THE ASSESSMENT OF ACUTE PAIN IN PRE-HOSPITAL CARE USING VERBAL NUMERICAL RATING AND VISUAL ANALOGUE SCALES

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Abstract—Background: Prehospital care (PHC) pain evaluation is an essential patient assessment to be performed by paramedics. Pain intensity is frequently assessed using Verbal Numerical Rating Scale (VNRS) or Visual Analog Scale (VAS). Objective: Our aim was to evaluate the agreement between VNRS and VAS in measuring acute pain in prehospital setting and to identify the preference among paramedics and patients. Methods: This was a 3-month cross-sectional study. Convenience sampling was used to enroll patients with acute pain responded to by the ambulance team. Data from consented patients were analyzed using Bland-Altman method, Spearman’s correlation test, and Cohen’s $\kappa$ test. Results: One hundred and thirty-three patients participated in this study (median age 32 years; 72.2% male). The median for pain score at the scene was 7.50 (interquartile range [IQR]: 5.00) for VAS and 7.00 (IQR: 5.00) for VNRS. The median for pain score on arrival at the hospital was 7.00 (IQR: 3.10) for VAS and 7.00 (IQR: 4.00) for VNRS. There was a strong correlation between VNRS and VAS at the scene ($r = 0.865$; $p < 0.001$), as well as on arrival at the hospital ($r = 0.933$; $p < 0.001$). Kappa coefficient values and Bland-Altman analysis indicate good agreement between both scales for measuring acute pain. VNRS was the preferred method to measure acute pain by patients and paramedics. Conclusions: VAS performs as well as VNRS in assessing acute pain in PHC. VAS and VNRS must not be used interchangeably to assess acute pain; either method should be used consistently. © 2015 Elsevier Inc.

Keywords—emergency; pain score; prehospital care; Verbal Numerical Rating Scale; Visual Analog Scale

INTRODUCTION

The International Association for the Study of Pain defines “pain” as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage” (1). Pain also includes the subjective interpretation of the discomfort (real or imaginative). This perception provides information on the pain’s location, intensity, and its nature. The various conscious and unconscious responses, including the emotional response, further define the overall concept of pain (1,2). Inadequately controlled pain has negative physiological consequences. This includes an increase in heart rate, respiration rate, and blood pressure, as well as anxiety and patient discomfort (3). The difficulties in quantifying pain intensity and the problem of inter-observer perception can be overcome by objectively gauging pain using various pain-scoring systems. Pain intensity can be simply classified as mild, moderate, or severe; however, specific pain measurement tools are available to determine pain intensity more objectively (4). These include the Faces Pain Scales (Wong-Baker scale), Visual Analog Scale (VAS), Oucher Scale, McGill Pain Questionnaire, Brief Pain Inventory, Verbal
Descriptor Scale, and Verbal Numerical Rating Scale (VNRS) (1–5). The VNRS and the use of face scales appear to be the most appropriate pain measurement tools in the prehospital setting (5). Any prehospital pain-measuring tool should be quick and simple to use, of high reliability, and should not rely on specific equipment. In addition, it should be based on patient self-reporting, and applicable irrespective of the patient’s age, psychological or emotional state, and cultural background.

The VRNS is the most commonly used tool to measure pain intensity in clinical practice (6). Patients are asked to rate the pain intensity by providing a numerical rating from 0 to 10. Zero indicates no pain and 10 indicates worst pain imaginable. The advantages of VNRS are that it can be performed quickly, does not depend on motor skill, and requires no additional tools (7). It is conceptually simple, has a high compliance rate, and is easy to score (8). However, language can be a major barrier in applying VNRS. In addition, although VNRS is used more commonly, there is limited information on its validity and reproducibility as compared to VAS, particularly in the prehospital environment (9).

When using the VAS, patients are asked to mark the pain that they are experiencing on a 100-mm-long horizontal line labeled “no pain” (with or without related facial expressions) at one extreme and “worst pain ever” at the other (Figure 1). Pain intensity is determined by the length of the line as measured from the left-hand side to the point marked (9). The VAS has been validated in measuring pain, and the technique has been applied to measuring alertness after sleep, quality of life, anxiety, breathlessness, nausea, dyspnea, pruritus intensity, and attitudes toward the environment (5–10). The VAS can also accurately and reliably reflect changes in pain (6,11). The VAS ruler is reusable, can be labeled in different languages, and is sensitive to changes in acute pain (6,8,11). However, it may take a longer time to measure, requires specific equipment, and patients may have difficulty with this measure, as they need to have intact fine motor skills that may be limited by their illness or injury (6,8).

