Clinical performance of the infant nutrition early warning score in routine practice across four international clinical settings in Europe: A study by the ESPGHAN special interest group in clinical malnutrition

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Abstract

There is a scarcity of nutritional screening tools for use in infants (<1 year). The infant Nutrition Early Warning Score (iNEWS) has been developed to identify infants who need further dietetic review. We introduced the iNEWS into clinical practice and evaluated its performance in Scotland, Belgium, Athens and Bulgaria. Of the 352 infants screened, 72 (20%) were placed in the high iNEWS category, and of these, 70 (97%) were reviewed by a hospital dietitian. iNEWS produced a true positive rate of 80% which increased to 96% after accounting for anticipated misclassified cases due to prematurity. In Belgium, false positive screens had a shorter length of stay ($p = 0.014$). Otherwise, misclassification was not related to a specific iNEWS component. This study corroborates previous research, underscoring the validity of iNEWS as a dietetic referral tool and demonstrating that it can be integrated into “real-world” clinical practice across international settings with diverse healthcare resources.

KEYWORDS

dietetic referral tool, malnutrition, nutritional screening

1 | INTRODUCTION

Disease can cause malnutrition, which is often under-recognised and untreated in clinical settings. This, in turn, may adversely influence patient outcomes and

development, particularly in infants whose energy demands per kg of mass outnumber those of adults by a factor of three to four.^{1,2} Routine nutritional screening is therefore required at hospital admission to enable early detection and prompt treatment.³

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Several nutritional screening tools (NST) have been developed and tested for use in paediatric populations,⁴⁻⁷ but most of these are unsuitable for infants. The Paediatric Yorkhill Malnutrition Score (PYMS) and the Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP) are only valid for children older than 1 and 2 years, respectively, and while STRONGKIDS was tested in children aged over 1 month and below 18, only 34 children of all ages (median age of participants: 8.7 years) were placed in high risk of undernutrition.^{5,7,8} This suggests the tool was tested only in a very small number of infants, and its performance in this age group is unclear and warrants further testing.⁷ In response to this clinical need, we have previously developed and tested the validity of the infant Nutrition Early Warning Score (iNEWS) in three countries with different dietetic inputs and resources.⁹ The iNEWS was designed for use by nursing staff or junior medical staff, presented high sensitivity and specificity to identify children in need for further dietitian's review and, in addition, identified almost all children with concomitantly low BMI and low-fat stores.⁹ Beyond validity, an important feature of any NST suitable for routine use is to test its performance in "real-world" clinical practice.⁶ Thus far, very few studies have explored this critical aspect for any paediatric NST previously published in the literature.⁶ The aim of this study was to introduce iNEWS into clinical practice and evaluate its performance in four international settings across Europe.

2 | METHODS

The iNEWS is a dietetic referral tool designed to be used primarily by nursing and junior medical staff to screen for nutrition risk in all infants (<1 years) at hospital admission and refer those at high risk for further dietetic review.⁹ Screening components include: (a) healthcare professional's concern for poor weight gain, (b) parental recall of reduced intake for at least the past 5 days, and (c) weight below cutoff values representing the 2nd or 9th centiles on WHO growth charts. Each component bears a score, with a total score of 3.9 or above indicating infants at nutrition risk who need referral and further dietetic assessment (Supporting Information S1: Digital Content 1). The validity of iNEWS was previously published in an international multicentre study against benchmarks of comprehensive nutritional assessment, including body composition.⁹

2.1 | Participants

The introduction of iNEWS in routine clinical practice was piloted in four paediatric hospitals and healthcare

What is New?

- iNEWS has a high predictive validity to detect children who need further dietetic review.
- iNEWS is practical and feasible for routine clinical use across international settings of different dietetic and clinical resource.

What is Known?

