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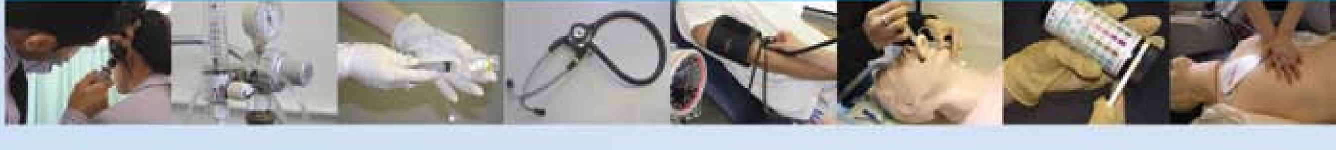
- 'docendo ac discendo' - 'by teaching and learning'



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The International Journal of Clinical Skills looks forward to contributing positively towards the training of all members of the healthcare profession.

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Foreword

Globalisation and Clinical Skills

The International Journal of Clinical Skills (IJOCS) – the new road to new skills? Maybe – but it has certainly opened a platform for the globalisation of clinical skills. The World Health Organisation's (WHO) programme on globalisation targets public health risks, security and outcomes. Driven by the concept of "global public goods" and cross-border health risks, the underpinning issue is to promote health for the poor by way of achieving national health targets. As with the IJOCS, the WHO strategy seeks new technologies in the clinical arena to provide investigative tests – with the WHO being particularly interested in those tests which are suitable for developing countries along with new drugs for endemic diseases. The aims are indeed noble. Investigative and therapeutic technologies create a vacuum for the dissemination, sharing and globalisation of clinical skills, which remain the main asset and commodity which clinicians of poorer nations exercise, promote and share. The IJOCS has released a bolt for health professionals to do just that – share knowledge.

The provisions of the healthcare industry in developed countries by sheer volume and demand, streamlines clinical skills into sub-specialised areas. Clinicians (medical, paramedical and nursing) in these areas gain clinical expertise that are unique to their field and emerge from rich patient-clinician interactions. The clinical skills of dealing with children with disabilities, rehabilitation medicine and terminal care are mere examples that are deficient in the poorer health economies that spend the best part of their human resources to combat diseases of malnutrition and poor sanitation.

The IJOCS provides a global resource centre for sharing and promoting clinical skills between clinicians and health professionals. Senior clinicians, who practiced medicine during the last four decades, will have recognised a gradual and progressive pattern of dependence on technologies with less reliance on clinical skills. The IJOCS provides a platform for sharing and debating the inter-phase and interactions between new technologies and clinical skills. It promotes the development of a new layer of clinical expertise that will emerge from the interpretation, application and/or exclusion of new technologies, for the benefit of clinical care.

I trust that clinicians practicing in poorer health economies will enhance the Journal by sharing their clinical skills and knowledge. Their special expertise of managing clinical needs, within restricted resources, expectedly stimulates the human ingenuity and creativity, leading to the development of clinical skills suitable for each unique circumstance. I, for one, will be actively supporting the IJOCS innovative approach to collaboration of skills. The IJOCS will provide a vehicle for the transmission of these skills across the globe for sharing expertise between different health economies to enrich the overall clinical skills arena.

Hippocrates recognised the professional responsibility of the individual clinician by stating that physicians "must have a wealthy …medical knowledge, clinical skills, medical ethics, interpersonal skills,…". The IJOCS improves the physician's opportunity to enhance his/her clinical skills "by teaching and learning".

