



Guidelines for the Prevention of Intravascular Catheter–Related Infections, 2011

2011血管内导管相关感染的预防指南

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目 录

致读者:	7
导言	7
建议摘要	7
教育、训练和人员配备	7
选择导管和穿刺部位	7
中心静脉导管	7
手卫生和无菌操作	8
最大化无菌屏障预防措施	8
皮肤消毒	8
穿刺部位敷料的应用	8
患者清洁	8
导管固定装置	8
含抗菌剂/杀菌剂的导管和套管	8
全身性预防应用抗生素	9
抗生素/消毒剂软膏	9
抗生素封管、抗菌液冲管和封管预防	9
抗凝剂	9
外周及中等长度导管的更换	9
CVC、PICC及血液透析导管的更换	9
脐带导管	9
成人和儿童患者的外周动脉导管和压力监测装置	9
输注装置的更换	9
无针连接系统	10
效果的提升	10
背景信息	10
术语和风险评估	10
成人和患儿的流行病学与微生物学	11
发病机理	11
成人和患儿导管相关感染的预防策略	11
教育、培训和人员配置	11
导管和穿刺部位的选择	11

外周和中等长度导管的建议 11

中心静脉导管相关建议 11

手卫生和无菌术 12

最大化无菌屏障预防措施..... 12

皮肤准备 13

置管部位敷料的应用 13

患者的清洁 14

含抗菌剂/杀菌剂的导管和套管..... 14

全身性预防应用抗生素 14

抗生素/消毒剂药膏..... 15

抗生素封管、抗菌导管冲洗和导管封管预防 15

抗凝剂..... 15

外周及中等长度导管的更换 16

CVC、PICC及血液透析导管的更换..... 16

脐带导管 17

成人和儿童患者的外周动脉导管和压力监测装置..... 17

输注装置的更换 18

无针连接系统..... 18

效果的提升 19

参考文献: 19

■ 致读者：

2009年，疾病控制和预防中心(CDC)以及医疗感染控制规范顾问委员会(HICPAC)将当前在指南形成和实施方面的进步整合进指南制定的过程当中

(<http://www.cdc.gov/hicpac/guidelineMethod/guidelineMethod.html>)。这种新的方法使CDC和HICPAC能够改善其指南的有效性和可用性，同时也体现出在感染预防和控制领域的指南制定中正逐渐形成的挑战。然而，血管内导管相关感染预防指南的制定在上述方法学上的改进之前就已经开始。因此，本指南采用与2009年以前开发的指南一样制定方法。未来的修订将采用更新后的方法进行。

此指南用于指导医疗工作者进行血管内置管，也适用于指导医院内、门诊及家庭医疗机构的感染监测及预防控制。本报告由如下专业组织的成员代表共同完成：危重症医学科、传染病、医疗相关感染控制科、外科、麻醉科、介入放射科、肺科、儿科以及护理。本工作组由危重症医学学会(SCCM)领导，并与以下单位共同协作：美国传染病协会(IDSA)，美国流行病学学会(SHEA)，外科感染学会(SIS)，美国胸科医师学院(ACCP)，美国胸椎协会(ATS)，美国危重症麻醉师协会(ASCCA)，感染控制与流行病专家协会(APIIC)，静脉输液护士协会(INS)，肿瘤护士学会(ONS)，美国肠外与肠内营养协会(ASPEN)，介入放射协会(SIR)，美国儿科研究院(AAP)，儿科传染病协会(PIDS)，疾病预防控制中心(CDC)医疗相关感染顾问委员会(HICPAC)。本指南旨在取代2002年发布的《血管内导管相关感染预防指南》，并为预防血管内导管相关感染提供询证性建议。其主要的关注领域包括：1) 教育和指导医疗工作者进行置管和维护，2) 中心静脉置管过程中应用最大化无菌屏障预防措施，3) 使用大于0.5%的洗必泰(氯己定)和酒精溶液进行皮肤消毒，4) 避免为了预防感染而常规性更换中心静脉导管，5) 如果坚持使用其他策略(例如教育和指导，最大化的无菌屏障预防措施，大于0.5%的洗必泰醇消毒皮肤)不能使感染率降低，则应用含消毒剂/抗生素的短期中心静脉导管和含有洗必泰的海绵敷料。这些策略同时还强调了提升表现，并通过执行一系列的策略，以及记录和报告该系列内策略的依从性为基准来确保质量和提升表现。

与CDC和HICPAC发布的前一个指南一样，每一个建议都是基于现存的科学数据、理论原理、适用性和经济影响来归类的。本指南中的建议是按如下系统来分类：

- I A，通过设计良好的实验性的、临床的、或流行病的研究，强烈建议执行和强烈支持。
- I B，通过一些实验的、临床的、或流行病的研究、以及较强的理论原理，强烈建议执行和支持；或由有限证据支持的公认惯例(例如无菌技术)。
- I C，州或联邦条例、法规或标准所要求。
- II，通过提示性的临床或流行病学研究或理论原理，建议执行。
- 未解决的问题，表示由于证据不足或尚未对其效果达成共识而未解决的问题。

■ 导言

在美国，重症监护病房(ICUs)的中心静脉置管(CVC)天数(例如，在特定的时间和人群内，中心静脉置管的总天数)为1500万个/每年。关于导管相关性血流感染(CRBSI)的研究也是多种多样。虽然这些感染增加了医疗成本，延长了住院时间，但并没有显示能够成为增加死亡率的独立因素。如果将全部医院都计算在内的话，当ICU的CRBSI发生率为8万例/年时，总的血流感染(BSI)发生率估计为25万例/年。经分析，血流感染相关的成本是巨大的，既影响发病

率同时也花费了资金。为了改善患者的预后并降低医疗开支，医务工作者、保险公司、监管机构和患者在致力于减少此类感染方面表现出浓厚的兴趣。相关的工作应该涉及多学科，包括开立医嘱进行CVC置管和拔管的医疗专业人员，置管和维护的人员，感染控制人员，医疗管理者包括首席执行官(CEO)和资源分配人员，以及可协助护理个人导管的病患。

有效预防策略的目标应为全面消除CRBSI，虽然是个挑战，但经验证具有可行性，并且需要持续的努力。本文所涉及的策略，其目标为尽可能降低特定人群的感染率，减少环境中的微生物，以及减少现行策略和技术的局限。

■ 建议摘要

※ 教育、训练和人员配备

1. 教育医护人员明确血管内导管的应用指征、置入和维护导管的正确操作、以及血管内导管相关感染的正确预防措施[7-15]。(IA类)
2. 对进行血管内导管置管和维护的全体人员进行定期的知识和依从性评估。[7-15]。(IA类)
3. 仅指定经过培训且有能力进行外周和中心血管内置管和维护的人员从事本操作。[14-28]。(IA类)
4. 确保重症ICU具有适当的护理人员水平。观察性研究表明，在护士对患者的CVC进行管理的ICU，较高比例的“非专科护士”或较高的病人/护士比与ICU的CRBSI相关[29-31]。(IB类)

※ 选择导管和穿刺部位

外周静脉导管和中心静脉导管

1. 对于成人，应该选择上部部位进行置管。应尽快用上肢部位取代位于下肢部位的置管。(II类)
2. 对儿科患者，可以使用上肢、下肢或者头皮(适用于新生儿和小婴儿)作为置管位置[32, 33]。(II类)
3. 根据置管目的和计划留置时间、已知的感染性和非感染性并发症(例如，静脉炎和静脉周围浸润)、以及操作者的个人经验来选择导管[33-35]。(IB类)
4. 避免使用钢针输液和给药，防止液体外渗时引起组织坏死[33, 34]。(IA类)
5. 当静脉输液有可能持续6天以上时，用中心静脉导管或者经外周置入的中心静脉导管(PICC)代替短外周静脉导管。(II类)
6. 对于使用透明敷料者，每天隔着敷料进行触诊判断是否有触痛，并用肉眼观察，评估置管部位情况。如果患者没有感染的临床指征，则不应拆除纱布和其他不透明敷料。如果患者出现局部触痛或者其他CRBSI的征象，应该拆除不透明敷料并观察置管部位。(II类)
7. 如果患者出现静脉炎征象(热、痛、红斑或者可扪及静脉线)、感染、或者导管发生故障时应拔掉外周静脉导管[36]。(IB类)

※ 中心静脉导管

1. 在推荐部位放置中心静脉导管时，相对于机械性并发症(例如，气胸，锁骨下动脉破裂、锁骨下静脉破损、锁骨下静脉狭窄、血胸、血栓、空气栓塞以及导管错位)，应权衡利弊从而减少感染性并发症[37-53]。(IA类)
2. 避免使用股静脉作为成人中心静脉通路[38, 50, 51, 54]。(IA类)
3. 应尽量选择锁骨下静脉作为穿刺部位而非颈静脉和股静脉，可

减少成人非隧道式的CVC感染风险[50–52]。(IB类)

- 对于减少隧道式中心静脉导管的感染风险，尚无明确的最佳穿刺部位的建议。(未明确事项)
- 对于血液透析患者和终末期肾病患者避免使用锁骨下静脉作为穿刺部位，以免发生锁骨下静脉狭窄[53，55–58]。(IA类)
- 对于慢性肾功能衰竭患者，使用动静脉造瘘或搭桥术替代CVC作为透析的永久通路[59]。(IA类)
- 可在超声引导下放置中心静脉导管(如果技术允许)，从而减少尝试置管的次数和机械损伤并发症。超声引导应由经全面培训并完全掌握技术的人员来操作。[60–64]。(IB类)
- 在能满足管理患者需要的前提下，中心静脉导管的端口或者腔道应尽量少[65–68]。(IB类)
- 对于胃肠外营养置管，尚无明确建议。(未明确事项)
- 应尽早拔除血管内导管[69–72]。(IA类)
- 当不能保证无菌操作的时候(如急诊置管)，应尽早替换该导管，例如48小时内[37，73–76]。(IB类)

※ 手卫生和无菌操作

- 可以采取的手卫生措施包括常规的用肥皂和水洗手或者使用含酒精的消毒液(ABHR)。在接触穿刺点前后，置管、更换导管、接触及维护导管或者更换敷料前后均应执行手卫生程序。在进行消毒处理后，不应触再碰穿刺部位，除非保持无菌操作[12，77–79]。(IB类)
- 在进行置管和血管内导管护理时应持续无菌操作[37，73，74，76]。(IB类)
- 进行外周血管内导管置管时，如进行皮肤消毒之后未接触置管部位，可戴清洁手套，无须戴无菌手套。(IC类)
- 置入动脉、中心静导管时应佩戴无菌手套[37，73，74，76]。(IA类)
- 当使用导丝更换导管时，在接触新导管前须更换新的无菌手套。(II类)
- 更换导管敷料时佩戴清洁或无菌手套均可。(IC类)

※ 最大化无菌屏障预防措施

- 应采用最大化无菌屏障预防措施进行CVC置管、PICC置管或者更换导丝，包括：佩戴帽子、口罩、无菌手术衣、无菌手套以及全身铺盖无菌消毒巾[14，75，76，80]。(IB类)
- 肺动脉置管过程中使用无菌保护套对其进行保护[81]。(IB类)

