

## REPRODUCIBILITY AND APPLICABILITY OF A PEDIATRIC SCORE OF CLINICAL DETERIORATION WARNING

REPRODUTIBILIDADE E APLICABILIDADE DE UM ESCORE PEDIÁTRICO DE ALERTA DE DETERIORAÇÃO CLÍNICA

REPRODUCIBILIDAD Y APLICABILIDAD DE UNA ESCALA PEDIÁTRICA DE ALERTA DE DETERIORO CLÍNICO

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### ABSTRACT

**Object:** to measure the reproducibility and applicability of the Brighton Pediatric Early Warning Score to the Brazilian context (BPEWS-Br) in order to detect clinical deterioration. **Method:** a study to test the performance of BPEWS-Br regarding its reproducibility and applicability. Two trained nurses randomly assigned a score to 50 children from zero to 10 years old with a three to five minute interval between evaluations. To verify the applicability, nurses timed the score assignment. Data were processed in SPSS and VassarStats.net. Reproducibility was measured by simple Kappa and weighted Kappa score. The mean was calculated regarding the time of the score. **Results:** simple Kappa was 0.85 and weighted Kappa was 0.80. The average time required for the nurses to evaluate and use BPEWS-Br was 4.14 and 3.48 minutes. **Conclusion:** BPEWS-Br proved to be reliable and feasible to recognize warning signs of clinical deterioration in the children studied.

**Keywords:** Reproducibility of Results; Feasibility Studies; Child, Hospitalized; Pediatric Nursing.

### RESUMO

**Objetivo:** medir a reprodutibilidade e aplicabilidade do Brighton Paediatric Early Warning Score para o contexto brasileiro (BPEWS-Br) no reconhecimento da deterioração clínica. **Método:** estudo para testar o desempenho do BPEWS-Br quanto à sua reprodutibilidade e aplicabilidade. Duas enfermeiras treinadas aplicaram o escore em 50 crianças de zero a 10 anos de forma cega com intervalo de três a cinco minutos entre as avaliações. Para verificar a aplicabilidade as enfermeiras mensuraram o tempo de aplicação do escore. Os dados foram processados no SPSS e VassarStats.net. A reprodutibilidade foi medida pelos índices Kappa simples e ponderado. Para o tempo de aplicação calculou-se a média. **Resultados:** o Kappa simples foi 0,85 e o Kappa ponderado, 0,80. Os tempos médios para avaliação e aplicação do BPEWS-Br pelas enfermeiras foram de 4,14 e 3,48 minutos. **Conclusão:** o BPEWS-Br mostrou-se confiável e viável para reconhecer sinais de alerta de deterioração clínica nas crianças estudadas.

**Palavras-chave:** Reprodutibilidade dos Testes; Estudos de Viabilidade; Criança Hospitalizada; Enfermagem Pediátrica.

### RESUMEN

**Objetivo:** medir la reprodutibilidad y aplicabilidad del Brighton Paediatric Early Warning Score para el contexto brasileño (BPEWS-Br) en el reconocimiento del deterioro clínico. **Método:** estudio para medir el desempeño del BPEWS-Br en cuanto a su reprodutibilidad y aplicabilidad. Dos enfermeras capacitadas aplicaron la escala a ciegos en 50 niños de 0 a 10 años con intervalo de 3 a 5 minutos entre las evaluaciones. Para verificar la aplicabilidad, las enfermeras midieron el tiempo de aplicación de la escala. Los datos se procesaron en SPSS y VassarStats. Net. La reprodutibilidad se midió por los índices Kappa simple y ponderado. Para el tiempo de aplicación se calculó el promedio. **Resultados:** el índice Kappa simple fue 0,85 y el Kappa ponderado 0,80. Los tiempos promedio para evaluación y aplicación del BPEWS-Br por las enfermeras fueron 4,14 y 3,48 minutos. **Conclusión:** el BPEWS-Br se mostró confiable y viable para reconocer señales de alerta de deterioro clínico en los niños estudiados.

**Palabras clave:** Reprodutibilidad de los Resultados; Estudios de Factibilidad; Niño Hospitalizado; Enfermería Pediátrica.

