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Human patient simulation in physiology teaching: designing a high fidelity cardiovascular demonstration for first year undergraduates

E. Lloyd, R. Helyer, P. Dickens and J. Harris

Department of Physiology, University of Bristol, Bristol, UK

Undergraduate cardiovascular teaching is traditionally delivered via lectures, tutorials and practical classes. The latter enable students to record their ECG and blood pressure but are necessarily limited to using non-invasive techniques in young, healthy individuals.

We are enhancing our existing teaching with a Human Patient Simulator (HPS 337, METI), a life-sized manikin equipped with mechanical and software modelling of many physiological variables. The HPS was designed for clinical training but is also well suited for demonstrating physiological principles. It has previously been used as a teaching tool to explore cardiovascular physiology [1] and we have extended the approach taken in that study by comparing the cardiovascular responses predicted by the HPS base model with published *in vivo* data. This has enabled us to refine the model so as to provide data that approximate more closely to *in vivo* measurements.

We have developed a teaching session to illustrate physiological principles that include the baroreceptor reflex and Starling's law of the heart, by using the HPS to model the response to blood loss in man of ca. 10%, 30% and 50% of total blood volume.

The HPS provides real-time waveform displays of arterial blood pressure (ABP), central venous pressure (CVP) and ECG. A simulated thermodilution method can be used to determine cardiac output (CO). The waveforms are generated by a software model that is pre-configured by the manufacturer, although some parameters within the model can be adjusted by the user. In order to construct a cardiac function curve and to 'dissect' the baroreceptor reflex, we also used data provided by the model to derive real-time values for stroke volume (SV) and total peripheral resistance (TPR).

The simulated data were compared with data from pigs [2] and dogs [3] subjected to a corresponding blood loss. A good correlation was identified between the *in vivo* data and the METI base model for changes in CVP, SV and CO in response to all three levels of blood loss. However, *in vivo* reflex control of ABP in response to haemorrhage was found to be inadequately simulated by the HPS base model. Calculation showed that the base model incorporates only a modest increase in TPR following haemorrhage. We therefore adjusted the model by increasing both the baseline systemic vascular resistance (by a factor of 1.5) and the 'gain' of the peripheral component of the baroreceptor reflex (by a factor of 2.0). These adjustments provided simulated data that closely approximated the porcine and canine data.

We conclude that, although the METI base model is suitable for illustrating qualitative changes in systemic arterial pressure and pulse rate in response to haemorrhage, it is necessary to refine the model in order to provide more robust simulation of experimentally-derived data.

Euliano TY (2001). *Adv Physiol Educ* **25**, 36-43.Preisman S *et al.* (2002). *Br J Anaesth* **88**, 716-718.Yoshihisa F *et al.* (2004). *Anesth Analg* **99**, 1780-1786.

Where applicable, the authors confirm that the experiments described here conform with the Physiological Society ethical requirements.

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Teaching physiology to mature pre-registration nursing students

E.A. Tansey, S.M. Roe and L.E. Montgomery

Physiology, Queens University Belfast, Belfast, UK

In recent years access to pre-registration nursing courses has been widened to incorporate the mature student (Lauder & Cuthbertson, 1998). To retain these students, and so avoid future shortages, strategies should be considered to provide for any additional educational requirements.

An anonymous questionnaire was used and distributed throughout two different intakes of students (90 mature respondents in total). Four themes were explored in detail.

1) Who are the students?

Mature students were defined as individuals of 26 years of age and older. The average age of mature respondents was 32, with ages ranging between 26 and 52 years of age, as you might expect the majority (62%) of the respondents stated that they had dependants. The majority of respondents (41%) entered the nursing diploma through an access course and prior employment was predominantly in the caring field (58%). There was however a general trend towards jobs at the lower end of the wages spectrum, which was reflected in the fact that 25% of students admitted that one of their major motivations for joining the course was to improve their job satisfaction and security. The majority of respondents however indicated that the course was a fulfilment of a life long desire to be a nurse (31%).

2) Barriers preventing students from continuing with the course
The most common barriers identified were financial (59% of respondents), family commitments (46%) and childcare issues (42%).

3) Differences between mature and younger nursing students
The major perceived difference was that the focus of mature students is more family orientated, with the many responsibilities that come with it (37%). However that mature students are more focused and committed was also frequently cited as a perceived difference (22%). Despite the obvious anxiety of mature students (with 44% of respondents expressing concern over balancing home and student life) there was a large number of respondents (47%) who indicated that they felt that their maturity would benefit them, they believe their life experience will enable them to show more patience and understanding with patients.

4) Additional teaching support for the mature student
A very high proportion (77% of respondents) indicated that they would appreciate extra teaching support. 22% requested study skills classes and 27% requested advice on essay writing. Students lacking in a scientific background frequently commented that they would appreciate extra classes regarding basic scientific concepts e.g. what is salt, that they were assumed to be familiar with already.

Lauder W & Cuthbertson P (1998). *Nurse Education Today* **18**, 419-425.