※ 皮肤消毒

- 在进行外周静脉置管，前使用消毒剂(70%酒精、碘酒或者葡萄糖酸洗必泰)清洁皮肤[82]。(IB类)
- 在进行中心静脉置管和外周动脉置管以及更换敷料时，使用浓度大于0.5%的洗必泰消毒皮肤。如果存在使用洗必泰的禁忌指征，则可用碘酒、碘伏或70%酒精替代[82，83]。(IA类)
- 尚无研究比较洗必泰加酒精消毒皮肤与碘伏酒精溶液消毒皮肤的效果。(未明确事项)
- 尚无关于2个月内婴儿应用洗必泰的安全性及有效性的建议。(未明确事项)
- 根据制造商的建议，应等到消毒剂充分干燥以后再置入导管[82，83]。(IB类)

※ 穿刺部位敷料的应用

- 使用无菌纱布或者无菌的透明、半透性敷料覆盖置管部位[84–87]。(IA类)
- 如果患者多汗，或者如果置管部位有出血或渗出，应使用纱布辅料直到问题解决[84–87]。(II类)
- 当置管部位敷料潮湿、松弛或者有明显污染时应及时更换。[84，85]。(IB类)
- 除透析导管以外，穿刺局部不可使用抗生素药膏或者乳膏，因为这些局部用药能促进真菌感染并引发抗微生物药物耐药[88，89]。(IB类)
- 禁止将导管或者置管部位浸入水中。可以允许淋浴，但前提是具备能够减少微生物进入导管的预防措施(例如，在淋浴过程中，用非渗透性覆盖物保护导管及连接设备)[90–92]。(IB类)
- 对于短期中心静脉导管置管部位的敷料，应每2天更换一次用纱布敷料。(II类)
- 至少每7天更换一次短期CVC置管部位的透明敷料，除非是患儿，因为移动导管的风险可能大于替换敷料的收益[87，93]。(IB类)
- 隧道式或植入式CVC置管部位更换透明辅料的频率不应超过每周一次(辅料有明显污垢或者松弛时例外)，直到置管部伤口愈合。(II类)
- 对于长期套管式和隧道式CVC，且置管部位愈合良好，尚无对其是否应使用敷料的建议。(未明确事项)
- 确保置管部位的维护与导管材料兼容[94，95]。(IB类)
- 行肺动脉置管时应使用无菌套管[81]。(IB类)
- 对于大于2个月的患者短期临时置管时，如果坚持遵循了基本的预防措施，包括教育和培训、正确使用洗必泰消毒皮肤以及最大化无菌屏障预防措施以后，CLABSI的感染率仍不降低，置管部位可使用含洗必泰的海绵辅料。(IB类)
- 尚无关于其他类型洗必泰敷料的建议。(未明确事项)
- 依据每个患者的临床情况选择检查置管部位的方式：在更换敷料时查看置管部位，或者定时触诊完整的敷料以确定有无异常。如果患者出现置管部位触痛，不明原因的发热，或者出现其他提示局部或血流感染的表现，则应在彻底检查置管部位后更换敷料[99–101]。(IB类)
- 鼓励患者向医护人员报告任何导管位置的变化或者任何新增的不适。(II类)

※ 患者清洁

每日使用2%洗必泰进行一次皮肤清洁，以减少CRBSI[102–104]。(II类)

※ 导管固定装置

使用免缝合固定装置降低血管内导管感染的风险[105]。(II类)

※ 含抗菌剂/杀菌剂的导管和套管

导管留置时间预计超过5天的患者，如果成功地实施了感染控制综合措施仍不能降低CRBSI的发生率，可使用含洗必泰/磺胺嘧啶银或者米诺环素/利福平浸渍的中心静脉导管。综合措施应至少包括下列三项措施：对置管和导管维护人员进行培训，使用最大化无菌屏障预防措施，CVC置管时使用浓度大于0.5%的洗必泰和酒精消毒皮肤[106–113]。(IA类)

※ 全身性预防应用抗生素

不可为了预防导管定植或CRBSI，而在置管前或血管内导管留置期间常规给予全身性预防应用抗生素[114]。(IB类)

※ 抗生素/消毒剂软膏

置管及每次透析结束之后，在血液透析导管出口处可使用碘伏消毒剂软膏或杆菌肽/短杆菌肽/多粘菌素B软膏。但要依据每个制造商提供的建议，确保软膏与血液透析导管的材质不会发生反应[59，115–119]。(IB类)

※ 抗生素封管、抗菌液冲管和封管预防

对于长期置管的患者，尽管较理想地执行了最大程度的无菌操作，但仍有多次CRBSI感染史，可采用预防性抗微生物药物溶液封管[120–138]。(II类)

※ 抗凝剂

对于一般患者，禁止常规使用抗凝以减少导管相关感染的风险[139]。(II类)

※ 外周及中等长度导管的更换

1. 为了减少感染及静脉炎的风险，成人外周导管的更换频率每次不宜少于72-96小时[36，140，141]。(IB类)
2. 对于是否仅当具有临床指征的时候才更换成人外周导管，尚无明确建议[142–144]。(未明确事项)
3. 仅当具有临床指征的时候才更换儿童外周导管[32，33]。(IB类)
4. 仅当具有特别指征的时候才更换中心导管。(II类)

※ CVC、PICC及血液透析导管的更换

1. 禁止为了预防导管相关感染而常规更换CVC、PICC、血液透析导管或肺动脉导管。(IB类)
2. 禁止由于发热即拔除CVC或PICC。应依据临床判断考虑拔管的适应性，判断是否有其他部位的感染证据，或发热为非感染性因素所致。(II类)
3. 对非隧道式导管，禁止为了预防感染而常规使用导丝更换导管。(IB类)
4. 对于可疑感染的非隧道式导管，禁止使用导丝更换导管。(IB类)
5. 如果不存在感染的证据时，可以使用导丝更换导管来替换故障的非隧道式导管。(IB类)
6. 使用导丝更换导管时，在接触新的导管前须更换新的无菌手套。(II类)

※ 脐带导管

1. 如果出现任何导管相关性血流感染、下肢血管功能不全或者血栓形成的征象时，应拔除且不再重新更换脐动脉导管[145]。(II类)
2. 如果出现任何导管相关性血流感染或者血栓形成的征象时，应拔除且不再更换脐静脉导管[145]。(II类)
3. 关于通过导管给予抗生素治疗以试图挽救脐带导管尚无明确建议。(未明确事项)
4. 置管前，使用消毒剂清洁脐带导管置管部位。为了避免对新生

儿甲状腺造成潜在影响，清洁时不宜使用碘酒。其他含碘产品(如，碘伏)可以使用[146–150]。(IB类)

5. 由于潜在地促进真菌感染和抗菌素耐药，应避免在脐带导管置管部位使用抗生素软膏或者乳膏[88，89]。(IA类)
6. 将低剂量肝素加入经脐动脉导管输液中(0.25–1.0 U/ml)[151–153]。(IB类)
7. 一旦不再需要脐带导管，或发现任何下肢血管功能不全的征象时，应尽快拔除导管。理想状态下，脐动脉导管的留置时间不宜超过5天[145，154]。(II类)
8. 一旦不再需要脐静脉导管，应尽快拔除，但是如果无菌管理得当，最多可留置14天[155，156]。(II类)
9. 如果脐带导管出现故障，而无其它拔管指征，且脐动脉导管总留置时间不超过5天或脐静脉导管总留置时间不超过14天时，可以更换脐带导管。(II类)

※ 成人和儿童患者的外周动脉导管和压力监测装置

1. 成人应使用桡、肱或者足背血管作为置管部位要比股或腋窝血管更有利于降低感染风险[46，47，157，158]。(IB类)
2. 儿童患者不应使用肱血管作为置管部位。选择桡、足背及胫后血管作为置管部位要优于股或腋窝血管[46]。(II类)
3. 在外周动脉置管过程中，至少使用帽子、口罩、无菌手套及小的消毒巾[47，158，159]。(IB类)
4. 在行腋窝或股动脉置管过程中，应使用最大化无菌屏障预防措施。(II类)
5. 仅当具有临床指征时才可更换动脉导管。(II类)
6. 一旦不再需要，应尽快拔除动脉导管。(II类)
7. 尽量使用一次性传感器组件，而不用可重复使用的组件[160–164]。(IB类)
8. 不可为了预防导管相关感染而常规更换动脉导管 [165，166，167，168]。(II类)
9. 一次性或可重复使用的传感器应每间隔96小时更换一次。更换传感器的同时还应更换系统内的其他组件(包括管道系统、连续冲洗装置和冲洗液)[37，161]。(IB类)
10. 保持压力监测系统的所有组件(包括校准设备和冲洗液)处于无菌状态[160，169–171]。(IA类)
11. 减少操作及进入压力监测系统的次数。使用封闭的冲洗系统(即连续冲洗)，而非开放性系统(即使用注射器和三通阀)来保持压力监测导管通畅[163，172]。(II类)
12. 当压力监测系统的通路入口不是三通阀而是隔膜板时，在进入系统前应使用适宜的消毒剂擦洗隔膜板[163]。(IA类)
13. 禁止通过压力监测管路输注含葡萄糖的溶液或者胃肠外营养液[163，173，174]。(IA类)
14. 如果无法使用一次性传感器，应依据制造商的说明消毒可重复使用的传感器[163，173–176]。(IA类)

※ 输注装置的更换

1. 对于不输注血液、血液制品或者脂肪乳的患者，连续使用的给药装置(包括辅助装置及附件)的更换周期不宜少于96小时[177]，但至少应每7天更换一次[178–181]。(IA类)
2. 对于间歇使用的给药装置，尚无对其更换频率方面的建议。(未明确事项)
3. 对于植入式输液港的连接针头，尚无对其更换频率方面的建议。(未明确事项)

- 用于输注血液、血液制品或者脂肪乳(可与氨基酸和葡萄糖组成混合液, 或者单独输注)的输液装置系统应在输液开始后的24小时内进行更换[182–185]。(IB类)
- 根据制造商的建议(美国食品药品监督管理局网站Medwatch), 输注异丙酚时应每6或12小时更换输液瓶时更换输液管[186]。(IA类)
- 对于植入式输液港的连接针头, 尚无对其留置时间方面的建议。(未明确事项)

※ 无针连接系统

- 无针装置的更换频率至少应与输液装置一样。更换周期小于每72小时一次并没有任何益处[39, 187–193]。(II类)
- 为了降低感染率, 更换无针连接系统接头的周期不应小于每72小时一次, 或参照制造商的建议[187, 189, 192, 193]。(II类)
- 确保系统的所有部分能互相兼容, 从而减少漏液和系统破裂[194]。(II类)
- 通过使用适当的消毒剂(洗必泰、碘伏、碘酒、或70%酒精)擦洗输液港的接入口, 同时仅使用无菌装置接触输液港入口, 从而减少污染风险[189, 192, 194–196]。(IA类)
- 使用无针系统接入静脉输液管。(IC类)
- 使用无针系统时, 分隔膜式输液接头(split septum valve)要优于机械阀输液接头, 因为机械阀接头可增加感染风险[197–200]。(II类)

※ 效果的提升

通过将多种策略“捆绑”在一起, 采用具有医院特色的或是以协作为基础的创新方式, 从而改善以循证为基础的操作依从性[15, 69, 70, 201–205]。(IB类)

