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Learning Model to Achieve Clinical Reasoning Competency Using Technology-Enhanced Learning in Neurology Clinical Rotation: An Exploratory Study

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ABSTRACT

The COVID-19 pandemic has necessitated major adaptations in learning activities related to developing clinical reasoning competencies in neurology clerkship. The application of technology in this context is promising, but there are also several limitations. This study explores a learning model for achieving clinical reasoning competency using technology-enhanced learning in neurology clinical rotation. The study used a case-study design and was conducted at the Faculty of Medicine of YARSI University and its two teaching hospitals. Data were collected by document analysis, three focus group discussions with eight medical students and 20 postgraduate medical students, and five in-depth interviews with five neurologists. All the transcribed data were analysed with thematic analysis using the Steps for Coding and Theorization (SCAT) approach. Two themes were revealed—contributing factors and learning strategies—and six factors were found to influence the learning model: the quantity and quality of teacher interactions, students' motivation and skills in learning and technology, the variety and number of patients in teaching hospitals, the quality and quantity of facilities and infrastructure for service and education at the teaching hospitals, the clinical rotation programme design, and learning adaptation during the pandemic. The following technology-enhanced learning strategies for developing clinical reasoning skills were identified: blended learning, online logbook, telemedicine, collaborative online learning between teaching hospitals, and learning videos. This learning model can be implemented in a limited resource setting. Importantly, the identified factors from the perspective of students, clinical teachers, and school of medicine/teaching hospital, as well as technical factors, should be considered for the implementation of this model.

Keywords: *Learning model, Clinical reasoning, Technology enhanced learning, Neurology clinical rotation*

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INTRODUCTION

Clinical reasoning is one of the competencies required to systematically translate history taking and physical examination into a diagnosis and management plan (1–3). Adequate clinical reasoning is required to establish a correct diagnosis and prevent misdiagnosis (2). Neurology is a medical discipline that requires deeper clinical reasoning to make a comprehensive diagnosis (4).

Neurological disorders are associated with high mortality and morbidity rates and high regional and national burden (5). Unfortunately, many medical schools provide neurology clerkships of a short duration for students. The standard duration at 90% of medical institutions is two to four weeks, even though students have to deal with a large number of diverse nervous system disorders (6–7).

Many students find neurology to be more complex and abstract, and far more difficult than other disciplines (7). Therefore, it is necessary to develop teaching and learning methods specifically for neurology clerkship (4). The American Academy of Neurology developed a core neurology registrar curriculum in 1988 that has been revised several times for adoption by medical schools (4, 8). Medical schools in different countries and regions face different problems in terms of heavy burden of clinical cases, culture, socioeconomic context, and availability of resources to support teaching and learning processes (4). Therefore, each medical faculty should create its own curriculum that is adapted to their context (4).

The COVID-19 pandemic has made the teaching and learning process for clinical clerkship more complicated (9–10) because of the decrease in the number and variety of patients, restrictions on the length of time that can be spent in the hospital environment, and the use of personal protective equipment (9–10). The pandemic

has resulted in postponement, cancellation, or special adaptations of clinical clerkship programmes to different contexts (11–15). Teaching and learning methods that require direct contact with patients, such as ward rounds and one-minute preceptor at outpatient clinics, have been disrupted (2, 13–17). The development of technology-enhanced learning has made the transition from direct to indirect contact with patients easier. Technological tools such as teleconference, virtual case discussions, virtual ward rounds, and virtual reality have ensured the continuity of clinical clerkships despite some limitations in terms of physical examination and communication with patients (16–19).

Many applications can be used to facilitate online learning in clinical clerkships, but there are ethical, legal, social, cybersecurity, and infrastructure issues involved (20). Despite this, several studies have shown a high level of engagement with online learning methods (21–23). Unfortunately, these studies did not specifically focus on students during their clinical years. As a result, there is still a lack of evidence about engagement with online learning methods during clinical years, especially learning methods that can achieve clinical reasoning competence. Therefore, the present study aims to identify the contributing factors and formulate a learning model to achieve clinical reasoning competence through technology-enhanced learning in clinical neurology rotation.

METHODS

Design

This study uses a qualitative method with a case study approach. This approach is suitable for in-depth exploration of processes and activities during neurology clerkship and is suitable for formulating a learning model. This study was conducted at the Faculty of Medicine of YARSI University, a private medical faculty in

Jakarta, and two teaching hospitals in Jakarta. Data collection was carried out via document analysis, focus group discussions, and in-depth interviews.

