22 *The Radiographer* 2005: 52 (1): 22–24

The visual analogue scale as a tool for self-reporting of subjective phenomena in the medical radiation sciences

Jennifer M Cox[AB] *and Alastair Davison*[A]

[A]School of Medical Radiation Sciences, The University of Sydney, NSW 1825, Australia
[B]Corresponding author email: J.Cox@fhs.usyd.edu.au

Abstract Medical radiation science researchers, due to their close patient contact in daily practice, may wish to investigate subjective phenomena which cannot be measured physically. These phenomena are best interpreted by the subject, not the researcher. A useful tool for quantitative measurement of subjective phenomena is the visual analogue scale. The scale can be adapted to measure a range of phenomena, provided that it is suitably validated. Examples of the use and validation of the visual analogue scale are given. The visual analogue scale is a valuable instrument for the comparison of scores in different groups of subjects, for the comparison of treatments in individuals, and for the observation of scores over time for individual subjects.

Introduction

The medical radiation sciences are relatively new to research, particularly in the professions of radiography, radiation therapy and nuclear medicine technology. As a bachelor's degree in these fields only became mandatory in Australia for the 1992 commencing student cohorts, to date very few practitioners have completed research degrees. Thus the field of research for medical radiation scientists has been largely undefined. Requirements for accreditation in Australia by the Australian Institute of Radiography[1] include undergraduate studies in the biomedical, behavioural, physics, instrumentation and medical radiation sciences. Patient care in all its aspects is important, as is a thorough understanding of disease processes. These sciences interact in daily practice (Fig. 1). Thus it could be assumed that qualified medical radiation practitioners may wish to carry out research in their area of practice incorporating elements of any of these sciences.

Research into practice that incorporates the instrumentation, physics and disease process fields can largely be carried out using quantitative methodology with physically measurable data. Psychological, sociological and patient care related research, however, will rely strongly on qualitative methodology and measurement of phenomena that do not readily lend themselves to physical measurement. It is the purpose of this paper to describe a measurement tool, the visual analogue scale (VAS), which is suited to the evaluation of many subjective phenomena. This tool is a valuable instrument in the armoury of medical radiation science researchers.

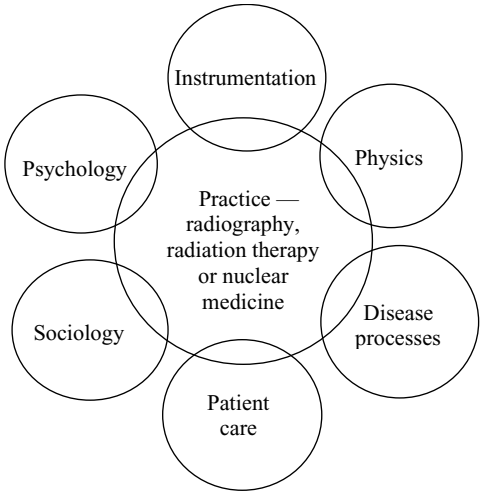

Fig. 1 Schematic representation of the interactions of different sciences with the medical radiation sciences domain

Definition of the visual analogue scale

The visual analogue scale is a line, usually 10 cm long, with each end-point clearly marked and described (Fig. 2). The subjects are asked to mark a point on the line that represents how they feel about the phenomenon at the time. Because the line is a known length, a measurement can be made of the distance from one end of the line to the subject's mark. This provides a quantitative variable that can be inserted into standard statistical tests of significance, such as t tests.

