Obstetrics Simulators as the Teaching Tools for Medical Undergraduates

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ABSTRACT

The use of simulation-based learning has been widely adopted in medical undergraduate training. This article aims to review the effectiveness and feasibility of obstetric simulators which are suitable for undergraduate teaching. For teaching procedural skills on episiorrhaphy, the sponge model is as effective as the beef tongue model but is more feasible. The commercial episiorrhaphy model is less suitable due to their high cost and high maintenance. The simple birthing pelvis is as effective as the full body obstetrics manikin in teaching simple vaginal birth. The use of cervical dilatation simulators and pregnant abdomen simulators still lacks evidence to support their effectiveness and their use may be limited only to the medical schools where clinical contact with the pregnant patients is restricted. Apart from considering the cost – effectiveness of each simulator, each medical school must also choose the simulators that suit the learning objectives and the needs of their context individually.

Keywords: Simulation, simulator, obstetric education, medical education

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INTRODUCTION

The use of simulation-based teaching in the medical curriculum has been validated in many previous studies.[1] Simulation creates an ideal educational environment where students can learn through experimentation with ability to rewind and rehearse without harm to the patient. In a meta-analysis of 14 literatures to compare effectiveness of traditional clinical education versus simulation-based medical education (SBME) with deliberate practice, the result showed that SBME is superior to traditional clinical medical education in achieving specific clinical skill acquisition.[2] The use of simulators for teaching practical skills in obstetrics has a long history. Dated back to the 1600s, "the Phantoms," an obstetric manikin torso was one of the first obstetric simulators used to teach midwives to manage abnormal childbirth.[3]

With increased medical liability concerns and decreased patient availability for teaching, medical simulation is now gaining a potential role in obstetrical education.[4] Simulators allow students to rehearse skills that would be considered

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unsafe to practice on real patients for their first time. With current advances in medical education and better technologies to develop good quality simulators, the use of simulators is getting more extensive. Simulation-based training in Obstetrics ranges from part task trainers to a life-size female manikin to practice procedural skills such as breech delivery, vacuum extraction or forceps extraction. Simulated emergency scenarios are also integrated to allow a realistic approach to optimising teamwork behaviours.[5] A report by the Association of American Medical colleges states that 60% of teaching hospitals in the US. use simulation as part of their teaching activities in Obstetrics & Gynaecology.[6]

Even though the high-fidelity obstetric simulation is more promising in terms of students' satisfaction and preparedness for obstetrical house jobs,[7,8] it inevitably comes with higher cost and is more time consuming to set up. Moreover, beyond certain levels, investing in a high-fidelity device will result in just small improvement in skills obtained over a simpler device.[9] Therefore, it does not mean that choosing only high fidelity simulators would be the final answer when implementing simulation in a curriculum. In a low-resource setting such as Thailand, where only limited budget is provided for simulation in medical education, choosing the appropriate device which suits the learning objectives and the needs of the students is not an easy task.

New medical graduates in Thailand are required to perform some procedures that are not required in the UK, for example, examining pregnant women and managing labour and deliveries.[10,11] According to the Thai Medical Competency Assessment Criteria for National License, procedural skills are categorized into four levels. Ranging from level 1 which are basic procedural skills that medical graduates must be able to perform without supervision, to level 4 which are procedural skills that medical graduates are not obligated to perform independently, but must be able to describe the indication, complication and steps in performing the procedure and should be able to assist the procedure during their internship.

In this article, the author will focus on the use of simulators for teaching obstetric procedural skills which newly graduated doctors are required to perform without supervision (level 1), which are as follows:[11]

- Episiotomy (with subsequent episiorrhaphy)
- Assisted vaginal delivery
- Delivery of the placenta (Crede maneuver).

Clinical competency to perform a physical examination correctly is not listed in the professional standards, but is essential and will be assessed by the OSCE examination as part of the national license examination. Important areas of physical examinations in obstetrics which possibly benefit from teaching with simulators are as follows.

Digital vaginal examination to assess cervical progression and fetal station/ presentation during labour.

Leopold's examination of pregnant abdomen and auscultation of fetal cardiac activity.

Considering that these inexperienced medical students are expected to complete such risky Obstetric tasks, optimising the use of simulators to enhance students' experience while keeping the risk to patients at minimum is imperative. The aim of this article is to review available literatures regarding the use of appropriate simulators for each of the mentioned skills above. The effectiveness and feasibility of the simulators for undergraduate level of Obstetrical training will also be addressed.

