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Enhancing pediatric and neonatal CPR competency through clinical simulation: an educational innovation approach

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Abstract

This study presents an educational innovation program aimed at enhancing pediatric and neonatal CPR competency among nursing degree students. The program utilizes clinical simulation, debriefing techniques, and an annual action research methodology to improve knowledge acquisition and student satisfaction. The specific aims include assessing the educational impact on CPR technique learning and identifying elements for improvement. Results indicate improvements in knowledge assessment items, but also highlight the need for ongoing quality enhancement, particularly in prior evaluations and access to materials. The study emphasizes the importance of continuous improvement and the utilization of debriefing techniques to enhance student satisfaction. Overall, the educational innovation has positively impacted student satisfaction, but further refinements are necessary to achieve optimal learning outcomes. This work contributes to the ongoing development of effective CPR training methodologies in nursing education.

Keywords: *Cardiopulmonary Resuscitation; Education, Nursing; Patient Simulation; Pediatrics; Neonatology; Educational Innovation.*

1. Introduction

Cardiorespiratory arrest (CPA) is defined as a sudden, unexpected and potentially reversible cessation of the heartbeat and breathing. This situation occurs both in the healthcare environment, with an annual incidence between 1.5 and 2.8 per 1000 hospital admissions, and in the out-of-hospital environment, with an annual incidence of between 0.67-1.70 per 1000 inhabitants (Perkins, Gräsner, Semeraro, Olasveengen, Soar, Lott et al, 2021).

Anyone who is facing CPR must begin cardiopulmonary resuscitation (CPR) as soon as possible. In the hospital environment, CPR will be initiated by health professionals and in the out-of-hospital environment by the person closest to the affected person. In both cases, nursing professionals must be competent to assess the emergency situation and apply the appropriate level of life support based on their resources and scientific evidence (Perkins, 2021).

To achieve this learning, which includes specific knowledge, skills and attitudes for emergency interventions, the educational methodology of clinical simulation can be used. This methodology is based on the artificial representation of real situations that promote learning in realistic clinical scenarios of varying complexity, in a safe environment and that allow formative evaluation of the participants. Clinical simulation is used in healthcare environments to train, train or evaluate people or teams in special clinical situations such as a PCR. Among the different modalities of clinical simulation we can find task trainers, virtual reality, standardized patients, virtual patients and high-fidelity simulators (López, Ramos, Pato and López, 2013; Casal, 2016).

Nursing degree students must achieve competency development that includes, as a specific competency, recognizing life-threatening situations and knowing how to execute basic and advanced life support maneuvers (Hinzmann et al, 2023; Ministry of Universities, 2023). Cardiac arrest is a time-dependent, high-acuity event, which requires the coordination of various healthcare professionals at once to optimise the success of cardiopulmonary resuscitation (CPR). Adjusting to the recommended times, as well as determining the optimal time to monitor the rhythm, epinephrine and defibrillation are important aspects that could improve the team's performance (Crabb et al, 2020) To achieve this competence, from the subject "Nursing in Child and Adolescent Health" (ESIA) of the Faculty of Nursing and Podiatry of the University of Valencia, a teaching innovation program was started in 2017 (SEPIE UV, 2017) linked to this specific competence. Similar experiences in our educational environment have shown good results in the acquisition of related competencies (Arrogante et al, 2021).

The ESIA teaching program includes a 2-hour theoretical session and a 2-hour practical laboratory dedicated to pediatric CPR. The practical laboratories allow you to put into practice and consolidate the knowledge acquired in the theoretical session (García-Molina et al, 2018 and 2019; Hinzmann et al, 2023) as well as implement or acquire skills and attitudes that are transversal to the nursing profession. The laboratory exercise consisted of three clinical simulations in which the students had to respond to instrumented CPR in a three-year-old person, to CPR to a 1-year-old infant, and to advance CPR to a newborn. To achieve maximum use of the laboratory, they were tutored by a member of the ESIA faculty and two collaborating students from 3rd and 4th year of the Nursing degree.

