GUIDELINES

a. The use of real-time ultrasound guidance is strongly recommended for the placement of haemodialysis catheters and results in improved rates of successful catheter placement, and reduced rates of both haematoma formation and inadvertent arterial puncture. (Level 1).

SUGGESTIONS FOR CLINICAL CARE
(Suggestions are based on Level III and IV evidence)

- The adherence to strict aseptic technique is proven to reduce the catheter related bacteraemia rate and all units should therefore audit this practise (Level 3).
- Tunneled haemodialysis catheters should be used as they are associated with lower rates of catheter related bacteraemia, catheter dysfunction and vascular damage (venous trauma, and stenosis) compared to temporary non-tunneled catheters (Level 3).
- The right internal jugular vein is the preferred insertion site with respect to ease of access and lower rates of short and long term complications. (Level 3/4)
- In ICU settings, subclavian catheter placement has excellent short term outcomes compared to jugular and femoral approaches but has significant long term sequelae recommending against their use (Level 3/4).
- A post procedural chest X-ray following internal jugular or subclavian catheter insertion should be performed to check placement of the tip below the right atrial/internal jugular junction in subjects where fluoroscopic guidance has not been utilised. (Level 3).

IMPLEMENTATION AND AUDIT

1. Need for adequate monitoring of the following:
   - Number of catheter infection to be <5 per 1000 catheter days
   - Minimal reattempts and failed access
   - Pneumothorax and arterial puncture rates to be <1%
2. A strict protocol for aseptic insertion technique should be implemented, and an audit conducted annually to assess compliance
3. Review of policies and practices regarding CVC insertion

BACKGROUND

Though vascular access is best achieved through a fistula with a longer access and patient survival, there are unfortunately a persistent number of patients commencing end-stage renal disease (ESRD) therapy through a temporary or tunneled cuffed catheter [1]. Insertion of these catheters is an invasive procedure with small but definite rates of morbidity and mortality. The patient mix presenting for ESRD therapy will have a variance in venous anatomy or be obese and diabetic patients for instance which
increases the risks for the procedure and limit alternative access like a fistula. This often warrants multiple long term catheters in the life of some patients. These guidelines will review and summarize the current evidence on catheter insertion ranging from vein localization via real time ultrasound to adequacy of access sites for both short and long term morbidity. Unfortunately as in all disciplines of nephrology, many other components of vascular catheter insertion have to yet obtain robust evidence and rely on small case based studies for the recommendation seen here.

SEARCH STRATEGY

Databases searched: MeSH terms and text words for central venous catheter were combined with MeSH terms and text words for haemodialysis, and combined with MeSH terms and text words for insertion, The search was carried out in Medline (1966 to January 2012). An update search was done in Medline (March 2012) using the same MeSH terms and text words.

Date of initial search: January 2012
Date of update search: March 2012

WHAT IS THE EVIDENCE?

Catheter insertion

The use of real time ultrasound guidance for the placement of haemodialysis catheters was examined by a large systematic review and meta-analysis [2] by the Cochrane group. In 7 trials of 830 catheter placements, ultrasound guidance was associated with improved rates of successful catheter placement (catheter placement failure RR 0.11, P=0.0002); shorter procedural times (mean difference -1.40 minutes) and reduced rates of both haematoma formation (RR 0.27, P=0.03) and inadvertent arterial puncture (RR 0.22, P=0.02). Procedural time is the time taken (minutes) from skin anaesthesia to successful vein puncture.

Ultrasound should ideally be supplemented with fluoroscopic guidance [3, 4] as venographic studies have revealed a significant incidence of central venous stenosis and venous angulation that could complicate "blind" insertion [5]. There are, however, case series of successful right internal jugular catheter placement without fluoroscopy [6].

Catheter related bacteraemia

The common catheter insertion sites have been evaluated with respect to the risks of catheter related bacteraemia and the rates of venous stenosis. A study of 134 ICU patients[7] showed comparable rates of catheter related bacteraemia between internal jugular and common femoral access sites in the short term. Robust long term data on the risk of catheter related bacteraemia stratified by catheter insertion site is lacking. In a Japanese surveillance report of catheter use, patients with femoral vein catheterisation reported a higher rate of catheter related bacteraemia of 15.7 per 1000 catheter days compared with 3.8 in subclavian and 6.1 in jugular catheterisation[8]. This conclusion was supported by a recent Cochrane Review [9] where catheter related bacteraemia in long term catheterisation was higher in the internal jugular RR 7.0 compared to subclavian catheterisation P=0.07. In short term catheterisation, femoral access had higher rates of catheter-related bacteraemia RR 2.03, catheter related thrombosis RR 11.53 and catheter colonisation RR 6.43 compared with subclavian access.

