

Evidence review: prevention and management of neutropenic sepsis in cancer patients

Reference and country	Study type and period	Number of patients	Prevalence	Patient characteristics	Tests used/prognostic factors	Outcomes and reference standard	Results	Source of funding	Additional comments																																																			
Al Bahar 2000 Kuwait	Retrospective case series. Consecutive sample. Study period not reported	133 FN episodes in 64 patients	Line preservation: 121/133 Clinically documented infection: 17/133 Microbiologically documented infection: 41/133 Catheter related infection: 32/133 Infectious mortality: 4/133 Overall mortality: 10/133	Patients with acute leukaemia, Hickman catheters, fever (38.5°C or >38°C twice within 12h) and neutropenia (<1.0 X 10 ⁹ /L) Median age 31 years. All had haematological cancer.	Infection type: catheter related versus not. Catheter related infection, further defined as exit site infection (further definition given), tunnel infection (further definition given), catheter related blood stream infection (further definition given) or septic thrombophlebitis (further definition given)	Catheter removal – not defined further. Response to antimicrobial treatment Infectious mortality	<table border="1"> <thead> <tr> <th rowspan="2">Infection type</th> <th colspan="2">Line preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Tunnel</td> <td>0</td> <td>3</td> </tr> <tr> <td>Exit site</td> <td>7</td> <td>5</td> </tr> <tr> <td>CVC-related bacteraemia/fungemia</td> <td>13</td> <td>2</td> </tr> <tr> <td>Septic phlebitis</td> <td>0</td> <td>1</td> </tr> <tr> <td>Not catheter related</td> <td>101</td> <td>0</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th rowspan="2">Catheter related infection</th> <th colspan="2">Infectious mortality</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Tunnel</td> <td>0</td> <td>3</td> </tr> <tr> <td>Exit site</td> <td>0</td> <td>12</td> </tr> <tr> <td>CVC-related bacteraemia/fungaemia</td> <td>2</td> <td>13</td> </tr> <tr> <td>Septic phlebitis</td> <td>0</td> <td>1</td> </tr> <tr> <td>None</td> <td>2*</td> <td>99</td> </tr> </tbody> </table> <p>*In 2/32 cases of catheter related infection the patients died of Candida albicans septicaemia. The two patients with non CVC-related infection died of pneumonia.</p> <table border="1"> <thead> <tr> <th rowspan="2">Catheter related infection</th> <th colspan="2">Response to antimicrobial</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Yes</td> <td>30</td> <td>2</td> </tr> <tr> <td>No</td> <td>101</td> <td>0</td> </tr> </tbody> </table>	Infection type	Line preservation		Yes	No	Tunnel	0	3	Exit site	7	5	CVC-related bacteraemia/fungemia	13	2	Septic phlebitis	0	1	Not catheter related	101	0	Catheter related infection	Infectious mortality		Yes	No	Tunnel	0	3	Exit site	0	12	CVC-related bacteraemia/fungaemia	2	13	Septic phlebitis	0	1	None	2*	99	Catheter related infection	Response to antimicrobial		Yes	No	Yes	30	2	No	101	0	Not reported	
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De Pauw	Retrospective	123 cases of catheter	Catheter removal	Patients with microbiological	Type of gram-positive	Catheter	In patients with confirmed Gram-	Merrell Dow																																																				

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Elishoov 1998. Israel	Prospective case series. Consecutive sample. 5 year study period (start not reported)	242 patients,	161 febrile episodes in 120 patients. 112 episodes of septicaemia in 90 patients. 100 catheter related infections in 81 patients.	