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Assessment of a low-fidelity human patient simulator for the acquisition of nursing skills

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Summary *Aim*. Assess the user-friendliness of a low-fidelity human patient simulator as a precursor to developing and evaluating nurses' health assessment knowledge and skills.

Method. An assessment tool was developed to assess nurse perceptions about the components and functions of the Nursing Anne Complete manikin in terms of its realism, perceived suitability for teaching purposes (rated on five-point scales from disagree to agree), and how it compared with other teaching tools (e.g., better than text book). The manikin was placed on hospital wards to assume patient realism and data was collected from two hospital sites over one month.

Results. Nurses (***N*** = 70) reported that most of the components and functions (appearance, movement, procedures and sounds) of Nursing Anne Complete were realistic, better than existing training products, and suitable for teaching purposes. Additional comments included suggestions for improvement.

Conclusions. Overall, the results indicated that this manikin is a very useful training product for nursing education.

Implications. Low-fidelity simulators may facilitate experiential learning concomitant with behaviour modification and improved health assessment competence of nurses. Moreover, utilising human simulators in nurse education has the potential to reduce the risk of adverse events and facilitate increased positive patient outcomes.

Introduction

Clinical education is pivotally important in the development of competency in clinical practice. Competence in practice ultimately determines advanced practice concomitant with improved patient safety and outcomes, and decreased

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healthcare costs (Catolico et al., 1996; Gibbons et al., 2002; Graham, 2002; Hellquist, 2001; Jackson et al., 2002). International and national reports of medical and nursing research indicate an increasing sophistication in the methodologies and technologies used in clinical education practices, and the use of human patient simulators in the education and assessment of clinical knowledge and skills is becoming increasingly commonplace (Bradley and Postlethwaite, 2003b). As a consequence, this paper reports on the user-friendliness of a low-fidelity simulation manikin, in terms of its realism for improving clinical practice, suitability for nurse education, and how it compares with other teaching and assessment techniques.

Background

Educational simulations are exercises designed to mimic real-life situations in which medical and nursing staff have an opportunity to reason through a clinical problem and make clinical decisions without the potential of harming actual patients (Bond and Spillane, 2002; Bradley and Postlethwaite, 2003a). They also provide the opportunity to become familiar with complex clinical conditions that occur infrequently in reality but require immediate treatment by an experienced clinician (Good, 2003). Importantly, simulation provides the opportunity for repeated clinical and reflective practice, where students can learn and make mistakes in a safe and controlled environment (Kneebone, 2003; Peteani, 2004).

Since clinical opportunities and patient availability are limited for student nurses, human patient simulators are thought to benefit the teaching and learning of their clinical skills in a controlled setting. Service demands in the health sector that often limit clinically based instruction time, expanding options for diagnosis and management, and advances in technology are contributing to the greater use of simulation technology (Bond and Spillane, 2002; Monti et al., 1998). Moreover, simulation technology can reduce the reliance on using in-patients for staff training.

Simulation technology helps to address problems of poor skills training and proficiency, and provides a method for self-directed lifelong learning by engaging learners in deliberate practice of clinical skills to produce improvements in a relatively short time (Issenberg et al., 2002). For example, this technology has benefited medical students while studying cardiology; they ultimately performed better than students who learned in the traditional manner with real patients (Issenberg et al., 2000; see also Ewy et al., 1987).

Research also shows that nurses and nursing students are often not competent in performing clinical skills such as basic life support (BLS). Results from one study showed that none of the 53 qualified nurses could perform BLS adequately; alarmingly, 30 of these nurses were completely incompetent (Wynne et al., 1987; see also Badger and Rawstorne, 1998; Devlin, 1999; Sefrin and Paulus, 1994). Additionally, Finnish researchers used a human patient simulator with 298 nurses and student nurses to assess the influence of resuscitation teaching and other group characteristics on performance. The best predictor to open the airway was a positive attitude (e.g. self-confidence) toward BLS skills, and the best predictor for adequate skills in artificial ventilation was recent resuscitation training. However, with a 50% success rate in artificial ventilation and chest compression, nurses' skills were inadequate in terms of a competent and prompt needs assessment for resuscitation (Nyman and Sihvonen, 2000).

Simulation in health care education may take many forms, including multimedia technologies (e.g., CD Rom), bench top models and part task trainers, and full body human patient simulators of varying fidelity. Low-fidelity patient simulation (LFPS) is the term given to patient simulators that are limited in their interactivity with the user (e.g., the educator or clinician). Unlike high-fidelity patient simulation (HFPS) that has a sophisticated level of interaction, facilitated by computer programmes, LFPS and associated part-task training devices provide the user the opportunity to simulate an array of scenario based assessments and activities, without the level of technical response and feedback that a HFPS tool may. Despite this difference, Grober et al. (2004) found that LFPS was as effective as HFPS for technical skill acquisition among novice surgeons, and both methods were significantly more effective than traditional didactic instruction.