- Sick infants may be at risk of malnutrition and need to be early identified and treated.
- The infant Nutrition Early Warning Score (iNEWS) is a valid tool to screen for sick infants who require further dietetic review.

settings across Europe, namely, all medical and surgical specialities except critical care in the Royal Hospital for Children, Glasgow in Scotland, UZ Brussel in Brussels, Belgium, all medical specialities of Agia Sofia Children's Hospital, Athens in Greece and a specialised tertiary centre in paediatric gastrointestinal diseases and nutritional support at St Stilian Medical Setting in Varna, Bulgaria. The selection of hospitals aimed to test the performance of iNEWS in countries with diverse practices and healthcare resources. Hence, the way the clinical performance of iNEWS was evaluated varied across each setting to fit local practice, and the tool was translated into the appropriate languages to support its ease of use. Infants were screened across all sites consecutively (Brussels and Varna) or by convenience sampling (Glasgow and Athens), and no exclusion criteria were applied. In Scotland, nutrition screening was performed by ward nursing staff following training on the use of the tool, in Belgium and in Greece by a ward hospital dietitian and in Bulgaria by a nurse with specialisation in dietetics.

2.2 | Proportion of appropriate referrals

Patients placed in the high iNEWS risk category subsequently had a face-to-face review by a hospital dietitian or in Bulgaria by a medical dietitian consultant, as dietitians do not exist in the hospitals of this country. Assessors have referred only patients who scored at high risk on iNEWS and were asked to classify the referrals as either appropriate or inappropriate, providing a brief explanation for the reason for the inappropriate referrals. The proportion of patients who were deemed to appropriately require further dietetic review after hospital dietetic assessment was used to evaluate the true and false positive rates of the NST. Assessors were hospital healthcare professionals and assessed each high-risk iNEWS referral using their

local routine assessment pathway; in most cases, this included evaluation of anthropometry, growth trajectory, feeding practices, dietary intake and taking into account the patient's clinical scenario.

2.3 | Completion rates

To audit the completion of iNEWS, a measure of tool feasibility, a list of all the infants discharged from the pilot wards in Scotland and Belgium within the pilot period was retrieved retrospectively using the electronic inpatients health records, and the proportion of patients who had an iNEWS form completed was calculated. Differences in demographics and disease characteristics were calculated between patients who had been screened and others who had not. In Bulgaria and in Greece, electronic health records review to determine the proportion of patients who missed screening and gather information about them was not possible.

2.4 | Nursing staff feedback

Nursing staff on the pilot wards in Scotland anonymously completed a short questionnaire comprised of binary (Yes/No) responses. This was to assess whether the staff found the tool useful, easy of use, and how it had impacted their workload.

2.5 | Statistical analysis and ethics

Differences in continuous data between groups were explored with the Kruskal–Wallis or Mann–Whitney *U* test and for categorical the chi-square test was used. Data analysis was conducted with Minitab version 19. Ethical approval was not required in Scotland and Bulgaria since this project was focused on service improvement, which precludes the requirement for ethical clearance.¹⁰ Instead, in Scotland, the study was registered with the Clinical Effectiveness Department of the Royal Hospital for Children, Glasgow. In Athens and Brussels the study was reviewed by the local research ethical committee.

3 | RESULTS

3.1 | Participants

Data were collected between January 2020 and December 2021. For each of the four sites, data collection varied from 6 weeks to 8 months due to pandemic-induced delays in hospital admissions. A total of 352 infants were screened across all four settings (Table 1). Screened patients were from a

variety of medical and surgical specialities, except for Athens, where screening was not introduced in surgical specialities. In Scotland and Belgium, 35 and 31 children missed screening, respectively, providing a completion rate of 71% and 75%, respectively. Infants not screened had a shorter length of stay ($p < 0.01$), were less likely to be premature ($p = 0.02$) and tended to be older ($p = 0.016$). Completion rates could not be assessed in Bulgaria or Greece.

3.2 | Patients with high iNEWS screening

Of the 352 patients screened, 72 patients (20%) were placed in the high iNEWS risk category, and of these, 70 infants (97%) were reviewed by a hospital dietitian (Table 1). The two patients not seen were from the Scotland cohort; this was because infants had been discharged during weekends when dietetic assessment could not be performed.

Half of all the high iNEWS screens seen by the dietitian ($n = 35$) scored positive on the basis of weight below the second centile, of which 13 patients were referred scoring solely on this component (Table 1). In Belgium and Bulgaria, almost all (100% and 99%, respectively) of the high iNEWS risk screens scored positive on the first step (i.e., HCP concern for poor weight gain/loss), and in Belgium, almost half (46%) of their referrals were made by scoring positive on all three steps. In comparison, just over half (52%) of positive Scotland screens scored on step one, and this was similar in Greece (62%).