Dr Atef R Markos FRCOG FRCP

Simulating haemorrhage in medical students

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Abstract

This article is a descriptive report of a novel way of teaching the cardiovascular response to progressive haemorrhage in a first year medical undergraduate setting using simulation. Simulation may provide the means to allow students to see in practice the theoretical knowledge they have gained from lectures, thus giving clinical relevance to that knowledge, which may improve retention. A progressive haemorrhage is simulated in a volunteer medical student by applying sub-atmospheric pressure to the air surrounding the lower body using a lower body negative pressure (LBNP) chamber. This sub-atmospheric pressure will result in 'pooling' of blood in the vessels (particularly veins) of the legs and pelvis. This 'pooling' will reduce the amount of blood returning to the heart (venous return) thus mimic the effects of loosing blood from the cardiovascular system. The body responds by engaging various physiological responses to blood loss. To demonstrate these responses a range of cardiovascular parameters are monitored throughout the demonstration to allow students to observe the response to progressive haemorrhage. One of these parameters is cardiac stroke volume, which is monitored by using a portable ultrasound device. In addition to demonstrating an important principle of physiology which students are likely to have encountered in their lectures, using the ultrasound device also fulfils an objective set out by the General Medical Council (GMC) to familiarise medical students with clinically relevant two-dimensional imaging equipment early in their studies. Conclusion: Durham University Medical Programme uses a LBNP chamber as a simulation to reinforce didactic teaching of the cardiovascular response to haemorrhage. The use of simulation in medical education is becoming increasingly more commonplace as its potential benefits are recognised. The simulated haemorrhage may provide the means to allow students to see the theoretical knowledge they have gained from lectures in a 'clinical' context, which ultimately may improve knowledge retention.

Introduction

The use of simulation in medical education is becoming increasingly more commonplace as its potential benefits are recognised. Simulation, or in this case demonstration of a simulation, may provide the means to allow students to see in practice the theoretical knowledge they have gained from lectures, thus giving clinical relevance to that knowledge, which may improve retention [1]. The inactivity of students encouraged in didactic lectures does not promote effective learning or retention of knowledge [2]. In addition, it has been widely noted that students are underprepared in the skills required of a doctor [3], and there are concerns that medical graduates do not have sufficient experience in several clinical skills [4].

As part of the Durham University medical degree programme learning outcomes it is essential that the medical undergraduate student can demonstrate knowledge and understanding of important mechanisms in maintaining homeostasis. This means they will need to be able to describe the effects of the autonomic nervous system on the cardiovascular system and also be able to explain the operation of the major reflex loops controlling blood pressure. The simulated haemorrhage in a healthy volunteer using lower body negative pressure (LBNP) demonstrates the changes which occur in these physiological parameters during a progressive haemorrhage. The aim of the simulated haemorrhage session is therefore to reinforce their theory learning of physiological concepts such as Starling's law of the heart and the Baroreceptor reflex. The demonstration forms part of a practical class in which students practice clinical skills on each other, such as taking blood pressure and measuring heart rate from an electrocardiogram (ECG). These clinical skills will allow the student to interpret changes in these basic clinical parameters in the context of a (simulated) clinical problem. Students can then relate all of the observed changes to the underlying physiological mechanisms hence consolidate information learnt in lectures.

Theory of Lower Body Negative Pressure

Exposing the lower body to negative (sub-atmospheric) pressure will increase the pressure gradient across the wall of the veins in that part of the body. The most immediate effect will be that the veins become distended as blood is trapped in them, rather than returning to the heart [5, 6]. A secondary effect would be increased net filtration of fluid from the capillaries in that part of the body. However, over the time course of the demonstration any pooling of water in the interstitial spaces is relatively minor and can be ignored. Thus, lower body negative pressure (LBNP) is a means of reducing venous return in a subject and hence can mimic a variety of conditions which involve reduced venous return e.g. haemorrhage, orthostasis (standing up), 'G' forces ("blast off" in a rocket, pulling out of a dive especially in military air craft) [5, 7]. Indeed, this technique has been used extensively in research to investigate a wide range of conditions including simulating haemorrhage [8]. The situation being mimicked depends on the degree and rate of change of LBNP used. By gradually increasing the degree of negative pressure around the lower body, venous return can be progressively reduced (mimicking a progressive haemorrhage); or if a high degree of negative pressure is rapidly produced, a catastrophic haemorrhage, sudden rocket "blast off" or a rapid air craft manoeuvre can be mimicked [7]. Conversely, by reducing LBNP (back to atmospheric pressure) the effect of a volume infusion in a haemorrhagic patient can be mimicked. The technique is used on the Durham University Phase I Medical Programme to demonstrate the effects of gradually increasing LBNP on a range of cardiovascular parameters in a volunteer to determine how the cardiovascular system responds to a diminishing venous return (and what would happen during progressive blood loss or prolonged standing), and then when venous return is returned to normal (e.g. during an intravenous infusion in a haemorrhaging patient, or when a standing subject lies down again). This model of haemorrhage is demonstrated to small groups of students (approximately 20), with one acting as a volunteer.