■ 背景信息

※ 术语和风险评估

由于许多临床工作者和研究者在非正式场合从不同的角度来描述导管, 使得导管的分类术语常被混淆。导管可以根据其放置的血管分类(例如, 外周静脉、中心静脉、或动脉导管); 导管留置时间分类(例如, 临时或短期, 永久或长期); 置管的部位分类(例如, 锁骨下、股、颈内、外周和经外周静脉置入的中心静脉导管[PICC]); 皮肤至血管通路分类(例如, 隧道式或非隧道式); 导管长度分类(例如, 长或短); 或某些特点(例如, 是否带有套管, 是否注入肝素, 是否含抗生素或消毒剂, 以及导管腔数)。为了准确定义导管的特定类型, 应描述上述的各个方面(见表1)。

同样的, 用于描述血管内导管感染的术语也常被混淆, 例如即使导管相关性血流感染(CRBSI)和中心静脉导管相关性血流感染(CLBSI)的概念不同, 还是经常被交换使用。

CRBSI是一个临床概念, 常在诊断和治疗的时候使用, 需要有特殊的实验室检查从而确定导管是血流感染(BSI)的来源, 但这些检查并不用于典型的监测目的。血流感染常(BSI)由于以下原因而很难明确诊断为导管相关性血流感染(CRBSI): 患者的临床需要(导管通常不拔除), 微生物学方法的局限性(许多实验室不使用定量血培养或时间差作为阳性指标), 以及直接护理人员对程序依从性(标记必须准确)等原因。相对简单的定义往常用于监测的目的。例如, CLBSI是一个由CDC国家医疗安全网(NHSN)使用的名称。CLBSI见于BSI发生的48小时内留置中心静脉导管, 且无其它部位血流感染的患者, 其初次发生的血流感染为CLBSI。然而, 由于其他来源的血流感染继发于中心静脉以外的器官(如胰腺炎, 黏膜炎), 使得明确诊断不那么容易, 因此, CLBSI监测定义的范围可能超过了CRBSI的真实范围。

导管类型	穿刺部位	植入长度	注释
外周静脉导管	通常为前臂或手	<3英寸	长期使用导致静脉炎; 少见血流感染
外周动脉导管	通常经桡动脉; 也可经股、腋窝、肱及胫骨后动脉	<3英寸	低感染风险; 少见血流感染
中等长度导管	经肘前窝进入贵要前端或头静脉; 不进入中心静脉, 外周导管	3-8英寸	弹性水凝胶制成的导管可见过敏反应; 与短外周导管相比, 静脉炎发生率较低
非隧道式中心静脉导管	经皮进入中心静脉(锁骨下、颈内或股静脉)	≥8厘米且依据患者身材调整	大部分CRBSI源于此
肺动脉导管	通过特氟龙导管引入器进入中心静脉(锁骨下、颈内或股静脉)	≥30厘米且依据患者体型调整	通常含肝素; 血流感染率与CVC类似; 锁骨下穿刺可降低感染风险
经外周静脉置入中心静脉导管(PICC)	经贵要、头、或肱静脉, 进入上腔静脉	≥20厘米且依据患者体型调整	与非隧道式CVC相比, 感染率低
隧道式中心静脉导管	植入锁骨下、颈内或股静脉	≥8厘米且依据患者体型调整	套管可抑制管路内的微生物移植; 与非隧道式CVC相比, 感染率较低
完全植入式	皮下建立隧道, 用针穿刺皮下输液港; 植入锁骨下或颈内静脉	≥8厘米且依据患者体型调整	CRBSI感染率最低; 改善患者自我形象; 不需要导管部位的局部护理; 拔管需手术
脐带导管	脐静脉或脐动脉	≤6厘米且依据患者体型调整	经脐静脉与经脐动脉置管发生CRBSI的风险类似

表1 动、静脉导管的应用

※ 成人和患儿的流行病学与微生物学

CDC的国家医疗安全网评估了CLABSI的发生率，C国家医疗安全网是一个医疗相关性感染的监测网，详情可访问CDC网站：<http://www.cdc.gov/nhsn/dataStat.html>。近期报告所强调的数据源自48个州和哥伦比亚地区的1545家医院，对一个或多个ICU及非ICU（如患者护理区，病房）进行了监测[207]。由于BSI的发生率受患者相关因素影响，例如疾病的严重程度和种类（如三度烧伤，心脏手术后），也受导管相关因素影响（如置管条件和类型），还应考虑制度因素的影响（如病床大小，学术隶属关系）。结合上述因素，医院使用调整后的风险概率作为基准，进行医院内和医院间的比较。

报道中最常见的病原微生物有凝固酶阴性葡萄球菌、金黄色葡萄球菌、肠球菌和念珠菌属[208]。上报至CDC和病原菌的流行病学重要性监测和控制（SCOPE）数据库的CLABSI中，由革兰氏阴性杆菌引起的分别占了19%[209]和21%[208]。

对于引发CLABSI的常见病原菌，抗生素的耐药是个问题，特别是在ICU。虽然目前ICU分离出的葡萄球菌中有超过一半的是耐甲氧西林的金黄色葡萄球菌（MRSA），但近些年来，MRSA引发的CLABSI有所减少，这或许是由于开展预防措施的结果[210]。革兰氏阴性杆菌中，耐三代头孢的肺炎克雷伯菌和大肠杆菌明显增多，正如耐亚胺培南和头孢他啶的绿脓杆菌明显增多一样[209]。念珠菌对氟康唑的耐药性也正在显著增加。

※ 发病机理

目前导管的污染途径有4种：1) 置管部位的表皮微生物侵入皮下，并沿导管表面定植于导管尖端；这是短期置管最常见的感染路径[37,211,212]；2) 通过接触手、污染的液体或设备导致导管或导管接口直接被污染；3) 某些较少的情况下，其他部位的感染可能经血液播散至导管[215]；4) 极少罕见情况下，由于输入污染的液体导致CRBSI[216]。

CRBSI的重要致病因素有：1) 设备的制作材料；2) 包括粘附蛋白的宿主因素，例如纤维蛋白和纤维粘连蛋白可在导管周围形成鞘[217]；3) 感染生物体的内在毒性因素，包括由附着生物产生的胞外聚合物（EPS）[218]。某些导管材料的表面不规则，这也增加了某类微生物的附着（例如，表皮葡萄球菌和白色念珠菌）[219,220]。由此类材料制成的导管常容易引发微生物定植与感染。由于能够形成纤维蛋白鞘，硅胶管与聚氨酯导管相比具有更高的感染风险[217]。另一方面，与聚氨酯导管相比，弹性硅胶管表面更容易引起由白色念珠菌生成的生物膜[219]。因此，改变生物材料的表面特性可以影响白色念珠菌生物膜的形成[220]。此外，某些导管材料与其他材料相比更易形成血栓，这一特点也同样使该类导管容易出现细菌定植和感染[221,222]。结合这一特点，预防导管相关的血栓是减少CRBSI的另一个有效途径[223,224]。

某些微生物的粘附特性与宿主因素也是CRBSI的重要致病因素。例如，通过传递粘附蛋白的聚集因子（ClfA和ClfB），金黄色葡萄球菌可粘附于导管表面常见的宿主蛋白（如纤维蛋白，纤维粘连蛋白）[217,222,225,226]。此外，微生物的生成物可增加上述粘附，例如凝固酶阴性的金黄色葡萄球菌[227,228]、金黄色葡萄球菌[229]、绿脓杆菌[230]以及念珠菌属[231]的胞外聚合物（EPS）包含大量可形成微生物膜层的胞外多糖[218,232]。二价金属离子促进了此类生物膜聚合物的生成，例如钙、镁和铁，可以加固聚合物使微生物有机体在其内定植[233-235]。这样的生物膜使细菌通过了宿主的防御系统（例如，由多核白细胞的吞噬和杀灭构成的屏障），减弱了对抗生素的易感性（例如，在接触生物细胞壁之前形成阻挡抗菌药的聚合物，或阻止代谢、产生耐药细胞）从而增加了细菌的致病性[228,236,237]。出现在含葡萄糖液体内的某些念珠菌属，可产生

类似粘液样的物质，对于那些接受肠外营养治疗的病人，增加了由真菌引发的血流感染的比例。

※ 成人和患儿导管相关感染的预防策略

※ 教育、培训和人员配置

建议

1. 教育医护人员明确血管内导管的应用指征、置入和维护导管的正确操作、以及血管内导管相关感染的正确预防措施[7-15]。（IA类）
2. 对进行血管内导管置管和维护的全体人员定期进行知识和依从性评估。[7-15]。（IA类）
3. 仅指定经过培训且有能力进行外周和中心血管内置管和维护的人员从事本操作。[14-28]。（IA类）
4. 确保重症ICU具有适当的护理人员水平。观察性研究表明，在护士对患者的CVC进行管理的ICU，较高比例的“非专科护士”或较高的病人/护士比与ICU的CRBSI相关[29-31]。（IB类）

背景

精心制定的计划可以使医疗工作者受到良好的培训，同时提供护理，并对其进行监督和评估，这是成功的关键要素。过去四十年的报告一致证实感染风险随着开展标准化的无菌护理而降低[7,12,14,15,239-241]，也证实了经验不足的人员进行置管和维护可以增加导管定植和CRBSI的风险[15,242]。专业的“静脉输液组”可以明显减少CRBSI的发病率、相关并发症以及花费[16-26]。此外，护理人员的数量低于临界水平时，感染风险随之而增加[30]。

※ 导管和穿刺部位的选择

※ 外周和中等长度导管的建议

1. 对于成人，应该选择上部部位进行置管。应尽快用上肢部位取代位于下肢部位的置管。（II类）
2. 对儿科患者，可以使用上肢、下肢或者头皮（适用于新生儿和小婴儿）作为置管位置[32, 33]。（II类）
3. 根据置管目的和计划留置时间、已知的感染性和非感染性并发症（例如，静脉炎和静脉周围浸润）、以及操作者的个人经验来选择导管[33-35]。（IB类）
4. 避免使用钢针输液和给药，防止液体外渗时引起组织坏死[33, 34]。（IA类）
5. 当静脉输液有可能持续6天以上时，用中心静脉导管或者经外周置入的中心静脉导管（PICC）代替短外周静脉导管。（II类）
6. 对于使用透明敷料者，每天隔着敷料进行触诊判断是否有触痛，并用肉眼观察，评估置管部位情况。如果患者没有感染的临床指征，则不应拆除纱布和其他不透明敷料。如果患者出现局部触痛或者其他CRBSI的征象，应该拆除不透明敷料并观察置管部位。（II类）
7. 如果患者出现静脉炎征象（热、痛、红斑或者可扪及静脉线）、感染、或者导管发生故障时应拔掉外周静脉导管[36]。（IB类）

※ 中心静脉导管相关建议

1. 在推荐部位放置中心静脉导管时，相对于机械性并发症（例如，气胸，锁骨下动脉破裂、锁骨下静脉破损、锁骨下静脉狭窄、血胸、血栓、空气栓塞以及导管错位），应权衡利弊从而减少感染性并发症[37-53]。（IA类）
2. 避免使用股静脉作为成人中心静脉通路[38, 50, 51, 54]。（IA类）