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## INTRODUCTION

The Pediatric Early Warning Scores (PEWS) are tools developed to assist in the early detection of deterioration of the clinical conditions of hospitalized children that are under observation of the health team,<sup>1</sup> in order to provide immediate assistance. Since 2005, many PEWS have been published in the international literature, and among them stands out the Brighton Pediatric Early Warning Score (BPEWS).

The BPEWS or Monaghan PEWS, as it is also known, is basically based on the assessment of neurological, cardiovascular, and respiratory signs of the child. It ranges from zero to 13 points and its minimum score for the risk of clinical deterioration is three points.<sup>2</sup> The clinical indicators that compose the instrument are: the child's spontaneous neurological response or neurological response to stimuli, skin color, capillary refill time (CRT), heart rate (HR), respiratory rate (RR), use of accessory muscles, need for oxygen support or nebulization, and post-surgical vomiting.

This instrument was described as valid and reliable to identify signs of clinical deterioration in hospitalized children in non-Brazilian contexts.<sup>3,7</sup> It is a simple, fast-paced score that evaluates clinical criteria in the child.<sup>2,6</sup> These are characteristics that should be considered for its use in the Brazilian hospital environment, especially in the public sector, whose human, material, and technological resources deficit is a reality.<sup>8</sup>

The BPEWS was translated, adapted,<sup>9</sup> and validated<sup>10</sup> to the Brazilian context in 2016, being necessary to verify its reproducibility and applicability in the detection of clinical deterioration in children. Reproducibility or reliability is defined as the ability of a test to show consistent results, performed independently, under the same conditions,<sup>11,12</sup> being one of the properties required for adopting a measurement tool in the health care.

In addition to validity and reliability, another important feature of PEWS is the time taken for its use, considering that it should not generate extra work for the nursing team,<sup>2,3</sup> especially in units where there is work overload.

Thus, the article aimed to measure the reproducibility and applicability of the Brighton Pediatric Early Warning Score to the Brazilian context (BPEWS-Br) in order to detect clinical deterioration.

## METHOD

This is a study to measure the performance of a diagnostic test conducted to test the inter-rater reproducibility and applicability (time of use) of the translated and adapted version of the Brighton Pediatric Early Warning Score to the Brazilian context (BPEWS-Br).

Fifty children with ages ranging from zero to 10 years old participated in the study and were randomly selected; they were hospitalized in a pediatric referral hospital located in the municipality of *Feira de Santana*, a city with approximately 600 thousand inhabitants in the countryside of *Bahia*, Brazil. A sample of 50 children was chosen in order to verify the reliability of BPEWS-Br, and other studies adopted similar samples.<sup>3,13</sup>

Inclusion criteria were: children aged zero to 10 years old, hospitalized in clinic-surgical wards and emergency observation/stabilization units, regardless of length of hospital stay. Exclusion criteria were: age  $\geq 11$  years old, medical discharge prescribed in medical records, children with heart disease, hospitalized at the Oncology unit and/or in isolation.

Children with heart disease were excluded because already exists in the international literature a proposed scale for this population.<sup>13</sup> The children of the Oncology unit and in isolation were excluded because they were under treatment, with restricted manipulation due to low immunity and risk of cross infection during data collection.

Table 1 - Translated, adapted, and validated version of the Brighton Pediatric Early Warning Score to the Brazilian context

Components	0	1	2	3	Partial Score
Neurological	Active	Sleepy / hypoactive	Irritable	Lethargic/confused or reduced response to pain	
Cardiovascular	Pink or CRT 1-2 sec	Pale or CRT 3 sec or HF above the upper limit for the age.	Mottled or CRT 4 sec or HF $\geq 20$ bpm above the upper limit for the age.	Grey/cyanotic or CRT $\geq 5$ sec or HR $\geq 30$ bpm above the upper limit for the age or bradycardia for the age	
Respiratory	Normal HR for the age, no retraction	HR above the upper limit for the age, using accessory muscles or $\text{FiO}_2 \geq 30\%$ or 4 liters/min of $\text{O}_2$ .	HR $\geq 20$ bpm above the upper limit for the age; subcostal, intercostal, and furcula retraction or $\text{FiO}_2 \geq 40\%$ or 6 liters/min of $\text{O}_2$ .	HR $\leq 5$ bpm below the upper limit for the age; subcostal, intercostal, furcula, and sternum retraction and moaning or $\text{FiO}_2 \geq 50\%$ or 8 liters/min of $\text{O}_2$ .	
Add 2 extra points if there was nebulization for up to 15 minutes or persistent vomiting after the surgery					
<b>FINAL SCORE</b>					