Participants

Eight medical students and 20 graduate medical doctors who had undergone clinical neurology rotations prior to the COVID-19 pandemic were selected for focus group discussions. The graduates were engaged to gain their perspectives on learning models because they can evaluate the connectivity between the learning model and their clinical practice as general practitioners. Ten medical students who have graduated are still in the internship stage, and the remaining have been practicing as general practitioners in hospitals and clinics. In-depth interviews were conducted with five neurologists to explore the learning model from the teacher's perspective. One neurologist from the medical school and four neurologists from the teaching hospitals were also involved. They were selected by purposive sampling to ensure an overall balance in the teaching experience of the participants. Data for document analysis were collected from the two teaching hospitals. The data gathered include the number of patients, types of neurological diseases, the number of neurological clinical teachers at each teaching hospital, and the availability of

discussion rooms and internet networks. All the participants were invited via email.

Description of Research and Data Analysis

Focus group discussions and in-depth interview questions were developed based on the literature on teaching and learning methods for clinical reasoning in neurology clerkships and technology-enhanced learning. Focus group discussions were conducted using the Zoom meeting application. Interviews were conducted twice over Zoom. One interview was conducted over the telephone, and another was conducted face-to-face. All discussions and interviews were recorded and lasted for approximately 60 minutes. All the transcript data were analysed by thematic analysis using the Steps for Coding and Theorization (SCAT) approach. Data for document analysis were collected via emails sent to the teaching hospitals.

RESULTS

Several factors that contribute to the learning model for achieving clinical reasoning competence using technology-enhanced learning in neurology clerkship were identified and classified into two themes (Table 1 and Figure 1). These themes are supplemented by quotations from the discussions and interviews.

Table 1: Identified themes and subthemes

Themes	Subthemes	Number of quotations
Factors that contributed to formulating the learning model for achieving clinical reasoning competency using technology-enhanced learning in neurology clinical rotation	Quantity and quality of teacher interaction	
	Amount of teaching and learning time	18
	Teachers' level in soft and hard skills	38
	Standardisation in granting authority to students	28

(Continued on next page)

Table 1: (Continued)

Themes	Subthemes	Number of quotations
	Students' motivation and skills in learning and technology	
	Students' motivation	5
	Initial preclinical knowledge and skills	3
	Abilities and activities in self-regulated learning	6
	Students' skills in using technology	2
	Variety and number of patients at teaching hospitals	
	Diversity of patients	14
	Number of patients	9
	Quality and quantity of facilities and infrastructure for service and education at teaching hospitals	
	Quality and quantity of workplaces at teaching hospitals	11
	Supporting facilities for technology-enhanced learning	15
	Design of the clinical rotation program	
	Timing of clerkship	7
	Teaching plan books, schedules, and logbooks	15
	Structured and interdisciplinary learning methods	20
	Good coordination between medical school and teaching hospitals	6
	Preparation of teaching hospitals by medical school	9
	Adjustment of teaching plans based on evaluation	2
Learning strategies using technology-enhanced learning	Learning adaptation during the pandemic	
	Security	9
	Learning adaptation	13
	Blended learning	13
	Online logbook	2
	Telemedicine	3
	Online learning based on collaboration between teaching hospitals	4
	Video learning	4

