Digital library on Pain and Analgesia: Structure and Impact on Professional Competencies

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Abstract. This article presents the structure of a digital library on pain and analgesia. Authors discuss the necessity of its creation, the steps of its introduction in the educational process of the medical staff, and the impact of its application on the professional competencies of members of the pain team.

Keywords: Pain, Neuropathic Pain, Nociceptive Pain, Drug Analgesia, Physical Analgesia, Digital Library.

1 Introduction

The availability of libraries and different teaching supports was an intrinsic part of the requirements in the field of medical education from the time of Abraham Flexner (Flexner, 1910). The famous Flexner's Report was the base of the Medical Education Reform in United States and Canada (Barzansky, 2010). During last years, we observe a rapid development of competency-based medical education, including resource provision and evaluation backgrounds (Zeng et al., 2024).

This was our motivation for the creation of digitalized repository. We selected the current topic, because the problem of pain management is crucial in the scientific literature and in clinical medical practice.

1.1 Medical and Healthcare Education

Ultimately, we observe a rapid reform in medical education (Barzansky, 2010). Requirements of professionalism were introduced in the field of Medical and health care education and professionalism (Doukas & Volpe, 2018). We apply modern technologies in the education – for preparation of educational materials, for development of course plans and programs, for enrichment of lectures' topics, for evaluation of students' results and teaching effectiveness (Zhang & Yu, 2025).

1.2 Pain

According to the International Association for the Study of Pain (IASP), pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in term of such damage (International Association for the Study of Pain, 2020). Pain is provoked by stimulation of nociceptors (pain receptors), by modifications in sensory roads, or in cerebral zones (Haute Autorite de Sante - France, 2008). Pain perception depends on different physical, chemical or psychological factors (Koleva et al., 2018).

The biological importance of pain is to safeguard the organism from negative stimuli (external or internal), liberating a defensive reaction. The French philosopher Rene Descartes explained the shielding character of pain and its capacity to unchain a reaction as a self-protective reflex (Descartes, 1664).

In 1965, one British physiologist Patrick Wall and one Canadian psychologist Ronald Melzack published the article "Pain Mechanisms: A New Theory“ (Melzack & Wall, 1965). According the theory of gate control, in the spinal medulla exists a controlling mechanism, which is closed in response to the normal stimulation of fast fibers of tactile sense, but is open if the slow fibers of pain perception transport numerous and intensive sensory signals. A subsequent stimulation of the fast fibers can close the gate and interrupt these signals (Wall, 1978; Melzack, 1999).

The pathogenesis of pain determines the differentiation of *acute and chronic (persistent) pain; nociceptive and neuropathic pain.* In clinical practice, every pain has elements of nociceptive and neuropathic elements, and this fact is the base of our *therapeutic impotence* behind pain (Calcutt& Dunn, 1997; Merskey & Bogduk, 1994).

Pain treatment is crucial for patients‘ quality of life (Merskey & Bogduk, 1994), (Reynes, 2021). The Declaration of Montréal of the International Pain Summit of IASP categorizes chronic pain as a serious health problem and considers access to pain management as a fundamental human right (IASP, 2020).

1.3 Pain Management and Analgesia

The drug treatment of pain is oriented to nociceptive and neuropathic mechanisms of pain (Calcutt & Dunn, 1997). In neurological clinical practice, we apply the guidelines of the European Federation of Neurological Societies - on neuropathic pain assessment and on pharmacological treatment of neuropathic pain: 2010 revision (Attal et al., 2010).

Physical analgesia is the application of physical factors for pain management. The anti-pain effect of physical modalities is significant (Koleva et al., 2018). Physical analgesia has not side effects and can be combined with other therapies.

Pain management is very important for the successful rehabilitation (Koleva, 2008). Different members of our multi-disciplinary multi-professional rehabilitation team are included in the process and the role of medical doctors – specialists in Physical and Rehabilitation Medicine (PRM) is crucial (Boureau & Willer, 1979), (European PRM Bodies Alliance, 2018).