Patients undergoing bone marrow transplant, who had Hickman or Broviac catheters. Median age 21 (range 1 to 53 years) All had haematologica l cancer	Bacteraemia: defined as a positive blood culture (further definition given). Septicaemia: bacteraemia (or fungaemia) plus clinical signs. Catheter related infection,	Mortality during infectious episode	<table border="1"> <thead> <tr> <th rowspan="2">Infection type</th> <th colspan="2">Infectious mortality</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>CVC related bacteraemia/fungaemia</td> <td>4</td> <td>47</td> </tr> <tr> <td>Not CVC-related</td> <td>6</td> <td>55</td> </tr> </tbody> </table> Gram-positive organisms <table border="1"> <thead> <tr> <th rowspan="2">Organism</th> <th colspan="2">Infectious mortality</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Coagulase negative staphylococcus aureus</td> <td>1</td> <td>28</td> </tr> <tr> <td>Streptococcus Viridans</td> <td>1</td> <td>2</td> </tr> </tbody> </table>	Infection type	Infectious mortality		Yes	No	CVC related bacteraemia/fungaemia	4	47	Not CVC-related	6	55	Organism	Infectious mortality		Yes	No	Coagulase negative staphylococcus aureus	1	28	Streptococcus Viridans	1	2	Not reported	
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				(N=209) or non-malignant haematological disorder (N=33).	defined as exit site infection (further definition given), tunnel infection (further definition given), catheter related blood stream infection (further definition given) or septic thrombophlebitis (further definition given) Type of infecting microorganism		<p>Gram-negative organisms</p> <table border="1"> <thead> <tr> <th rowspan="2">Organism</th> <th colspan="2">Infectious mortality</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Pseudomonas aeruginosa</td> <td>4</td> <td>9</td> </tr> </tbody> </table> <p>Other organisms</p> <table border="1"> <thead> <tr> <th rowspan="2">Organism</th> <th colspan="2">Infectious mortality</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Candida species</td> <td>2</td> <td>8</td> </tr> <tr> <td>Polymicrobial</td> <td>2</td> <td>7</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th rowspan="2">Infection type</th> <th colspan="2">Infectious mortality</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Septic thrombophlebitis with septicaemia</td> <td>2</td> <td>1</td> </tr> <tr> <td>Tunnel infection with septicaemia</td> <td>0</td> <td>3</td> </tr> <tr> <td>Exit site infection ONLY</td> <td>0</td> <td>25</td> </tr> <tr> <td>CVC-related bacteraemia or fungaemia ONLY</td> <td>2</td> <td>42</td> </tr> <tr> <td>Non CVC-related septicaemia</td> <td>6</td> <td>56</td> </tr> <tr> <td>Colonization only (no clinical signs)</td> <td>0</td> <td>24</td> </tr> </tbody> </table>	Organism	Infectious mortality		Yes	No	Pseudomonas aeruginosa	4	9	Organism	Infectious mortality		Yes	No	Candida species	2	8	Polymicrobial	2	7	Infection type	Infectious mortality		Yes	No	Septic thrombophlebitis with septicaemia	2	1	Tunnel infection with septicaemia	0	3	Exit site infection ONLY	0	25	CVC-related bacteraemia or fungaemia ONLY	2	42	Non CVC-related septicaemia	6	56	Colonization only (no clinical signs)	0	24		
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Hanna 2004. USA	Retrospective case series. 1990-1996	72 patients	Removal of CVC, 67/72 Mortality: 34/72 Mortality due	Patients with cancer and catheter-related Gram-negative bacteraemia.	ICU, mechanical ventilation, steroids, radiotherapy, transplantation	Removal of CVC Relapse of infection.	<p>In patients with CVC related Gram-negative bacteraemia:</p> <table border="1"> <thead> <tr> <th>CVC site inflammation</th> <th>Line preserved</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> </tbody> </table>	CVC site inflammation	Line preserved																																										