Fonte: Miranda JOF *et al.*<sup>9</sup>

To test the inter-rater reliability of BPEWS-Br, two nurses, specialists in Pediatrics, were properly trained. They answered a pre-test on clinical evaluation of critically ill children and the use of pediatric early warning scores to detect clinical deterioration, achieving 50%. Then they underwent a theoretical and practical training with the same themes organized in five meetings. After the training, the nurses answered the post-test and achieved 90%.

As a strategy to calibrate the measurements in the training phase, the nurses, together with the responsible researcher, read and discussed the operational manual created to systematize the evaluation criteria for children and the use of BPEWS-Br. The score was then assigned by the two nurses in a pilot test with 10 children and the remaining doubts were answered.

After the training phase, data were collected on 50 children. Two instruments were used: BPEWS-Br and the instrument for collection of identification, socio-demographic and clinical data. The BPEWS-Br variables have a discrete categorical, ordinal, and interval nature, collected from the clinical examination of the child by the nurses. The identification, socio-demographic, and clinical variables of the children were categorical and nominal and were collected from medical record data and data provided by the parents or guardians.

The BPEWS-Br was randomly assigned with an interval of three to five minutes between the nurses' evaluations. The period spent in the BPEWS-Br was timed by the nurses in order to evaluate the applicability of the score.

Based on the study that verified the accuracy/validity of BPEWS-Br,<sup>10</sup> the score  $\geq 3$  was defined to determine signs of clinical deterioration. In these cases, the on-call nurse was advised to evaluate and proceed according to the routine of the service.

It is important to note that inter-rater reliability depends on accurate operational definitions of variables measured and observers trained to use the instrument. The agreement between independent observers when applying the scoring criteria is the most important factor.<sup>12</sup>

The collected data were accounted and analyzed in SPSS, version 9.0 for Windows, and in VassarStats.net. For variables related to the characterization of the sample studied, the absolute and relative frequencies were calculated. For the time required for assigning the BPEWS-Br, the average was calculated.

In order to verify the reproducibility of BPEWS-Br, the children were categorized into two groups (scores  $\leq 2$  and  $\geq 3$ ) and the simple Kappa index was calculated, since its use is recommended for scales with nominal variables. To calculate the weighted Kappa index, indicated for scales with ordinal variables, the scores from zero to 13 of the final score, and from zero to three of the partial scores, were kept. The weighted Kappa is important when the weight of the first mismatch should be lower than the second, and so on,<sup>14</sup> the specific case of BPEWS-Br.

For evaluation of the Kappa index, reference criteria proposed for interpretation of the agreement level was adopted:  $< 0.00$  (poor),  $0.00-0.20$  (slight),  $0.21-0.40$  (fair),  $0.41-0.60$  (moderate),  $0.61-0.80$  (substantial),  $0.81-1.00$  (almost perfect).<sup>15</sup>

## DATA ARE PRESENTED IN TABLES.

Following the ethical questions of research with children, the parents/guardians were submitted to the application of the free and informed consent and, children  $> 6$  years old, to the Consent to Treatment. The research was approved by the *Comitê de Ética da Escola de Enfermagem* of Nursing of the *Universidade Federal da Bahia*, Brazil, registered in the *Comissão Nacional de Ética em Pesquisa* under opinion number 964.177 and the Certificate of Presentation for Ethical Consideration (CAAE – “*Certificado de Apresentação para Consideração Ética*”, in Portuguese language) 40030314.7.0000.5531.