1.4 Team for Pain Patients

The obligatory condition for the staff in Pain management is to have competencies in Pain theories and in the correspondent clinical field (American Academy of Physical Medicine and Rehabilitation Task Force on Medical Inpatient Rehabilitation Criteria, 2006). From the point of view of rehabilitation, the objective must be to assure the quality of care and to guarantee the quality of life of pain patients (European PRM Bodies Alliance, 2018).

The multi-disciplinary multi-professional team must include:

- Medical doctors: specialists in Pain medicine, Anesthesiology, Neurology, Neurosurgery, Oncology (Neuro-Oncology), Radiology (Neuroradiology), Orthopedics and Traumatology; Physical and Rehabilitation Medicine (PRM);
- Healthcare professionals: Physiotherapist, Ergotherapist (occupational therapist), Nurse, Dietitian, Psychologist, Sociologist, *etc.*

2 Exposition of the Investigation

2.1 Goals and Tasks

Our goals were to prepare a digitalized repository (e-repository) on the topic "Pain and Analgesia" and to realize an assessment of professional competences of learners – before and after the introduction of the e-library. A secondary objective was to analyze the opinion of members of the pain team: medical doctors and students.

We formulated several tasks: review of scientific literature, including electronic media; exposition of the material; choice of illustrative clinical cases; construction of the educational module; application of the e-library in the educational process of different types of learners; evaluation of students' competencies at the end of the educational module; assessment of learners' opinion.

2.2 Hypothesis

The null hypothesis (H0) is that the application of electronic learning will not influence the education of members of the pain team. The alternative hypothesis (H1) is in favor of the opposite idea: we will improve the professional competences of learners with the application of the e-library.

2.3 Design of Our Study

A comparative study design was used to evaluate the impact of the e-library on professional competencies of students and trainees. For this, we created an electronic repository of digitized classic manuals and we prepared contemporary books, including principal elements of the European Curriculum for pain and pain medicine. These educational materials were implemented in the process of education of students, PRM trainees, and in the long-life learning programs for the members of the pain team (physicians

specializing in PRM, physiatrists, general practitioners, physiotherapists, nurses). We developed tests to assess learners' level of theoretical knowledge. For practical skills assessment, quizzes based on clinical case scenarios were included. Finally, we conducted face-to-face both theoretical and practical exams, using the standard grading scale in our country (from Excellent 6 to Poor 2). After the exams, but before sharing their results, our students and trainees completed questionnaires for assessment of their opinions on the e-library – using a 7-levels Likert's scale (from strongly positive to strongly negative judgment). This is a personal investigation (anonymous for the assessment of learners' opinion), and includes a detailed analysis of results from fully completed studies and questionnaires.

2.4 Structure of the e-Library

The educational module was divided into several principal chapters, presented in Figure 1. Subsections are presented in figures 2, 3, 4 and 5.

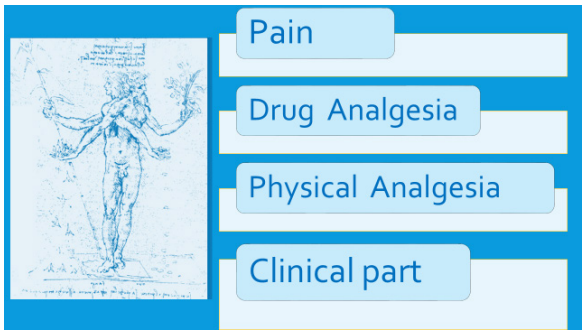

Fig. 1. Principal chapters in the educational module.

The first part of figure 1 includes basics of pain: definition, theories, levels of pain perception (receptors, sensory roots, posterior columns of spinal medulla, thalamus opticus, reticular formation, and cerebral cortex). Here (see fig.2), we included the three principal groups of theories for explanation of pain perception: specific, non-specific and combined (Calcutt & Dunn, 1997) (Merskey & Bogduk, 1994). Specific theories accept the existence of specific pain receptors – nociceptors. According non-specific theories: pain perception depends on decoding (at spinal level) of temporo-spatial organization of patterns – signals, perceived by intensive stimulation of non-specific receptors. The third group of theories accept both theories.

