

老年患者术后谵妄评估预测和干预措施的研究进展

李 晖¹, 赵 伟¹, 周 峰^{2*}

¹大连医科大学研究生院, 辽宁 大连

²大连医科大学附属第二医院麻醉科, 辽宁 大连

收稿日期: 2025年10月6日; 录用日期: 2025年10月31日; 发布日期: 2025年11月11日

摘 要

术后谵妄(POD)是通常发生于老年患者的一种急性脑功能障碍综合征, 严重影响老年患者预后和转归。早期识别老年高危POD患者并及时干预是POD防治的关键。目前, 各种谵妄评估方法虽然在一定程度上能够早期识别和诊断POD, 但每种方法均有其局限性。预测模型的开发验证有助于实现对POD的早期预测。本文综述了老年患者术后谵妄的各种评估预测方法及干预措施, 为老年患者POD的防治提供参考。

关键词

老年患者, 术后谵妄, 评估, 预测, 干预措施

Progress on the Assessment, Prediction and Intervention Measures of Postoperative Delirium in Elderly Patients

Hui Li¹, Wei Zhao¹, Feng Zhou^{2*}

¹Graduate School, Dalian Medical University, Dalian Liaoning

²Department of Anesthesiology, The Second Hospital of Dalian Medical University, Dalian Liaoning

Received: October 6, 2025; accepted: October 31, 2025; published: November 11, 2025

Abstract

Postoperative delirium (POD) is an acute brain function disorder syndrome that usually occurs in

*通讯作者。

文章引用: 李晖, 赵伟, 周峰. 老年患者术后谵妄评估预测和干预措施的研究进展[J]. 临床医学进展, 2025, 15(11): 901-910. DOI: 10.12677/acm.2025.15113174

elderly patients and seriously affects the prognosis and outcome of elderly patients. Early identification of elderly patients at high risk of POD and timely intervention are the keys to the prevention and treatment of POD. Although various delirium assessment methods can identify and diagnose POD to some extent, each method has its limitations. The development and validation of prediction models can help achieve early prediction of POD. This article reviews various assessment and prediction methods and intervention measures for postoperative delirium in elderly patients, providing a reference for the prevention and treatment of POD in elderly patients.

Keywords

Elderly Patients, Postoperative Delirium, Evaluation, Prediction, Intervention

Copyright © 2025 by author(s) and Hans Publishers Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

1. 引言

随着人口老龄化进程的加速,老年患者接受外科手术的比例显著增加。术后谵妄(Postoperative Delirium, POD)作为老年患者术后最常见的神经精神并发症之一,不仅会导致患者的住院时间延长,术后并发症和病死率增加,还会对患者的生活质量造成严重的影响,从而给社会和家庭带来严重的医疗和经济负担,成为围手术期管理中的重大挑战[1]。POD的发病机制尚不完全明确,各种评估手段在辅助诊断POD中发挥着重要作用,但同时都具有各自局限。近年来,预测模型的开发和验证在术后谵妄的早期预测方面展现出广泛前景,有助于早期识别高风险POD风险患者。本综述旨在系统梳理老年患者POD的流行病学特征、评估预测及干预措施的研究进展,以期优化老年患者围术期管理,降低POD的发生率。

2. POD的定义与老年患者流行病学特征

谵妄(Delirium)是一种由多种因素引起的急性脑功能障碍综合征,其核心特征是注意力不集中、意识水平的急性波动以及认知功能的紊乱。根据美国精神病学学会《精神障碍诊断与统计手册》第五版(DSM-5)的定义[2],谵妄的诊断需满足以下条件:①存在注意力不集中(如难以集中、维持或转移注意力);②意识水平的急性起病和波动性(通常在24小时内出现波动);③认知功能障碍(如记忆力减退、定向力障碍或语言障碍),这些症状不能用其他神经认知障碍(如痴呆)单独解释;④症状可归因于某种生理疾病、物质暴露或戒断(即由于滥用药物)或者是由于多种病因所致。POD通常是指在术后1~7d或出院前急性起病的谵妄,其发病率因患者人群、手术类型、谵妄评估工具等因素而异。有国外数据显示,POD的发病率从4%到53%不等[3],老年患者是POD发生的高危人群,Yan E [1]等的研究纳入20,988名年龄≥60岁的非心脏和非神经外科手术的老年患者,结果发现择期手术后和急诊手术后POD的发生率分别为19%和32%。Ho MH等人[4]纳入了19项研究,共计3533例术后年龄大于65岁的老年患者,结果显示老年患者POD的总的发生率为24%。非心脏手术、骨科手术和肿瘤手术的发生率估计值分别为23%、27%和19%。而心脏外科手术患者POD发生率为11.3%~54.9% [5]-[7],神经外科手术患者POD的发生率约为19% [8] [9]。我国的数据显示,心脏手术患者POD发生率为5.5%~46.0%,65岁以上非心脏手术患者POD发生率为6.1%~57.1%,总体发病率为11.1%,其中发病率较高的手术类型包括神经外科手术(57.1%)、上腹部手术(18.1%)、胸科手术(16.3%)、脊柱与关节手术(15.2%) [10]-[12]。

