SIMBA: Using Kolb's Learning Theory in Simulation-Based Learning to Improve Participants' Confidence

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Abstract

Background

Simulation via Instant Messaging- Birmingham Advance (SIMBA) delivers simulation-based learning (SBL) through WhatsApp and Zoom based on Kolb's experiential learning theory. This study aimed to implement Kolb's theory in practice during SIMBA adrenal session.

Methods

Kolb's 4-stage cycle: concrete experience—simulation, reflective observation—discussion following simulation, abstract conceptualisation and assimilation of new information—Q&A and MCQs, and active experimentation—reflect on the acquired knowledge. Participants' self-reported confidence levels pre- and post-SIMBA were analysed using Wilcoxon Signed Rank test. Key takeaway and feedback were assessed quantitatively and qualitatively in a thematic analysis.

Results

Participants' self-reported confidence improved significantly post-SIMBA in their approach to Cushing's syndrome ($p<0.0001$) and adrenocortical carcinoma ($p<0.0001$). 93.9% (n=31/33) and 84.8% (n=28/33) strongly agreed/agreed the topics were applicable to their clinical practice and accommodated their personal learning style, respectively. 81.8% (n=27/33) reported increase in knowledge on patient management, and 75.8% (n=25/33) anticipated implementing learning points in their practice.

Conclusions

SIMBA effectively adopts Kolb's theory to provide best possible experience to learners, highlighting the advantages of utilising social media platforms for SBL in medical education. The ability to conduct SIMBA sessions at a low cost with high fidelity internationally paves way to engage more healthcare professionals worldwide.

Introduction

Medical education has been evolving over the years, with digital advancement resulting in development of novel teaching methods. Technology assisted learning has become increasingly integral in contemporary medical education, where flexibility and learner-centred teaching methods take precedence, with e-learning being a major modality (1, 2). E-learning refers to the use of the Internet to enhance knowledge and allows the learning process to transcend geographical boundaries (3). E-learning can be a strategy to deliver a simulation-based learning (SBL), designed to provide a learner with a guided experience in a realistic and safe environment, followed by a debriefing to facilitate abstraction and conceptualisation (4, 5). SBL addresses two important ethical considerations in medical education: (i) replicates real-life scenarios for acquisition of necessary clinical skills and (ii) ensures patient safety (6). Contrary to the traditional approaches to medical education, such as lecture-based learning (LBL), SBL

calls upon the learner's integrative capacity and trains the learners to adapt to the dynamics of variation in the field (7). Evidence has shown that SBL is superior to LBL in teaching situation awareness (8) and acquisition of critical assessment and management skills (9). Despite its advantage, SBL is still not well established across disciplines in medicine where patients are managed in an outpatient/clinic setting.

The educational benefits of SBL and the technologies it could employ are informed and shaped by theories from domains closely related to them. One example is Kolb's experiential learning theory which is based on the theory of constructivism and states that knowledge results from the process of grasping and transforming experience, whereby each phase of the Kolb's cycle must be experienced for optimal learning (10). This learning cycle consists of four phases: (a) concrete experience where the learner participates in an experience such as simulation, (b) reflection on the experience, (c) abstract conceptualisation where the learner considers thoughts and reflections to identify significance of the learning experience and considers what could have been done differently to enhance the outcome, and (d) active experimentation using what was learned to direct future practice (11). Constructivism supports the idea that learning is a social experience and requires reflection. The ability to provide immediate feedback through social media is a primary advantage of SBL (4). Persistent gaps in healthcare quality and safety across the globe may also be tackled in this way, demonstrating the advantage of providing SBL in medical education via social media.

Simulation via Instant Messaging- Birmingham Advance (SIMBA) is an innovative teaching model designed to construct SBL through WhatsApp (12). With its concept, SIMBA is replicating the whole learning cycle proposed by Kolb's experiential learning theory. Throughout the simulation, participants are individually guided through each case scenario, to arrive at a diagnosis and propose a management plan. At the end of each SIMBA session, structured feedback/debriefing is provided by the consultant, followed by a post-SIMBA survey reflecting on the learners plans to bring changes to future practice based on the experience gained through simulation. The results from previous sessions have demonstrated that SIMBA is an effective teaching model to increase participants' confidence in managing various endocrine and diabetes simulated cases (12).

The pandemic due to coronavirus (COVID-19) disrupted postgraduate teaching and learning significantly (13). In our region, there was a complete halt of teaching with all available resources and personnel diverted to tackle the pandemic. To enable sustained training during the pandemic, SIMBA conducted its first international, completely virtual session on Adrenal pathologies. Expert input and discussions were delivered using the Zoom videoconferencing platform, as opposed to a conference hall during the previous sessions.

In this study, we describe how Kolb's experiential learning theory is adapted in SIMBA by providing concrete experience and reflective observation throughout the session, and to evaluate the acceptance of the SIMBA and readiness of the participants to apply built on the knowledge gained.

Methods

The study was conducted in May 2020 by the SIMBA team with the support of the Institute of Metabolism and Systems Research at the University of Birmingham.