The visual analogue scale in recent research

The VAS has been used as a measuring tool for phenomena in fields where few objective measures exist. These include pain,[2,3] panic,[4] depression,[5] health states,[6] tension headache,[7] fatigue,[8,9] anxiety,[10–13] 'psychological distress,[14] quality of life,[15,16] and worry.[10] These phenomena, as well as having few physically measurable characteristics, have affective components. Some, such as quality of life and perceptions of health states, are dependent upon the subject's own conscious or unconscious standards. Reporting of some phenomena will be affected by previous experience and conditioning, so where one subject will freely admit to pain, another will see this as weakness and complain

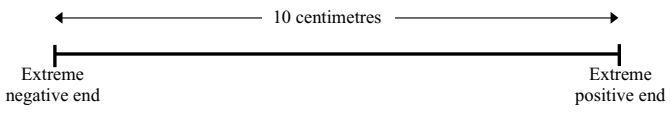

Fig. 2 The visual analogue scale

only when the pain level is high. The subject's state of mind can also influence these subjective phenomena. The phenomena are therefore multi-dimensional, with the various dimensions interacting so that in an anxious subject, for instance, high pain levels might be reported, but if the subject's anxiety can be reduced the reported pain level may also diminish. This connection between anxiety and pain was investigated by Nielson et al., who found that women who said they were anxious prior to a mammogram reported significantly higher levels of pain and discomfort than other women.[17]

Use of the visual analogue scale

The affective natures of the phenomena described above mean that their degree is best measured by the subject. They frequently have no observable correlates, so are opaque to anyone but the subject.

Measurement tools used by research subjects must be easily understood and quick and easy to use. The VAS fits these requirements. Cartoons have sometimes been placed at the end points for subjects who have an imperfect understanding of English. An example of this is the placement of pictures of happy and nervous faces at either end of an anxiety scale for adolescents.[13] It is more common, however, for the ends of the scale to have descriptors representing the extreme negative and positive aspects of a phenomenon, for instance 'As anxious as I could possibly be' and 'Not anxious at all'.

When using the VAS it is assumed that it is possible to grade a phenomenon on a linear scale from one extreme to another. Subjects are asked to make a mark on the line that corresponds to their feeling about the degree or extent of the phenomenon. The result is an objective representation of a previously subjective and unquantified phenomenon.[18] The use of numbers along the line of the VAS is discouraged,[19,20] as subjects tend to have preferences for the numbers 5, 10 and 15, although Grunberg found that the addition of hash marks at 25%, 50% and 75% did not significantly affect where subjects placed their marks.[21] Grunberg found reasonable linearity, with the median values on a 100 mm line being 24 mm for 'mildly', 43 mm for 'moderately', and 84 mm for 'severely'.

The placement of descriptors along the line can induce subjects to place their mark close to the descriptor, removing some of the instrument's power, and making it more like a simple descriptive scale.[20] The use of descriptors is also subject to interpretation. Grunberg examined the descriptors 'mild', 'moderate' and 'severe' by asking subjects to place the words on a VAS describing the weather, as in 'The weather is mildly bad.'[21] There was a distinct meaning for 'severely', but marked overlap between 'moderately' and 'mildly'. When a line is used without descriptors, however, subjects will find it more difficult to understand, which necessitates careful instructions from the investigator.

Subjects may have some difficulty in conceptualising the extreme points on a scale. Pain scales have been well tested, and it has been found that subjects may mark pain at its most severe one day, then find that the next day it is worse.[19] When pain relief is to be assessed, it is therefore better to administer a 'pain relief' VAS rather than a simple 'pain' VAS. Scott and Huskisson[20] state that 'With a pain relief scale, all patients start at the same baseline and all have the same amount of potential response' (page 183).

The VAS has been found to be of limited value in subjects who are cognitively impaired; these subjects find verbal scales easier to complete.[5] Younger and more highly educated subjects have reported the most difficulty in using the VAS, which may relate to their more 'conscientious' approach than older and less educated subjects, who have produced more inconsistent responses when evaluating health states.[6] Scott and Huskisson found inability to satisfactorily complete the scale in no more than 5% of first-time users of the VAS, with completion times of less than 30 seconds.[20]

While the VAS can give no information as to the absolute value of the phenomenon being measured, it is a good instrument for the comparison of scores in different groups of subjects, for the comparison of treatments in individuals, and for the observation of scores over time for individual subjects.[19] The VAS is in the public domain and its end points can be defined by the user, making it a very accessible test for a range of subjective phenomena.

Validation of the visual analogue scale

Any measurement tool must be validated before use. A valid tool is one that actually measures what it sets out to measure.[22] Validation is carried out in a variety of ways.