Models for performing episiotomy and episiorrhaphy

Episiotomy is a surgical cut at the perineum to aid vaginal delivery and episiorrhaphy is a surgical repair of an episiotomy by suturing. Even though routine use of episiotomy is not recommended in general,[12,13] it is still a necessary skill that needs to be performed when assisting a complicated delivery. Episiorrhaphy is usually done by a doctor who is responsible for the duty shift in the rural hospital. Since new graduate doctors are required to attend labour and deliver babies in a rural hospital on their own, episiotomy and episiorrhaphy are surgical skills that should be mastered before they leave their medical school.

Sponge perineum

This inexpensive, simple model using a car washing sponge as perineum was first introduced by Sparks et al,[14] as a teaching tool for severe vaginal-rectal and perineal laceration repair. The sponge model was reported to increase the learners' confidence in the episiorrhaphy procedure.[14] A simpler model was developed later to simulate episiotomy and episiorrhaphy of simple perineal laceration (Fig 1). The sponge model may lack the realistic texture of human tissue, but it can adequately represent the anatomical landmarks by using a pen marker to draw the lines. The sponge model and the beef tongue model are comparable in terms of improving students' confidence and knowledge, but students' satisfaction with the sponge model is lower than with the beef tongue. With regard to feasibility, each sponge costs only 20-50 Baht (approximately 1-2 USD). Therefore, every student can easily get their hands-on experience to improve their apprehension of how each layer of the perineal tissue should be approximately. For teaching a larger number of students such as medical undergraduate class, this sponge model should be justifiable as a valuable and cost-effective option.

Pig tongue and beef tongue

There are many published literatures addressing the use of beef tongue and pig tongue in the perineal laceration repair workshop.[15-18]

Fig 1. A car wash sponge model for practicing episiorrhaphy; note that the red line represents the hymenal ring.

There is evidence supporting that the structured workshops with simulators improves learners' knowledge and skills in repairing perineal injuries.[18]

The advantage of these models is that they closely resemble the consistency of human tissue. The beef tongue has to be prepared to simulate the anatomy of the vaginal and anal canals. The preparation of beef tongue can be done by threading a rubber tube through the tongue muscle to simulate the anal sphincter and use a pen for marking vaginal opening. The price for these models is not expensive. Pig tongue usually can be bought from a local butchery at very low price. A piece of beef tongue would cost around 300-400 baht. However, both of them have to be refrigerated to prevent spoilage. Because of their burdensome preparation, these models are usually reserved for teaching repair of a more severe and complicated vaginal-anal laceration for obstetric residents.[15-18] Using these models for teaching simple vaginal laceration repair at undergraduate levels might not be convenient but still is feasible in some situations.[19] Due to the difficult preparation, the number of these models are often limited at a time and students have to take turn practicing if there is a large number of students in a session.

Commercially available models

There are more than ten companies offering episiotomy and perineal repair suturing kits. Most of them are made with silicone or rubber to imitate the consistency of human tissue. The advantage of these models is that they resemble realistic sensation when handling the tissue, and they represent close to real perineal anatomy with layers of muscles, fascia, and subcutaneous tissue. Unfortunately, these models are expensive, costing around 10,000 -20,000 baht (300-600 USD) for one model. At the author's institution, there are four episiorrhaphy trainers (Fig 2). These models are used to teach the 5th and 6th year medical students. With 20 students rotating in OB-GYN clinical placement at a time and adding up to a total number of 150 students each year, these models are worn out in just one year. Thus, considering that these models may need to be replaced once every few year, the high main-