To consolidate learning, the debriefing technique was used, an activity carried out after a clinical session, led by an expert, and in which information is transmitted to the participants about their

performance during the simulation. This technique allows you to emphasize activities carried out successfully, highlight positive attitudes and review errors made during practice. It also allows participants to share concerns and feelings related to the simulation, which allows deepening attitudinal learning. This methodology is based on the educational principles of experiential learning and reflective practice. (Kolb, 1984; Schön, 1992; Tortajada-Lohaces, 2018; Hinzmann et al, 2023).

The entire teaching innovation program has been based on an annual action research methodology aimed at improving the acquisition of knowledge and student satisfaction. Once the data was collected through knowledge and student satisfaction questionnaires, in the 2017-18 academic year a possibility of improvement was observed in the project's teaching materials, on which the satisfaction of the participants was intervened and improved. In the 2018-19 academic year, the physical simulation facilities were identified as a proposal for improvement; the pandemic situation prevented this action from being evaluated since the in-person clinical simulation had to be suspended. During the 2019-20 and 2020-21 academic years, the clinical simulation could not be reproduced under optimal working conditions and a physical change also occurred when the Faculty of Nursing and Podiatry moved to a new building.

The improvement proposals proposed for the 21/22 course collected from the teachers and students of the previous courses included a new layout of the simulation room that would allow a closer relationship between teachers and students, resuming the two-hour duration of clinical simulation, development of a Debriefing guide to normalize and standardize this training activity, including a system for checking the use of virtual resources prior to the laboratory and completing the questionnaires at the end of the training session in digital mode.

The objective of this educational innovation is to assess the educational impact on the learning of pediatric and neonatal CPR techniques in students in the 2nd year of the Nursing Degree. Assess student satisfaction with the teaching methodology used in the educational innovation project. Identify elements for improvement in the educational innovation project.

2. Educational innovation

From 2017 to the 2021/22 academic year, the process of continuous improvement of the proposed educational innovation has configured a work methodology that includes 2 areas of action: educational innovation that affects the teaching team and educational innovation implemented with the students.

2.1. Teaching educational innovation.

The teaching team is made up of teachers from the ESIA subject and collaborating students from the 3rd and 4th nursing courses who will participate as facilitators and promoters of the clinical

simulation. To achieve quality standards in the use of simulators, computer systems and training dynamics, the entire team attends a work session in which members of the Association of Health Sciences Students in Emergencies and Emergencies (AEMES) and the Project directors carry out a review of materials management, an update of the current algorithms in PCR performance and the teaching methodology to be implemented.

2.2. Educational innovation with students

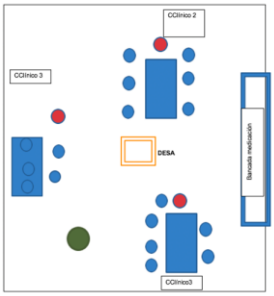
Clinical simulation is the fourth stage of educational innovation aimed at students. The first phase includes a two-hour theoretical session in the classroom. The second phase is composed of a telematic self-training process that includes: a) bibliography and consensus documents on pediatric and neonatal CPR that are shared in the virtual classroom, b) a document is shared with the presentation of the theoretical session and, c) two Serious Games focused on the management of the crash cart and the implementation of pediatric Basic Life Support. The third phase of the project includes the transversal nature of a pediatric medication management laboratory, which affects the preparation and administration of medication in urgent or emergency situations. And the fourth phase includes clinical simulation with three clinical cases: instrumented CPR in a three-year-old person, CPR in a 1-year-old infant, and advanced CPR in a newborn and subsequent debriefing.

During the 2021/22 academic year, the improvements proposed in the previous year were incorporated:

1. The period dedicated to the simulation was increased to 2 hours, distributed in 10 minutes for completing the prior knowledge questionnaire, 10 minutes for the presentation of the activity, 60 minutes dedicated to the clinical simulation, 30 minutes for debriefing and 10 minutes for completing the knowledge questionnaire.