3. 应尽量选择锁骨下静脉作为穿刺部位而非颈静脉和股静脉，可减少成人非隧道式的CVC感染风险[50–52]。(IB类)
4. 对于减少隧道式中心静脉导管的感染风险，尚无明确的最佳穿刺部位的建议。(未明确事项)
5. 对于血液透析患者和终末期肾病患者避免使用锁骨下静脉作为穿刺部位，以免发生锁骨下静脉狭窄[53, 55–58]。(IA类)
6. 对于慢性肾功能衰竭患者，使用动静脉造瘘或搭桥术替代CVC作为透析的永久通路[59]。(IA类)
7. 可在超声引导下放置中心静脉导管(如果技术允许)，从而减少尝试置管的次数和机械损伤并发症。超声引导应由经全面培训并完全掌握技术的人员来操作。[60–64]。(IB类)
8. 在能满足管理患者需要的前提下，中心静脉导管的端口或者腔道应尽量少[65–68]。(IB类)
9. 对于胃肠外营养置管，尚无明确建议。(未明确事项)
10. 应尽早拔除血管内导管[69–72]。(IA类)
11. 当不能保证无菌操作的时候(如急诊置管)，应尽早更换该导管，例如48小时内[37, 73–76]。(IB类)

背景

置管的部位与其后的导管相关感染及静脉炎的发生有直接关系。置管部位对于导管相关感染的影响又与血栓性静脉炎和局部皮肤菌群密度有一定关系。

与成人一样，对患儿进行外周静脉置管也可能合并静脉炎、输液外渗、和导管感染[243]。置管部位、持续静脉点滴含脂肪乳的肠外营养液、置管前在ICU的治疗时间，上述因素均增加了患儿静脉炎的风险。然而，与成人相反，患儿静脉炎的风险不随置管时间的延长而增加[243,244]。

置管部位皮肤的菌群密度是诱发CRBSI最重要的风险因素。目前，尚无独立的实验能够较全面的比较颈静脉、锁骨下静脉、及股静脉置管的感染风险。一些回顾性的观察实验表明，颈内静脉置管通常比锁骨下静脉置管伴有更高的细菌定植和/或CRBSI风险[37-47]。类似的结果也在对于婴儿的回顾性研究中发现[245]。

与锁骨下静脉和颈内静脉相比，成人股静脉置管在某些研究中被证实具有更高的CLABSI感染率[40,45-47,50,51,246]。如果可能，也应尽量避免股静脉置管，这是因为较之颈内静脉和锁骨下静脉，股静脉更易引发深静脉血栓[48-50,53,247]。一项研究发现，肥胖增加了股静脉置管的感染风险[38]。与成人相反，对于患儿的研究表明，股静脉置管的机械性并发症较少，且与非股静脉置管的感染率相同[248-251]。因此，对于成人患者，虽然置管时还应考虑其他因素(如，潜在的机械性并发症，锁骨下静脉狭窄的风险，以及置管人员的技术水平)，但锁骨下静脉仍是控制感染的最佳穿刺点。

两篇荟萃分析研究表明，与传统的定位置管相比，使用实时二维超声辅助放置CVC可显著减少机械性并发症，并在需要套管置管术且尝试置管失败的情况下，减少尝试置管次数[60,61]。此外，一些证据更倾向于使用二维超声辅助操作而非多普勒超声[60]。置管部位的选择应遵循病人舒适的原则，同时兼顾导管安全、保持无菌以及患者的特殊情况(如，之前已留置的导管、解剖畸形，以及出血因素)、机械性并发症的相对风险(如出血和气胸)、床旁超声的可行性、置管人员的经验、以及感染的风险。

导管应尽可能的置于远离开放性伤口的一端。一项研究表明，导管置于靠近开放性烧伤(如，25cm²的伤口)处，细菌定植和菌血症风险分别是置于伤口远端的1.79和5.12倍[252]。

导管材料的种类聚四氟乙烯(特氟龙®)或聚氨酯导管较聚氯乙烯或聚乙烯导管更不易产生感染[36,253,254]。钢针可作为导管

与外周静脉连接的入口，与特氟龙导管相比具有相同的感染发生率[33,34]。然而，频繁使用钢针可并发静脉液体浸入皮下组织，而如果液体为发泡剂，那么将成为潜在的严重威胁[34]。

※ 手卫生和无菌术

建议

1. 可以采取的手卫生措施包括常规的用肥皂和水洗手或者使用含酒精的消毒液(ABHR)。在接触穿刺点前后，置管、更换导管、接触及维护导管或者更换敷料前后均应执行手卫生程序。在进行消毒处理后，不应再触碰穿刺部位，除非保持无菌操作[12, 77–79]。(IB类)
2. 在进行置管和血管内导管护理时应持续无菌操作[37, 73, 74, 76]。(IB类)
3. 进行外周血管内导管置管时，如进行皮肤消毒之后未接触置管部位，可戴清洁手套，无须戴无菌手套。(IC类)
4. 置入动脉、中心静脉导管时应佩戴无菌手套[37, 73, 74, 76]。(IA类)
5. 当使用导丝更换导管时，在接触新导管前须更换新的无菌手套。(II类)
6. 更换导管敷料时佩戴清洁或无菌手套均可。(IC类)

背景

置管或导管维护前应注意手部卫生，操作导管过程中要结合适当的无菌操作，以此来提供保护以预防感染[12]。适当的手部卫生可通过使用含酒精的产品[255]或肥皂和水以及充分的清洗来达到[77]。对于外周血管置管，通过恰当的无菌操作则不需要戴无菌手套；新的一次性非无菌手套可结合“非接触式”技术用于外周静脉置管。由于“非接触式”技术无法在中心静脉置管中应用，因此中心静脉置管操作过程中必须使用无菌手套。

※ 最大化无菌屏障预防措施

建议

1. 应采用最大化无菌屏障预防措施进行CVC置管、PICC置管或者更换导丝，包括：佩戴帽子、口罩、无菌手术衣、无菌手套以及全身铺盖无菌消毒巾[14, 75, 76, 80]。(IB类)
2. 肺动脉置管过程中使用无菌保护套对其进行保护[81]。(IB类)

背景

最大化无菌屏障(MSB)可定义为在CVC置管过程中，穿无菌隔离服、戴无菌手套和帽子，使用覆盖全身的消毒巾(与手术室类似)。一项对比随机试验研究了在CVC置管过程中，将使用最大化无菌屏障与戴无菌手套和铺较小的消毒巾相比较。MSB组具有较小的导管定植(RR=0.32,95%CI,0.10-0.96, P=0.04)及CR-BSI(RR=0.16,95%CI, 0.02-1.30, P=0.06)。此外，使用MSB预防隔离的一组发生感染的时间较晚，且革兰氏阴性菌多于革兰氏阳性菌[76]。一项有关肺动脉导管的研究也间接的证明了使用MSB预防措施降低了感染风险[37]。另一研究评估了一项培训计划，该计划旨在改善感染控制操作，尤其是MSB预防措施。在这一研究中，CRBSI随着MSB预防措施的使用而减少[14]。一个小试验证明了应用MSB预防措施，可降低置管部位的皮肤定植风险。

※ 皮肤准备

建议

1. 在进行外周静脉置管，前使用消毒剂(70%酒精、碘酒或者葡萄糖酸洗必泰)清洁皮肤[82]。(IB类)
2. 在进行中心静脉置管和外周动脉置管以及更换敷料时，使用浓度大于0.5%的洗必泰消毒皮肤。如果存在使用洗必泰的禁忌征，则可用碘酒、碘伏或70%酒精替代[82, 83]。(IA类)
3. 尚无研究比较洗必泰加酒精消毒皮肤与碘伏酒精溶液消毒皮肤的效果。(未明确事项)
4. 尚无关于2个月内婴儿应用洗必泰的安全性及有效性的建议。(未明确事项)
5. 根据制造商的建议，应等到消毒剂充分干燥以后再置入导管[82, 83]。(IB类)

背景

两项设计良好的研究评估了含洗必泰的皮肤消毒方案与碘伏或酒精的皮肤消毒方案的差异，两者对血管内导管置管部位的消毒效果提示了经洗必泰消毒后导管定植和CRBSI感染率更低[82,83]。(未做葡萄糖酸洗必泰酒精与碘伏酒精的比较)。0.5%的洗必泰酊与10%碘酊比较，对于预防中心静脉导管的细菌定植或CRBSI方面没有区别[256]。多组分试验(2%葡萄糖酸洗必泰溶液 vs 10%碘伏 vs 70%酒精)表明，2%葡萄糖酸洗必泰溶液与10%碘伏或70%酒精相比更能减少CRBSI。一项包含4143根导管的荟萃分析表明，相对于碘伏，洗必泰可减少49%的导管相关感染风险[257]。一项基于现有证据的经济结果分析表明，与碘伏相比，使用洗必泰可使CVC减少1.6%的CRBSI感染率，减低0.23%的死亡率，每根导管可节省113美元[258]。虽然洗必泰已成为中心及外周静脉置管准备的标准皮肤消毒剂，5%碘伏和70%酒精溶液相对于10%碘伏溶液更能显著减少CVC相关的定植和感染。

※ 置管部位敷料的应用

建议

1. 使用无菌纱布或者无菌的透明、半透性敷料覆盖置管部位[84-87]。(IA类)
2. 如果患者多汗，或者如果置管部位有出血或渗出，应使用纱布辅料直到问题解决[84-87]。(II类)
3. 当置管部位敷料潮湿、松弛或者有明显污染时应及时更换。[84, 85]。(IB类)
4. 除透析导管以外，穿刺局部不可使用抗生素膏药或者乳膏，因为这些局部用药能促进真菌感染并引发抗微生物药物耐药[88, 89]。(IB类)
5. 禁止将导管或者置管部位浸入水中。可以允许淋浴，但前提是具备能够减少微生物进入导管的预防措施(例如，在淋浴过程中，用非渗透性覆盖物保护导管及连接设备)[90-92]。(IB类)
6. 对于短期中心静脉导管置管部位的敷料，应每2天更换一次用纱布敷料。(II类)
7. 至少每7天更换一次短期CVC置管部位的透明敷料，除非是患儿，因为移动导管的风险可能大于替换敷料的收益[87, 93]。(IB类)
8. 隧道式或植入式CVC置管部位更换透明辅料的频率不应超过每周一次(辅料有明显污垢或者松弛时例外)，直到置管部伤口愈合。(II类)
9. 对于长期套管式和隧道式CVC，且置管部位愈合良好，尚无对其是否应使用敷料的建议。(未明确事项)

10. 确保置管部位的维护与导管材料兼容[94, 95]。(IB类)

11. 行肺动脉置管时应使用无菌套管[81]。(IB类)

12. 对于大于2个月的患者短期临时置管时，如果坚持遵循了基本的预防措施，包括教育和培训、正确使用洗必泰消毒皮肤以及最大化无菌屏障预防措施以后，CLABSI的感染率仍不降低，置管部位可使用含洗必泰的海绵辅料。(IB类)

13. 尚无关于其他类型洗必泰敷料的建议。(未明确事项)

14. 依据每个患者的临床情况选择检查置管部位的方式：在更换敷料时查看置管部位，或者定时触诊完整的敷料以确定有无异常。如果患者出现置管部位触痛，不明原因的发热，或者出现其他提示局部或血流感染的表现，则应在彻底检查置管部位后更换敷料[99-101]。(IB类)

15. 鼓励患者向医护人员报告任何导管位置的变化或者任何新增的不适。(II类)