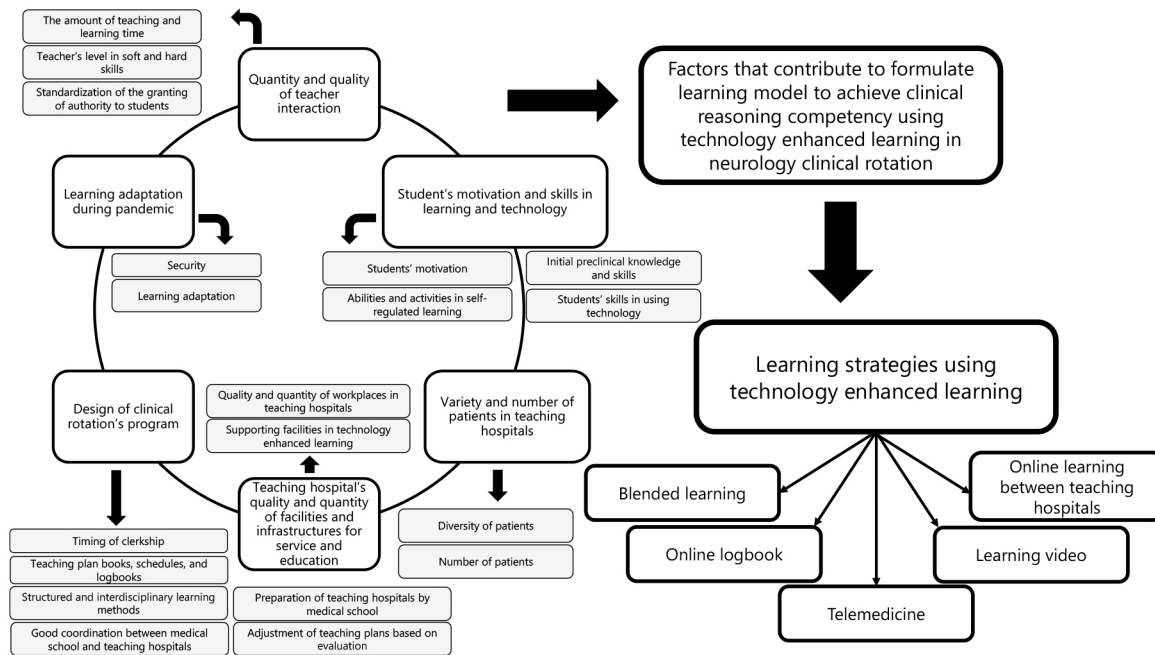


Figure 1: Schematic of the relationships between themes.

Document Analysis

We analysed all the available data from the teaching hospitals in the pre-pandemic period 2018–2019, and at the beginning and during the 2020 pandemic. One of the hospitals in a type A hospital and the other one is a type B hospital, according to the classification system of the Indonesian Ministry of Health (24–25) which is based on the number of hospital beds and the availability of medical services such as the number of specialist doctors and diagnostic facilities. Based on these factors, these hospitals have different abilities to diagnose patients. Type A hospitals are equipped with subspecialty doctors and advanced diagnostic and therapeutic facilities that help diagnose and treat patients with complex illnesses. Thus, type A hospitals have fewer outpatients but manage more complicated cases. This correlates with the competencies that students must have at the end of their medical education according to the Indonesian Doctor Competency Standards issued by the Indonesian Medical Council in 2012 (1). Further, some competencies are rarely found in type A hospitals, and vice versa.

Both teaching hospitals have three clinical teachers in the neurology department. One clinical teacher can accommodate up to five medical students in accordance with the Decree of the Minister of Health of Indonesia on Classification Guidelines and Standards for Academic Hospitals (26). Neither of the teaching hospitals has a dedicated internet network for medical education. Students and teachers rely on internet services provided by their own mobile phones to use technology-enhanced learning. Both hospitals have sufficient discussion rooms to accommodate all students in a single batch.

Factors that Contributed to Formulating the Learning Model

Quantity and quality of teacher interaction

The participants indicated that the amount of teaching and learning time, teachers' level of soft and hard skills, and the granting of authority determined whether students achieved clinical reasoning competence. Lack of clinical interaction between students and teachers made it difficult to achieve the appropriate competencies. This

probably occurs because clinical teachers focus on patient care rather than education. Teachers' skills in using technology are also a contributing factor, as unskilled or uncreative teachers can hinder technology-enhanced learning activities. Due to a lack of knowledge about granting authority to clinical students, some teachers do not give them the authority to manage their own patients. This affects students' self-esteem when it comes to managing patients, and they find it difficult to apply the clinical reasoning skills they have learnt.

Some teachers didn't give us the opportunity to manage patients on our own. We are just observers. I think it's influencing our clinical reasoning's practice. Everything is done by the teacher himself. If we are given the opportunity, I think we can learn and be confident in managing patients. (Student Z)

Students' motivation and skills in learning and technology

Students' motivation, initial preclinical knowledge and skills, abilities, and activities in terms of self-regulated learning, and students' skills in using technology were correlated with their clinical reasoning competence at the end of the neurology rotation. Lack of motivation and misconceptions about the neurology clerkship affected students' preparation. Further, the knowledge and skills acquired during the preclinical year determined the readiness of students and made it convenient for them to participate in several learning activities. Thus, the learning method used in neurology clerkship requires students to engage in self-regulated learning, and students' skills in using technology were also a supporting factor.

