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Ternary graph as a questionnaire: a new approach to assessment of quality of life?

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Abstract

This study was prompted by awareness of the importance of research into quality of life (QoL) for patients with diseases of the head and neck, the important part questionnaires currently play in this field, and awareness of the "questionnaire fatigue" experienced by many patients. Our multidisciplinary research group raised coincidental awareness of the widespread use of ternary graphs in the sciences, social sciences, and humanities as a graphical tool for quantitative, semiquantitative, or purely graphical characteristics of ternary mixtures. We explored how the basic properties of ternary graphs could be translated into an interactive electronic tool as an alternative to conventional questionnaires. We have described how this was done, and offered open access to an interactive ternary-graph based (self) assessment tool, specifically designed for the needs of patients with conditions of the head and neck. Finally, have we made open-source code available for those who may wish to adapt or develop the tool for further applications.

Keywords: Questionnaires; Ternary graphs; Quality of Life; Assessment; Cancer; Mouth

Introduction

The role of questionnaires in research into quality of life (QoL) is commonplace and well- established,[1] and questionnaires of various degrees of complexity are used in all walks of life despite the fact that patients (and others) become exhausted by having to complete standardised, often dull, questionnaires.

We have used a multidisciplinary approach to interact across widely different disciplines, and incorporate both patients' and clinicians' perspectives, to develop a prototype interactive tool that we think can be adapted to replace many types of questionnaire. Our clinical model was that of a maxillofacial surgical patient. It is essential to understand that in this paper we have described the development of, and given access to, a simple interactive online tool. This tool now exists, but has not yet been used in any comparative QoL studies. This (and its use beyond maxillofacial surgery) is beyond the scope of a single publication.

Questionnaires resemble an algorithm based on language, through which the user is guided in steps. A simple computer algorithm will only ever do what it was programmed

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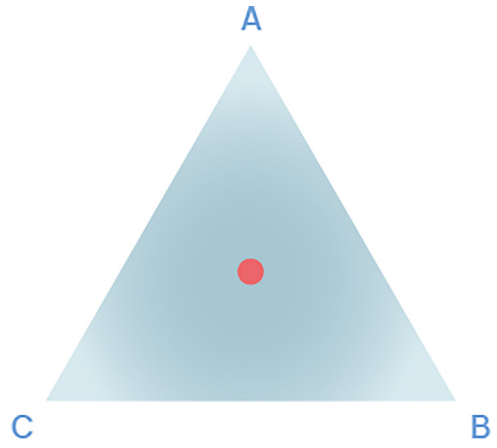

Fig. 1. An equilateral triangle where the corners each indicate one of the three components A, B, C and A + B +C = 100%.

to do, and allows no spontaneous digressions, which often precludes unforeseen discoveries. This "top-down" design applies equally to the design and use of questionnaires, where more active engagement with the user may often be highly desirable.

Others[2] have commented on the integration of information technology (IT) and health-related QoL with the intention of benefitting patients, carers, and clinicians:

Through the better use of IT, it is possible that these advances could lead to improved information, more informed choice based on HR-QoL, more effective doctor-patient communication, less frequent appointments, multiprofessional input, more cost-efficient targeted earlier intervention, and a realistic expectation between patient and health-care professional set within the health context of the individual.

Here we have introduced an alternative to conventional questionnaires. Our tool can provide quantifiable output that is similar to the scales used in questionnaires (if wanted) as well as qualitative output, it is interactive and intuitive to use, and it needs a high degree of involvement by the user. The design is extremely flexible, and adaptable to a wide range of applications. We wish to share this tool for others to use freely and to develop it in their own areas. The basic prototype must now to be designed with a series of directly relevant, progressive terms, and validated using established standard techniques.

Material and methods

The underlying mathematical properties of equilateral triangles that allow the quantitative compositional analysis of ternary mixtures is shown in Appendix A (Supplementary data, online only). This gives a brief description of two common compositional analyses of ternary graphs as well as the full description of the general case of an equilateral triangle placed in a two-dimensional Cartesian coordinate system (as used in our code).

Our source code has been deposited in the GitHub repository at https://github.com/laurenkt/magic-triangle,[3] and a demonstration version of our interactive tool can be accessed and run at https://laurenkt.github.io/magic-triangle/.[4]

The interactive tool was designed so that it runs on any standard web browser and on lower-end hardware. We have not yet implemented a version to run on tablet computers or other gadgets with touch screen technology. It would, however, be straightforward to adapt our tool for this kind of hardware.

The design of our code is such (https://github.com/laurenkt/magic-triangle)[4] that all metadata (for example, lists of all descriptor terms) are contained in one file and so to change these is straightforward.

Discussion

The working of our interactive self-assessment tool is underpinned by the mathematical properties of an equilateral triangle.

Take an equilateral triangle and label each corner A, B, C as shown in Fig. 1. If A, B, and C indicate three components of a mixture - A + B + C that adds up to 100% - then each point in the triangle uniquely indicates a particular percentage composition of the mixture (see Appendix A for an explanation of the underlying mathematics). For example, the corner of the triangle labelled C would indicate a mixture composed of 100% C, and the centre of the triangle would indicate a mixture made up of 1/3 A + 1/3 B + 1/3C.

A, B, and C can be just about anything, and the quantifiable way in which an equilateral triangle (a ternary graph) indicates the composition of a ternary mixture explains why ternary graphs are widely applied in so many different areas. So far, to the best of our knowledge, quantitative graphical illustrations such as ternary graphs have not yet been exploited in a clinical or wider medical context for any sort of assessment.

Fig. 2. The seven top-level descriptor terms.