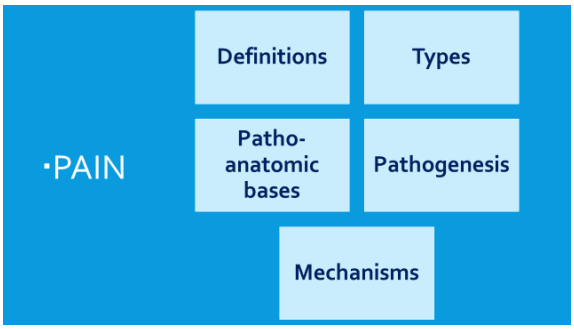

Fig. 2. Subsection 1 of the educational module: Pain.

In the subsection 2 (Drug analgesia – fig.3), we presented different types of drugs, used for pain reduction: opioids analgesics (Codeine, Fentanyl, Oxycodone, Oxymorphone), local anesthetics (Procaine, Lidocain, Buvicain), non-opioid analgesics (steroids and non-steroidal anti-inflammatory drugs, e.g. Diclofenac, Ibuprofen, Ketoprofen, Piroxicam; Celecoxib, Valdecoxib). In this part, we mentioned too basic Guidelines: the Pain Relief Ladder of the World Health Organization and the Guidelines of the European Society of Neurology.

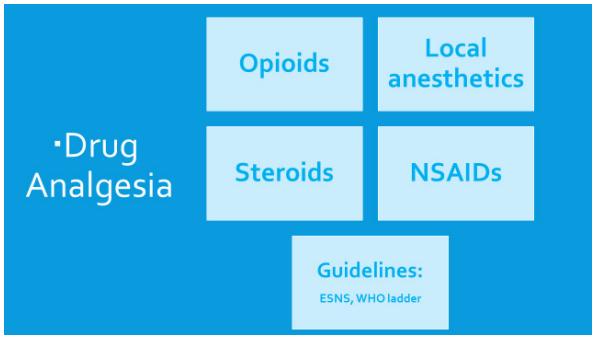

Fig. 3. Subsection 2 of the educational module: Drug analgesia.

Next figure 4 presents the topic of subsection 3 (Physical analgesia), with the used physical modalities (Koleva et al., 2018):

- *Preformed modalities*: Electric currents; Magnetic fields; Ultra-sound; Light beams: infra-red, ultra-violet or Laser (Walsh, 1995), (Walsh, 1997), (Koleva et al., 2018);
- *Natural modalities*: Kryo-factors; Thermo-agents; Mineral waters; Hydro and balneo-physiotherapy techniques; Peloids; Physiotherapy techniques – analytic exercises or soft-tissue techniques (Koleva et al., 2015);
- *Reflectory methods*: electrotherapy, thermotherapy and physiotherapy in reflectory points and zones; acupuncture, laserpuncture, acupressure, etc. (Che & Lu, 2020);
- *Telerehabilitation techniques* (Xie et al., 2021), (Tsang et al., 2022).

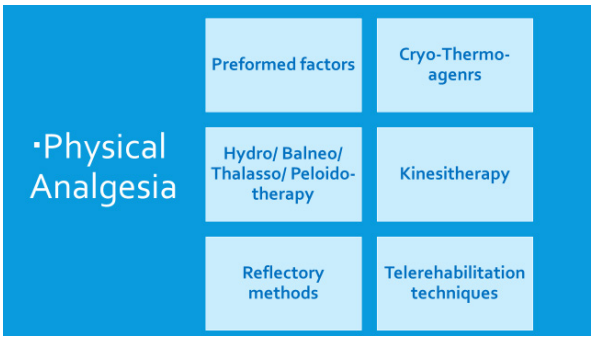

Fig. 4. Subsection 3 of the educational module: Physical analgesia.

