Towards evidence based medicine for paediatricians

Edited by Bob Phillips

In order to give the best care to patients and families, paediatricians need to integrate the highest quality scientific evidence with clinical expertise and the opinions of the family. Archimedes seeks to assist practising clinicians by providing “evidence based” answers to common questions which are not at the forefront of research but are at the core of practice. In doing this, we are adapting a format which has been successfully developed by Kevin Macawey-Jones and the group at the Emergency Medicine Journal—“BestBets”.

A word of warning. The topic summaries are not systematic reviews, through they are as exhaustive as a practising clinician can produce. They make no attempt to statistically aggregate the data, nor search the grey, unpublished literature. What Archimedes offers are practical, best evidence based answers to practical, clinical questions.

The format of Archimedes may be familiar. A description of the clinical setting is followed by a structured clinical question. (These aid in focusing the mind, assisting searching, and gaining answers.) A brief report of the search used follows—this has been performed in a hierarchical way, to search for the best quality evidence to answer the question. A table provides a summary of the evidence and key points of the critical appraisal, and the measures of effect (such as number needed to treat, NNT) books by Sackett and Moyer may help. To pull the information together, a commentary is provided. But to make it all much more accessible, a box provides the clinical bottom lines.

The electronic edition of this journal contains extra information to each of the published Archimedes topics. The papers summarised in tables are linked, by an interactive table, to more detailed appraisals of the studies. Updates to previously published topics will be available soon from the same site, with links to the original article.

Readers wishing to submit their own questions—with best evidence answers—are encouraged to review those already proposed at www.bestbets.org. If your question still hasn’t been answered, feel free to submit your query according to the Instructions for Authors at www.archdischild.com. Three topics are covered in this issue of the journal.

• Is gradual introduction of feeding better than immediate normal feeding in children with gastroenteritis?
• Are follow up chest x ray examinations helpful in the management of children recovering from pneumonia?
• Should preterm neonates with a central venous catheter and coagulase negative staphylococcal bacteremia be treated without removal of the catheter?

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REFERENCES


4 http://cebm.jr2.ox.ac.uk/docs/levels.htm (accessed July 2002).


Additional information on each of the topics is available on the ADC website (www.archdischild.com/supplemental)
Is gradual introduction of feeding better than immediate normal feeding in children with gastroenteritis?

Report by
Nico Grunenberg, General Practitioner, Coupar Angus, Fife, UK

A mother with her 11 month old daughter attends the surgery. The child has gastroenteritis and is mildly dehydrated. Mum has been starving the child the past 24 hours as “everything comes back up”. She has read this and also that milk feeds should be avoided, in her health manual at home. Having read a paper once on continuous milk feeding as opposed to gradual regrading of milk, I decide to investigate which approach would be better.

Structured clinical question
In [children with gastroenteritis] is [gradual introduction of feeding better than immediate normal feeding] with regard to [symptom control and time to resolution]?

Search strategy and outcome
Medline 1966–09/01 using the OVID interface.


A total of 145 papers were found, of which 133 were irrelevant or of insufficient quality. The remaining 12 are shown in table 2.

