FROM STATISTICIAN TO OPHTHALMOLOGIST VIA NURSING, OCCUPATIONAL THERAPY AND PHYSIOTHERAPY

Angus K. McFadyen
Glasgow Caledonian University, Scotland
akmf@gcal.ac.uk

Bridging the gap between the statistical specialist and students from clinical areas must be, at least initially, the primary responsibility of the statistician. If the relevance of statistics is to be appreciated by undergraduates from other academic areas then the statistics must be taught in a relevant context using knowledge gained by the statistician from collaborative research. This paper outlines the experiences of one academic statistician who has taken a long and winding journey through various clinical areas. The journey has been enjoyable, creating close links with academic colleagues and seeing the appreciation shown by students who realise that the dreaded "statistician" has a working knowledge of their area of practice which improves credibility and enhances rapport. Ways of encouraging collaborative work with academics from other areas will be discussed as will the nerve-wracking but rewarding experiences of presenting at clinical conferences.

INTRODUCTION

Most academic statisticians in the U.K. have had successful undergraduate and post-graduate experiences with contextual problems used to illustrate various statistical techniques. However unless their qualifications were linked in some way to a Medical Faculty then, in the author's experience, it is rare for them to have much experience with many clinical experiments from the areas that are often referred to as professions allied to health. With this in mind it is not surprising that many academic statisticians have rather simplistic views of professions such as occupational therapy and physiotherapy and many could be excused from thinking that occupational therapy was something to do with helping elderly people weave baskets or crochet tablemats and that physiotherapists simply stretched limbs after accidents.

Unless the academic statistician is willing to spend time seeking out information about the types of work and hence the variables measured by professional clinicians then, lecturing to students from such clinical groups can firstly be a strain on the academic, with them not feeling confident about the contexts and secondly, an embarrassment when the students realise the lecturer knows very little or indeed nothing about the clinical relevance of the material being discussed. Anyone who has attempted to lecture on a topic such as two independent sample tests without knowing that for most clinicians this is the context of a control/experimental group scenario, may suffer embarrassment and loose the attention of such students. In a similar vein how can the student be expected to fully understand statistical significance and its difference from clinical significance if the statistician does not mention clinical significance and hence make clear the distinction between the terminologies?

The remainder of this paper will hopefully encourage some novices to the clinical areas to spread their wings or even dip their toes in the water and possibly, like the author, experience:

- a very varied clinical base, which often relieves boredom
- a broad publishing avenue
- attendance/presentations at health conferences
- a great social life, clinicians know how to enjoy themselves

EXPERIENCES

Obviously the clinical areas available within any institution vary but the author's first invitation to lecture to a clinical group (not sure it was really an invitation, more an order from on high) was to what was then known as vision science but more commonly referred to now as ophthalmology. The reaction was simple – panic – think of spectacles, contact lenses and perhaps given personal experiences, cataracts or even glaucoma. What did they do? What did they measure? Now we are talking about thirty years ago when search engines like Google and MSN

had still to be thought of but even then any good library would have had either textbooks or journals in relevant areas but how does the statistician know from ophthalmology books and papers which variables young keen but naïve students will have heard about?

The only easy way round this problem is to go and speak to the clinical staff lecturing the subject to the students. In the author's opinion there is nothing worse than for the statistician to find some really interesting, one might say even "juicy" variables and scenarios, that appeal to the statistical mind but that are so far removed from the student's, as yet, limited knowledge of their own subject that they end up neither appreciating the statistics nor the clinical relevance. Speak to the academic clinicians, they in general do not bite and remember you are a statistician and the day will come when they will need your advice – it always does.

In ophthalmology there are several variables that will be meaningful even early in a clinical student's life e.g., osmolarity, blood pressure, intraocular pressure, visual acuity. Osmolarity is perhaps one of the most interesting as an initial statistical variable since it is a continuous variable and it has been shown to be, both for normal eyes and dry eyes, approximately normally distributed. Hyper osmolarity is when tears become highly concentrated due to an imbalance between the amount of incoming fluid to the eye and fluid loss due to evaporation. It is measured in moles per litre or by some as osmolality when in moles per kg.