2. A change was implemented in the distribution of the simulation room, adapting it to the new facilities and allowing closer contact between teachers and students. In addition, a redistribution of the material was carried out within the stop cars to facilitate location by the participants (figure 1, figure 2).

3. The new guide for carrying out the debriefing (figure 3), based on the DASH methodology (Center Medical Simulation, s.f.; Neil, Cert & Wotton, 2013; Waxman, 2010) was shared among the teaching team.



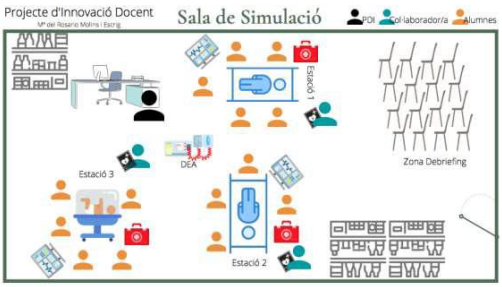
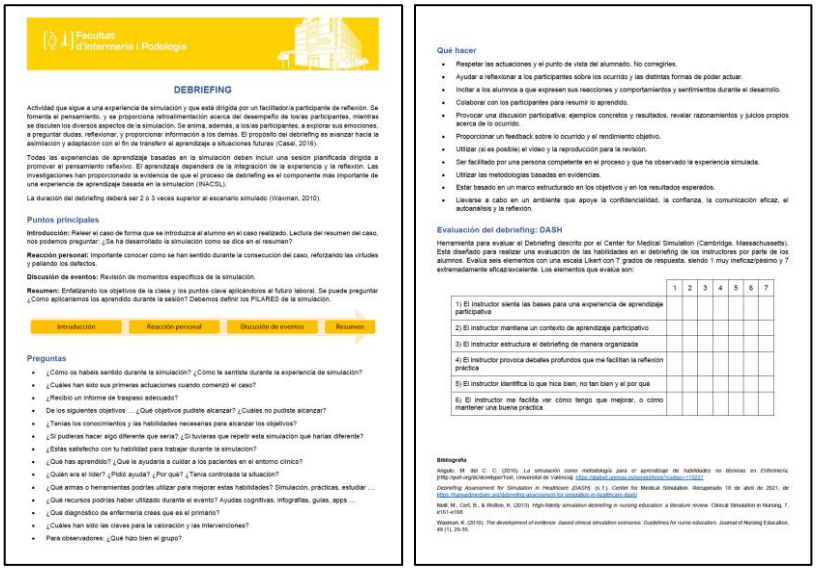


Figure 1: Distribution of the simulation room 2019. *Figure 2: Distribution of the simulation room 2021*



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DEBRIEFING

Actividad que sigue a una experiencia de simulación y que está dirigida por un facilitador/a participante de reflexión. Se fomenta el pensamiento, y se proporciona retroalimentación acerca del desempeño de los/as participantes, mientras se discuten los diversos aspectos de la simulación. Se anima, además, a los/as participantes, a explorar sus emociones, a preguntar dudas, reflexionar, y proporcionar información a los demás. El propósito del debriefing es avanzar hacia la asimilación y adaptación con el fin de transferir el aprendizaje a situaciones futuras (Casal, 2016).

Todas las experiencias de aprendizaje basadas en la simulación deben incluir una sesión planificada dirigida a promover el pensamiento reflexivo. El aprendizaje dependerá de la integración de la experiencia y la reflexión. Las investigaciones han proporcionado la evidencia de que el proceso de debriefing es el componente más importante de una experiencia de aprendizaje basada en la simulación (NACSL).

La duración del debriefing deberá ser 2 o 3 veces superior al escenario simulado (Waxman, 2010).

Puntos principales

Introducción: Relear el caso de forma que se introduzca al alumno en el caso realizado. Lectura del resumen del caso, nos podemos preguntar: ¿Se ha desarrollado la simulación como se dice en el resumen?

Reacción personal: Importante conocer cómo se han sentido durante la consecución del caso, reforzando las virtudes y palando los defectos.