Students must have good ability in self-regulated learning. The learning method in the clinical rotation is different from the preclinical year. There are not many lectures here. So, students have to learn on their own to achieve good clinical reasoning. (Teacher A)

Variety and number of patients in teaching hospitals

The diversity and number of patients in the teaching hospital determined students' clinical reasoning competence at the end of the neurology rotation. A lack of variety prevented students from being able to observe and manage the wide variety of cases that general practitioners encounter. It should be noted that case variation is correlated with hospital classification. Having enough patients also determines the achievement of clinical reasoning competence, because a high number of patients allows for repeated observation and treatment.

If we encounter many types and patients during rotation, we can study many cases through observation and self-management of patients. But if not, we don't have enough cases to study. It impacts our clinical reasoning competence. (Student C)

Quality and quantity of facilities and infrastructure for service and education at teaching hospitals

Several factors related to teaching hospitals contributed to the participants' learning activities using technology, such as the quality and quantity of workplaces at the teaching hospitals; supporting facilities such as internet networks, internet quotas, services, and applications; and accessibility to experts in technology and information in the medical faculty. The availability of discussion rooms and diagnostic procedures, such as computed tomography scans and electroencephalograms, helped students achieve adequate clinical reasoning competence because students were able to study and discuss patient management from a holistic perspective.

Case-based discussions can be carried out by Zoom meetings. We don't have to meet face to face. However, facilities and infrastructure must be prepared and provided. (Student U)

Design of the clinical rotation programme

Several factors should be considered when designing a clinical rotation programme to help students achieve clinical reasoning competencies. These include the order and duration of clinical rotation, teaching plan books, schedules, logbooks, structured and interdisciplinary learning methods, good coordination between medical school and teaching hospitals, preparation of teaching hospitals by medical schools, and adjustment of teaching plans based on evaluation. The sequence and duration of neurology clinical rotations determine clinical reasoning competence, as some cases can be understood better if students have completed other rotations prior to neurology. Further, a complete teaching plan book that includes learning objectives and schedules would be useful. Structured and diverse learning methods that involve other disciplines provide a holistic clinical rotation. In addition, good coordination between medical faculty and teaching hospitals is important to improve the quality of clinical teachers and deal with teaching and learning situations in clinical rotation during the pandemic. Thus, medical schools need to consider the number of patients, the variety of cases, and the facilities and infrastructure provided by the teaching hospital before collaborating, to provide good learning opportunities for medical students.

Teaching hospital facilities must be considered properly. If it's not good enough for teaching and learning, it's better not to collaborate. Because it affects students' learning opportunities and ultimately their clinical reasoning competence. (Student N)

Learning adaptation during the pandemic

The participants stated that safety and learning adaptation should be considered carefully during the pandemic. Security is the main factor in determining a learning model. However, limited access during

the pandemic has affected learning opportunities. Thus, teaching and learning methods need to be adjusted to the restrictions posed by the pandemic. Some learning methods can be changed to a distance learning format using technology-enhanced learning, but methods that involve direct contact with patients still need to be employed.

Modification of teaching and learning methods during the pandemic needs to be done. Case presentations and discussions can be done virtually. But taking the patient's history and physical examination cannot be done. Maybe 30% online and 70% offline. (Teacher A)

Learning strategies using technology-enhanced learning

Five learning strategies were suggested by the participants: blended learning, online logbook, telemedicine, online learning based on collaboration between students at different teaching hospitals, and video learning. In clinical rotations, students need to interact directly with patients to learn skills that support clinical reasoning competencies, but further discussions can be conducted remotely. Online logbooks are useful because of their easy access. Regarding telemedicine, there are certain ethical considerations. Online learning involving students from different teaching hospitals has also been suggested. Social media may assist teachers in providing learning videos that can help students understand neurological clinical reasoning because the material on such media is interesting, accessible, and not limited by space and time.

Bedside teaching can be done together using technology. We can share cases through Zoom meetings if it turns out that one of the teaching hospitals is short of certain cases. So, we can learn together. (Student A)

DISCUSSION

The development of a learning model using technology-enhanced learning in clinical neurology clerkship is not easy. An initial analysis of the factors that influence the learning model and strategy is needed to develop such a learning model properly before it can be implemented. The present results indicate that six factors influence the learning model, and these are related to students, clinical teachers, the clinical clerkship programme director, medical educational institutions, and teaching hospitals. These factors are interrelated and influence one other to provide learning opportunities for students to achieve clinical reasoning competencies. This study also identified several learning strategies that combine online and offline learning methods.