Preparation for the session

Standardised transcripts of five anonymised real-life adrenal cases were prepared for the following conditions: adrenal incidentaloma, adrenocortical carcinoma (ACC), Cushing's syndrome, Conn's syndrome, and COVID-19 infection in a patient with congenital adrenal hyperplasia (CAH). Each transcript included medical history, clinical examinations, investigation results, imaging studies, management and follow-up plan, which were validated by a consultant endocrinologist to ensure accuracy of the real-life scenarios. Figure 1 describes in detail the steps building up to SIMBA session and on the day itself.

29 medical students and 2 junior doctors volunteered to be moderators for the session. To ensure proficiency, all moderators were trained in six mock simulation sessions using the finalised transcripts.

The session was advertised on social media platforms (Facebook and twitter) by SIMBA and by endorsing organisations. Interested candidates registered for the session using Google forms. A few days before the session, participants were emailed their moderator's contact details and instructions on how to join the session. To keep the participants' identities anonymous, each participant was given a unique identification number (SIMBA ID).

On the day of SIMBA adrenal session

Each moderator was assigned to two or three participants. The participants were asked to complete a pre-SIMBA survey about their socio-demographic information and self-reported confidence on managing various simulated and non-simulated adrenal cases. At this point, the participants were blinded as to which cases would be simulated. Once the submission of pre-SIMBA survey was confirmed by the moderator, simulation was initiated with the instructions shown in Fig. 2 via WhatsApp. To familiarise with the SIMBA model, the first simulated case on adrenal incidentaloma was run as a trial where moderators prompted participants to ensure they followed the standard system of history-taking, examination, and investigations to arrive at the diagnosis and propose management plan. Following this, the participants underwent simulation on case scenarios for adrenocortical cancer (ACC), Cushing's syndrome, Conn's syndrome, and COVID-19 infection in a woman with Congenital Adrenal Hyperplasia (CAH). If a participant requested information that was unavailable in the transcript (e.g. request an irrelevant investigation), the moderators replied that the information was not available.

Each simulated case started with the moderator sending the presenting complaint of the patient to the participant. Initially, the moderator played a role of a patient by answering questions from medical history. Once the history-taking was complete, the moderators simulated a senior clinician asking the participants to request the relevant examinations and providing the appropriate results given in the transcripts. The participants were asked to complete electronic investigation forms to request necessary investigations such as blood and urine tests, dynamic function tests, and imaging. Once these forms

were submitted, the moderators would provide participants with all available results for the patient at that point in real life. The final role of the moderator was as a multidisciplinary team (MDT) liaison to prompt the participant to summarise the findings, propose differential diagnoses and management plan. The participants were informed whether their diagnosis was accurate and given the details on how these patients were managed in real life. The participants had 25 minutes to solve each case scenario. The simulation ended once the participant provided the follow-up plan or when the 25 minutes expired, whichever came first.

Following simulation, in order to reflect on the concrete experience gained through simulation, the participants were invited to discussions of simulated cases by consultant endocrinologist with special interest in adrenal pathology via Zoom. The consultant discussed the most suitable approach for each case including relevant investigations and management based on evidence-based international guidelines (14–23). The chair highlighted the most important learning aspects for each case, with opportunities for participants to ask questions regarding each case as an interactive discussion.

After the discussion, participants were invited to complete a post-SIMBA survey with questions on their confidence levels to manage simulated and non-simulated adrenal pathologies. The survey also contained multiple choice questions (MCQs) related to simulated cases thus enabling abstraction of the knowledge received. To evaluate whether the participants would actively experiment in the future, the survey asked them an open-ended questions regarding changes they intend to make in patient care based on the experience gained during the session.

Evaluation of SIMBA

The post-SIMBA evaluation form was designed to obtain feedback from participants regarding its impact. Kirkpatrick's training evaluation model was adopted, and three outcomes were identified (24). Level 1 (reaction) was assessed with questions regarding engagement of the session on a 7-point Likert scale. Level 2 (learning) involved acquiring self-perceived gain in core competencies and confidence levels in approaching various adrenal cases, as well as related multiple-choice questions (MCQs). Level 3 (behaviour) was addressed by asking participants open-ended questions regarding changes they intend to make in patient care following the session.

Participants' assessment and feedback

Two independent reviewers scored the participants on their performance in each simulated case using an adapted version of the global rating scale (Fig. 3). Seven items (history, examinations, initial investigations, diagnostic tests, imaging, clinical judgement, and management/follow-up) were assessed on a scale of 1 (not done) to 5 (excellent). The participants received written feedback for each case based on Pendleton's model of feedback (25).

Statistical analysis

The adrenal cases included in the questionnaire can be divided into two categories: (a) simulated: adrenal incidentaloma > 4 cm, ACC, Conn's syndrome, Cushing's syndrome, and COVID-19 infection in a patient with CAH; and (b) non-simulated: bilateral macronodular adrenal hyperplasia (BMNAH), Addison's disease, secondary adrenal insufficiency, androgen secreting adrenal tumours, adrenal incidentaloma < 4 cm, phaeochromocytoma, and adrenal metastases.

Data from participants' self-reported confidence levels extracted from pre- and post-SIMBA survey were categorised into 3 groups: (i) confident: for those who responded with "strongly agree" and "agree"; (ii) unsure: for those who responded with "agree somewhat", "undecided", and "disagree somewhat"; (iii) not confident: for those who responded with "strongly disagree" and "disagree". Participants who completed only the pre-SIMBA evaluation form were excluded. The Wilcoxon signed-rank test was used to statistically investigate differences between confidence levels in pre- and post-SIMBA; performed using Stata (Stata/SE 16.0). Statistical significance was accepted at 95% confidence level (significance set at $p < 0.05$). The change in confidence levels of managing cases pre- and post-SIMBA are reported as percentages and presented in bar charts.