3. POD 的临床表现

目前 POD 根据临床表现可分为 3 个临床亚型[10][13]: ① 活动亢进型: 约占 25%, 表现为话语或运动增多, 躁动不安、容易激惹, 甚至出现攻击性行为, 是最容易被发现的一种类型; ② 活动抑制型: 约占 50%, 表现为语速和动作缓慢、嗜睡、神志淡漠以及互动减少等, 因临床症状不典型常常不易被察觉而被漏诊, 在 3 种类型中病死率最高; ③ 混合型: 约占 25%, 表现为以上两种谵妄的症状交替出现、反复波动。活动抑制型谵妄的临床识别率显著低于混合型或活动亢进型谵妄。其隐匿性症状常被误判为“安静型谵妄”, 老年患者可能更易罹患活动抑制型 POD, 且活动抑制型 POD 的预后可能更差, 可能是由于医护人员相对检测不足而延误治疗[14]。由于病因的不同可能造成 POD 的临床表现的不同, 比如, 酒精或其他药物戒断性谵妄、中毒性谵妄往往会呈现出活动亢进型, 而代谢性因素往往会导致活动抑制型谵妄[15]。此外有研究提出, 为基于潜在类别分析的统计方法在择期手术老年患者中识别出以认知症状为主的谵妄亚型可称为认知改变型, 患者主要表现为新出现的思维混乱、记忆障碍和定向障碍[16], 将认知症状纳入 POD 分类体系, 为更全面地理解谵妄提供了新的视角, 有助于更准确地诊断和识别不同类型谵妄患者。

4. POD 的评估

4.1. 神经心理学量表

神经心理学量表通常以 DSM-5 或《疾病和有关健康问题的国际统计分类》第十次修订本(International Statistical Classification of Diseases and Related Health Problems. Tenth Revision, ICD-10)中的相关标准为金标准进行诊断[10][17]; 但是由于该标准诊断较为复杂, 评估耗时且需由精神科专业医生实施未经专门训练的医师和护士不易掌握。目前主要应用于 POD 诊断的量表如下: 意识模糊评估量表(CAM)、ICU 患者意识模糊评估量表(CAM-ICU)、3 分钟谵妄诊断量表(3D-CAM)等[10]。其中 CAM 量表自 1990 年问世以来, 仍然是全球使用最广泛的谵妄工具, 其诊断效度经跨国验证已被转化为 19 种语言版本。其评估框架建立在四大核心诊断要素之上: 包括急性起病且症状呈波动性变化、注意力障碍、思维紊乱及意识状态改变, 具有高敏感性(94%~100%)、高特异性(90%~95%) [18][19]。CAM-ICU 作为经典 CAM 量表的临床改良版本, 针对重症患者特征优化设计了注意力评估模块, 其主要应用于机械通气及语言功能受限患者的谵妄评估, 是美国危重病医学会推荐的 ICU 筛查诊断 POD 的方法。其在早期识别重症监护病房住院的成年患者的谵妄中发挥作用, 且该量表评估对于排除谵妄最有用[20]。

3D-CAM 是 CAM 的一个简短评估, 它简化了 4 个 CAM 的特征评估并把它们放在 22 个评估项目中, 通过对患者询问问题和观察患者状态给出评估意见, 操作简单且耗时短, 其在住院患者中敏感度为 95%, 特异度为 94% [21], 其中文版本对中国手术患者具有较好的适用性和准确性[22]。

此外, 护理谵妄筛查量表(Nursing Delirium Screening Scale, Nu-DESC)、4 项谵妄快速诊断方案(The 4 A's Test, 4AT)等许多其他成熟的谵妄筛查工具也已得到了各种临床环境的验证, 并可用于 POD 的筛查和诊断[23]-[25]。由于每种量表的灵敏度和特异性测定可能因所使用的参考标准而异, 这些量表的准确性还需多中心、大样本临床试验进一步验证。同时量表评估可能受到患者配合度和评估者经验的影响, 存在一定的主观性。量表评估阳性也应结合进一步系统性检查和评估, 以获得更明确的 POD 诊断。未来简单易行、灵敏度特异度均较高、适用性强的诊断量表有待进一步开发。

4.2. 生物标志物

神经炎症学说表明, 手术和麻醉应激的免疫及炎症反应激活下丘脑 - 垂体 - 肾上腺轴(HPA 轴), 进

进一步增强神经炎症和缺血性损伤, 炎症因子破坏血脑屏障后引起脑内功能区发生炎性级联反应, 最终导致患者最终导致学习、记忆功能下降。目前研究的炎症标志物众多, 白细胞介素(Interleukin IL)-8、IL-10、肿瘤坏死因子- α (TNF- α)和 S-100 钙结合蛋白 β (S-100 β), 已被发现在谵妄危重患者中上调, 并且似乎与谵妄持续时间和严重程度增加以及死亡率升高相关[26]。术前和术后血浆 C 反应蛋白(C-Reactive Protein CRP)水平升高可预测接受择期大手术的老年患者术后谵妄的发生率、持续时间和严重程度[27] [28], IL-6 也在多项研究中被证实与 POD 高度相关[29]-[32]。

皮质醇作为手术应激的核心介质, 其水平异常也可能通过多重机制促进 POD 的发生, 高皮质醇浓度在阿尔茨海默病、痴呆和轻度认知失调患者中也普遍存在。过高的皮质醇可能损害富含糖皮质激素受体的海马体神经元, 影响记忆和认知功能, 另外其抗炎作用在过度应激下可能失效, 导致促炎因子释放, 加剧神经炎症[33] [34]。一项 meta 分析评估了术前血液中的众多炎症介质能否预测老年患者 POD 的发生, 结果显示术前血液中较高的 IL-6 可能与 POD 有关, 术前 CRP 升高可能与心脏手术后 POD 发生有关, 术前 IL-8、IL-10、TNF- α 和胰岛素样生长因子-1 (Insulin-Like Growth Factor IGF-1)水平与 POD 发生率之间缺乏相关性, 术前皮质醇水平与 POD 发生率无关。然而, 鉴于血液采样时间的多样性, 以及皮质醇水平的昼夜变化, 这一发现的准确性尚不清楚。有研究还指出炎症介质的术前血液水平与术后谵妄的相关性可能受手术类型和特定介质的影响[35]。