Discusión de eventos: Revisión de momentos específicos de la simulación.

Resumen: Enfatizando los objetivos de la clase y los puntos clave aplicándolos al futuro laboral. Se puede preguntar ¿Cómo aplicaríamos los aprendido durante la sesión? Debemos definir los PILARES de la simulación.

Introducción → Reacción personal → Discusión de eventos → Resumen

Preguntas

- ¿Cómo os habéis sentido durante la simulación? ¿Cómo la sentiste durante la experiencia de simulación?
- ¿Cuáles han sido sus primeras actuaciones cuando comenzó el caso?
- ¿Recibió un informe de traspaso adecuado?
- De los siguientes objetivos … ¿Qué objetivos pudiste alcanzar? ¿Cuáles no pudiste alcanzar?
- ¿Tenías los conocimientos y las habilidades necesarias para alcanzar los objetivos?
- ¿Si pudieras hacer algo diferente que sería? ¿Si tuvieras que repetir esta simulación qué harías diferente?
- ¿Estás satisfecho con tu habilidad para trabajar durante la simulación?
- ¿Qué has aprendido? ¿Qué le ayudaría a cuidar a los pacientes en el entorno clínico?
- ¿Quién era el líder? ¿Pidió ayuda? ¿Por qué? ¿Tenía controlada la situación?
- ¿Qué armas o herramientas podrías utilizar para mejorar estas habilidades? Simulación, prácticas, estudiar …
- ¿Qué recursos podrías haber utilizado durante el evento? Ayudas cognitivas, infografías, guías, apps …
- ¿Qué diagnóstico de enfermería crees que es el primario?
- ¿Cuáles han sido las claves para la valoración y las intervenciones?
- Para observadores: ¿Qué hizo bien el grupo?

Qué hacer

- Respetar las actuaciones y el punto de vista del alumnado. No corregirles.
- Ayudar a reflexionar a los participantes sobre los ocurrido y las distintas formas de poder actuar.
- Incitar a los alumnos a que expresen sus reacciones y comportamientos y sentimientos durante el desarrollo.
- Colaborar con los participantes para resumir lo aprendido.
- Provocar una discusión participativa: ejemplos concretos y resultados, revelar razonamientos y juicios propios acerca de lo ocurrido.
- Proporcionar un feedback sobre lo ocurrido y el rendimiento objetivo.
- Utilizar (si es posible) el video y la reproducción para la revisión.
- Ser facilitado por una persona competente en el proceso y que ha observado la experiencia simulada.
- Utilizar las metodologías basadas en evidencias.
- Estar basado en un marco estructurado en los objetivos y en los resultados esperados.
- Llevarse a cabo en un ambiente que apoye la confidencialidad, la confianza, la comunicación eficaz, el autoanálisis y la reflexión.

Evaluación del debriefing: DASH

Herramienta para evaluar el Debriefing descrito por el Center for Medical Simulation (Cambridge, Massachussetts). Está diseñado para realizar una evaluación de las habilidades en el debriefing de los instructores por parte de los alumnos. Evalúa seis elementos con una escala Likert con 7 grados de respuesta, siendo 1 muy ineficaz/pésimo y 7 extremadamente eficaz/excelente. Los elementos que evalúa son:

	1	2	3	4	5	6	7
1) El instructor sienta las bases para una experiencia de aprendizaje participativa							
2) El instructor mantiene un contexto de aprendizaje participativo							
3) El instructor estructura el debriefing de manera organizada							
4) El instructor provoca debates profundos que me facilitan la reflexión práctica							
5) El instructor identifica lo que hice bien, no tan bien y el por qué							
6) El instructor me facilita ver como tengo que mejorar, o cómo mantener una buena práctica							

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Figure 3: New guide for debriefing.

To analyze the impact of the interventions carried out, the knowledge and satisfaction questionnaire specific to the innovation project since 2017 was used. The knowledge assessment questionnaire is made up of 11 multiple response items that are completed at the beginning and at the end of the simulation with an order of questions and random answers. Satisfaction is measured using a scale made up of 20 items that are evaluated using a Likert-type response from 0 to 10.