Additionally, in the post-SIMBA evaluation form, participants were asked close- and open-ended questions for feedback and key takeaway from the SIMBA Adrenal session. Findings from close-ended responses are reported in frequencies and percentages. Material collected from open-ended responses were reviewed and combined in a thematic analysis to identify common themes. Using an inductive thematic analysis approach, data were analysed for main ideas, reduced to themes, and presented in tables with examples.

Results

A total of 40 participants attended the session, which was carried out in May 2020. 33 (82.5%) completed both pre- and post-SIMBA evaluation forms and were included in the analyses. This includes 18 (54.5%) participants from the UK (West Midlands (n = 13), London (n = 1), North West (n = 2), and one participant did not complete specific location data), and 15 (45.5%) internationally (Bosnia and Herzegovina (n = 1), Cote d'Ivoire (n = 2), Georgia (n = 4), India (n = 1), Ireland (n = 2), Spain (n = 2), Syria (n = 1), Turkey (n = 1), and Ukraine (n = 1)). These participants comprise of consultants (n = 6), specialist (n = 1), senior residents/fellows (n = 6), specialty trainee registrars (n = 15), resident physicians (n = 3), medical doctor (n = 1), and currently out of training programme (n = 1).

Participants' confidence levels

Significant improvement was seen in participants' self-reported confidence post-SIMBA in their approach to simulated scenarios (Table 1), as well as in some non-simulated conditions (adrenal incidentaloma < 4 cm ($p = 0.0020$), BMNAH ($p = 0.0000$), and Phaeochromocytoma ($p = 0.0005$)). No statistically significant improvement was observed when participants were assessed for their confidence in approaching Addison's disease ($p = 0.2891$) (Fig. 4).

Table 1
Changes in participants' confidence levels post-SIMBA session for approaching simulated and non-simulated cases with p values.

Case	Confident	Unsure	Not confident	Significance
Adrenal incidentaloma > 4 cm	+ 30.3%	-21.3%	-9.1%	P = 0.0020
ACC	+ 45.5%	-33.4%	-12.1%	P < 0.0001
Conn's syndrome	+ 36.3%	-27.3%	-9.0%	P < 0.0001
Cushing's syndrome	+ 39.3%	-36.3%	-3.0%	P < 0.0001
COVID-19 infection in a patient with CAH	+ 30.3%	-15.1%	-15.2%	P = 0.0029
BMNAH	+ 45.5%	-39.4%	-6.1%	P < 0.0001
Addison's disease	+ 12.1%	-12.1%	0.0%	P = 0.2891
Secondary adrenal insufficiency	+ 24.2%	-18.1%	-3.0%	P = 0.0332
Androgen secreting adrenal tumours	+ 39.3%	-24.2%	-15.2%	P < 0.0001
Adrenal incidentaloma < 4 cm	+ 30.3%	-21.3%	-9.1%	P = 0.0020
Phaeochromocytoma	+ 33.3%	-30.3%	-3.1%	P = 0.0005
Adrenal metastases	+ 33.3%	-15.1%	-18.2%	P < 0.0001

ACC, adrenocortical carcinoma; COVID-19, novel coronavirus disease; CAH, congenital adrenal hyperplasia; BMNAH, bilateral macronodular adrenal hyperplasia.

Participants' feedback/satisfaction and key takeaway

91.1% (n = 30/33) strongly agreed/agreed the session was engaging. 84.9% (n = 28/33) reported the session accommodated their personal learning style. 97.0% (n = 32/33) agreed the chair provided balanced and evidence-based, where possible, approach to the cases. 93.9% (n = 31/33) found the simulated topics applicable to their clinical practice, and the session impactful at a personal level. 97.0% (n = 32/33) found the content of the session translatable to patient care. Six domains of medical education based on the core competencies by Accreditation Council for Graduate Medical Education (ACGME) were assessed and seen to improve: knowledge on patient management – 81.8% (n = 27/33), practice-based learning – 75.8% (n = 25/33), patient care – 45.5% (n = 15/33), systems-based practice – 39.4% (n = 13/33), professionalism – 30.3% (n = 10/33), and communication skills – 12.1% (n = 4/33) (Fig. 5).

Thematic Analysis of open-ended questions

Answers to the open questions were analysed to identify broad themes represented within them. 54.5% (n = 18/33) provided a response to the question "as a result of what I have learned today, I intend to make

the following changes to my practice that I believe will impact my patients' care in a positive way", suggesting a positive influence that can be translated to patient care (Fig. 6A). 36.4% (n = 12/33) responded to the open-ended section to provide "additional comments regarding the chair's contribution", and 8.3% (n = 1/33) was negative, based on technical issues during the session, and the participant was unable to comment on the chair's contribution. The remaining 33.3% (n = 11/33) responses were positive (Fig. 6B).