Method and equipment

The learning objectives for this session are to observe the effects of simulated mild/moderate haemorrhage on heart rate, blood pressure, and stroke volume and to calculate cardiac output and vascular resistance, and to explain the physiological basis of all aspects of the response.

Risk analysis and ethical approval: A full risk assessment of this procedure was carried out and ethical approval was gained from the Durham University Ethics Committee for Teaching Work and Practicals.

After reading the information sheet (demonstration schedule) and signing a consent form (Appendix 1) the volunteer lays supine with the lower part of their body (legs and pelvis up to the iliac crest) sealed in the LBNP chamber (Figure 1):

Figure 1: The lower body negative pressure chamber, which is sealed up to the iliac crest of the volunteer.

The LBNP is applied in the presence of a qualified clinician for health and safety reasons. The subject is monitored closely for symptoms of presyncope such as nausea, light headedness, pallor and sweating, as well as their comfort at all times, however it is NOT the intention to apply such negative pressure to bring on these symptoms. If any of these symptoms do develop, the negative pressure would be changed back to atmospheric pressure.
The following measurements are made:

Stroke volume: measured with the SonoSite MicroMaxx™ portable ultrasound system (SonoSite Ltd, Herts., UK) using the P17 cardiac probe with a frequency of 1 - 5MHz (Figure 2):

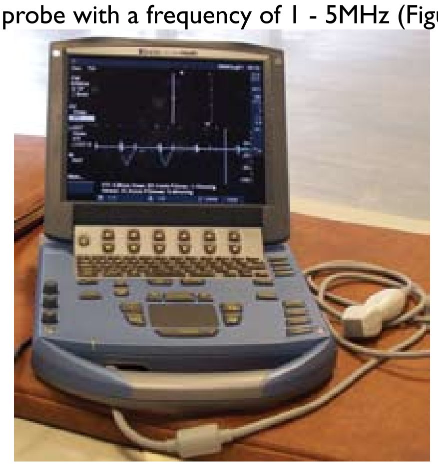

Figure 2: SonoSite MicroMaxx™ portable ultrasound system (SonoSite Ltd, Herts., UK) with the P17 cardiac probe attached. The screen shows a Doppler waveform.

A 2D measurement of the transverse aorta is made by placing the probe on the suprasternal notch and the probe angled so as to direct the beam of ultrasound across the arch of the aorta (Figure 3):

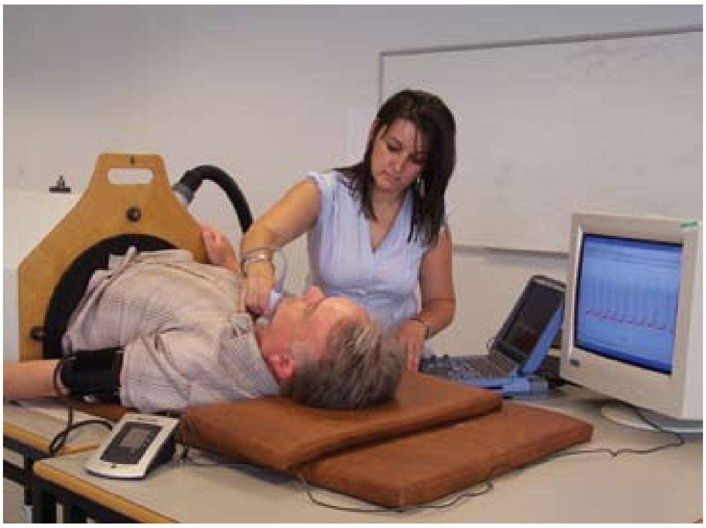

Figure 3: Demonstration of the placement of the cardiac probe of the SonoSite MicroMaxx™ portable ultrasound system on the suprasternal notch. The probe is angled so as to direct the beam of ultrasound across the arch of the aorta.

This allows the diameter of the aorta to be measured. Blood flow velocity is then determined by assessing the change in frequency (Doppler shift) of the beam of ultrasound directed towards the aorta from the suprasternal notch and reflected by the blood moving in the aorta. The velocity time integral is then calculated by integrating blood flow velocity in the aorta over time, and together with the diameter of the aorta, stroke volume is calculated.

