Developing the "NUS Tummy Dummy", A Low-Cost Simulator to Teach Medical Students to Perform the Abdominal Examination

Dear Editor,

Simulators may be used to provide adequate exposure to learning experiences that allow clinical skills to develop, that is, allow medical students and trainees to perform the steps of clinical examinations and to acquire diagnostic skills. To date, simulators have been developed for trainees to perform cardiac and respiratory examinations, deliver a baby and perform surgical and endoscopic procedures. Interestingly, simulator use to perform the abdominal examination has not been described in the literature. This paper describes the creation of the National University of Singapore (NUS) Tummy Dummy (NUS-TD), a low-cost, portable abdominal simulator, which can be used to teach the steps of the abdominal examination. During the recent outbreak of H1N1 influenza, contact between medical students and live patients was restricted. Our medical school adopted contingency measures to impart clinical skills, such as the use of simulated patients and e-learning modules. In addition, a teaching module using the NUS-TD was piloted, to impart clinical skills to a group of 44 medical students during their clinical skills foundation course. Feedback was positive with 93.2% opining that the NUS-TD was useful and 79.6% saying that it increased their confidence in performing the steps of the abdominal examination. Abdominal simulators can be adopted to impart palpation skills to medical students, in addition to using live patients with good clinical signs.

Introduction

Upwardly spiralling healthcare costs have prompted the advent of healthcare management systems such as the casemix classification system, which categorises all diseases into clinically meaningful diagnostic clusters [diagnosis-related groups (DRG)] requiring similar utilisation of resources. Each DRG describes a group of patients with related diagnoses incurring similar health management costs.[1] Healthcare management systems, whilst ostensibly resulting in better allocation and utilisation of resources, have brought about shortened inpatient care, with a move to outpatient and ambulatory care.[1] Pandemic outbreaks of H5N1, H1N1 influenza and the severe acute respiratory syndrome (SARS) have, likewise, mandated the barring of medical students from live patient contact.[2] Such events have resulted in both a scarcity of patients with "good" signs on which medical students can acquire clinical skills. Patients may, in addition, refuse to be examined by a medical student or trainee doctor.[3] In order to provide adequate exposure to learning experiences that allow clinical skills to develop,[4] educationists have incorporated simulator use for the acquisition of skills in basic cardiac life support (e.g. Resusci Anne), the cardiorespiratory examination (e.g. Harvey) and delivery of the neonate (e.g. BirthSIM).[2] Simulator training has been well received by trainees, and has shown to be effective for the teaching and assessment of these skills.[4]

Interestingly, although the abdomen features prominently in the teaching of endoscopic, sonographic, laparoscopic and surgical skills, abdominal palpation skills have not featured in the literature, other than models and virtual simulator programmes designed to teach trainees to perform the digital rectal examination. Interestingly, Parkes et al[5] have described a mixed-reality simulator to train trainee veterinarians to palpate the feline abdomen.

Building the NUS Tummy Dummy

We sought to build and test the utility of a low-cost abdominal simulator. For verisimilitude, we determined that the mannequin, named the NUS-TD, should be life-sized, yet easily manoeuvred during the examination. Desirable attributes of the NUS-TD included hardiness, facile manufacture, portability and cost-effectiveness. We incorporated accoutrements such as a range of viscera of various sizes which could be palpated (liver, spleen, gallbladder, urinary bladder or uterus) or balloted (kidneys). Using previously-established techniques,[6-8] we created a durable, stretchable, opaque, flesh-coloured abdominal "skin" of silicon that allowed the user to palpate the viscera.

The "shell" was created in 2 parts by applying plaster of paris (POP) strips to the torso, from the second rib to the pubic symphysis. The anterior and posterior halves were then joined together, and the shell reinforced with clay and strips of fibreglass. Three apertures were then created, two 9 x 7 cm apertures over the loins of the mannequin, to allow ballottement of the kidneys, and one large aperture, measuring 40 x 50 cm anteriorly, to simulate costal margins and the iliac crests of the pelvis (Fig. 1). Thick styrofoam boards were added, not only to simulate the diaphragm and pelvic floor, but to provide support to the viscera. Additional support was provided by a spinal column made of styrofoam and foam. To replicate the experience of ballottement of enlarged kidneys, we affixed a silicon skin to each "loin window", as well as taut rubber bands, beneath which each enlarged kidney would be placed (Fig. 1). Finally, the NUS-TD was spray painted in flesh tones and Velcro affixed with silicon glue and metal clips to the edges of the apertures, to enable the silicon skin to be securely fastened to the torso.