Factors that Contributed to Formulating the Learning Model

Quantity and quality of teacher interaction

Clinical teachers must divide their time between patient services and teaching activities, and this decreases their teaching intensity. This is more pronounced in teaching hospitals with only a limited number of teachers. Accordingly, O'Doherty et al. (27) reported that clinical teachers often have difficulty managing time. Clinical teachers in hospitals with residents can be assisted in teaching and supervision by the residents (28). Clinical teachers are also role models for students and, therefore, they must present themselves as competent teachers including good time management skills (29). Technology-enhanced learning requires more preparation and time commitment on the part of teachers: for example, they need to master, develop, and apply learning methods, including administrative processes, after each teaching session (27, 30).

Differences in the reasoning approach of clinical teachers in terms of diagnosis

and management are related to their educational background and knowledge of recent developments. These differences also stem from differences in teaching methods. Clinical teachers who do not come from medical education institutions usually teach based on their experiences during medical school; that is, their teaching method and teaching skills are not based on teaching guidelines. Steinert's research (31) explained that medical teachers need knowledge of various teaching and learning strategies so that they can improve their teaching performance and students' learning outcomes. Periodic faculty developments are required to improve the quality of teaching staff (31). Further, the quantity and quality of faculty development programmes will affect the knowledge and skills of the students (31).

The lack of ability and creativity of the teacher in using technology-enhanced learning can lead to poor delivery, boredom and a lack of curiosity about the teaching materials. This is in line with the research of O'Doherty et al. (27), which states that poor teacher skills in using technology are an obstacle in the implementation of technology-enhanced learning. Limited skills in the use of software and online teaching skills determine the willingness or ability of teachers about their involvement in the development of online learning (27).

If clinical teachers lack knowledge regarding student authority in clinical clerkship, students may miss out on various opportunities, such as studying emergency cases in the emergency room and practicing medical record writing. The inability to practice such skills affects students' confidence. According to Steinert et al. (31), they mentioned that faculty development programmes must also provide knowledge about granting student authority so that every student has the same learning opportunity.

Students' motivation and skills in learning and technology

A lack of motivation that is driven by misconceptions about learning activities and the ease of passing the neurology clinical clerkship affects students' ability to prepare for and carry out learning activities properly and prevents them from achieving adequate competence. Kusurkar et al. (32) explained that students who have intrinsic motivation have more hours of study, deep learning strategies, good academic achievement, and low levels of fatigue. Further, lack of motivation affects students' time management and ability to develop learning strategies (32).

Preclinical knowledge and skills determine the readiness and ease with which students participate in activities in the neurology clinical clerkship, and lack of initial knowledge prevents students from pursuing the competencies that must be achieved. Bodkyn and Stevens (33) stated that intrinsic motivation is an important factor that affects student competence. Further, students' initial knowledge is one of the intrinsic motivational factors, in addition to attitudes, personality, and goals, the quality of which will determine student output (33).

The ability and active participation of students in terms of learning independently are important. In clinical clerkships, students are faced with limited time and lecture sessions. Students who study independently have a positive effect on competence gained because they can determine their learning goals, monitor themselves and have good self-efficacy (33).

Students' mastery of technology is also related to their mastery of competencies. In line with this notion, Aguilera-Hermida (34) stated that the quantity of usage of online learning platforms and instruments during the pandemic is related to students' knowledge and experience. The more often technology-enhanced learning is used, the more students' knowledge and experience will increase. That is, knowledge, experience

and self-efficacy gained can improve students' ability to learn independently (34).

Variety and number of patients in teaching hospitals

A sufficient variety and number of cases in teaching hospitals can provide opportunities for students to observe, practice and manage patients directly. The number of cases and their variation are related to the type of teaching hospital used. The importance of the diversity and number of patients in clinical education has also been highlighted by Rattner et al. (35). That is, students who lack exposure to cases due to the limited number and variety of patients will have inadequate competencies (35). Given this, it is important for the programme director to ensure that it is feasible for a teaching hospital to provide students with the opportunity to achieve competencies (35). Importantly, concerns about the lack of variety and patient numbers are increasing with the pandemic because the number and variety of patients at hospitals have reduced.

