

预后营养指数对炎症性疾病预后影响的研究进展

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收稿日期: 2025年12月27日; 录用日期: 2026年1月21日; 发布日期: 2026年1月29日

摘要

预后营养指数(prognostic nutritional index, PNI)是一种综合评价患者营养状况和免疫状态的指标, 目前已逐渐应用于多种疾病的预后评估, 尤其在肿瘤学、感染性疾病和老年医学等领域显示出重要的临床价值。本文旨在综述PNI在炎症性疾病预后评估中的最新研究进展, 为临床实践提供参考。

关键词

预后营养指数, 炎症性疾病, 预后评估, 研究进展

Research Progress on the Impact of Prognostic Nutritional Index on the Prognosis of Inflammatory Diseases

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Received: December 27, 2025; accepted: January 21, 2026; published: January 29, 2026

Abstract

Prognostic Nutritional Index (PNI) is a composite indicator that assesses a patient's nutritional status

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文章引用: 梅雪, 李禄全. 预后营养指数对炎症性疾病预后影响的研究进展[J]. 临床医学进展, 2026, 16(2): 93-99.
DOI: 10.12677/acm.2026.162365

and immune function. It has been increasingly applied in prognostic evaluation across various diseases and has demonstrated significant clinical value, particularly in the fields of oncology, infectious diseases, and geriatric medicine. This article reviews recent advances in the use of PNI for prognostic assessment in inflammatory diseases, with the aim of providing insights for clinical practice.

Keywords

Prognostic Nutritional Index, Inflammatory Diseases, Prognosis Evaluation, Research Progress

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1. 引言

预后营养指数(prognostic nutritional index, PNI)最初由 Buzby 等于 1980 年提出,后由日本学者 Onodera 进行修正和完善[1]。主要用于评估胃肠道手术患者的营养风险和术后并发症发生的可能性[2] [3]。近年来, PNI 已被应用于评价急性心力衰竭、各类肿瘤性疾病、感染性疾病等患者的临床转归[4]-[8]。PNI 的计算基于血清白蛋白和淋巴细胞计数,反映了患者的营养储备和免疫能力。其计算公式为: $PNI = \text{血清白蛋白(g/L)} + \text{外周血淋巴细胞计数}(\times 10^9/\text{L}) \times 5$ [9]。PNI 的生理学基础在于它通过两个关键指标反映患者的整体状况:血清白蛋白由肝脏合成,是评估患者营养状况的可靠指标,其水平降低可能预示着营养不良和系统性炎症反应;而淋巴细胞计数则反映了患者的免疫状态,淋巴细胞减少与免疫功能受损相关,可能在疾病免疫监视中发挥作用[10]。因此, PNI 能够综合评估患者营养状况和免疫状态,这或许是它在多种疾病预后预测中具有价值的重要原因[11]。近年来, PNI 在疾病预后评估、治疗策略制定和风险分层中的价值日益凸显,成为临床研究的热点。本文旨在综述 PNI 在炎症性疾病预后评估中的最新研究进展,为临床实践提供参考。

2. PNI 在心血管系统炎症性疾病预后评估中的研究进展

在感染性心内膜炎(infective endocarditis, IE)患者中, PNI 对于手术治疗患者的预后预测具有重要价值。研究表明,前 PNI 值与 IE 住院患者院内死亡率相关[12],在接受心脏瓣膜手术的感染性心内膜炎患者中,较低的术前 PNI 评分是 IE 患者术后院内死亡的独立危险因素[13]。同时,术前 PNI 评分也是 IE 手术患者 1 年全因死亡率的独立预测因子。住院死亡率的曲线下面积(area under curve, AUC)为 0.74,表明其具有中等预测效力,且对 1 年死亡率预测也具有中等价值[13] [14]。Kahraman 等报告了 PNI 预测感染性心内膜炎手术预后的临界值约为 35.6 (AUC = 0.691) [12],而在其他心脏手术队列中,则报告了更高的阈值。在成人心脏手术体外循环中, PNI 的临界值约为 46.1,在经导管主动脉瓣置换术(transcatheter aortic valve replacement, TAVR)队列中约为 43.4~48.3 [15] [16]。Cai 等研究发现, $PNI < 36.11$ 的结核性缩窄性心包炎手术后患者总住院时间和术后住院时间更长。 $PNI < 36.11$ 组围手术期不良事件发生率为 76.6% (82/107)。单因素及多因素分析均证实较低的 PNI 与围手术期不良结局的增加显著相关[17]。

3. PNI 在呼吸系统炎症性疾病预后评估中的研究进展

在肺炎患者中, PNI 与死亡风险也呈现出显著相关性。Ding 等研究发现, PNI 每增加 1 个单位,肺炎患者 30 天死亡风险降低 5.0%, 90 天死亡风险降低 4.5%,与 PNI 最低三分位数组相比,最高三分位数