背景

置管部位使用透明、半透气聚氨酯敷料时，可随时查看置管部位，其更换频率可少于标准的纱布胶带敷料。在一项涉及外周导管敷料的最大对照试验中，共监测了约2000根外周导管[254]，该试验研究了感染的发病率与使用透明敷料间的关系。研究中的数据显示使用透明敷料的导管定植率(5.7%)与使用纱布敷料(4.6%)类似，两者的置管部位细菌定植或静脉炎发生率也无显著的临床差异。此外，数据还提示透明敷料可以在导管留置期间，较安全地覆盖在外周静脉导管上，且不增加血栓性静脉炎的风险[254]。

一项荟萃分析评估比较了透明敷料和纱布敷料对于CRBSI的影响。两者对引发CRBSI的风险没有区别。可依个人偏好来选择敷料。如果置管部位出现渗血，纱布敷料是首选。另系统回顾一项随机对照试验，将纱布和胶带与透明敷料相比较，发现此两类敷料对于CRBSI、导管尖端定植、或皮肤定植并无显著差别[261]。

含洗必泰的敷料已经应用于降低CRBSI的感染风险。目前，最大的多中心随机对照试验将ICU中使用含洗必泰海绵的敷料与标准敷料相对比，得出洗必泰敷料的CRBSI发生率有所降低。即使是在总体感染发生率很低的情况下也一样可靠降低感染率。这一研究共评估了1636名患者(3778根导管，28931个导管日)。含洗必泰海绵的敷料降低了严重导管相关性血流感染(10/1953[0.5%], 0.6/千导管日 vs 19/1825[1.1%], 1.4/千导管日；危险率[HR], 0.39[95%CI, 0.17-0.93]; P=0.03)和严重导管相关性血流感染(6/1953导管, 0.4/千导管日 vs 17/1825导管, 1.3/千导管日；HR, 0.24[95%CI, 0.09-0.65])的发生率[93]。一项包括了140个患儿使用聚氨酯或洗必泰海绵敷料的随机对照试验，提示了两者对BSI没有统计学差别；然而，洗必泰一组的CVC定植率更低。601名接受化疗的癌症患者中，使用含洗必泰海绵敷料的患者与使用标准敷料的患者相比，CRBSI发病率更低(P=0.016, 相对风险0.54; CI, 0.31-0.94)[262]。一项包括8个随机对照试验的荟萃分析证明了，含洗必泰海绵的敷料可减少血管导管和硬膜外导管出口部位的细菌定植，但是不能显著降低CRBSI(2.2% vs 3.8%，或0.58, 95%CI: 0.29-1.14, P=0.11)[97]。

关于儿童使用含洗必泰海绵敷料的数据还比较有限，一项涉及705名新生儿的随机对照研究报道了用洗必泰海绵敷料与标准敷料的比较，可显著降低导管定植(15% vs 24%; RR=0.6; 95%CI=0.5-0.9)，但对于CRBSI或不明原因BSI的发病率无明显区别。使用洗必泰海绵敷料与较低出生体重婴儿的局部接触性皮炎由一定关系。在98名低出生体重婴儿中，15(15%)出现局部接触性皮炎；237名婴儿中有4名(1.5%)出现副作用且体重大于1000g。孕期小于26周且于出生后8天内留置CVC的婴儿，局部接触性皮炎的风险增加，对照组则没有局部副作用出现。

※ 患者的清洁

建议

每日使用2%洗必泰进行一次皮肤清洁，以减少CRBSI[102–104]。(II类)

背景

ICU患者使用2%洗必泰湿润的毛巾进行每日清洁，可作为一个减少原发性BSI发生率的简便而有效地措施。一项包括836名ICU患者的研究提示，与使用肥皂和水洗浴的患者相比，使用洗必泰的患者可显著减少原发性BSI的发生 (4.1 vs 10.4 个感染/千患者日；发病率差异，6.3 [95% CI, 1.2-11.0]) [102]。

导管固定装置

建议

使用免缝合固定装置来降低血管内导管感染的风险[105]。分类II

背景

导管的固定被认为是减少静脉炎、导管细菌移植和拔管风险的一项有效干预措施，可能有利于CRBSI的预防。CRBSI的发病机理是皮肤菌群经穿刺部位进行移植。免缝合固定装置避免了对导管穿刺部位的损伤，并可以减少细菌定植的程度[105]。使用免缝合固定装置也减少了对医务人员意外针刺伤的风险。

※ 含抗菌剂/杀菌剂的导管和套管

导管留置时间预计超过5天的患者，如果成功地实施了感染控制综合措施仍不能降低CRBSI的发生率，可使用含洗必泰/磺胺嘧啶银或者米诺环素/利福平浸渍的中心静脉导管。综合措施应至少包括下列三项措施：对置管和导管维护人员进行培训，使用最大化无菌屏障预防措施，CVC置管时使用浓度大于0.5%的洗必泰和酒精消毒皮肤[106–113]。(IA类)

背景

某些导管和套管含抗菌剂或消毒剂涂层，尽管增加了额外的成本，但可以降低CRBSI的风险，并且可能节省治疗CRBSI的医疗成本[110]。有关抗菌剂/消毒剂导管的全部研究几乎均是对成人使用三腔、无套管的导管，导管保留不超过30天。虽然大部分的研究对象均为成年人，但是FDA允许将这些导管用于体重大于3公斤的任何患者。关于儿科ICU的两项非随机研究建议这类导管可减少导管相关感染的风险[112,113]。目前，尚无适用于体重小于3公斤婴儿的含杀菌剂或消毒剂的导管。

洗必泰/磺胺嘧啶银导管 仅在管腔外表面含有洗必泰/磺胺嘧啶银涂层的导管，经研究对减少CRBSI具有一定意义。有关第一代导管的两项荟萃分析表明，与标准无涂层导管相比，此类导管减少了CRBSI的风险[1,263]。在一项研究中，导管留置时间从5.1天至11.2天不等。第二代导管管内表面含有洗必泰涂层并扩展至外延设备和输液港，同时管外腔表面还涂有洗必泰/磺胺嘧啶银。与第一代导管相比，外表面含有3倍的洗必泰，同时延长释放表面杀菌剂。三项关于第二代导管的前瞻性随机试验证明了其可显著减少导管微生物定植，但与第一代相比，尚不能发现其对CRBSI的影响有任何不同[106-108]。抗感染活性的延长改善了预防感染的效果。虽然很少发生，但仍可见对洗必泰/磺胺嘧啶银导管的过敏反应。

洗必泰/磺胺嘧啶银导管比普通导管更贵。然而，一项分析表明在那些CRBSI风险较高且已严格执行预防策略 (例如，最大屏障预

防措施和无菌操作) 的科室，使用氯己定/磺胺嘧啶银导管每根可节省68至391美元的费用[271]。使用这种导管对于ICU患者、烧伤患者、中性粒细胞减少患者、和其它感染率超过3.3/千导管日的患者群体具有较高的成本收益率[264]。

米诺环素/利福平导管 在一项多中心的随机试验中，内外表面涂有米诺环素/利福平的CVC与第一代洗必泰/磺胺嘧啶银涂层的导管相比，CRBSI的发生率更低[109]。置管6天后开始出现利好影响。含米诺环素/利福平的硅胶CVC，平均留置时间超过60天，展示出能有效降低CRBSI[111]。在这些研究中，没有关于米诺环素/利福平的耐药微生物报道。两项研究表明，与无涂层导管相比，上述导管能够显著减少CRBSI[110, 111]。目前尚无关于第二代洗必泰/磺胺嘧啶银导管对比研究的报道。虽然对此种导管的耐药性进展具有一定的潜在性担忧，但是几项前瞻性临床研究表明这种风险还比较低[272, 273]。此外，尚无与导管使用有关的米诺环素或者利福平耐药的临床记录。两项使用决策模型分析的研究表明，这类导管与第一代洗必泰/磺胺嘧啶银导管相比，更能节约成本[274, 275]。目前更需要对第二代导管进行类似的分析研究。然而，由于感染发生的基线率降低和导管相关的费用减少，成本效益比率将发生变化。

决定是否使用含洗必泰/磺胺嘧啶银或者米诺环素/利福平的导管，应基于在执行了一系列的标准措施(例如，教育医务人员，使用最大化无菌屏障预防措施，以及浓度大于0.5%洗必泰和酒精消毒皮肤)之后，是否需要加强预防CRBSI，以及权衡考虑耐药微生物的出现和相关的费用问题。

铂/银导管 含有铂/银混合物的导管(即，银离子导入导管)已在美国使用。几项前瞻性随机研究将其与无涂层导管进行了对比[276–279]。一项研究表明导管微生物定植密度和CRBSI发病率均有所减少[278]，但其他研究发现有涂层导管与无涂层导管在导管微生物定植或者CRBSI方面没有差异[39, 276, 277]。鉴于这种情况，无法对使用或者禁止使用此类导管给出明确的意见。

※ 全身性预防应用抗生素

建议

不可为了预防导管定植或CRBSI，而在置管前或血管内导管留置期间常规给予全身性预防应用抗生素[114]。(IB类)

背景

几项研究评估了全身性预防应用抗生素对预防导管相关感染的作用。最近的一项荟萃分析研究回顾了对肿瘤患者的研究[114]。有4项研究在置管之前预防性使用糖肽。然而，这些研究的多样性很难对预防效果达成任何结论。

一项试验针对接受白介素2治疗的癌症患者，研究其连续口服利福平和新生霉素预防导管相关感染的效果[280]，尽管在26名患者中有9名 (35%) 由于药物副作用或者毒性停止了预防性抗生素治疗，试验中仍观察到CRBSI有所减少。对于非肿瘤患者，55名行置管并给予胃肠外营养治疗的患者，对其置管前给予万古霉素并未见任何收益。[281]。相似地，对于心血管手术的患者，延长围手术期预防性应用抗生素并不能减少中心静脉导管的细菌定植[282]。近期一项关于新生儿脐静脉导管预防性应用抗生素的回顾性研究，其结论表明源自随机研究的证据不足以支持或反驳预防性抗生素的作用[283]。

晚发性新生儿败血症常见致病菌为凝固酶阴性葡萄球菌，并且经常被认为源自污染的中心静脉导管。包括371名新生儿的5项比较研究采用了通过胃肠外营养持续输注万古霉素，或间歇性给药，以及给予安慰剂等方式。接受万古霉素治疗的婴儿，其败血症的发生率更低(RR0.11; 95%CI 0.05-0.24)，并且由凝固酶阴性葡萄球菌引

起的败血症相对较少(RR0.33; 95%CI 0.19–0.59)[284]。然而,在两组当中死亡率和住院时间并没有显著区别。对于万古霉素耐药微生物的选择风险,尚无足够的数据对其进行评估。

※ 抗生素/消毒剂药膏

建议

置管及每次透析结束之后,在血液透析导管出口处可使用碘伏消毒剂软膏或杆菌肽/短杆菌肽/多粘菌素B软膏。但要依据每个制造商提供的建议,确保软膏与血液透析导管的材质不会发生反应[59, 115–119]。(II类)

背景

为了试图减少置管部位的抗菌素负担并预防感染,许多局部抗生素或者消毒药膏都被使用过。一系列关于主要外周静脉导管的早期研究得出了不相同的结论[82, 285, 286]。另外,使用抗真菌活性有限的抗生素药膏可能会增加念珠菌属的定植或者感染[89]。

