

**CREACIÓN DE UN SIMULADOR PARA EL
ENTRENAMIENTO DE PERICARDIOCENTESIS
ECOGUIADA EN LOS RESIDENTES DE MEDICINA DE LA
UNIVERSIDAD SIMÓN BOLÍVAR.**

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Trabajo de Investigación del Programa Ingeniería Biomédica

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RESUMEN

Este proyecto de investigación tiene como objetivo crear un simulador para entrenamiento de pericardiocentesis eco guiada en los residentes de medicina de la universidad Simón Bolívar. La pericardiocentesis eco guiada es un procedimiento que se le realiza a pacientes con taponamiento cardiaco o un derrame de líquido en el pericardio que puede causar complicaciones graves a largo plazo. El problema que se indaga tiene como base la falta de entrenamiento e incorrecta ejecución del proceso clínico de pericardiocentesis por parte de los estudiantes y residentes de la Universidad Simón Bolívar. El simulador que se creará será diseñado específicamente para el entrenamiento en pericardiocentesis eco guiada y estará dirigido a los estudiantes y residentes del programa académico en medicina. Se espera que este simulador mejore significativamente la formación práctica y teórica en esta técnica médica, lo cual podría tener un impacto positivo en la calidad del cuidado médico brindado a los pacientes. El proyecto también incluirá una evaluación de la efectividad del simulador en el aprendizaje y la praxis de los estudiantes y residentes. Se espera que los resultados de esta evaluación puedan ser utilizados para mejorar aún más el diseño del simulador y su implementación en el programa académico.

Palabras clave: pericardiocentesis, simulador, entrenamiento, medicina, eco-guiada.

ABSTRACT

This research project aims to create a training simulator for ultrasound-guided pericardiocentesis in medical residents of the Simón Bolívar University. Echo-guided pericardiocentesis is a procedure performed on patients with cardiac tamponade or a fluid leak in the pericardium that can cause serious long-term complications. The problem that is investigated is based on the lack of training and the incorrect execution of the clinical process of pericardiocentesis by the students and residents of the Simón Bolívar University. The simulator that will be created will be specifically designed for training in ultrasound-guided pericardiocentesis and will be aimed at students and residents of the academic program in medicine. This simulator is expected to significantly improve practical and theoretical training in this medical technique, which could have a positive impact on the quality of medical care provided to patients. The project also allowed an evaluation of the effectiveness of the simulator in the learning and praxis of students and residents. It is hoped that the results of this evaluation can be used to further improve the simulator design and its implementation in the academic program.

KeyWords: pericardiocentesis, simulator, training, medicine, echo-guided.