Various researchers have reported that human patient simulators are valuable tools in critical care education, and can provide an avenue for identifying weaknesses both in individual student performance and in program content (Hammond et al., 2002; see also Schwid et al., 2002). Nonetheless, Ravert (2002) conducted a literature search to review quantitative studies related to simulation and healthcare education to examine the effect of simulation on education and learning. Surprisingly, out of 513 references, only nine quantitative studies since 1980 met strict inclusion criteria. Seventy-five percent of the nine studies showed

positive effects of simulation on skill and/or knowledge acquisition, indicating the enormous potential of simulation technology to augment education, although Ravert emphasised the need for further research to determine effective and successful uses of simulations for nursing education.

With the increasing development and use of human patient simulators of varying fidelity in clinical teaching, practice and assessment, evaluation of these products in terms of their user-friendliness and learning effectiveness is essential (Tsai et al., 2003). Simulation manikins are expensive, and with increasing budgetary constraints, communication to manikin users (e.g. clinical educators) about these products is imperative. Likewise, feedback to the manufacturers of the manikins can facilitate the improvement of their current models and the development of more realistic simulators in the future. As Kneebone (2003) suggests, those who develop the simulators are not necessarily driven by the same agenda as those who actually use them. To our knowledge, there are no previously published reports of quantitative research concerning the realism of simulation manikins and their suitability for healthcare education.

Our objective was to assess the realism of a low-fidelity simulation manikin, compare to other teaching methods and examine nurses' perceptions about the suitability of the manikin for teaching purposes, as a precursor to developing and evaluating nurses' health assessment knowledge and skills. This article reports findings for the Laerdal Nursing Anne Complete. It was expected that nurses and nurse educators would regard this manikin as a suitable learning tool, sufficiently realistic for improving clinical performance, and an improvement to existing education products including other simulation manikins.

Method

Sample

A volunteer sample of 70 nurses (57 females and 13 males) agreed to take part in this study. Participants had an average age of 37 years (SD = 10) and were from two Southern Health Hospital sites (site one: $n = 34$; site two: $n = 36$). The majority of nurses were Division 1 Registered Nurses (RNs) ($n = 43$, 61.4%) and half had completed their pre-registration training at university ($n = 35$), while 11 participants (15.7%) were undergraduate students completing clinical placements. Twenty percent of participants had over 21 years of nursing experience ($n = 14$), and 45.7% had postgraduate qualifications ($n = 32$). In addition, 32.9% of the nurses worked on general adult wards ($n = 23$) and almost half of the participants had been working in their current positions for less than 5 years ($n = 34$) (see Table 1).

Materials

Manikin

Preliminary discussions took place between Laerdal and Nursing Education and Research (NE & R) at Southern Health regarding the value of an assessment of the realism and perceived education benefits of the Nursing Anne Complete manikin. As Laerdal was preparing to launch the manikin on the Australian market, it was an opportune time to conduct such research and both parties were unaware of any other formal evaluative research taking place. During these discussions, NE & R negotiated the retention of the manikin for future research and nurse education, regardless of the outcomes of this study. Laerdal exhibited a high degree of confidence in their product and consented to the dissemination of both positive and negative findings from the research, recognising that any negative data had the potential for future improvement of the manikin.

The Nursing Anne Complete manikin (FCS-4000) is a lifelike, full-body manikin with male and female interchangeable genitalia. It is a low-fidelity patient simulator that enables the practice of a diverse range of nursing skills (e.g., tracheostomy care, oral and nasal intubation, stoma management and IV cannulation). The manikin was accompanied by a Multi Sounds Complete Trainer to simulate auscultation of normal and abnormal heart, breath and bowel sounds.

Questionnaire

A diverse range of nursing practices can be simulated on Nursing Anne Complete and a comprehensive questionnaire was considered the most efficient evaluation method to enable quantitative analysis of the data. The first page of the four page questionnaire included a plain language statement about the research and also asked participants to provide demographic information pertaining to age, gender, nursing qualifications, nursing division, ward/unit or department name, and current position. It was anticipated that this information could facilitate comparative analysis of nurses' responses in terms of demographic characteristics.

Table 1 Demographic characteristics of nurses who assessed Nursing Anne Complete ($N = 70$)

Demographic characteristics	Category	*n*
Age	Up to 25 years	8
($M \pm SD$)	26–35 years	25
37 ± 10	36–45 years	23
	46–55 years	11
	56 years and over	3
Gender	Male	13
	Female	57
Training	Hospital	28
	University	35
	TAFE	7
Years	Undergraduate	11
Nursing Experience	1–5 years	9
	Graduate	4
	6–10 years	13
	11–15 years	12
	16–20 years	7
	21 plus years	14
Division[a]	Div 1	43
	Div 2	14
	Div 3	2
Postgraduate studies[a]	None	27
	Certificate	11
	Graduate diploma	14
	Masters	7
Current position[a]	Assoc. nurse unit mngr.	5
	Nurse unit mngr.	1
	Clinical nurse specialist	6
	RN div 1 graduate	4
	RN div 1 grade 2	14
	RN div 2	11
	Nurse educator	15
	Clinical nurse consultant	2
	Midwife	1
Years in current position[a]	1–5 years	34
	6–10 years	11
	11–15 years	5
	16–20 years	4
	21 plus years	5
Ward unit or department[a]	Aged rehabilitation	4
	Bank staff	3
	Child/adolescent psych	3
	Education	10
	Emergency	6
	General adult wards	23
	Maternity/midwifery	3
	Paediatrics	1
	Stomal therapy	1
	Theatre	5
Site	Site 1	34
	Site 2	36

[a] Undergraduates not included.