### Table 2  Gradual introduction of feeding versus normal feeding in children with gastroenteritis

<table>
<thead>
<tr>
<th>Citation, country</th>
<th>Study type</th>
<th>Study group</th>
<th>Outcome</th>
<th>Key results</th>
<th>Study weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dugdale et al (1982), Australia</td>
<td>RCT</td>
<td>59 inpatients older than 6 months (average 22 months) with acute gastroenteritis were given clear fluids and then allocated either to half strength milk for 24 h and then full strength milk and food or immediate normal milk and food</td>
<td>Hospital stay (days)</td>
<td>Immediate group 4.7; graduated group 5.4, p&gt;0.5</td>
<td>Small numbers; 7 length of clear fluids</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Weight</td>
<td>During first 24 h of refeeding: immediate group lost 0.02 (0.25) kg and the graduated group lost 0.14 (0.21), p&gt;0.05</td>
</tr>
<tr>
<td>Haque et al (1983), Saudi Arabia</td>
<td>RCT</td>
<td>150 inpatients, all stages of dehydration between 1 month and 2 years of age randomised to three different feeding regimens: (1) clear fluids (6–24h) then gradual 1/4 strength milk reintroduction (2) clear fluids (6–24h) then full strength milk (3) continuing full strength milk</td>
<td>Increase in weight at discharge</td>
<td>(1) 0.4 (0.1) (2) 0.8 (0.2) (3) 1.2 (0.7)</td>
<td>Large proportion malnourished; Not statistically significant</td>
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<tr>
<td></td>
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<td></td>
<td>Diarrhoea length (days)</td>
<td>(1) 3.0 (1.4) (2) 3.0 (1.3) (3) 3.8 (1.2)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Vomiting length (days)</td>
<td>(1) 1.0 (1.1) (2) 1.8 (1.3) (3) 1.6 (1.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Length in hospital (days)</td>
<td>(1) 3.1 (1.4) (2) 3.6 (1.2) (3) 3.8 (1.2)</td>
</tr>
<tr>
<td>Placzek and Walker-Smith (1984), UK</td>
<td>RCT</td>
<td>48 inpatients less than 18 months of age with gastroenteritis, &gt;5% dehydration were after 24 h of GEM allocated to immediately full strength milk or gradual reintroduction</td>
<td>Complicated clinical course = recurrence of either severe vomiting or watery diarrhoea with 2% or more reducing substances</td>
<td>70% (16) of full strength group uncomplicated; 96% (24) of gradual group uncomplicated</td>
<td>Small numbers; Alternate allocation = randomisation 20% not thriving</td>
</tr>
<tr>
<td>Rajah et al (1988), South Africa</td>
<td>RCT</td>
<td>72 male black inpatients between 6 weeks and 2 years with prolonged dehydration gastroenteritis (needing more than 72 h IV fluids) assigned to 4 different feeds: partially modified cows’ milk formula, a lactose free casein containing formula, a lactose free soy protein formula, a lactose free whey hydrolysate formula</td>
<td>Stool weights in 3 days following formula change</td>
<td>Significant drop in stool weight AL110 p&lt;0.01 Alfare p&lt;0.05 Alsoy p&lt;0.05 No change with Lactogen</td>
<td>Only male black children</td>
</tr>
<tr>
<td>Bhan et al (1988), India</td>
<td>RCT</td>
<td>60 outpatients &lt;5% dehydration between 3 and 24 months were fed either cereal based formula(A) or cows’ milk (B)</td>
<td>Duration of diarrhoea post intervention (days)</td>
<td>Gr A 11.0 (10.0) &gt; gr B 7.6 (10.8) NS p&gt;0.05</td>
<td>Small numbers; Difficulty comparing two preparations; Selection criteria (close to hospital); 7% compliance to treatment at home</td>
</tr>
</tbody>
</table>
**Table 2 continued**