REFERENCIAS

- [1] María José Cifuentes-Gaitán, D. González-Rojas, A. Ricardo-Zapata, and Diego Andrés Díaz-Guio, "Transferencia del aprendizaje de emergencias y cuidado crítico desde la simulación de alta fidelidad a la práctica clínica," vol. 21, no. 1, pp. 17–21, Jan. 2021, doi: <https://doi.org/10.1016/j.acci.2020.06.001>.
- [2] Ridruejo Sáez, R and Zalba Etayo, B, "Pericardiocentesis en una Unidad de Cuidados Intensivos," *Anales de Medicina Interna*, vol. 22, no. 6, pp. 275–278, 2023, Accessed: marzo 10, 2023. [Online]. Available: https://scielo.isciii.es/scielo.php?script=sci_abstract&pid=S0212-71992005000600005
- [3] "Clinical Key," *Pericardiocentesis*. <https://ezproxy.unisimon.edu.co:2104/#!/content/book/3-s2.0-B9780323354783000166?scrollTo=%23hl0001613> (accessed Marzo 13, 2023).
- [4] D. Claudio Euler, T. Cerpa, D. Marco, and A. Iriarte, "SERIE DE CASOS," 1998. Available: https://sisbib.unmsm.edu.pe/bvrevistas/cardiologia/v33_n2/pdf/a06.pdf
- [5] R. Ridruejo, R. Sáez, B. Etayo, L. Blesa, and Zaragoza, "Pericardiocentesis en una Unidad de Cuidados Intensivos," *An Med Interna (Madrid)*, vol. 22, no. 6, pp. 275–278, 2005, Accessed: May 23, 2023. [Online]. Available: <https://scielo.isciii.es/pdf/ami/v22n6/original4.pdf>
- [6] M. Loukas, A. Walters, J. M. Boon, T. P. Welch, J. H. Meiring, and P. H. Abrahams, "Pericardiocentesis: A clinical anatomy review," vol. 25, no. 7, pp. 872–881, Oct. 2012, doi: <https://doi.org/10.1002/ca.22032>.
- [7] J. G. Krikorian and E. William Hancock, "Pericardiocentesis," vol. 65, no. 5, pp. 808–814, Nov. 1978, doi: [https://doi.org/10.1016/0002-9343\(78\)90800-8](https://doi.org/10.1016/0002-9343(78)90800-8).
- [8] Guberman, B. A., Fowler, N. O., Engel, P. J., Gueron, M., & Allen, J. M. (1981). Cardiac tamponade in medical patients. *Circulation*, 64(3), 633–640. <https://doi.org/10.1161/01.cir.64.3.633>
- [9] Callahan, J. A., Seward, J. B., Nishimura, R. A., Miller, F. A., Reeder, G. S., Shub, C., Callahan, M. J., Schattenberg, T. T., & Tajik, A. Jamil. (1985). Two-dimensional echocardiographically guided pericardiocentesis: Experience in 117 consecutive patients. *The American Journal of Cardiology*, 55(4), 476–479. [https://doi.org/10.1016/0002-9149\(85\)90397-2](https://doi.org/10.1016/0002-9149(85)90397-2)
- [10] Risti, A. D., Imazio, M., Adler, Y., Anastasakis, A., Badano, L. P., Brucato, A., Caforio, A. L. P., Dubourg, O., Elliott, P., Gimeno, J., Helio, T., Klingel, K., Linhart, A., Maisch, B., Mayosi, B., Mogensen, J., Pinto, Y., Seggewiss, H., Seferovi, P. M., & Tavazzi, L. (2014). Triage strategy for urgent management of cardiac tamponade: a position statement of the European Society of Cardiology Working Group on Myocardial and Pericardial Diseases. *European Heart Journal*, 35(34), 2279–2284. <https://doi.org/10.1093/eurheartj/ehu217>