近来的研究分析了此种方法对高风险患者的效果,尤其是对血液透析的患者[116–119]。三项随机对照试验评估了10%碘伏的使用效果[117–119]。研究中观察到细菌定植、出口部位感染以及血流感染均出现显著的减少。收益最显著的方面为金黄色葡萄球菌在鼻腔部位的定植[117–119]。

鼻腔携带金黄色葡萄球菌的患者比无菌者更易发生CRBSI[287–289]。这就促使了研究人员评估外用莫匹罗星的疗效,该药为抗葡萄球菌的有效药物。几项研究证实了,在置管部位使用莫匹罗星药膏能使CRBSI的风险有效降低[117, 290–292]。其他的研究也显示鼻部应用莫匹罗星能产生类似的效果[288, 289, 293]。然而,一些研究中心快速出现了对莫匹罗星的耐药[88, 294, 295],以及莫匹罗星对聚氨酯导管的潜在不良影响[94, 95],都减弱了人们对这种方案的热衷。

唯一证实了在死亡率方面有显著影响的研究是在对169名血液透析患者中开展的,其中一组在置管部位使用杆菌肽/短杆菌肽/多粘菌素B药膏,对照组使用安慰剂[296]。与使用杆菌肽/短杆菌肽/多粘菌素B一组相比,使用安慰剂的一组患者出现了更多的感染(34%对比12%;相对风险0.35; 95%CI 0.18到0.68)。安慰剂一组患者的每千个导管日的感染数量(4.10对比1.02; $P<0.0001$)及每千个导管日的菌血症数量(2.48对比0.63; $P=0.0004$),均比较多。在6个月的研究期间内,安慰剂组的死亡人数为13,杆菌肽/短杆菌肽/多粘菌素B组的死亡人数为3($P=0.004$)。因此,在对透析患者的研究中所提供的证据表明,杆菌肽/短杆菌肽/多粘菌素B药膏能产生疗效,但是尚无类似数据支持其可用于其他类型的患者[296]。须注意的是,目前美国尚无含短杆菌肽的药膏。

※ 抗生素封管、抗菌导管冲洗和导管封管预防

建议

对于长期置管的患者,尽管较理想地执行了最大程度的无菌操作,但仍有多次CRBSI的病史,可采用预防性抗微生物药物溶液封管[120–138]。(II类)

背景

为了预防CRBSI,许多抗生素和消毒剂溶液被用来冲管或者封管[120–138]。封管是一项技术,当导管不使用时,通过这一操作将抗生素溶液注入导管腔并且置留一段时间。各种浓度抗生素可单独使用(针对特定微生物)或者混合使用(为了达到更广的覆盖面),预防性冲管或者对中心静脉导管进行封管,这些抗生素包括万古霉

素、庆大霉素、环丙沙星、米诺环素、丁胺卡那霉素、头孢唑林、头孢噻肟和头孢他啶;而消毒剂则包括酒精、牛磺罗定、柠檬酸钠。(牛磺罗定和柠檬酸钠未通过美国的审批)。这些药物通常与一种抗凝血剂混合使用,例如肝素或者EDTA。这些研究中的大多数都是针对数量较少的高风险患者进行的,例如血液透析者,新生儿,或者中性粒细胞减少的肿瘤患者。虽然大多数研究提示了抗生素冲管或封管对预防导管相关感染产生有利影响,但必须要与一些潜在的副作用、毒性、过敏反应、或出现耐药等相权衡。所用化合物的种类繁多、患者群体的差异性以及研究规模的限制或者研究设计的局限,均妨碍形成一般性的建议。另外,尚无被FDA批准上市的配方,大多数的配方均来自医院药房。下面是对一些研究的简要概述。

至少有10项研究涉及血液透析患者的冲管和封管[128, 129, 131–138]。三项荟萃分析均证实封管能降低血液透析患者CRBSI的感染风险[297–299]。这些研究中规模最大的是对291名患者进行前瞻性随机对比研究,分别使用30%柠檬酸钠与肝素进行比较[133]。用柠檬酸钠封管的组中CRBSI的比率明显降低(4.1BSI/千导管日对比1.1BSI/千导管日, $P<0.001$),对于血栓或者导管堵塞方面没有发现明显差异。然而,如果注入速度较快且浓度大的柠檬酸盐会导致严重的低钙血症、心律失常和死亡。血液透析患者中的第二大研究分析了用含有头孢唑林、庆大霉素和肝素的混合溶液封管与只用肝素的对照组间,对于封管效果的比较[135]。在120名受试者中,使用抗生素溶液封管的患者CRBSI的发生率明显降低(0.44BSI/千导管日对比3.12BSI/千导管日, $P=0.03$)[135]。其他血液透析患者的试验研究了米诺环素、庆大霉素、EDTA、肝素、牛磺罗定、万古霉素和头孢噻肟的情况。

至少有5项研究是针对儿童肿瘤患者开展的[120, 121, 124, 126, 127]。其中最大的一项是对126名患者进行的前瞻性、随机、双盲研究,对比研究了万古霉素/环丙沙星/肝素(VCH)与万古霉素/肝素(VH)以及单独使用肝素(H)的不同[124]。VCH和VH组发生中心静脉导管相关感染的时间明显滞后于肝素组,含抗生素的两组的感染率也明显低于肝素组(1.72/千CVC日[H]对比0.55/千CVC日[VCH]对比0.37/千CVC日[VH])。

一个包括7项随机对照试验的荟萃分析在使用含万古霉素溶液封管或者冲洗与单独使用肝素之间开展对比研究,万古霉素与肝素的风险比率为0.49(95%CI 0.26–0.95, $P=0.03$)[300]。使用封管技术明显比仅用万古霉素冲洗导管的收益大。

今日,一项前瞻性、双盲、随机试验对比了使用70%酒精封管与肝素生理盐水封管在预防肿瘤患者原发性CRBSI方面的作用。使用酒精封管的患者原发性CRBSI明显减少(0.60/千CVC日对比3.11/千CVC日; 0.18, 95%CI 0.05–0.65, $P=0.008$)[301]。

※ 抗凝剂

建议

对于一般患者,禁止常规使用抗凝以减少导管相关感染的风险[139]。(II类)

背景

置管后,血管内导管就会立即被一层调节膜所覆盖,其是由纤维素、血浆蛋白、以及细胞成分如血小板和红细胞所构成的[213, 302]。微生物与这层调节膜相互作用,导致了导管的定植[303]。中心静脉导管的血栓形成与感染之间有着密切的联系[221, 304, 305]。因此,使用抗凝剂来预防导管的血栓形成,并由此推测能够减少感染的风险。

一项荟萃分析评估了肝素(每毫升胃肠外营养液中加入3个单位

的肝素,每6或12小时用5,000单位冲管一次或2500单位低分子肝素皮下给药)对短期CVC患者的预防收益,预防性应用肝素可降低导管相关性中心静脉血栓的风险[139]。然而,对降低CRBSI感染率方面没有发现显著差异。更新的一项前瞻性、随机试验中,对204名使用非隧道式导管的患者给予连续肝素输液(100单位/公斤体重/天)或者生理盐水(50 mL/天)[306]。肝素组患者CRBSI感染率明显降低(2.5BSI/千CVC日对比6.4BSI/千CVC日)。由于大多数肝素溶液含有抗微生物活性的防腐剂成分,因此CRBSI感染率的下降是否由于血栓形成还是防腐剂或者是两者共同作用的结果还尚不清楚。大多数肺动脉导管、脐带导管和中心静脉导管都有含肝素的导管类型。大多数导管是混合含有肝素与苯甲烷铵的,这样就使导管具有抗菌活性[307]同时具有抗血栓形成的功能[308]。然而,也有一些导管直接与肝素结合而不含苯甲烷铵[309]。研究表明含肝素的导管能减低血栓的形成和CRBSI的风险[306, 308–310],但是与含洗必泰/磺胺嘧啶银的导管相比不能有效降低导管定植[311]。不幸的是,肝素可能引发血小板减少症,这使得许多临床工作者放弃对肝素的使用[312]。由于柠檬酸钠具有抗凝和抗菌两项特性,已将其作为推荐使用的封管溶液[133]。一项关于血液透析患者的前瞻性、随机、双盲对照研究中,与使用30%柠檬酸钠相比,透析间期使用肝素(5000 U/mL)明显增加了CRBSI的感染率(4.1BSI/千CVC日对比1.1BSI/千CVC日)[313]。

对华法令减少CVC血栓形成同时减少感染率的作用进行了研究评估[314–318]。长期置管CVC的患者中,低剂量的华法令(即,0.1 mg/天)能减少导管血栓的出现[142, 143]。然而,其他的研究并不确定能够减少血栓的形成,甚至有另外一些研究发现在用量为5-FU的患者中会发生一些不良的相互作用[319, 320]。相关数据非常有限;虽然低剂量华法令能够降低癌症患者血栓形成的风险,但并未提示能降低感染并发症。在一些研究中,超过20%的患者发生凝血酶原时间延长并需要调整剂量[321]。其他抗凝剂,例如Xa因子抑制剂或者直接凝血酶抑制剂,在减低导管相关感染方面尚未进行充分地评估。

※ 外周及中等长度导管的更换

建议

1. 为了减少感染及静脉炎的风险,成人外周导管的更换频率每次不宜少于72-96小时[36, 140, 141]。(IB类)
2. 对于是否仅当具有临床指征的时候才更换成人外周导管,尚无明确建议[142–144]。(未明确事项)
3. 仅当具有临床指征的时候才更换儿童外周导管[32, 33]。(IB类)
4. 仅当具有特别指征的时候才更换中心导管。(II类)

背景

已有建议将定期更换血管内导管作为一种预防静脉炎和导管相关感染的方法。对短外周静脉导管的研究提示,当导管留置时间超过72小时,血栓性静脉炎的发病率及导管的细菌定植就会增多[258]。然而,留置时间为72小时与96小时相比,外周导管静脉炎的发生率并无明显的不同[141]。由于静脉炎和导管定植与导管相关感染的风险升高有关,短外周导管通常每间隔72–96小时更换一次,从而减少感染的风险以及患者与静脉炎相关的不适感。

一些研究提示每72小时定期拔除导管与根据需要随时拔除导管,在静脉炎和导管故障的发生率方面效果类似[142–144]。然而,这些研究未解决CRBSI的问题,也并未研究CRBSI风险方面的问题。

中等长度导管与短外周导管相比,静脉炎发生率更低,与中心静脉导管相比感染发生率更低[322–324]。在一项涉及140根中等长

度导管的前瞻性研究中,相应的BSI发生率为0.8/千导管日[324]。没有与感染相关的特殊风险因素,包括导管留置时间。中等长度导管留置时间的中位数为7天,但最长可达49天。虽然研究结果提示,可以仅在出现特殊指征的时候才进行更换,但尚未有前瞻性随机实验对更换导管的方案进行评估,而该方案能够预防中线导管相关的CRBSI。

