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小儿脓毒症相关性脑病的大脑 MRI、EEG、 动脉血流表现及临床特征

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[摘要] 目的: 探讨小儿脓毒症相关性脑病(sepsis-associated encephalopathy, SAE)的大脑磁共振成像(magnetic resonance imaging, MRI)、脑电图(electroencephalogram, EEG)、动脉血流表现及临床特征。方法: 选取2016年1月至2020年3月于衡水市人民医院诊疗的396例脓毒症患儿为研究对象。根据检查结果, 将合并SAE的患儿作为SAE组($n=146$), 将无脑病脓毒症的患儿作为非SAE组($n=250$)。分析小儿SAE的临床特征、MRI影像学表现、EEG检测结果、大脑动脉血流参数及主要感染病原菌分布情况。结果: SAE组患儿发热时间、机械通气时间、住重症监护室(intensive care unit, ICU)时间均明显长于非SAE组患儿, 血乳酸及28 d病死率均高于非SAE组患儿, 小儿危重病评分(pediatric critical illness score, PCIS)低于非SAE组患儿, 差异均有统计学意义(均 $P<0.05$)。两组患儿MRI检测阳性率比较, 差异无统计学意义($P>0.05$)。SAE组EEG检测阳性率明显高于非SAE组患儿, 差异有统计学意义($P<0.05$)。SAE组患儿舒张末期流速(end-diastolic velocity, Vd)、平均流速(mean velocity, Vm)均明显低于非SAE组患儿, 搏动指数(pulsatility index, PI)、阻力指数(resistance index, RI)均明显高于非SAE组患儿, 差异均有统计学意义(均 $P<0.05$)。SAE组患儿革兰氏阳性菌感染率明显高于非SAE组患儿, 革兰氏阳性菌中金黄色葡萄球菌感染率明显高于非SAE组患儿, 差异有统计学意义($P<0.05$); 革兰氏阴性菌、真菌感染率比较, 差异均无统计学意义(均 $P>0.05$)。结论: SAE患儿有发热时间、机械通气时间、住ICU时间长及血乳酸水平高的特征, 但SAE患儿MRI表现无特异性, 需结合EEG、大脑动脉血流参数、感染菌群分布进行诊断和预后评估。

[关键词] 脓毒症; 脑病; 患儿; 临床特征; 功能学检查; 影像学表现

Cerebral MRI, EEG, artery blood findings, and clinical features of pediatric sepsis-associated encephalopathy

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Abstract Objective: To explore the clinical features, cerebral magnetic resonance imaging (MRI), electroencephalogram

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(EEG), and artery blood manifestations of sepsis-associated encephalopathy (SAE) in children. **Methods:** A total of 396 children with sepsis who were treated in Hengshui People's Hospital from January 2016 to March 2020 were selected as research subjects. According to the examination results, children with SAE were included in a SAE group ($n=146$), and children with sepsis without encephalopathy were included in a non-SAE group ($n=250$). The clinical features, MRI findings, EEG test results, cerebral artery blood flow parameters, and the distribution of main infectious pathogens in children with SAE were analyzed. **Results:** The fever time, mechanical ventilation time and intensive care unit (ICU) stay duration of the SAE group were significantly longer than those of the non-SAE group. The blood lactic acid and 28-day mortality of the SAE group were higher than those of the non-SAE group, and the pediatric critical illness score (PCIS) of the SAE group was lower than that of the non-SAE group (all $P<0.05$). The difference in the positive rate of MRI test between the 2 groups was not statistically significant ($P>0.05$). The positive rate of EEG test in the SAE group was significantly higher than that in the non-SAE group ($P<0.05$). The end-diastolic velocity (Vd) and mean velocity (Vm) of the SAE group were significantly lower than those of the non-SAE group, and the pulsatility index (PI) and resistance index (RI) of the SAE group were significantly higher than those of the non-SAE group (all $P<0.05$). The infection rate of Gram-positive bacteria in the SAE group was significantly higher than that in the non-SAE group, and the infection rate of *Staphylococcus aureus* among Gram-positive bacteria in the SAE group was significantly higher than that in the non-SAE group ($P<0.05$). There was no statistically significant difference in Gram-negative bacteria and fungal infection rate (all $P>0.05$). **Conclusion:** SAE children have the characteristics of fever time, mechanical ventilation time, long ICU stay, and high blood lactate level. However, the MRI manifestations of SAE children are not specific. It is necessary to combine EEG, cerebral artery blood flow parameters, and the distribution of infectious flora for diagnosis and prognosis.

