Promoting the awareness of hospital malnutrition in children: ePINUT 10th anniversary in 2020

Arnaud de Luca, Maya Patel, Olivier Mantha, Noël Peretti, Régis Hankard

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Promouvoir la sensibilisation à la dénutrition chez l'enfant hospitalisé : 10ème anniversaire d'ePINUT en 2020

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Abstract

Objective

The year 2020 marks the 10th consecutive year of the ePINUT study which is used for promoting awareness of hospital malnutrition in paediatric wards. The present article describes the methods and the studied population.

Materials and methods

ePINUT is a cross-sectional study gathering data each year over 2 weeks in March. Any child up to 18 years old, hospitalized except in neonatal and intensive care units could be included in this study. Length of hospitalization, weight variations and height were measured. An online calculator was made available for nutritional indices, in accordance with the French Paediatric Society guidelines (www.epinut.fr). A geographic grouping was done based on university inter-regions.

Results

A total of 13,332 entries in France were included from 2010 to 2019. On a geographic level, 6 of the 7 regions contributed yearly to 10 to 15% of these entries, while the western region accounted for 25% of the entries ($p<0.001$). Ninety-two cities participated, with 36% participating 5 to 9 years, 39% participating 2 to 4 years, and 26% participating once. The median age was 4 years old, 10.2 % of children had a Weight-for-Height z-score smaller than -2 at admittance. These children stayed longer in the hospital (8.3±11.3 vs. 6.4±9.3days, $p=0.02$) and had a greater percent weight change during hospitalization (2.8±4.7 vs. 0.4±3.8%, $p<0.0001$).

Conclusion

Such a long-term promotion of awareness about hospital malnutrition is unique. The future aim is to empower young patients and their parents and to get them involved in reducing hospital malnutrition in children.

Keywords: multidisciplinary nutritional team; survey; wasting; stunting; undernutrition

Résumé

Objectif

L'année 2020 marque la 10ème année consécutive de l'enquête ePINUT qui promeut la sensibilisation à la dénutrition hospitalière en Pédiatrie. Cet article présente la méthode utilisée et la population d'étude.

Matériels et méthodes

ePINUT est une enquête observationnelle, transversale, durant deux semaines, réalisée chaque année en mars. Les critères d'inclusion étaient tout enfant jusqu'à 18 ans, hospitalisé en Pédiatrie excepté en néonatalogie et réanimation. La durée d'hospitalisation, la variation de poids et la taille ont été mesurés. Le calculateur « e-PINUT » (www.epinut.fr) a permis le calcul des index nutritionnels, conformes aux recommandations pour la dénutrition pédiatrique de la Société Française de Pédiatrie. Les régions étaient déterminées par les interrégions universitaires.

Résultats

Les réponses françaises de 2010 à 2019 totalisaient 13 332 entrées. La contribution de la région ouest est de 25%, et de 10 à 15% pour les 6 autres interrégions (p<0,001). Sur la période de 10 ans, 92 villes ont participé à ePINUT. L'âge médian était 4 ans. Les enfants admis avec un rapport poids-pour-taille (Z-P/PAT) <-2ET étaient 10,2% et avaient une durée moyenne de séjour plus longue (8,3±11,3 vs 6,4±9,3 jours, p=0,02). Le pourcentage de changement de poids pendant l'hospitalisation variait plus chez les enfants avec Z-P/PAT<-2ET à l'admission (2,8±4,7 vs 0,4±3,8 % du poids à l'admission, p<0,0001).

Conclusion

Une telle expérience à long terme de sensibilisation à la dénutrition hospitalière est unique. L'objectif est désormais de responsabiliser les jeunes patients et leurs parents et de les impliquer dans la dénutrition chez l'enfant hospitalisé.

Mots clés : équipe nutritionnelle multidisciplinaire ; enquête ; émaciation ; retard de croissance ; dénutrition

1. Introduction

Malnutrition concerns 10 to 15% of hospitalized children in European countries [1–3] but only 50% of cases are diagnosed [4], and receive appropriate nutritional care. Malnutrition is a common issue observed in paediatric medical, surgical and rehabilitation wards. Moreover, malnutrition is a well-known risk factor for poor outcomes and prolonged length of hospital stay [5]. These observations formed the rationale for launching the ePINUT study in 2010, with the aim of raising the awareness of children's malnutrition in paediatric wards. Including paediatric staff in this programme was an opportunity to communicate about good practices when diagnosing undernutrition, the consequences of malnutrition on medical outcomes, and the fundamentals for nutritional care. The diagnostic procedure relied on the 2013 recommendations of the Nutrition Committee of the French Paediatric Society [3].