Various studies have been published over the last 25 years (Gilbard *et al.*, 1978; Farris *et al.*, 1983; Thai *et al.*, 2005) some with small samples, some with large. Most studies are interested in diagnostic testing between the distribution of normal eyes and that of dry eyes, which is the main result of hyper osmolarity in that the high concentration of the tears can damage the eyes cells causing discomfort and redness. A meta analysis recently presented (Tomlinson, 2005) concluded that for normal eyes osmolarity was N(302.2, 9.7^2) and for dry eyes was N(326.9, 22.1^2). Now as can be seen finding a referent value to separate those two distributions is a very interesting task given the very large standard deviation of the dry eye data and this type of variable is a classic for use in discussing sensitivity and specificity of any diagnostic test procedure (Tomlinson *et al.*, 2006). Figure 1 illustrates clearly why so much time is spent on this area of research but just think of the fun even mathematical statistics students can have solving such "nice" equations to calculate intercepts or, for more advanced courses, the illustrative nature of such data for sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV). There are however, the simple scenarios of either the normal eyes distribution or the dry eye distribution for the ophthalmology students who have to understand Normal distributions and be able to calculate *Z*-scores and areas under curves in order to appreciate continuous distributions and probability.

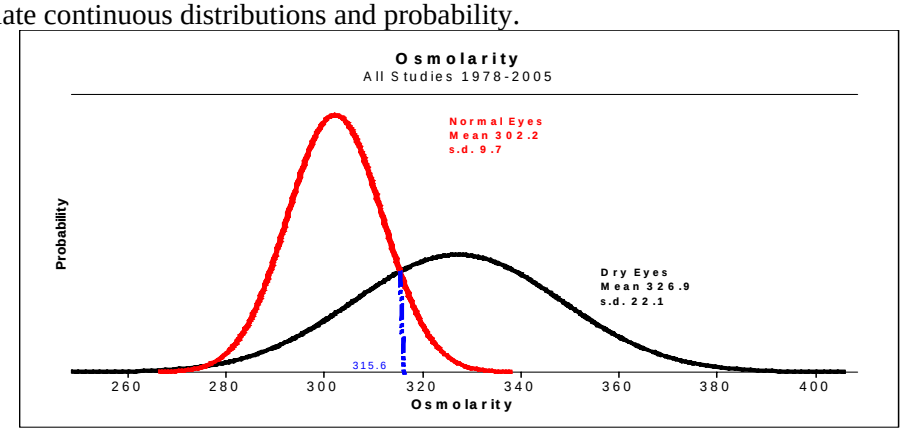

Figure 1: Normal distributions of Normal and Dry eyes

Nursing as an area of research has advanced considerably over the years and whilst many undergraduate nurses are not, shall we say, over enthusiastic about numeric work they do understand the importance of general numeric health measures such as temperature, diastolic and systolic blood pressure and, more in vogue measures such as cholesterol levels, all of which can be used both within descriptive and inferential statistical teaching. Nursing as a profession is very committed, like most health professions, to "evidence based practice" and this results in

undergraduate nurses being inculcated at an early stage in their education that they must be able to weigh-up published evidence. In the authors experience undergraduate health students make far more use of journal publications than any of the mathematics students.

Nursing research, whilst having a high proportion of excellent qualitative approaches is generally rigorous in design when it comes to quantitative methodologies with excellent use of control groups and power calculations. Two current topical areas of interest in many countries are the possible benefits of minimal/brief nursing interventions on over use of alcohol (Watson, 1999a) as well as smoking cessation (Rice and Stead, 2005). Both of these areas deliver simple variables, which are obvious to the student, and as such, make the link between the statistician and the clinician easier to bridge. Obviously when considering alcohol consumption several blood alcohol measures can be taken but even a variable such as "number of units of alcohol consumed during the previous week" has been shown to be important and a reliable measure of intake (Watson, 1999b). [In the U.K. 1 unit of alcohol is defined as one half pint of lager/beer or one measure of spirit or one glass of wine and recommended maximum numbers of units have been published by government health experts]. When considering smoking not only do we have simple count variables but there is also the possibility of testing proportions of smokers between age groups and between genders.