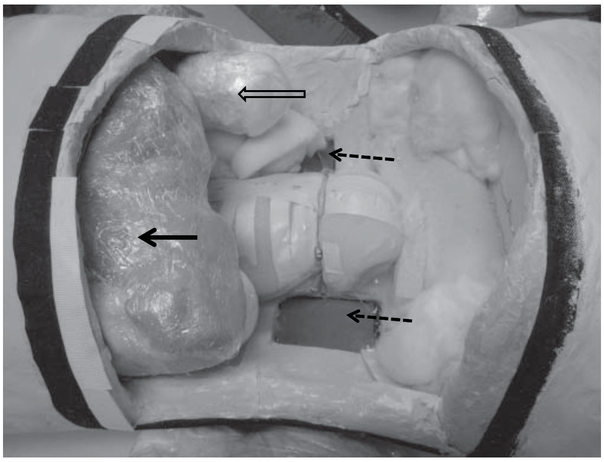

Fig. 1. NUS Tummy Dummy (NUS-TD) with moderately enlarged liver (solid arrow), spleen (unfilled arrow) and apertures for ballotting kidneys (dotted arrow). Note the rubber bands attached to the foam "spine" which secure the kidneys, to make ballotement possible.

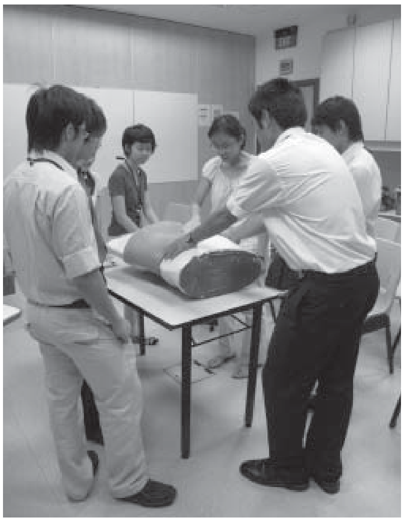

Fig. 2. Students trying out the NUS-TD during the clinical skills foundation course. The senior (final-year) medical student (hands supporting the NUS-TD at the "ribs") is teaching the 3rd year medical student to palpate the abdomen through the silicon skin.

The silicon skin was made in 3 layers using RTV-2 silicone. Each vulcanised layer was made by mixing 250 g of silicone with 25 g of catalyst and 3 g of flesh-coloured pigment. The initial layer was applied over a negative cast of the anterior abdominal aperture, and heat-dried using a heat-gun for 15 minutes (although a hair drier would also suffice). A second layer was applied in the same way. Prior to applying the third layer, a nylon mesh was laid over the second layer, to reinforce the structure.[6,9] Finally, velcro was affixed to the vulcanised silicon skin, to allow it to be attached to the torso of the NUS-TD.

We focused on building a utilitarian rather than aesthetically pleasing simulator, prioritising the palpability and ballotability of the viscera for the NUS-TD. As such, viscera of 3 sizes (normal, moderately and massively enlarged) were created using wads of newspaper, on top of which the organ was shaped using plasticine and moulding clay. Cling wrap and adhesive tape completed the packaging. Different degrees of visceromegaly were simulated by wadding the space between the styrofoam "diaphragm" and the viscus to be palpated with newspaper or foam.

Pilot Teaching Module using the NUS-TD

Completion of the NUS-TD coincided with the outbreak of H1N1 influenza, which mandated closure of the wards to medical students during their clinical skills foundation course (CSFC), a 6-week programme bridging pre-clinical studies and clinical attachments. Although contingency measures were in place in the form of simulated patients and e-learning,[2] we piloted a trial of the NUS-TD on a group of 44 students attached to our university hospital for the CSFC posting (Fig. 2). Forty-one students (93.2%) found the NUS-TD to be a useful tool in learning the steps of the abdominal palpation properly. Thirty-five (79.6%) reported being more confident of their ability to perform the abdominal examination after completing the pilot. We intend to extend the module to more students, and assess the usefulness of the NUS-TD in a formal study.

Conclusions

Owing to decreasing opportunities for patient contact and increasing unwillingness of patients to be examined by medical students and trainee doctors,[3] there is a place for the use of simulators in medical education. The NUS-TD, a low-cost and easy-to-build abdominal simulator, can be used to teach medical students to perform steps of the abdominal examination in conjunction with the examination of live patients with good clinical signs.

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