A Simple Interactive Prototype for Monitoring Chemotherapy-Induced Peripheral Neuropathy with CTCAE Grading and Supportive Natural Compound Suggestions

Alexandra ZAIŢ [1,2,*], Speranţa AVRAM [2]

[1] „Prof. Dr. Agrippa Ionescu" Clinical Emergency Hospital, Arhitect Ion Mincu Street 7, 011356 Bucharest, Romania.
[2] Faculty of Biology, University of Bucharest, Splaiul Independenţei 91–95, Sector 5, 050095 Bucharest, Romania.
E-mails: alexandra.zait@rez.umfcd.ro; speranta.avram@gmail.com

* Author to whom correspondence should be addressed;

Received: 21 December 2025/Accepted: 26 May 2026/ Published online: 10 June 2026

Abstract
Chemotherapy-induced peripheral neuropathy (CIPN) represents a frequent dose-limiting toxicity in oncology patients treated with neurotoxic agents such as taxanes and platinum compounds. Natural compounds with neuroprotective properties demonstrate supportive potential, particularly in preclinical studies, although their clinical integration remains limited due to insufficient practical tools and heterogeneous clinical evidence. A basic interactive prototype was developed in Python using Google Colab and the pandas and matplotlib libraries. The tool evaluates CIPN severity through a 0–4 scoring system for five common symptoms (numbness, tingling, pain, difficulty with fine motor tasks, and balance issues), achieving a maximum score of 20 (5 symptoms × 4 points). It computes the total score, provides an approximate grading according to NCI-CTCAE v5.0 criteria for Peripheral Sensory Neuropathy, and, in cases of elevated risk, displays a detailed table summarizing selected natural compounds (curcumin, quercetin, resveratrol, omega-3 fatty acids, vitamin E) including mechanisms of action, separate preclinical and clinical evidence levels, studied doses, precautions, and potential interactions. Results are presented in the form of a bar chart for symptom profile visualization. Preliminary testing on simulated patient profiles confirmed instant risk stratification and intuitive usability without installation requirements. This simple, accessible informatics prototype supports oncology clinicians in standardized CIPN monitoring and facilitates discussions with patients during consultations regarding adjunctive natural supportive options while taking into consideration pharmacological safety. It offers a low-cost solution suitable for clinical extension in Romanian medical practice, such as mobile applications or electronic health record integration. AI tools assisted in code development and drafting; the prototype and final content represent original work by the author.

Keywords: Chemotherapy; Neuroprotection; Medical Oncology; Neurotoxicity Syndromes

Introduction

Chemotherapy-induced peripheral neuropathy (CIPN) is one of the most debilitating adverse effects occurring during treatment with several neurotoxic agents such as taxanes and platinum-based compounds. Symptoms persist in approximately 30% of patients beyond six months and have lifelong effects even after the end of the treatment [1]. Typical manifestations include sensory symptoms such as numbness, tingling, and pain that can lead to functional impairment. Unfortunately, these symptoms often require dose reductions, treatment delays, or

premature discontinuation, thereby compromising oncological outcomes and quality of life. Patients receiving taxanes during chemotherapy frequently experience alterations in gait, balance, and patient-reported outcomes potentially negatively influencing treatment continuation [2]. Preclinical studies have demonstrated neuroprotective effects of various natural compounds (curcumin, quercetin, resveratrol, omega-3 fatty acids, vitamin E) through antioxidant, anti-inflammatory, and anti-apoptotic mechanisms [3]. Clinical oncology guidelines currently lack strong evidence-based approaches for treatment of severe neuropathy in oncologic patients [4,5]. Patients frequently inquire about complementary options during doctor-patient visits, yet clinicians lack rapid, evidence-based tools to guide safe discussions regarding supportive natural compounds for this toxicity. The purpose of this work was to develop a simple, freely accessible interactive prototype that enables standardized CIPN severity assessment alongside CTCAE-based grading and conditional presentation of summarized evidence on multiple natural supportive compounds to facilitate safe patient counselling. Our prototype differentiates itself through its distinctive simplicity (it requires no installation, relies on only five rapid symptom inputs), rapid output with CTCAE-aligned grading, conditional display of evidence-based natural compound summaries (including precautions and interactions), and immediate graphical representation of symptoms—all designed for real-time use during busy oncology consultations to guide informed discussions about supportive natural options.