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			to Gram-negative infection: 3/72	Mean age was 51 years in those with CVC removed and 49 years in the others. 26% of patients had haematological cancer.	chemotherapy, fever, CVC-site inflammation, fever, neutropenia		<table border="1"> <tr> <td></td> <td>Yes</td> <td>No</td> </tr> <tr> <td>CVC site inflammation</td> <td>0</td> <td>13</td> </tr> <tr> <td>No CVC site inflammation</td> <td>5</td> <td>54</td> </tr> </table> <table border="1"> <tr> <td rowspan="2">Fever</td> <td colspan="2">Line preserved</td> </tr> <tr> <td>Yes</td> <td>No</td> </tr> <tr> <td>Yes</td> <td>5</td> <td>62</td> </tr> <tr> <td>No</td> <td>0</td> <td>5</td> </tr> </table>		Yes	No	CVC site inflammation	0	13	No CVC site inflammation	5	54	Fever	Line preserved		Yes	No	Yes	5	62	No	0	5		
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Hartman 1987	Case series 1979-1984	63 catheters in 50 patients	Complications 76 in 40 catheters . Catheter related infections: 39/63 Mechanical complications: 24 in 20 catheters. Death due to catheter complication:	Paediatric oncology patients selected for long term catheterization with Hickman or Broviac catheter. Patients had demonstrated ablation of peripheral sites or were predicted to have difficult	Infectious complication type (CVC related bacteraemia or exit site/tunnel infection), infection organism, neutropenia at time of insertion. Exit site infection: defined as	Removal of CVC	<p>In 39 patients with CVC-related infections:</p> <table border="1"> <tr> <td rowspan="2">Infection type</td> <td colspan="2">Line preserved</td> </tr> <tr> <td>Yes</td> <td>No</td> </tr> <tr> <td>CVC related bacteraemia</td> <td>30</td> <td>2</td> </tr> <tr> <td>Exit site inflammation</td> <td>6</td> <td>1</td> </tr> </table> <p>In 39 catheters with CVC-related</p>	Infection type	Line preserved		Yes	No	CVC related bacteraemia	30	2	Exit site inflammation	6	1	Not reported										
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			1/63 Tumour seeding: 1/63	induction therapy. Median age was 3.1 years. 63% had haematological cancer.	progressive erythema of exit site or subcutaneous tunnel. Catheter related sepsis: defined as at least one positive blood culture with fever or other signs of systemic sepsis without an identified source.		infections there were 44 organisms isolated (some cultures yielded than one organism): Gram positive <table border="1" data-bbox="1327 496 1656 886"> <thead> <tr> <th rowspan="2">Organism</th> <th colspan="2">Line preserved</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Staphylococcus aureus</td> <td>3</td> <td>1</td> </tr> <tr> <td>Staphylococcus epidermis</td> <td>8</td> <td>0</td> </tr> <tr> <td>Streptococcus</td> <td>5</td> <td>0</td> </tr> <tr> <td>Enterococcus*</td> <td>2</td> <td>1</td> </tr> </tbody> </table> Gram negative <table border="1" data-bbox="1327 995 1656 1412"> <thead> <tr> <th rowspan="2">Organism</th> <th colspan="2">Line preserved</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Escherichia coli*</td> <td>2</td> <td>1</td> </tr> <tr> <td>Gram negative bacilli</td> <td>3</td> <td>0</td> </tr> <tr> <td>Klebsiella</td> <td>2</td> <td>0</td> </tr> <tr> <td>Acintobacter</td> <td>2</td> <td>0</td> </tr> <tr> <td>Enterobacter</td> <td>2</td> <td>0</td> </tr> </tbody> </table>	Organism	Line preserved		Yes	No	Staphylococcus aureus	3	1	Staphylococcus epidermis	8	0	Streptococcus	5	0	Enterococcus*	2	1	Organism	Line preserved		Yes	No	Escherichia coli*	2	1	Gram negative bacilli	3	0	Klebsiella	2	0	Acintobacter	2	0	Enterobacter	2	0		
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Holloway 1995. USA	Case series-unclear whether prospective / consecutive 1990 - 1993	105 women with 111 catheter insertions.	Removal of CVC due to complications: 13/111	Women attending a gynaecologic oncology service who were fitted with Groshong catheters. Mean age 60 years. None	Infectious complications (tunnel infection, bacteraemia, thrombosis, cellulitis),	Catheter removal	<table border="1"> <thead> <tr> <th rowspan="2">Infectious complications</th> <th colspan="2">Line preserved</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Tunnel</td> <td>0</td> <td>3</td> </tr> </tbody> </table>	Infectious complications	Line preserved		Yes	No	Tunnel	0	3																				