Discussion

SIMBA was well received by the participants and proved to be an effective learning model to increase the self-reported confidence level in managing various cases on adrenal pathologies. During a pandemic, moving our SIMBA approach online, combining use of WhatsApp and Zoom to deliver the session, played a crucial role in the context of distance learning to provide sustained medical education. This is relevant for the ability of SIMBA to deliver enhanced training across the globe, with minimal resources and low cost.

The results provide insight into participants' perceived outcomes of the session, demonstrating the Kolb's 4-stage experiential learning cycle (10), according to which the SIMBA model was constructed (Fig. 7). This process begins with concrete experience—a SIMBA session conducted via WhatsApp, where the participants were able to work through the motion of realistic case scenarios. Participants' satisfaction from this session was high, indicating that the model was well-received. The majority of participants found the SIMBA model engaging and accommodating to their personal learning style. This also demonstrates that participants from various backgrounds were able to quickly familiarise themselves and adapt with the concept. SIMBA as a model combines e-learning and SBL and evolved with the learning preferences and strengths of the learners of this digital age. This is in line with suggestions to utilise instructions and environments learners are familiar with to improve responsiveness and enhance learning (26, 27). Further, studies have found that training professionals respond to different learning preferences between generational groups, with younger generations finding greater comfort in technology-based training (27).

The second stage of the cycle—reflective observation—refers to the Zoom discussion in the SIMBA session. An expert consultant discussed each case with evidence-based rationale. Participants were able to compare what was done differently, reflecting on their personal performance during the simulation. 97.0% of the respondents strongly agreed/agreed that the chair's contribution was evidence-based, and thematic analysis of feedback indicated positive overall rating. Overall, feedback regarding the delivery of the session demonstrated reflective observation where participants felt "important management steps" were addressed, and that the chair guided the participants through the case explaining current evidence, rather than spelling out the guidelines.

In the third stage of the Kolb's cycle of abstract conceptualisation, assimilation of the new information was facilitated by the interactive Q&A session and post-SIMBA MCQs related to the simulated cases.

Throughout the session, participants were able to conceptualise the learnt key points and rationalise/make sense of it, to be added to their existing knowledge. Significant improvements in self-reported confidence levels of simulated cases were observed, and surprisingly, in non-simulated cases as well, likely due to the similarity in topics, requiring a similar approach. Additionally, topics such as phaeochromocytoma were reviewed during discussion which may have influenced participants' increased confidence levels for non-simulated case scenarios. Feedback on participants' performance was provided via the SIMBA assessment tool using an adapted global rating scale and Pendleton's method to allow reflection.

In the fourth stage of the Kolb's learning cycle—active experimenting—the participant builds on the knowledge in their personal clinical practice. An important finding from this session was the positive impact on participants' personal and professional learning, translating to personal knowledge and patient care. This matches patient management and practice-based learning components of the ACGME's core competencies. Practice based learning refers to achieving recertification following initial certification through continued education in the midst of daily clinical practice, taking into account the constantly evolving nature of the latter (28). This supports the aims of the SIMBA model, which employs the theory of connectivism, to disseminate latest evidence on the management of patients in the topic, while guiding participants through a scenario to allow subsequent self-appraisal according to scientific evidence, in a safe environment. Additionally, participants responded with intentions to improve aspects of their professional competence, and to implement specific changes in clinical practice and personal behaviour. These can be anticipated to have long-term positive consequences in clinically relevant settings, with a perceived ability to improve patient care.

Limitations and future research

While providing beneficial insight and supporting evidence, the study has certain limitations. While we were able to assess the effectiveness of SIMBA model using Kirkpatrick's levels 1 (reaction), 2 (learning), and 3 (behaviour) in our pre- and post-SIMBA evaluation forms, level 4 (results/outcomes) translating to longitudinal measurement of our model's impact remains a challenge. Our evaluation is currently limited to self-reported perceptions of improvement and personal plans. Further longitudinal evaluation is needed to determine whether actual clinical competence is subsequently improved. Another potential line of research would be to investigate the cognitive outcomes such as knowledge and retention of information, in addition to the current non-cognitive outcomes evaluated (self-reported confidence levels, perceived impact, personal plans).

Furthermore, acceptance of the model may be biased, by attracting participants who were particularly intrigued by the unconventional method of delivery (WhatsApp) offered by SIMBA and chose to participate. These participants might represent a population of learners who prefer the use of modern technology and are keen to participate in novel and innovative methods of learning. This sample selection bias may disproportionately tilt the positive response from respondents, leading to false belief of population acceptance of the model. Further research investigating how individual differences such as

learning styles and personality play a role in acceptability and preference for the model would be interesting. Nevertheless, the results demonstrate participants' satisfaction with the session.

Future of SIMBA

The results from this SIMBA Adrenal session provide evidence that the delivery of SBL via social media is a promising strategy, with a potential of engaging healthcare professionals worldwide. We aim to further expand the reach of SIMBA with more frequent sessions to encourage globalisation and bridge existing gaps in healthcare. Additionally, SIMBA may be used in future credentialing and assessment processes. Thus, our vision is to achieve low-cost teaching delivery, with minimal resources required to organise each session.

Conclusion

The SIMBA model mirrors the Kolb's experiential learning theory from practical point of view. The results demonstrate the positive reception of SIMBA highlighting the advantages of utilising social media as a platform for medical education. Improvements in confidence levels and core competencies using existing freeware social media softwares paves way for such sessions to be conducted at a low cost with high fidelity internationally.