A tool may be compared with physical factors known to be associated with the phenomenon to be measured. Thus, a new pain assessment instrument may be compared with physical measurements of heart rate and sweating rate, both of which are known to be associated with pain.[23] Subjective phenomena, however, rarely have physically measurable correlates. In such cases, the new tool may be compared with an existing, previously validated, tool. An example of this is the VAS for assessment of anxiety. In many studies, both an anxiety VAS and another instrument, the Spielberger State-Trait Anxiety Inventory (STAI),[24] are used concurrently.

The STAI had been used in more than 2000 studies up to 1985[25] for the assessment of anxiety in many medical, psychiatric and behavioural domains and is considered to be a highly valid and reproducible tool. An example of the comparison of the STAI and the anxiety VAS is in a study where 54 subjects with 12 controls had their anxiety levels manipulated by the administration of caffeine. There was a highly significant correlation of their scores on the VAS and the STAI State Anxiety scale both before and after administration of the caffeine.[26] In another study, strong correlations were seen when levels of 5-Hydroxytryptamine, which is thought to modulate anxiety, were increased by the administration of fenfluoramine in subjects suffering from panic disorder, who were then challenged with 7% Carbon Dioxide. The STAI and VAS-Anxiety Scale scores showed almost identical results across the 5 hours of the experiment, as did the Acute Panic Inventory and VAS-Panic Scale scores.[4]

When no physical correlates of the subjective phenomenon and no previously validated tests exist, it may be possible to use stimuli that are known (or perhaps logically argued) to create the phenomenon, and ask the subject to rate the level of the phenomenon on a VAS.[18] This method was used when it was desired to measure the physical comfort on treatment couches of patients undergoing radiotherapy.[27] Four treatment couches were simulated, one couch with a thin mattress (couch A), one without a mattress (couch B), one with a 'tennis racket' insert at the level of the pelvis (couch C), and one with eight 1 cm high masses of Plaster of Paris placed on the surface of the couch (couch D). The aim was to simulate different levels of comfort. Normal volunteers lay in random order on each couch for 10 minutes each, then ranked the couches on a VAS from 'As comfortable

as I could possibly be' to 'Unbearably uncomfortable'. The VAS was found to clearly discriminate between couches A, B and D. Couch C was rated very similarly to couch B. The subjects' ratings covered the majority of the scale and followed a normal distribution. No correlation was found between subject age or subject body mass index and their comfort ratings for the various couches. This was a useful finding because it indicates that the VAS to assess comfort could be used for adults of any age and body mass index.

Another important aspect of validation is repeatability. Any new VAS should be tested in a range of circumstances with different subject groups and repeated to ensure that it is robust over time.[22]

Conclusion

The difficulties with objective measurement of subjective phenomena make subject self-reporting essential. The VAS is a useful tool for subject self-reporting and has been shown to be valid in many situations. It allows the statistical manipulation of quantitative values for phenomena which are otherwise manageable only through qualitative means. The application of the VAS is not hindered by its lack of an absolute value for the phenomenon under investigation, because its strength lies in its comparative use for individuals across a time period or across populations. The VAS could be usefully applied in many research projects undertaken in the medical radiation sciences, provided that the validity of the particular VAS under use is established.

References

1 Australian Institute of Radiography. Educational Policies (revised) 2002.

2 Terry R, Gijsbers K. Memory for the quantitative and qualitative aspects of labour pain: a preliminary study. *J Reprod Infant Psychol* 2000; 18 (2): 143–152.

3 Wilkie D, Keefe FJ, Dodd M, Copp L. Behaviour of patients with lung cancer: description and associations with oncologic and pain variables. *Pain* 1992; 51 (2): 231–240.

4 Mortimore C, Anderson I. d-Fenfluramine in panic disorder: a dual role for 5-hydroxytryptamine. *Psychopharmacology* 2000; 149 (3): 251–258.