## RESULTS

### CHARACTERIZATION OF THE SAMPLE

The characterization of the socio-demographic and the clinical profile of the 50 children evaluated in the study is described in Table 2. Regarding socio-demographic data, the majority were  $< 6$  years old (66%), brown or black (82%), as declared by the accompanying persons, with income  $< 1$  minimum wage, which reflects a socially vulnerable population, a common characteristic of the population assisted in the Brazilian public services. Regarding the clinical profile, 84% were hospitalized for clinical reasons, 52% were hospitalized for 15 days or more, and 44% had a history of previous hospitalization.

Table 2 - Distribution of the socio-demographic and clinical characteristics of the children evaluated. *Feira de Santana, Bahia, Brazil, 2015*

Socio-demographic and clinical characteristics(n=50)	N	%
<b>Age group (years)</b>		
6 to 10	17	34
3 to 5	9	18
1 to 2	10	20
$< 1$	14	28
<b>Race</b>		
Caucasian	9	18
Black/brown	41	82
<b>Income (minimum wages)</b>		
2 to 4	3	6
1 to less than 2	6	12
Less than 1	41	82

Continue...

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Table 2 - Distribution of the socio-demographic and clinical characteristics of the children evaluated. *Feira de Santana, Bahia, Brazil, 2015*

Socio-demographic and clinical characteristics(n=50)	N	%
<b>Diagnoses of hospitalization*</b>		
Clinical	42	84
Surgical	8	16
<b>Comorbidity</b>		
Does not have	31	62
Had	19	38
<b>Hospitalization period (days)</b>		
< 7	21	42
7 to 14	3	6
≥ 15	26	52
<b>History of previous hospitalization</b>		
No	28	56
Yes	22	44

According to Table 3, the coefficients of agreement of the final scores among the nurses' evaluations were 0.85 (simple Kappa) and 0.80 (weighted Kappa). The interpretation of the simple Kappa coefficient showed an almost perfect agreement (0.81-1.00). On the other hand the weighted Kappa showed substantial agreement (0.61-0.80).<sup>14</sup>

As for partial neurological, cardiovascular, and respiratory scores, the coefficients were 1.00, 0.54, and 0.93(weighted Kappa), respectively. Thus, the agreement measures calculated by the weighted Kappa were perfect (1.00) regarding the neurological score, moderate (0.41-0.60) regarding the cardiovascular score, and almost perfect (0.81-0.99) regarding the respiratory score.

The classification of the evaluated children and the average time of use of BPEWS-Br according to the final scores calculated by the nurses are described in Table 4. Nurses 1 and 2 identified, respectively, that 3 (6%) and 4 (8%) of the 50 children evaluated were showing warning signs.

The average time during which the nurses used the BPEWS-Br was 4.14 minutes and 3.48 minutes, with a minimum time of two minutes and a maximum of six. The nurses needed

more time to evaluate and use the BPEWS-Br in children with a final score ≥ 3 (5 and 4.25 minutes) in comparison with children with a score ≤ 2 (4.09 and 3.41 minutes), thus the time seemed to vary according to the final score.

Table 4 - Distribution of the number of children and the average time of evaluation and use of BPEWS-Br\* pursuant to the final scores calculated by nurses 1 and 2. *Feira de Santana, Bahia, Brazil, 2015*

Final score of nurse 1	N	%	Average time (minutes)	SD†
≤ 2	47	94	4.09	1.12
≥ 3	3	6	5.00	0.00
Final score of nurse 2	N	%	Average time (minutes)	SD†
≤ 2	46	92	3.41	0.884
≥ 3	4	8	4.25	0.957

\* Brighton Pediatric Early Warning Score. † Standard Deviation.

## DISCUSSION

### RELIABILITY OF BPEWS-BR

Some studies that measured the interobserver reliability of adapted/modified BPEWS versions found good agreement indicators and considered the score to be reliable.