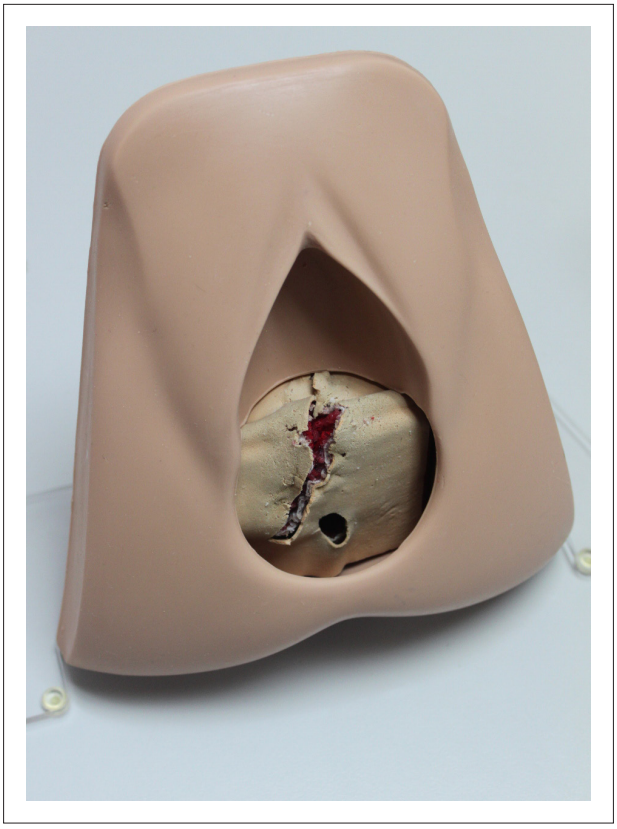

Fig 2. A commercially available episiorrhaphy trainer

tenance cost may impede them from being the best option for teaching the undergraduate students, (If I take the average cost from above of 15,000 per kit and four kits and life one year of medical students and divide by 150 students the cost is just 400 baht per student [(4x15,000)÷150=400], whereas you quoted in the previous paragraph 300-400 baht for pig or beef tongue with burdensome storage and preparation. Therefore I calculate that these kits are not more expensive than pig or beef tongue based on your numbers. I think you may need to reconsider either your numbers or the logic of your argument and add more explanation.)

Models for performing normal delivery

Prior simulation training of vaginal delivery is believed to increase students' confidence to engage in real clinical environment and improve their procedural performance.[20-23] Three recent studies also prove that students who receive simulation training have higher confidence and score higher on written and performance examination compared to students who only receive traditional didactic teaching. For undergraduate level, the key learning objective for students is to be able to perform assisted vaginal delivery in cephalic presenting foetus safely. The key steps that they need to practice with simulators are:

1. When and how to do an episiotomy
2. How to do Ritgen manoeuvre to assist delivering of baby's head
3. How to grab the baby's head correctly and deliver the shoulder
4. How to safely handle the fast expulsed baby's body.

The reason is, that these are key steps which need repetitive practices with the simulator before performing with a real patient, because in the actual situation, these steps happen in rapid sequence. There is no time to explain each step during the procedure. Thus, the students need to perform confidently by deliberate practicing with a simulator before performing the procedure on real patients.

There are several commercially available birthing models produced by different companies. Performance of the models ranges from low fidelity part task trainer, such as simple birthing pelvis, to high-fidelity interactive birthing simulator, such as Noelle® and SIMMOM™ birthing simulators. A study by Sabourin et al compared students' confidence in performing vaginal delivery after training with a part task trainer (PROMPT® birthing pelvis) and a full equipped obstetrics manikin (Noelle®) and found that there was no significant differences between the two models.[25] Therefore, the low-fidelity birthing pelvis can adequately serve as a teaching tool for undergraduates. It might be burdensome for the teacher to manipulate and apply force to push the baby out of the pelvis while the student performs delivery. However, this provides the teacher with an excellent opportunity to closely observe student's action and give them constructive feedback, which is the crucial part of experiential learning.

Using a high-fidelity birthing simulator may be more appropriate for teaching obstetric residents to deal with a complicated vaginal delivery and obstetrical emergencies. There is evidence that simulation training improved residents' performance in management of shoulder dystociaand[26,27] helped residents' in improving shoulder

dystociadelivery. Simulated vaginal breech delivery also improves resident's performance, and their skills are maintained at up to three months after the training.[30,31] Most of the high fidelity models are presented as a life-size interactive manikin equipped with elaborate features to imitate these complications. In particular circumstances, when the simulation involves communication skill, a hybrid simulator, which combines a human actor with a birthing pelvis might be another great option.[32]

Teaching the procedure of delivering placenta may not benefit much from simulation as simulators can hardly mimic the sensation perceived during the process of delivering the placenta, because the manikin cannot imitate the contracting uterus which is the primary force that expulses the placenta. However, the steps of performing the procedure can be recited when practicing on the manikin.

Models for evaluating labour progression with digital vaginal examination

Traditionally, in Thailand, digital examination to assess cervical dilatation and progression of labour is performed on a real patient without any prior practice with simulators. The consultant or senior doctor examines first, followed by a medical student. After that, their results of the examinations are compared, with the result of the consultant being the correct one. This teaching practice has many pitfalls. First, it is very awkward, and sometimes even offensive to the patient being examined by more than one doctor at a time. Second, there are evidences that transvaginal digital examination of the progressing cervix has a high rate of error even in a skilled obstetricians' hand.[33,34] Thus, one cannot be certain that the result obtained from the most senior doctor is the standard result.

Using simulators could be potential alternatives that may alleviate the previously mentioned problems. The models that are currently available give very realistic sensation of dilating cervix and foetal fontanelle. The models are labelled with particular characteristics, such as cervical progression in centimetres or foetal station compared to the pelvis. Therefore, teaching is more accurate than relying on the result performed by a more senior doctor alone. However, there are some pitfalls of the simulator, as they cannot represent the changing position and consistency of cervical progression during labour as happens in the real patient.