Next figure 5 presents the subsection "Clinical part", with the different types of pain and their peculiarities (Koleva et al., 2018):

- ✓ *Nociceptive* and *Neuropathic* pain, *Central* pain,
- ✓ *Degenerative and Inflammatory pain* (in rheumatologic diseases);
- ✓ *Traumatic (Post-traumatic) pain; Post-operative pain* (in neurological and neurosurgical conditions);
- ✓ *Fibromyalgia or Myofascial pain, Pain due to muscle imbalance; Tendinopathy pain* or *Ligamentar pain* (in orthopedic and traumatic conditions);
- ✓ *Cancer pain (oncological); Phantom pain.*
- ✓

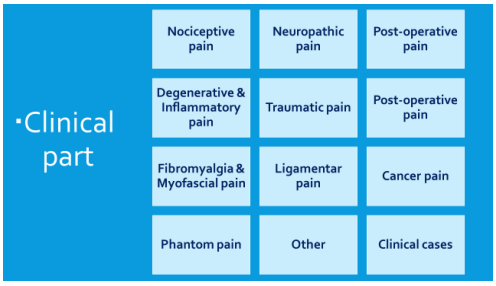

Fig. 5. Subsection "Clinical part" of the educational module.

2.5 Material (Learners' Distribution)

Last years (from the summer semester of 2022 up to the winter semester of 2024 / 2025 academic year), we introduce these modules in the educational courses of different types of learners (experimental group of 105 participants):

- ➢ students in Bachelor's degree (Kinesitherapy /KT/, Medical rehabilitation and Ergotherapy /MRB/) and in Master's degree (Medical rehabilitation and Balneotherapy /MRB/),
- ➢ participants in long-life learning /LLL/ courses (physiotherapists /PTs/, nurses) and medical doctors /MD/ (general practitioners /GPs/ and trainees in "Physical and Rehabilitation medicine /PRM/").

We compared the level of competences of these learners with learners receiving traditional education of the years 2018-2021 (control group of 108 learners).

The structure of all responders is presented in table 1 and figure 6.

Table 1. Distribution of responders by profession / future profession.

	Students			LLL-courses		MDs		
	KT	MRET	MRB	PTs	Nurses	PRM	GPs	
Bachelors	**37**	**20**		**36**	**42**			
Masters			**24**	**11**		**7**	**36**	
				47				
	81			**89**		**43**		
Total	**81**			**132**				**213**

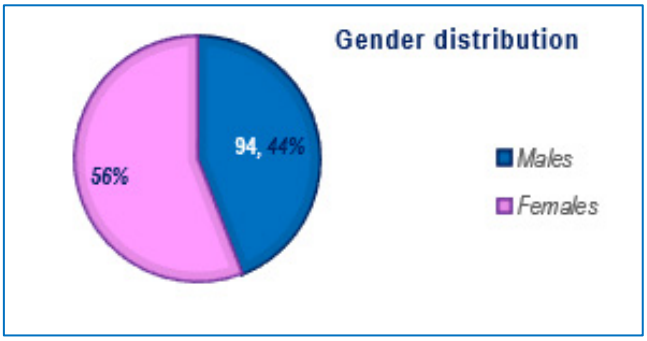

Fig. 6. Responders' distribution by gender.

All students and trainees were included. We excluded learners who could not complete the respective educational course (due to personal issues). For interpreting learners' opinion, we considered only fully completed questionnaires.

2.6 Evaluation Methods. Statistical Methods

For the current study, we applied different methods: Screening, Questionnaires, Analysis of documents, and Statistics. We created a bank with questions for evaluation of professional competences in the field of pain medicine. The questionnaire was proposed to the cited target groups. Here we refer only to the results of the learners' opinions from fully answered questionnaires (84 responders of a total of 105 participants in the experimental group).

