

Evaluation of an undergraduate paediatric simulation programme within a resource constrained setting: Does effective learning occur?

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ABSTRACT

Aim: To evaluate the utility of an undergraduate paediatric simulation workshop developed within a resource constrained setting over a three-year period.

Methods: Student perceptions were gathered exploring the usefulness of the workshop and the appropriateness of the level of difficulty of scenarios in relation to their experience utilising Likert scales. Free-text qualitative responses were collected identifying the learning points encountered, what students found useful, and suggestions for improvement.

Results: All 170 students who participated in the workshop responded. All students strongly agreed or agreed that the workshop was a useful learning exercise, and 165 (97%) thought that the level of difficulty of the scenarios was appropriate for their experience. Key learning points identified included the importance of a structured approach, having effective communication skills, the appreciation of human factors, and the application of knowledge and utilisation of resources when managing an unwell child. Reported useful aspects of the simulation workshop included the supportive learning environment, the designed clinical scenarios, the opportunity to negotiate complex human factors, and the debriefing process. Variations in themes emphasised were observed amongst fifth and sixth year student groups, with the most common suggestion for improvement being additional sessions.

Conclusions: Simulation is a useful and effective learning tool for paediatric medical students when tailored appropriately to their level of experience, even within a resource constrained setting.

Keywords: Paediatric, Medical Education, Undergraduate, Patient Simulation

INTRODUCTION

Simulation has been increasingly used in the delivery of undergraduate medical education in recent years, providing a means for the application of learned knowledge without causing patient harm.¹

In an era in which pressures exist for the provision of target-driven health care, standardised training of medical students in the management of seriously unwell children is becoming increasingly difficult.² Simulation has been identified as a means to bridge this gap, with benefits

including the ability to ensure standardised exposure to various clinical presentations, deliberative practice and enhanced opportunities for feedback.^{3,4} Nonetheless, many centres lack the luxury of dedicated personnel or simulation suites with high fidelity equipment, and often operate with significant resource constraints. For the purposes of this study, we defined “resource constraints” as an environment limited by time, personnel, clinical duties and access to appropriate dedicated space and/or equipment such as high-fidelity manikins.⁵

Within New Zealand, undergraduate medical students currently undertake their paediatric attachments during their fifth and sixth years of training. Throughout the year, students rotate through our secondary level general paediatric department which does not have access to a high-fidelity simulation suite or designated simulation staff, with up to 10 students present at any one time. Although students are frequently able to observe the management of moderately unwell children in an acute setting, there are limited opportunities for them to participate in resuscitations or be involved in decisions regarding management. Students have also reported few opportunities to explicitly practice communication tools such as ISBARR and closed-loop communication during their clinical attachment.⁶ Therefore, we developed an undergraduate paediatric simulation workshop integrated within the current curriculum to address these identified learning needs.

The aim of this study was to evaluate the utility of our paediatric simulation workshop over a three-year period, based on students’ reports of their experience. In particular, we aimed to assess if the

students found the workshop useful for their learning, whether the level of difficulty of the scenarios was appropriate for their experience, what they learned from the workshop, aspects of the workshop they found most useful, and suggestions for improvement.

METHODS

Description of the workshop

Four common paediatric conditions formed the basis for the scenarios in our workshop; bronchiolitis, gastroenteritis, asthma and sepsis. Each session was undertaken with four to five students who were all at the same level of training, at the end of each rotation cycle, to encourage students to draw from their learning and experiences over the preceding weeks. Each rotation cycle varied between four to six weeks in length, and hence this equated to a workshop approximately once every three weeks. The workshop was conducted by two facilitators (residents within the department) with simulation and debriefing training. Simulations were conducted in a ward setting, to provide greater realism and promote learning. A simple manikin was used alongside an electronic application (SimpleSim) allowing remote control of real-time clinical data.⁷ The learning objectives for our workshop are shown in Figure 1.

