

儿童哮喘专题

哮喘合并鼻炎儿童的呼出气一氧化氮的临床研究

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[摘要] **目的**·分析哮喘(asthma, AS)合并变应性鼻炎(allergic rhinitis, AR)儿童在AS不同临床分期下不同AR严重程度时的鼻呼出气一氧化氮(fractional concentration of nasally exhaled nitric oxide, F_nNO)、口呼出气一氧化氮(fractional concentration of exhaled nitric oxide, F_eNO)水平,为指导临床诊治提供依据。**方法**·纳入2021年4月至11月期间于苏州大学附属儿童医院呼吸科确诊为AS合并AR的儿童,选取同期至儿保科正常体检的健康儿童作为对照组。所有入组儿童均行F_eNO、F_nNO、外周血嗜酸细胞(eosinophil, EOS)检测,以评估患儿的病情严重程度。对比分析AS合并AR的儿童在AS不同临床分期下不同AR严重程度时的F_eNO、F_nNO水平及其与肺功能的相关性。**结果**·哮喘急性发作期儿童中鼻炎持续中重度的比例更高,哮喘临床缓解期儿童中的鼻炎间歇轻度比例更高。哮喘急性发作期的F_eNO值高于慢性持续期、临床缓解期(调整后 $P=0.022$ 、 $P=0.000$),慢性持续期高于临床缓解期(调整后 $P=0.002$);哮喘急性发作期F_nNO值高于临床缓解期(调整后 $P=0.044$)。哮喘慢性持续期中,鼻炎持续轻度组及持续中重度组的F_nNO水平高于间歇轻度组(调整后 $P=0.001$ 、 $P=0.000$)。在临床缓解期中,鼻炎持续轻度组及持续中重度组的F_nNO水平高于间歇轻度组(调整后 $P=0.001$ 、 $P=0.007$)。在鼻炎间歇轻度组中,急性发作期的F_nNO高于慢性持续期及临床缓解期(调整后 $P=0.010$ 、 $P=0.019$)。哮喘急性发作期的部分肺功能指标与F_eNO、F_nNO水平具有一定负相关性(均 $P<0.05$),而慢性持续期的FEV₁/pred与F_eNO水平具有一定负相关性($P=0.010$)。**结论**·AS急性发作期儿童的F_eNO、F_nNO水平更高,且AR症状积分更高;AS合并AR儿童的F_eNO、F_nNO水平与肺功能指标呈负相关。

[关键词] 哮喘; 变应性鼻炎; 呼出气一氧化氮; 儿童**[DOI]** 10.3969/j.issn.1674-8115.2023.06.003 **[中图分类号]** R72 **[文献标志码]** A

Clinical study of exhaled nitric oxide in children with asthma and allergic rhinitis

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[Abstract] **Objective**·To determine the levels of nasally exhaled nitric oxide (F_nNO) combined with fractional concentration of exhaled nitric oxide (F_eNO) in children with asthma (AS) complicated with allergic rhinitis (AR), and analyze the levels of F_nNO and F_eNO in different clinical stages of AS with different severities of AR, so as to provide basis for guiding clinical diagnosis and treatment. **Methods**·Children diagnosed with AR with AS in the Department of Respiratory and Otolaryngology of Children's Hospital of Soochow University from April 2021 to November 2021 were included, and healthy children who visited the Department of Pediatrics for normal physical examination during the same period were enrolled as the control group. F_eNO and F_nNO were measured in all children to assess the severity of the children's diseases. The levels of F_eNO and F_nNO in children with AR and AS at different clinical stages of AS and their correlation with pulmonary function were compared and analyzed. **Results**·The proportion of persistent moderate-to-severe rhinitis was higher in the acute exacerbation stage of AS, and the proportion of intermittent mild rhinitis was higher in the clinical remission stage of AS. The F_eNO level in the acute exacerbation stage were higher than that in the chronic persistent stage and clinical remission stage of AS (adjusted $P=0.022$, $P=0.000$), and higher in the chronic persistent stage than that in the clinical remission stage of AS (adjusted $P=0.002$). The F_nNO level in the acute exacerbation stage was higher than that in the clinical remission stage of AS (adjusted $P=0.044$). In the chronic persistent stage of AS, the F_nNO