In a study of over 10,000 ICU central line insertions, the use of strict aseptic technique resulted in a significant reduction in nosocomial infections, where central line-associated bacteraemia dropped from 3.0 to 1.2 per 1000 catheter days (P<0.001) [10]. Strict asepsis should therefore be compulsory for the insertion of haemodialysis catheters and its implementation should be subject to regular audit. There is no evidence that the use of prophylactic intravenous antibiotics reduces the risk of catheter related bacteraemia [11, 12] and the use of silver-impregnated collagen cuffs on tunnelled catheters has also shown no benefit [13]. This study randomised patients to a control group (dual-lumen tunnelled cuffed catheter [TCC]) and to an experimental group, (TCC with an additional silver-impregnated cuff). There was no significant difference in the infection/day hazard rate of 0.0022 for the control group versus 0.0027 for the experimental group.
Central venous stenosis

The long term central venous stenosis rate (up to 50%) for haemodialysis catheters that are inserted into the subclavian vein preclude its use except in the rarest of situations [14-16].

Short term non-tunnelled catheters have now been shown in multiple small case series to have high rates of venous trauma, thrombosis and stenosis, even within two weeks of use. The use of tunnelled catheters even for the short term patient is preferable, although this may not be feasible in all centres [5, 17-19].

Catheter survival

The predictors of catheter survival have been reviewed in single centre experience of 812 catheter insertions [20]. The predictors of better outcomes include the right internal jugular insertion site, being a non-diabetic and first catheter insertion. Survival times were also greatest for the right internal jugular vein (RIJV) with 633 days compared to 430 days for the left internal jugular vein (LIJV) and 116 days for the femoral vein (FV) The catheter type did not influence catheter survival although case series would suggest that contemporary catheters survive longer than older models [21]. The latter studies are however, smaller and industry sponsored.

In patients in whom conventional access sites have been exhausted, the placement of catheters via occluded or collateral veins warrants consideration. In a study by Powell et al, [22] 19 patients had their catheter inserted by an interventional radiologist via an occluded or collateral vein while 38 patients (two control groups) had conventional catheter insertion. There was no short term difference in the rates of catheter survival, catheter flow, infection or procedural complications between the experimental and control groups. In a series of 24 patients, Funaki et al., reported increased rates of catheter dysfunction using these techniques but secondary patency rates were still 100% and 70% at 6 and 12 months respectively[23].

The use of long-term catheters is increasing and in such patients venous access options are often limited. This situation has demanded comparison between the uses of catheter exchange over a guide wire versus an alternative insertion site. Several small retrospective case series suggest that catheter exchange is a safe, effective and viable option in terms of catheter survival and nosocomial infection rate [22, 24-26]. However, two contemporary studies [27, 28] do not concur with these findings, and this practice warrants further prospective investigation.

Beyond the occasional case report, surgical insertion of haemodialysis catheters has never been trialled in any experimental study and is lacking from any published audit data for Australia.

SUMMARY OF THE EVIDENCE

It is now standard of care to insert a haemodialysis catheters under real time ultrasound (and preferably fluoroscopic) guidance. The internal jugular vein insertion site results in the longest catheter survival times and the use of tunnelled rather than temporary catheters produces lower rates of venous thrombosis and trauma even in the short term (<2 weeks). Strict aseptic technique improves catheter infection rates and should be enforced and audited. Exchange of dysfunctional catheters over a guide wire can prolong access site survival.

WHAT DO THE OTHER GUIDELINES SAY?

Kidney Disease Outcomes Quality Initiative (Patient evaluation prior to access placement): (2000) [29]
Guideline 5:
A. Tunnelled cuffed venous catheters are the method of choice for temporary access of longer than three weeks’ duration (but are acceptable for access of shorter duration as well). In addition, some patients who have exhausted all other access options require permanent access via tunnelled
cuffed catheters. For patients who have a primary AV fistula maturing but need immediate haemodialysis, tunneled cuffed catheters are the access of choice. (Evidence/Opinion)

B. The preferred insertion site for tunneled cuffed venous dialysis catheters is the right internal jugular vein. Other options include: the right external jugular vein, the left internal and external jugular veins, subclavian veins, femoral veins, or translumbar access to the inferior vena cava. Subclavian access should be used only when jugular options are not available. Tunneled cuffed catheters should not be placed on the same side as a maturing AV access, if possible. (Evidence)