组患者的 30 天死亡风险降低 64.5%，90 天死亡风险降低 60.6% [18]。De Rose 等发现，对于被诊断患有社区获得性细菌性肺炎的个体，PNI 每降低一个单位，死亡风险就会增加 13.6% [19]。社区获得性肺炎患者 30 天和 90 天时的 PNI 高低与死亡率之间存在反比关系[20]。此外，一项利用 MIMIC-III 数据库数据的研究表明，与 PNI 较高的患者相比，PNI 低于 35.07 的危重症患者在 30 天和 90 天时的死亡风险分别增加了 21.6%和 23.3% [19]。在新冠肺炎患者群体中，PNI 值降低一直与更高的死亡风险相关联[21]-[23]。还有研究表明了 PNI 在预测儿童肺炎预后中的价值。研究表明，肺炎组患儿的 PNI 值显著低于对照组，低 PNI (<40)与住院时间、氧气支持需求和机械通气需求显著相关，PNI 值与住院时间和恢复时间呈强负相关关系，PNI 对肺炎严重程度的预测能力为中等[8]。

4. PNI 在消化系统炎症性疾病预后评估中的研究进展

4.1. PNI 与急性胆管炎

在急性胆管炎(acute cholangitis, AC)患者中，PNI 对于疾病进展具有预测价值。Mandai 等回顾性分析了 239 例在就诊 24 小时内接受内镜胆道引流的 I 级或 II 级 AC 患者，结果显示，进展组比非进展组有更低的 PNI (36.67 vs 39.81, $P=0.003$)，并且低 PNI (<38)患者在进展组中的比例显著高于在非进展组中的比例(66.6% vs 37.6%, $P=0.023$)。多变量分析确定，II 级 AC、免疫抑制治疗和低 PNI 是疾病进展的独立预测因素[24]。

4.2. PNI 与急性胰腺炎

研究发现，PNI 评分大于 45 的急性胰腺炎患者临床结局明显优于 PNI 评分较低的患者[25]。Huang 等构建预测重症急性胰腺炎(severe acute pancreatitis, SAP)预后的模型，发现血清铁蛋白、C 反应蛋白、预后营养指数和白细胞均为影响 SAP 预后的独立危险因素($P < 0.05$)，Hosmer 和 Lemeshow 拟合优度检验($P=0.596$)、Brier 分数以及校准曲线的结果均表明，该模型具有良好的准确性[26]。也有其他研究发现，虽然坏死性胰腺炎患者的 PNI 评分较低，但单独的 PNI 并未被发现是强有力的预测指标[27]。Gungor 等关于急性胰腺炎患者营养状况指标与临床结局的相关性研究中也发现，有并发症组与无并发症组患者的 PNI 评分无显著差异($P>0.05$)。然而，在出现胰腺坏死的病例中，PNI 评分显著更低($P=0.036$) [28]。因此，在急性病例(如胰腺炎)的预后预测方面，虽然 PNI 可能提供营养状况的信息，但其预测价值有待进一步研究。

5. PNI 在全身炎症性疾病预后评估中的研究进展

5.1. PNI 与脓毒症

PNI 较低的脓毒症患者可能存在营养不足、感染控制不佳和免疫失衡，这可能导致白蛋白和淋巴细胞水平降低，从而影响预后。Back 等发现，PNI 水平低的老年脓毒症患者死亡率更高[29]。Pan 等发现，高 PNI 脓毒症患者的 14 天、28 天和 90 天死亡风险更低($P < 0.001$)。多变量 Cox 比例风险模型表明，在校正混杂因素前后，高 PNI 与 14 天、28 天和 90 天全因死亡率独立相关($P < 0.0001$) [30]。PNI 在儿科脓毒症诊断和预后预测中也显示出重要价值。Li 等探讨了 PNI 在预测新生儿败血症存在和严重程度中的临床价值，结果表明，脓毒症新生儿的 PNI 随脓毒症的严重程度增高而显著降低，相关性分析表明，PNI 与炎症标志物降钙素原、C 反应蛋白水平及住院时间呈负相关。多因素 Logistic 回归分析显示，PNI 与新生儿脓毒症的存在和严重程度呈独立且负相关的关系[31]。

5.2. PNI 与川崎病

有研究发现，PNI 值可预测冠状动脉瘤(coronary artery aneurysm, CAA)的发展，并且是 CAA 持续长

达2年的独立危险因素[32][33]。Yalcinkaya等发现, 较低的PNI水平与川崎病患者的冠状动脉病变(coronary artery lesion, CAL)独立相关。CAL组的PNI值显著低于未发生CAL组($P < 0.001$) [34]。Zhang等评估PNI与CAL之间的关系发现, PNI与冠状动脉直径呈负相关($r = -0.260$, $P < 0.001$)。PNI水平低(< 46.575)的患者发生CAL的可能性是PNI水平高(≥ 46.575)的患者的4.25倍, PNI预测CAL预后的价值为中等[35]。

