Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/poamed


Original research article

# Application of $T_1$ scale in evaluating effects of long-term therapy

Wojciech Kiebzak [a,g,*], Michał Kosztołowicz [b], Katarzyna Zaborowska-Sapeta [c], Małgorzata Kiebzak [d], Michał Dwornik [e,f]

[a] Department of Physiotherapy, Faculty of Medicine and Health Sciences, Jan Kochanowski University, Kielce, Poland
[b] Kielce Scientific Society, Kielce, Poland
[c] Chair and Clinic of Rehabilitation, Faculty of Medical Sciences, University of Warmia and Mazury in Olsztyn, Poland
[d] Świętokrzyski Branch of the National Health Fund in Kielce, Poland
[e] Department of Osteopathic Medicine, Medical College of Podkowa Leśna, Poland
[f] Department of Physiotherapy, Medical College of Podkowa Leśna, Poland
[g] Department of Physiotherapy, Świętokrzyskie Centre of Paediatrics Provincial Integrated Hospital, Kielce, Poland

ARTICLE INFO

*Article history:*
Received 2 February 2016
Received in revised form
7 March 2016
Accepted 10 March 2016
Available online 19 April 2016

*Keywords:*
$T_1$ scale
Normal distribution
EBM

ABSTRACT

*Introduction:* Modern medicine employs various approaches to analyzing data collected through clinical observation. The results of such analyses demonstrate general tendencies of the observations, yet they do not point to the dynamics of the therapeutic process.
*Aim:* The authors of the present study propose introducing the $T_1$ scale, thanks to which one can analyse the results and course of each patient's treatment in relation to normal distribution. The aim of this study is to prove that $T_1$ scale is functional in evaluating the effects of long-term therapy.
*Material and methods:* The study shows that $T_1$ scale, which is realized through the formula $y = 10z_i + 50$, is a universal scale. It has been concluded that the interval of $T_1$ scale determines effective dynamics of therapeutic procedures. The study encompasses 234 term infants born with normal weights who were diagnosed with neurodevelopmental disorders. The subjects were observed every 6 weeks. $T_1$ scale was applied in order to evaluate the dynamics of clinical change of the analysed features.
*Results and discussion:* The scale precisely differentiates the population, that is the number of patients for whom beneficial therapeutic effects were observed, the closer the values in $T_1$ scale are to the mean value of $T_1$ scale. $T_1$ scale makes it possible to evaluate clinical observations in the treatment process in a precise manner in line with evidence-based medicine (EBM).
*Conclusions:* $T_1$ scale makes it possible to evaluate clinical observations in the course of treatment in a precise manner in line with EBM.



* *Correspondence to:* Department of Physiotherapy, Faculty of Medicine and Health Sciences, Jan Kochanowski University, Żeromskiego 5, 25-369, Kielce, Poland. Tel.: +48 41 349 54 69.
E-mail address: kiebzakw@wp.pl (W. Kiebzak).

http://dx.doi.org/10.1016/j.poamed.2016.03.001

## 1. Introduction

All the dynamically developing branches of modern science, including medicine, should evaluate incidents and observations. In order to ensure that, one needs to apply mathematical models as well as statistical analysis, which can be predicted during the research planning.[1]

According to the authors, all the investigations are to focus on determining the effects of therapeutic procedures. At present, medical viability is determined by conclusions drawn on the basis of studies performed in line with evidence-based medicine (EBM).[2]

Following these rules, one needs to carefully select methods of analysis of the observations. The obtained results can have various clinical values, which can in turn be decisive in choosing a particular treatment.[3]

The authors believe that $T_1$ scale presents differences in the clinical value of research conclusions in line with the rules of EBM. The study constitutes an attempt to apply the solutions of a mathematical model of $T_1$ scale in which standard deviation is a unit of measurement in order to interpret clinical results.[4] This is especially crucial because a human being is a subject of therapeutic procedures, it is a particular patient, and the time of commencing the treatment, its length and dynamics play a decisive role when it comes to therapeutic success.[5–7]

The name of $T_1$ scale as a mathematical model is validated by the fact that the correlations between a priori and a posteriori results constitute simplified assumptions. Currently in medicine various approaches to clinical data analysis are followed, most often researchers apply an analysis of results variability with Student's t- or $\chi^2$-distribution, or a correlation of variables with Pearson correlation coefficient, linear regression, etc. These methods do not demonstrate the dynamics of a therapeutic process.

## 2. Aim

To show the functional application of $T_1$ scale in evaluating the dynamics of long-term therapy.

## 3. Material and methods

The study encompassed 234 term infants with normal weights diagnosed with neurodevelopmental disorder during a routine pediatric examination. The patients were referred with a diagnosed posture asymmetry. Identifying the disorders constituted the basis for extended examination of psychomotor function and for implementing treatment in the Rehabilitation Department of Children's Hospital in Kielce. Following the neurokinesiological assessment, central coordination disorder related to the posture asymmetry was found, which according to Vojta is a basis to implement treatment.[8] The examination included assessing the whole range of psychomotor functions of the infants according to the model proposed by the Children's Centre in Munich.[9] This model assesses neurodevelopmental changes and the level of functional ability on the basis of four criteria: (1) the level of social interaction; (2) spontaneous motor function in the supine position and the lying face down position; (3) seven postural responses according to Vojta; and (4) neurological reflexes according to Vojta.[10] Each of the analysed features was assigned 0 (for pathological responses), 1 (for partly abnormal responses), or 2 (for normal responses). Next, values in $T_1$ scale were attributed to these scores. The observations were performed every 6 weeks. All the children were undergoing rehabilitation treatment program with the use of Vojta's method, SI and NDT-Bobath techniques until optimal improvement of their motor function was achieved. The observations were performed in 2009–2012 in Kielce Province Children's Hospital.

### 3.1. Statistical analysis

In order to establish a method to evaluate the dynamics in long-term therapy, normal distribution was applied.[11] The density function of normal distribution is determined as follows:

$$f(z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}z^2} \quad (1)$$

where standardized score (z) is defined as:

$$z = \frac{x_i - x_m}{\sigma} \quad (2)$$

while

$x_i$ – ith empirical score,
$x_m$ – the mean score,
$\sigma$ – the standard deviation.

The parameters of normal distribution, that is the expected value ($x_m$) and standard deviation ($\sigma$) were calculated according to the following formulas[12,13]:

$$x_m = \frac{1}{n}\sum_{i=1}^{n} x_i \quad (3)$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - x_m)^2}{n}} \quad (4)$$

where $n$ – the number of scores.

Standardized scores are difficult to interpret due to the fact that they may assume negative, positive and zero value. Thus a new scale was construed, in which scores become positive and equivalent to empirical results. The equivalence is ensured by the relationship of equality between the empirical standardized scores and the standardized scores in the new scale.[14]

The standardized score $z_y$ in the new scale was defined as:

$$z_y = \frac{y - b}{a} \quad (5)$$

where

$y$ – the score in the new scale – a priori,
$b$ – the mean value of scores in the new scale – a priori,
$a$ – the standard deviation in the new scale – a priori.

The relationship of equality of standardized scores, that is the standardized scores (formula 5) which result from the scale