Abbreviations

SBL: Simulation-based learning

LBL: Lecture-based learning

SIMBA: Simulation via Instant Messaging – Birmingham Advance

ACC: Adrenocortical carcinoma

CAH: Congenital adrenal hyperplasia

MDT: Multidisciplinary team

MCQ: Multiple-choice questions

BMNAH: Bilateral macronodular adrenal hyperplasia

ACGME: Accreditation Council for Graduate Medical Education

Declarations

Ethics approval and consent to participate

SIMBA was commissioned as a joint initiative by Health Education West Midlands Diabetes and Endocrinology specialist training committee and Institute of Metabolism and Systems Research, University of Birmingham as part of specialist training improvement initiative. All participants were provided with the same opportunity to attend and learn from the session. There are no ethical concerns and hence we did not seek further ethical committee review. All participants completed a consent form as part of registration for these sessions. The session was carried out in accordance with relevant guidelines and regulations.

Consent for publication

All authors have agreed to be accountable for and have given consent to publish all aspects of the work in ensuring that questions related to the accuracy and integrity of all parts of the work are appropriately investigated and resolved.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interests.

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The study did not receive any funding.

Authors contributions

MD and EO are the joint first authors having made all round contributions to the study. EM contributed to the study conception and supervised executive aspects of SIMBA. DZ, LT, and TH helped write the first draft. CYN, PB, NE, and WC were core moderators during the session, and helped create the transcripts, advertisements, and other relevant materials. WA supervised the design and delivery of the simulation session. PK conceptualised and supervised the delivery of all aspects of SIMBA. All authors made substantial contributions to drafting and approving the final draft of the manuscript. The final version has been reviewed and approved by all the named authors.