Keywords sepsis; encephalopathy; children; clinical features; functional testing; imaging findings

脓毒症相关性脑病(sepsis-associated encephalopathy, SAE)是指由脓毒症引发的一种急性可逆性脑功能障碍,是脓毒症的严重并发症之一。近年来,脓毒症的发病率呈不断上升趋势,SAE也愈发常见^[1-2]。SAE在临床具有预后差、病死率高的特点,这与病情严重程度、自身机体功能差有关^[3]。此外,由于对SAE的认知不足,临床容易出现误诊、漏诊情况,进而影响了其后续治疗及预后转归^[4-5]。因此,提高临床医务工作者对SAE的临床特征、功能学及影像学表现方面的认知十分必要。鉴于此,本研究对396例脓毒症患儿进行分析,探讨SAE患儿的临床特征等,现报道如下。

1 对象与方法

1.1 对象

选取2016年1月至2020年3月于衡水市人民医院住院诊疗的396例脓毒症患儿为研究对象。纳入标准:1)符合脓毒症诊断标准^[6];2)存在发热等症状;3)临床资料保存完整;4)年龄<15岁。排除标准:1)合并低血压、低血糖;2)合并颅内

感染、中枢神经系统疾病;3)合并肝肾功能障碍;4)合并毒物、药物等引起的神经系统病变;5)转入重症监护室(intensive care unit, ICU)48 h内死亡。本研究由衡水市人民医院医学伦理委员会批准实施(审批号:2017-1-004)。根据检查结果,将合并SAE的患儿作为SAE组,将无脑病脓毒症的患儿作为非SAE组。SAE诊断标准:在确诊为脓毒症的基础上,有 ≥ 1 种不符合镇静程度的定向或意识障碍、人格改变、注意困难、癫痫发作、扑翼样震颤等异常表现,且经脑脊液、脑电图(electroencephalogram, EEG)检查确诊。SAE组共包括146例患儿,其中男77例,女69例;年龄2~13(5.14 ± 1.31)岁;原发病:肺炎16例、胰腺炎12例、腹膜炎11例、阑尾炎6例、泌尿系感染11例、细菌性痢疾4例。非SAE组共包括250例患儿,其中男131例,女119例;年龄1~12(5.41 ± 1.29)岁;原发病:肺炎27例、胰腺炎16例、腹膜炎15例、阑尾炎11例、泌尿系感染29例、细菌性痢疾10例。两组一般资料比较,差异均无统计学意义(均 $P>0.05$)。患儿家属对本次研究知情同意,并签署知情同意书。

1.2 方法

两组患儿入院后24 h内完成小儿危重病评分(pediatric critical illness score, PCIS), 进行血常规、血糖、血脂、电解质、血乳酸、血培养、C反应蛋白、肝肾功等检测, 记录患儿的临床表现、相关生命体征变化, 给予大脑磁共振成像(magnetic resonance imaging, MRI)影像学检测、EEG监测、头颅多普勒超声检查、病原学检查, 记录患儿的转归情况。