Of the 70 patients seen by a hospital dietitian, 14 (20%) did not require further dietetic review or input and were classified as false positive referrals. There were seven false positive referrals from the Scotland cohort, three from Belgium, and four from Greece. The Bulgarian cohort did not identify any false positive referrals. Ten of these infants (71%) were premature, scoring positive due to weight being below the second centile, who otherwise had a normal weight when corrected for gestational age. Two other infants were surgical patients who were fasting before surgery; of these two patients, one scored positive solely on a weight below the second centile and the other scored on all three steps. Therefore, 56 out of the 70 patients classified as high risk required further dietetic input, producing a true positive rate of 80% (Table 2). Discounting the 10 premature infants who were anticipated to be misclassified by iNEWS, increased the true positive rate to 93%. Less than half of the false positive screens scored on Step 1 or Step 2 of iNEWS, but most true positive screens (86% and 68%, respectively) scored on these steps (Table 2).

The length of stay between true and false positives was not significantly different in Scotland ($p = 0.409$)

TABLE 1 Demographics, length of stay, and infant Nutrition Early Warning Score (iNEWS) scores of patients admitted to Scotland, Bulgaria, Belgium, and Greece.

Setting	All sites			Scotland			Bulgaria			Belgium			Greece		
	Total screened (n = 352)	Screened positive (n = 70)	Total screened (n = 95)	Screened positive (n = 21)	Total screened (n = 88)	Screened positive (n = 23)	Total screened (n = 99)	Screened positive (n = 13)	Total screened (n = 70)	Screened positive (n = 13)	Total screened (n = 70)	Screened positive (n = 13)			
Male, N (%)	170 (48)	35 (50)	52 (55)	11 (52)	32 (41)	11 (48)	54 (55)	6 (46)	32 (46)	7 (53)					
Medical, N (%)	313 (89)	66 (94)	69 (73)	17 (81)	87 (99)	23 (100)	87 (88)	13 (100)	70 (100)	13 (100)					
Premature, N (%)	55 (16)	27 (39)	25 (26)	11 (52)	17 (19)	7 (30)	8 (8)	5 (38)	5 (7)	4 (30)					
Age (days)	118 (53, 209)	105 (49, 184)	129 (48, 219)	82 (15, 165)	123 (73, 209)	80 (32, 119)	111 (47, 229)	112 (49, 215)	104 (181, 65)	181 (81, 213)					
Length of stay (days)	3 (1, 5)	3 (1, 6)	3 (2, 6)	5 (4, 6)	1 (1, 1)	1 (1, 1)	4 (3, 7)	9 (4, 15)	3 (2, 5)	2 (2, 5)					
iNEWS step 1, N (%)	69 (20)	55 (79)	12 (13)	11 (52)	32 (36)	22 (96)	16 (16)	13 (100)	9 (13)	8 (62)					
iNEWS step 2, N (%)	96 (27)	44 (63)	32 (34)	12 (57)	28 (32)	13 (57)	21 (21)	9 (69)	15 (21)	9 (69)					
iNEWS step 3 (<9th centile), N (%)	32 (9)	15 (21)	9 (9)	0 (0)	10 (11)	9 (39)	7 (7)	3 (23)	6 (9)	3 (23)					
iNEWS step 3 (<2nd centile), N (%)	37 (11)	35 (50)	17 (18)	15 (71)	4 (5)	4 (17)	9 (9)	9 (69)	7 (10)	7 (54)					

Note: Quantitative data are presented with medians (Q1, Q3). iNEWS Step 1: Healthcare professionals concerned about weight gain (scores 1-7). iNEWS Step 2: Reduced intake (including feeds) for at least the past 5 days (scores 2-2). iNEWS Step 3: Infant weight below column A (9th centile) or column B (2nd centile) (scores 2 and 4, respectively).

TABLE 2 Demographics, length of stay, and infant Nutrition Early Warning Score (iNEWS) scores of positive screens in Scotland, Bulgaria, Belgium, and Greece.