Two 20-minute scenarios were undertaken with students participating as a pair or group of three. In line with these learning objectives, students were expected to identify and assess a moderately unwell child drawing from components of the history provided by an attending parent, and their clinical assessment, working alongside a nurse confederate. They were

- Demonstrate the use of an ABCDE approach to managing an unwell child
- Apply principles of effective communication as part of a multidisciplinary team, utilising tools such as closed-loop communication and the use of an ISBARR handover to senior support at an appropriate time
- Correctly identify and manage a moderately unwell child with gastroenteritis, bronchiolitis, asthma or sepsis, demonstrating an understanding of important factors in assessing severity

Figure 1: Predetermined learning objectives for our simulation workshop. ABCDE: Airway, breathing, circulation, disability, exposure; ISBARR: Identify, situation, background, assessment, recommendation, read back.

also expected to undertake initial management utilising an ABCDE approach, and escalate care to a senior as appropriate.

The remaining students were present as active observers within the same room, with these roles reversed for the second scenario. A structured 25-minute debrief followed each scenario, allowing for discussion of the clinical facts, as well as participants' and observers' perspectives and experiences. Emphasis was placed on the workshop serving as a learning tool rather than summative assessment. A more detailed description of our workshop has previously been described.⁵

Following the simulation workshop, anonymised written evaluation forms were provided and completed by all students as part of a quality improvement process. Consultation with the University of Auckland Ethics Committee determined that ethics approval was not required, as this evaluation was deemed to be an audit reviewing an established aspect of the student teaching programme.

Data collection

Student perceptions were gathered exploring the usefulness of the workshop and the appropriateness of the level of difficulty of scenarios in relation to their level of experience. These were evaluated using a Likert scale of 1 to 5 (1 being

strongly disagree, 5 being strongly agree). Free text qualitative responses were also collected regarding learning points encountered, what students found useful, and suggestions for improvement.

Data analysis

Descriptive statistics were used for analysis of Likert scale data. Free text qualitative responses were analysed using an inductive thematic analysis with a six-step approach.⁸ Data was coded by two independent coders, and themes generated until thematic saturation was achieved, facilitated by the use of nVivo software. A process of peer review of identified codes and themes, whereby these were interrogated as part of a collaborative, iterative process, occurred to ensure trustworthiness. In addressing reflexivity, the concept that an individual's background, skills and experience impacts on the entirety of the research process including data analysis, the two independent coders were both paediatric registrars and facilitators of the programme.

RESULTS

A total of 44 simulation workshops were conducted from the 1st of June 2017 to the 1st of June 2020. 170 students participated in these workshops, including 69 fifth year and 101 sixth year medical students. Feedback was obtained from all students.

Usefulness of the learning exercise

157 students (92%) strongly agreed with the statement 'I found this exercise useful for my learning', with the remaining 13 students (8%) reporting that they agree (Figure 2).

Appropriateness of the level of difficulty in relation to their level of experience

In evaluating students' perceptions regarding the difficulty of the cases in relation to their experience, 133 students (78%) strongly agreed that the scenarios were appropriate for their level of training, whilst 32 students (19%) agreed and 5 students (3%) were neutral to this statement (Figure 2).

What did the students learn from the workshop?

Thematic analysis of students' responses revealed four key themes (Table 1). Students reported learning about the importance of utilising a structure to manage acutely unwell patients; the importance of effective communication during the clinical encounter; an appreciation of the human factors within an acute clinical context; and the application of knowledge and utilisation of resources when managing an unwell child. Fifth year medical students tended to place greater emphasis than their sixth year student colleagues on the utilisation of structures to ensure that they avoided 'missing things'. Fifth year students also noted the importance of clinical knowledge, and learning how to interpret investigations and manage the conditions they encountered within the scenarios. In contrast, sixth year students focussed on the practicalities of tasks related to the scenario, such as negotiating tensions and challenges when

taking a history while concurrently performing an assessment in an acute setting, and how to ask for help in a high pressure situation. A greater emphasis on learning how to prescribe and utilise guidelines was also reported by sixth year students.