1.3 观察指标

1) 比较两组患儿的临床特征, 包括发热时间、血乳酸、平均动脉压(mean arterial pressure, MAP)、PCIS、机械通气时间、住ICU时间及28 d病死率。2) 比较两组患儿MRI影像学 and EEG检测结果。用Philips Achieva 3.0T磁共振扫描仪明确患儿MRI特征, 以患儿皮质及白质区、基底节区等部位有 ≥ 2 个异常信号改变或有脑沟加深、大脑皮质肿胀等表现为MRI检测阳性。用Natus Nicolet Monitor脑功能监测仪明确患儿EEG特征, 以患儿在受到疼痛或声音刺激时有过多的抑制或爆发抑制、三相波、 θ 波、 δ 波、癫痫持续状态或癫痫波发放为EEG检测阳性。3) 比较两组患儿大脑动脉血流参数。应用经颅多普勒超声检测大脑动脉血流参数。4) 比较两组患儿主要感染病原菌分布情况。采集患儿应用抗菌药之前的血液样本, 用全自动血液增菌培养仪(BATEC 9240, 美国BD)对血样进行48 h恒温(37 °C)病原菌培养, 分离菌种, 用全自动微生物鉴定系统(VITEK2-COMPACT, 法国梅里埃)进行菌种鉴定, 质控菌株来自中国疾病预防控制中心微生物实验室。

1.4 统计学处理

采用SPSS 19.0统计学软件进行数据分析。计

量资料采用均数 \pm 标准差($\bar{x}\pm s$)表示, 组间比较采用 t 检验; 计数资料比较采用 χ^2 检验或Fisher精确概率法。 $P<0.05$ 为差异有统计学意义。

2 结果

2.1 两组患儿临床特征比较

SAE组患儿发热时间、机械通气时间、住ICU时间均明显长于非SAE组患儿, 血乳酸及28 d病死率均高于非SAE组患儿, PCIS低于非SAE组患儿, 差异均有统计学意义(均 $P<0.05$); 两组患儿MAP比较, 差异无统计学意义($P>0.05$, 表1)。

2.2 两组患儿MRI影像学 and EEG检测情况比较

两组患儿MRI检测阳性率比较, 差异无统计学意义($P>0.05$); SAE组EEG检测阳性率明显高于非SAE组患儿, 差异有统计学意义($P<0.05$, 表2)。

2.3 两组患儿大脑动脉血流参数比较

两组患儿收缩峰流速(systolic peak velocity, V_s)比较, 差异无统计学意义($P>0.05$); SAE组患儿舒张末期流速(end-diastolic velocity, V_d)、平均流速(mean velocity, V_m)均明显低于非SAE组患儿, SAE组患儿搏动指数(pulsatility index, PI)、阻力指数(resistance index, RI)均明显高于非SAE组患儿, 差异均有统计学意义(均 $P<0.05$, 表3)。

2.4 两组患儿主要感染病原菌分布情况比较

SAE组患儿革兰氏阳性菌感染率明显高于非SAE组患儿, 革兰氏阳性菌中金黄色葡萄球菌感染率明显高于非SAE组患儿, 差异有统计学意义($P<0.05$); 革兰氏阴性菌、真菌感染率比较, 差异均无统计学意义(均 $P>0.05$, 表4)。

表1 两组患儿临床特征比较

Table 1 Comparison of clinical features between the 2 groups

| 组别 | <i>n</i> | 发热时间/d | 血乳酸/(mmol·L ⁻¹) | MAP/mmHg | PCIS/分 | 机械通气时间/d | 住ICU时间/d | 28 d病死/[例(%)] |
|------------|----------|-------------|-----------------------------|--------------|--------------|-------------|--------------|---------------|
| SAE组 | 146 | 3.71 ± 1.12 | 3.57 ± 1.04 | 79.38 ± 8.27 | 66.95 ± 6.14 | 7.83 ± 2.35 | 10.21 ± 3.07 | 39 (26.71) |
| 非SAE组 | 250 | 2.64 ± 0.89 | 2.01 ± 0.65 | 77.92 ± 8.31 | 83.26 ± 9.87 | 3.92 ± 1.12 | 8.42 ± 2.26 | 18 (7.20) |
| t/χ^2 | | 10.472 | 18.365 | 1.690 | 18.028 | 22.333 | 6.641 | 28.479 |
| <i>P</i> | | <0.001 | <0.001 | 0.092 | <0.001 | <0.001 | <0.001 | <0.001 |

1 mmHg=0.133 kPa.

