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Towards Implementing Upper Limb Spasticity Simulator(ULSS) in Medical Education; An Integrative Literature Review and Methodology

Nurul Atiqah Othman[1], Noor Ayuni Che Zakaria[1], Fazah Akhtar Hanapiah[2], Low Cheng Yee[3], Khairunnisa Johar[1]

[1] Faculty of Mechanical Engineering, University Teknologi MARA, 40450 Shah Alam, Selangor Malaysia
[2] Faculty of Medicine, Universiti Teknologi MARA, 47000 Sungai Buloh, Selangor Malaysia
[3] Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussien Onn, 86400 Parit Raja, Johor Malaysia

nurulatiqah_othman@yahoo.com, ayuni.uitm@yahoo.com, fazahakhtar@yahoo.com, low.uth@gmail.com, khairunnisa_johar@yahoo.com
Tel: +6014 3090 654

Abstract
Simulation is widely used in Medical Education as a teaching and learning method. The purpose of this paper is to discover the implication of the simulator into clinical trainee behaviour, medical education, and patient safety. At the other hand, a methodology of quantitative research design towards implementing Upper Limb Spasticity Simulator (ULSS) named BITA1.0 is discussed. The Descriptive Quantitative Research design is focused on formative clinical assessment with students of Master in Rehabilitation, Universiti Teknologi MARA as subjects with pre and post-response test. With the intention of implementing BITA1.0 into medical education, the result from The Descriptive Quantitative Research is essential.

Keywords: simulation; spasticity; upper limb; medical education

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1.0 Introduction

Usage of simulation-based training (SBT) is widely used in medical education to enhance clinical trainee to develop good technical skills (Hammoud et al., 2008, pp. 338-343). Accoding to Gaba (2004), 'Simulation' is referring to imitation to a real problem to achieve an educational goal through experimental learning. The simulator is used worldwide as a teaching and learning method. In medical education, the intervention of simulation was designed to expose clinical trainee into a real clinical scenario without any injury risk to the patients. As a review by Øgård-Repål (2018), limited source to obtain real clinical scenario is the main constraint for the clinical trainee to acquire enough skills and experience (pp. 149–157). Hence, the usage of simulation training with standardized stipulation is giving a big impact to improve the knowledge, performance, confidence level and reduce the anxiety level among clinical trainee (Borg Sapiano et al., 2018, pp 128-133). The purposes of this paper are; to provide an integrative review of the impact of the intervention of simulator in medical education and methodology of quantitative research design in implementing Upper Limb Spasticity Simulator (ULSS) into medical education.

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2.0 Background of Study

Several studies have indicated the advantages of applying simulator in medical education. Based on the review, the advantages were divided into three main criteria; Impact on clinical trainee behaviour, Impact on Medical Education, and Impact on Patient Safety.

Table 1. The significant impact of implementing simulator in medical/nursing education.

Journal, Year	Assessment/method	Analysis Summary
Experience of lecturers with simulation training in midwifery education in Slovakia (Maskálova et al. 2018, pp. 1-3)	The intervention of simulator in laboratory practical session for midwifery education. Using low-fidelity simulator when practising normal labour with expert supervision. Subject: Third-year medicine students	The engagement of the simulator into midwifery education is beneficial to allow students to practice competencies and skills repeatedly in a safe environment without any risk to patients. The training simulation motivates the student to deal with normal labour case with confidence.
The effectiveness of virtual simulation in improving student nurses' knowledge and performance during patient deterioration: A pre and post-test design (Borg Sapiano et al., 2018, pp. 128-133)	To investigate the effectiveness by using virtual simulation in improving nursing student knowledge and performance during patient deterioration. The student is provided a virtual lecture and participated in three scenarios of simulated patient deterioration. Subject: 166 second and third-year diploma and degree nursing student.	The intervention of simulation is showing an improvement for both knowledge and performance of nursing students during patient deterioration.
Nursing students' perception of high-fidelity simulation activity instead of clinical placement: A qualitative study (Au et al., 2016, pp. 16-21)	To explore the student's perception of using simulator into the clinical study course. A qualitative study with the integration of simulator designed for students during clinical lab session. Subject: 80 years one nursing student.	The study was found out that the using of the high-fidelity simulator is one of good ways to improve the understanding ability during clinical course study.
Clinical simulations for learning medical skills: a work-based approach to simulators (Toader, E. 2015, pp. 2443-2448)	To measure the effectiveness if using medical simulation for training and professional assessment. Medicine student attending the clinical simulation course for one semester. Subject: 135 medicine students.	Comparing with traditional teaching method, the usage of clinical simulation represents better and comprehensive learning.
Simulation Usage in Nursing Fundamentals: Integrative Literature Review (Stroup, C. 2014)	A literature study to determine the effectiveness of simulator application in the fundamental nursing study. Analysed 15 research articles out of 193 articles. During the filtering process, from 198 articles, 138 articles were excluded due to title containing exclusionary criteria. Another 43 articles owing to the inclusion of speciality practice areas or upper-level course work, and the last 2 articles were outside the scope of this review.	Based on the review, the simulator application have positive impacts on students critical thinking development, increasing students and faculty satisfaction level, and the effectiveness in imitating cognitive gains, skills development, and self-confidence ratings
Patient safety and simulation in prelicensure nursing education: An integrative review (Berndt, J. ,2014, pp 16-22)	An integrative review to analyse the evidence of using the simulator as an education intervention in prelicensure nursing education. The literature study was using Cumulative Index of Nursing and Allied Health Literature (CINAHL), Educational Resources Information Center (ERIC), Medline, and Joanna Briggs Institute (JBI) as a database. There are 17 articles were obtained and classified based on focused on simulation, patient safety, and simulation and patient safety.	From the study, implementing simulator in a classroom resulting significant improvements in patient safety and more interactive lecture method. Thus, the literature study is supporting the use of the simulator as an educational intervention.
Simulation in nursing education: An evaluation of students' outcomes at their first clinical practice combined with simulations (Khalaila, R., 2014, pp252-258)	To evaluate the effectiveness of using simulator in reducing anxiety, increasing self-confidence and caring ability among nursing students. Each student scheduled to participate in two simulation days during clinical practice. Subject: 61 second-year nursing students at their first clinical practice.	After using the simulator, the anxiety while during clinical session is reduced. The self-confidence is escalated, and caring ability is growth accordingly.
Evaluation of Simulation in Undergraduate Nurse Education: An Integrative Review (Foronda, C., Liu, S., & Bauman, E. B. ,2013)	The literature research found out that the intervention of simulator into nursing education is one of effective ways to increase the confidence level and decrease the anxiety. Students were satisfied	