This article describes the methods and the study population of the ePINUT study.

2. Methods

2.1 Regulatory and ethics

ePINUT study meets the criteria of non-interventional observational research in humans (Art L 1121-1-1 of public health law). ePINUT study (15-984bis) received approval from the Advisory Committee for Data Processing in Health Research (CCTIRS) on March 17th, 2016 (French law on the use of data in medical research: 94-548 on July 1st, 1994. The computer database has also been authorized by the National Commission for Data Protection (CNIL), relating to the declaration of conformity 2034866 on February 13th, 2017.

2.2 Studied Population

Any hospitalized child up to 18 years old could be included in this study. Neonatology units were excluded as premature children are a very specific population and intensive care units were excluded due to important modifications of the hydration status and severity of diseases.

2.3 Data collection

A cross-sectional survey, gathering data over 2 weeks in March of each year, was used to screen for malnutrition in paediatric wards. Data were collected using anonymous electronic case report forms. Participating health professionals were trained by phone teleconferences before each yearly session. Precision of numerical variables was pre-defined: 1 digit for weight in kg, integer for height and head circumference in cm, 1 digit for mid-upper arm circumference and 1 day for length of stay (LOS) (treated as discrete variable). If height measurement was not possible, it was estimated from the knee height [6]. It was up to each centre to ensure that measuring tools were accurate and conditions of use thoroughly followed. Growth standards allowing Z-score calculations were that of Sempé et al. for weight and height [7] and of Rolland-Cachera et al. for BMI [8]. They were those figuring in any child health-book up to 2019. Z-scores were calculated for weight for height (ZWFH) and Body Mass Index (ZBMI) using an online calculator (www.epinut.fr).

Nutritional assessment and anthropometric measurements at discharge were recorded since 2016. Variation of BMI during hospitalization was calculated assuming that height did not change from admittance to discharge. Weight change during hospitalization was the difference between weight at admittance and discharge. LOS was obtained from discharge and admittance dates when available.

Recent growth was recorded since 2017. Only weights and heights measured less than 3 months before admittance for children under 2 years old, less than 6 months before admittance for children under 5 years old and less than 1 year before admittance for older children were used for the calculation of weight and height variation before admittance. Referrals to hospital were recorded as fever, pain, dyspnoea, diarrhoea, injury, scheduled hospitalization and others. The presence of dehydration was also recorded. Medical speciality was defined as medicine ward, surgery wards or rehabilitation centre.

All calculations were performed in accordance with the French Paediatric Society guidelines for paediatric malnutrition using the "e-PINUT" nutritional calculator (www.epinut.fr) (FileMaker Pro Advanced 11 – Apple Inc., Cupertino, CA, USA), labelled as a nutritional tool by the French-speaking Society for Clinical Nutrition and Metabolism.

Only results from French hospitals are presented here.

2.4 Statistics

Participating cities and wards were grouped geographically according to the 7 French university hospital inter-regions (north-western, western, south-western, north-eastern, Rhône-Alpes, Île de France) for further analyses. These pre-existing inter-regions are based on the geographic locations where residents are trained. Subject age groups were defined as 2-year steps from 0 to 17 years. All statistics were performed using RStudio, Version 1.3.1073 and R version 4.0.2. Results are shown as means ± standard deviation and $p<0.05$ was considered significant. Comparisons between categorical variables (sex, ZWFH smaller than -2 at admittance, ZBMI smaller than -2 at admittance, referrals for diarrhoea and dyspnoea) across years and age groups were performed using chi-squared tests and standardized residual (SR) were analysed for post-hoc comparisons considering SR <-2 and >2 significant. Comparisons of quantitative data (LOS and weight variation) across years, age groups, inter-regions, referrals, ZWFH smaller than -2 at admittance and medical specialties) were done using ANOVAs and non-parametric Kruskal-Wallis sum tests. Post-hoc comparisons were done using Tukey Honestly Significant Difference test. A trend in the evolution over the years of the number of entries was assessed using Pearson product-moment correlation coefficient. In order to provide individual city results, a "Data viewer" was developed using RStudio, Shiny and made available online at https://epinut.shinyapps.io/epinutncm/.