Materials and Methods

Symptom Scoring and Grading System

Five key CIPN symptoms were selected based on common clinical presentation and alignment with validated instruments (EORTC QLQ-CIPN20): numbness in hands/feet, tingling, pain/burning sensation, difficulty with fine motor tasks (e.g., writing), and balance/walking issues. Each symptom is scored by the user on a 0–4 scale (0 = absent, 4 = disabling). The total score (maximum 20) is automatically calculated, and an approximate NCI-CTCAE v5.0 grade for Peripheral Sensory Neuropathy is assigned as follows: Grade 1 (score 0-1), Grade 2 (2–6), Grade 3 (7–12), Grade 4 (13–20). According to the NCI-CTCAE ver 5.0, grade 5 neuropathy is defined as the death of the patient, and this parameter was therefore excluded from the prototype [5]. These proposed thresholds were chosen pragmatically to distribute severity levels roughly proportionally across the 0–20 range while highlighting increasing functional impact of the patient (e.g., mild sensory changes in Grade 1 vs. disabling symptoms in Grade 4). The score-to-grade system is approximate and not directly derived from official CTCAE criteria, which rely on clinician judgment of symptom interference with activities of daily living (ADLs). The proposed scoring system is a tool developed for rapid consultation use and has not been formally validated against established instruments such as the Total Neuropathy Score (TNS) or EORTC QLQ-CIPN20. It aims to facilitate quick risk stratification for the clinician rather than replace comprehensive medical assessment.

Technical Information

The prototype was implemented as a Python 3 notebook executed in Google Colab (no installation required). Core libraries used were pandas (for tabular data handling) and matplotlib (for visualization).

Statistics

A predefined evidence table containing selected natural compounds is displayed only when the total score exceeds 1 (corresponding to Grade 2 or higher). The table includes the mechanism of action, separate preclinical and clinical evidence summaries, typical studied doses, precautions, and potential natural compound-drug interactions, derived from recent literature reviews. The proposed five natural compounds (curcumin, quercetin, resveratrol, omega-3 fatty acids, and vitamin E) were selected based on:

(1) availability of preclinical data demonstrating neuroprotective effects against chemotherapy-induced neuropathy;
(2) presence of some clinical trial data (despite being limited or mixed);
(3) relatively favorable safety profiles in patients.

Evidence summaries were derived from recent literature reviews and key trials. [3, 7]. Symptom scores are each visualized immediately via a horizontal bar chart. Functionality was tested using simulated patient profiles with low, moderate, and high neuropathic severity scenarios.

Results

The prototype executes immediately (a couple of seconds computation time after input) in any web browser via Google Colab. It accurately computes the total score, assigns the corresponding CTCAE grade, conditionally presents the evidence-based compound table with safety information, and generates a clear bar chart of the individual symptom profile. Preliminary testing requires only five numeric inputs and provides immediate, clinically relevant output suitable for real-time consultation. Preliminary informal feedback from oncology colleagues indicated potential utility during clinical consultations.

Prototype example outputs: (a) low-risk case/ asymptomatic (Grade 1) (Figure 1), (b) moderate-risk case (Grade 2) (Figure 2) with displayed compound table (Table 1), (c) high-risk case (Grade 3 or 4) with bar chart visualization (Figure 3). An exemplification of natural compounds table (Table 1) as potential treatment options in clinical setting is presented in Table 1 as associated to a Grade 2 case (Figure 2) and Grade 3 case (Figure 3).

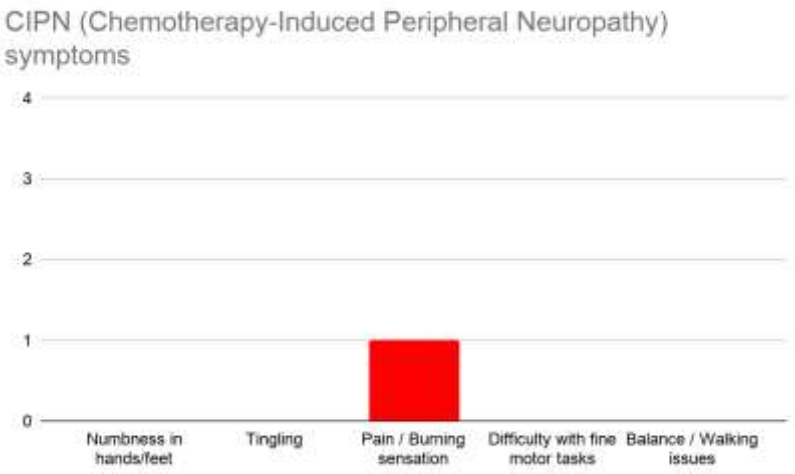

Figure 1. Low-risk case visual symptom chart and table (Total Score 1/20, approximate CTCAE Grade 1).