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Analysis of exams using certainty-based marking

A.R. Gardner-Medwin

Physiology, UCL, London, UK

Certainty-based marking (CBM) has been used at UCL in 17 summative medical exams (years 1&2), each with 250-300 True/False questions and >300 students. Students enter answers on OMR sheets (Speedwell Computing Services) with an index of certainty or confidence that each one is correct. The 3-point scale (C=1,2,3) corresponds to marks given for correct answers, with penalties 0,-2,-6 for errors. This mark scheme is proper, in the sense that students gain by indicating low C when their probability of error is low and high C when it is high. Optimal threshold probabilities are 0.67 and 0.8 for C=2,3. Students were well practised through self-assessments (www.ucl.ac.uk/lapt) and formative tests with detailed feedback. The aim is to encourage care in justification of answers and to improve exam data.

CBM and conventional (number-correct: NCOR) scores were both scaled so 0%=chance performance (at C=1) and 100%=maximum. CBM scores were linearised (raised to the power 0.6), so that the regression of CBM vs NCOR is typically close to the line of equality. Mean scores were $CBM=55.0\pm12.6\%$ SD and $NCOR=53.3\pm12.8\%$ SD. A measure of exam reliability is Cronbach Alpha, indicating how well the combined data reflect a single variable ('ability') characteristic of the student. This was higher for CBM scores than for NCOR (92.4% vs 88.7%, difference $3.7\pm0.31\%$ SEM, $n=17$, $P<0.001\%$).

A more intuitive way to view reliability is in terms of the correlation between scores from alternate questions: sets with odd and even numbers. If the data are reliable, then the score on one set is a good predictor of the score on the other. The mean correlation coefficient (r) for CBM was 0.859 ± 0.030 SD, significantly greater than for NCOR (0.814 ± 0.030 ; difference 0.045 ± 0.0042 SEM, $P<0.001\%$). CBM scores were not only better predictors of CBM on the alternate set, but also better predictors of NCOR (CBM vs NCOR: $r=0.829\pm0.030$ SD, greater than NCOR vs NCOR by 0.015 ± 0.0021 SEM, $P<0.001\%$). Improvements were largest for the bottom third of each class, critical for standard setting and pass/fail decisions: NCOR alone $r=0.428$, CBM 0.560 ($P<0.001\%$), NCOR vs CBM 0.460 ($P<0.1\%$).

Most students achieve percentages correct in the optimal ranges for each C level. Where students were over- or under-confident (too low or high a % correct with a given level), upward score adjustments (averaging 1.2%) were used in the above analysis, calculated by re-assigning C to the optimal level. The proportion of papers where this adjustment exceeded 2% was just 3.1% for over-confidence and 18% for under-confidence. Though such compensation is perhaps generous, it ensures that no student can argue that a fail mark was simply due to poor calibration of confidence. Weak students benefit if they correctly identify reliable answers, but do not lose out if they fail to do this correctly.

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A procedure for peer assessment of physiology practical reports by medical science undergraduates

J.R. Harris

Physiology, University of Bristol, Bristol, UK

Peer assessment of student coursework has several advantages over assessment by staff. These include provision of rapid formative feedback to students; increased student understanding of what constitutes a 'good' piece of work; and significant savings in staff time, especially for large student cohorts (Orsmond, 2004). However, there are concerns amongst both staff and students that the process is not sufficiently robust, and that marking should remain the preserve of 'experts', i.e. staff.

In this study, 132 first year medical science students completed a 'proforma' report for a practical investigating the effect of posture on drinking-induced diuresis. During the class, students worked in pairs and were allocated to one of three 'posture groups' – seated, exercising and lying with feet raised. Each pair collected their own data, and class data for all three 'posture groups' were collated. The latter were uploaded to a Virtual Learning Environment (Blackboard). Students were required to complete a paper copy of the proforma report in their own time, using their individual data and the collated class data. This required graph-plotting, analysis of results and the identification of appropriate words/phrases to complete ca. 60 'blanks' in the proforma report.

A formative marking session was held one week after the practical class in which students were asked to 'double-swap' their work – this avoided reciprocal marking and reduced the likelihood of 'buddy marking'. The session was led by a lecturer who annotated an electronic version of the proforma using a SMART interactive TFT writing and graphical display panel. The annotated proforma was broadcast simultaneously to 40 student PCs within our physiology teaching laboratory using SMART Synchroneyes classroom management software. Assessment was informed by a marking scheme devised by the lecturer and explained to the students during the session. To ensure that markers took the process seriously, they were asked to record their name on the marked script.

Marks were collected at the end of the session and a random sample of scripts was double-marked by the lecturer. Students were asked to evaluate the procedure in terms of reinforcing subject-specific knowledge; increasing awareness of effective data presentation; and providing encouragement to complete the report carefully and to reflect on their work.

Conclusions were:

- Assessment of 132 practical reports was completed in two sessions of 45 min each, compared with an estimated 30 hrs of staff marking time;
- The standard of work was high (average peer mark of 80.1%);
- With very few exceptions, there was good agreement between the marks allocated by students and staff;

d) Whilst a small minority of students questioned the value of the process, most reported that it was a motivating and very useful experience.

Orsmond (2004). Self- and Peer-Assessment: Guidance on Practice in the Biosciences. Teaching Bioscience: Enhancing Learning Series. Higher Education Academy Centre for Bioscience.

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