3. Results

3.1 Cities and annual variations

ePINUT study totals 13,332 entries in French hospitals, from 2010 to 2019. We excluded data from other countries of the current analysis. Including for cities outside of France, yearly summary statistics for age at admittance and ZWFH are available at https://epinut.shinyapps.io/epinutncm/. There were 128 entries in 2010 (pilot phase), 908 in 2011, a peak at 2323 in 2012, and a decrease leading to 828 entries in 2019, with a significant evolution over the years (Pearson R=-0.81, p=0.01). On a geographic level, 6 of the 7 regions contributed yearly to 10 to 15% of these entries, while the western region accounted for 25% of the entries (Chi-square p<0.001, Figure 1).

Contribution of each region by year is represented in Figure 1. Ninety-two cities participated in the survey at least once, 36 cities participated five to nine times (39%), 32 cities two to four times (35%) and 24 participated once (26%). The sex ratio per year was on average 47.3% female except in 2011 where it was 52.2% female (Chi-square p = 0.004). Percent female was higher in older children (>12 years old) (Chi-square p <0.001).

3.2 Characteristics of the population

Age had a skewed distribution (Figure 2). The median age was four years old, with 36.9 % of children in the [0-2[y age group and 13.1% in the [2-4[y age group. Other 2-years age groups from 4 to 18 years represented 3.8 to 9.2% of the studied population. The [0-2[y group was over-represented in 2015 (43.1% of the population studied that year) while the [12-14[y and [14-16[y age groups were over-represented in 2011, representing respectively 10.6 and 13.8% of the population studied that year (Figure 2).

Concerning pathologies, 11.1% of the studied population had a referral for diarrhoea, with higher frequencies observed in the [0-2[y and the [2-4[y age groups (Chi-square p <0.001, 20.0% and 14.4% with SR of 15.35 and 3.42, respectively). A referral for dyspnoea was observed more frequently in the [0-2[y age group (19,7%) (Chi-square p <0.001, SR = 14.3), while overall 11.3 % of studied children had a referral for dyspnoea. There were more referrals for diarrhoea in 2015 (12.8% of all referrals, Chi-square p<0.001, SR= 2.08).

3.3 Indices of nutritional status

Children with a ZWFH smaller than -2 at admittance represented 10.2 % of the studied population. This proportion was slightly lower in 2012 and higher in 2017 (Chi-square p = 0.02, SR of -2.53 and 2.59, respectively). Children with a ZBMI smaller than -2 at admittance represented on average 13% of the studied population with no significant difference between years (Chi-square p = 0.07).

The proportion of children with a ZWFH smaller than -2 at admittance was higher for the [0-2[y and the [2-4[y age groups (Chi-square p <0.001, SR of 5.92 and 3.78, respectively) and remained when removing referrals for diarrhoea and presence of dehydration from the analysis (Chi-square p <0.001, SR of 3.59 and 3.43, respectively).

The proportion of children with a ZWFH smaller than -2 at admittance was higher in males (11.1 vs. 9.2 %, chi-square p <0.001, SR = 2.43).

3.4 Length of stay

LOS was available in 3,363 children (25%): (6.6±9.6 days). LOS varied significantly with age, nutritional status, referral, and medical speciality.

Comparing age-groups of 2-year intervals, LOS was shorter in younger children of less than 4 years old compared to in the older ones (5.5±7.8 days and 6.6±11.5 days vs 9.8±11.6 days, for the [0-2[y, [2-4[y and [16-18[y groups, respectively, post-hoc tests both p<0.0001). The same results were observed when we removed children hospitalized for diarrhoea or with dehydration (data not shown).

Children admitted with a ZWFH smaller than -2 stayed longer in the hospital compared to children with a ZWFH greater than -2 (8.3±11.3 vs. 6.4±9.3 days, p=0.02). This difference remained significant when the 236 children hospitalized in the rehabilitation centres where removed from the analysis (6.4±8.0 vs. 4.8±6.3 days, p=0.02).

LOS was shorter in children hospitalized for diarrhoea or dyspnoea when compared to any other referral cause (respectively 4.2±6.8 days and 4.0±4.3 days vs. 6.8 ±9.1 days, p <0.0001 with no difference between diarrhoea and dyspnoea.

LOS was greater for children in rehabilitation centres compared to in medical or surgical wards (respectively 24.4 [1-82] vs 4.9[1-71] and 5.8 [1-61] days, p<0.0001) with no difference between medicine and surgery.

3.5 Weight variation

Weight variation during hospitalization was available in 3,363 children (25.3%). Mean weight change was 0.7±4.0 % over LOS and higher in children with a ZWFH smaller than -2 at admittance compared to in children with a ZWFH greater than -2 (2.8±4.7 vs 0.4±3.8 % of weight at admittance, p<0.0001) and the difference remained significant when children with diarrhoea and dehydration were removed from the analysis, 2.4±4.6 vs. 0.3±3.7%, p<0.0001.