C. Fluoroscopy is mandatory for insertion of all cuffed dialysis catheters. The catheter tip must be adjusted to the level of the cavo-atrial junction or beyond to ensure optimal blood flow. (Opinion)

D. Real time ultrasound guided insertion is recommended to reduce insertion related complications. (Evidence/Opinion)

E. There is currently no proven advantage of one cuffed catheter design over another. Catheter choice should be based on local experience, goals for use and cost. (Evidence/Opinion)

Guideline 6:

A. Haemodialysis access of less than three weeks’ duration should be obtained using a non cuffed or a cuffed double lumen percutaneously inserted catheter. (Evidence/Opinion)

B. These catheters are suitable for immediate use and should not be inserted before needed. (Evidence)

C. The subclavian insertion site should not be used in a patient who may need permanent vascular access. (Evidence)

D. Chest x-ray is mandatory after subclavian and internal jugular insertion prior to catheter use to confirm that the catheter is positioned at the cavo-atrial junction or the superior vena cava and to exclude complications prior to starting haemodialysis. (Evidence/Opinion)

E. Where available, ultrasound should be used to direct insertion of these catheters into the internal jugular position to minimise insertion related complications. (Evidence/Opinion)

F. Femoral catheters should be at least 19cm long to minimise recirculation. Non cuffed femoral catheters should not be left in place longer than five days and should be left in place only in bed bound patients. (Evidence/Opinion)

G. Non-functional non-cuffed catheters can be exchanged over a guidewire (but only if the access and the tunnel are not infected) or may be treated with intraluminal urokinase. (See protocols in Table III-2) (Evidence)

H. Exit site, tunnel tract or systemic infections should prompt the removal of non cuffed catheters. Treatment guidelines for catheter infection are discussed in Catheter Care and Accessing the Patient’s Circulation (Guideline 15). (Evidence/Opinion)


1.1 Two-dimensional (2-D) imaging ultrasound guidance is recommended as the preferred method for insertion of central venous catheters (CVCs) into the internal jugular vein (IJV) in adults and children in elective situations.

1.2 The use of two-dimensional (2-D) imaging ultrasound guidance should be considered in most clinical circumstances where CVC insertion is necessary either electively or in an emergency situation.

1.3 It is recommended that all those involved in placing CVCs using two-dimensional (2-D) imaging ultrasound guidance should undertake appropriate training to achieve competence.

1.4 Audio-guided Doppler ultrasound guidance is not recommended for CVC insertion.

UK Renal Association: No recommendation.

Scottish Intercollegiate Guidelines Network: No recommendation

Canadian Society of Nephrology: No recommendation.

European Best Practice Guidelines: [31]

Guideline 10.1. Central venous catheters should be inserted as a last resort in patients without a permanent access and the need for acute haemodialysis (Evidence level III).

Guideline 10.2. The percutaneous route should be used for both acute and chronic catheter insertion. Insertion should be guided by ultrasound. A plain X-Ray (chest or abdomen) should be performed before use to locate catheter and detect any complication (Evidence level II).

Guideline 10.3. The right internal jugular vein is the preferred location for insertion (Evidence level II).
Guideline 10.4. Non-tunneled catheters should only be used in emergency situations and should be exchanged as soon as possible for tunnelled catheters (Evidence level III).

**American Society of Anesthesiologists: (2012) [32]**

- Use static ultrasound imaging in elective situations before prepping and draping for prepuncture identification of anatomy to determine vessel localization and patency when the internal jugular vein is selected for cannulation.
- Static ultrasound may be used when the subclavian or femoral vein is selected.
- Use real-time ultrasound guidance for vessel localization and venipuncture when the internal jugular vein is selected for cannulation.
- Real-time ultrasound may be used when the subclavian or femoral vein is selected.
- Real-time ultrasound may not be feasible in emergency circumstances or in the presence of other clinical constraints.
- For central venous catheters placed in the operating room, perform the chest radiograph no later than the early postoperative period to confirm the position of the catheter tip.