表2 两组患儿MRI影像学 and EEG检测情况比较

Table 2 Comparison of MRI imaging and EEG detection in the 2 groups

| 组别 | <i>n</i> | MRI检测阳性/[例(%)] | EEG检测阳性/[例(%)] |
|----------|----------|----------------|----------------|
| SAE组 | 146 | 2 (1.37) | 105 (71.92) |
| 非SAE组 | 250 | 0 (0.00) | 0 (0.00) |
| χ^2 | | — | 244.668 |
| <i>P</i> | | 0.135* | <0.001 |

*Fisher精确概率法。

*Fisher exact probability method.

表3 两组患儿大脑动脉血流参数比较

Table 3 Comparison of cerebral artery blood flow parameters between the 2 groups

| 组别 | <i>n</i> | Vs/(cm·s ⁻¹) | Vd/(cm·s ⁻¹) | Vm/(cm·s ⁻¹) | PI/(cm·s ⁻¹) | RI/(cm·s ⁻¹) |
|----------|----------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| SAE组 | 146 | 93.89 ± 17.47 | 33.24 ± 9.85 | 52.89 ± 11.47 | 1.14 ± 0.25 | 0.66 ± 0.07 |
| 非SAE组 | 250 | 96.17 ± 16.53 | 44.02 ± 11.31 | 61.17 ± 13.53 | 0.89 ± 0.14 | 0.54 ± 0.05 |
| <i>t</i> | | 1.277 | 9.939 | 6.4788 | 11.108 | 18.181 |
| <i>P</i> | | 0.203 | <0.001 | <0.001 | <0.001 | <0.001 |

表4 两组患儿主要感染病原菌分布比较

Table 4 Comparison of the distribution of major pathogens between the 2 groups

| 感染病原菌 | 菌种 | SAE组(<i>n</i> =146) | 非SAE组(<i>n</i> =250) | χ^2 | <i>P</i> |
|-------------------|---------|----------------------|-----------------------|----------|----------|
| 革兰氏阳性菌/ [例(%)] | 金黄色葡萄球菌 | 42 (28.77) | 31 (12.40) | 16.421 | <0.001 |
| | 溶血性葡萄球菌 | 25 (17.12) | 26 (10.40) | 3.713 | 0.053 |
| | 粪肠球菌 | 11 (7.53) | 9 (3.60) | 2.975 | 0.084 |
| | 屎肠球菌 | 11 (7.53) | 8 (3.20) | 3.790 | 0.051 |
| 革兰氏阴性菌/ [例(%)] | 鲍氏不动杆菌 | 40 (27.39) | 51 (20.40) | 2.549 | 0.110 |
| | 绿脓杆菌 | 29 (19.86) | 36 (24.66) | 2.005 | 0.156 |
| | 大肠杆菌 | 13 (8.90) | 31 (12.40) | 1.140 | 0.285 |
| | 阴沟肠杆菌 | 12 (8.22) | 29 (11.60) | 1.135 | 0.286 |
| | 肺炎克雷伯杆菌 | 11 (7.53) | 25 (10.00) | 0.678 | 0.410 |
| 真菌/[例(%)] | 志贺杆菌 | 4 (2.74) | 10 (4.00) | 0.429 | 0.512 |
| | 念珠菌 | 16 (10.96) | 23 (9.20) | 0.321 | 0.570 |
| | 假丝酵母菌 | 10 (6.84) | 16 (6.40) | 0.030 | 0.861 |
| | 曲霉菌 | 7 (4.79) | 12 (4.80) | 0.000 | 0.998 |

3 讨论

SAE属于儿科重症监护病房的常见脑部疾病之一, 主要是由脓毒症引发。虽然SAE临床表现具有

多样化, 但在与其他脑部疾病的鉴别诊断中缺乏特异性, 加上机械通气、镇静药、肌松药的应用以及原有脑部疾病、代谢因素的影响, 漏诊、误诊率高^[7-9]。SAE属于可逆性脑损伤, 目前并无特效治疗