Müller 等[36]通过分析 650 例平均年龄 61.5 岁患者围术期外周血中乙酰胆碱酯酶(AChE)和丁酰胆碱酯酶(BuChE)的低活性与住院手术患者 POD 的发生有关, 脑脊液中的胆碱能生物标志物与 POD 的相关性也有研究报道, 围手术期 BuChE 活性测量可用作识别有 POD 风险患者的工具[37] [38]。

一些神经元损伤标志物如神经元特异性烯醇化酶、神经丝轻链蛋白(nfL)、tau 蛋白等可能是 POD 的潜在生物标志物[39]-[41], 它们的水平变化可以反映神经元损伤的程度。脑源性神经营养因子(BDNF)在神经元的生长、发育、存活、突触可塑性、学习记忆、神经保护、再生以及情绪调节等多个方面发挥着关键作用, 其血浆水平可能是 POD 的生物标志物之一[42]。此外一些代谢相关因素如载脂蛋白 E (APOE) ϵ 4 基因型、胰岛素生长因子-1 (IGF-1)等也有少量研究报道[43] [44]。

相较于量表评估, 生物标志物指标对 POD 的客观评价可能更具优势。但当前 POD 相关的生物标志物多处于发现阶段, 缺乏前瞻性、大规模、多中心研究验证其在不同人群、不同手术类型中的稳定性与预测力; 且多数研究为横断面设计, 缺乏动态监测数据; 同时一些生物标志物获取复杂、成本较高(如脑脊液)。未来需通过大规模验证研究确认其效能, 通过临床效用和成本效益分析证明其价值, 通过实施性研究确保其可用性, 并通过技术开发解决其临床可行性。

4.3. 脑电检测

脑电图(Electroencephalogram, EEG)作为一种无创性神经监测技术, 能够实时监测大脑的电活动, 提供关于大脑功能状态的直接信息, 在 POD 的研究中受到了越来越多的关注。研究发现, 全身麻醉期间的 EEG 爆发抑制与 POD 相关, 而全身麻醉维持期间 α 和 β 中频段功率的降低与爆发抑制的易感性相关, 术中 α 和 β 频段的功率降低可能是预测 POD 的脑电信号[45] [46]。Sumner 等[47] Ovid medline、Embase 和 Cochrane 等数据库进行检索, 纳入 9 项随机对照试验, 共 4648 例患者, 结果表明尽管脑电图引导下麻醉显示出降低 POD 发生率的潜力, 但由于研究设计的异质性和数据报告的不完整性, 目前尚不能得出明确的结论。未来需要进行更大规模、设计更严谨、高标准化实施的 RCT 研究。

4.4. 影像学

影像学技术的进步尤其 MRI 技术的发展为研究 POD 的发病机制和预测风险提供了重要的工具。扩

散张量成像(DTI)是一种 MRI 技术,可用于显示脑实质的微观结构完整性。研究发现,术前 DTI 异常与多种脑区的谵妄发生率和严重程度显著相关,尤其是小脑区域[48]。此外,一项针对肺癌手术患者的研究显示,POD 组患者的脑白质异常高信号(WMH)比例显著高于非 POD 组,术前 WMH 比例可能是 POD 的预测因素[49]。然而也有研究指出,在无痴呆的老年患者中,术前脑血流量、全脑萎缩程度、海马体积和 WMH 程度与 POD 的发生率和严重程度无关[50][51]。目前,用于评估 POD 的影像学证据相对有限,且相关临床研究仍显不足。此外,影像学检查在实际临床应用中面临诸多挑战,如操作复杂、成本高昂等,这些因素均在一定程度上制约了影像学技术在预测 POD 风险方面的应用。

5. POD 的预测

早期识别 POD 的高风险患者对于改善预后和优化围术期管理至关重要。近年来,研究者们开发了多种 POD 预测模型,旨在通过整合临床、神经影像学、生物标志物等多维度数据,提高对 POD 风险的预测能力。预测模型的发展历程经历了从传统统计方法如常见 Logistic 模型和 Cox 模型估计某一事件的发生概率到现代机器学习、深度学习的变革。由于老年患者 POD 好发于心脏及骨科手术患者,已有很多研究探索开发和验证心脏手术及骨科术后 POD 的预测模型[5][52]-[55]。Oberai [52]等通过建立 Logistic 回归模型确定了包含 7 个预测指标(年龄超过 80 岁、男性、未进行术前认知评估、术前认知状态受损、既往认知功能障碍、未及时手术、术后首日无法下地活动)的髋部手术 POD 临床预测模型。

de la Varga-Martínez [54]等基于四个术前危险因素(年龄超过 65 岁、简易精神状态检查(MMSE)评分 25~26 分或<25 分、需要药物治疗的失眠和体力活动少)建立预测模型可以在术前预测接受心脏手术的患者发生术后谵妄的风险。一项系统性综述纳入 13 项研究含 10 个心脏手术 POD 的预测模型,结果发现现有模型虽有一定预测能力,但普遍存在高偏倚风险,适用性局限[5]。

Zhang 等[56]研究于 2018 年 1 月至 2021 年 10 月对 663 名接受退行性脊柱疾病手术的患者进行了 POD 评估,通过 LASSO 模型确定出 12 个关键变量(年龄、血清白蛋白、入院到手术时间间隔、CRP 水平、高血压、术中出血量、术中最低血压、心脑血管疾病、吸烟、饮酒、肺部疾病以及入院到术中最大血压差)的脊柱手术 POD 的九种机器学习模型,且其中 XGBOOST (eXtreme Gradient Boosting)算法模型在训练集和验证集中均表现出最佳的预测。通过整合年龄、ASA 分级等常规变量首个经欧盟医疗器械认证的适用于非心脏非颅内手术广泛人群的 POD 术前风险评估预测模型已被开发和验证,其预测指标易于获取,模型简单,网页版提供实时风险评估,可有效识别老年高危 POD 患者并指导针对性干预[57]。