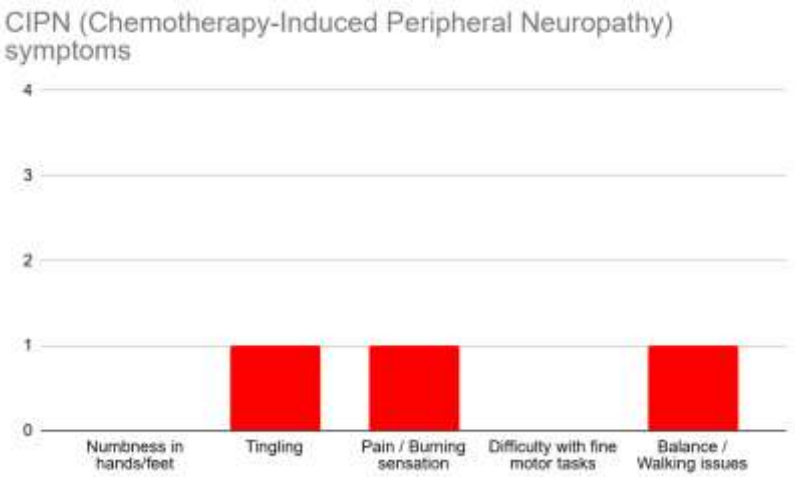

Figure 2. Moderate risk-case (Total Score 3/20, approximate CTCAE Grade 2).

Table 1. Summary of selected natural compounds for potential supportive use in CIPN (translated prototype output).

Compound	Possible Mechanism of Action	Preclinical Evidence (animal/in vitro studies)	Clinical Evidence (human trials)	Doses Used in Studies	Precautions and Possible Interactions	Notes
Curcumin	Strong anti-inflammatory and antioxidant.	High: Numerous studies show clear protection against neuropathy induced by vincristine, paclitaxel, oxaliplatin, and cisplatin.	Moderate: A randomized trial in children with vincristine showed significant reduction in incidence; other small positive studies.	500–2000 mg/day (enhanced absorption form + piperine).	May potentiate antiplatelet and anticoagulant effects (warfarin, aspirin); increased bleeding risk. Caution in gallbladder disease.	From turmeric – better absorption with piperine.
Quercetin	Neuroprotective and antioxidant.	High: Protection demonstrated in animal models with vincristine, paclitaxel, and cisplatin.	Low: Very limited direct data for CIPN.	500 mg/day.	Weak CYP3A4 and P-gp inhibitor – may increase levels of some chemotherapeutics (e.g., docetaxel, vincristine). Rare allergic reactions.	Found in onions, apples, tea.
Resveratrol	Anti-inflammatory and reduces oxidative stress.	High: Positive effects in models with oxaliplatin and paclitaxel.	Low: No direct clinical evidence for CIPN.	100–500 mg/day.	Mild estrogenic effect – use with caution in hormone-dependent cancers (breast, prostate). Minor CYP3A4 interaction.	Found in red grapes and red wine
Omega-3 Fatty Acids	Anti-inflammatory.	Moderate: Some studies show preventive benefits.	Mixed: Some small trials show preventive benefits, others inconsistent.	1–2 g/day (EPA + DHA).	Antiplatelet effect – increased bleeding risk with anticoagulants/antiplatelets. Caution in fish allergy.	From fish oil or algae (vegan options).
Vitamin E	Strong antioxidant.	Moderate: Positive effects in animal models.	Mixed: Some positive prevention trials, but contradictory results [7].	400–800 IU/day.	At high doses (>800 IU/day) increased hemorrhagic risk. Generally safe at moderate doses.	Often combined with Omega-3.