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levels in the persistent mild group and persistent moderate-to-severe control group were higher than those in the intermittent mild group (adjusted $P=0.001$, 0.000). In the clinical remission stage of AS, the F_nNO levels in the persistent mild group and persistent moderate to severe control group were higher than those in the intermittent mild group (adjusted $P=0.001$, 0.007). In the intermittent mild group of AR, the F_nNO levels in the acute exacerbation stage were higher than those in the chronic persistent stage and clinical remission stage of AS (adjusted $P=0.010$, 0.019). Part of pulmonary functions in the acute exacerbation stage of AS children were negatively correlated with the FeNO and F_nNO levels (all $P<0.05$), while FEV₁/pred in the chronic persistent stage was negatively correlated with FeNO level ($P=0.010$). **Conclusion**·FeNO and F_nNO levels increased in the acute exacerbation stage of AS, and symptom scores of AR also increased. FeNO and F_nNO levels were negatively correlated with pulmonary function in AS with AR children.

[Key words] asthma (AS); allergic rhinitis (AR); exhaled nitric oxide; children

哮喘 (asthma, AS) 和变应性鼻炎 (allergic rhinitis, AR) 均系辅助型 T 细胞 2 (T helper2 cell, Th2) 介导的气道炎症。上、下气道目前被认为是一个整体, 需同时评估。多达 19%~38% 的 AR 患者伴有 AS, 30%~80% 的 AS 患者患有 AR^[1-2]。有学者^[3]提出, AS 症状恶化可能与 AR 症状控制不佳有关, AR 可增加 2~7 倍 AS 发生的可能, 上气道的持续炎症可增加下气道的高反应性, 进而导致 AS 症状的加重。过敏原对鼻黏膜的刺激会导致鼻塞、黏膜水肿、鼻甲肥大, 从而降低鼻腔的呼吸和过滤功能, 导致支气管炎和下呼吸道阻塞。研究^[3]表明, 主动治疗 AR 可减轻 AS 症状、支气管高反应性, 并减少 AS 药物治疗的需要。目前国内相关研究甚少, 本研究拟分析不同 AS 临床分期下不同 AR 严重程度时的鼻呼出气一氧化氮 (fractional concentration of nasally exhaled nitric oxide, F_nNO)、口呼出气一氧化氮 (fractional concentration of exhaled nitric oxide, FeNO) 水平及其与肺功能的相关性, 以期为指导临床诊治提供依据。

1 对象与方法

1.1 研究对象

选取 2021 年 4 月至 11 月期间于苏州大学附属儿童医院呼吸科诊断为 AS 合并 AR 的 99 例儿童。纳入标准: 经呼吸科医师诊断的 AS、AR, 符合《儿童支气管哮喘规范化诊治建议 (2020 年版)》^[4] 及《儿童变应性鼻炎诊断和治疗的专家共识 (2010 年, 重庆)》^[5]。排除标准: 排除存在闭塞性细支气管炎、原发性纤毛不动综合征、囊性纤维化、变应性肺曲霉病等疾病。患儿按 AS 临床分期^[4] 进行分组, 其中急性发作期 33 例, 慢性持续期 32 例, 临床缓解期 34 例。对照组均为同期至儿保科体检的健康儿童, 排除变应性疾病。

1.2 研究方法

1.2.1 肺功能检测 采用德国 Jaeger 公司的肺功能仪, 参考美国胸科学会^[6] 标准, 检测前结合患儿性别、年龄、身高等指标查对预计值, 指导患儿正确地进行吹气。连续测量 3 次, 取最高值作为检测结果。