<table>
<thead>
<tr>
<th>Citation, country</th>
<th>Study group</th>
<th>Study type (level of evidence)</th>
<th>Outcome</th>
<th>Key results</th>
<th>Study weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conway and Ireson (1989), Leeds</strong></td>
<td>200 well hydrated inpatients, formula fed, ages 6 weeks to 12 months, acute gastroenteritis</td>
<td>RCT</td>
<td>Mean weight gain (g/kg/24h)</td>
<td>GrA 2.0 (4.2) &lt; grB 5.8 (7.8) significant p&lt;0.05</td>
<td>117 had ORS before treatment, so this immediate or delayed full strength feeding</td>
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<td></td>
<td>Gr1: 24h dextrose and gradual reintroduction of SMA gold</td>
<td></td>
<td>Duration of diarrhoea (h)</td>
<td>Gr1 6.9 (3.2); Gr2 6.9 (1.9); Gr3 6.9 (2.2); Gr4 7.1 (3.6); NS</td>
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<td></td>
<td>Gr2: special full strength HN25 until stools normal, gradual substitution by SMA gold</td>
<td></td>
<td>Severity of diarrhoea</td>
<td>Gr2 0.8 (1.7) &lt; Gr3 1.8 (1.5); p=0.05; group 1 1.6 (1.7), gr4 1.4 (1.9)</td>
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<td></td>
<td>Gr3: continued full strength SMA gold cap</td>
<td></td>
<td>Weight gain</td>
<td>Weight gain grA 2.3, grB 3.4 &gt; gr1 p=0.01; remains significant on day 5 p&gt;0.05</td>
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<td>Gr4: continued formula S</td>
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<tr>
<td><strong>Ooi et al (1989), Singapore</strong></td>
<td>70 inpatients mild/ moderate dehydration, age 1 week to 50 months, either milked feeds or full strength soy feed</td>
<td>CT</td>
<td>Duration of hospitalisation [days]</td>
<td>Soy 2.8; milk group 2.5, not statistically different</td>
<td>Small numbers ?randomised ?received clear fluids</td>
</tr>
<tr>
<td><strong>Armitstead et al (1989), UK</strong></td>
<td>68 children, admitted or gastroenterology casualty, bottle fed, mild acute gastroenteritis</td>
<td>RCT</td>
<td>Hospital stay [days]</td>
<td>Hospital stay [days] Gr1 4 (0.2); gr2 3.6 (0.6); gr3 3.5 (0.4) NS</td>
<td>? sufficient number Bottled only (sponsored by Nestle)</td>
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<td></td>
<td>plus: (1) gradual milk reintroduction</td>
<td></td>
<td>Reducing substances</td>
<td>Weight gain</td>
<td>Most mild dehydration</td>
</tr>
<tr>
<td></td>
<td>(2) full strength milk</td>
<td></td>
<td>Stool frequency Day 1–4: gr1 4–2.2; gr2 3.7–1.6; gr3 4.3–2.5</td>
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<td></td>
<td>(3) rapid grade to whey hydrolysate formula</td>
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<tr>
<td><strong>Haffejee (1990), South Africa</strong></td>
<td>309 hospital patients age 3 days to 28 months, acute diarrhoea, all stages of dehydration</td>
<td>RCT</td>
<td>Recovery time [hrs]</td>
<td>Formula 70.5 (60.3); breast 60.9 (44.8); breast plus supplement 64.8 (43.3); soya 61.4 (43.5) p&lt;0.05 NS</td>
<td>?blinded No patient characteristics (race, % dehydration)</td>
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<td></td>
<td>Formula fed children were randomised to their formula or soy based formula; breast fed children continued this and were divided in breast feeding only and breast feeding plus supplement</td>
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<td><strong>Lifschitz et al (1991), USA</strong></td>
<td>8 children &lt;5 months, mild to moderate dehydration, addition of 13C labelled rice at 6–22h and repeat at 14–17d later. Breath test measurement</td>
<td>CT</td>
<td>13C in breath when ill and after recovery</td>
<td>Apparent absorption not different, 13C diarrhoea H2.6% recovery 94%. NS</td>
<td>Small numbers Boys only Mild/moderate dehydration only</td>
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<tr>
<td><strong>Hoghton et al (1996), UK</strong></td>
<td>59 outpatient children &lt;3 years old, &lt;7 d gastroenteritis, &lt;5% dehydrated; either immediate modified feeding + ORT [2] or ORT only for 24–48h after which modified food (no milk/wheat) [1]</td>
<td>PRCT, single blind</td>
<td>Median duration of diarrhoea</td>
<td>Grp 1 6.6 h; grp2 5.6h p=0.4 not significant</td>
<td>Small numbers Mild dehydration only Parents assessed and charted symptoms [bias]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Median % weight change</td>
<td>Grp 1 0.005; grp 2 0.96 p=0.24 NS</td>
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<td></td>
<td></td>
<td></td>
<td>Complication rate</td>
<td>Similar, NS</td>
<td></td>
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<tr>
<td><strong>Sandhu et al (1997), Europe</strong></td>
<td>230 weaned European children under the age of 3 admitted to hospital; rehydrated with ORS for 4 hours, then Group A: immediate normal diet, Group B: 20% of ORS then normal diet, breast feeding continued throughout</td>
<td>RCT</td>
<td>Weight gain</td>
<td>After rehydration weight gain grA 9.5g, grB 2g p&lt;0.01; during hospitalisation grA&gt; 200g, grB &lt; 100g p=0.001; weight gain similar by day 5 and 14</td>
<td>No severely dehydrated children</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Complications</td>
<td>No significant differences re complications</td>
<td></td>
</tr>
</tbody>
</table>