Whilst much nursing research could involve the in-depth study of more complicated variables by a statistician, keeping the variables simple and topical can make the learning of the statistical techniques easier and perhaps more enjoyable.

As mentioned previously the perception by the general public of what occupational therapists actually do is often far from reality. This profession has matured over the last few decades so that students are educated in intervening when functional problems disrupt or impact on the occupational nature of clients or patients. The assessment of clients requires the practitioner to interpret both objective and subjective aspects of functional performance to determine the level of client needs (Pratt, 1997). One major area within occupational therapy where the statistician can link easily with students from the profession is work-related performance. Occupational therapists frequently assess clients using procedures which comprise a functional capacity evaluation (FCE) measuring variables such as: perceived exertion; pain severity; grip strength, postural tolerances and stamina and self-efficacy amongst others. From a statistical viewpoint physical measurements such as grip strength, which is often assessed as an indicator of upper body strength, can be used both for descriptive statistics and inferential testing. There are all the possible scenarios of comparing right hand dominants with left hand dominants as well as paired analysis of right and left hands but there are also published normative data for adults from various socioeconomic and occupational backgrounds (Mathiowetz *et al*., 1985) along with detailed summary statistics for various age groups and occupations (Harth and Vetter, 1994). Simple right –left hand male comparisons can be seen for grip strengths (lbs) in Table 1 and in Figures 2 and 3.

Table 1: Summary statistics of grip strength from a random sample of 20 males

Variable	*n*	*Mean*	*St.Dev.*	*Min.*	*Max.*
Male Grip Right	20	116.07	14.96	93.47	149.29
Male Grip Left	20	111.16	28.82	57.75	166.95
Male Right-Left	20	4.91	29.31	-67.52	49.18

It should be obvious to the reader that this small sample was selected deliberately such that there were some right and some left hand dominant males resulting in large variation and also in one exceedingly large negative difference. With the normality of the paired differences being confirmed (p=0.469) for this small sample of 20 males in Figure 2, a paired *t*-test can be easily illustrated, Figure 3.

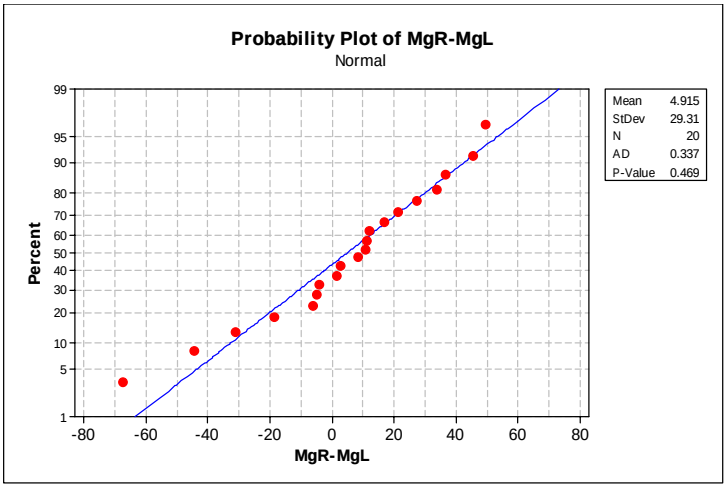

Figure 2: Testing the distribution of the differences between right and left hand grip strengths

95% CI for mean difference: (-8.80358, 18.63369)
T-Test of mean difference = 0 (vs not = 0): T-Value = 0.75 P-Value = 0.463

Figure 3: Results from paired *t*-test for differences in right and left grip strengths

If perhaps this sample had come only from right hand dominant males then other more interesting tests such as the 10% rule (Peterson *et al*., 1989), which suggests that on average the dominant hand is 10% stronger than the non-dominant hand could be explored.