1.2.2 FeNO、F_nNO 测定 采用瑞典 Aerocrine 公司的 FeNO 分析仪, 参考美国胸科学会^[6] 指南进行测定。受试者检测前 2 周内禁止服用糖皮质激素类药物, 检测前 1 h 内禁食、禁止剧烈运动或情绪过激等。采取坐位为测试体位。FeNO 有在线法和离线法 2 种测定方式, 2 种方式均要求呼气压力达到 5 cmH₂O (1 cmH₂O=0.098 kPa), 关闭软腭, 避免上气道影响。呼气流速为 50 mL/s, 保持±10% 的流速范围。在线法要求一口气呼气完成, 时间不少于 6 s (>12 岁, 成人模式) 或至少 4 s (≤12 岁, 儿童模式)。离线法为多口气测定, 对呼气的时不作要求, 可多次呼气直至采样完成^[7]。3 岁及以上儿童如果不能配合在线法测定, 可采用离线法。F_nNO 测定根据 2019 年欧洲鼻科建议书^[8] 推荐, 研究显示在 0.7 L/min (1.7 mL/s) 流速下鼻抽气 10 s 的鼻 eNO 测定重复性更好, 因此国内鼻 eNO 测定多采用 10 mL/s 流速的抽气法, 即 F_nNO₁₀, 简称 F_nNO。且为避免下气道影响, 受试者在鼻抽气采样过程中需吹响口哨以保持口呼气压力>10 cmH₂O, 从而达到关闭软腭的效果, 期间口哨要保持吹响不换气。鼻抽气时应抽前清理鼻腔, 确保仪器抽气畅通, 避免鼻内分泌物、鼻翼等堵塞抽气孔。

1.3 病情严重程度评估

1.3.1 AS 临床分期 ①急性发作期 (acute exacerbation stage) 是指喘息、气急、胸闷或咳嗽等症状突然发生, 或原有症状加重, 伴有呼气流量降低。②慢性持续期 (chronic persistent stage) 是指近 3 个月内不同频度和/或不同程度地出现过喘息、咳嗽、气

促、胸闷等症状。③临床缓解期（clinical remission stage）是指经过治疗或未经治疗症状、体征消失，肺功能恢复到急性发作前水平，并维持3个月以上。

1.3.2 AR病情评估 ①分类。根据症状持续时间分为间歇性和持续性。间歇性：症状表现<4 d/周或持续不到4周。持续性：症状表现≥4 d/周且持续4周或以上^[5]。②病情分度。依据症状的严重程度和对生活质量的影响分为轻度和中/重度。轻度：症状较轻，对学习、文体活动和睡眠无明显影响。中/重度：症状明显，对学习、文体活动和睡眠造成影响^[5]。

1.4 统计学分析

采用SPSS 23.0软件进行数据分析。符合正态分布的定量资料以 $\bar{x}\pm s$ 表示，采用 t 检验及方差分析进

行组间比较；非正态分布的定量资料以 $M(Q_1, Q_3)$ 表示，采用非参数检验进行组间比较；定性资料以频数（百分率）表示，采用 χ^2 检验进行组间比较。变量间相关性分析采用Spearman相关性分析。 $P<0.05$ 表示差异具有统计学意义。

2 结果

2.1 基础资料对比

如表1所示，哮喘急性发作期、慢性持续期、临床缓解期的儿童在年龄、性别、身高、体质量方面的差异无统计学意义（均 $P>0.05$ ）。哮喘急性发作期儿童中鼻炎症状持续中重度的比例更高，临床缓解期儿童中鼻炎间歇轻度比例更高（ $P=0.047$ ）。