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Figures

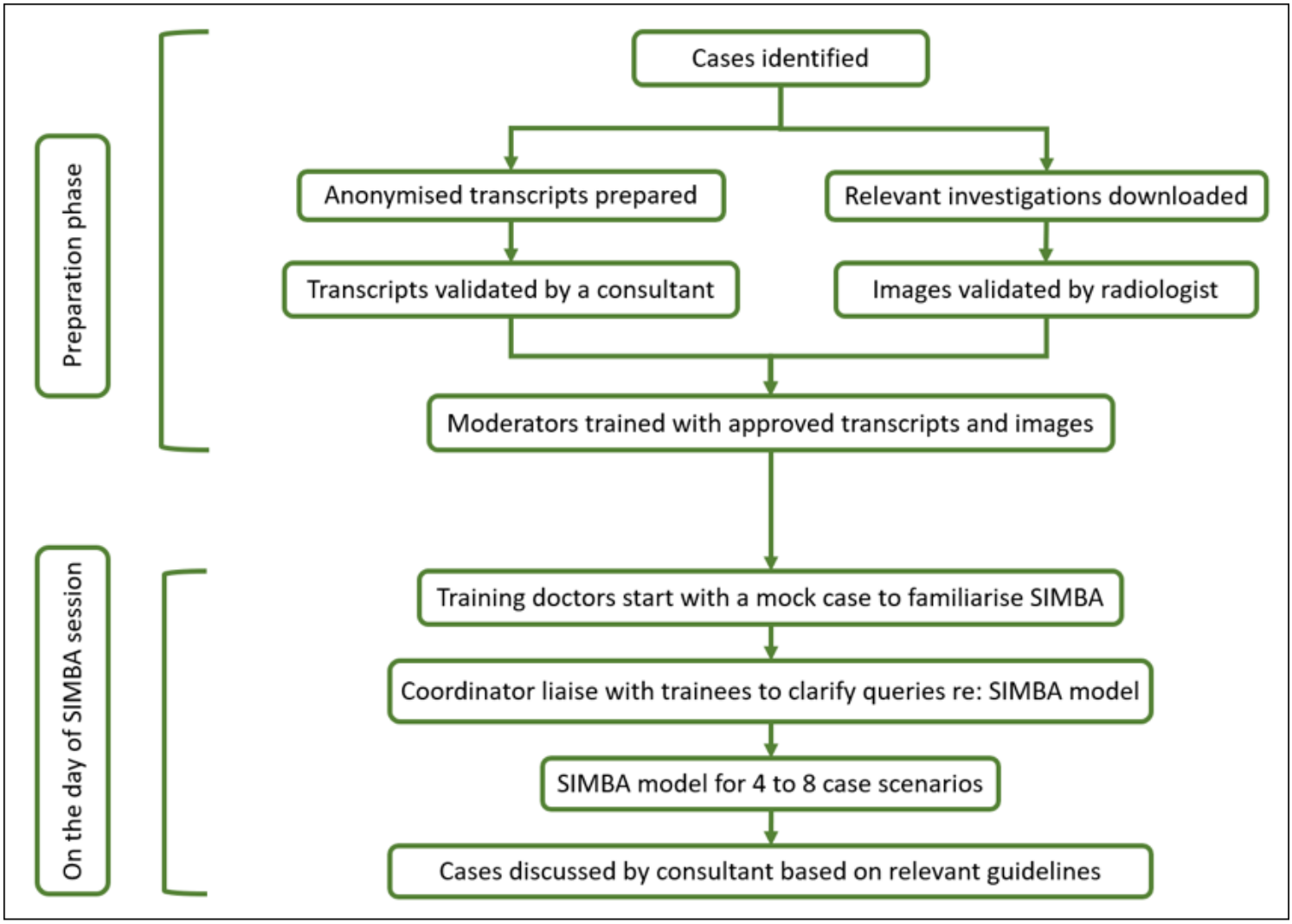

Figure 1

Working model of SIMBA. There are generally two stages - preparation and on the day. In the preparation phase, suitable cases are identified from outpatient clinics. Anonymised transcripts containing relevant history, examination, and investigations are prepared. These are then approved by an expert in the field. The approved transcripts are used to train the moderators. Prior to the actual day of the session, the sessions are advertised and registered healthcare professionals are provided with detailed instructions how to join the session. On the day, participants are assigned to moderators usually in a 3:1ratio. The participant contacts the moderator who then initiates the mock case with a focus to let the participant familiarise with the SIMBA model. Usually, this lasts about 20 min following which the coordinator for the day liaises with the participant to clarify any technical issues. This is followed by SIMBA session for 4 to 8 cases with a short break for every 2-3 cases. After this, an expert discusses the simulated cases based on the transcripts and current relevant guidelines. The participants have ample time to engage with the expert to clarify any doubts.

Simulation via **I**nstant **M**essaging-
Birmingham **A**dvance

Please assess the patient as you would interact in a real-life clinic. Please request as much information about the patient as you like. However, please bear in mind you have 25 minutes to complete all of the following in each case:

1. History
2. Physical Examination
3. Investigations (forms will be provided)
4. Your diagnosis and proposed management plan to the MDT
5. Post-op follow-up plan (if indicated)

You will receive instructions as you go through the cases. Please feel free to ask the moderators if any doubts at anytime throughout the case. You have about 25 minutes to complete the simulation, please type "ready" when you are ready to start.

Figure 2

Instructions provided by a moderator before each simulated case.

Score	1	2	3	4	5	Score
Eliciting history	Not done	25% of history	50% of history	75% of history	100% of history	**<<A>>**
Physical examination	Not done	25% of relevant and many irrelevant examinations	50% of relevant and some irrelevant examinations	75% of relevant and few irrelevant examinations	100% of relevant and very few to no irrelevant examinations	**<<B>>**
Initial investigations	Not done	25% of relevant and many irrelevant investigations	50% of relevant and some irrelevant investigations	75% of relevant and few irrelevant investigations	100% of relevant and very few to no irrelevant investigations	**<<C>>**
Diagnostic tests	Not done	25% of relevant and many irrelevant diagnostics	50% of relevant and some irrelevant diagnostics	75% of relevant and few irrelevant diagnostics	100% of relevant and very few to no irrelevant diagnostics	**<<D>>**
Imaging	Not done	25% of relevant and many irrelevant imaging	50% of relevant and some irrelevant imaging	75% of relevant and few irrelevant imaging	100% of relevant and very few to no irrelevant imaging	**<<E>>**
Clinical judgement	Not done	Inaccurate diagnosis and rationale	Accurate diagnosis with no rationale	Accurate diagnosis with incomplete rationale	Accurate diagnosis with complete rationale	**<<F>>**
Management and follow up	Not done	Inaccurate management plan	Accurate plan with no rationale	Accurate plan with incomplete rationale	Accurate plan with complete rationale	**<<G>>**

Figure 3

SIMBA rating scale, adapted from the Global Rating Scale.