The prehospital setting poses a number of unique difficulties in measuring pain. Loud ambient noise, poor lighting, and movement may hinder any assessment technique. Time constraints in performing assessment and treatment interventions may add more difficulties (5). Currently, the prehospital care (PHC) team only uses the VNRS to score pain. This study assessed an alternative method of measuring acute pain in PHC.

The main objective of this study was to compare two different pain-assessment scales in measuring acute pain in the prehospital setting by determining their correlation and level of agreement. A secondary objective was to determine the preferred method for measuring pain among patients and paramedics.

**METHODS**

This was a single-center prospective observational study of patients treated by the ambulance team of a university hospital. The study was approved by the Institutional Ethics Committee prior to data collection and all data was treated with strict confidentiality. Convenience sampling method was used to collect data from March to May 2013. All patients responded to by the ambulance team and having acute pain were invited into the study by the investigators. Recruitment of participants was on voluntary basis. All participants were informed of the purpose of the study and consented before data collection. The exclusion criteria were refusal to provide consent, inability to communicate verbally, age <18 years, altered mental status with Glasgow Coma Scale <15 and pain >24 h. Patients were also excluded if they were transported to other hospitals.

Before commencing the study, a short seminar on measuring pain intensity using VAS and VNRS was conducted for the paramedics to explain the proper use of pain measuring tools and to standardize measurement. Each patient was assessed by the paramedics on scene, en route to the hospital (every 5 min), and on arrival at the emergency department (ED). Each patient was asked by the paramedics to score their pain using both VAS and VNRS. Patients were not allowed to review their previous pain scores. The scoring sequence for the same patient was maintained throughout the assessment. The initial scoring tool (VAS or VNRS) was alternated. A standardized data collection form was used to record data. The score from 0 to 10 was obtained using a VAS ruler. One side of the ruler depicts faces numbered 1–5, where...
“1” stands for “no pain” and “5” for “extreme pain” and on the opposite side was etched a 0–100-mm analog scale. The patient was asked to score their pain on VNRS from 0 to 10, where 0 indicates “no pain” and 10 indicates “worst pain imaginable.” Patients were allowed to give their score as half integers. For comparison purposes, the VNRS score was considered to represent an equivalent distance on the VAS in centimeters with one decimal point. At the end of the data collection, both patients and the paramedics involved were asked in an openended survey for their preference of the pain scoring methods. All data was analyzed with the assistance of institutional clinical statisticians. Calculations for the sample size required for correlating the two pain scores is based on the formula below (12):

\[
N = \left( \frac{Z\alpha/2 + Z1 - \beta}{\log \frac{1+\kappa}{1-\kappa}} \right)^2 + 3
\]

Based on a previous study with high correlated VAS and VNRS \(r = 0.95, 95\%\text{ confidence interval})\), the minimum sample size recommended to provide 80% power \(\alpha = 0.05\) for a two-tailed significance test was 23 (7). For contextual representativeness, a sample of 323 is proposed to ensure the inclusion of the estimated 30% of patients with moderate to severe pain in the prehospital setting, according to the previously stated level of significance and power (13,14). Both the VNRS and VAS are ordinal scales, as they act as analogues to the perception of pain. The weighted \(\kappa\) value can be interpreted based on the generally accepted five-level scale of strength of agreement: poor (<0.20), fair (0.21–0.40), moderate (0.41–0.60), good (0.61–0.80), and very good (0.80–1.0). However, calculations for weighted \(\kappa\) is not possible, for the fact that the raters are individual patients with varying degrees of pain for which they alone have the unique perception of the pain felt. This invalidates the assumption of paired observations where the minimum of two observers measuring the same phenomenon at any given time is mandatory. A high correlation between two methods for measuring pain does not necessarily mean they have good agreement. Analysis of a typical method-comparison study should include the visual examination of data patterns plotted in a graph and quantification of the estimates of the difference between the methods, where the estimated standard deviation (SD) of the differences provides a measure of agreement. Bland-Altman analysis is a graphical tool to measure agreement between two clinical methods of measurement with the assumption that each method provides some errors in their measure (15,16). This analysis involves examining the difference between each pair of measurements plotted against the mean of the VAS and VNRS. By computing the 95% limits of agreement for each comparison (2 SD), it will show how far apart the measurements by the two methods were more likely to be for most individuals. The detailed description for the interpretation of this form of analysis is described elsewhere (15,16). In this study, for each device, two assessments were made (at the scene and on arrival to the hospital). If the differences within mean ± 2 SD are so small and do not affect clinical decision on patient management, then VAS and VNRS may be used interchangeably.