Setting	All sites (70)		Scotland (21)		Bulgaria (23)		Belgium (13)		Greece (13)	
	True positive (56)	False positive (14)	True positive (14)	False positive (7)	True positive (23)	False positive (0)	True positive (10)	False positive (3)	True positive (9)	False positive (4)
Male, N (%)	28 (50)	8 (57)	8 (57)	4 (57)	11 (47)	N/A	4 (60)	2 (67)	5 (56)	2 (50)
Medical, N (%)	55 (98)	11 (79)	13 (93)	4 (57)	23 (100)	N/A	10 (100)	3 (100)	9 (100)	4 (100)
Premature N (%)	17 (30)	10 (71)	5 (36)	6 (86)	7	N/A	4 (40)	1 (34)	1 (11)	3 (75)
Age (days)	101 (49, 185)	145 (44, 182)	89 (46, 182)	135 (47, 156)	80 (97)	N/A	149 (227, 49)	46 (36, 157)	180 (81, 261)	183 (65, 205)
Length of stay (days)	2 (0, 6)	4 (2, 6)	5 (7, 3)	6 (4, 6)	1 (0)	N/A	12 (8, 16)	2 (2, 3)	2 (2, 5)	3 (2, 6)
iNEWS Step 1, N (%)	48 (86)	6 (43)	9 (64)	2 (29)	22 (96)	N/A	10 (100)	3 (100)	7 (78)	1 (25)
iNEWS Step 2, N (%)	38 (68)	5 (36)	9 (64)	3 (43)	13 (57)	N/A	9 (90)	3 (100)	7 (78)	2 (50)
iNEWS Step 3 (<9th centile), N (%)	13 (23)	2 (14)	0	0	9 (39)	N/A	2 (20)	1 (33)	2 (22)	1 (25)
iNEWS Step 3 (<2nd centile), N (%)	24 (43)	11 (79)	9 (64)	6 (86)	4 (17)	N/A	7 (70)	2 (67)	4 (44)	3 (75)
Total iNEWS score: 3.9 (%)	13 (23)	8 (14)	0	5 (71)	12 (52)	N/A	0	1 (33)	1 (11)	2 (50)
Total iNEWS score: 4 (%)	9 (16)	3 (5)	7 (50)	1 (14)	2 (9)	N/A	0	0	0	2 (50)
Total iNEWS score: 4.2 (%)	5 (9)	1 (2)	0	0	5 (21)	N/A	0	1 (33)	0	0
Total iNEWS score: 5.7 (%)	5 (9)	0	3 (21)	0	0	N/A	0	0	2 (22)	0
Total iNEWS score: 5.9 (%)	5 (9)	1 (2)	0	0	1 (4)	N/A	1 (10)	1 (33)	3 (33)	0
Total iNEWS score: 6.2 (%)	9 (16)	0	2 (14)	0	2 (9)	N/A	3 (30)	0	2 (22)	0
Total iNEWS score: 7.9 (%)	10 (18)	1 (2)	2 (14)	1 (14)	1 (4)	N/A	6 (60)	0	1 (11)	0

Note: Quantitative data are presented with medians (Q₁, Q₃). iNEWS Step 1: Healthcare professional concerned about weight gain (scores 1-7). iNEWS Step 2: Reduced intake (including feeds) for at least the past 5 days (scores 2-2). iNEWS Step 3: Infant weight below column A (9th centile) or column B (2nd centile) (scores 2 and 4, respectively).

and Greece ($p = 0.758$), whereas in Belgium, false positives had a shorter length of stay ($p = 0.014$); albeit sample size was small. Over a third of high iNEWS screens were premature infants, and the proportions of patients screened positive compared to the total population who were premature was higher in Belgium ($p < 0.001$), Scotland ($p = 0.04$), and Greece ($p < 0.001$) but not in Bulgaria ($p = 0.116$). Nonetheless, there was no significant difference between the proportion of premature infants who were true positives and false positives in Belgium ($p = 0.343$) and Scotland ($p = 0.350$), but there was a higher proportion of false positives in Greece ($p = 0.021$).