The first study that evaluated the use of an adapted version of BPEWS for detection of clinical deterioration in hospitalized children measured its reliability between two nurses. They assigned the score independently in 55 patients with a few minutes interval. The intraclass correlation coefficient was 0.92, evidencing a high interobserver reliability.<sup>15</sup>

Another study examined the psychometric properties of the Texas Children's Hospital Pediatric Advanced Warning Score (TCH PAWS) as an indicator of clinical deterioration in 150 infants and children. The TCH PAWS is an instrument modified from an adapted version of BPEWS. For the calculation of interobserver reliability, two nurses evaluated the patients and assigned the score at the same time. The agreement measure calculated by the intraclass correlation coefficient was 0.74, and the TCH PAWS was considered reliable.<sup>16</sup>

Table 3 - Agreement indicators of the use of BPEWS-Br\* among nurses 1 and 2. *Feira de Santana, Bahia, Brazil, 2015*

Scores	Simple Kappa	CI 95%†	Weighted Kappa	CI 95%†
Final score	0.85	0.55-1.00	0.80	0.55-1.00
Neurological partial score	–	–	1.00	1.00-1.00
Cardiovascular partial score	–	–	0.54	0.30-0.76
Respiratory partial score	–	–	0.93	0.85-1.00

\* Brighton Pediatric Early Warning Score. †Confidence Interval of 95%.

By modifying BPEWS for use in children with heart disease aiming at validating the Cardiac Children's Hospital Early Warning Score (C-CHEWS) tool in order to identify clinical deterioration in hospitalized pediatric patients with heart disease, the study measured the interobserver reliability in a sample of 37 children. An agreement was found among the scores in 67% of the times, with Kappa of 0.50, which is considered moderate. However, when the score was categorized and classified as  $\geq 3$  (the first cut-off point in the C-CHEWS algorithm that triggers a response) and  $\leq 2$ , the scores matched 100% of the times, with Kappa of 1.00 (perfect).<sup>13</sup>

With the purpose of exploring whether BPEWS assigned to children in the emergency could predict the need for ICU hospitalization or clinical deterioration in hospitalized patients, a study also found its inter-rater reliability, finding a ICC of 0.91, considered excellent.<sup>17</sup>

In this study, a perfect agreement was found for the neurological score and almost perfect for the respiratory score. However, for the cardiovascular score, the agreement was moderate. These data may be related to measurement of capillary refill time (CRT), since this was the clinical sign that varied the most in the evaluation of the nurses.

The CRT, measured in seconds, consists in the time it takes for a distal capillary bed to recover its color after sufficient pressure is applied to cause bleaching. It can be measured by different techniques, and its result is susceptible to certain factors such as age, ambient, skin, and body temperature, lighting, as well as duration, quantity, and place of application of pressure.<sup>18</sup> The study that investigated the graduation of CRT by a group of nine nursing assistants and 37 nurses revealed that the value of Kappa for normality was 0.56 and the intraclass correlation coefficient was 0.62. In view of these results, the authors concluded that CRT should be used with caution in clinical practice.<sup>19</sup>

Based on the data from this study and the final score agreement, BPEWS-Br proved to be a reliable instrument for detection of warning signs of clinical deterioration among the children studied.

### TIME INTERVAL OF BPEWS-BR

The time required to assign the BPEWS was described by its author in the original study of the score. The time it took to calculate the score was 30 seconds from a standard set of observations, which time was reduced as the nurse became familiar with the scoring system.<sup>2</sup>

It should be noted that in this study the vital data necessary for assigning the score (respiratory and cardiac frequencies) were measured at the time of the evaluation, even if some child was monitored, which required more time to evalu-

ate and use the instrument. Thus, if the use of BPEWS-Br was linked to control of vital signs, a routine already established in the hospitalization units, the average time spent evaluating and assigning the score could have been reduced.

Early warning scoring systems, because of their objectivity and ease of use (about 15-20 seconds), helped to increase confidence in nurses to detect children with risk of deterioration.<sup>16</sup> In addition, the use of early warning instruments promotes fast and efficient communication among nurses, physicians, and the health team.<sup>20</sup>

No studies were found that reported the total average time spent evaluating children and assigning the score. However, this is a prerequisite that needs to be considered. The BPEWS was chosen by some researchers, who considered it an instrument easily adaptable to the assistant nursing workflow,<sup>4</sup> and can be assigned quickly and accurately by nurses with work overload in emergency units.<sup>17</sup>

The authors suggested some standards for selection and use of a PEWS: validity; ease of use; practicality; generalization for any kind of child care; incorporation of other observations and assessment scales. In addition, a PEWS must be properly taught to nurses prior to its implementation so that it can strengthen professional relationships and communication.<sup>21</sup>

This study provides evidence on the reproducibility and applicability of BPEWS-Br in a Brazilian context. Few studies using BPEWS presented detailed description of the process followed by its reliability measure, and few researches described the time required for this score application.