Quality and quantity of facilities and infrastructure for service and education at teaching hospitals

The availability of a special discussion room that does not require direct contact with patients facilitates discussion between clinical lecturers and students by reducing the risk of infection. Further, basic diagnostic tools, such as CT scanners and electroencephalography devices, can help students to develop adequate clinical reasoning by understanding and studying basic examinations in neurology that have an impact on holistic patient management. The capacity of teaching hospitals that can accommodate all students in a single clinical clerkship batch that includes polyclinics, wards and emergency units is also important, because it provides students with more consistent learning opportunities. Naem et al. (36) explained that teaching hospitals must be standardised and adapted to the learning needs of students. In

addition, teaching hospitals should provide discussion rooms with good security and sufficient space for students. Ellaway et al. (37) stated that teaching hospitals need administrative and technical support to run a good clinical clerkship. An unsupportive clinical learning environment creates external barriers to attaining competency among students (37).

Supporting technological facilities must be provided, including a stable internet network, internet quota to access online learning and software or services such as Zoom meetings and learning management systems. Technical aspects, including infrastructure and technology-related aspects, must be considered in the implementation of technology-enhanced learning (38). Keengwe and Kidd (39) mentioned that inadequate hardware and software, for example, a slow internet connection, are obstacles that need to be considered in technology-enhanced learning.

Design of the clinical rotation programme

The short duration of neurology clinical clerkships limits students' opportunities to repeatedly utilise the knowledge and skills acquired. Therefore, the order of clerkship must be considered carefully because some clerkships might require mastery of other fields first. The order and duration of rotation are based on the level of clinical reasoning competence achieved (40). Strowd et al. (41) stated that more than 90% of students achieved neurology clinical competence in a clerkship that lasted for four weeks.

Teaching and learning plan books with incomplete structure, such as the absence of learning objectives and activity schedules, makes it difficult for students to determine targets and strategies. A logbook can help student to focus on the competencies to be achieved and is useful for routine evaluations by the programme director. Strowd et al. (41) has also linked learning objectives with student performance in neurology clinical clerkship. Importantly,

students who set learning targets at the beginning of the clinical clerkship achieve better competence (41–42).

Structured learning methods assist students in undergoing clinical clerkships. The involvement of other disciplines is also important, considering that neurology is closely related to other branches of medical science. Zhou et al. (43) stated that curriculum design, including learning methods, is an important factor that determines the final competence of neurology clinical clerkship students. According to Curtis et al. (44), neurology needs to be integrated with other sciences because there are many diseases in the field of neurology that are also related to other branches of science.

Coordination between medical education institutions and teaching hospitals is needed for faculty development to improve the quality of clinical teachers. Good coordination is especially important during the pandemic. One-sided limitation in the number of teaching/learning hours affects students' learning opportunities at teaching hospitals. Mubuuke et al. (45) examined the factors that influence coordination between educational institutions and teaching hospitals and affect the clinical clerkship programme and found that the following factors placed students in an uncomfortable position and prevented them from achieving the expected competencies: poor coordination such as scheduling problems, unilateral restrictions on clerkship activities, and financial problems (45).

Educational institutions must consider many factors that affect learning opportunities for students when working with teaching hospitals. Ellaway et al. (37) identified the factors that must be considered by educational institutions before they place their students in a teaching hospital: location, number of clinical teachers, administrative and technical support, and the number and variety of cases (37). These factors can subsequently affect students' learning opportunities and

determine whether they achieve the required competencies (37).

The programme director needs to adjust the teaching design based on an evaluation of the teaching programme. Further, periodic evaluations need to be carried out to improve the clinical clerkship system. Accordingly, Vassar et al. (46) and Frye and Hemmer (47) have reported that the role of programme evaluation in medical education is to provide feedback to the programme directors, teachers and other stakeholders regarding the need for a programme to be maintained, changed, or even discontinued (46–47). Changes made to the programme can cause major changes to the output and vice versa (46–47).

Learning adaptation during the pandemic

Safety is the main consideration in determining the learning model during the pandemic. However, limited access to learning due to the pandemic must also be considered, so that students can still achieve adequate competencies. In agreement with this, Khamees et al. (48) and Kreimer (49) reported that safety is an important factor for students undergoing clinical clerkship at teaching hospitals. The experience of interacting directly with patients cannot be replaced by online learning with regard to some skills. However, student exposure to activities at the hospital also increases their risk of exposure to the COVID-19 virus. Therefore, students must be provided with adequate personal protective equipment, the duration of activities in the hospital must be limited, and the number of students attending the same offline discussion room must be restricted (48–49).