**Commentary**

Nearly all studies showed no significant difference in length of symptoms and hospital stay. Two larger studies showed a significant increase in weight in the initial stages with immediate full strength feeding. One larger study also showed an increase in severity but not in length of diarrhoea with immediate feeding. This was associated with faster weight gain. One study showed benefit of lactose free feeds in severe dehydrating gastroenteritis. One smaller study showed more complicated clinical courses with immediate feeding; this was
a small study and 20% of the children needed intravenous hydration, possibly related to a more severe illness. In two smaller studies children had solids as well and did not do worse.

**REFERENCES**


**Are follow up chest x ray examinations helpful in the management of children recovering from pneumonia?**

**Report by**

Ian Wacogne, Specialist Registrar, Department of Paediatrics, North Staffordshire Hospital, Stoke-on-Trent, UK

Robert J S Negrine, Senior House Officer, Department of Paediatrics, North Staffordshire Hospital, Stoke-on-Trent, UK

A 4 year old boy with a cough and a fever is referred by his general practitioner. On auscultation of his chest there are focal sounds suggestive of a lower respiratory tract infection; a chest x ray examination confirms right lower lobe collapse and consolidation. He is started on oral antibiotics and discharged home within 24 hours. He is given a follow up appointment in four weeks time in the “registrar clinic” to be reviewed after having a repeat chest x ray examination according to your unit’s protocol.

At the follow up appointment he is clinically well and has a normal radiograph. After discharging him you wonder whether the “routine” exposure to radiation outweighs the detection of persistent radiological changes.

**Structured clinical question**

In asymptomatic children with prior radiological evidence of pneumonia [patient] are routine follow up chest radiographs [intervention] necessary to assist in management decisions [outcome]?

**Search strategy and outcome**

Cochrane Database of Systematic Reviews—none relevant.

PubMed—“pneumonia” AND “radiography” AND “follow-up”—480 references (four pertinent articles, three in English).

See table 3.

**Commentary**

There were only two studies, Heaton and Arthur, and Gibson et al, which looked at both clinical and radiological features at