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Joo 2011. Korea	Retrospective case series. 1996-2007	51 patients	<p>Catheter removal: 13/51</p> <p>Catheter salvage: 38/51</p> <p>Successful salvage: 20/38</p>	<p>Patients with neutropenia and a catheter related infection,</p> <p>Mean age was 50 years.</p> <p>59% had haematological malignancy.</p>	<p>Gender, underlying disease, comorbid conditions, CVC type, duration of catheterization, risk group, neutropenia, initial ANC, isolated pathogens, presence of complication</p>	<p>Salvage attempted (CVC not removed immediately)</p> <p>Successful salvage: defined as retaining the catheter at the time of discharge</p>	<p>In 38 patients where salvage was attempted:</p> <table border="1"> <tr> <td rowspan="2">Septic shock</td> <td colspan="2">Successful salvage</td> </tr> <tr> <td>Yes</td> <td>No</td> </tr> <tr> <td>Septic shock</td> <td>1</td> <td>4</td> </tr> <tr> <td>No septic shock</td> <td>19</td> <td>14</td> </tr> </table> <table border="1"> <tr> <td rowspan="2">Risk group</td> <td colspan="2">Successful salvage</td> </tr> <tr> <td>Yes</td> <td>No</td> </tr> <tr> <td>High</td> <td>6</td> <td>8</td> </tr> <tr> <td>Low</td> <td>14</td> <td>10</td> </tr> </table> <p>Gram-positive organisms</p> <table border="1"> <tr> <td rowspan="2">Organism</td> <td colspan="2">Successful salvage</td> </tr> <tr> <td>Yes</td> <td>No</td> </tr> <tr> <td>Staphylococcus aureus</td> <td>3</td> <td>3</td> </tr> </table>	Septic shock	Successful salvage		Yes	No	Septic shock	1	4	No septic shock	19	14	Risk group	Successful salvage		Yes	No	High	6	8	Low	14	10	Organism	Successful salvage		Yes	No	Staphylococcus aureus	3	3	Not reported	
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Junqueira	Retrospective	192 catheters were inserted	Catheter-related	Children with acute	Type of infection,	Catheter removal,		No conflicts																																							

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Reference and country	Study type and period	Number of patients	Prevalence	Patient characteristics	Tests used/prognostic factors	Outcomes and reference standard	Results	Source of funding	Additional comments																																		
2010. Canada	observation study. Consecutive sample. 2005-2008	in 179 children	infection: 43/192 Catheter removal due to infection: 12/192 Catheter removal due to mechanical complication: 3/192	lymphoblastic leukaemia who had a port-a-catheter inserted.	infecting organism	catheter related infection.	<table border="1"> <thead> <tr> <th rowspan="2">Infection type*</th> <th colspan="2">Line preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Tunnel</td> <td>1</td> <td>7</td> </tr> <tr> <td>Exit-site inflammation</td> <td>9</td> <td>0</td> </tr> <tr> <td>CVC-related bacteraemia/fungae mia</td> <td>25</td> <td>5</td> </tr> <tr> <td>Bacteraemia – not CVC related</td> <td>15</td> <td>4</td> </tr> </tbody> </table> <p>*Some children had more than one infection type.</p> <table border="1"> <thead> <tr> <th rowspan="2">Organism</th> <th colspan="2">Line preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Coag. Neg. Staphylococcus</td> <td>4</td> <td>7</td> </tr> <tr> <td>Staphylococcus aureus</td> <td>1</td> <td>2</td> </tr> <tr> <td>Streptococcus species</td> <td>6</td> <td>0</td> </tr> <tr> <td>Gram-negative organisms</td> <td>N.R.</td> <td>0</td> </tr> </tbody> </table>	Infection type*	Line preservation		Yes	No	Tunnel	1	7	Exit-site inflammation	9	0	CVC-related bacteraemia/fungae mia	25	5	Bacteraemia – not CVC related	15	4	Organism	Line preservation		Yes	No	Coag. Neg. Staphylococcus	4	7	Staphylococcus aureus	1	2	Streptococcus species	6	0	Gram-negative organisms	N.R.	0	of interest reported.	