The following two pages contained a list of the various components and functions of Nursing Anne Complete which were separated into four sub-sections: appearance (e.g., head, female genitalia), movement (e.g., head tilt, leg rotation at the hip), procedures (e.g., eye irrigation, intramuscular injections) and sounds (e.g., normal heart rate, wheezing). In total, there were 52 individual items. Participants were asked to assess each item in terms of two separate criteria; realism and comparison. Realism referred to how lifelike and realistic Nursing Anne Complete was for improving clinical performance, and participants were asked to respond to each item using a five-point Likert scale, ranging from 1 = disagree to 5 = agree, with a neutral mid-point included. Based on participants own experience, comparison referred to how Nursing Anne Complete compared to a range of other teaching methods commonly utilised in nurse education. The response format included 2 = superior to a textbook, 3 = superior to an instructional program, 4 = superior to existing training products (including other manikins), and 5 = similar to an actual patient. Additionally, an option 1 = not Applicable was included for those who felt unable to comment on a particular item (e.g., undergraduate students). Space was provided for additional comments at the end of each sub-section, and also at the end of the overall Realism and Comparison.

The final page of the assessment tool investigated nurses' perceptions about the suitability of Nursing Anne Complete for teaching purposes, and originally contained 10 items. However, one of these items was removed during the data collection period because it was discovered that the task could not be performed on the manikin, as originally thought; therefore, results are reported for nine items (these items are listed in Table 7 of the Results). The five-point Likert scale described above for the Realism was also used for these items, with space again provided for comments under each item. A further comments box was included at the end of the assessment tool for any general feedback, or suggestions for improvement of the manikin.

The first draft of the questionnaire was reviewed by several expert nurses (e.g., nurse educators and nurse specialists) for language and terminology accuracy. They were given the opportunity to examine the manikin while reviewing the questionnaire to ensure all items were relevant. Their feedback resulted in minor changes to the tool (e.g., addition of some items and modification of others) before it was finalised and ready for data collection.

Equipment

To evaluate the capabilities of Nursing Anne Complete appropriately, an accompanying kit with relevant equipment (e.g., suction catheters, nasopharyngeal tubes, oropharyngeal airways, tracheostomy tubes etc.) was assembled. This equipment enabled nurses to actually practise the procedures listed on the assessment tool in order to properly investigate the manikin's realism and suitability for teaching purposes.

Procedure

The Southern Health Human Research and Ethics Committee was consulted prior to the research, and they classified the study as a quality assurance activity, according to their guidelines and those of the National Human Medical Research Committee (NHMRC). Following the research, all data has been stored in a secure location, as per NHMRC guidelines.

All nurses and nurse educators from sites one and two were invited to assess the manikin. To maintain impartiality participants were asked to volunteer to be involved in the research activity and provide written feedback on the manikin. The plain language statement was included to ensure all volunteers were aware of the reason for the study, and no coercion or inducements of any form were used. In order to assure anonymity, no identifying data were collected.

Directors of Nursing, Nurse Unit Managers (NUMs) and Nurse Educators received information flyers about the research via email both prior to and during the data collection phase. They were asked to assist in distributing the flyers (e.g., in staff rooms and stairwells) to reach as many nursing staff as possible. In addition, to encourage participation, the researchers visited many wards to speak directly to NUMs and in some cases to ward staff during staff handover times.

Due to time constraints and service demand, the data could only be collected during June 2003. At site one, the manikin was set up in adult wards to simulate a realistic hospital setting, while at site two it was set up in a suitable training room. During the day, one of the researchers was available in the room to provide instructions and answer questions, and to distribute and collect questionnaires. Nurses did not receive any formal briefing on the manikin and were instructed to work through the questionnaire at their own speed, using the equipment provided to simulate various procedures. A researcher was on hand to assist with technical aspects of the manikin such as the blood pressure training arm

and the sounds trainer. Completed questionnaires were placed into a folder which was cleared at the end of each day. The manikin was available for assessment 24 h a day to allow nurses to participate when most convenient. Detailed instructions were provided so that nurses could complete the questionnaire unassisted, however few nurses took advantage of this opportunity. Although individual times varied, it took approximately 20 min to complete an assessment of the manikin.