**Table 3** Follow up chest x ray examinations in children recovering from pneumonia

<table>
<thead>
<tr>
<th>Citation</th>
<th>Study group</th>
<th>Study type (level of evidence)</th>
<th>Outcome</th>
<th>Key results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heaton and Arthur (1998)</td>
<td>65 children with pneumonia (history, clinical and radiological diagnosis); mean age 3.5 years (0.4–13)</td>
<td>Retrospective cohort (level 4)</td>
<td>Chest radiograph findings at follow up</td>
<td>37/41 children asymptomatic 35 (95%) normal CXR (95% CI 87% to 100%) 2 improved (5%) CXR</td>
<td>Only 41/65 children followed up fully; 11 were not offered follow up and a further 13 were lost to follow up</td>
</tr>
<tr>
<td>Gibson et al (1993)</td>
<td>77 children with pneumonia (history, clinical and radiological diagnosis)</td>
<td>Prospective cohort (level 4)</td>
<td>Clinical symptoms, signs and chest radiograph findings at follow up</td>
<td>59/72 children asymptomatic 51 (87%) normal CXR 8 (13%) improved CXR</td>
<td>5 patients defaulted follow up; 7 of the 8 patients with symptoms, signs, and radiological findings at follow up had pleural effusions on their original chest x ray</td>
</tr>
<tr>
<td>Grossman et al (1979)</td>
<td>129 children with a radiological diagnosis of pneumonia (6 weeks – 15 years)</td>
<td>Prospective cohort (level 4)</td>
<td>Chest radiograph findings at follow up</td>
<td>56/70 (80%) children normal CXR by 4 weeks; 9/9 (100%) children with residual CXR changes at 4 weeks had normal CXR by 3 months</td>
<td>59 were lost to first follow up; no data regarding clinical symptoms and signs was collected at follow up</td>
</tr>
</tbody>
</table>
follow up. The study by Grossman et al provided no information about clinical features at follow up but gave similar overall resolution rates. The studies by Heaton and Arthur, and Gibson et al came to similar conclusions despite significant differences in study design. The study by Heaton and Arthur was retrospective; Gibson et al’s prospective. Heaton and Arthur’s study included children with asthma as it was felt that their exclusion would compromise the practical value of the study. By contrast, Gibson et al excluded children with “pre-existing disease”—which may have included asthma—and excluded children presenting with acute asthma, even if radiological findings suggested pneumonia consolidation.

The issue of interobserver variation in the interpretation of x-rays was raised in both studies. In Gibson et al’s study a paediatric radiologist (Hollman) described minor, but improved radiological findings in eight chest x-rays of asymptomatic children. When viewed by other radiologists four were reported as clear and four with minor changes; and when viewed by clinicians seven were reported clear and one with minor changes. This has practical implications for the paediatrician reviewing the child at follow up.

### CLINICAL BOTTOM LINE

- In asymptomatic children with prior radiological evidence of pneumonia, routine chest radiology provides no benefit.

### REFERENCES


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**Should preterm neonates with a central venous catheter and coagulase negative staphylococcal bacteraemia be treated without removal of the catheter?**

**Report by**

K Nistala, Neonatal SPR, Northwick Park Hospital, Harrow, UK

R Nicholl, Consultant Neonatalogist, Northwick Park Hospital, Harrow, UK

A 10 day old neonate (corrected gestation 29 weeks, birth weight 960 g) has been slow to establish feeds. Intravenous access is difficult and he is receiving parenteral nutrition through a central venous catheter (CVC). He develops temperature instability and hyperglycaemia. You decide to start empirical intravenous antibiotics but keep the CVC in situ as the infant is relatively stable. Peripherally taken blood cultures grow coagulase negative staphylococci (CoNS).

Should the CVC be removed, knowing that a future replacement may be very difficult?

**Structured clinical question**

In a preterm neonate, with a central venous catheter in situ, who is bacteraemic with coagulase negative staphylococcus [patient], can catheter sterilisation [intervention] be achieved without increased morbidity or mortality [outcome]?

**Search strategy and outcome**

Secondary sources

- Cochrane Database of Systematic Reviews, Cochrane Controlled Trials Register, Database of Abstracts of Reviews of Effectiveness: none relevant.

Primary sources

- PubMed: "Catheterization, Central Venous”[MESH] AND "Staphylococcus”[MESH] AND "Central Venous Catheter”[MESH] limit (newborn: birth–1 month). There were 22 hits—one relevant study found.³
- "Central venous catheter” AND “neonate” AND “CONS” [all textwords]. There were seven hits—two relevant studies, one previously found above. See table 4.