POD 预测模型在精准识别高危患者方面展现出潜力,但需克服方法学局限性和临床验证不足的挑战。未来的研究可通过对预测对象、预测指标的不断细化,并对预测模型进行反复验证,筛选出准确性较高的预测指标,从而进一步建立个体化预测模型实现精准预测。同时应强化实施性研究,推动模型从科研向临床实践转化助力临床决策。

6. 老年患者 POD 的干预措施

目前 POD 的干预措施大致可分为药物干预及多模式非药物干预两大类。多组分非药物方法的一级预防已被证明是老年患者谵妄预防的最有效策略且具有成本效益[58][59]。在充分评估老年患者围术期的易感因素和诱发因素的基础上,积极融入志愿者与家庭成员协助,由包括内科、外科、麻醉科、老年病科及护理等组成的多学科团队为谵妄高危老年手术患者提供实施综合性非药物干预措施明显有助于减少 POD 的发生率、持续时间和严重程度[60]。住院老人生活计划(Hospital Elder Life Program, HELP)管理模式是最早成功实现减少 POD 发生并改善老年患者远期预后的多学科项目[10]。其具体包括以下几个核心部分:① 认知刺激:通过每日定向沟通(如告知时间、地点、事件)及每日三次的治疗性活动(如交谈、游

戏、阅读), 对抗认知障碍与感觉剥夺; ② 睡眠优化: 实施非药物睡眠促进方案, 包括睡前提供温饮、放松措施(如背部按摩、音乐)以及病区层面的噪声控制与流程调整, 以确保睡眠周期不受干扰; ③ 早期与持续活动: 规定每日三次的早期活动计划, 包括协助患者下床活动或进行主动关节运动, 旨在减少因制动引发的并发症; ④ 感官缺陷代偿: 对于听力或视力减退患者, 使用助听器或眼镜等辅助设备改善视听障碍; ⑤ 生理稳态维持: 保持良好营养状态、维持水电解质平衡、充分管理疼痛、避免不必要约束及插管等[61]。Wang 等[62]的研究开展了家庭成员参与为核心的 HELP 方案, 明显降低了 POD 的发生率并有望提高 HELP 方案实施的普遍性。此外, 对新入院的老年患者基于老年综合评估(Comprehensive Geriatric Assessment, CGA)的通过多维度评估与多学科协作, 为识别老年患者脆弱性、制定以老年患者为中心的个体化综合护理计划奠定基础。在围术期, 将 CGA 整合入常规流程, 是实现 POD 预防的有效策略之一[10]。

药物干预包括右美托咪定、抗精神病药物、胆碱酯酶抑制剂、褪黑素、中药注射液等。有研究发现围术期右美托咪定输注可降低成人心脏和非心脏手术患者的 POD 发生率[63], 但 Momeni 等[64]的研究发现基于丙泊酚的镇静方案中加入低剂量右美托咪定不会降低接受心脏手术的老年患者 POD 风险。右美托咪定可能在某些研究中具有明显的积极作用, 但由于其心动过缓与低血压风险、研究人群的不同选择以及治疗效果的异质性, 并没有足够的证据支持使用右美托咪定预防 POD [65]。对于抗精神病药物, 一项荟萃分析发现与安慰剂比较, 口服利培酮、口服奥氮平、静脉内或肌肉内注射氟哌啶醇等并未降低 POD 的发生率, 同时预防性使用抗精神病药物可能增加包括镇静、直立性低血压、锥体外系症状的风险[66]。围术期应用褪黑素或褪黑激素受体激动剂可能对于预防接受手术的老年人 POD 的发生有潜在益处[67], 但目前相关研究较少。总之, 目前尚无确切证据支持使用某种药物来预防术后谵妄。当 POD 发生时, 应立即判断和处理可能导致谵妄的潜在诱因, 在强化多组分非药物干预的基础上, 若出现严重症状, 可以谨慎使用低剂量抗精神病药如氟哌啶醇进行短期干预, 在监护条件下, 可考虑使用右美托咪定作为辅助, 只有对于酒精或苯二氮草类药物戒断所直接导致的谵妄, 可考虑应用苯二氮类药物[65]。

7. 小结

术后谵妄是老年患者常见的术后并发症, 综合运用传统神经心理学量表、生物标志物、脑电监测、影像学等手段有助于识别高危患者, 基于多种风险因素建立的预测模型有望实现精准预测, 但未来仍需进一步开发和验证。由多学科团队参与实施的综合非药物干预措施是未来 POD 预防的研究方向。

参考文献

- [1] Yan, E., Veitch, M., Saripella, A., Alhamdah, Y., Butris, N., Tang-Wai, D.F., *et al.* (2023) Association between Postoperative Delirium and Adverse Outcomes in Older Surgical Patients: A Systematic Review and Meta-Analysis. *Journal of Clinical Anesthesia*, **90**, Article 111221. <https://doi.org/10.1016/j.jclinane.2023.111221>
- [2] Sachdev, P.S., Blacker, D., Blazer, D.G., Ganguli, M., Jeste, D.V., Paulsen, J.S., *et al.* (2014) Classifying Neurocognitive Disorders: The DSM-5 Approach. *Nature Reviews Neurology*, **10**, 634-642. <https://doi.org/10.1038/nrneuro.2014.181>
- [3] Igwe, E.O., Nealon, J., O'Shaughnessy, P., Bowden, A., Chang, H., Ho, M., *et al.* (2023) Incidence of Postoperative Delirium in Older Adults Undergoing Surgical Procedures: A Systematic Literature Review and Meta-Analysis. *Worldviews on Evidence-Based Nursing*, **20**, 220-237. <https://doi.org/10.1111/wvn.12649>
- [4] Ho, M., Nealon, J., Igwe, E., Traynor, V., Chang, H., Chen, K., *et al.* (2021) Postoperative Delirium in Older Patients: A Systematic Review and Incidence of Postoperative Delirium. *Worldviews on Evidence-Based Nursing*, **18**, 290-301. <https://doi.org/10.1111/wvn.12536>
- [5] Cai, S., Li, J., Gao, J., Pan, W. and Zhang, Y. (2022) Prediction Models for Postoperative Delirium after Cardiac Surgery: Systematic Review and Critical Appraisal. *International Journal of Nursing Studies*, **136**, Article 104340. <https://doi.org/10.1016/j.ijnurstu.2022.104340>
- [6] Smulter, N., Lingehall, H.C., Gustafson, Y., Olofsson, B. and Engström, K.G. (2013) Delirium after Cardiac Surgery: Incidence and Risk Factors. *Interactive CardioVascular and Thoracic Surgery*, **17**, 790-796. <https://doi.org/10.1093/icvts/ivt323>