表1 基础资料对比

Tab 1 Comparison of basic information

Item	Acute exacerbation stage (n=33)	Chronic persistent stage (n=32)	Clinical remission stage (n=34)	H/ χ^2	P value
Age/year	7.48±2.43	8.31±3.48	6.50 (5.00, 9.00)	1.329	0.514
Gender (male/female)/n(%)	24 (72.7)/9 (27.3)	24 (75.0)/8 (25.0)	21 (61.8)/13 (38.2)	1.582	0.453
Height/cm	129.00 (115.00, 139.50)	134.16±20.34	125.00 (117.75, 134.88)	1.369	0.504
Weight/kg	26.00 (20.50, 32.00)	28.00 (19.25, 43.00)	24.50 (21.00, 30.50)	0.475	0.789
Different severity of rhinitis/n(%)				9.644	0.047
Intermittent mild	10 (30.3)	14 (43.8)	21 (61.8)		
Persistent mild	11 (33.3)	13 (40.6)	8 (23.5)		
Persistent moderate-to-severe	12 (36.4)	5 (15.6)	5 (14.7)		

2.2 哮喘不同分期儿童的EOS、FeNO、FnNO水平比较

如表2所示，急性发作期的FeNO值高于慢性持续期及临床缓解期（调整后 $P=0.022$ 、 $P=0.000$ ），慢

性持续期高于临床缓解期（调整后 $P=0.002$ ）。急性发作期FnNO水平高于临床缓解期（调整后 $P=0.044$ ），EOS比例及计数在慢性持续期较高，但差异无统计学意义（均 $P>0.05$ ）。

表2 哮喘不同分期儿童的EOS、FeNO、FnNO水平比较

Tab 2 Comparison of EOS, FeNO and FnNO among children in different stages of asthma

Item	Acute exacerbation stage (n=33)	Chronic persistent stage (n=32)	Clinical remission stage (n=34)	H/F	P value
EOS proportion/%	3.97±2.80	5.42±2.69	3.55 (2.13, 5.88)	5.437	0.066
EOS count/($\times 10^9 \cdot L^{-1}$)	3.40 (1.95, 5.45)	0.42±0.20	0.29 (0.19, 0.48)	1.916	0.384
FeNO/ppb	45.00 (31.50, 56.00) ^{①②}	27.00 (13.25, 45.75) ^③	12.50 (9.00, 17.25)	38.861	0.000
FnNO/ppb	664.03±244.13 ^④	573.22±261.69	516.29±224.41	3.128	0.048

Note: FeNO/FnNO is expressed in ppb (parts per billion; 1 ppb=1×10⁻⁹), which is equivalent to nanoliters per liter. ^①Adjusted $P=0.022$, compared with the chronic persistent stage; ^②adjusted $P=0.000$, ^③adjusted $P=0.002$, ^④adjusted $P=0.044$, compared with the clinical remission stage.

2.3 哮喘不同分期下不同鼻炎严重程度下的FnNO水平比较

如表3所示，在鼻炎间歇轻度组中，急性发作期的FnNO高于慢性持续期及临床缓解期（调整后 $P=0.010$ 、 $P=0.019$ ）；在哮喘慢性持续期中，持续轻度

组及持续中重度组的FnNO水平高于间歇轻度组（调整后 $P=0.001$ 、 $P=0.000$ ）；在哮喘临床缓解期中，持续轻度组及持续中重度组的FnNO水平高于间歇轻度组（调整后 $P=0.001$ 、 $P=0.007$ ）。

表3 哮喘不同分期下不同鼻炎严重程度的FnNO水平比较

Tab 3 Comparisons of FnNO in different severities of rhinitis among different stages of asthma

Item	Different severities of rhinitis			F value	P value
	Intermittent mild (n=45)	Persistent mild (n=32)	Persistent moderate-to-severe (n=22)		
Different stages of asthma					
Acute exacerbation stage (n=33)	596.70±211.16	614.27±243.68	765.75±255.02	1.725	0.195
Chronic persistent stage (n=32)	373.86±190.12 ^①	678.77±171.15 ^②	857.00±222.23 ^③	15.709	0.000
Clinical remission stage (n=34)	405.05±140.56 ^④	693.38±287.44 ^⑤	700.20±46.19 ^⑥	10.730	0.000
F value	5.510	0.347	0.643		
P value	0.008	0.710	0.537		

Note: FnNO is expressed in ppb (parts per billion; 1 ppb=1×10⁻⁹), which is equivalent to nanoliters per liter. ^①Adjusted *P*=0.010, compared with the acute exacerbation stage; ^②adjusted *P*=0.001, ^③adjusted *P*=0.000, compared with the intermittent mild group; ^④adjusted *P*=0.019, compared with the acute exacerbation stage; ^⑤adjusted *P*=0.001, ^⑥adjusted *P*=0.007, compared with the intermittent mild group.