- [11] Maggiolini, S., Gentile, G., Farina, A., De Carlini, C. C., Lenatti, L., Meles, E., Achilli, F., Tempesta, A., Brucato, A., & Imazio, M. (2016). Safety, Efficacy, and Complications of Pericardiocentesis by Real-Time Echo-Monitored Procedure. *The American Journal of Cardiology*, 117(8), 1369–1374. <https://doi.org/10.1016/j.amjcard.2016.01.043>
- [12] Balmain, S., Hawkins, N. M., MacDonald, M. R., Dunn, F. G., & Petrie, M. C. (2007). Pericardiocentesis practice in the United Kingdom. *International Journal of Clinical Practice*, 62(10), 1515–1519. <https://doi.org/10.1111/j.1742-1241.2007.01536.x>
- [13] Fardman, A., Charron, P., Imazio, M., & Adler, Y. (2016). European Guidelines on Pericardial Diseases: A Focused Review of Novel Aspects. *Current Cardiology Reports*, 18(5). <https://doi.org/10.1007/s11886-016-0721-1>
- [14] Fardman, A., Charron, P., Imazio, M., & Adler, Y. (2016). European Guidelines on Pericardial Diseases: a Focused Review of Novel Aspects. *Current Cardiology Reports*, 18(5). <https://doi.org/10.1007/s11886-016-0721-1>
- [15] Eichler, K., Zangos, S., Thalhammer, A., Jacobi, V., Walcher, F., Marzi, I., Moritz, A., Vogl, T. J., & Mack, M. G. (2010). CT-guided pericardiocenteses: Clinical profile, practice patterns and clinical outcome. *European Journal of Radiology*, 75(1), 28–31. <https://doi.org/10.1016/j.ejrad.2010.04.012>
- [16] Tsang, T. S. M., Enriquez-Sarano, M., Freeman, W. K., Barnes, M. E., Sinak, L. J., Gersh, B. J., Bailey, K. R., & Seward, J. B. (2002). Consecutive 1127 Therapeutic Echocardiographically Guided Pericardiocenteses: Clinical Profile, Practice Patterns, and Outcomes Spanning 21 Years. *Mayo Clinic Proceedings*, 77(5), 429–436. <https://doi.org/10.4065/77.5.429>
- [17] Tsang, T. S. M., El-Najdawi, E. K., Seward, J. B., Hagler, D. J., Freeman, W. K., & O'Leary, P. W. (1998). Percutaneous Echocardiographically Guided Pericardiocentesis in Pediatric Patients: Evaluation of Safety and Efficacy. *Journal of the American Society of Echocardiography*, 11(11), 1072–1077. [https://doi.org/10.1016/s0894-7317\(98\)70159-2](https://doi.org/10.1016/s0894-7317(98)70159-2)
- [18] DUBOURG, O., DELORME, G., GUERET, P., JARDIN, F., TERDJMAN, M., & C, F. J. (2023). Pericardiocentesis guided by contrast two-dimensional echocardiography in cardiac tamponade. *Journal of Cardiovascular Technology*, 8(2), 135–140. <https://pascal-francis.inist.fr/vibad/index.php?action=getRecordDetail&idt=7326022>
- [19] Akyuz, S., Zengin, A., Arugaslan, E., Yazici, S., Onuk, T., Ceylan, U. S., Gungor, B., Gurkan, U., Kemaloglu Oz, T., Kasikcioglu, H., & Cam, N. (2014). Echo-guided pericardiocentesis in patients with clinically significant pericardial effusion. *Herz*, 40(S2), 153–159. <https://doi.org/10.1007/s00059-014-4187-x>
- [20] Lindenberger, M., Kjellberg, M., Karlsson, E., & Wranne, B. (2003). Pericardiocentesis guided by 2-D echocardiography: the method of choice for

treatment of pericardial effusion. *Journal of Internal Medicine*, 253(4), 411–417.
<https://doi.org/10.1046/j.1365-2796.2003.01103.x>

[21] Borowiec, J. (2016). Complications of Percutaneous Pericardiocentesis under Fluoroscopic Guidance - O. Duvernoy, J. Borowiec, G. Helmius, U. Erikson, 1992. *Acta Radiologica*.
<https://journals.sagepub.com/doi/abs/10.1177/028418519203300405?journalCode=arcrc>

[22] Maisch, B., Seferovic, P. M., Tsang, T. S. M., Ristic, A. D. (2011). *Interventional Pericardiology: Pericardiocentesis, Pericardioscopy, Pericardial Biopsy, Balloon Pericardiotomy, and Intrapericardial Therapy*. Alemania: Springer Berlin Heidelberg.

[23] *Pulmonary Involvement in Patients with Hematological Malignancies*. (2011). Alemania: Springer Berlin Heidelberg.

[24] Maisch, B., Seferovic, P. M., Tsang, T. S. M., Ristic, A. D. (2011). *Interventional Pericardiology: Pericardiocentesis, Pericardioscopy, Pericardial Biopsy, Balloon Pericardiotomy, and Intrapericardial Therapy*. Alemania: Springer Berlin Heidelberg.

[25] Seferović, P. M., Ristić, A. D., Imazio, M., Maksimović, R., Simeunović, D., Trincherio, R., Pankuweit, S., & Maisch, B. (2006). Management Strategies in Pericardial Emergencies. *Herz Kardiovaskuläre Erkrankungen*, 31(9), 891–900.
<https://doi.org/10.1007/s00059-006-2937-0>

[26] Stawicki, S., Kumar, R., Sinha, A., Lin, M., Uchino, R., Butryn, T., O'Mara, Ms., Nanda, S., & Shirani, J. (2015). Complications of pericardiocentesis: A clinical synopsis. *International Journal of Critical Illness and Injury Science*, 5(3), 206.
<https://doi.org/10.4103/2229-5151.165007>