**RESULTS**

A total of 1,149 ambulance responses were recorded during the study period. Of these, 133 patients were recruited: 96 males (72.2%) and 37 females (27.8%). Most were in the age category of 18–30 years (40.6%), with a median age of 32 years. The ethnic breakdown of participants was Malay (54.1%), Chinese (17.3%), Indian (16.5%), and others (12%). The most common causes for acute pain were trauma following motor vehicle accident (47.4%), medical cases (33.8%), other trauma (14.3%), and obstetrics and gynecology (4.5%).

The median pain score at the scene was 7.50 (IQR: 5.00) when measured with VAS and 7.00 (IQR: 5.00) when measured with VNRS. The median pain score on arrival at the hospital was 7.0 (IQR: 3.10) when measured with VAS and 7.00 (IQR: 4.00) when measured with VNRS. The two methods correlate with each other with the coefficient of 0.865 \((p < 0.001)\) at the scene and 0.933 \((p < 0.001)\) on arrival at the ED (Table 1). The pain score using VAS was directly proportional to the pain score using VNRS at the scene (Figure 2) and on arrival at the ED (Figure 3). The \(\kappa\) values of the agreement in measuring pain using VNRS and VAS at the scene and on arrival are 0.68 \((p < 0.001)\) and 0.746 \((p < 0.001)\) respectively. Based on the Bland-Altman analysis, the 95% limits of agreement between the two methods ranges from −2.55 to 2.90 at the scene (mean 0.18; ± 1.36) and −2.03 to 1.97 (mean −0.03; ± 1.00) on arrival (Table 2, Figures 4 and 5).

Slightly more than half of the paramedics (54.1%) and patients (52.6%) preferred VNRS to measure pain (Table 3). The following reasons were indicated by those paramedics who preferred the VRNS: it was faster to perform (57%), it did not require a specific tool (29%), and it did not require any motor skills (14%).

**DISCUSSION**

This study evaluated two major pain severity assessment tools. Because the data of individual pain score for both
pain measuring instruments was not normally distributed, Spearman’s rank correlation was used to test the association between the VNRS and VAS in measuring acute pain. Our study shows that VAS and VNRS strongly correlate in the assessment of acute pain. However, patients consistently scored their pain higher using the VNRS (17). The VNRS does not require associated equipment, and patients find it easier to use. It also requires less explanation when used in the PHC environment (9,17).

The use of more than one pain measurement method would be time-consuming and impractical in most acute settings (8). Although the two methods that we used correlate well, patients systematically scored their pain higher on the VNRS than on the VAS. There was considerable variability in the differences between scores, and it is impossible to know if the score indicates a true change in pain or if the change is artefactual, owing to the alternating method of pain assessment. Accordingly, VAS and VNRS should not be used interchangeably when assessing acute pain (7,9).

Cohen’s $\kappa$ test was used to determine the agreement between VNRS and VAS (18,19). The values achieved in this study reflect good agreement between VAS and VNRS for measurement of acute pain in PHC setting.