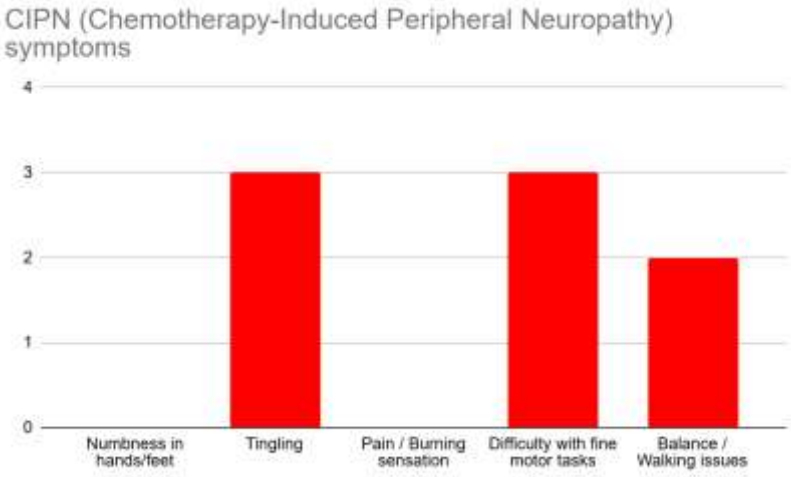

Figure 3. High risk-case (Total Score 8/20 , approximate CTCAE grade 3).

Discussion

The developed prototype addresses an unmet need for rapid, standardized CIPN assessment aligned with international oncological toxicity criteria while integrating balanced evidence on natural supportive agents. Although ASCO guidelines recommend standardized assessment and prevention strategies for chemotherapy-induced peripheral neuropathy in adult cancer survivors, effective and widely adopted approaches remain limited [6,8].The conditional display of precautions (e.g., increased bleeding risk with omega-3 fatty acids in anticoagulated patients) promotes responsible doctor-patient dialogue. Limitations include the use of a simplified non-validated scoring system, static literature-derived evidence (rather than real-time database information), and testing restricted to simulated cases. Validated instruments such as the Total Neuropathy Score [10] and the EORTC QLQ-CIPN20 [11], together with ESMO recommendations [4,6], highlight the need for standardized evaluation, yet their complexity limits routine use in busy clinical settings. Future developments could incorporate patient-facing interfaces and integration with electronic health records.

Our study had several limitations that must be discussed. The prototype was developed with Romanian oncology practice in mind. To meet international publication standards, all data is provided entirely in English. However, the open-source Colab notebook permits easy localization of the compound summary table and symptom labels into Romanian. Limitations of this Python prototype include the use of a simplified, non-validated scoring system that relies on patient-reported outcomes (PROs) and may introduce subjectivity in input. The evidence table is static (based on literature available currently) rather than dynamically linked to real-time databases. Testing was restricted to simulated oncological patient profiles, and real-world data has not yet been obtained. Additionally, the tool does not replace exhaustive neurological examination or validated patient-reported outcome measures.

Our prototype provides a simple, online, and no-cost informatics tool that supports standardized CIPN monitoring and evidence-informed supportive care discussions in oncology practice for peripheral sensory neuropathy. Effective patient-clinician communication is essential in managing chemotherapy-induced adverse effects, as emphasized by international oncology guidelines [8, 9]. This open-source Colab prototype is meant to provide a freely accessible tool that bridges standardized neuropathic toxicity grading with practical supportive care information, which is particularly valuable in high-volume clinics.

List of Abbreviations: CIPN: Chemotherapy-induced peripheral neuropathy; CTCAE: Common Terminology Criteria for Adverse Events; NCI: National Cancer Institute.

Author Contributions: Alexandra ZAIȚ conceived the study, designed and implemented the prototype, performed testing, and drafted the manuscript. All authors read and approved the final manuscript.

Funding: This research received no funding.

Ethics Statement: Not applicable (no human or animal subjects involved; prototype tested on simulated data only).

Data Availability Statement: The complete prototype notebook and source code are available upon request from the corresponding author, linked here: https://colab.research.google.com/drive/14Le6DAX8USwSsi0zt3Tvyh5sNRtnqxOI?usp=sharing

Acknowledgments: The author acknowledges the use of artificial intelligence tools (Grok by xAI) for code assistance and initial manuscript drafting support.