Results

Overall, the results were positive; nurses and nurse educators reported that most of the components and functions of Nursing Anne Complete were sufficiently realistic for improving clinical performance, superior to existing training products and suitable for teaching purposes. Given the limited sample size, comparative analysis based upon the various demographic characteristics (beyond descriptive statistics) was not feasible and this section therefore focuses on overall sample results. Nevertheless, it was thought that a comparison of nurse educators' responses with other nursing staff was relevant and such analyses were conducted where appropriate. For these analyses, several groups with small numbers (Nurse Unit Managers and Associates, Clinical Nurse Specialists, Clinical Nurse Consultants and Midwives) were combined into one group entitled 'Senior/Specialist Staff', and the Division 1 Graduate Nurses were combined with the Division 1 RNs. Caution is advised in interpreting these results however, due to the small group numbers.

Table 2 Nurses' responses to the realism of the appearance, sounds and movement of the Nursing Anne Complete manikin

Item	Mean	SD	Response breakdown[a] (%)		
			D	N	A
Appearance					
Head	3.94	0.81	7.2	10.0	82.8
Trunk	4.01	0.75	2.8	14.3	82.9
Female genitalia	4.09	0.86	5.7	11.4	82.9
Male genitalia	4.01	0.96	7.2	14.3	78.6
Breast location	4.34	0.67	1.4	7.1	91.5
Breast size	4.10	0.80	2.9	18.6	78.6
Extremities	4.16	0.83	2.8	14.3	82.8
Stump	3.88	0.97	10.0	18.6	71.5
Overall	4.25	0.65	1.4	7.1	91.5
Bowel sounds					
Normal	4.31	0.85	4.3	8.6	87.1
Hyperactive	4.27	0.84	4.3	8.6	87.1
Hypoactive	4.09	0.86	4.3	15.7	80.0
Chest sounds					
Normal breath	4.45	0.66	1.4	5.7	92.9
Simultaneous heart/lungs	4.49	0.65	1.4	5.7	92.9
Normal heart	4.55	0.62	1.4	2.9	95.7
Normal systolic BP	4.48	0.72	2.9	5.7	91.4
Systolic murmur	4.42	0.75	2.9	7.1	90.0
Normal diastolic BP	4.56	0.65	1.4	5.7	92.9
Wheezing	4.35	0.71	2.9	5.7	91.4
Crackles/rhonchi	4.44	0.72	2.9	5.7	91.4
Movement					
Head tilt	4.10	0.97	11.4	7.1	84.1
Head rotation	4.14	0.80	4.3	21.9	82.8
Arm rotation	4.10	0.76	2.9	15.7	81.4
Leg rotation	4.19	0.80	4.3	11.4	84.3

[a] D, disagree + moderately disagree; N, neutral; A, moderately agree + agree.

Realism

Regardless of the demographic variables, higher proportions of respondents either agreed or moderately agreed with the realism of Nursing Anne Complete for improving clinical performance. This was consistent across all four sub-sections, including appearance, movement, procedures and sounds. Table 2 provides the mean scores and response breakdowns for the appearance, sound, and movement items of the questionnaire and Table 3 provides this information for the procedures (note that for simplification, the disagree and moderately disagree responses have been combined into one 'disagree' column and similarly, moderately agree and agree have been combined into an 'agree' column).

For the overall sample, the lowest mean score for Realism was for eye irrigation ($M = 3.46$, SD = 1.16), and based on the five-point response scale, this equates to a neutral response (e.g., 3). For this item, 20% of nurses disagreed that it was realistic, however the majority of respondents (58.6%) actually agreed about the realism. All other mean scores were above 3.50 and therefore represented either moderately agree or agree response options. In particular, the sounds were viewed most favourably with mean scores ranging from 4.35 (SD = 0.71) for wheezing to 4.56 (SD = 0.65) for normal diastolic BP. In fact, 95.7% of nurses either moderately agreed ($n = 23$) or agreed ($n = 44$) with the realism of the normal heart rate.

ANOVA results showed that there were significant differences between the different nursing groups for only six items (refer Table 4). For the systolic murmur, post hoc comparisons using Tukeys HSD showed that the mean score for Division 2 RNs was significantly higher than the mean score for the Division 1 RNs. For the hyperactive bowel sounds, the mean score for Division 2 RNs was sig-

Table 3 Nurses' responses to the realism of nursing procedures simulated on the Nursing Anne Complete manikin