Many other assessments both functional and cognitive are performed by occupational therapists via instruments with outcome measures on ordinal, interval and visual analogue scales. Such instruments are continuously being assessed regarding their psychometric properties and as such their reliability is an area where the statistician should feel at home using such data at early stages to explain variation within and between and, later such methodologies as intra-class correlation (ICC). Some of the commonly applied instruments you may wish to investigate are: Functional Independence Measure (FIM) (Hamilton *et al.*, 1987); Canadian Occupational Performance Measure (COPM) (Law *et al.*, 2005); Barthel Index (Mahoney and Barthel, 1965) or the McGill Pain Questionnaire (Melzack, 1992). An excellent text for such health instruments is Measuring Health, authored by McDowell and Newell (1996).

The final area, and possibly one of the most interesting and popular, where the statistician should be able to achieve contextual lecturing, without considerable clinical experience, is that of physiotherapy. In the U.K. the academic area of physiotherapy is very popular with students and as a result demand for places is exceedingly high elevating the average entry qualifications of students being accepted on such programmes. As a result these students usually have higher mathematical and scientific backgrounds than many other clinical groups. This, along with the almost exclusively quantitative nature of the measurements they perform, makes this clinical area an excellent area for designing, and developing good applied statistical practices. Some of the measurements taken by young enthusiastic physiotherapy students are similar to those in other clinical areas e.g., heart rate, blood pressure, grip strength. There are however other measurements such as those taken when a patient is being assessed on their balance on a force plate where anterior, posterior and medio-lateral forces are measured and such variables are excellent for statistical analysis. With the advent of more computer orientated measurement however, motion analysis is one area where numerous quantitative variables are measured electronically by attaching motion sensors to a subject and simply asking them to walk a few paces. Figure 4 illustrates a lower body motion analysis and from such observations, variables such as range of movement (ROM, degrees) of numerous joints can be measured as can stride length (cm) and simple variables such as time (sec) to walk a given distance. This form of

experiment can also be used to ascertain balance and thus assess the risk of a patient falling while walking.

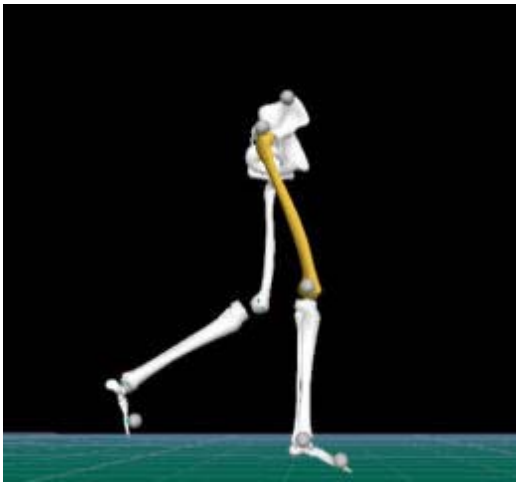

Figure 4: Motion analysis of lower body

The popularity of physiotherapy as a career appears to me widespread and is most probably due to the popularity of sport with individual athletes and most sports teams having their own physiotherapists. This area for the statistician is easy to enter without a great deal of knowledge of the clinical side and thus the gap between the statistician and the student should be simple to close for anyone willing to make the effort of simply watching a motion analysis or force plate experiment or even better volunteering to take part in one.

CONCLUSIONS

Having established links with clinical colleagues from various areas the time will come, for those statisticians interested, when joint conference abstracts and presentations can expand joint research areas. The statistician must however always remember when at a clinical conference that the audience will be clinicians and that they unlike some students may have extensive knowledge of statistics and research methodologies as well as of the clinical research area itself. For the author, the initial joint conference presentations were all a great experience but the initial solo presentation at an international clinical conference was to say the least daunting. After the initial shock however many links have been established in various countries and it is important, in the author's opinion, that such links are fostered as they will both advance the statistical aspects of clinical research and this in turn will enhance the educational experience of the clinical student.