[27] Iatrogenic Pericardial Effusion and Tamponade in the Percutaneous Intracardiac Intervention Era: (2022). *JACC: Cardiovascular Interventions*.
<https://www.jacc.org/doi/10.1016/j.jcin.2009.04.019>

[28] Langdon, S. E., Seery, K., & Kulik, A. (2016). Contemporary outcomes after pericardial window surgery: impact of operative technique. *Journal of Cardiothoracic Surgery*, 11(1). <https://doi.org/10.1186/s13019-016-0466-3>

[29] NAUNHEIM, K., KESLER, K., FIORE, A., TURRENTINE, M., HAMMELL, L., BROWN, J., MOHAMMED, Y., & PENNINGTON, D. (1991). Pericardial drainage: subxiphoid vs. transthoracic approach. *European Journal of Cardio-Thoracic Surgery*, 5(2), 99–104. [https://doi.org/10.1016/1010-7940\(91\)90007-7](https://doi.org/10.1016/1010-7940(91)90007-7)

[30] Allen, K. B., Faber, L. Penfield., Warren, W. H., & Shaar, C. J. (1999). Pericardial effusion: subxiphoid pericardiostomy versus percutaneous catheter drainage. *The Annals of Thoracic Surgery*, 67(2), 437–440.
[https://doi.org/10.1016/s0003-4975\(98\)01192-8](https://doi.org/10.1016/s0003-4975(98)01192-8)

[31] McDonald, J. M., Meyers, B. F., Guthrie, T. J., Battafarano, R. J., Cooper, J. D., & Patterson, G. Alexander. (2003). Comparison of open subxiphoid pericardial

drainage with percutaneous catheter drainage for symptomatic pericardial effusion. *The Annals of Thoracic Surgery*, 76(3), 811–816. [https://doi.org/10.1016/s0003-4975\(03\)00665-9](https://doi.org/10.1016/s0003-4975(03)00665-9)

[32] Saltzman, A. J., Paz, Y. E., Rene, A. G., Green, P., Hassanin, A., Argenziano, M. G., Rabbani, L., & Dangas, G. (2012). Comparison of surgical pericardial drainage with percutaneous catheter drainage for pericardial effusion. *The Journal of Invasive Cardiology*, 24(11), 590–593. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3713510/>

[33] Horr, S. E., Mentias, A., Houghtaling, P. L., Toth, A. J., Blackstone, E. H., Johnston, D. R., & Klein, A. L. (2017). Comparison of Outcomes of Pericardiocentesis Versus Surgical Pericardial Window in Patients Requiring Drainage of Pericardial Effusions. *The American Journal of Cardiology*, 120(5), 883–890. <https://doi.org/10.1016/j.amjcard.2017.06.003>

[34] Rafique, A. M., Patel, N., Biner, S., Eshaghian, S., Mendoza, F., Cercek, B., & Siegel, R. J. (2011). Frequency of Recurrence of Pericardial Tamponade in Patients with Extended Versus Nonextended Pericardial Catheter Drainage. *The American Journal of Cardiology*, 108(12), 1820–1825. <https://doi.org/10.1016/j.amjcard.2011.07.057>

[35] A. J. Ristić, H.-J. Wagner, Rado Maksimović, and B. Maisch, “Epicardial halo phenomenon: a guide for pericardiocentesis?” vol. 18, no. 3, pp. 307–316, May 2013, doi: <https://doi.org/10.1007/s10741-012-9326-y>.

[36] Ristic, A. D., Seferovic, P. M., & Petrovic, P. (1999). Pericardiocentesis feasibility and safety revisited: improvement with simultaneous right ventricular and puncturing needle contrast injections. *J Am Coll Cardiol*, 32(Suppl A), 516A.