Eleven members of the nursing staff who used the tool in Scotland completed the feedback questionnaire. All recognised the importance of nutritional screening in routine clinical practice and 64% felt it facilitated them in their referrals. The tool was easy to use for most (82%), and although it did increase their workload (64%), it was thought to be easy to integrate into their admission procedure (91%).

4 | DISCUSSION

Screening for malnutrition risk is recommended by national and international guidelines, but until recently, an NST for infants was unavailable for use. The findings of this study corroborate previous research, underscoring iNEWS validity as a dietetic referral tool.⁹ Furthermore, we demonstrated that it can be easily integrated into “real-world” routine clinical practice across a variety of international settings.

Although iNEWS was introduced into four hospitals with differing availabilities of staff and resources, it maintained a high completion level across all the sites pre- and post-pandemic, even during the COVID-19 pandemic. This suggests that iNEWS can easily and seamlessly be implemented into hospital wards with minimal support and without overburdening available resources. In Scotland and Belgium, where data were available, very few admitted patients were not screened. These patients tended to have a shorter length of stay, often associated with patients with low risk of malnutrition, and therefore screening may have been missed due to time of admission and quick patient discharge. Patients not screened were also more likely to be older infants and were less likely to be premature at birth. These are characteristics of children associated with a low risk of malnutrition, and we believe that these children suffered from acute, benign conditions bearing a low risk of malnutrition and need for dietetic review.

The screening was compared to a dietitian's routine assessment because no gold standard diagnostic assessment exists. However, this reflects “real world” routine clinical practice where children in a hospital in need of dietetic input would be assessed and

nutritionally managed by a hospital dietitian. The positive predictive validity of the iNEWS tool was very high, suggesting that it identifies children in need of dietetic assessment. However, due to the impact that this would have on hospital dietetic services and the nature of this practice development project, children placed in the low-risk iNEWS category were not seen so the negative predictive value could not be calculated, but the diagnostic performance of iNEWS has been demonstrated elsewhere.⁹

During the pilot, more medical patients compared to surgical were admitted and screened, but data from Scotland and Belgium which admitted both medical and surgical patients, shows that the ratio of high iNEWS screens medical/surgical patients was similar to that of the total screened population, suggesting that this tool works well for both specialties. Two surgical patients in the Scotland cohort were referred but did not require further dietetic input (false positives), but their fasting status highlights the importance of screening early in the admission period. Most of the false positives were premature infants suggesting that the tool over-identifies this group of patients, but this was anticipated, and it does not undermine the tool's quality.⁹ Encompassing prematurity into the tool would have made it too complicated for quick and easy use by nursing or junior nursing staff, and one can argue that reviewing premature patients may be beneficial anyway since this group of patients often requires further nutritional care. Apart from prematurity, we did not identify any iNEWS step, which increased the risk of false positive referrals.

A strength of iNEWS is that it does not require a length measurement to compute the total score without compromising its accuracy, and its components are simple and do not take much time to complete. This makes use of iNEWS quick and practical to use, particularly when measurements of weight are routinely collected at hospital admission for estimation of drug dosage.¹¹ The fact that most of the patients (97%) who were screened as high iNEWS screens were referred and seen by a dietitian meant that the impact on dietetic workload was not too high nor unachievable. Future research should formally explore additional aspects pertinent to the practicality and implementation of iNEWS in routine clinical practice, including focus group interviews with users to identify enablers and barriers of routine use and health economic evaluation.

In conclusion, the data presented here support the good performance of iNEWS in routine clinical practice and across international settings of different dietetic and clinical resources. By extension, the integration of iNEWS into routine clinical practice is likely to enhance infant nutrition assessment and quality of care.

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CONFLICT OF INTEREST STATEMENT

K Gerasimidis reports personal fees from Nutricia-Danone, research grants and personal fees from Nestle Health Science, and personal fees from Dr Falk Pharma, Abbott, Servier, Janssen, Abbvie, Mylan, and Baxter. The rest of the authors declare no conflict of interest.

DISCLAIMER

Although this paper is produced by the ESPGHAN SIG in Clinical Malnutrition, it does not necessarily represent ESPGHAN policy and is not endorsed by ESPGHAN.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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