Item	Mean	SD	Response breakdown[a] (%)		
			D	N	A
Eye irrigation	3.46	1.16	20.0	21.4	58.6
Denture remove/replace	3.79	1.16	15.8	11.4	72.8
Tracheostomy cuff	4.05	0.92	5.7	14.3	80.0
Tracheostomy dressing	4.13	0.75	1.4	18.6	80.0
Securing trachy line	4.22	0.75	1.4	15.7	82.9
Changing trachy tube	4.14	0.76	2.9	14.3	82.9
Tracheal suctioning	4.06	0.87	4.3	12.9	82.9
Guedel airway insertion	4.33	0.74	2.9	8.6	88.6
NGT[b] insertion	3.92	1.09	10.0	20.0	70.0
NGT aspiration	3.90	1.00	8.6	15.7	75.7
Air auscultation of NGT	3.54	1.14	17.1	18.6	64.3
NS[c] via nares	3.98	0.84	4.3	18.6	77.1
NS via nasopharyngeal tube	3.94	0.96	8.6	14.3	77.2
Bag-valve mask	4.06	0.85	5.7	11.4	82.9
Blood pressure	4.21	0.85	5.7	7.1	87.2
Stoma cleaning	4.21	0.66	1.4	10.0	88.6
Changing stoma bag	4.28	0.70	1.4	11.4	87.2
Flushing CVC[d]	4.09	0.67	1.4	14.3	84.3
Remove CVC	4.14	0.69	1.4	14.3	84.3
Dressing CVC	4.09	0.77	2.8	12.9	84.3
Changing CVC	4.21	0.65	1.4	10.0	88.6
Mastectomy care	4.00	0.72	5.7	8.6	85.7
Venous access (arm/leg)	4.08	0.78	4.3	10.0	85.7
Female catheterisation	3.72	1.06	17.2	5.7	77.1
Male catheterisation	3.58	0.96	15.7	7.7	77.2
Intramuscular injection	4.19	0.66	2.9	7.1	89.9
Subcutaneous injection	4.13	0.70	4.3	7.1	88.5

[a] D, disagree + moderately disagree; N, neutral; A, moderately agree + agree.
[b] NGT, nasogastric tube.
[c] NS, nasal suctioning.
[d] CVC, central venous catheter.

nificantly higher than the Nurse Educators, and the Division 2 RNs again had the highest mean score for the hypoactive bowel sounds, which differed significantly from the Senior/Specialist Staff, Division 1 RNs, and Nurse Educators.

For eye irrigation, Tukeys HSD results showed that the mean score of the Nurse Educators was significantly lower than that of the Senior/Specialist Staff, Division 1 RNs, and Division 2 RNs. There were also significant differences for changing a stoma bag, where the mean score for Senior/Specialist Staff was significantly lower than that of the Division 2 RNs. Finally, there was also a significant difference for female catheterisation, where the Nurse Educators had a significantly lower mean score than all other groups.

Comparison

With one exception, regardless of demographic variables, higher proportions of respondents selected the 'Superior to Existing Training Products' response option for all components and functions of Nursing Anne Complete (refer Tables 4 and 5). For example, 71.4% ($n = 50$) selected this response to describe the overall appearance of the manikin, and 65.7% ($n = 46$) for the arm rotation.

The exception to this response pattern was for the normal heart sound, where the highest proportion of nurses (47.1%) responded that the manikin was 'Similar to an Actual Patient'. Furthermore, for six of the remaining 10 sound items, over 40% of respondents suggested the manikin was similar to an actual patient.

Eye irrigation was once again the lowest rated item, with 12.9% of nurses suggesting it was Superior to a Text Book, but not an Instructional Program. Similarly, for denture removal and replacement, 11.4% of participants also selected the superior to a text book option. However, for both items, it is important to note that the highest proportions of respondents still considered the Nursing Anne Complete manikin to be 'Superior to Existing Training Products'. For male catheterisation, 27.1% of nurses reported that the manikin was only Superior to an Instructional Program while 35.7% suggested it was Superior to Existing Training Products, a result which was also quite low compared to most other items.

Excluding those who selected the not applicable response, the non-parametric Kruskal—Wallis test was used to compare the responses of the various nursing groups. Several significant differences were evident among the movement items, including the head tilt $\chi^2_{(4)} = 14.04,\ p < 0.01$, arm rotation $\chi^2_{(4)} = 10.43,\ p < 0.05$ and leg rotation $\chi^2_{(4)} = 11.16,\ p < 0.05$. Likewise, there were significant differences among the groups for the abdomen sounds including normal bowel $\chi^2_{(4)} = 9.58,\ p < 0.05$, hyperactive bowel $\chi^2_{(4)} = 12.25,\ p < 0.05$, and hypoactive bowel $\chi^2_{(4)} = 15.37,\ p < 0.01$. Finally, for nursing procedures, a significant difference among the groups' responses was found only for subcutaneous injections $\chi^2_{(4)} = 9.56,\ p < 0.05$,and there were no significant differences for any of the appearance items.

Suitability

Once again, across all demographic variables, higher proportions of nurses moderately agreed with the suitability of Nursing Anne Complete for

Table 4 Comparison of responses by different nursing groups to the realism of the Nursing Anne Complete manikin, for items where a statistically significant difference was found