The training for assignment of alert scores should be guided by well-designed operational protocols. The measurement of the clinical criteria of the score needs to be well standardized and thoroughly known by the professionals who will assign it, so that their values are similar and do not generate very distant interpretations. Both the well-executed training and the involvement of the health team in the use of a PEWS are important prerequisites for the success of its implementation and possible impact on the service.

### CONCLUSION

The adoption of a PEWS involves important criteria that not only validity and reproducibility, such as ease of use, practicality, and training. This study intended to follow these criteria.

Based on the BPEWS-Br clinical parameters, the accuracy already described in another research, and its reproducibility indicators and average time of application found in this study, it can be considered a valid, reliable, and feasible instrument to measure clinical deterioration in hospitalized children, which help to stimulate its use in pediatric hospital services throughout the country.

This is still the first research on the reproducibility of BPEWS-Br in the Brazilian scenario, which show the need for other studies to strengthen the evidence so that this score can be used.

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## REFERENCES

1. Seear M. PEW scores: what are they good for? *Arch Dis Child*. 2016[cited 2017 Sept 18];101:627. Available from: <http://adc.bmj.com/content/101/7/627>.
2. Monaghan A. Detecting and managing deterioration in children. *Paediatr Nurs*. 2005[cited 2017 Jan 18];17(1):32–5. Available from: <http://journals.rcni.com/doi/pdfplus/10.7748/ paed2005.02.17.1.32.c964>
3. Tucker KM, Brewer TL, Baker RB, Demeritt B, Vossmeier MT. Prospective evaluation of a pediatric inpatient early warning scoring system. *J Spec Pediatr Nurs*. 2009[cited 2017 Jan 18];14(2):79–85. Available from: <http://onlinelibrary.wiley.com/doi/10.1111/j.1744-6155.2008.00178.x/epdf>.
4. Randhawa S, Roberts-Turner R, Woronick K, DuVal J. Implementing and sustaining evidence-based nursing practice to reduce pediatric cardiopulmonary arrest. *West J Nurs Res*. 2011[cited 2017 Apr 18];33(3):443–56. Available from: <http://wjn.sagepub.com/content/33/3/443.long>
5. Skaletzky SM, Raszynski A, Totapally BR. Validation of a modified pediatric early warning system score: a retrospective case-control study. *Clin Pediatr*. 2012[cited 2017 Feb 18];51(5):431–5. Available from: <http://cpj.sagepub.com/content/51/5/431.long>
6. Brady PW, Muething S, Kotagal U, Ashby M, Gallagher R, Hall D, et al. Improving situation awareness to reduce unrecognized clinical deterioration and serious safety events. *Pediatrics*. 2012[cited 2017 Mar 18];131(1):e298–308. Available from: <http://pediatrics.aappublications.org/content/131/1/e298.long>
7. Solevåg AL, Eggen EH, Schröder J, Nakstad B. Use of a modified pediatric early warning score in a department of pediatric and adolescent medicine. *PLoS One*. 2013[cited 2017 Mar 18];8(8):e72534. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3753259/?tool=pmcentrez>
8. Miranda J, Camargo C, Sobrinho C, Portela D, Monaghan A. Deterioração clínica em crianças hospitalizadas: revisão integrativa de um escore pediátrico de alerta precoce. *Rev Enferm UFPE*. 2016[cited 2017 Sept 18];10(3):1128–36. Available from: <http://www.scielo.br/pdf/reben/v69n5/0034-7167-reben-69-05-0888.pdf>
9. Miranda JOF, Camargo CL, Nascimento CLS, Portela DS, Monaghan A, Freitas KS, et al. Translation and adaptation of a pediatric early warning score. *Rev Bras Enferm*. 2016[cited 2017 Aug 18];69(5):833–41. Available from: <http://www.scielo.br/pdf/reben/v69n5/0034-7167-reben-69-05-0888.pdf>