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Millar 2011. UK	Prospective multicentre observational study, HTA report and systematic review. 2005-2006	181 children (179 included in analysis)	<p>FRC (fever, rigors, chills and or hypotension associated with CVC manipulation): 13/179</p> <p>At 28 days of follow-up: CVC removal due to infection: 10/181</p> <p>CVC removal for any other reason 0/181</p> <p>Positive blood culture: 36/179</p> <p>Pathogenic organism in blood culture</p>	<p>Children, aged 0–18 years with fever having treatment for cancer or severe haematological disorder.</p> <p>Participants had a tunnelled CVC or an implanted CVC port required for at least 3 months. Median age was 7yrs (IQR 3 to 11). 65% had haematological cancer</p> <p>Fever was defined by an axillary or ear temperature of</p>	<p>Clinical data were collected at baseline (within 72 hours of fever presentation) and at 4 weeks later.</p> <p>Age, type of cancer, number of lumens, type of CVC, duration of CVC insertion before episode, oral antibiotics within 2 weeks of episode, FRC, quantitative bacterial DNA results and blood culture result.</p>	<p>Duration of IV antibiotics, recurrent episode of infection requiring IV treatment, reason CVC removed, time to CVC removal and incidence of CVC removal.</p>	<table border="1"> <tr> <td rowspan="2">FRC</td> <td colspan="2">Line preservation</td> </tr> <tr> <td>Yes</td> <td>No</td> </tr> <tr> <td>Yes</td> <td>8</td> <td>5</td> </tr> <tr> <td>No</td> <td>161</td> <td>5</td> </tr> </table> <p>Hazard ratios (95%) for outcomes in patients with FRC compared to those without. HR < 1.0 means the time to the outcome was <i>longer</i> in patients with FRC.</p> <p>Time to end of FN episode: HR 0.49 (0.27 to 0.88), p=0.017</p> <p>Time to recurrence: HR 0.37 (0.05 to 3.46), p=0.333</p> <p>Time to CVC removal: HR 16.39 (4.73 to 56.79), p<0.0005</p> <p>Recurrence (yes/no): RR 0.47 (0.06 to 3.46), p=0.461</p> <p>Total duration of IV treatment 3.61 times longer in patients with FRC</p>	FRC	Line preservation		Yes	No	Yes	8	5	No	161	5	HTA programme of the NIHR	Low number of CVC removal events compared the number of prognostic factors.