5 Snowdon J, Lane F. Use of the Geriatric Depression Scale by nurses. *Aging and Mental Health* 1999; 3 (3): 227–233.

6 Badia X, Monserrat S, Roset M, Herdman M. Feasibility, validity and test-retest reliability of scaling methods for health states: The visual analogue scale and the time trade-off. *Qual Life Res* 1999; 8 (4): 303–310.

7 Devi S, Kaliappan K. Improvement of psychosomatic disorders among tension headache subjects using behaviour therapy and somatic inkblot series. *J of Proj. Psy. and Mental Health* 1997; 4 (2): 113–120.

8 LaChappelle D, Finlayson M. An evaluation of subjective and objective measures of fatigue in patients with brain injury and healthy controls. *Brain Inj* 1998; 12 (8): 649–659.

9 Brunier G, Raydon J. A comparison of two methods of measuring fatigue in patients on chronic haemodialysis: visual analogue vs Likert scale. *Intl J Nurs Stud* 1996; 33 (3): 338–348.

10 Butler G, Wells A, Dewick H. Differential effects of worry and imagery after exposure to a stressful stimulus: a pilot study. *Beh. and Cog. Psychotherapy* 1995; 23 (1): 45–56.

11 Klaassen T, Klumperbeek J, Deutz E, van Praag H, Griez E. Effects of tryptophan depletion on anxiety and on panic provoked by carbon dioxide challenge. *Psychiatry Res* 1998; 77 (3): 167–174.

12 Frattola L, Piolti R, Bassi S, Albizzati M, Cesana B, Bottani M, et al. Effects of alpidem in anxious elderly outpatients: a double-blind, placebo-controlled trial. *Clin Neuropharmacol* 1992; 15 (6): 477–487.

13 Bernstein G, Garfinkel B. The visual analogue scale for anxiety – revised: psychometric properties. *J Anxiety Disord* 1992; 6: 223–239.

14 Payne D, Hoffman R, Theodolou M, Dosick M, Massie M. Screening for anxiety and depression in women with breast cancer. *Psychosomatics* 1999; 40 (1): 64–69.

15 Johnston K, Brown J, Gerard K, O'Hanlon M, Morton A. Valuing temporary and chronic health states associated with breast screening. *Soc Sci Med* 1998; 47 (2): 213–222.

16 Hopman-Rock M, Kraaimaat F, Bijlsma J. Quality of life in elderly subjects with pain in the hip or knee. *Qual Life Res* 1997; 6 (1): 67–76.

17 Nielsen B, Miaskowske C, Dibble S, Beber B, Altman N, McCoy C. Pain and discomfort associated with filmscreen mammography. *J Natl Cancer Institute* 1991; 83: 1754–1756.

18 Miller M, Ferris D. Measurement of subjective phenomena in primary care research: the visual analogue scale. *Fam Prac Res* J 1993; 13 (1): 15–24.

19 Huskisson E. Visual analogue scales. In: Melzack R, editor. Pain measurement and assessment. New York: Raven Press; 1983. p. 33–37.

20 Scott J, Huskisson E. Graphic representation of pain. *Pain* 1976; 2: 175–184.

21 Grunberg S, Groshen S, Steingass S, Zaretsky S, Meyerowitz B. Comparison of conditional quality of life terminology and visual analogue scale measurements. *Qual Life Res* 1996; 5 (1): 65–72.

22 Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 2nd ed. Oxford: Oxford University Press; 1995.

23 Turk D, Okifuji A. Assessment of patients' reporting of pain: an integrated perspective. *Lancet* 1999; 353: 1784–1788.

24 Spielberger C. Anxiety as an emotional state. In: Spielberger CD, editor. Anxiety; current trends in theory and research. New York: Academic Press; 1972.

25 Spielberger C. Assessment of state and trait anxiety: conceptual and methodological issues. *Southern Psychologist* 1985; 2 (4): 6–16.

26 Bond A, Shine P, Bruce M. Validation of visual analogue scales in anxiety. *Int. J. Methods Psych. Res.* 1995; 5: 1–9.

27 Cox J. Design of a self-rating comfort scale for radiotherapy patients. *Radiation Therapist* 1996; 5 (2): 119–125.