**International Guidelines:** No recommendation.

**SUGGESTIONS FOR FUTURE RESEARCH**

1. RCT of guide wire exchange versus de novo catheter insertion
2. RCT of uncoated versus catheters coated with antimicrobial/thrombotic agents
3. RCT of prophylactic antibiotics prior to insertion

**CONFLICT OF INTEREST**

Rob MacGinley and Andrew Owen have no relevant financial affiliations that would cause a conflict of interest according to the conflict of interest statement set down by KHA-CARI.
REFERENCES


## APPENDICES

### Table 1. Characteristics of included studies

<table>
<thead>
<tr>
<th>Study ID (author, year)</th>
<th>N</th>
<th>Study Design</th>
<th>Setting</th>
<th>Participants</th>
<th>Follow up (months)</th>
<th>Comments</th>
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<tr>
<td><strong>Ultrasound and fluoroscopic guidance</strong></td>
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| Rabindranath et al (2011)[2] | 7 trials = 830 catheters | Systematic review and meta-analysis of RCTs | UK | Patients needing haemodialysis catheter insertion | N/A | Ultrasound guidance significantly decreased the risk of:  
- Catheter placement failure RR 0.11 (95%CI: 0.03-0.35, P=0.0002) Seven trials, 830 catheters  
- First attempt catheter placement failure RR 0.40 (95%CI: 0.30-0.52, P<0.00001) Five trials, 705 catheters  
- Arterial punctures RR 0.22 (95%CI: 0.06-0.81; P=0.02) Six trials, 785 catheters  
- Formation of haematoma RR 0.27 (95%CI: 0.08-0.88; P=0.03) Four trials, 323 catheters  
The following outcomes had only one trial each, but with significant results:  
- Decrease in time to cannulate the vein, mean difference (MD) – 1.40 min (95%CI: -2.17 to –0.63) 1 study, 73 catheters  
- Number of attempts/catheter insertion MD – 0.35 (95%CI: -0.54 to –0.16) 1 study, 110 catheters  
Real time Doppler ultrasound guidance is strongly recommended for the placement of haemodialysis catheters as it provides more clinically important benefits compared to the landmark method. |
| Yezlin et al (2007)[4] | 202 tunnelled catheters | Retrospective analysis | Tertiary hospital, Wisconsin USA | Patients needing short to medium term vascular access for haemodialysis | N/A | Modified traditional catheter placement technique ('blind') was associated with a decreased odds ratio (OR) of immediate success OR = 0.13 (95%CI: 0.02-0.71)  
There was no difference in major or minor bleeding complications between the blind vs fluoro-guided group  
Blind technique represents a substantial reduction in total costs |
| Koruglu et al (2006)[3] | 80 | RCT | Multicentre, Turkey | Emergent haemodialysis patients randomized to either the anatomical landmark method (Group 1) or the radiologically guided technique (Group 2) | | Catheter insertion via the internal jugular vein was successful in 39 patients in group 1 and in 40 patients in group 2 (p=0.32). 38 patients had temporary catheters in Gp1 while 9 had it in Gp2. One patient had long-term tunnelled catheter in Gp 1 while 31 had it in Gp2.  
Gp1: 3 catheters non-functional vs zero non-functional catheters in Gp2 (p=0.08)  
Arterial puncture: Gp1: 14 vs 0 in Gp2 (p<0.0001)  
Minor haematoma: Gp1: 7 vs 2 in Gp2 (0.08)  
Bleeding through incision: Gp1: 0 vs 1 in Gp 2 (p=0.32)  
Ecchymosis at the tunnel site: Gp1: 0 vs 1 in Gp2 (p=0.32)  
Malposition of catheter: Gp1: 1 vs 0 in Gp2 (p=0.32)  
Pneumothorax requiring chest tube: Gp1: 1 vs 0 in Gp2 |
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<tr>
<th>Study ID (author, year)</th>
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<th>Participants</th>
<th>Follow up (months)</th>
<th>Comments</th>
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| Taal et al (2004)[5]   | 69 | Cohort       | Single centre, UK | Patients undergoing central venous catheter insertion (right internal jugular) under ultrasound guidance and venography prior to guide-wire insertion | N/A | • Stenosis (>50%) was detected in 10 (14.5%) of cases  
• Angulation of central veins was detected in 10 (14.5%) of cases  
• Angulation and stenosis in 9 (13%) of cases  
• Patients with previous tunnelled internal jugular catheters had more than double the incidence of central vein abnormalities compared to those who did not have a previous catheter [15/23 (65%) vs 14/46 (30%); P=0.009]  
• Differences in the complication rates between the two groups were statistically significant (P<0.0001) |
| Motta et al (2010)[6]  | 122 | Prospective cohort | Single centre, Brazil | Incident patients receiving haemodialysis through a non-tunnelled right internal jugular vein catheter, had their catheters changed to tunnelled cuffed catheters (TCC) | 45 | • 130 procedures were done in 122 patients.  
• Primary patency rates were: 92%, 82% and 68% at 30, 60 and 120 days, respectively.  
• Reasons for catheter removal include: Death 18 (20%) of cases; Infection occurred in 24 (26%) of cases; bleeding in 1 (1%) case; malfunction 8 (9%) of cases and accidental removal 6 (7%) of cases; elective removal in 34 (37%)  
• A non-tunnelled catheter in situ for <2 weeks was significantly associated with higher patency of the TCC p=0.02 |