FRC	Line preservation																			
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Reference and country	Study type and period	Number of patients	Prevalence	Patient characteristics	Tests used/prognostic factors	Outcomes and reference standard	Results	Source of funding	Additional comments														
			(e.g S. Aureus or P. Aeruginosa): 5/179 Other organism or skin bacteria in blood culture: 31/179	> 38 °C for > 4 hours, or > 38 °C on two occasions > 4 hours apart within a 24-hour period, or > 38.5 °C on one occasion, or based on the oncology centre's definition of fever.			(95% CI 0.55 to 6.68), p=0.022. <table border="1"> <thead> <tr> <th rowspan="2">Pathogens in blood culture</th> <th colspan="2">Line preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Yes - Bacteria that normally prompt CVC removal (like S. aureus or P. aeruginosa)</td> <td>3</td> <td>2</td> </tr> <tr> <td>Other - organisms normally treated with antimicrobial lock, or skin bacteria</td> <td>26</td> <td>5</td> </tr> <tr> <td>None</td> <td>140</td> <td>3</td> </tr> </tbody> </table> Hazard ratios for outcomes in patients with pathogenic microorganisms in blood cultures versus those with negative blood cultures Time to end of FN episode: HR 0.48 (0.19 to 1.17), p=0.105 Time to recurrence: HR 0.97 (0.13 to 7.12), p=0.976 Time to CVC removal: HR 25.71 (4.27 to 154.7), p<0.0005 Recurrence (yes/no): RR 1.17	Pathogens in blood culture	Line preservation		Yes	No	Yes - Bacteria that normally prompt CVC removal (like S. aureus or P. aeruginosa)	3	2	Other - organisms normally treated with antimicrobial lock, or skin bacteria	26	5	None	140	3		
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							<p>(0.16 to 8.62), p=0.875</p> <p>Total duration of IV treatment 4.39 times longer in patients with pathogenic organisms (95% CI - 0.39 to 9.18), p=0.074.</p> <p>Hazard ratios for outcomes in patients with "other" organisms or skin bacteria in blood cultures versus those with negative blood cultures</p> <p>Time to end of FN episode: HR 0.57 (0.38 to 0.84), p=0.005</p> <p>Time to recurrence: HR 0.61 (0.21 to 1.74), p=0.355</p> <p>Time to CVC removal: HR 8.40 (2.01 to 35.14), p=0.004</p> <p>Recurrence (yes/no): RR 0.73 (0.26 to 2.08), p=0.560</p> <p>Total duration of IV treatment 2.99 times longer in patients with "other" organisms or skin bacteria than those with negative blood cultures (95% CI 0.91 to 5.08), p=0.005</p>				
Nosari 2008. Italy	Prospective case series Consecutive	388 catheterizations in 279 patients	CVC malfunction 39/388	Adult patients with haematological cancer who were	Infecting organism	Removal of catheter.	<p>In patients with bacteraemia:</p> <p>Gram-positive organisms</p> <table border="1" style="width: 100%;"> <tr> <td style="width: 50%;">Organism</td> <td style="width: 50%;">Line</td> </tr> </table>	Organism	Line		
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Evidence review: prevention and management of neutropenic sepsis in cancer patients

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	sample 2003-2004		Infection: 92/388 Mortality 7/388 CVC removal due to infection: 10/388	catheterized during therapy. Mean age 49.7 years.			<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Staphylococcus epidermis</td> <td>17</td> <td>5</td> </tr> <tr> <td>Staphylococcus aureus</td> <td>3</td> <td>0</td> </tr> <tr> <td>Streptococcus species</td> <td>7</td> <td>0</td> </tr> <tr> <td>Enterococcus species</td> <td>4</td> <td>1</td> </tr> <tr> <td>Other Gram-positive bacteria</td> <td>6</td> <td>0</td> </tr> </tbody> </table> <p>Gram-negative organisms</p> <table border="1"> <thead> <tr> <th rowspan="2">Organism</th> <th colspan="2">Line preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Pseudomonas aeruginosa</td> <td>4</td> <td>0</td> </tr> <tr> <td>Escherichia coli</td> <td>8</td> <td>1</td> </tr> <tr> <td>Enterobacter species</td> <td>3</td> <td>1</td> </tr> <tr> <td>Klebsiella species</td> <td>1</td> <td>0</td> </tr> </tbody> </table>		preservation		Yes	No	Staphylococcus epidermis	17	5	Staphylococcus aureus	3	0	Streptococcus species	7	0	Enterococcus species	4	1	Other Gram-positive bacteria	6	0	Organism	Line preservation		Yes	No	Pseudomonas aeruginosa	4	0	Escherichia coli	8	1	Enterobacter species	3	1	Klebsiella species	1	0		