- Heart rate: detected accurately from an ECG trace
- Blood pressure: using an automated sphygmomanometer

Three baseline measurements of stroke volume, heart rate and blood pressure are initially made. The volunteer is then subjected to a progressively increasing LBNP of -17.5, -35 and -50 mmHg (thought to correspond approximately to 500ml, 750ml and 1000ml fluid displaced [9]), followed by a stepwise decrease (-35 and -17.5 mmHg) to baseline (0 mmHg). Each pressure step is maintained while cardiovascular measurements are made at each pressure level.

Data Analysis

The students were asked to analyse the data by completing a table showing the following at each level of pressure:

- stroke volume (SV)
- heart rate (HR)
- cardiac output (CO); calculated by multiplying stroke volume with heart rate
- systolic blood pressure (SBP)
- diastolic blood pressure (DBP)
- mean blood pressure (MBP); calculated as one third of the pulse pressure plus diastolic pressure
- pulse pressure (PP); systolic pressure minus diastolic pressure
- total peripheral resistance (TPR); calculated by dividing mean arterial blood pressure by cardiac output

Students were also asked to draw a flow diagram relating the above measurements/calculations, to indicate the physiological basis of a) the effect of lower body negative pressure on venous return and stroke volume and b) the body's response to this disturbance.

Response to Haemorrhage/LBNP

Progressive haemorrhage will reduce venous return and preload, thus reducing stroke volume by Starling's law of the heart [10]. This will result in a reduced pulse pressure and an unloading of the baroreceptors leading to sympathoexcitation and vagal inhibition [11, 12]. The body's response to reduced venous return is an increase in heart rate and peripheral resistance, thus mean blood pressure is maintained in the face of a falling cardiac output. Results from our LBNP demonstrations to medical undergraduates reflect this cardiovascular response.

As the haemorrhage becomes more severe (or the lower body pressure is further reduced) cardiovascular decompensation occurs involving sympathoinhibition and vagal activation causing a fall in heart rate [11] and peripheral resistance and a resulting profound hypotension [13, 14]. However, it must be stressed that the undergraduate practical does not take the demonstration to this phase of the response.

Improving the diagnosis of haemorrhage

Demonstrating a simulated haemorrhage and the monitoring of cardiac stroke volume using a Doppler ultrasound device in undergraduate medical education may ultimately help the qualified doctor to improve the diagnosis of occult blood loss in a trauma patient. The Advanced Trauma Life Support (ATLS) courses stress the importance of increasing heart rate and decreasing blood pressure as signs of severe blood loss. However, studies have shown that this occurs in only approximately one third of trauma victims [15]. A study for the Royal College of Surgeons [16] carried out a retrospective analysis of 1000 trauma related deaths in England and Wales and concluded that 63% of non head injury deaths were preventable, and that an important factor of these deaths was failure to recognise blood loss. One of the reasons for this may be that in the majority of trauma victims in the UK, heart rate and blood pressure (the vital signs monitored in trauma patients) do not follow the pattern outlined by ATLS and thus overt blood loss may easily be missed by the less experienced clinician. The diagnosis of haemorrhage may be improved with the use of ultrasound technology to monitor stroke volume as this falls early and progressively throughout haemorrhage [13] due to Starling's law of the heart, and can be detected early before changes in heart rate and blood pressure are apparent [15].

Conclusion

Durham University Medical Programme uses simulation to reinforce didactic teaching of the cardiovascular response to haemorrhage utilising a LBNP chamber [8]. The use of ultrasound during the demonstration allows measurements of stroke volume, which falls progressively throughout blood loss, to be made throughout the demonstration. This demonstration may enhance students' understanding of the theoretical knowledge, introduce clinically relevant imaging equipment at an early stage, and may produce generations of practitioners whom will be willing to use ultrasound to detect overt blood loss in an emergency care setting. Ultimately, this may lead to a reduction in preventable deaths from misdiagnosis of haemorrhage.

Author Information

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Appendix 1: CVRRM 30. Simulated 'Simple' Haemorrhage Volunteer consent form

I hereby consent to act as subject for the simulated haemorrhage (lower body negative pressure).

I am not suffering from any cardiovascular disease and am not taking any medication (prescribed or otherwise), and I am not pregnant. I do not normally suffer dizziness or fainting. I further confirm that I do not suffer from varicose veins and have not consumed alcohol within the past 24 hours and am not an endurance athlete.

I understand that my acting as volunteer will have no effect on any assessment made of me and that I am free to withdraw at any time.

Signed	Name	Date
Witness	Name	Date

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