4. Discussion

The ePINUT study is a unique long-term study used for promoting the awareness of hospital malnutrition in children. Its population is skewed toward younger children of less than 4 years old. The proportion of children with malnutrition at admittance averaged 10% over the 10 years of the study, a figure consistent with previous observations [1,5,9–11]. Children with lower anthropometric indices of nutritional status were hospitalized longer. The present article focuses on the methods used and describes the studied population.

Strengths of the present study are the large number of observations, the diversity of paediatric wards (i.e., university/general centres, medicine/surgery) and representativity of children hospitalized in France, the consistency of the methods over several years, the yearly training of investigators participating in the study, and the use of a common web interface helping diagnostic standardisation. We have therefore included children up to 18 in order to better reflect the diversity of patients hospitalized in paediatric wards.

Although a large number of patients were included in this study over 10 years, incidence of ZWFH smaller than -2 at admittance cannot be determined because the surveys were not designed to gather fully exhaustive data so that missing patients were not recorded. For this reason, we use proportion or frequency and not incidence when referring to % malnutrition.

Standards for the diagnosis of malnutrition in children have been recently updated and new recommendations have been released as of November 2019 by the French National Health

Authority [10]. Diagnostic procedures require both anthropometric nutritional indices and knowledge about the cause of malnutrition. These guidelines provide updated BMI cut-off values [12] and diagnostic criteria of malnutrition in children for all practitioners. They rely on 2018 French growth standards [13]. The impact on child's malnutrition frequency needs to be assessed but is out of the scope of the present article.

Although observational, the present study provides variables that can be considered as outcome variables in nutrition: LOS and weight change during hospitalisation. LOS and weight variation during hospitalisation are both available as of 2016. LOS is the number of days from admittance to discharge and is treated as a discrete variable in this study. As for weight change during hospitalisation factors such as dehydration and diarrhoea must be considered to differentiate weight loss from other causes than malnutrition. It is worth noting that the [0-2[y group was over-represented in 2015 since investigators were asked to focus on young infants. Diarrhoea was thus more frequent that same year. Acknowledging the limits of our study is crucial for future investigations on nutritional assessment in children that will use the data gathered.

The contribution to study data was balanced across French regions, except for western France that accounts for about twice as much as the other regions. The study was initiated there, which explains the high and persistent contribution of participating centres in this region. It is noteworthy that the number of cities involved, 92, is not fully representative of the extent of this study because, for some cities, several hospitals were involved. ePINUT has been conducted outside of France (Belgium, Canada, Colombia, Democratic Republic of Congo, Morocco, Togo, Tunisia). In order to present homogenous population data, we decided not to present these results here. Population characteristics, diseases leading to hospitalisation and many other factors such as malnutrition diagnosis definition [14] differ from what is observed in the French population. Moreover, the small sample size for some countries makes comparisons across countries less relevant.

The number of yearly inclusions increased exponentially from the pilot study in 2010 to 2012, and remained stable for several years, then decreased over the last years. Maintaining participation from participating centres was difficult. It was facilitated by leading new focuses each year on different groups of patients (babies, surgery, rehabilitation, cardiology), or on in-depth diagnostic aspects such as weight variation during hospitalisation and weight measures before admission. Requesting participation from all health professionals involved in nutritional care helped us maintain the enthusiasm of participating centres. Involvement of societies such as the French-speaking Society for Clinical Nutrition and Metabolism, and annual communication of results through scientific/medical congresses and general communication and lobbying are mandatory to improve the diagnostic and the care of hospital malnutrition.

To our knowledge ePINUT is the only nutritional study in paediatrics of such a duration and cohort size. The data gathered will be valuable for addressing many questions in paediatric nutrition related to, for instance, hospital nutritional assessment, standards of nutritional care and the evaluation of nutritional strategies. Standardized outcome variables in paediatric nutrition clinical research are lacking. Making studies more easily comparable remains challenging. After ten years we must now push toward new frontiers. The next step will be to empower more patients and parents to be actors of their own health and that of the child.

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Conflict of Interest

R.H., A.DL. declare research support from Nutricia, Advanced Medical Nutrition (logistics of the survey). None of the other authors declare any conflict of interest regarding the present survey.

Authorship

ADL, RH carried out the studies and data analyses and drafted the manuscript.

ADL, RH participated in the design of the study.

ADL, RH performed the statistical analysis.

ADL, RH conceived the study, and participated in its coordination and helped to draft the manuscript.

MP, OLM, NP contributed to data interpretation and revised final manuscript

All authors read and approved the final manuscript.