	Nursing position					$F_{(4,65)}$
	Senior/specialist Mean (SD)	Nurse educator Mean (SD)	RN division 1 Mean (SD)	RN division 2 Mean (SD)	Student nurse Mean (SD)	
Sounds						
Systolic murmur	4.52 (0.61)	4.49 (0.50)	4.00 (1.03)	4.81 (0.40)	4.45 (0.69)	2.54*
Hyperactive bowel	4.04 (0.93)	3.92 (1.00)	4.18 (0.79)	4.91 (0.30)	4.55 (0.52)	3.27*
Hypoactive bowel	3.94 (0.89)	3.61 (0.92)	3.95 (0.80)	4.91 (0.30)	4.36 (0.67)	5.06**
Procedures						
Denture remove/replace	4.12 (0.75)	2.93 (1.03)	3.99 (1.03)	4.27 (1.01)	3.71 (1.01)	4.25**
Changing stoma bag	3.90 (0.93)	4.21 (0.67)	4.31 (0.66)	4.75 (0.43)	4.35 (4.35)	2.59*
Female catheterisation	3.81 (1.05)	2.53 (1.13)	4.21 (0.74)	4.26 (0.60)	3.90 (0. 47)	9.75***

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 5 Nurses' responses comparing the appearance, sounds and movement of the Nursing Anne Complete manikin with other education methods

Item	Response breakdown[a] (%)				
	NA	TB	IP	ET	AP
Appearance					
Head	1.4	7.1	15.7	65.7	10.0
Trunk	1.4	2.9	20.0	61.4	14.3
Female genitalia	1.4	4.3	18.6	60.0	15.7
Male genitalia	1.4	4.3	14.3	62.8	17.1
Breast location	1.4	5.7	14.3	60.0	18.6
Breast size	1.4	5.7	15.7	61.4	15.7
Extremities	1.4	4.3	11.4	64.3	18.6
Stump	1.4	1.4	20.0	65.7	11.1
Overall	1.4	—	10.0	71.4	17.1
Bowel sounds					
Normal	1.4	5.7	7.1	47.1	38.6
Hyperactive	1.4	5.7	5.7	51.4	35.7
Hypoactive	1.4	7.1	7.1	55.7	28.6
Chest sounds					
Normal breath	—	1.4	7.1	54.3	37.1
Simultaneous heart/lungs	1.4	1.4	7.1	47.1	42.9
Normal heart	—	1.4	7.1	44.2	47.1
Normal systolic BP	—	2.9	7.1	45.7	44.3
Systolic murmur	—	2.9	7.1	50.0	40.0
Normal diastolic BP	—	1.4	4.3	51.4	42.9
Wheezing	—	2.9	8.6	48.6	40.0
Crackles/rhonchi	—	2.9	7.1	47.1	42.9
Movement					
Head tilt	—	10.0	15.7	55.7	18.6
Head rotation	—	5.7	15.7	64.3	14.3
Arm rotation	—	7.1	15.7	65.7	11.4
Leg rotation	—	4.3	14.3	64.2	17.1

[a] NA, not applicable; TB, superior to text book; IP, superior to instructional programs; ET, superior to existing training products; AP, similar to actual patient.

teaching purposes. In fact, for the blood pressure training arm, 94.2% of participants either agreed or moderately agreed that it was suitable for teaching patient evaluation. This is supported by the mean score ($M = 4.48$, $SD = 0.75$), which was higher than for all other suitability items (see Table 6). Similarly, 97.1% of nurses either agreed or moderately agreed with the suitability of the simulated sounds for nurse education, and there were no disagree or moderately disagree responses for this item.

In contrast, the lowest mean score ($M = 3.60$, $SD = 1.14$) was for the accessibility of the veins, where 17.2% of nurses responded that they were not suitable for teaching cannulation procedures.

One Way ANOVA results show that there were no significant differences among the mean scores of the various nursing groups for the suitability items.

Comments and suggestions for improvement

Despite the positive results outlined above, participants also provided feedback on some of the components they found less satisfactory. For example, several respondents commented that the male urethra is too large and the female labia not pliable enough to be realistic, the eyelids are too stiff for eye irrigation, and the below knee stump too long. Also, some suggested that the stand alone IV training arm (also produced by Laerdal) is more realistic than Nursing Anne Completes IV arm, and the mastectomy suture line too high.

Suggestions for improvement included making the flesh more pliable to enable ''pinching'' of the flesh for subcutaneous injections, and positioning speakers so that heart and breath sounds can be heard through the manikin's back, as this is common practice with human patients. Also, the bowel

Table 6 Nurses' responses comparing the simulated procedures of the Nursing Anne Complete manikin with other education methods