**Commentary**

Catheter related sepsis in preterm infants is a common neonatal problem (up to 15.3 infections per 1000 catheter

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**Table 4** Coagulase negative staphylococcal bacteraemia in preterm neonates with a central venous catheter

<table>
<thead>
<tr>
<th>Citation</th>
<th>Study group</th>
<th>Study type (level of evidence)</th>
<th>Prevalence of end organ damage (mortality, osteomyelitis, abscess, death)</th>
<th>Sterilisation of catheter was attempted in 72 of 84 neonates with CoNS bacteremia with salvage achieved in 51% without complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin et al</td>
<td>NICU infants with central venous catheter and CoNS bacteremia (single positive culture)</td>
<td>Retrospective case notes review (level 4)</td>
<td>Complicated bacteremia = end organ damage or &gt;2 positive cultures</td>
<td></td>
</tr>
<tr>
<td>(2001)</td>
<td></td>
<td></td>
<td>Sterilisation of catheter was attempted in 72 of 84 neonates with CoNS bacteremia with salvage achieved in 51% without complications</td>
<td></td>
</tr>
<tr>
<td>Karbowicz et al</td>
<td>NICU admission with CVC and CoNS bacteremia (2 +ve culture, same organism)</td>
<td>Observational cohort (level 4)</td>
<td>Persistent bacteremia (&gt;3 days) Death</td>
<td></td>
</tr>
<tr>
<td>(2002)</td>
<td></td>
<td></td>
<td>63 of 119 infants had attempted sterilisation of CVC with salvage in 46%, but a 30% absolute increase in persistent bacteremia, NNH 3.3 (95% CI 2.2–6.8)</td>
<td></td>
</tr>
</tbody>
</table>

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www.archdischild.com
days). Inspite of this there is no good quality data informing
the decision to remove central catheters in bacteraemic
neonates. Both papers cited are retrospective case notes
reviews. As a result the criteria for removal of catheters was
not standardised and the management and follow up of the
two groups (catheter retained versus removed) may have dif-
fered.

Benjamin et al did not distinguish between contaminated
blood cultures, catheters colonised with CoNS and true cath-
eter related CoNS sepsis. This is a practical problem for
clinicians and researchers alike and has been recently
reviewed. Karlowicz et al used two positive peripheral
cultures of the same organism within three days as their de-
dinition of CoNS bacteraemia consistent with US Center for
Disease Control guidelines.

Karlowicz et al found that attempting CVC sterilisation did
increase the risk of prolonged bacteraemia, but the numbers
were too small to detect a difference in end organ infection
and mortality. The concern that bacteraemia may ultimately
seed to end organs appears to be supported by Benjamin et al.
If the CVC was not removed after four positive cultures there
was a significant increase in end organ damage. As the
number of positive cultures or the duration of bacteraemia
increased, CVCs were less likely to be successfully salvaged. These studies suggest that catheters should be removed in
infants who remain bacteraemic on treatment as the morbid-
ity increases and the chances of line salvage diminishes with
time. It is still unclear exactly how long clinicians should wait
before abandoning sterilisation attempts and actually remov-
ing the catheter.

REFERENCES
1 Trotter CW. Percutaneous central venous catheter-related sepsis in the
2 Hodge D, Puntis JWL. Diagnosis, prevention and the management of
catheter related bloodstream infection during long term parental nutrition.
3 Hospital Infection Control Advisory Committee. Recommendations
for preventing the spread of vancomycin resistance. Infect Control Hosp
removal versus in situ treatment in neonates with coagulase-negative
5 Benjamin DK Jr, Miller W, Garges H, et al. Bacteremia, central

CLINICAL BOTTOM LINE
• CVCs infected with coagulase negative staphylococcus can be successfully salvaged in ~50% of cases.
• Attempting sterilisation of infected lines increases the risk
of persistent bacteraemia, NNH = 3. End organ damage
may be increased if the CVC is retained despite
repeated positive cultures.
• Prospective randomised studies are required to convinc-
ingly address the risks versus benefits of treating infected
CVCs in situ.