### Catheter related bacteraemia

| Ge et al (2012)[9]     | 4 studies [1513 participants] | Systematic review | China/USA | Adult haemodialysis and oncology patients requiring central venous catheterization. | N/A | Long term catheterization – internal jugular versus subclavian venous access:  
• Venous thrombosis complications were higher for the internal jugular compared to the subclavian venous access RR 1.97 (95%CI:0.87 – 4.48; p=0.1)  
• Venous stenosis: there was no difference in the total number of mechanical complications for the internal jugular compared to the subclavian.  
• Catheter-related bacteraemia: exit site infection was higher for the internal jugular RR 7.0 (95%CI:0.88 – 55.86; p=0.07) vs subclavian venous access  
Short term catheterization  
• Femoral access had higher rates of: catheter colonization RR 6.43 (95%CI:1.95 – 21.21); catheter-related bloodstream infection RR 2.03 (95%CI:0.19 – 22.12); and catheter related thrombotic complications RR 11.53 (95%CI:2.80 – 47.52) compared with subclavian access  
• Femoral access had lower: catheter-related bloodstream infection RR 0.58 (95%CI:0.14 – 2.40); catheter related thrombosis RR 0.46 (95%CI:0.21 – 1.01); and total mechanical complications RR 0.51 (95%CI:0.29 – 0.88) compared with internal jugular venous access. |
<p>| Parienti et al         | 10 studies | Meta-analysis | France | Patients with non- | N/A | Catheter duration: subclavian vein catheters were left in situ |</p>
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<th>Study ID (author, year)</th>
<th>N</th>
<th>Study Design</th>
<th>Setting</th>
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<td>(2012)[7]</td>
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<td>[3250: subclavian; 3053-internal jugular; 1554-femoral vein]</td>
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<td>tunnelled central venous catheters inserted in the subclavian vein compared with those inserted in the femoral or internal jugular veins.</td>
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<td>longer than alternative catheters (mean difference: 2 days,[95%CI: 0.9-3.1; p&lt;0.001])</td>
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<td>• Catheter-associated infection: subclavian vein site was associated with fewer infections (1.3 vs 2.7 per 1000 catheter days for alternative sites, incidence density ratio 0.50, 95%CI: 0.33-0.74; p&lt;0.001)</td>
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<td>• Limitations in study such as confounding bias, study heterogeneity limit interpretation of results.</td>
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<tr>
<td>Nagashima et al (2006)[8]</td>
<td>806 catheters</td>
<td>Surveillance Report</td>
<td>Single centre, Japan</td>
<td>All patients having a central venous catheter inserted for a variety of reasons including: nutritional support, haemodialysis, cardiac support and other treatments.</td>
<td>N/A</td>
<td>Blood stream infection (BSI) rates were 3.8 per 1000 catheter-days in subclavian, 6.1 in jugular and 15.7 in femoral vein catheterization.</td>
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<td>• In high-risk departments, BSI rates were: 5.4/1000 catheter days in subclavian, 10.2 in jugular and 14.7 in femoral vein catheterization</td>
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<td>• In low-risk departments the BSI rates were: 3.6/1000 catheter-days in subclavian, 4.6 in jugular and 15.8 in femoral vein catheterization</td>
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<tr>
<td>Burrell et al (2011)[10]</td>
<td>10,890 checklists</td>
<td>Quality improvement study</td>
<td>Multicentre, Australia</td>
<td>Clinicians and patients in intensive care units. Completion of checklists for clinician compliance (clinician bundle) and patients (patient bundle)</td>
<td>18</td>
<td>Compliance with aseptic central venous line (CVL) insertion improved over the period of the study (p&lt;0.001)</td>
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<td>• Rates of central line-associated bacteraemia (CLAB) dropped from 3.0 to 1.2 per 1000 catheter-days (p=0.001)</td>
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<td>• Relative risk (RR) of CLAB was 1.62 times greater (95%CI; 1.1-2.4; p=0.018) in patients with CVLs inserted by non-compliant clinicians compared with those inserted by compliant clinicians</td>