10. Miranda JOF, Camargo CL, Sobrinho CLN, Portela DS, Monaghan A. Accuracy of a pediatric early warning score in the recognition of clinical deterioration. *Rev Latino-Am Enferm*. 2017[cited 2017 Nov 18];25:e2912. Available from: [http://www.scielo.br/pdf/rlae/v25/pt\\_0104-1169-rlae-25-e2912.pdf](http://www.scielo.br/pdf/rlae/v25/pt_0104-1169-rlae-25-e2912.pdf)
11. Fletcher RH, Fletcher SW, Fletcher GS. *Epidemiologia clínica: elementos essenciais*. 5ª ed. Porto Alegre: Artmed; 2014. 296 p.
12. Kimberlin CL, Winterstein AG. Validity and reliability of measurement instruments used in research. *Am J Heal Pharm*. 2008[cited 2017 Jan 18];65(1). Available from: <http://www.ashpfoundation.org/FundamentalsKimberlinArticle>
13. Mclellan MC, Gauvreau K, Connor JA. Validation of the cardiac children's hospital early warning score: An early warning scoring tool to prevent cardiopulmonary arrests in children with heart disease. *Congenit Heart Dis*. 2014[cited 2017 Mar 18];9(3):194–202. Available from: <http://onlinelibrary.wiley.com/doi/10.1111/chd.12132/pdf>
14. Ministério da Saúde (BR). Secretaria de Políticas de Saúde. Departamento de Atenção Básica. Projeto SB2000: condições de saúde bucal da população brasileira no ano 2000: manual de calibração de examinadores. Brasília: Ministério da Saúde; 2001.
15. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977[cited 2017 Jan 18];33(1):159–74. Available from: <http://www.jstor.org/stable/pdf/2529310.pdf?acceptTC=true>
16. Bell D, Mac A, Ochoa Y, Gordon M, Gregurich MA, Taylor T. The texas children's hospital pediatric advanced warning score as a predictor of clinical deterioration in hospitalized infants and children: a modification of the pews tool. *J Pediatr Nurs*. 2013[cited 2017 Apr 18];28(6):e2–9. Available from: <http://www.sciencedirect.com/science/article/pii/S0882596313001565>
17. Gold DL, Mihalov LK, Cohen DM. Evaluating the Pediatric Early Warning Score (PEWS) system for admitted patients in the pediatric emergency department. *Acad Emerg Med*. 2014[cited 2017 Mar 18];21(11):1249–56. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4300231/pdf/nihms-654089.pdf>
18. Pickard A, Karlen W, Ansermino JM. Capillary refill time: is it still a useful clinical sign? *Anesth Analg*. 2011[cited 2017 Jan 18];113(1):120–3. Available from: [http://journals.lww.com/anesthesia-analgesia/Abstract/2011/07000/Capillary\\_Refill\\_Time\\_\\_\\_Is\\_It\\_Still\\_a\\_Useful.21.aspx](http://journals.lww.com/anesthesia-analgesia/Abstract/2011/07000/Capillary_Refill_Time___Is_It_Still_a_Useful.21.aspx)
19. Brabrand M, Hosbond S, Folkestad L. Capillary refill time: a study of interobserver reliability among nurses and nurse assistants. *Eur J Emerg Med*. 2011[cited 2017 Jan 18];18(1):46–9. Available from: [http://journals.lww.com/euro-emergencymed/Abstract/2011/02000/Capillary\\_refill\\_time\\_\\_\\_a\\_study\\_of\\_interobserver.11.aspx](http://journals.lww.com/euro-emergencymed/Abstract/2011/02000/Capillary_refill_time___a_study_of_interobserver.11.aspx)
20. Andrews T, Waterman H. Packaging: A grounded theory of how to report physiological deterioration effectively. *J Adv Nurs*. 2005[cited 2017 Jan 18];52(5):473–81. Available from: <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2648.2005.03615.x/epdf>
21. Adshead N, Thomson R. Use of a paediatric early warning system in emergency departments. *Emerg Nurse*. 2009[cited 2017 Jan 18];17(1):22–5. Available from: <http://journals.rcni.com/doi/pdfplus/10.7748/en2009.04.17.1.22.c6984>