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Park 2010. Korea	Retrospective consecutive case series. 1997-2008	56 episodes of S. Aureus bacteraemia in 50 patients	<p>MRSA: 20/56</p> <p>Attempted catheter salvage: 48/56</p> <p>Successful catheter salvage: 29/26</p> <p>Failed catheter salvage: 14/56</p> <p>SAB-related death: 2/56</p>	<p>Adult cancer patients with Hickman catheter , neutropenia and staphylococcus aureus bacteraemia (SAB: at least one positive blood culture for S. aureus).</p> <p>All had haematological cancer.</p> <p>Median age was</p>	<p>Age, gender, chronic renal failure, methicillin resistance, profound neutropenia, septic shock, catheter-related infection, external signs of infection, persistent fever, positive follow-up blood culture, type of initial antibiotic therapy</p>	<p>Attempted salvage: defined as catheter still in place 3 days after clinical recognition of bacteraemia.</p> <p>Successful salvage: defined as catheter still in place after 12 weeks, without recurrent bacteraemia or SAB related death.</p>	<p>The outcome of attempted catheter salvage was known in 43/46 cases. 5 indeterminate cases were excluded from analysis.</p> <table border="1"> <tr> <td rowspan="2">External signs of infection?</td> <td colspan="2">Successful salvage</td> </tr> <tr> <td>Yes</td> <td>No</td> </tr> <tr> <td>External signs of infection</td> <td>1</td> <td>4</td> </tr> <tr> <td>No external signs of infection</td> <td>28</td> <td>10</td> </tr> </table> <table border="1"> <tr> <td rowspan="2">Septic shock</td> <td colspan="2">Successful salvage</td> </tr> <tr> <td>Yes</td> <td>No</td> </tr> <tr> <td>Septic shock</td> <td>0</td> <td>2</td> </tr> <tr> <td>No septic shock</td> <td>29</td> <td>12</td> </tr> </table> <table border="1"> <tr> <td rowspan="2">Persistent fever</td> <td colspan="2">Successful salvage</td> </tr> <tr> <td>Yes</td> <td>No</td> </tr> </table>	External signs of infection?	Successful salvage		Yes	No	External signs of infection	1	4	No external signs of infection	28	10	Septic shock	Successful salvage		Yes	No	Septic shock	0	2	No septic shock	29	12	Persistent fever	Successful salvage		Yes	No	Not reported. No conflicts of interest reported.	
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							due to underlying disease and 4 cases of recurrent SAB amongst the attempted salvage group.																
Ruggiero 2010. Italy	Retrospective consecutive case series. 2000-2005	190 Groshong catheters in 166 children.	<p>Febrile episodes: 104/190</p> <p>CVC related sepsis: 36/190</p> <p>Catheter removal: 128/190</p> <p>Removal due to infection: 10/190</p> <p>Removal due to end of treatment: 112/190</p> <p>Removal due to mechanical complication 6/190</p> <p>CVC-related infectious mortality: 2/166</p>	<p>Children with a Groshong catheter inserted at a single centre.</p> <p>Median age was 6.6 years (range 0.6 to 22)</p> <p>27% had haematological cancer.</p>	Organism isolated in CVC-related infection	<p>CVC-related infection: bacterial abscess or cellulitis at the exit site or CVC tunnel; or septic signs/symptoms with bacteraemia in which the same organism was isolated from CVC and peripheral cultures, or from at least 2 CVC cultures or isolation of any fungus from at least one CVC culture.</p> <p>Central line removal, and reason for</p>	<p>Microorganisms isolated in the 36 cases of CVC-related infection (in 10 cases more than one organism was isolated):</p> <table border="1"> <thead> <tr> <th rowspan="2">Organism</th> <th colspan="2">Line preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Gram positive</td> <td>7</td> <td>1*</td> </tr> <tr> <td>Gram negative</td> <td>17</td> <td>3</td> </tr> <tr> <td>Fungal</td> <td>0</td> <td>6</td> </tr> </tbody> </table> <p>*Polymicrobial Gram-positive infection</p> <p>Two patients died as a result of CVC-related sepsis complicated by haematological toxicity phase.</p>	Organism	Line preservation		Yes	No	Gram positive	7	1*	Gram negative	17	3	Fungal	0	6	Not reported. No conflicts of interest declared.	