手段,主要通过早期给予针对性治疗措施进行弥补和扭转^[10-11]。因此,及时有效的诊断及预后评估对改善小儿SAE预后,降低病死率有重要意义。

SAE发病机制复杂,主要是受炎症介质的推动,引起颅内血流动力学变化、血脑屏障受损,继而引发脑水肿、中枢神经系统病变等^[12-13]。本研究调查显示:轻症SAE患儿早期主要表现包括注意力差、意识错乱、书写错误、定向力障碍等,中重症SAE患儿则会出现意识障碍、昏睡、昏迷等,部分患儿会出现肌病、多发性神经病,但几乎无颅神经异常,与既往研究^[14-15]一致。单凭SAE的临床体征难以与高胆酸血症、药物中毒、多器官衰竭等进行鉴别。但本研究将合并相关脑病的脓毒症患儿与无脑病脓毒症患儿的临床特征进行了鉴别诊断,结果显示:SAE患儿在发热时间、机械通气时间、住ICU时间均长于非SAE患儿,血乳酸及28 d病死率均高于非SAE患儿,PCIS低于非SAE患儿。由此得出,PCIS越低,脓毒症病情越重,出现SAE的可能性越高。而且,SAE患儿的病死率也显著高于非SAE患儿,与既往报道^[16]相近。乳酸值可反映细胞水平代谢情况,与多种脏器功能相关,其水平变化在SAE诊断和预后评估中有一定价值。MRI影像学也参与了检测,但其在SAE和非SAE鉴别诊断中的效果并不明显。SAE的发病与脑白质、海马有关,还累及脑皮质,因此有研究^[17]认为可通过EEG检测辅助诊断SAE。EEG检测分为5级,1级为正常,2级为 θ 波过多,3级为 δ 波过多,4级为三相波,5级为抑制或爆发抑制^[18]。本研究中,SAE患儿和非SAE患儿EEG检测结果显示:SAE患儿EEG检测阳性率明显高于非SAE患儿。由此可见,EEG诊断SAE敏感度较高,SAE的脑电波会随着病情恶化而逐渐升级,可用于SAE诊断和预后评估。

已有研究^[17]提出SAE发病过程中也会引起颅内血流动力学变化。经颅多普勒超声可对SAE患者颅内血流动力学进行评估。Vd反映血管远端阻力,Vd越高,则阻力越小。Vm能反映脑灌注是否充足,脑灌注不足会导致Vm水平降低。PI、RI同样是反映血管远端阻力的指标,当出现病理变化时,其也会发生相应改变,提示血流动力学变化。既往研究^[19]证实PI、RI参数越高表示脑灌注不足。本研究中,SAE患儿Vd、Vm均明显低于非SAE组患儿,SAE组患儿PI、RI均明显高于非SAE组患儿。由此认为,SAE患儿可能存在脑灌注不足的情况,一旦颅内发生脑灌注压不足,颅内血流动力学参数也会发生变化,可将其作为诊断SAE和

预后评估的参考指标。研究^[20]发现肠道菌群在多种脑部疾病的发生、发展中发挥重要作用。已有研究^[21]发现:无论是脓症患者还是SAE患者的主要感染病原菌均为革兰氏阳性菌、革兰氏阴性菌、真菌感染。本研究通过血培养发现,SAE患儿的革兰氏阳性菌感染率明显高于非SAE患儿,但其余菌种并无明显差异。SAE患儿革兰氏阳性菌感染率更高主要是因为金黄色葡萄球菌的感染比例高于非SAE患儿。由此提示,在临床中有必要进行血培养,通过明确病原菌的分布,尤其是金黄色葡萄球菌的感染比例来判断SAE,并给予对应的抗生素治疗。