	with the teaching and learning mechanism for clinical education.

Focusing on the first criteria, review from table 1 shows that the intervention of the simulator into the medical education is giving a positive implication towards clinical trainee understanding ability. According to Borg Sapiano et al. (2018), the effectiveness of the virtual simulation was investigated by using pre and post-test design and the findings stated that there are significant improvement of student knowledge and performance after implementing virtual simulation in nursing curricular (pp. 128-133). From the review, it can be concluded that the engagement of the clinical trainee with the simulator is improving the confidence level, critical thinking skill, and reducing the anxiety.

Referring to second criteria, the impact of medical education was written by Mio Leng Au et al. (2016) define that the usage of high-fidelity simulator is giving positive impact on gaining better experience on clinical situation (pp.16-21). As stated by Toader (2015), a Clinical Simulation course is implemented into Medicine student, Faculty of Medicine and the duration of the Clinical Simulation course is one semester (p. 197). After the Clinical Simulation course ended, the practical ability of the students is evaluated by the experts. In term of learning process, it is identify that the teaching and learning process is more comprehensive. With respect to the lecturer view, research by Maskálová et al (2018), stated that the engagement of the simulator during laboratory session for midwifery education is giving a good impact on skills development without risking any lives (pp. 1-3),. The students are allowed to practise repeatedly to understand the environment and labour room needs.

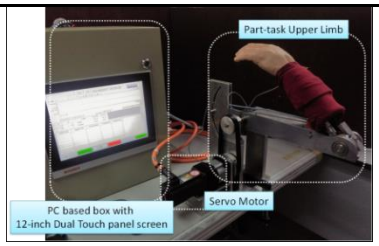
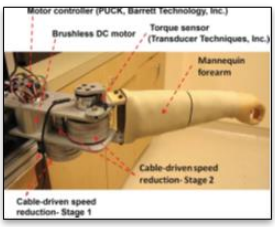
As for the third impact; patient safety, review from Mio Leng Au et al (2016) and Berndt, J. (2014), stated that, with adequate training and skill development, patient safety during real physical engagement is more persuasive serious injury can be avoided (pp. 16-21) & (pp. 16-22),.

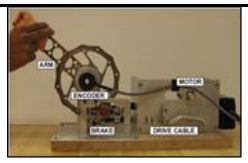
Based on the review in Table 1, it can be concluded that the intervention of the simulator into the medical education provides positive intellectual effect, safe practical environment, improving technical skill and develop a better clinical trainee personality.

2.1 Upper Limb Spasticity Simulator (ULSS)

Spasticity refers to the abnormal symptom of having resistance in the joints when patients attempt to make a movement (Fujisawa, T, 2007, pp. 48-51). Spasticity can be classified as a syndrome which is known to reduce quality of life (QOL).