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						removal.																															
Sariosmanoglu 2008. Turkey	Prospectiv e, consecutive case series. 2005-2007	93 catheters fitted in 83 patients.	Catheter removal due to infection: 27/93. Catheter removal for other reasons:19/93.	Patients with haematologica l cancer, fitted with tunnelled long-term catheter. Patients were either neutropenic (ANC < 1.0 X 10 ⁹ /L) at the time of catheter insertion or became neutropenic during treatment. Mean age 45 years (range 9 months to 80 years)	Previous line infection, neutropenia at the time of insertion, type of cancer CVC related bacteraemia: defined as more than 10 fold increase in colony forming units of an organism in a culture from the catheter compared with one from peripheral blood, or 1000 cfu of organisms in the absence of peripheral blood culture, or positive catheter tip culture in a suspected	Catheter removal, unclear who decided the reason for removal	For the 27 catheters removed due to infection: <table border="1"> <thead> <tr> <th rowspan="2">Previous line infection</th> <th colspan="2">Line preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Previous line infection</td> <td>9</td> <td>7</td> </tr> <tr> <td>No previous line infection</td> <td>57</td> <td>20</td> </tr> </tbody> </table> For the 43 catheters removed : <table border="1"> <thead> <tr> <th rowspan="2">Removal reason</th> <th colspan="2">Line preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Tunnel infection</td> <td>-</td> <td>22</td> </tr> <tr> <td>CVC related bacteraemia/fungae mia</td> <td>-</td> <td>5</td> </tr> <tr> <td>End of treatment</td> <td>-</td> <td>17</td> </tr> <tr> <td>Mechanical problem</td> <td>-</td> <td>2</td> </tr> </tbody> </table>	Previous line infection	Line preservation		Yes	No	Previous line infection	9	7	No previous line infection	57	20	Removal reason	Line preservation		Yes	No	Tunnel infection	-	22	CVC related bacteraemia/fungae mia	-	5	End of treatment	-	17	Mechanical problem	-	2		
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					CVC infection. Catheter tunnel infection: defined as induration, tenderness and erythema beginning more than 1 cm from the exit site and tracking up the tract.															
Viscoli 1988. Italy	Retrospective consecutive case series. 1983-1986	157 catheters in 145 patients	Febrile episodes: 102/157 Catheter related infection: 21/157 Catheter unrelated infections: 32/157 Infections of unknown source: 26/157	Paediatric patients (usually with cancer), fitted with Broviac catheters. 30% had haematological cancer. Median age was 4 years (range 2 months to 20 years).	Type of infection, infecting organism, neutropenia at catheter insertion	Catheter removal, Catheter-infection related mortality	In 21 cases of catheter related infections: <table border="1"> <thead> <tr> <th rowspan="2">Type of infection</th> <th colspan="2">Line preservation</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Tunnel or exit site infection with or without bacteraemia</td> <td>2</td> <td>4</td> </tr> <tr> <td>CVC-related bacteraemia/fungemia only</td> <td>10</td> <td>5</td> </tr> </tbody> </table> 23 organisms were isolated in 21 cases of catheter related	Type of infection	Line preservation		Yes	No	Tunnel or exit site infection with or without bacteraemia	2	4	CVC-related bacteraemia/fungemia only	10	5	Not reported	
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Evidence review: prevention and management of neutropenic sepsis in cancer patients

Reference and country	Study type and period	Number of patients	Prevalence	Patient characteristics	Tests used/prognostic factors	Outcomes and reference standard	Results	Source of funding	Additional comments									
							<table border="1"> <tr> <td></td> <td colspan="2">preservation</td> </tr> <tr> <td></td> <td>Yes</td> <td>No</td> </tr> <tr> <td>Candida albicans</td> <td>1</td> <td>1</td> </tr> </table> <p>No patient died as a result of catheter related infection</p>		preservation			Yes	No	Candida albicans	1	1		
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	Yes	No																
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