Item	Response breakdown[a] (%)				
	N/A	TB	IP	ET	AP
Eye irrigation	5.7	12.9	24.3	48.6	8.6
Denture remove/replace	–	11.4	14.3	57.1	17.1
Tracheostomy cuff	8.6	1.4	5.7	61.4	22.9
Tracheostomy dressing	7.1	1.4	10.0	61.4	20.0
Securing trachy line	7.1	1.4	10.0	61.4	20.0
Changing trachy tube	10.0	1.4	10.0	60.0	18.6
Tracheal suctioning	5.7	1.4	10.0	64.2	18.6
Guedel airway insertion	5.7	1.4	7.1	64.3	21.4
NGT[b] insertion	8.6	4.3	11.4	47.1	28.6
NGT aspiration	11.4	5.7	7.1	57.2	18.6
Air auscultation of NGT	10.0	10.0	24.3	41.4	14.3
NS[c] via nares	11.4	1.4	17.1	54.3	15.7
NS via nasopharyngeal tube	8.6	5.7	15.7	54.2	15.7
Bag-valve mask	4.3	4.3	17.1	55.7	18.6
Blood pressure	4.3	5.7	11.4	54.3	24.3
Stoma cleaning	5.7	2.9	4.3	62.8	24.3
Changing stoma bag	5.7	1.4	4.3	62.8	25.7
Flushing CVC[d]	12.9	–	10.0	55.7	21.4
Remove CVC	12.9	–	8.6	60.0	18.6
Dressing CVC	12.9	1.4	10.0	55.7	20.0
Changing CVC	14.3	–	8.6	54.3	22.9
Mastectomy care	12.9	2.9	8.6	62.8	12.9
Venous access (arm/leg)	14.3	4.3	24.2	42.9	14.3
Female catheterisation	10.0	7.1	14.3	50.0	18.6
Male catheterisation	20.0	4.3	27.1	35.7	12.9
Intramuscular injection	14.3	–	7.1	55.7	22.9
Subcutaneous injection	12.9	2.9	8.6	55.7	20.0

[a] NA, not applicable; TB, superior to text book; IP, superior to instructional programs; ET, superior to existing training products; AP, similar to actual patient.
[b] NGT, nasogastric tube.
[c] NS, nasal suctioning.
[d] CVC, central venous catheter.

sounds were judged to be difficult to hear via a stethoscope and many respondents reported problems differentiating between the normal and hypoactive bowel sounds.

Discussion

The aim of this research was to investigate the realism of the Nursing Anne Complete human patient simulator, compare it to other teaching devices and measure nurses perceptions about its suitability for teaching purposes, as a precursor to developing and evaluating nurses' health assessment knowledge and skills. It was expected that nurses would regard this manikin as realistic for improving clinical performance, suitable for nursing education, and superior to existing training methods.

Overall, the hypotheses were supported by the feedback from the nurses and nurse educators and the assessment results for Nursing Anne Complete were very positive. Encouragingly, for items where nurses were undecided or disagreed with the realism and suitability of this manikin, higher proportions still rated it better than existing training products. Moreover, information was elicited about the perceived strengths and weaknesses of this manikin which provides the manufacturer with valuable feedback to facilitate the development and improvement of future models.

A limitation of this research is the smallness of the samples which can be attributed to several factors. Since there was no direct line of communication between researchers and nursing staff

Table 7 Nurses' responses to the suitability of the Nursing Anne Complete manikin for educational purposes

Item	Mean	SD	Response Breakdown[a] (%)		
			D	N	A
The soft skin overlay of the chest simulates realistic rise and fall when ventilating	3.81	1.02	12.9	14.3	72.9
The bilateral carotid pulse is realistic for teaching patient evaluation	4.10	0.83	4.3	12.9	82.8
The blood pressure training arm is realistic for teaching patient evaluation	4.48	0.75	2.9	2.9	94.2
The mastectomy module is realistic for teaching post surgical care	3.89	1.02	8.6	14.3	77.1
Accessibility of the veins is suitable for teaching cannulation procedures	3.60	1.14	17.2	11.4	71.4
Overall, the simulated sounds are realistic for teaching patient evaluation	4.38	0.54	–	2.9	97.1
The manikin simulates realistic spreading of the toes to allow for bandaging	4.23	0.84	2.8	12.9	84.3
The overall appearance of the manikin is suitable for teaching realistic patient handling	4.26	0.81	4.3	5.7	90.0
The full range of motion is suitable for teaching realistic patient handling	4.22	0.76	2.9	7.1	90.0

[a] D, disagree + moderately disagree; N, neutral; A, moderately agree + agree.

this may have reduced their awareness of the research, despite the research team's best efforts in promoting the study. Furthermore, the data collection period coincided with winter which resulted in the reopening of beds for patients and an increased workload for nurses. This, in turn, led to the continual relocation of the manikin to available beds and constant updating of flyers and notices about the whereabouts of the manikin; this made it difficult for interested participants to readily find the assessment location to take part in the study. The voluntary nature of the research combined with the confounding factors outlined above, resulted in a sample that was smaller than anticipated. While the generalisation of these results to the wider nursing population remains uncertain, the demographic information collected suggests that the sample represented a diverse cross-section of nurses of various age groups and levels of education and experience, and descriptive analyses suggests positive results from all demographic categories.

Conclusion

The data suggest that LFPS may facilitate experiential learning. The inclusion of simulation in educational programs may provide nurses with the opportunity to learn new techniques and update their existing knowledge and skills in a controlled setting without the risk of harming patients (Bond and Spillane, 2002; Bradley and Postlethwaite, 2003a). Furthermore, they have the potential to help reduce the risk of adverse events, thereby facilitating increased positive patient outcomes (Catolico et al., 1996; Gibbons et al., 2002). We also support other commentators' views about the importance of investigating the learning effectiveness of human patient simulators (i.e., Good, 2003; Tsai et al., 2003). This research assessed nurses' perceptions about the realism and suitability of this manikin for nursing education but further research is required to investigate the effectiveness of low-fidelity human patient simulators on nurses' health assessment knowledge and skills.