5.3. PNI与其他胃肠道疾病过敏性紫癜

过敏性紫癜(Henoch-Schönlein purpura, HSP)是儿童期最常见的系统性血管炎性疾病, 其中以小血管炎为主要表现, 部分患儿可并发十二指肠溃疡(duodenal ulcer, DU)。Li等探究了PNI预测HSP患儿发生DU的价值, 结果发现PNI ≤ 53.0 时, DU极有可能发生[36]。有报道称, 白蛋白水平降低是成人消化性溃疡的危险因素[37][38]。在儿童中, 一些报告表明白蛋白水平降低可能是由于HSP中蛋白质丢失性肠病造成的[39][40], 血清白蛋白水平降低是HSP儿童胃肠道出血的独立危险因素[41]。目前还没有关于淋巴细胞绝对计数与DU之间关联的报告。但有报告表明, 高淋巴细胞绝对计数HSP的儿童可能有胃肠道出血的风险[42]-[44]。有研究发现, DU组的白蛋白低于非DU组, 但并非影响DU发病的独立危险因素, 患有DU的儿童淋巴细胞计数与对照组相比, 差异无统计学意义, 提示单独的指标在预测DU风险方面存在局限性[36]。

6. PNI的生理机制及使用的局限性

PNI的核心在于通过白蛋白和淋巴细胞计数这两个易于获得的指标, 量化在疾病压力下机体的营养与免疫的状态。疾病状态下机体免疫系统被激活, 促进炎症因子如肿瘤坏死因子- α 、白介素-1、白介素-6等的释放。在炎症因子驱动下, 肝脏合成白蛋白减少, 而C-反应蛋白、纤维蛋白原等合成增多。机体处于炎症反应时, 淋巴细胞激活并持续消耗。白蛋白降低会导致组织水肿, 器官灌注及氧供变差, 加重器官功能障碍, 使淋巴细胞持续消耗, 细胞免疫被削弱, 进一步加剧全身炎症和消耗。

尽管PNI在多个临床领域展现出价值, 但其局限性也不容忽视。首先, 不同疾病与PNI的契合程度不同。心血管事件的进展和预后与持续的全身性炎症与免疫状态直接相关, 因此PNI的预测效能高。而重症肺炎、急性胰腺炎等疾病的预后更多取决于病原体毒力、局部感染控制、器官功能衰竭等因素。尽管机体也存在炎症与免疫失衡, 但这并不是决定预后的主要矛盾, 因此PNI预测能力有限。其次, PNI的临界值不统一是当前面临的主要问题。在不同研究中, PNI的最佳临界值存在较大差异。造成这种差异的原因可能是研究人群特征不同、统计方法各异以及疾病类型的特异性。此外, 现有证据主要来自回顾性研究, 偏倚较大, 尽管大多数研究控制了混杂因素, 但不同研究的控制变量各不相同, 降低了结果的可比性。

PNI的生理影响因素也构成了其应用挑战。血清白蛋白水平不仅受营养状况影响, 还受到肝功能、肾脏丢失、炎症状态和液体平衡等多种因素影响。同样, 淋巴细胞计数也可能受到感染、应激、药物治疗和血液稀释等因素影响。患者脱水时血液浓缩, 白蛋白及淋巴细胞计数假性升高, 从而高估患者营养状态。应在患者容量状态稳定时测量并计算PNI值, 并动态监测。肝功能不全患者白蛋白合成能力下降, 主要反映肝病的严重程度及预后, 而非特异的营养状态, 可结合其他营养评估工具或Child-Pugh评分等综合评估机体状态。肾功能不全患者体内白蛋白合成受阻、分解增加或丢失, 体内毒素堆积可抑制淋巴细胞增殖, 导致淋巴细胞减少。此种情况下PNI无法准确反映机体营养及免疫情况。使用激素时也应避免使用PNI评估机体状况。长期大剂量使用激素会抑制蛋白质合成, 导致白蛋白降低。同时体内淋巴细胞重新分布, 外周血淋巴细胞数急剧减少。此时PNI值将显著降低。以上因素均会导致PNI评估的偏差, 因此, 在解读PNI结果时还需要结合患者的临床情况, 而非孤立依赖单一指标。

7. 结论

PNI作为一种经济、简便、可靠的综合评估工具, 在临床多个领域展现出重要的应用价值, 其与多种

疾病的发展和转归密切相关。通过识别 PNI 低的患者, 临床医生可以及时实施营养干预和免疫支持, 从而改善患者的临床结局。然而, PNI 的临床应用仍面临挑战, 主要是临界值标准化、证据等级提升和生理影响因素控制等问题。未来的研究应致力于通过更严谨的设计、更广泛的人群和更深入的机制探索, 推动 PNI 从研究工具向临床实践的转化。将 PNI 整合入多模态评估系统和临床决策路径, 结合其他营养评估工具和新型复合指标, 可能实现更精准、个体化的患者管理, 最终改善疾病预后。

基金项目

重庆市科卫联合医学科研项目(2025MSXM024)。

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