Currently, there are two types of part-task trainers available, the hard cervical model and the soft cervical model. The soft models are made of very soft and flexible silicone like material (Biolike^{TM}), and the texture and consistency is very close to a real ripe cervix. The hard models are made of PVC and are less realistic. However, it is suggested that the hard models are preferable when teaching learners at beginning level as learners tend to give more accurate examining result when practicing on the hard model. After mastering the assessment with the hard model, learners may proceed to examine using the soft model which is more realistic, but may be more difficult to accurately assess because of its elasticity.[35] A high fidelity simulator which includes not only the dilating cervix, but also the pelvic cavity and the palpable amniotic membranes/fetal head is also available.

The cost for each unit of the cervical assessment model is around 20,000-30,000 baht. Due to the nature of their use, these models do not require high maintenance. It is a promising option for teaching at a medical school where availability of consenting patients is limited.

Models for abdominal examination of a pregnant abdomen

Medical graduates are encouraged to be able to examine the pregnant abdomen using the Leopold's manoeuvre to predict the presentation and the size of the foetus and listening to the foetal heartbeat with a stethoscope to confirm foetal viability. Because ultrasonography is not available in some rural hospitals, it is important that they have enough physical examination skills to screen for abnormal pregnancy in order to appropriately refer the patient to secondary care.

In Thailand, teaching the Leopold's manoeuvre still mainly relies on real patients as the teaching resources. Usually during antenatal clinic, one or two medical students are assigned to

examine a pregnant patient and report their result back to the consultant, who then confirms the result. Since we usually have enough numbers of volunteer pregnant women, the use of simulators to teach this skill is somewhat limited.

However, pregnant abdomen simulators still have their roles in some situation. For example, a consultant demonstrating the correct technique with detailed narration for the first time to a large group of students, or in some teaching hospitals where only a limited number of patients will give consent to participate in a teaching activity, such as in a Muslim community, where exposing of body parts to male doctors is forbidden due to cultural beliefs. In these circumstances, simulators are inevitably required to substitute real patients.

There are two types of maternity models that are currently available. The comprehensive pregnant manikin with Leopold manoeuvre being integrated as a part of its multiple features (teaching vaginal delivery and episiorrhaphy are also possible in this type of manikin), and the part task trainer model which only presented with pregnant abdomen and a baby manikin. The comprehensive model such as SIMMOM® and Noelle® obstetric simulators cost around 80,000-500,000 baht (2,900-17,000 USD), while the part task trainer models which are the cheaper option cost between 20,000-70,000 baht (600-2,000 USD) depending on the design and materials used for the manikin.

From the author's limited personal experience, the model provides very realistic sensation of the pregnant abdomen which, in the author's perception, is sufficient to facilitate students' learning of the unique tactile sensation of foetal position in the pregnant abdomen. However, these simulated pregnant abdominal models still lack evidence to support their use in medical education. There is no evidence to support, that physical examination skills obtained from the simulated abdomen, can be transferred into accurate clinical practice. A further study regarding this issue may help to determine whether these pregnant abdominal models are the effective tools for teaching Leopold's manoeuvre or not.

CONCLUSION

There are many factors that must be taken into account when choosing an appropriate manikin for teaching purposes. Does the performance of the simulator correspond with the learning objectives? What is the class size? How many students will be using it at a time? What is the cost of maintenance? What is the sum of available funding to be invested? When teaching at undergraduate level which is dealing with a large number of students, a sufficient number of simulators and appropriate maintenance must be available to ensure that all students can have their own deliberate practice. Thus, the cost – effectiveness of each model should be clearly evaluated before making a decision. For teaching the episiorrhapy procedure, a sponge model is an appropriate option because it is as effective as the beef tongue model and is available at lower cost. The commercial episiorrhaphy model, while offering better anatomical resemblance, also requires higher cost and maintenance. Simulation for normal vaginal delivery can be effectively taught with a simple birthing pelvis. A full obstetrics manikin should be preserved for teaching operative vaginal delivery or improving teamwork in obstetric emergencies using simulated scenarios. The evidence supporting the effectiveness of the cervical dilatation and pregnant abdomen model is still scarce. Therefore, its use may still be limited to medical schools where patients' availability is insufficient.

While selecting cost effective manikins is an important issue when implementing simulation in a curriculum, there are still many other steps that must be taken into account in order to make the simulation based study successful which are; *Preparation, Briefing, Scenario encounter, Debriefing, Reflection and Evaluation.*[36] These steps should be used effectively. According to Kolb experiential learning,[37] the educational theory that underpins the simulation-based education, the ability to reflect on the events is crucial for developing effective learning. Therefore, in order to have a facilitator who can provide prompt constructive feedback and debriefing to students, professional development of the staff is also as important and cannot be overlooked.

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