What did students find useful from the workshop?

Five key themes regarding the usefulness of the workshops emerged from students' responses (Table 2). Students reported the safe learning climate and the fact that the workshop was not assessed as being useful for their learning. As part of this, they also reported that having their peers participate as active observers within the same room provided a sense of comradery and the opportunity to learn vicariously. The designed clinical scenarios were described to be practical, adequately supported and realistic, which fostered a sense of autonomy not routinely encountered in their training. Sixth year students in particular described the scenarios as useful preparation for their imminent responsibilities as first year house officers, especially when encountering acute stressful situations. Students also found valuable the process of applying learned knowledge within a clinical context, and the opportunity to negotiate complex human factors within an acute setting. Finally, the immediacy and content of the debrief, in addition to the utilisation of peer feedback, was reported to be useful in facilitating their learning.

Suggestions for improvement?

107 (63%) students felt that no improvements were required. Of those who did offer suggestions, the most common was for a greater breadth of

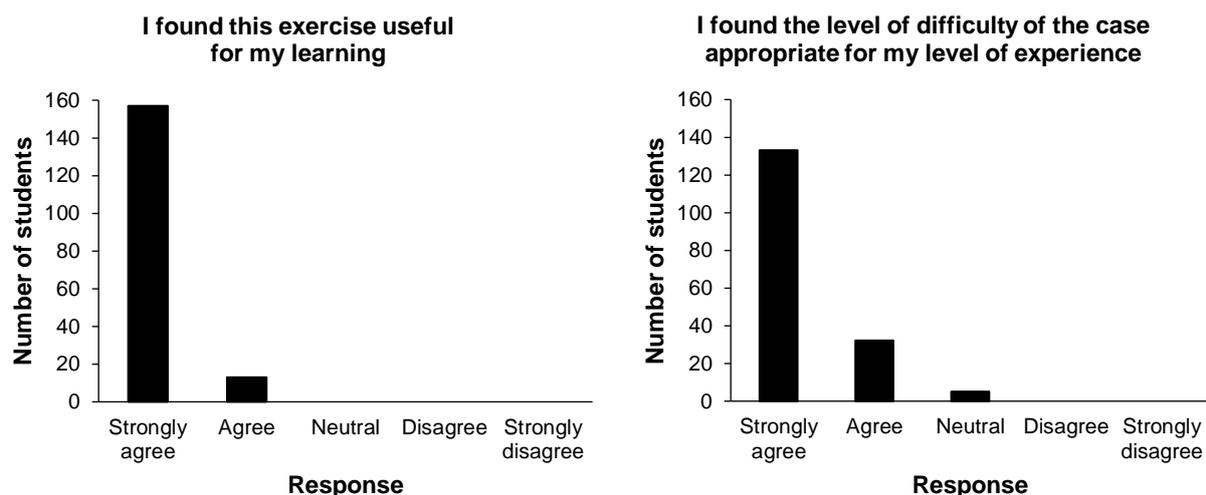


Figure 2: Participants' perceptions of the usefulness of the exercise and the appropriateness of the level of difficulty in relation to their level of experience.

scenarios or increased number of workshops ($n = 45$, 26%). A few students also commented on technical difficulties related to the SimpleSim application which we encountered in the first few months of the programme. This issue was resolved through use of a back-up alternative application (SimMon) if required.⁹

DISCUSSION

The utility of simulation in the field of undergraduate education has been widely reported.^{1,2,3} However, a paucity of data exists assessing its use for the education of undergraduate medical students in paediatrics. We have previously reported on the design and implementation of a simulation programme for undergraduate students in paediatrics within a resource constrained setting, and early feedback collated from students supported its continuing use.⁵ With a large number of students now having participated in the workshop over the last three years, a formal evaluation of the programme was warranted to assess its value for students' learning, the perceived benefits of learning through simulation, and students' suggestions for improvement.