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Legends

Figures

Figure 1: Mosaic-graph-1. Contribution of each university-hospital region by year

Legend: Colors figure the standardized residuals of contingency table. Values over 2 or below -2 indicate significant deviation from predicted values (Chi-square test <10-5)

IDF: Ile-de-France, NE: North-East, NW: North-West, RA: Rhone-Alpes, S: South, SW: South-West, W: West

Figure 2: Mosaic-graph-2. Age groups by year in the ePINUT population

Legend: Colors figure the standardized residuals of contingency table. Values over 2 or below -2 indicate significant deviation from predicted values (Chi-square test <10-5)

Table

Legend: IDF: Ile-de-France, NE: North-East, NW: North-West, RA: Rhone-Alpes, S: South, SW: South-West, W: West

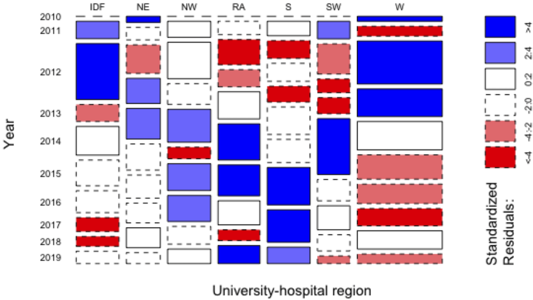
Table

Table: Contribution to ePINUT by city and university-hospital region grouping

City	**Number**	Region
Albi	55	SW
Amiens	475	NE
Angers	254	W
Angoulême	151	W
Annecy	198	RA
Antibes	17	S
Argenteuil	13	IdF
Auch	19	SW
Auxerre	72	NE
Basse-Terre	50	SW
Belfort	143	NE
Besançon	172	NE
Béziers	32	SW
Blois	157	W
Bordeaux	134	SW
Brest	70	W
Brolles	18	IdF
Bullion	202	IdF
Caen	354	NE
Cahors	20	SW
Cannes	62	S
Carcassonne	60	SW
Castres	20	SW
Cayenne	54	SW
Chambéry	136	RA
Charleville-Mezières	28	NE
Chartres	58	W
Cholet	99	W
Clermont-Ferrand	156	RA
Clichy	14	IdF
Dijon	186	NE
Dreux	62	W
Eaubonne	59	IdF
Firminy	20	RA
Foix	6	SW
Francheville	20	RA
Gonesse	21	IdF
Grenoble	249	RA
Kourou	20	SW

La Rochelle	238	W
Lagny	43	IdF
Laval	17	W
Le Havre	79	NE
Le Mans	58	W
Lille	589	NE
Limoges	139	SW
Lyon	583	RA
Margency	237	IdF
Marseille	960	S
Meaux	18	IdF
Metz	102	NE
Mont-de-Marsan	36	SW
Montauban	21	SW
Montpellier	411	SW
Montreuil	73	IdF
Mulhouse	11	NE
Nancy	133	NE
Nantes	313	W
Nice	77	S
Nîmes	103	SW
Niort	53	W
Noumea	51	SW
Orléans	57	W
Paris	975	IdF
Pau	48	SW
Perpignan	50	SW
Pointe-à-Pitre	75	SW
Poitiers	623	W
Quimper	61	W
Reims	47	NE
Rennes	261	W
Rodez	18	SW
Roubaix	140	NE
Rouen	148	NE
Saintes	154	W
St Brieuc	58	W
St Denis de la Réunion	213	SW
St Etienne	372	RA
St Laurent du Maroni Guyane	5	SW
St Martin Réunion	13	SW
St Maurice	13	Idf
St Nazaire	148	W

St Paul de la Réunion	21	SW
St Pierre de la Réunion	36	SW
St Trojan	115	W
Strasbourg	424	NE
Tarbes	19	SW
Toulouse	275	SW
Tours	495	W
Troyes	87	NE
Vannes	15	W
Villejuif	85	IdF
Grand total	**13332**	



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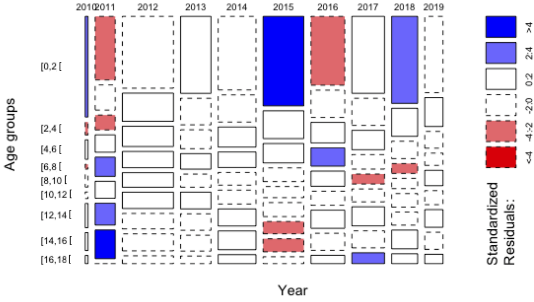
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