- [7] Kotfis, K., Szylińska, A., Listewnik, M., Strzelbicka, M., Brykczynski, M., Rotter, I., *et al.* (2018) Early Delirium after Cardiac Surgery: An Analysis of Incidence and Risk Factors in Elderly (≥ 65 Years) and Very Elderly (≥ 80 Years) Patients. *Clinical Interventions in Aging*, **13**, 1061-1070. <https://doi.org/10.2147/cia.s166909>
- [8] Kappen, P.R., Kappen, H.J., Dirven, C.M.F., Klimek, M., Jeekel, J., Andrinopoulou, E.R., *et al.* (2023) Postoperative Delirium after Intracranial Surgery: A Retrospective Cohort Study. *World Neurosurgery*, **172**, e212-e219. <https://doi.org/10.1016/j.wneu.2022.12.132>
- [9] Chakrabarti, D., Bharadwaj, S., Akash, V.S., Wadhwa, A., Konar, S., Kamath, S., *et al.* (2023) Postoperative Delirium after Intracranial Neurosurgery: A Prospective Cohort Study from a Developing Nation. *Acta Neurochirurgica*, **165**, 1473-1482. <https://doi.org/10.1007/s00701-023-05610-w>
- [10] 中国老年医学学会麻醉学分会. 中国老年患者术后谵妄防治专家共识[J]. 国际麻醉学与复苏杂志, 2023, 44(1): 1-27.
- [11] Shi, Q., Mu, X., Zhang, C., Wang, S., Hong, L. and Chen, X. (2019) Risk Factors for Postoperative Delirium in Type a Aortic Dissection Patients: A Retrospective Study. *Medical Science Monitor*, **25**, 3692-3699. <https://doi.org/10.12659/msm.913774>
- [12] 洪亮, 孙加奎, 沈晓, 等. 心脏手术后谵妄的危险因素分析及预测模型构建[J]. 临床麻醉学杂志, 2020, 36(12): 1195-1200.
- [13] Robinson, T.N. (2011) Motor Subtypes of Postoperative Delirium in Older Adults. *Archives of Surgery*, **146**, 295-300. <https://doi.org/10.1001/archsurg.2011.14>
- [14] Oh, S. and Park, J.Y. (2019) Postoperative Delirium. *Korean Journal of Anesthesiology*, **72**, 4-12. <https://doi.org/10.4097/kja.d.18.00073.1>
- [15] 周宇, 裘毅敏. 术后谵妄的研究进展[J]. 国际麻醉学与复苏杂志, 2017, 38(5): 474-480.
- [16] Yang, L., Do, Q., Zhu, X., Leung, J.M. and Sands, L.P. (2024) Assessing Patterns of Delirium Symptoms Reveals a Novel Subtype among Elective Surgical Patients with Postoperative Delirium. *International Journal of Geriatric Psychiatry*, **39**, e6049. <https://doi.org/10.1002/gps.6049>
- [17] Battle, E.D. (2014) Diagnostic and Statistical Manual of Mental Disorders (DSM). *Codas*, **25**, 191-192.
- [18] Wei, L.A., Fearing, M.A., Sternberg, E.J. and Inouye, S.K. (2008) The Confusion Assessment Method: A Systematic Review of Current Usage. *Journal of the American Geriatrics Society*, **56**, 823-830. <https://doi.org/10.1111/j.1532-5415.2008.01674.x>
- [19] Oh, E.S., Fong, T.G., Hsieh, T.T. and Inouye, S.K. (2017) Delirium in Older Persons: Advances in Diagnosis and Treatment. *JAMA*, **318**, 1161-1174. <https://doi.org/10.1001/jama.2017.12067>
- [20] Miranda, F., Gonzalez, F., Plana, M.N., Zamora, J., Quinn, T.J. and Seron, P. (2023) Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) for the Diagnosis of Delirium in Adults in Critical Care Settings. *Cochrane Database of Systematic Reviews*, No. 11, CD013126. <https://doi.org/10.1002/14651858.cd013126.pub2>
- [21] Marcantonio, E.R., Ngo, L.H., O'Connor, M., Jones, R.N., Crane, P.K., Metzger, E.D., *et al.* (2014) 3D-CAM: Derivation and Validation of a 3-Minute Diagnostic Interview for Cam-Defined Delirium. *Annals of Internal Medicine*, **161**, 554-561. <https://doi.org/10.7326/m14-0865>
- [22] Mu, D., Ding, P., Zhou, S., Liu, M., Sun, X., Li, X., *et al.* (2020) Cross-Cultural Adaptation and Validation of the 3D-CAM Chinese Version in Surgical ICU Patients. *BMC Psychiatry*, **20**, Article No. 133. <https://doi.org/10.1186/s12888-020-02544-w>
- [23] Kim, S., Choi, E., Jung, Y. and Jang, I. (2023) Postoperative Delirium Screening Tools for Post-Anaesthetic Adult Patients in Non-Intensive Care Units: A Systematic Review and Meta-Analysis. *Journal of Clinical Nursing*, **32**, 1691-1704. <https://doi.org/10.1111/jocn.16157>
- [24] De, J. and Wand, A.P.F. (2015) Delirium Screening: A Systematic Review of Delirium Screening Tools in Hospitalized Patients. *The Gerontologist*, **55**, 1079-1099. <https://doi.org/10.1093/geront/gnv100>
- [25] Shenkin, S.D., Fox, C., Godfrey, M., Siddiqi, N., Goodacre, S., Young, J., *et al.* (2019) Delirium Detection in Older Acute Medical Inpatients: A Multicentre Prospective Comparative Diagnostic Test Accuracy Study of the 4AT and the Confusion Assessment Method. *BMC Medicine*, **17**, Article No. 138. <https://doi.org/10.1186/s12916-019-1367-9>
- [26] Khan, B.A., Perkins, A.J., Prasad, N.K., Shekhar, A., Campbell, N.L., Gao, S., *et al.* (2020) Biomarkers of Delirium Duration and Delirium Severity in the ICU. *Critical Care Medicine*, **48**, 353-361. <https://doi.org/10.1097/ccm.0000000000004139>
- [27] Dillon, S.T., Vasunilashorn, S.M., Ngo, L., Otu, H.H., Inouye, S.K., Jones, R.N., *et al.* (2017) Higher C-Reactive Protein Levels Predict Postoperative Delirium in Older Patients Undergoing Major Elective Surgery: A Longitudinal Nested Case-Control Study. *Biological Psychiatry*, **81**, 145-153. <https://doi.org/10.1016/j.biopsych.2016.03.2098>