We used Kirkpatrick's framework to evaluate our simulation programme.^{10,11} Kirkpatrick's model classifies learning resulting from training programs into four levels; reaction, learning, behaviour, and results (Figure 3).¹⁰ Our evaluation focused on the first two levels in order to explore evidence to support or refute the validity of our programme. Within level 1 (reaction), evaluation relates to the participants' perceptions of, and satisfaction with the training program, whereas level 2 (learning) assesses the value of the exercise with respect to knowledge gained, skills acquired, and/or changes in attitudes.^{10,11} Whilst several studies have employed validated questionnaires and quantitative data with a deductive framework for this type of evaluation, our study is one of the largest qualitative reports published to date from undergraduate paediatric medical student simulation participants.^{12,13,14}

Utilising an inductive approach allowed for generation of unintended themes that may not otherwise have emerged. Our findings suggest that students perceived the simulation workshop to be useful for their learning, allowing them the

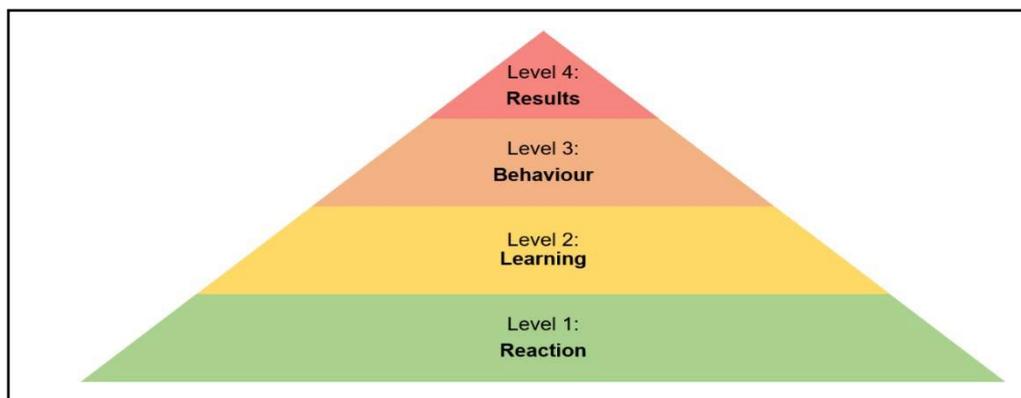


Figure 3: Kirkpatrick's framework for evaluation.¹⁰

opportunity to integrate and apply learned theory to practice, and that the difficulty of the scenarios was appropriate for their level of experience.

It was pleasing to see that the learning points reported by students were in line with our objectives for the workshop. The learning themes generated from our data appear to reflect and build on previously published findings.^{15,16} Morrissey et al. reported that simulated paediatric emergency scenarios provide a means of applying learned knowledge and insight into the role of human factors involved in such cases.¹⁴ Our study adds to the nuanced differences between learning points identified by fifth and sixth year medical students which may help guide the future development of the medical school curriculum, recognising the priority that final year students place on more practical aspects of learning in preparation for their postgraduate years. This may be particularly relevant when refining learning outcomes for simulation workshops, and integrating these within the intended curriculum. Our findings also add to the observation that the formal and active utilisation of designated peers as observers in the same room as participants had a positive effect on learning, as students reported a sense of comradery and opportunity to learn vicariously. A recent

meta-analysis also noted the act of 'active observation' through provision of observer tools as being associated with equal or better learning outcomes for participants in observer roles.¹⁷ As our student observers are provided with an observation sheet to complete to assist them in this role, this finding supports our current approach.¹⁷

Strengths of this study include the use of student evaluation, which allows the provision of diagnostic feedback on the facilitators' teaching and workshop, and for the complexity of the learning experience to be comprehended from a student's perspective.¹⁸ In addition, the use of written evaluation forms for data collection provided the advantages of time and cost-effectiveness given our current resource constraints, in comparison to other methods such as focus groups.¹⁸ Anonymised, free text responses also permitted students to give feedback as desired, allowing for unexpected or emerging themes to be identified and subsequently inform the development of the learning curriculum.^{19,20}