The study variables were the level of knowledge of the students, identified as score per item and final score of the knowledge questionnaire, the level of satisfaction valued as average score per

item and average final score of the scale. A score of 9 out of a maximum of 10 in the questionnaire was identified as a quality standard in student satisfaction, identifying as possibilities for improvement those items that did not reach the standard. A descriptive study of the variables was carried out, a comparative study of the variables of the 21/22 course with those of the 20/21 course was carried out using the SPSS 23.0 program.

3. Results

A total of 221 students participated in the 2021/22 academic year, compared to 263 participants in the previous academic year. In the level of knowledge prior to educational innovation, the correctness in questions 1 and 10 stands out, in both cases greater than 76%, and the low level of correctness in presumed questions 7 and 8, in both cases less than 20%. In relation to the learning reflected in the level of knowledge after the intervention, there are increases in accuracy of 53.26% in item 8 and 24.82% in item 9 and decreases in accuracy of 49.65% in item 1 and 11.99% in item 4. The final score of the knowledge test, measured as a percentage of correct answers, gives us an average correct score of 44.9%, improving the score of the previous questionnaire by 8.91%. to innovation (table 1). Regarding the reliability of the measurement scales, Cronbach's alpha for the satisfaction questionnaire was 0.944 and the knowledge questionnaire was 0.757.

Educational innovation has produced improvements in 5 of the 10 knowledge items in relation to the previous year, with a greater increase (8.91%) in the impact of innovation measured as an overall score of the questionnaire compared to the previous year (4.26 %). It is important to highlight the overall difference in prior knowledge that the participants present: 55.61% in the 2020/21 academic year and 35.99% in the 2021/22 academic year in order to interpret the impact, use and improvement of the practical workshops of the innovation.

Satisfaction with the innovation project reaches an average of 9.1 points out of 10, highlighting that 15 of the 20 items exceed the quality standard of 9 points. Five items would be identified as possible proposals for improvement, highlighting: the teaching media and resources used in the innovation (8.84 points), the delivery of material and documentation with sufficient time (8.73 points) and the logistical organization of the laboratory (8.76 points) (Table 2).

The new layout of the simulation room or the logistics of the laboratory, although it does not reach the quality standards proposed, has shown a clear improvement, increasing satisfaction from 6.82 to 8.76. Furthermore, the impact of innovation has been reflected in the typology of the laboratory as appropriate for acquiring knowledge, going from 8.86 to 9.14.

Table 1: Absolute number, percentage and calculation of the difference of participants who get the question right

	2020/2021					2021/2022				
	Pre (n=263)		Post (n=221)		Difference	Pre (n=221)		Post (n=220)		Difference
	n	%	n	%		n	%	n	%	
Q1. Duration of Insufflation	186	70.72%	98	44.34%	-26.38%	170	76.92%	60	27.27%	-49.65%
Q2. FBAO, Choking	175	66.54%	156	70.59%	4.05%	108	48.87%	128	58.18%	8.31%
Q3. Compressions ratio 15:2	170	64.64%	151	68.33%	3.69%	76	34.39%	64	29.09%	-5.3%
Q4. Revaluation 2 min	170	64.64%	132	59.73%	-4.91%	138	62.44%	111	50.45%	-11.99%
Q5. Depth of Compression	171	65.02%	191	86.43%	21.41%	140	63.35%	174	79.09%	15.74%
Q6. Adrenalin dose	195	74.14%	194	87.78%	13.64%	147	66.52%	193	87.73%	21.21%
Q7. Adrenalin mins	138	52.47%	85	38.46%	-14.01%	37	16.74%	74	33.64%	16.9%
Q8. Adrenalin dilution	156	59.32%	171	77.38%	18.06%	34	15.38%	151	68.64%	53.26%
Q9. Instrumental	202	76.81%	194	87.78%	10.97%	136	61.54%	190	86.36%	24.82%
Q10. Duration of Intubation	195	74.14%	168	76.02%	1.88%	168	76.02%	154	70.00%	-6.02%
Q11. Vital Signs	170	64.64%	159	71.95%	7.31%	110	49.77%	121	55.00%	5.23%
Overall score	55.61%+/-22.13%		59.87%+/-18.86%		4.26%	35.99%+/-20.32%		44.90%+/-19.53%		8.91%

The improvements introduced in the evaluation process through Debriefing have had a positive impact and, although they do not reach the proposed quality standards, an increase from 8.78 to 8.91 in student satisfaction has been observed.