- [28] Vasunilashorn, S.M., Dillon, S.T., Inouye, S.K., Ngo, L.H., Fong, T.G., Jones, R.N., *et al.* (2017) High C-Reactive Protein Predicts Delirium Incidence, Duration, and Feature Severity after Major Noncardiac Surgery. *Journal of the American Geriatrics Society*, **65**, e109-e116. <https://doi.org/10.1111/jgs.14913>
- [29] Alexander, S.A., Ren, D., Gunn, S.R., Kochanek, P.M., Tate, J., Ikonovic, M., *et al.* (2014) Interleukin 6 and Apolipoprotein E as Predictors of Acute Brain Dysfunction and Survival in Critical Care Patients. *American Journal of Critical Care*, **23**, 49-57. <https://doi.org/10.4037/ajcc2014578>
- [30] Chen, Y., Lu, S., Wu, Y., Shen, Y., Zhao, H., Ding, S., *et al.* (2019) Change in Serum Level of Interleukin 6 and Delirium after Coronary Artery Bypass Graft. *American Journal of Critical Care*, **28**, 462-470. <https://doi.org/10.4037/ajcc2019976>
- [31] Lv, X., Lin, Y., Wu, Q., Wang, L., Hou, Y., Dong, Y., *et al.* (2021) Plasma Interleukin-6 Is a Potential Predictive Biomarker for Postoperative Delirium among Acute Type a Aortic Dissection Patients Treated with Open Surgical Repair. *Journal of Cardiothoracic Surgery*, **16**, Article No. 146. <https://doi.org/10.1186/s13019-021-01529-4>
- [32] McKay, T.B., Khawaja, Z.Q., Freedman, I.G., Turco, I., Wiredu, K., Colecchi, T., *et al.* (2023) Exploring the Pathophysiology of Delirium: An Overview of Biomarker Studies, Animal Models, and Tissue-Engineered Models. *Anesthesia & Analgesia*, **137**, 1186-1197. <https://doi.org/10.1213/ane.0000000000006715>
- [33] Kazmierski, J., Banys, A., Latek, J., Bourke, J. and Jaszewski, R. (2013) Cortisol Levels and Neuropsychiatric Diagnosis as Markers of Postoperative Delirium: A Prospective Cohort Study. *Critical Care*, **17**, R38. <https://doi.org/10.1186/cc12548>
- [34] Zheng, G., Chen, X., Chen, L. and Luo, Z. (2022) Thyroid Hormone, Cortisol, Interleukin-2, and Procalcitonin Regulate Postoperative Delirium in Acute Type a Aortic Dissection Patients. *BMC Cardiovascular Disorders*, **22**, Article No. 503. <https://doi.org/10.1186/s12872-022-02962-6>
- [35] Noah, A.M., Almghairbi, D., Evley, R. and Moppett, I.K. (2021) Preoperative Inflammatory Mediators and Postoperative Delirium: Systematic Review and Meta-Analysis. *British Journal of Anaesthesia*, **127**, 424-434. <https://doi.org/10.1016/j.bja.2021.04.033>
- [36] Müller, A., Olbert, M., Heymann, A., Zahn, P.K., Plaschke, K., von Dossow, V., *et al.* (2019) Relevance of Peripheral Cholinesterase Activity on Postoperative Delirium in Adult Surgical Patients (CESARO). *European Journal of Anaesthesiology*, **36**, 114-122. <https://doi.org/10.1097/eja.0000000000000888>
- [37] Lin, X., Tang, J., Liu, C., Li, X., Cao, X., Wang, B., *et al.* (2020) Cerebrospinal Fluid Cholinergic Biomarkers Are Associated with Postoperative Delirium in Elderly Patients Undergoing Total Hip/Knee Replacement: A Prospective Cohort Study. *BMC Anesthesiology*, **20**, Article No. 246. <https://doi.org/10.1186/s12871-020-01166-9>
- [38] Gruendel, M.S., Brenneisen, W., Wollborn, J., Haaker, G., Meersch, M., Gurlit, S., *et al.* (2024) Perioperative Point-of-Care-Testing of Plasmacholinesterases Identifies Older Patients at Risk for Postoperative Delirium: An Observational Prospective Cohort Study. *BMC Geriatrics*, **24**, Article No. 136. <https://doi.org/10.1186/s12877-023-04627-1>
- [39] Casey, C.P., Lindroth, H., Mohanty, R., Farahbakhsh, Z., Ballweg, T., Twadell, S., *et al.* (2020) Postoperative Delirium Is Associated with Increased Plasma Neurofilament Light. *Brain*, **143**, 47-54. <https://doi.org/10.1093/brain/awz354>
- [40] Fong, T.G., Vasunilashorn, S.M., Ngo, L., Libermann, T.A., Dillon, S.T., Schmitt, E.M., *et al.* (2020) Association of Plasma Neurofilament Light with Postoperative Delirium. *Annals of Neurology*, **88**, 984-994. <https://doi.org/10.1002/ana.25889>
- [41] Ballweg, T., White, M., Parker, M., Casey, C., Bo, A., Farahbakhsh, Z., *et al.* (2021) Association between Plasma Tau and Postoperative Delirium Incidence and Severity: A Prospective Observational Study. *British Journal of Anaesthesia*, **126**, 458-466. <https://doi.org/10.1016/j.bja.2020.08.061>
- [42] Wyrobek, J., LaFlam, A., Max, L., Tian, J., Neufeld, K.J., Kebaish, K.M., *et al.* (2017) Association of Intraoperative Changes in Brain-Derived Neurotrophic Factor and Postoperative Delirium in Older Adults. *British Journal of Anaesthesia*, **119**, 324-332. <https://doi.org/10.1093/bja/aex103>
- [43] Vasunilashorn, S.M., Ngo, L.H., Inouye, S.K., Fong, T.G., Jones, R.N., Dillon, S.T., *et al.* (2020) Apolipoprotein E Genotype and the Association between C-Reactive Protein and Postoperative Delirium: Importance of Gene-Protein Interactions. *Alzheimer's & Dementia*, **16**, 572-580. <https://doi.org/10.1016/j.jalz.2019.09.080>
- [44] Yen, T.E., Allen, J.C., Rivelli, S.K., Patterson, S.C., Metcalf, M.R., Flink, B.J., *et al.* (2016) Association between Serum IGF-I Levels and Postoperative Delirium in Elderly Subjects Undergoing Elective Knee Arthroplasty. *Scientific Reports*, **6**, Article No. 20736. <https://doi.org/10.1038/srep20736>
- [45] Fritz, B.A., Kalarickal, P.L., Maybrier, H.R., Muench, M.R., Dearth, D., Chen, Y., *et al.* (2016) Intraoperative Electroencephalogram Suppression Predicts Postoperative Delirium. *Anesthesia & Analgesia*, **122**, 234-242. <https://doi.org/10.1213/ane.0000000000000989>
- [46] Plummer, G.S., Ibala, R., Hahm, E., An, J., Gitlin, J., Deng, H., *et al.* (2019) Electroencephalogram Dynamics during General Anesthesia Predict the Later Incidence and Duration of Burst-Suppression during Cardiopulmonary Bypass. *Clinical Neurophysiology*, **130**, 55-60. <https://doi.org/10.1016/j.clinph.2018.11.003>