※ CVC、PICC及血液透析导管的更换

1. 禁止为了预防导管相关感染而常规更换CVC、PICC、血液透析导管或肺动脉导管。(IB类)
2. 禁止由于发热即拔除CVC或PICC。应依据临床判断考虑拔管的适应性,判断是否有其他部位的感染证据,或发热为非感染性因素所致。(II类)
3. 对非隧道式导管,禁止为了预防感染而常规使用导丝更换导管。(IB类)
4. 对于可疑感染的非隧道式导管,禁止使用导丝更换导管。(IB类)
5. 如果不存在感染的证据时,可以使用导丝更换导管来替换故障的非隧道式导管。(IB类)
6. 使用导丝更换导管时,在接触新的导管前须更换新的无菌手套。(II类)

背景

定期更换导管作为一种减少CRBSI的方法,并不能降低感染率。两项试验评估了每7天更换一次导管和按需更换导管这两种方案[165, 325]。其中的一项研究涉及112名外科ICU患者,这些患者需要留置CVC、肺动脉导管或者外周动脉导管[165],而另一项研究只涉及锁骨下血液透析导管[325]。两项研究均未发现这两种方案在预防CRBSI方面有任何差异。

定期使用导丝更换CVC是另一项预防CRBSI的建议性策略。一项包括12个随机对照实验的荟萃分析,评估了CVC的管理,其结果并未证实常规使用导丝更换CVC与按需更换导管的方法相比能够降低CRBSI的发生率[326]。因此对于功能良好的CVC不须常规更换,也没有证据显示能引起局部或系统性并发症。

通过导丝更换导管已经是一种被认可的技术,用于更换故障导管,或者当不再需要进行监测时将肺动脉导管更换为中心静脉导管。与在新部位经皮置管相比,通过导丝进行置管时,患者的不适感更低,机械损伤性并发症的发生率也明显降低[327]。另外,这一技术为某些患者保护了有限的静脉通路。由于感染源通常是从置管部位的皮肤隧道定植进入血管的,在出现菌血症时,通过导丝替换临时导管并非一种可接受的方案[37, 327]。然而,在隧道式血液透析导管患者发生菌血症时,通过导丝更换导管同时结合抗生素治疗,对于有限静脉通路的患者是一种替代性的挽救措施[328–331]。

由于儿童患者获得血管通路的难度较高,因此这类患者的换管频率需要特别注意。在一项使用生存分析技术的研究中,分析了儿科ICU的患者中心静脉置管留置时间与并发症的关系,研究中所有的患者(n=397)在观察时间的中位值为23.7天时,均未发生感染[250]。另外,尚未发现导管留置时间与感染发生的可能性之间存在关系($r=0.21$; $P>0.1$),提示常规更换CVC可能并不会减少导管相关感染的发生[250]。

新生儿的血管通路更为有限。近期Cochrane数据库系统中总结了4项随机试验(n=368),比较了经皮中心静脉导管给予胃肠外营养与经外周静脉导管通路的效果。对随机分入经皮放置CVC组的新生儿很少行疼痛的操作(例如静脉穿刺),也没有证据表明增加了BSI的风险[332]。

由血栓引起的CVC闭塞是拔除新生儿CVC的最常见原因之一。实验采用了各种各样的方法来预防导管堵塞。最近有一项随机试验($n=201$)评估了连续输入肝素(0.5单位/公斤体重/小时)能有效延长导管留置时间,对照组使用安慰剂。肝素组由于导管堵塞导致拔管的比率较低(6%对比31%, $P=0.001$; $NNT=4$)。虽然该研究没有能力评估CRBSI感染率的不同,但两组CRBSI的感染率很类似。肝素相关抗体水平没有被常规测量[333]。

血液透析导管。使用导管进行血液透析是导致透析患者菌血症的最常见因素[334, 335]。使用透析导管的患者,其菌血症的感染风险是动静脉(AV)瘘患者的7倍[336]。慢性肾脏衰竭患者采用动静脉瘘或动静脉移植优于血液透析导管,这是因为相应的感染风险更低。如果需要建立透析的临时通路,隧道式的套管导管优于不带套管的导管,如果预计的导管留置时间将超过3周,那么即使在ICU也是如此[59]。

肺动脉导管。肺动脉导管通过一个特氟隆®导引器植入,通常平均留置时间为3天。大多数肺动脉导管含有肝素,这样不但减少了导管血栓的形成,也减少了微生物的定植[307]。荟萃分析提示了肺动脉导管相关的CRBSI感染率为每千个导管日3.7例,比不含药物、非隧道式CVC要略高一些(2.7每1000导管天)[6, 45]。

前瞻性研究中的数据提示,有意义的导管定植和CRBSI的风险随着置管时间的延长而升高。一般来说,有意义的导管定植风险在置管4天以后开始升高[75, 337, 338],而CRBSI的感染风险在置管5-7天以后开始增加[75, 84, 166]。必须努力区分导管感染是与导引器相关的还是与由肺动脉导管引发的。有意义的导引器定植的发生常常早于肺动脉导管定植的发生[337, 339]。然而,没有研究表明定期更换导管能够有效地减少CRBSI的感染风险[165, 327, 339]。对于需要持续血液动力学监测的患者,肺动脉导管的更换周期不宜少于7天[339]。对于需要留置7天以上的患者,尚无常规更换导管方面的建议。

肺动脉导管通常装在一个薄塑料套里,以防止放置导管时的接触污染。在一项对166根导管进行的研究中,随机分配的带有这种塑料套导管的患者组,其CRBSI的风险相对于无塑料套导管的一组患者低($P=0.002$)[81]。

※ 脐带导管

建议

1. 如果出现任何导管相关性血流感染、下肢血管功能不全或者血栓形成的征象时,应拔除且不再重新更换脐动脉导管[145]。(II类)
2. 如果出现任何导管相关性血流感染或者血栓形成的征象时,应拔除且不再更换脐静脉导管[145]。(II类)
3. 关于通过导管给予抗生素治疗以试图挽救脐带导管尚无明确建议。(未明确事项)
4. 置管前,使用消毒剂清洁脐带导管插管部位。为了避免对新生儿甲状腺造成潜在影响,清洁时不宜使用碘酒。其他含碘产品(如,碘伏)可以使用[146–150]。(IB类)
5. 由于潜在地促进真菌感染和抗菌素耐药,应避免在脐带导管置管部位使用抗生素软膏或者乳膏[88, 89]。(IA类)
6. 将低剂量肝素加入经脐动脉导管输液中(0.25–1.0 U/ml)[151–153]。(IB类)
7. 一旦不再需要脐带导管,或发现任何下肢血管功能不全的征象时,应尽快拔除导管。理想状态下,脐动脉导管的留置时间不宜超过5天[145, 154]。(II类)
8. 一旦不再需要脐静脉导管,应尽快拔除,但是如果无菌管理得当,最多可留置14天[155, 156]。(II类)

9. 如果脐带导管出现故障,而无其它拔管指征,且脐动脉导管总留置时间不超过5天或脐静脉导管总留置时间不超过14天时,可以更换脐带导管。(II类)

背景

虽然出生以后不久脐带残端即被大量微生物定植,但是脐带血管置管通常被新生儿作为血管通路。脐带血管置管方便,既可采集血液样本又能进行血液动力学测量。脐带静脉导管与脐动脉导管发生导管定植和血流感染的几率相类似。在几项研究中,脐动脉导管定植的发生率估计为40%–55%,并且有5%引发CRBSI;脐带静脉导管定植的发生率为22%–59%[147, 148, 340],3%–8%引发CRBSI[148]。虽然高位(即,横膈膜以上)与低位(即,横膈膜以下主动脉分叉以上)留置脐带导管所引发CRBSI的概率相似,但是高位置管所引发的血管并发症更少,并且不会增加后遗症[148]。

脐动脉和脐带静脉导管的感染风险因素不同。一项研究发现,极低出生体重的新生儿,同时使用10天以上的抗生素,会增加脐动脉CRBSI的风险[148]。相比之下,出生体重较高的婴儿,同时接受胃肠外营养液治疗,则会增加脐带静脉CRBSI的风险。对于任何类型的脐带导管,置管时间都不是感染的独立风险因素。

一项近期的随机试验($n=210$)评估了长期脐带静脉置管(最多28天)的新生儿,其导管相关的CRBSI感染率与短期(7–10天)脐带静脉置管随后进行经皮中心静脉置管组的新生儿相比较,是否类似或者更低,其中的分配是随机的。长期置管的新生儿CRBSI感染率(20%)要高于短期置管的新生儿(13%)。虽然此项研究没有力度,这一差别仍不具有统计学意义($P=0.17$)。此研究尚不能对于静脉血栓的发生率做出评估[341]。

※ 成人和儿童患者的外周动脉导管和压力监测装置

建议

1. 人应使用桡、肱或者足背血管作为置管部位要比股或腋窝血管更有利于降低感染风险[46, 47, 157, 158]。(IB类)
2. 儿童患者不应使用肱血管作为置管部位。选择桡、足背及胫后血管作为置管部位要优于股或腋窝血管[46]。(II类)
3. 在外周动脉置管过程中,至少使用帽子、口罩、无菌手套及小的消毒巾[47, 158, 159]。(IB类)
4. 在行腋窝或股动脉置管过程中,应使用最大化无菌屏障预防措施。(II类)
5. 仅当具有临床指征时才可更换动脉导管。(II类)
6. 一旦不再需要,应尽快拔除动脉导管。(II类)
7. 尽量使用一次性传感器组件,而不用可重复使用的组件[160–164]。(IB类)
8. 不可为了预防导管相关感染而常规更换动脉导管[165, 166, 167, 168]。(II类)
9. 一次性或可重复使用的传感器应每间隔96小时更换一次。更换传感器的同时还应更换系统内的其他组件(包括管道系统、连续冲洗装置和冲洗液)[37, 161]。(IB类)
10. 保持压力监测系统的所有组件(包括校准设备和冲洗液)处于无菌状态[160, 169–171]。(IA类)
11. 减少操作及进入压力监测系统的次数。使用封闭的冲洗系统(即连续冲洗),而非开放性系统(即使用注射器和三通阀)来保持压力监测导管通畅[163, 172]。(II类)
12. 当压力监测系统的通路入口不是三通阀而是隔膜板时,在进入系统前应使用适宜的消毒剂擦拭隔板[163]。(IA类)
13. 禁止通过压力监测管路输注含葡萄糖的溶液或者胃肠外营养液

[163, 173, 174]。(IA类)

14. 如果无法使用一次性传感器, 应依据制造商的说明消毒可重复使用的传感器[163, 173–176]。(IA类)

背景

动脉导管通常置入桡动脉或者股动脉, 同时允许连续的血压和血气监测。动脉导管CRBSI的风险要低于无涂层、无套管、非隧道式的短期CVC(1.7对比2.7/千导管日)[6]。然而, 动脉导管的CRBSI风险与有涂层、无套管、非隧道式的短期CVC相比具有可比性[6]。与CVC不同, 在动脉置管期间使用完全屏障预防措施并不能显著减少动脉的CRBSI感染风险[158, 159]。尽管如此, 当使用包括最大化无菌屏障的方案进行动脉置管时, 仍可出现较低比例的CRBSI(0.41/千导管日)[47]。一项荟萃分析虽然没能区别出三个不同部位(桡, 股和腋窝的)置管的CRBSI感染率差异[342], 股动脉导管定植的发生率常更多见一些[158]。此外, 一项包括2900根动脉导管的前瞻性观察研究中, 置管过程均采用了最大化无菌屏障措施, 其结果证实了与桡动脉置管相比, 股动脉置管的CRBSI感染率几乎增加了8倍[343]。此外, 选择股动脉作为置管部位时, 由革兰氏阴性细菌引发的CRBSI感染风险更高[343]。桡动脉与足背动脉相比, 导管定植和CRBSI的发生率相似[157]。随着导管留置时间的延长, CRBSI的风险也增高[166, 344]; 然而, 定期更换动脉导管并不能减少CRBSI的风险[165]。如果没有发现感染的证据, 留置时间超过5天的导管不应该常规更换。