Bland-Altman analysis was applied to measure the agreement between VAS and VNRS. This examines how much the VAS is likely to differ from VNRS in measuring pain. A range of agreement was defined as the mean of bias between $2\, SDs$. Improved agreement between methods is represented by a smaller range between the two limits (18,20). The lack of agreement can be assessed by calculating the bias, estimated by the mean difference and the $SD$ of the differences (Table 2). For pain score data measured by VAS and VNRS in this study, there is no obvious relation between the difference and the mean. The majority of the differences plotted in the graphs lies within the mean $\pm 2\, SD$s and is likely to follow a normal distribution. However, for pain measurement, the difference within the limits of agreement is clinically important. The measurement of pain at the scene reflects that VAS score may be 2.5 below or 3.0 above VNRS. The measurement of pain on arrival reflects that VAS score may be 2.0 below or above VNRS. Therefore, if the two methods were to be used interchangeably for an individual, the differences in measuring and documenting pain score would be too great to be clinically meaningful.

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<th>Table 1. Spearman’s Correlation at Scene and Arrival</th>
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VAS, Visual Analog Scale; VNRS, Verbal Numeric Rating Scale.

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<th>Table 2. Limits of Agreement Between the Difference of Visual Analog Scale and Verbal Numeric Rating Scale at Scene and Arrival to the Hospital</th>
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SD = standard deviation.
The assessment for repeatability is relevant to method comparison study. However, based on the findings above, the reliability assessment was not performed as it would not provide additional useful information.

Appropriate pain assessment including the use of pain scores has been shown to optimize analgesic use (5,20,21). VAS and VNRS may be used to assess pain score in ED setting and have a linear correlation between each other. This study confirms that VAS and VNRS may be used reliably to assess pain score in the prehospital setting. Although both scales allow finer distinctions up to one decimal point, the VAS score provided a more fine-tuned delineation of pain scoring. Therefore, as their agreement is imperfect, these scoring methods cannot be used interchangeably for the same patient.

We note that 15.8% of our study sample were patients >60 years old. In previous studies, VAS has been found to be less accurate in the elderly and young children because of visual and cognitive limitations (17,22,23). However, the VNRS has been shown to be a valid and reliable for measuring pain in young and elderly patients (17).

Patients and paramedics in this study did not appear to strongly favor VNRS over VAS. Lord and Parsell reported that approximately one-quarter (26%) of paramedics considered VAS too cumbersome and the device was often difficult to locate when required, or lost (24). The benefits of the VNRS scale are that it is quick to perform, provides a quantitative rating of pain intensity, and does not require specialized equipment. However, a potential barrier to the use of the VNRS is the difficulty conveying instructions to the patient. Therefore, in a multicultural or multidenominational setting, the VAS may have an advantage.

**Limitations**

This study used convenience sampling, therefore limiting data collection to the investigators availability and time. Only a small number of PHC paramedics from one medical center participated in this study. This study did not include pediatric patients and pain scores were not evaluated according to patients’ age group. Patients and paramedics could have been confused by the alternating use of the scoring system. However, this protocol was made clear to all paramedics during the training session and did not affect the data-collection process.

**CONCLUSIONS**

The two methods of measuring acute pain in this study were highly correlated. This study confirms that VAS and VNRS
may be used reliably to document pain scores in the prehospital setting. However, they must not be used interchangeably in assessing acute pain for the same patient. The VAS appears to be equally well received as an alternative tool for assessing acute pain in the PHC setting.

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REFERENCES

ARTICLE SUMMARY

1. Why is this topic important?
   The prehospital setting poses a number of unique difficulties in measuring pain, which may affect the choice of scoring acute pain. The difficulties in quantifying pain intensity and the problem of inter-observer perception justifies the need to objectively identify the appropriate pain-scoring system for prehospital care.

2. What does this study attempt to show?
   This study attempts to assess alternative methods of measuring acute pain in prehospital care. This study attempts to show the difference between two pain-measuring tools for acute pain in the prehospital setting by determining their correlation and level of agreement. It attempts to determine the agreement between both methods and how these should be used in the prehospital setting. It also attempts to show the preferred method for measuring pain among patients and paramedics.

3. What are the key findings?
   The Visual Analog Scale (VAS) performed as well as Verbal Numeric Rating Scale (VNRS) in assessing acute pain. It can be used as an alternative. However, VAS and VNRS must not be used interchangeably in assessing acute pain in the same patient.

4. How is patient care impacted?
   Appropriately measured and documented pain scores in prehospital setting for acute pain will result in the appropriate pain intervention and control.