- [47] Sumner, M., Deng, C., Evered, L., Frampton, C., Leslie, K., Short, T., *et al.* (2023) Processed Electroencephalography-Guided General Anaesthesia to Reduce Postoperative Delirium: A Systematic Review and Meta-Analysis. *British Journal of Anaesthesia*, **130**, e243-e253. <https://doi.org/10.1016/j.bja.2022.01.006>
- [48] Cavallari, M., Dai, W., Guttman, C.R.G., Meier, D.S., Ngo, L.H., Hsieh, T.T., *et al.* (2016) Neural Substrates of Vulnerability to Postsurgical Delirium as Revealed by Presurgical Diffusion MRI. *Brain*, **139**, 1282-1294. <https://doi.org/10.1093/brain/aww010>
- [49] Root, J.C., Pryor, K.O., Downey, R., Alici, Y., Davis, M.L., Holodny, A., *et al.* (2013) Association of Pre-Operative Brain Pathology with Post-Operative Delirium in a Cohort of Non-Small Cell Lung Cancer Patients Undergoing Surgical Resection. *Psycho-Oncology*, **22**, 2087-2094. <https://doi.org/10.1002/pon.3262>
- [50] Hsieh, T.T., Dai, W., Cavallari, M., Guttman, C.R., Meier, D.S., Schmitt, E.M., *et al.* (2017) Cerebral Blood Flow MRI in the Nondemented Elderly Is Not Predictive of Post-Operative Delirium but Is Correlated with Cognitive Performance. *Journal of Cerebral Blood Flow & Metabolism*, **37**, 1386-1397. <https://doi.org/10.1177/0271678x16656014>
- [51] Cavallari, M., Hsieh, T.T., Guttman, C.R.G., Ngo, L.H., Meier, D.S., Schmitt, E.M., *et al.* (2015) Brain Atrophy and White-Matter Hyperintensities Are Not Significantly Associated with Incidence and Severity of Postoperative Delirium in Older Persons without Dementia. *Neurobiology of Aging*, **36**, 2122-2129. <https://doi.org/10.1016/j.neurobiolaging.2015.02.024>
- [52] Oberai, T., Oosterhoff, J.H.F., Woodman, R., Doornberg, J.N., Kerkhoffs, G. and Jaarsma, R. (2021) Development of a Postoperative Delirium Risk Scoring Tool Using Data from the Australian and New Zealand Hip Fracture Registry: An Analysis of 6672 Patients 2017-2018. *Archives of Gerontology and Geriatrics*, **94**, Article 104368. <https://doi.org/10.1016/j.archger.2021.104368>
- [53] Wan, W., Li, L., Zou, Z. and Chen, W. (2025) Study on the Predictive Model of Delirium Risk after Surgery for Elderly Hip Fractures Based on Meta-Analysis. *European Geriatric Medicine*, **16**, 245-270. <https://doi.org/10.1007/s41999-024-01095-7>
- [54] de la Varga-Martínez, O., Gómez-Pesquera, E., Muñoz-Moreno, M.F., Marcos-Vidal, J.M., López-Gómez, A., Rodenas-Gómez, F., *et al.* (2021) Development and Validation of a Delirium Risk Prediction Preoperative Model for Cardiac Surgery Patients (DELIPRECA): An Observational Multicentre Study. *Journal of Clinical Anesthesia*, **69**, Article 110158. <https://doi.org/10.1016/j.jclinane.2020.110158>
- [55] Cai, S., Cui, H., Pan, W., Li, J., Lin, X. and Zhang, Y. (2022) Two-Stage Prediction Model for Postoperative Delirium in Patients in the Intensive Care Unit after Cardiac Surgery. *European Journal of Cardio-Thoracic Surgery*, **63**, eac573. <https://doi.org/10.1093/ejcts/ezac573>
- [56] Zhang, Y., Wan, D., Chen, M., Li, Y., Ying, H., Yao, G., *et al.* (2023) Automated Machine Learning-Based Model for the Prediction of Delirium in Patients after Surgery for Degenerative Spinal Disease. *CNS Neuroscience & Therapeutics*, **29**, 282-295. <https://doi.org/10.1111/cns.14002>
- [57] Dodsworth, B.T., Reeve, K., Falco, L., Hueting, T., Sadeghirad, B., Mbuagbaw, L., *et al.* (2023) Development and Validation of an International Preoperative Risk Assessment Model for Postoperative Delirium. *Age and Ageing*, **52**, afad086. <https://doi.org/10.1093/ageing/afad086>
- [58] Hsieh, T.T., Yue, J., Oh, E., Puelle, M., Dowal, S., Trivison, T., *et al.* (2015) Effectiveness of Multicomponent Non-pharmacological Delirium Interventions. *JAMA Internal Medicine*, **175**, 512-520. <https://doi.org/10.1001/jamainternmed.2014.7779>
- [59] Siddiqi, N., Harrison, J.K., Clegg, A., Teale, E.A., Young, J., Taylor, J., *et al.* (2016) Interventions for Preventing Delirium in Hospitalised Non-ICU Patients. *Cochrane Database of Systematic Reviews*, No. 3, CD005563. <https://doi.org/10.1002/14651858.cd005563.pub3>
- [60] Janssen, T.L., Alberts, A.R., Hooft, L., Mattace-Raso, F.U.S., Mosk, C.A. and van der Laan, L. (2019) Prevention of Postoperative Delirium in Elderly Patients Planned for Elective Surgery: Systematic Review and Meta-Analysis. *Clinical Interventions in Aging*, **14**, 1095-1117. <https://doi.org/10.2147/cia.s201323>
- [61] Hsieh, T.T., Yang, T., Gartaganis, S.L., Yue, J. and Inouye, S.K. (2018) Hospital Elder Life Program: Systematic Review and Meta-Analysis of Effectiveness. *The American Journal of Geriatric Psychiatry*, **26**, 1015-1033. <https://doi.org/10.1016/j.jagp.2018.06.007>
- [62] Wang, Y., Yue, J., Xie, D., Carter, P., Li, Q., Gartaganis, S.L., *et al.* (2020) Effect of the Tailored, Family-Involved Hospital Elder Life Program on Postoperative Delirium and Function in Older Adults: A Randomized Clinical Trial. *JAMA Internal Medicine*, **180**, 17-25. <https://doi.org/10.1001/jamainternmed.2019.4446>
- [63] Pan, H., Liu, C., Ma, X., Xu, Y., Zhang, M. and Wang, Y. (2019) Perioperative Dexmedetomidine Reduces Delirium in Elderly Patients after Non-Cardiac Surgery: A Systematic Review and Meta-Analysis of Randomized-Controlled Trials. *Canadian Journal of Anesthesia/Journal canadien d'anesthésie*, **66**, 1489-1500. <https://doi.org/10.1007/s12630-019-01440-6>