※ 输注装置的更换

建议

1. 对于不输注血液、血液制品或者脂肪乳的患者, 连续使用的给药装置 (包括辅助装置及附件) 的更换周期不宜少于96小时[177], 但至少应每7天更换一次[178–181]。(IA类)
2. 对于间歇使用的给药装置, 尚无对其更换频率方面的建议。(未明确事项)
3. 对于植入式输液港的连接针头, 尚无对其更换频率方面的建议。(未明确事项)
4. 用于输注血液、血液制品或者脂肪乳(可与氨基酸和葡萄糖组成混合液, 或者单独输注)的输注装置系统应在输液开始后的24小时内进行更换[182–185]。(IB类)
5. 根据制造商的建议(美国食品药品监督管理局网站Medwatch), 输注异丙酚时应每6或12小时更换输液瓶时更换输液管[186]。(IA类)
6. 对于植入式输液港的连接针头, 尚无对其留置时间方面的建议。(未明确事项)

背景

许多良好的对照研究和荟萃分析都对静脉输液给药装置的理想更换周期进行了研究。这些研究中的数据揭示, 从装置使用开始, 更换周期不小于每72-96小时一次是安全且成本收益最大化的[141, 177, 179–181]。近来更多的研究建议, 如果使用消毒导管或者不输注促进微生物生长的液体(例如, 肠胃外营养液或者血液), 则给药装置可安全使用至7天[216, 345]。当输注促进微生物增长的液体时(例如, 脂肪乳和血液制品), 更换给药装置的频率应增加, 因为这些制品已经被确认为是引发CRBSI的独立风险因素[182, 216, 346–350]。尚无数据涉及连接植入式输液港的针头可留置时间的长度以及CRBSI的风险。一些医疗中心留置了数周而未引起CRBSI[351], 这一实践尚未得到充分地研究。

※ 无针连接系统

建议

1. 无针装置的更换频率至少应与输液装置一样。更换周期小于每72小时一次并没有任何益处[39, 187–193]。(II类)
2. 为了降低感染率, 更换无针连接系统接头的周期不应小于每72小时一次, 或参照制造商的建议[187, 189, 192, 193]。(II类)
3. 确保系统的所有部分能互相兼容, 从而减少漏液和系统破裂[194]。(II类)
4. 通过使用适当的消毒剂(洗必泰、碘伏、碘酒、或70%酒精)擦洗输液港的接入口, 同时仅使用无菌装置接触输液港入口, 从而减少污染风险[189, 192, 194–196]。(IA类)
5. 使用无针系统接入静脉输液管。(IC类)
6. 使用无针系统时, 分隔膜式输液接头 (split septum valve) 要优于机械阀输液接头, 因为机械阀接头可增加感染风险[197–200]。(II类)

背景

注射药物、给予静脉输液以及采集血液标本时使用的三通(stopcock)是微生物进入导管和静脉输液中的潜在通道。这种污染是否为引发CRBSI的微生物的主要来源尚不能明确。尽管如此, 三通在不用时应盖上盖子。一般来说, 密闭式的导管系统比开放式统引发CRBSI的几率要少一些, 应尽量使用密闭式系统[352]。

“背负式”系统(通过主系统上的输液港连接, 间断给液)可作为三通的替代物使用。然而, 如果设备连接输液港入口处的橡胶膜暴露于空气, 或如果连接设备直接接触了被用于固定针头和输液港的胶带, 这一系统仍然具有污染静脉液的风险。经过改进的背负式系统能够潜在地预防这些部位的污染[353]。

为了减少医护人员被锐器刺伤以及减少由此导致血源性感染的风险, 促使了无针输液接头被引进及使用。市场上有多种类型的无针输液接头。

第一类无针输液接头是由一个分隔膜接头组成, 使用一种钝套管代替了针头(外部套管控制的分隔膜)。由于连接头具有大量的空间容纳管套, 当拔除管套时可产生负压, 会使血液被吸入末端腔内, 并可能增加导管闭塞或者血栓形成的风险。鲁尔(Luer)控制装置被设计成能够防止液体通过接头而外流, 因此被用于解决上述问题。一些鲁尔装置要求在不使用时加盖一个盖子以达到效果, 这就给保持无菌状态带来困难, 因此也使得这种装置易于被污染。

另一类第二代类无针输液接头解决了阻塞的问题, 其原理是通过结合阳性或中性的流体置换来冲洗吸出的血液或防止吸出物进入输液管。

在一些(而不是所有)研究中[356], 与使用三通和盖子相比较, 使用无针输液接头或者机械阀, 似乎可以有效的减少连接器定植[196, 354, 355]。在一项研究中[354], 与使用标准的三通相比, 使用无针连接头可有效减少CRBSI的发生。为了预防微生物通过输液接头传播, 必须使用恰当的消毒剂[357]。一些研究已经提示, 使用洗必泰/酒精溶液消毒设备在减少细菌定植方面似乎是最有效的[195, 196]。此外, 消毒的时间可能是很重要的。一项研究发现用70%酒精擦拭鲁尔控制装置仅3至5秒钟不足以达到对隔膜表面消毒的目的[358]。然而, 一些感染爆发调查研究报告了, CRBSI的增多与将外部套管控制的分隔膜无针装置转换为机械阀门装置有关[197, 198, 200, 359]。这一相关性的原因尚不清楚, 同时也不清楚是否与设备的特殊性或类型有关, 特别是由于各种无针输液接头之间材质和机械属性的不同。另外, 一项调查发现随着将鲁尔控制的负置换机械阀更换为鲁尔控制的正液体置换机械阀时, CRBSI随之而增加了[199]。然而在一项观察研究中显示, 能使CRBSI显

著降低的一系列措施中的一部分,是将一个鲁尔控制的负置换机械阀更换为一个不同的鲁尔控制的正置换机械阀[201]。对那些与设备有关的感染爆发的可能解释包括:由于隔膜界面塑料外壳的物理特性,导致了接头表面消毒困难;液体流动的特性(层流或者快速流动的);内表面;潜在的液体死腔;由于很难看见不透明装置内的液体流动路径,造成了冲洗的不充分;以及能容纳微生物的内部沟纹,特别是如果用导管抽血时[199]。一些研究表明,更换鲁尔控制装置所引发的CRBSI的增加,可能与清洁不当和感染控制措施不力相关,例如很少更换装置[192, 194]。另外, FDA已经批准了银涂层的接头阀;然而关于这种设备的随机试验尚未发表,也没有涉及其应用的相关建议。同样,一种用于无针接头的消毒屏障盖已经开始了实验室研究,结果显示可有效预防微生物的进入 [360],但仍未在临床试验中进行过研究。

※ 效果的提升

通过将多种策略“捆绑”在一起,采用具有医院特色的或是以协作为基础的创新方式,从而改善以循证为基础的操作依从性[15, 69, 70, 201–205]。(IB类)

背景

临床决策者、医疗费用的承担者和患者安全倡导者均强调了将研究成果转化为日常操作的重要性。使用具有高内在效力的研究设计对CRBSI的预防操作进行严格评估,同时还包括对优化外在效力的人群开展研究。一旦确定某些操作是有效的、高效率的,下一步就是引入这些基于循证医学的操作,使之作为常规临床护理来执行。不幸的是,在美国的医院中,基于询证医学的CRBSI预防措施的执行并不是最理想的[361, 362]。一项于2005年3月进行的全国性调查,包括了超过700家美国医院,大约四分之一的美国医院提示无论中心静脉置管时使用最大化无菌屏障预防措施,还是用葡萄糖酸洗必泰进行置管部位消毒,这两项措施均没有被常规执行,而此两项措施在2002年出版的指南中是被强烈推荐推荐的[364]。大约15%的美国医院为了预防感染而常规更换CVC,尽管有证据表明不应再常规对其进行更换[362, 364]。

因此,研究者尝试了各种各样的方法来将研究发现和循证医学建议更好地转化为临床实践。在过去的几年当中,许多关于改善质量的研究被陆续发表,它们采用了各种各样的方法,例如对医护人员的教育,审核与反馈,组织结构的改建,以及设置临床提醒人员[8–11, 69, 70, 202, 365–367]。教育干预措施主要关注手部卫生,置管时使用最大化无菌屏障,选择正确的置管部位,使用葡萄糖酸洗必泰进行正确的局部护理,以及立即拔除不必要的导管。当大量使用同期对照组的前后研究被发表时,仍未见研究进行涉及评估质量改善策略的随机对照试验,其目的旨在预防CRBSI[368]。大多数的前后对照研究报道了在执行了质量提升策略以后, CRBSI的发生率出现了统计学上的显著下降[368]。另外, 两项对照研究也发现, 干预病房与对照病房相比, CRBSI均出现统计学上的显著下降[15, 70]。

研究者也从多个不同角度采取措施,将几项策略捆绑在一起来提高循证医学指南的依从性[15, 69, 70]。这些合作研究[69]中有一项涉及了密西根州的108个ICU,目的是评价临床工作者对5项循证医学实践的应用,包括:手卫生、最大化无菌屏障预防措施、洗必泰局部消毒、避免股静脉置管、并且立即拔除不再需要的中心静脉导管。除了为临床工作者提供CRBSI预防措施的培训,还包括其他干预措施:1)中心静脉导管推车,装有所有必须用品;2)清单,用于确保坚持适当的操作;3)如果循证医学操作没得到遵循,在非急症情况下应立即停止操作进程;4)立即拔除在日常查房中确认不再需要的中心导管;5)向临床团队反馈CRBSI流行情况和总体发病

率;6)从医院的首席执行官处购入葡萄糖酸洗必泰产品/溶液,并在研究开始前储存好。研究者在使用一种中断的时间序列和多变量回归分析的方法下,报道了在开始执行这些干预措施后的大约18个月, CRBSI降低66%,具有统计学意义[69],并随着时间的推移持续减低[369]。基于已经明确的为了提升表现的领域,追踪和反馈的特殊过程和结果评估措施也应该在各自的领域内确定(即,中心静脉感染率、中心静脉置管的总比例或个体比例,及使用或记录的全部捆绑措施)。

最后,置管后注意导管的护理和维护,应该是所有程序措施内提升表现和保证质量的重心。一项研究,旨在评估操作和医务人员CVC置管后护理知识,以及明确可能改善CVC护理方面的问题,该研究提示了几个方面能改善置管后的护理[370]。一共包括了106名患者,记录了151根中心静脉导管的数据,总共721个导管日。该研究共确定了323次护理方面的不规范操作,不规范率为44.8%,并发现ICU与非ICU病房之间有显著的差别。敷料(不完整)和盖子(放置不正确)被确定是CVC护理中的主要问题,分别为每千导管日158次和156次不规范操作。改善护理可靠性的措施应该将注意力集中于如何使最好的操作更易于执行。

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