Table 2. Summarize of current and previous upper limb simulator projects

Journal, Year	Prototype and Structure	Simulator Purpose
High-fidelity Part-task Trainer of Upper Limb Disorder for Physiotherapist Education (Othman, N. A et al., 2018, pp.127–141) (Che Zakaria, N. A et al., 2015, pp. 31–36) (Idris, F, et al.,2017, pp. 328–332) (Othman, N. A et al., 2016, pp. 731–736 (Othman, N. A, et al., 2015) (On-Going)	 • Imitate human forearm and elbow • Flexion and extension movements • Integrated with Programmable Logic Controller (PLC)	The research is focusing on developing an artificial human upper limb for the purposed of medical education. The simulator is able reproduce the stiffness as in patient of upper limb disorder
Development of a Haptic Elbow Spasticity Simulator (HESS) for Improving Accuracy and Reliability of Clinical Assessment of Spasticity (Park, H. S et al., 2012, pp. 361-370)	 • Imitate human forearm • Flexion and extension movement with fixed position	The haptic simulation has been designed and constructed to recreate the clinical feel of elbow spasticity based on the quantitative measurement. The purpose is for Improving Accuracy and reliability of Clinical Assessment of Spasticity.
Haptic simulation of Elbow Joint Spasticity (Grow, D. I et al., 2008, pp. 475–476)		The simulator was developed to replicate the spastic arm dynamics for clinical training of physical therapists and neurologists purpose. it is designed as a spastic elbow of a child by using a

	 • Imitate spastic elbow of a children. • Flexion and extension movement. • Covered with prosthetic silicon glove.	brake actuator and high-resolution optical encoder
Development of robot hand for therapist education/training on rehabilitation (Mouri, T et al., 2007)	 • Build with forearm and fingers to imitate sense of contracture • Pronation and supination movement at the forearm and palmar flexion and dorsiflexion movement at the fingers. • Covered with artificial skin	The design of the robot hand is based on the human hand with disability. The robot hand can generate torque based on the patient spasticity condition and it had 5-fingered hand driven by built in servo motor. To propose the concept of a robot hand system for repeated rehabilitation training.

From the literature search, it is shown that the development of part-task trainer for upper limb began in 2008. Previous three projects was developed for rehabilitation training, clinical training of physical therapists and neurologists and research of quantitative measurement respectively. However, the other simulator does not appear to imitate real behaviour of spasticity.

Based on Che Zakaria, N. A (2015) this project began in year 2008 in Shibaura Institute of Technology, Japan with recent collaborative work on further development of the Upper Limb Spasticity Part-task Trainer in Universiti Teknologi MARA (UiTM), Malaysia (pp. 31-36). The Upper Limb Spasticity Part-task Trainer was successfully developed on 2016 and it is named BITA1.0. The targeted end users of the BITA1.0 are students in medical education courses. This particular course is taught with the innovative problem-based learning approach, with an emphasis on practical application of skills and knowledge. With this program, the novice and clinical trainee can also assist the ever-growing demands of public health awareness.

3.0 Quantitative Research Design; A Methodology

In an effort to obtain the students perception of intervention of BITA1.0 into medical education, the response from the clinical trainee is crucial to make judgments on the effectiveness of the final prototype. The feedbacks from the students regarding the performance of BITA1.0 in emulating the spasticity symptoms, characteristic and behavior are essential.

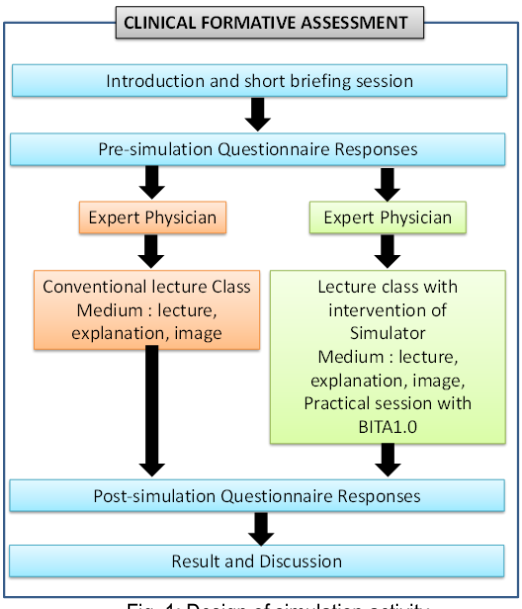


Fig. 1: Design of simulation activity

Then, the subject is required to attend the lecture class. One group is designed in a conventional lecture class with normal pattern of teaching and learning process. The other group of subject will attend a lecture class and ended with practical session with BITA1.0. At the end of the session, all the subjects are required to complete the post-simulation questionnaire response form. All the responses during class and practical session will be recorded for further analysis purpose.

4.0 Research Implications

This study was conducted with a main focus of developing the alternative technique to clinical trainee skills through the benefits of transferring industrial robotics precision into medical and healthcare education. By implementing the simulator into the medical education, the characteristic and behaviour of the patient with spasticity is easy to decipher by the clinical trainee. It ensures patient safety and enables clinical trainee to gain experience and build up their confidence before engaging with real patients. On top of that, it leads to the improvement in educational practices and curriculum, by contrivance the mechanical and robotic sections

5.0 Conclusion

Since robots and technologies revolutionize with medical education, BITA1.0 intervention will have a major impact on clinical trainees in developing skills and personality. With the intention of implementing BITA1.0 in conventional lecture classes, it believes the teaching and learning process will be more comprehensive. With better education and research efforts, medical education expectations are far to a higher level.

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