Learning methods need to be adapted to the situation created by the current pandemic. However, these modifications must be carried out while prioritising direct exposure to patients. Several methods, such as case presentations and discussion sessions after clinical exposure, can be done online. However, the bedside teaching method, polyclinic hours, and ward rounds are still

carried out offline while paying attention to safety aspects. Accordingly, Khamees et al. (48) have reported that many learning activities in neurology clinic clerkships have changed their format in order to adapt to the pandemic. For example, lectures and didactic sessions can be conducted online, but hands-on examinations are still required (48).

Learning strategies using technology-enhanced learning

Learners cannot rely entirely on online learning to achieve clinical reasoning competence. Therefore, a blended learning strategy with a larger proportion of offline learning activities than online learning activities has been suggested. Halstead et al. (50) stated that a blended learning strategy with more than 60% of the activities conducted offline was correlated with a high level of final performance. This result was expected since students have repeated exposures and receive direct instruction. A curriculum with 90% e-learning is associated with increased long-term retention, which is thought to be facilitated through self-directed critical thinking. Case-based lectures and teaching sessions can use an online format facilitated by the Zoom platform, while small class discussion sessions involving six students can be done directly if a room is available (50).

Another strategy identified was the use of online logbooks, which are easier to access and evaluate than offline logbooks. Virtual logbooks ease data collection, storage and analysis in a clinical clerkship, and have been in use for more than 10 years in the United States (51). Telemedicine can also be applied to several skills such as history taking and communication, although it is necessary to consider the ethical issues that will arise. Specifically, through tele-neurology, students can learn how to modify communication and examination in video format while understanding parts of patient interactions that can or cannot be adequately understood through videos (49).

Online learning with students at different teaching hospitals is possible with technology. Students who are not exposed to a sufficient variety of cases at one teaching hospital can have access to cases presented by students at other hospitals. Thus, this strategy can help improve overall competence in clinical reasoning. Kreimer (49) revealed that online teleconferences made it easier to involve many clinical teachers as speakers, which was difficult in pre-pandemic learning programmes. Through teleconferencing, it is possible for students at different hospitals to collaborate and learn together (49). The use of social media applications and services makes it easier for teachers to share learning videos with students. Some examples of applications that are attractive and easy to access include YouTube channels and 360° cameras. Video learning can be facilitated through live streaming a procedure using an application without the presence of students at the location (52). Learning videos help students determine specific learning needs and allow them to set the pace according to their abilities (52).

Various technology-enhanced learning strategies can be applied by considering various aspects. Schweighofer and Ebner (38) mention that three aspects must be considered based on the preparation of stakeholders, namely, teaching staff, students and other stakeholders. Another aspect which is not related to stakeholders and must also be considered is technology development (38).

Study Limitations

This research was carried out within a limited time frame and was faced with obstacles that arose due to social restrictions during the pandemic. As a result of these restrictions, this research could only be conducted at one medical faculty and two teaching hospitals in Jakarta. Teaching hospitals outside Jakarta may face different

situations and constraints, so there are limitations in terms of generalising the results of this study. Despite the limitations, this study was able to explore a learning model based on data on factors and strategies suggested by respondents and supported by the triangulation of data from document analysis. The learning model may not be ideal for technology-enhanced learning because there are still many limitations to technological developments in Indonesia, including unevenly distributed and stable internet networks and limited accessibility to learning software due to a lack of financial resources.

CONCLUSION

This study explores a learning model that uses learning enhancement technology to achieve clinical reasoning competence in neurology clinical rotation. We identified six factors that influence the learning model: the quantity and quality of teacher interaction; students' motivation and skills in learning and technology; the diversity and number of patients at teaching hospitals; the quality and quantity of facilities and infrastructure for services and education at teaching hospitals; the design of the clinical rotation programme and learning adaptation strategies employed during the pandemic.

Several learning strategies, including blended learning, online logbooks, telemedicine, online learning based on collaboration between teaching hospitals and video learning, were identified. The learning model constructed in this study can be applied with some limitations related to different stakeholders, including students, clinical teachers and medical schools. Improvements and developments can be made based on these limitations to create a learning model using enhanced learning technology in clinical neurology rotation that can be applied to intensify students' clinical reasoning competence.

ETHICAL APPROVAL

This study was approved by the Research Ethics Committee of the Faculty of Medicine of YARSI University (112/KEP-UY/BIA/III/2021).

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