References

Badger, T., Rawstorne, D., 1998. An evaluative study of pre-registration nursing students' skills in basic life support. Nurse Education Today 18, 231–236.

Bond, W.F., Spillane, L., 2002. The use of simulation for emergency medicine resident assessment. Academic Emergency Medicine 9 (11), 1295–1299.

Bradley, P., Postlethwaite, K., 2003a. Setting up a clinical skills learning facility. Medical Education 37 (Suppl. 1), 6—13.

Bradley, P., Postlethwaite, K., 2003b. Simulation in clinical learning. Medical Education 37 (Suppl. 1), 1—5.

Catolico, O., Navas, M., Sommer, C., Collins, M., 1996. Quality of decision making nursing staff development. Journal of Nursing Staff Development 12 (3), 149—154.

Devlin, M., 1999. An evaluative study of the basic life support skills of nurses in an independent hospital. Journal of Clinical Nursing 8, 201—205.

Ewy, G.A., Felner, J.M., Juul, D., Mayer, J.W., Sajid, A.W., Waugh, R.A., 1987. Test of a cardiology patient simulator with students in fourth-year electives. Journal of Medical Education 62 (9), 738—743.

Gibbons, S., Adamo, G., Padden, D., Ricciardi, R., Graziono, M., Levine, E., Hawkins, R., 2002. Clinical evaluation in advanced practice nursing education: using standardized patients in health assessment. Journal of Nursing Education 41 (5), 215—221.

Good, M.L., 2003. Patient simulation for training basic and advanced clinical skills. Medical Education 37 (Suppl. 1), 14—21.

Graham, T., 2002. What nurses say: In the search for solutions, a NurseWeek/AONE survey provides some tools for a turnaround. Nurse Week News [On-line]. Available from: <http://nurseweek.com/news/features/02-04/aone_print.html>.

Grober, E.D., Hamstra, S.J., Wanzel, K.R., Reznick, R.K., Matsumoto, E.D., Sidhu, R.S., Jarvi, K.A., 2004. The educational impact of bench model fidelity on the acquisition of technical skill: the use of clinically relevant outcome measures. Annals of Surgery 240 (2), 374—381.

Hammond, J., Bermann, M., Chen, B., Kushins, L., 2002. Incorporation of a computerised human patient simulator in critical care training: a preliminary report. Journal of Trauma-Injury, Infection and Critical Care 53 (6), 1064—1067.

Hellquist, K., 2001. NCSBN responds to the nursing shortage: news release. National Council of State Boards of Nursing, Inc., Chicago.

Issenberg, S.B., Gordon, D.L., Stewart, G.M., Felner, J.M., 2000. Bedside cardiology skills training for the physician assistant using simulation technology. Perspective on Physician Assistant Education 11 (2), 99—103.

Issenberg, S.B., McGachie, W.C., Gordon, D.L., Symes, S., Petrusa, E., Hart, I.R., Harden, R.M., 2002. Effectiveness of a cardiology review course for internal medicine residents using simulation technology and deliberate practice. Teaching and Learning in Medicine 14 (4), 223—228.

Jackson, M., Chiarello, L.A., Gaynes, R.P., Gerberding, J.L., 2002. Nurse staffing and healthcare-associated infections: proceedings from a working group meeting. Journal of Nursing Administration 32, 314—322.

Kneebone, R., 2003. Simulation in surgical training: educational issues and practical implications. Medical Education 37 (3), 267—277.

Monti, E., Wren, K., Haas, R., Lupien, A., 1998. The use of an anesthesia simulator in graduate and undergraduate education. CRNA: The Clinical Forum for Nurse Anesthetists 9 (2), 59—66.

Nyman, J., Sihvonen, M., 2000. Cardiopulmonary resuscitation skills in nurses and nursing students. Resuscitation 47, 179—184.

Ravert, P., 2002. An interactive review of computer-based simulation in the education process. CIN: Computers, Informatics, Nursing 20 (5), 203—208.

Schwid, H.A., Rooke, G.A., Carline, J., Steadman, R.H., Murray, M., Olympio, M., Tarver, S., Steckner, K., Wetstone, S., 2002. Evaluation of anesthesia residents using mannequin-based simulation: a multi-institutional study. Anesthesiology 97 (6), 1434—1444.

Sefrin, P., Paulus, T., 1994. Resuscitation skills of hospital nursing staff. Anaesthetist 43 (2), 107—114.

Tsai, T.-C., Harasym, P.H., Nijssen-Jordan, C., Jennet, P., Powell, G., 2003. The quality of simulation examination using a high-fidelity child manikin. Medical Education 37 (Suppl. 1), 72—78.

Wynne, G., Marteau, T., Johnston, M., Whiteley, C., Evans, T., 1987. Inability of trained nurses to perform basic life support. British Medical Journal 294, 1198—1199.