Administration of the questionnaire at the end of the session ensured that feedback was related to the entirety of the workshop and learning experience.²⁰ The use of a questionnaire completed in "real-time",

rather than a delayed modality such as a link to an electronic survey sent to participants some time later, provided higher rates of questionnaire completion thus reducing the degree of sampling error and bias.²⁰

In undertaking a qualitative content analysis, trustworthiness of a method can often be defined according to confirmability, credibility, dependability and transferability.^{21,22} The trustworthiness of our findings was maintained using several approaches. To ensure objectivity, two researchers independently coded the initial raw data, and subsequently generated themes. Findings were discussed amongst all authors to ensure credibility, whilst a clearly documented defined research trail ensured dependability. In line with qualitative principles of promoting rigour, we also aimed to embed the findings of our study through the provision of a rich description of the nature of our programme, to promote contextualisation.^{5,22}

However, limitations of utilising student evaluations need to be acknowledged. Student evaluations may reflect the expectations of the student or their satisfaction with the teaching rather than the actual learning experience.¹⁸ The implicit and explicit hierarchies that may impact on the quality of feedback obtained through the student evaluation process also need to be recognised.²³ Attempts were made to address this by explicitly describing the drivers for the development of the workshop when providing the evaluation forms, and by making it clear that the workshop was purely formative for the students' learning. It was also emphasised that any constructive feedback would be highly valued and utilised in future development of the workshop.

The fact that the findings are solely based on student perceptions is a further limitation of this study. Obtaining feedback from other sources, such as peer facilitators and self-reflection, would allow for triangulation of the evaluative process, and thus we aim to incorporate such feedback into future evaluations of our programme.^{24,25} Furthermore, building on Level 3 of Kirkpatrick's model evaluating for behavioural change, we also wish to assess if knowledge and skills gained by workshop participants have been transferred into real life contexts following graduation. Dudas et al. explored the implementation of a simulation-based curriculum within a paediatric rotation, demonstrating higher knowledge scores and improvements in medical student performance during a paediatric clerkship.¹³ Comparison with a control arm of those not attending the simulation programme would help validate the utility of such a learning tool. Ultimately, evaluation at an organisational level based on patient outcomes in the long-term would also be ideal, to see if lessons learnt have become embedded within day-to-day practice.²⁶

CONCLUSION

In conclusion, simulation is a useful and effective learning tool for paediatric undergraduate students when tailored appropriately to their level of experience. Our study demonstrates its feasibility and functionality, establishes encountered learning points, and deepens our understanding on how such a workshop facilitates the application of theory within a practical context from a student's perspective. Our findings suggest that simulation serves as an effective tool in encouraging the application of learned

knowledge and the acquisition of technical and non-technical skills when facilitated within a safe learning climate, even in resourced constrained settings.

DECLARATION OF INTEREST

No potential conflict of interest was reported by the authors.