2.4 哮喘不同分期儿童的肺功能指标与 FeNO/FnNO 的相关性分析

如表4所示,哮喘急性发作期的第1秒用力呼气容积占预计值百分比(forced expiratory volume in 1 s of the predicted, FEV₁/pred)、用力肺活量占预计值百分比(forced vital capacity of the predicted, FVC/pred)、呼气峰流速占预计值百分比(peak expiratory

flow of the predicted, PEF/pred)、用力呼气中期流速占预计值百分比(average expiratory flow rate at 25% to 75% of lung capacity of the predicted, MMEF_{75/25}/pred)与FeNO水平具有一定负相关性(*r*值分别为-0.393、-0.477、-0.367和-0.358, *P*值分别为0.024、0.005、0.036和0.041),慢性持续期的FEV₁/pred与FeNO水平具有一定负相关性(*r*=-0.451, *P*=0.010)。

表4 哮喘不同分期儿童的肺功能指标与 FeNO 的相关性分析

Tab 4 Correlation analysis between lung function indicators and FeNO in children with different stages of asthma

Item	Acute exacerbation stage		Chronic persistent stage		Clinical remission stage	
	<i>r</i> value	<i>P</i> value	<i>r</i> value	<i>P</i> value	<i>r</i> value	<i>P</i> value
FEV ₁ /pred/%	-0.393	0.024	-0.451	0.010	-0.321	0.064
FVC/pred/%	-0.477	0.005	-0.279	0.122	-0.184	0.298
FEV ₁ /FVC/pred/%	-0.015	0.936	-0.308	0.086	-0.324	0.061
PEF/pred/%	-0.367	0.036	-0.050	0.786	0.065	0.714
MEF ₇₅ /pred/%	-0.154	0.392	-0.197	0.279	-0.304	0.081
MEF ₅₀ /pred/%	-0.323	0.066	-0.329	0.066	-0.261	0.135
MEF ₂₅ /pred/%	-0.243	0.174	-0.320	0.074	-0.095	0.592
MMEF _{75/25} /pred/%	-0.358	0.041	-0.266	0.141	-0.248	0.158

Note: MEF₇₅—maximal expiratory flow without exhaling 75% FVC; MEF₅₀—maximal expiratory flow without exhaling 50% FVC; MEF₂₅—maximal expiratory flow without exhaling 25% FVC.

如表5所示,哮喘急性发作期的FEV₁/pred、FVC/pred、PEF/pred与FnNO水平具有一定负相关性(*r*值分别为-0.378、-0.422和-0.421, *P*值分别为

0.030、0.014和0.015),其余各项指标与FnNO水平均无相关性(均*P*>0.05)。

表5 哮喘不同分期儿童的肺功能指标与 FnNO 的相关性分析

Tab 5 Correlation analysis between lung function indicators and FnNO in children with different stages of asthma