综上所述,SAE患儿有发热时间、机械通气时间、住ICU时间长及血乳酸水平高的特征,但SAE患儿MRI影像学表现无特异性,需结合EEG、大脑动脉血流参数、感染菌群分布进行诊断和预后评估。但本研究仍存在一定局限性:其一,未将不同时期的SAE分成亚组,进一步分析其临床特征;其二,未收集中枢神经系统感染患儿资料,将其与SAE患儿进行对比分析。未来仍需前瞻性、大样本研究验证和完善结论。

参考文献

1. 毛明杰,张玲,杨建军,等.不同环境条件对脓毒症相关性脑病小鼠认知功能的影响[J].临床麻醉学杂志,2019,35(7):693-696.
MAO Mingjie, ZHANG Ling, YANG Jianjun, et al. Effects of different environmental conditions on cognitive function in mice with sepsis-associated encephalopathy[J]. Journal of Clinical Anesthesiology, 2019, 35(7): 693-696.
2. 刘蕾,纪木火,杨建军.脓毒症相关性脑病大鼠静息态神经网络功能改变[J].临床麻醉学杂志,2019,35(1):57-60.
LIU Qiang, JI Muhuo, YANG Jianjun. Abnormality of resting-state functional network in a rat animal model of sepsis-associated encephalopathy[J]. Journal of Clinical Anesthesiology, 2019, 35(1): 57-60.
3. Ehler J, Petzold A, Wittstock M, et al. Correction: The prognostic value of neurofilament levels in patients with sepsis-associated encephalopathy - a prospective, pilot observational study[J]. PLoS One, 2019, 14(2): e0212830.
4. Fujita M, Tsuruta R. Sepsis and sepsis-associated encephalopathy: its pathophysiology from bench to bed.//Kinoshita K. Neurocritical care[M]. Singapore: Springer, 2019: 175-186.
5. 成怡冰,王檬.脓毒症相关性脑病治疗进展[J].中华实用儿科临床杂志,2020,35(6):415-418.