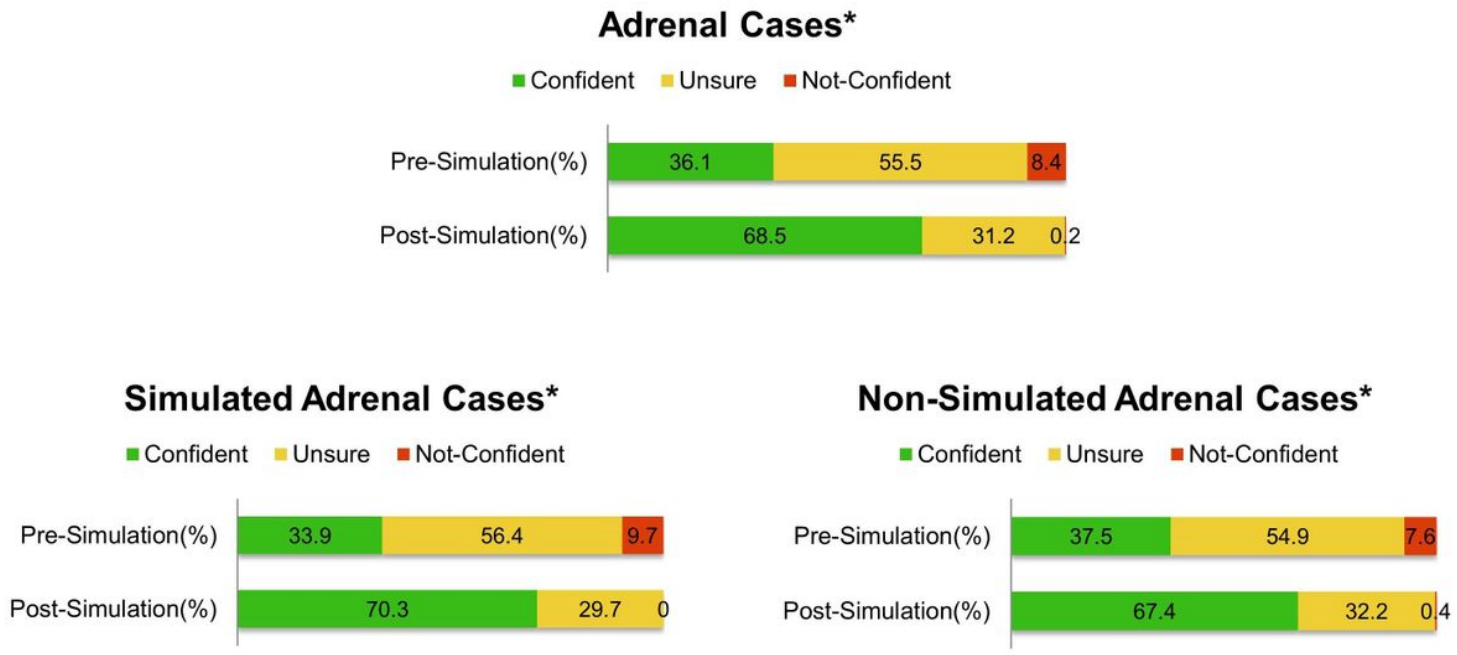

Figure 4

Illustration of changes in participants' confidence levels for managing simulated vs. non-simulated adrenal cases. *p<0.0000

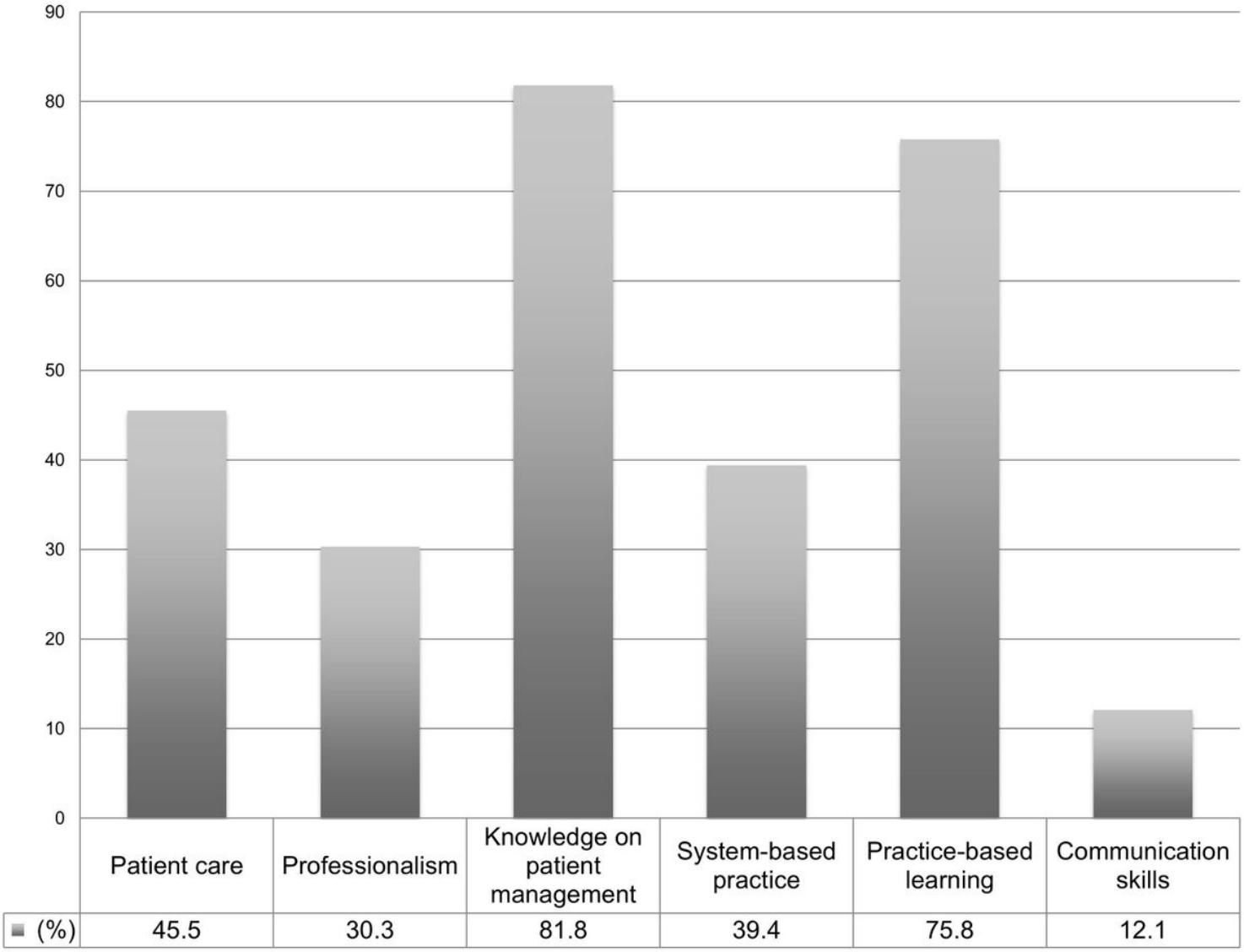

Figure 5

Illustration of changes in Six domains of medical education based on the core competencies proposed by Accreditation Council for Graduate Medical Education (ACGME).