Item	Acute exacerbation stage		Chronic persistent stage		Clinical remission stage	
	<i>r</i> value	<i>P</i> value	<i>r</i> value	<i>P</i> value	<i>r</i> value	<i>P</i> value
FEV ₁ /pred/%	-0.378	0.030	-0.291	0.107	-0.043	0.809
FVC/pred/%	-0.422	0.014	-0.01	0.957	0.073	0.682
FEV ₁ /FVC/pred/%	-0.063	0.729	-0.144	0.431	-0.149	0.402
PEF/pred/%	-0.421	0.015	-0.063	0.731	0.117	0.509
MEF ₇₅ /pred/%	-0.041	0.819	-0.208	0.254	-0.176	0.318
MEF ₅₀ /pred/%	-0.215	0.230	-0.096	0.602	-0.102	0.567
MEF ₂₅ /pred/%	-0.104	0.564	-0.064	0.729	-0.019	0.913
MMEF _{75/25} /pred/%	-0.194	0.278	-0.119	0.516	-0.058	0.747

3 讨论

近年来,多位学者^[9-11]均提出:AS和AR具有共同的免疫机制,均系Ⅱ型气道炎症;鼻炎控制不佳可加重哮喘症状,加大急性发作的风险,且产生的各种炎症因子促进诱导型一氧化氮合酶(inducible nitric oxide synthase, iNOS)表达增加,产生大量的NO。哮喘的诊疗不单单要治疗下气道,也应同时关注上气道炎症。

肺功能可一定程度上客观地反映哮喘控制情况,但在病情趋于稳定的持续期及缓解期,肺功能反映哮喘控制情况的价值有所下降。本研究发现慢性持续期的FeNO水平较临床缓解期升高,两者差异具有统计学意义(均 $P<0.05$);吴琳琳等^[12]及王婧婧^[13]的研究结果类似,即持续期儿童的FeNO水平均高于缓解期。故考虑在病情相对稳定的持续期及缓解期,当肺功能无明显差异时,FeNO测定较肺功能更加灵敏,更能反映疾病的控制情况。因此,在哮喘的长期管理中,定期行肺功能及FeNO测定对于评估哮喘严重程度、控制程度,优化治疗方案,确保达到治疗目标等具有重要作用;且在病情趋于稳定的持续期及缓解期,FeNO测定更具价值^[14]。

国外多项研究^[15-18]结果均表明FeNO水平与肺功能具有一定负相关性,即FeNO水平高的儿童FEV₁/FVC降低,且在难治性哮喘中两者相关性也较明显,FeNO水平可用于预测这部分患儿的肺功能。这与本研究结果具有一致性。本研究中急性发作期的FEV₁/pred、FVC/pred、PEF/pred、MMEF_{75/25}/pred与FeNO水平具有一定负相关性,慢性持续期的FEV₁/pred与FeNO水平具有一定负相关性,临床缓解期的肺功能各项指标则与FeNO水平无明显相关性。哮喘控制不佳患者嗜酸性炎症严重程度较高,肺功能损害更严重;FeNO水平越高,肺功能相关指标越低。但在临床症状基本消失的临床缓解期,气道嗜酸性炎症趋于平稳,肺功能趋于正常,进而FeNO水平与肺功能无明显相关性。尽管多项研究表明FeNO水平与肺功能具有明确的负相关性,但仍有较多学者^[19-21]研究结果显示FEV₁越低,FeNO水平则越低。这部分学者认为FeNO水平的高低主要由气道口径决定,只有当气道口径恢复正常时,FeNO水平才会上升。HACCURIA等^[22]在对哮喘患者进行激发试验后于不同时间进行FeNO及FEV₁测定,结果表明