Conflict of Interest: The author declares no conflict of interest.

References

1. Seretny M, Currie GL, Sena ES, Ramnarine S, Grant R, MacLeod MR, et al. Incidence, prevalence, and predictors of chemotherapy-induced peripheral neuropathy: A systematic review and meta-analysis. Pain. 2014 Dec;155(12):2461-2470. doi: 10.1016/j.pain.2014.09.020.
2. Monfort SM, Pan X, Patrick R, Ramaswamy B, Wesolowski R, Naughton MJ, et al. Gait, balance, and patient-reported outcomes during taxane-based chemotherapy in early-stage breast cancer patients. Breast Cancer Res Treat. 2017 Jul;164(1):69-77. doi: 10.1007/s10549-017-4230-8.
3. Shen CL, Castro L, Fang CY, Castro M, Sherali S, White S, et al. Bioactive compounds for neuropathic pain: An update on preclinical studies and future perspectives. J Nutr Biochem. 2022 Jun;104:108979. doi: 10.1016/j.jnutbio.2022.108979.
4. Fallon M, Giusti R, Aielli F, Hoskin P, Rolke R, Sharma M, Ripamonti CI; ESMO Guidelines Committee. Management of cancer pain in adult patients: ESMO Clinical Practice Guidelines. Ann Oncol. 2018 Oct 1;29(Suppl 4):iv166-iv191. doi: 10.1093/annonc/mdy152.
5. U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute. Common Terminology Criteria for Adverse Events (CTCAE) Version 5.0. Published November 27, 2017. Accessed December 21, 2025. Available from: https://ctep.cancer.gov/protocolDevelopment/electronic_applications/docs/CTCAE_v5_Quick_Reference_5x7.pdf
6. Jordan B, Margulies A, Cardoso F, Cavaletti G, Haugnes HS, Jahn P, et al; ESMO Guidelines Committee. Electronic address: clinicalguidelines@esmo.org; EONS Education Working Group. Electronic address: eons.secretariat@cancernurse.eu; EANO Guideline Committee. Electronic address: office@eano.eu. Systemic anticancer therapy-induced peripheral and central neurotoxicity: ESMO-EONS-EANO Clinical Practice Guidelines for diagnosis, prevention, treatment and follow-up. Ann Oncol. 2020 Oct;31(10):1306-1319. doi: 10.1016/j.annonc.2020.07.003.
7. Salehi Z, Roayaei M. Effect of Vitamin E on Oxaliplatin-induced Peripheral Neuropathy Prevention: A Randomized Controlled Trial. Int J Prev Med. 2015 Nov 2;6:104. doi: 10.4103/2008-7802.169021.
8. Loprinzi CL, Lacchetti C, Bleeker J, Cavaletti G, Chauhan C, Hertz DL, et al. Prevention and Management of Chemotherapy-Induced Peripheral Neuropathy in Survivors of Adult Cancers: ASCO Guideline Update. J Clin Oncol. 2020 Oct 1;38(28):3325-3348. doi: 10.1200/JCO.20.01399.
9. Gilligan T, Coyle N, Frankel RM, Berry DL, Bohlke K, Epstein RM, et al. Patient-Clinician Communication: American Society of Clinical Oncology Consensus Guideline. J Clin Oncol. 2017 Nov 1;35(31):3618-3632. doi: 10.1200/JCO.2017.75.2311.
10. Cavaletti G, Frigeni B, Lanzani F, Piatti M, Rota S, Briani C, et al; Italian NETox Group. The Total Neuropathy Score as an assessment tool for grading the course of chemotherapy-induced peripheral neurotoxicity: comparison with the National Cancer Institute-Common Toxicity Scale. J Peripher Nerv Syst. 2007 Sep;12(3):210-5. doi: 10.1111/j.1529-8027.2007.00141.x.
11. Postma TJ, Aaronson NK, Heimans JJ, Muller MJ, Hildebrand JG, Delattre JY, et al; EORTC Quality of Life Group. The development of an EORTC quality of life questionnaire to assess chemotherapy-induced peripheral neuropathy: the QLQ-CIPN20. Eur J Cancer. 2005 May;41(8):1135-9. doi: 10.1016/j.ejca.2005.02.012.