The final statistical evaluation of results was conducted using the statistical package SPSS, version 19: with options for comparing two samples using parametrical analysis of variances ANOVA and correlation analysis, as follows: t-test (t-criterion, p value),

Signed test, Signed rank test, Kolmogorov – Smirnov test. For statistically significant effects, we considered results with a value of $p<0.05$).

3 Results

The obtained results validated the alternative hypothesis H1.

3.1 Evaluation of Competencies in the Field of Pain Medicine

The comparative analysis of the results demonstrated significant qualitative and quantitative improvement in the theoretical knowledge and practical skills of students and trainees, using the digital repository, as objectivized during online tests and face-to-face exams (theoretical and practical). The complete evaluation was performed during theoretical and practical exams – during the final exam for students and trainees in PRM, and at the end of every educational course for participants in LLL-courses. The maximal result of the tests is 100 points. The notes of the exams in our country ranges from Poor (2) to Excellent (6).

Next figures 7 and 8 present the comparison of theoretical knowledge and practical skills of learners of the experimental and control groups. So. We can conclude that the results approved the alternative hypothesis – the application of the electronic library ameliorates the theoretical knowledge and the practical skills of our learners.

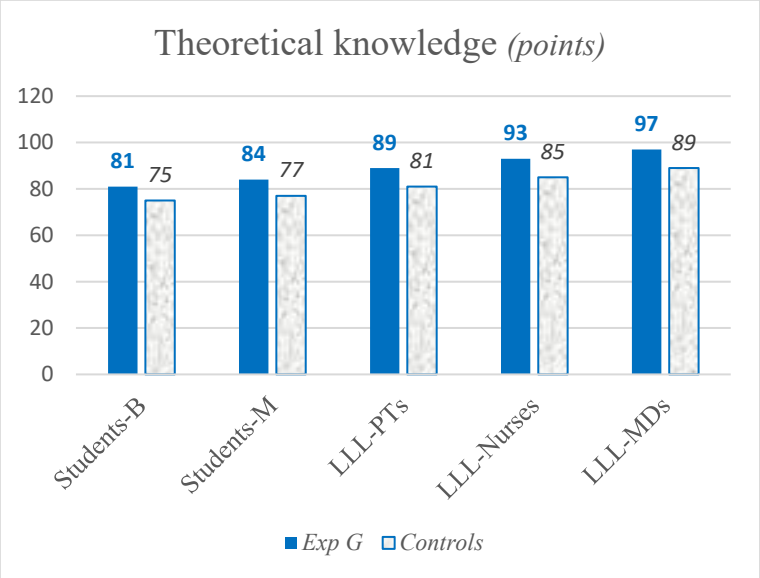

Fig. 7. Evaluation of theoretical knowledge in the domain of Pain medicine.

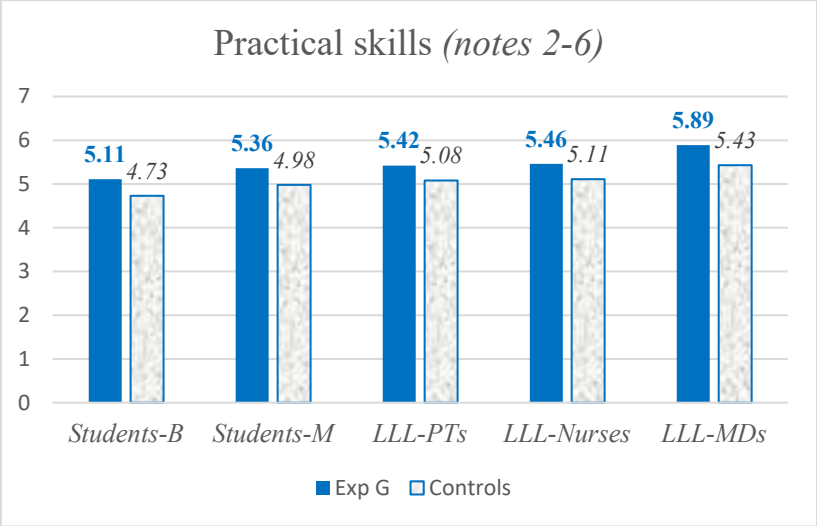

Fig. 8. Evaluation of competencies in the domain of Pain medicine (practical skills).