-
- [64] Momeni, M., Khalifa, C., Lemaire, G., Watremez, C., Tircoveanu, R., Van Dyck, M., *et al.* (2021) Propofol Plus Low-Dose Dexmedetomidine Infusion and Postoperative Delirium in Older Patients Undergoing Cardiac Surgery. *British Journal of Anaesthesia*, **126**, 665-673. <https://doi.org/10.1016/j.bja.2020.10.041>
- [65] Aldecoa, C., Bettelli, G., Bilotta, F., *et al.* (2024) Update of the European Society of Anaesthesiology and Intensive Care Medicine Evidence-Based and Consensus-Based Guideline on Postoperative Delirium in Adult Patients. *European Journal of Anaesthesiology*, **41**, 81-108.
- [66] Neufeld, K.J., Yue, J., Robinson, T.N., Inouye, S.K. and Needham, D.M. (2016) Antipsychotic Medication for Prevention and Treatment of Delirium in Hospitalized Adults: A Systematic Review and Meta-Analysis. *Journal of the American Geriatrics Society*, **64**, 705-714. <https://doi.org/10.1111/jgs.14076>
- [67] Campbell, A.M., Axon, D.R., Martin, J.R., Slack, M.K., Mollon, L. and Lee, J.K. (2019) Melatonin for the Prevention of Postoperative Delirium in Older Adults: A Systematic Review and Meta-Analysis. *BMC Geriatrics*, **19**, Article No. 272. <https://doi.org/10.1186/s12877-019-1297-6>