FeNO水平随FEV₁下降而下降。故哮喘患者的FeNO水平与肺功能相关性仍具有较大争议,需进一步扩大样本量进行研究。

COMPALATI等^[1]的研究表明单纯AR患者的FEV₁等肺功能指标也可下降,高达80%患者可有气道高反应性,且中重度及持续性AR患者的气管受累更严重,更可能出现小气道功能障碍。还有多项研究^[23-25]均表明,哮喘患者联合使用鼻喷激素、抗组胺药等鼻炎用药可降低因哮喘病情加重至急诊就诊和住院的概率,特别是鼻喷激素的使用,可显著预防哮喘的恶化,而未将鼻炎治疗纳入哮喘的长期管理内容则不利于哮喘的临床控制。在本研究中的哮喘急性发作期患儿中,鼻炎临床症状持续中重度比例更高,FeNO、FnNO水平均较临床缓解期高,且FeNO、FnNO水平与部分肺功能指标呈负相关关系。考虑可能原因如下:①鼻-支气管反射,即鼻腔接触过敏原等刺激可导致支气管收缩、气道高反应性等。这种现象在动物试验中已经被证实,但它是否存在于人类呼吸道中仍存在争议^[26]。②上气道在呼吸时可起到过滤、加热、加湿等作用,上气道炎症发作或加重时,各项上气道功能均减弱。例如鼻塞会导致经口呼吸,直接吸入过敏原或者冷空气等可导致下呼吸稳态破坏,诱发下气道炎症产生或加重。③AR和AS具有共同的免疫机制,机体的致敏状态不单存在于某一方面,AR导致的全身炎症介质的释放可同样作用于下气道,引起哮喘症状的产生及加重^[27]。④即使当过敏程度较低时,仍有可能引发微弱的炎症反应,这种炎症反应可导致作为人类鼻病毒的主要受体细胞间黏附分子-1(intercellular cell adhesion molecule-1, ICAM-1)持续表达,而上气道鼻病毒感染常与儿童哮喘的发作有关^[28-29]。

故考虑到哮喘与鼻炎的临床控制具有一定相关性,对于哮喘合并鼻炎的患儿,在治疗其下气道的同时,需注意鼻炎的联合诊治,积极控制鼻炎的临床症状,尽量达到上、下气道最佳控制状态;而FeNO、FnNO的联合测定可减少哮喘急性发作的可能,降低急诊就诊及住院治疗的可能性,减轻儿童生活、学习压力和家庭经济负担。

利益冲突声明/Conflict of Interests

所有作者声明不存在利益冲突。

All authors disclose no relevant conflict of interests.

伦理批准和知情同意/Ethics Approval and Patient Consent

本研究符合苏州大学附属儿童医院医学伦理委员会所指定的伦理学标准并获得批准 (伦理审核编号: 2021CS100)。

This study meets the ethical standards specified by the Medical Ethics Committee of Children's Hospital of Soochow University and has been approved (ethical review number: 2021CS100).

作者贡献/Authors' Contributions

李鹏云、戴银芳、于兴梅参与了实验设计; 李鹏云、徐丽娜参与了数据收集和数据分析; 李鹏云、陆燕红、第五建峰、郝创利参

与了论文的写作和修改。所有作者均阅读并同意了最终稿件的提交。

The study was designed by LI Pengyun, DAI Yinfang and YU Xingmei. The data collection and analysis were conducted by LI Pengyun and XU Lina. The manuscript was drafted and revised by LI Pengyun, LU Yanhong, DI Wujianfeng and HAO Chuangli. All the authors have read the last version of paper and consented for submission.

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学术快讯

上海交通大学公共卫生学院宋海云、王慧等团队开发基于VB3代谢重编程的化学治疗耐药性肿瘤治疗新策略

2023年6月,上海交通大学公共卫生学院宋海云研究员、王慧教授、季晓媛副研究员和化学化工学院樊春海院士团队在 *Advanced Materials* 在线发表题目为 *Targeted reprogramming of vitamin B3 metabolism as a nanotherapeutic strategy towards chemoresistant cancers* 的研究论文。该研究利用肿瘤微环境响应性水凝胶递送平台装载双子纳米粒子,通过对肿瘤干细胞周围的壁龛基质肿瘤相关成纤维细胞的代谢重编程和表观遗传调控,阻断肿瘤干细胞干性维持因子和免疫抑制性细胞招募因子的分泌,诱导肿瘤干细胞分化和免疫激活,提高乳腺癌、肝癌、胰腺癌和结直肠癌在内的多种化学治疗耐药性肿瘤对一线化学治疗药物的响应性,有效抑制肿瘤生长并诱导长期免疫记忆。