3.2 Analysis of Learners' Opinion

For the investigation of the learners' opinions, we applied a Likert scale of 7 levels: Strongly positive, Positive, Maybe Yes, Indifferent, Maybe no, Negative, and Strongly Negative. Results are presented in table 2.

Table 2. Distribution of opinions of the responders.

Learners' opinion	Number of answers	Percent
Strongly positive	**79**	**94.05 %**
Positive	**3**	**3.57 %**
Maybe Yes	**1**	**1.19 %**
Indifferent	**1**	**1.19 %**
Maybe No	**0**	**0**
Negative	**0**	**0**
Strongly Negative	**0**	**0**
TOTAL	**84**	**100 %**

As authors and teachers, we appreciate the learners' satisfaction of the introduction of the digitalized library on the topic "Pain and Physical analgesia".

4 Discussion and Conclusion

The efficacy of the application of the electronic archive is shown by the obtained results during the comparative evaluation of professional competencies of our students, trainees and participants in LLL-courses – from the experimental and the control groups.

Learners consider very important the topics “Pain medicine” and “Analgesia”. Their opinion on these educational materials and the electronic repository is predominantly positive. They consider useful the creation of these educational modules.

In the future, the creation of digitalized materials in the field of pain medicine must be amplified. One possible perspective is the introduction of new technologies, as virtual reality (Liu, 2024) and augmented reality. Another perspective is the potential of Artificial Intelligence, e.g. Chat GPT (Wang & Liu, 2023)

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References

American Academy of Physical Medicine and Rehabilitation Task Force on Medical Inpatient Rehabilitation Criteria. (2006). *Standards for Assessing Medical Appropriateness Criteria for Admitting Patients to Rehabilitation Hospitals or Units.* (J. M. Chair, Ed.) Retrieved March 13, 2008, from www.aapmr.org: http://www.aapmr.org / hpl/legislation/mirc.htm

Attal, N., Cruccu, G., Baron, R. et al. (2010). EFNS guidelines on the pharmacological treatment of neuropathic pain: 2010 revision. *European Journal of Neurology*, 1113-1123. doi:10.1111/j.1468-1331.2010.02999.x

Barzansky, B. (2010, September). Abraham Flexner and the Era of Medical Education Reform. *Academic Medicine, 85*(9), S19-S25. doi:10.1097/ACM.0b013e3181f12bd1

Boureau, F., Willer, J.C. (1979). *La Douleur - exploration, traitement par neurostimulation et electro-acupuncture.* Paris - New York - Barcelone - Milan: Masson.

Calcutt, N.A., Dunn, J.S. (1997). *Pain: Nociceptic and Neuropathic Mechanisms.* Anesthesiology Clinics of North America.

Che, J.Y., Lu, Da-Yong. (2020). Acupuncture for Bone Disease Treatments. *EC Orthopedics, 12*(1), 15-16.

Descartes, R. (1664). *L'Homme de Rene Descartes.* Paris: Charles Angot.

Doukas, D.J., Volpe, R.L. (2018, November). Why put the arrow when ypu can not see the target? Framing professionalism goals in Medical education. *Academic Medicine, 93*(11), 1610-1612. doi:10.1097/ACM.0000000000002264

European PRM Bodies Alliance. (2018). White Book on Physical and Rehabilitation Medicine in Europe. *European Journal of Physical and Rehabilitation Medicine, 54*(2), 1-204.

Flexner, A. (1910). *Medical Education in the United States and Canada: A Report to the Carnegie Foundation for the Advancement of Teaching.* New York: Carnegie Foundation.