Access control to virtual resources by students could not be implemented due to technical problems of the organization. These elements have been highlighted as a necessary improvement to be implemented in future courses since the items with the lowest rating are linked to this area of improvement: the teaching media and resources used in innovation (8.84 points) and the delivery of material and documentation with enough time (8.73 points).

The lower score in the prior knowledge test could be linked to the decrease in perceived satisfaction in delivering the documentation with sufficient notice, but the decrease in satisfaction is 0.3 out of 10 and would not justify the decrease of almost 20% in successes among students of both courses.

Finally, the inclusion of the digital questionnaire after the intervention as part of the laboratory itself has allowed us to eliminate the percentage of participants who did not return the questionnaire at the end of the intervention.

4. Conclusion

Educational innovation has shown improvements in 5 of the knowledge assessment items, but not in the rest, making it necessary to continue with the quality improvement cycle.

The improvements implemented in this educational innovation have had a positive impact on student satisfaction, although items remain below the proposed quality standard.

Elements for improvement have been identified related to the low level of correctness of the students in the prior evaluation phase and in access to the materials used prior to the laboratory.

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Table 2. Average assessment of the satisfaction of the participants in the innovation. Comparison of the 4 previous courses

	2017-18	2018-19	2019-20	2020-21
The expectations I had regarding the usefulness of the training action in which I participated have been met.	8.651	9.070	8.663	9.050
The content developed during the training action has been useful and has been adapted to my expectations.	8.581	9.232	8.810	9.097
I will be able to apply the knowledge acquired in my professional practice.	9.062	9.280	9.006	9.223
The typology (laboratory) has been appropriate for learning to perform CPR.	8.968	9.118	8.859	9.139
The modality (face-to-face, non-face-to-face, e-learning, etc.) has facilitated the learning of the contents taught.	8.384	9.184	8.086	9.017
The teaching methods used by the teachers have been appropriate for optimal development...	8.159	9.196	8.736	9.000
In your case, the distribution of the groups has been appropriate for the development of the activity.	8.742	9.266	8.896	9.013
The evaluation system (the briefing) used has allowed me to know my level of CPR mastery…	8.774	9.136	8.779	8.912
The documentation and materials have been available sufficiently in advance for the development of the laboratory.	8.518	8.941	9.000	8.735
The teaching media and resources made available have been appropriate for the optimal development of the laboratory.	8.566	9.011	8.748	8.840
The duration of the laboratory has been adequate to acquire knowledge about CPR…	8.484	8.615	8.791	8.916
In general, the logistics organization has contributed to the development of the laboratory.	8.254	8.643	6.822	8.759
In general, I am satisfied with the participation and intervention of the team of 3rd and 4th grade students.	8.474	8.881	8.509	9.038
In general I am satisfied with the participation and intervention of the teaching team.	9.375	9.629	9.160	9.395
The teacher has shown to have mastery of the contents he/she has taught.	9.157	9.586	9.104	9.282
The teacher has managed to maintain the students' interest and adapt the case to the expectations...	9.488	9.800	9.595	9.513
The teacher has encouraged participation.	9.344	9.638	9.368	9.399
In general, I am satisfied with the development of the laboratory.	9.379	9.638	9.479	9.445
I would recommend other students to take this laboratory on pediatric and neonatal CPR.	9.143	9.492	8.982	9.332
The duration of the laboratory has been adequate to acquire knowledge about CPR…	9.541	9.726	9.411	9.521
Media	8.851	9.253	8.840	9.131

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