[37] Tsang, T. S. M., Freeman, W. K., Sinak, L. J., & Seward, J. B. (1998). Echocardiographically Guided Pericardiocentesis: Evolution and State-of-the-Art Technique. *Mayo Clinic Proceedings*, 73(7), 647–652. [https://doi.org/10.1016/s0025-6196\(11\)64888-x](https://doi.org/10.1016/s0025-6196(11)64888-x)

[38] Europe PMC. (2016). Europe PMC. [europepmc.org. https://europepmc.org/article/med/27901332](https://europepmc.org/article/med/27901332)

[39] Degirmencioglu, A., Karakus, G., Güvenc, T. S., Pinhan, O., Sipahi, I., & Akyol, A. (2013). Echocardiography-Guided or “Sided” Pericardiocentesis. *Echocardiography*, n/a-n/a. <https://doi.org/10.1111/echo.12214>

[40] Europe PMC. (2016). Europe PMC. [europepmc.org. https://europepmc.org/article/med/10579740](https://europepmc.org/article/med/10579740)

[41] Tsang, T. (2001). Pericardiocentesis Under Echocardiographic Guidance. *European Journal of Echocardiography*, 2(1), 68. <https://doi.org/10.1053/euje.2001.0068>

- [42] Naqvi, T. Z., & Huynh, H. K. (2006). A New Window of Opportunity in Echocardiography. *Journal of the American Society of Echocardiography*, 19(5), 569–577. <https://doi.org/10.1016/j.echo.2005.12.028>
- [43] Catena, E., Addamiano, C., Bertoli, E., Maggiolini, S., Farina, A., & Achilli, F. (2011). Pericardiocentesis From Back Under Echographic Guidance. *Circulation*, 124(24). <https://doi.org/10.1161/circulationaha.111.024786>
- [44] Sharma, R. K., Khanna, A., & Talwar, D. (2016). Endobronchial Ultrasound. *Chest*, 150(5), e121–e123. <https://doi.org/10.1016/j.chest.2016.03.013>
- [45] 3B-Scientific-Education-Medica-2017_ES.pdf. (2017). Scribd. <https://es.scribd.com/document/470104736/3B-Scientific-Education-Medica-2017-ES-pdf>
- [46] Nasco healthcare 2019-2020 - Nasco - PDF Catalogs | Technical Documentation. (2019). Medicaexpo.com. <https://pdf.medicaexpo.com/pdf/nasco/nasco-healthcare-2019-2020/79136-221639.html>
- [47] Gogalniceanu, P., Sheena, Y., Kashef, E., Purkayastha, S., Darzi, A., & Paraskeva, P. (2010). Is Basic Emergency Ultrasound Training Feasible as Part of Standard Undergraduate Medical Education? *Journal of Surgical Education*, 67(3), 152–156. <https://doi.org/10.1016/j.jsurg.2010.02.008>
- [48] Gleeson, T., & Blehar, D. (2018). Point-of-Care Ultrasound in Trauma. *Seminars in Ultrasound, CT and MRI*, 39(4), 374–383. <https://doi.org/10.1053/j.sult.2018.03.007>
- [49] Andersen, C. A., Holden, S., Vela, J., Rathleff, M. S., & Jensen, M. B. (2019). Point-of-Care Ultrasound in General Practice: A Systematic Review. *The Annals of Family Medicine*, 17(1), 61–69. <https://doi.org/10.1370/afm.2330>
- [50] Emergency Ultrasound Guidelines. (2009). *Annals of Emergency Medicine*, 53(4), 550–570. <https://doi.org/10.1016/j.annemergmed.2008.12.013>
- [51] Nicholson, R. A., & Crofton, M. (1997). Training phantom for ultrasound guided biopsy. *The British Journal of Radiology*, 70(830), 192–194. <https://doi.org/10.1259/bjr.70.830.9135447>
- [52] Niazi, A. U., Ramlogan, R., Prasad, A., & Chan, V. W. S. (2010). A New Simulation Model for Ultrasound-Aided Regional Anesthesia. *Regional Anesthesia and Pain Medicine*, 35(3), 320–321. <https://doi.org/10.1097/aap.0b013e3181df226b>
- [53] Merali, H. S., Tessaro, M. O., Ali, K. Q., Morris, S. K., Soofi, S. B., & Ariff, S. (2019). A novel training simulator for portable ultrasound identification of incorrect newborn endotracheal tube placement – observational diagnostic accuracy study protocol. *BMC Pediatrics*, 19(1). <https://doi.org/10.1186/s12887-019-1717-y>