Haute Autorite de Sante - France. (2008, September 1). *Chronic pain guideline.* Retrieved 2018, from www.has-sante.fr: www.has-sante.fr/portail/upload/docs/application/pdf/2010-09/chronic_pain_guideline.pdf

IASP. (2020). *Declaration of Montreal.* Retrieved from www.iasp-pain.org: www.iasp-pain.org

International Association for the Study of Pain. (2020). *Pain - Definition.* Retrieved from www.iasp-pain.org: https://www.iasp-pain.org/wp-content/uploads/2022/04/revised-definition-flysheet_R2-1-1-1.pdf

Koleva, I. (2008). Chronic pain and physical analgesia: the impact of physical modalities to reduce pain. *Journal of Biomedical and clinical research, 1*(1), 12-17.

Koleva, I., Yoshinov, B., Yoshinov, R.R. (2018). Perspectives in pain management: Physical analgesia. *Med J Clin Trials Case Stud, 2*(1), 1-3.

Koleva, I., Yoshinov, R.D., Marinov, M., Hadjijanev, A. (2015). Efficacy of hydro-, balneo- and peloidotherapy in the pain management and quality of life of patients with socially-important diseases and conditions of the locomotory and nervous system: Bulgarian experience. In *Balnea. Serie de Monografias.* (10 ed., pp. 273-274).

Koleva, I., Yoshinov, R.D., Yoshinov, B. (2018). *Physical analgesia.* (I.Koleva, Ed.) Saint-Denis, Paris, France: "Connaissance et savoirs" , Science Sante.

Liu, Y. (2024). Virtual reality: The bridge between medical education and clinical practice. *World J Clin Cases, 12*(32), 6575-6579. doi:10.12998/wjcc.v12.i32.6575

Melzack, R. (1999). From the gate to the neuromatrix. *Pain*(6), Suppl 6: S121-126.

Melzack, R., Wall, P. (1965). Pain mechanisms: A new theory. *Science*(150), 971-979.

Merskey, H., Bogduk, N. Editors. (1994). *Classification of chronic pain - description of chronic pain syndromes and definition of pain terms.* Seattle: IASP Press.

Reynes, C. (2021). *Neuropathie diabetique peripherique: Reponses vaso-motrices.* These de Doctorat d'Avignon Universite, Avignon. France.

Tsang, M.P., Man, G.C.W., Xin, H. et al. (2022). The effectiveness of telerehabilitation techniques in patients after total knee replacement: A systematic review and meta-analysis of randomized controlled trials. *Journal of Telemedicine and Telecare*, 1-14. doi:10.1177/1357633X221097469

Wall, P. (1978). The gait control theory of pain mechanisms. A re-examination and re-statement. *Brain, 101*(1), 1-18.

Walsh, D. (1997). *TENS: Clinical applications and related therapy.* Chirchill Livingstone.

Walsh, D.M., Foster, N.E., Baxter, G.D. (1995). Transcutaneous electrical nerve stimulation: Relevance of stimulation parameters to neurophysiological and hypoalgesic effects. *Americal Journal of Physical Medcine and Rehabilitation, 74*(3), 199-206.

Wang, X., Liu, X.Q. (2023). Potential and limitations of ChatGPT and generative artificial intelligence in medical safety education. *World J Clin Cases, 11*(32), 7935-7939. doi:10.12998/wjcc.v11.i32.7935

Xie, S.H., Wang, Q., Wang, L.Q. et al. (2021). Effect of Internet-based rehabilitation programs on improvement of pain and physical function in patients with knee osteoarthritis: Systematic review and meta-analysis of Randomized controlled trials. *Journal of Medical Internet Research, 23*(1), 1-13.

Zeng, Y. Y. (2024). Post competency training in standartized training of resident physicians and integrated postgraduates. *World J Clin Cases, 12*(29), 6250-6254. doi:10.12998/wjcc.v12.i29.6250

Zhang, H.Y., Yu, Y. (2025). Psychological education in higher education: Opportunities and challenges in the Internet+ era. *World J Psychiatry, 15*(5), 103274. doi:10.5498/wjp.v15.i5.103274

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