A

Theme	Examples
Professional competence	*"Evidence based practice to include latest guidelines…"* *"Read more updated resources"* *"Better understanding of pathophysiology"*
Specific changes in clinical practice	*"COVID 19 and adrenal insufficiency treatment strategy…"* *"Radiology follow up in adrenocortical carcinoma"* *"Avoid unnecessary follow-up imaging…"* *"Request appropriate imaging for incidentaloma"* *"…unenhanced HU not useful in heterogeneous adrenal lesions"*
Personal behavioural changes	*"I am more confident in assessing patients…"* *"To practice more and attend MDT"* *"Because I am more confident, I am going to explore incidentalomas better"* *"…to improve my analytical methods and work on improving clinical acumen"*

B

Theme	Examples
Overall rating	"Great effort put in during difficult COVID period" *"Excellent discussion"* "…*so* knowledgeable, highly appreciated" *"Excellent, very encouraging"*
Evidence-based	*"Evidence-based"*
Delivery	**Positive** "Always a guide which likes to interact rather than giving only guidelines" *"Very professional"* *"Good and interesting case mix"* *"Highlighted important management steps"* **Negative** *"Audio (speakers and headphone) did not work at my end despite repeated attempts…"*

Figure 6

Thematic tabulation of responses to open-ended questions. (A) "as a result of what I have learned today, I intend to make the following changes to my practice that I believe will impact my patients' care in a positive way", and (B) "additional comments regarding chair's contribution".

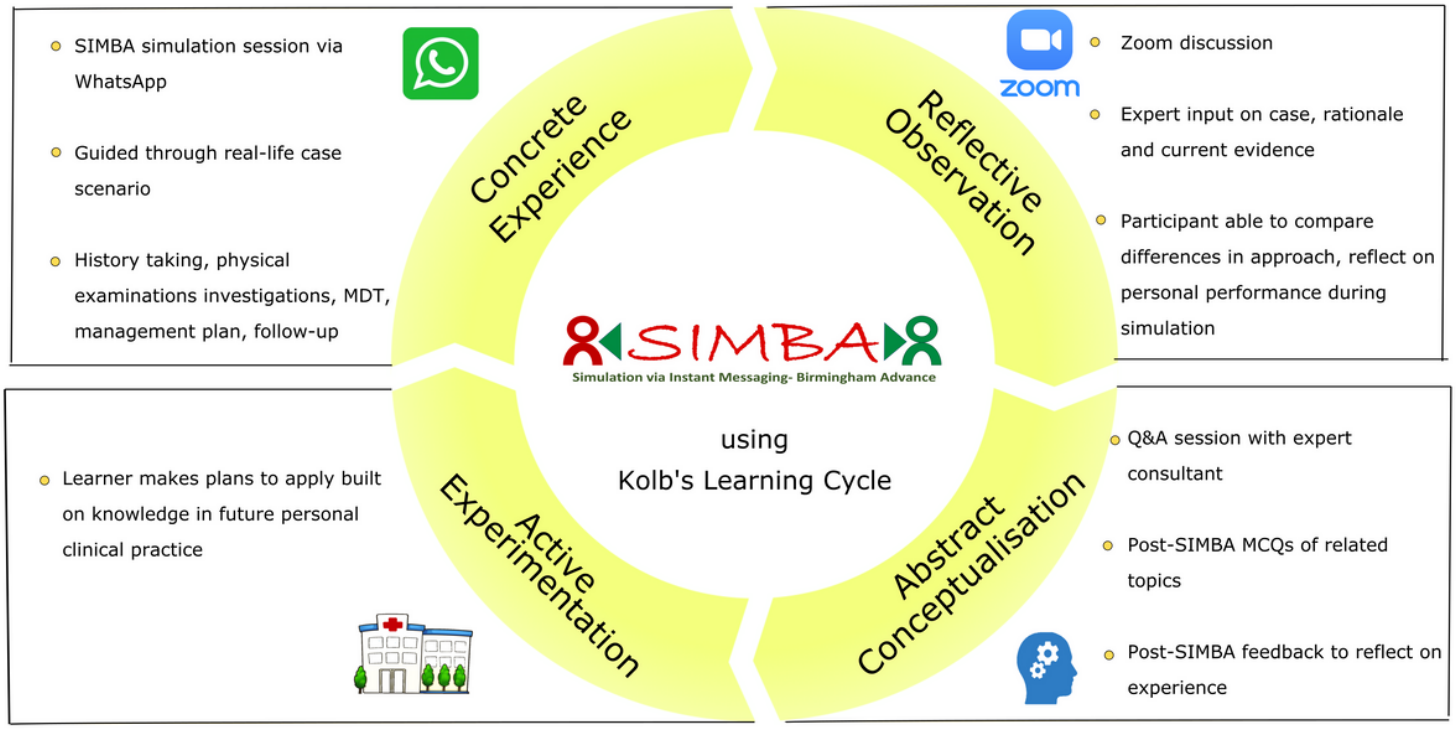

Figure 7

SIMBA replicating Kolb's 4-stage experiential learning cycle.