The variety of areas of interest can have its disadvantages but the enjoyment of the applied nature of the statistics and the obvious appreciation of the students seriously outweighs this. The clinical staff will very much appreciate the interest of a statistician and this can lead to career benefits for both them and the statistician in terms of joint research and journal publications. Most of all however, the clinical students are some of the highest motivated students in many universities as they want to find evidence to support clinical practice and they understand clearly that much of this evidence is numeric and can be analysed using good statistical methodologies.

As statisticians, we must support the development of such eager minds on their way to achieve their ultimate goal, the improvement of patient care and thus the health of our communities.

REFERENCES

Farris, R. L., Gilbard, J. P., Stuchell, N. (1983). Diagnostic tests in keratoconjunctivitis sicca. *Contact Lens Association of Ophthalmologists Journal*, 21, 221-228

Gilbard, J. P., Farris, R. L., Santa Maria II, J. (1978). Osmolarity of tear micro volumes in keratoconjunctivitis sicca. *Archives of Ophthalmology*, 96, 677-681

Hamilton, B. B., Granger, C. V., Sherwin, F. S. (1987). A uniform national data system for medical rehabilitation. In M. J. Fuhrer (Ed.), *Rehabilitation Outcomes: Analysis and Measurement*, (pp. 137-147). Baltimore, Maryland: Paul H. Brookes.

Harth, A. and Vetter, W. R. (1994). Grip and pinch strength among selected adult occupational groups. *Occupational Therapy International*, 1, 13-28

Holloway, A. and Watson, H. E. (2002). Role of self-efficacy and behaviour change. *International Journal of Nursing Practice*, 8, 106-115.

Law, M., Baptiste, S., Carswell, A., McColl, M. A., Polataiko, H., and Pollock, N. (2005). *The Canadian Occupational Performance Measure (COPM)©*, McMaster University, California.

Mahoney, F. I. and Barthel, D. W. (1965). Functional evaluation: The Barthel Index. *Maryland State Medical Journal*, 14, 61-65.

Mathiowetz, V., Kashman, N., and Volland, G. (1985) Grip and pinch strength: Normative data for adults. *Archives of Physical Medicine and Rehabilitation*. 66, 69-74.

McDowell, I. and Newell, C. (1996). *Measuring Health: A Guide to Rating Scales and Questionnaires* (2nd edition). Oxford: Oxford Press.

Melzack, R. (1992). The McGill Pain Questionnaire. In D. Milne (Ed.), *Assessment: A Mental Health Portfolio, Psychological Adjustment to Illness* (pp. 4-9). Windsor: NFER-Nelson.

Peterson, P., Petrick, M., Connor, H., and Conklin, D. (1989). Grip strength and hand dominance: Challenging the 10% rule. *American Journal of Occupational Therapy*. 43(7), 444-447.

Pratt, J. (1997). The assessment of work performance. In J. Pratt and K. Jacobs (Eds.), *Work Practice: International Perspectives*, (pp. 101-125). Oxford: Butterworth Heinemann.

Rice V. H. and Stead L. F. (2005). Nursing interventions for smoking cessation. *Cochrane Databases of Systematic Reviews*, 2.

Thai, L. C., Tomlinson, A., and Pearce, E. I. (2005). Tear film changes in the initial and mid term adaptation to contact lens wear. *The Ocular Surface*, 3, S119.

Tomlinson, A. (2005). Tear Film Osmolarity. Keynote address to the NEI Dry Eye Workshop Group at ARVO, Florida. April.

Tomlinson, A., Khanal, S., Ramaesh, K., Diaper, C., and McFadyen, A. K. (2006 in print). Tear film osmolarity: Determination of a referent value for diagnosis of KCS. *Ophthalmology*.

Watson, H. E. (1999a). A study of minimal interventions for problem drinkers in acute care settings. *International Journal of Nursing*, 36(5), 425-34.

Watson, H. E. (1999b). Problem drinkers in acute care settings: Validation of an assessment instrument. *International Journal of Nursing*, 36(5), 415-23.