Table 1: Learning points encountered by students

Theme	Subtheme	Supporting quotes
Theme 1: Importance of utilising a structure to manage acutely unwell patients	ABCDE for initial assessment and re-assessment	<p>“Importance of using an ABCDE structure in panic situations and re-assessment for response/clinical changes.”</p> <p>“ABCDE and importance of addressing each individually. Don’t miss anything and don’t forget interventions at each stage.”</p> <p>“Go back to ABCDE when unsure what is going on.”</p>
Theme 2: Importance of effective communication during the clinical encounter	Ensuring a shared mental model with colleagues utilising strategies such as closed communication loops, “time-outs” and microsummaries	<p>“The importance of regular communication between colleagues and being on the same page. Ways to communicate under pressure – closed communication loops.”</p> <p>“Slow down, take a breath. Use team time-outs.”</p> <p>“Regular recaps to establish status quo and planning of next steps.”</p>
	Including families during the clinical encounter	“Importance of continued communication with concerned parents. Include the parents, tell them what you are doing. Not to use too much jargon.”
	Escalation of care	<p>“When to call for help and how to present information. ISBARR.”</p> <p>“When calling for help, indicate urgency of the situation to the registrar and consultant. You need to be clear and concise with what you want/requesting over the phone.”</p>
Theme 3: Appreciation of human factors within an acute clinical context	Teamwork, prioritisation, delegation, recognising limitations and assertiveness skills	<p>“The leader doesn’t have to dictate everything, active followers follow in the background.”</p> <p>“How to prioritise tasks, allocate roles and splitting so that things are efficiently done.”</p> <p>“Understanding limits. When to call the senior for help.”</p> <p>“Don’t be afraid to escalate and call for senior help and clarify plan if I’m unsure.”</p>
Theme 4: Application of knowledge and utilisation of resources when managing an unwell child	Identification of an unwell child	“Distinguishing life threatening or acute asthma.”
	Management of common conditions and interpretation of relevant investigations	<p>“Management of asthma – Use of nebulisers versus MDI via spacer.”</p> <p>“Treatment of gastroenteritis, hypovolaemic shock, and fluid resuscitation.”</p> <p>“How to interpret a venous blood gas.”</p>
	Utilisation of guidelines	“Following and finding protocols. Life threatening asthma protocol.”
	Prescribing skills	“Practicalities of emergency management. How to give resus fluids. Paediatric dosing.”

Table 2: Aspects of the programme students found useful

Theme	Subtheme	Supporting quotes
Theme 1: The learning environment	Practical, safe, non-intimidating learning environment	“Having the hands-on experience under supervision and guidance was a safe way to learn and experience these emergency situations.” “Non-judgmental. The fact that it wasn’t an assessment.”
	Peer participation provided sense of comradery and opportunity to learn vicariously	“It was nice having everyone in the same room as those doing the simulation – sense of not being alone in a stressful situation.” “Being in pairs/group of three was helpful.” “It was really helpful to be an observer too. Observing how my classmates do things and learning from their successes and failures.”
Theme 2: The clinical scenarios	The designed scenarios were practical, adequately supported and provided a sense of realism	“It felt real. All the equipment was present.” “Encouraging supportive facilitators. Assistance and guidance during the scenario.”
	Scenarios fostered a sense of autonomy and responsibility not routinely experienced during their training	“Having to make decisions. Thinking on feet. Practicing the level of responsibility/duty expected of us in 1 months’ time.” “Really good realistic practice to take up the role as a doctor. Was good to be the person in charge of management rather than being a passive bystander.”
Theme 3: Applying learned knowledge to a clinical context and identification of knowledge gaps	Applying learned knowledge and the practicalities of managing of an acutely unwell child	“Doing a scenario is very different from reading about it.” “Learning to recognise when the child is sick and when to escalate. Practicing algorithms/ structures, calling seniors. Back to basics with ABCDE.” “Getting us to perform things we’re not yet completely comfortable doing - being able to do practical ‘doctor things’ e.g. filling out forms, charts etc.”
	Identification of knowledge gaps	“It was really good to have this realistic simulation to make us identify what we don’t know and need to work on.”
Theme 4: Negotiating complex human factors	Experience of negotiating human factors involved in the management of an unwell child	“Useful to try working in a team setting. How to organise a team. Splitting tasks.” “Becoming aware of own weaknesses. Realising what you don’t know. Learning to know when to seek help.”
Theme 5: The debriefing process	Timing and content of the debrief	“The immediacy of feedback. Being able to ask questions about real life applications in these scenarios – putting learning points into context.” “Highlighting what was done well and not just focusing on negatives. Practical aspects discussed point by point.”
	Utilisation of peer and facilitator feedback	“Getting feedback from both students and registrars.”

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