- CHENG Yibing, WANG Meng. Progress in sepsis-associated encephalopathy therapy[J]. Chinese Journal of Applied Clinical Pediatrics, 2020, 35(6): 415-418.
6. 赵祥文. 儿科急诊医学[M]. 2版. 北京: 人民卫生出版社, 2001: 146-147.
- ZHAO Xiangwen. Pediatric emergency medicine[M]. 2nd ed. Beijing: People's Health Press, 2001: 146-147.
7. 李素彦, 张立涛, 徐鑫, 等. 粪菌移植对大鼠脓毒症相关性脑病的影响及机制[J]. 中国中西医结合急救杂志, 2019, 26(3): 278-283.
- LI Suyan, ZHANG Litao, XU Xin, et al. Impact and mechanisms of fecal microbiota transplantation on sepsis associated encephalopathy via intestinal microbiota[J]. Chinese Journal of Integrated Traditional and Western Medicine in Intensive and Critical Care, 2019, 26(3): 278-283.
8. 葛许华, 缪红军. 脓毒症相关性脑病的预后与康复[J]. 中华实用儿科临床杂志, 2020, 35(6): 419-421.
- GE Xuhua, LIAO Hongjun. Prognosis and rehabilitation of sepsis-associated encephalopathy[J]. Chinese Journal of Applied Clinical Pediatrics, 2020, 35(6): 419-421.
9. Ehler J, Petzold A, Sharshar T, et al. Biomarker panel to differentiate brain injury from brain dysfunction in patients with sepsis-associated encephalopathy[J]. Crit Care Med, 2020, 48(5): e436-e437.
10. Saxena A, Bhargava V, Shreya A, et al. Posterior reversible encephalopathy syndrome in a patient of sepsis-induced cardiomyopathy, successfully managed with intra-aortic balloon pump[J]. Indian J Crit Care Med, 2019, 23(4): 188-190.
11. 杨梅, 钱素云. 脓毒症相关性脑病的生物学标志物研究进展[J]. 中华实用儿科临床杂志, 2020, 35(6): 411-414.
- YANG Mei, QIAN Suyun. Research progress in biomarkers of sepsis-associated encephalopathy[J]. Chinese Journal of Applied Clinical Pediatrics, 2020, 35(6): 411-414.
12. 蓝欣, 肖书, 张家玮, 等. 脓毒症相关性脑病小鼠模型的建立及其认知功能障碍的初步研究[J]. 中国病理生理杂志, 2019, 35(5): 851-857.
- LAN Xin, XIAO Shu, ZHANG Jiawei, et al. Establishment of a mouse model of sepsis associated encephalopathy and preliminary research of cognitive dysfunction in this model[J]. Chinese Journal of Pathophysiology, 2019, 35(5): 851-857.
13. 古丽菲热·塔依尔, 王毅, 于湘友. 经颅多普勒超声在脓毒症相关性脑病中的应用[J]. 临床内科杂志, 2022, 39(2): 137-139.
- GULIFEIRE-Tayier, WANG Yi, YU Xiangyou. Application of transcranial Doppler ultrasound in sepsis-related encephalopathy[J]. Journal of Clinical Internal Medicine, 2022, 39(2): 137-139.
14. Rhalib SM, Sviridov SV, Vedenina IV, et al. The sepsis-induced encephalopathy[J]. Rossiiskii Meditsinskii Zhurnal, 2019, 24(2): 99-103.
15. Molnár L, Fülesdi B, Németh N, et al. Sepsis-associated encephalopathy: a review of literature[J]. Neurol India, 2018, 66(2): 352-361.
16. 艾美林, 黄立, 冯清, 等. 经颅多普勒超声在早期诊断脓毒症相关性脑病中的临床意义[J]. 中华内科杂志, 2019, 58(11): 814-818.
- AI Meilin, HUANG Li, FENG Qing, et al. The clinical significance of transcranial Doppler in early diagnosis of sepsis-associated encephalopathy[J]. Chinese Journal of Internal Medicine, 2019, 58(11): 814-818.
17. 魏锋, 洪志敏, 董海涛, 等. ICU重度脓毒症的流行病学特点及预后影响因素的分析[J]. 中华医院感染学杂志, 2018, 28(10): 1469-1471, 1484.
- WEI Feng, HONG Zhimin, DONG Haitao, et al. Epidemiological characteristics of severe sepsis in ICU and influencing factors for prognosis[J]. Chinese Journal of Nosocomiology, 2018, 28(10): 1469-1471, 1484.
18. Ehler J, Petzold A, Wittstock M, et al. The prognostic value of neurofilament levels in patients with sepsis-associated encephalopathy — a prospective, pilot observational study[J/OL]. PLoS One, 2019, 14(1): e0211184. (2019-02-20)[2022-10-15]. <https://doi.org/10.1371/journal.pone.0211184>
19. 宁永忠, 王辉. 病毒性脓毒症的流行病学和处置[J]. 中华医院感染学杂志, 2018, 28(10): 1446-1449.
- NING Yongzhong, WANG Hui. Epidemiology of viral sepsis and its treatment[J]. Chinese Journal of Nosocomiology, 2018, 28(10): 1446-1449.
20. 游懿君, 韩小龙, 郑晓皎, 等. 肠道菌群与大脑双向互动的研究进展[J]. 上海交通大学学报(医学版), 2017, 37(2): 253-257.
- YOU Yijun, HAN Xiaolong, ZHENG Xiaojiao, et al. Research progress of the bidirectional interaction between gut microbiota and brain[J]. Journal of Shanghai Jiaotong University. Medical Science, 2017, 37(2): 253-257.
21. 李素彦, 许宁, 花然亮, 等. 粪菌移植通过肠道菌群调节脓毒症大鼠脑皮层胆碱能抗炎通路[J]. 中华危重病急救医学, 2019, 31(9): 1102-1107.
- LI Suyan, XU Ning, HUA Ranliang, et al. Fecal microbiota transplantation regulates the cholinergic anti-inflammatory pathway in cerebral cortex of septic rats through intestinal microbiota[J]. Chinese Critical Care Medicine, 2019, 31(9): 1102-1107.

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