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<td>• Compliance by clinicians and patients, reduced the risk of CLAB by 50%, RR 0.5 (95%CI: 0.4-0.8; p=0.004)</td>
</tr>
<tr>
<td>Groeger et al (1993)[13]</td>
<td>200 patients [108 – control group; 92 – experimental group]</td>
<td>Prospective RCT</td>
<td>Single centre, USA</td>
<td>Cancer patients were randomized to either a dual-lumen tunnelled cuffed catheter (TCC) [control] or a TCC with an additional silver-impregnated cuff [experimental].</td>
<td>Not stated</td>
<td>There were no tunnelled infections in the control group compared to two in the experimental group</td>
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<td>• The hazard rate for infection/day was 0.0022 (95%CI: 0.0015-0.003) for the control group versus 0.0027 (95%CI: 0.0019-0.0037) for the experimental group (p=not significant)</td>
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<td>• There was no significant difference in the infection-free interval for both catheters over the catheter lifetime (p=0.39) as well as over the first 48 days after insertion (p=0.55)</td>
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<tr>
<td>Ranson et al (1990)[12]</td>
<td>98 patients (35 catheters GpA; 37 catheters Gp B)</td>
<td>Prospective RCT</td>
<td>Single centre, UK</td>
<td>Cancer patients were allocated to either Gp A (acute leukaemia or bone marrow transplantation) or Gp B (chemotherapy for solid tumour). Each group was randomized to either placebo (saline alone) or vancomycin</td>
<td>Not stated</td>
<td>• Catheter related sepsis occurred 32 times in 20/35 catheters (57%) in GpA and only in 6/37 catheters (16%) in GpB.</td>
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<td>• No differences were detected between the control and experimental arms in either group.</td>
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<td>Study ID (author, year)</td>
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| McKee et al (1985)[11]  | 47 patients (55 catheters) | Prospective RCT | Single centre, UK | Patients receiving intravenous nutrition were randomized to receive either vancomycin (experimental) or no vancomycin (control), pre catheter insertion | 18 | • Catheter-related sepsis was 1.9 per 100 catheter-days in the control group and 1.8 in the experimental group  
• Confirmed sepsis occurred in 24% of catheters in the control group and 25% of catheters in the experimental group |
| Thomson et al (2010)[18]  | 365 patients (823 catheters) | Prospective cohort | Multicentre, UK | Incident haemodialysis patients requiring vascular access, catheter insertions. | 24 | • Catheter-related bacteraemia (CRB): 115 cases (2.57 per 1000 catheter-days)  
• CRB for non-tunnelled central venous catheters (NTCVC) was higher, hazard ratio (HR) 5.9 (95%CI:2.1 – 12.9; p<0.001) for femoral vein and HR 2.9 (95%CI:1.5 – 4.8; p<0.001) for internal jugular vein insertion compared with tunnelled CVC  
• Catheter removal: 131 cases due to poor haemodialysis blood flow (2.94 per 1000 catheter days)  
• Catheter removal was also higher in the NTCVC insertions: HR 9.2 (95%CI:4.3 – 20.0; p<0.001) for femoral vein and HR 4.7 (95%CI:2.4 – 9.2; p<0.001) for internal jugular vein insertions compared with TCVC  
• Tunnelled central venous catheter insertions are associated with lower complication rates compared with non-tunnelled CVC insertions |
| Weijmer et al (2004)[19]  | 149 patients (272 catheters) | Prospective cohort | Single centre, The Netherlands | Haemodialysis patients requiring venous access, catheter insertions. [tunnelled cuffed catheters (TCCs) and untunnelled catheters (UCs)] | 36 | • 37 TCCs and 235 UCs  
• Patients with UCs were mainly acute renal failure (40% vs 8% for TCCs, p<0.001); they had higher hospitalization rates (54% vs 14%, P<0.001)  
• Catheter removal was higher in UCs: 35.3 for untunnelled femoral catheters (UFCs), 17.1 for untunnelled jugular catheters (UJCs) compared with 1.8 per 1000 catheter-days for TCCs.  
• Infection rates were also higher for: UFCs 20.2 and UJCs 15.6 compared to TCCs 2.9 per 1000 catheter-days  
• UC was the strongest risk factor for preliminary removal (RR 9.69, p<0.001) and infection (RR 3.76, p<0.001) |
| Oguzkurt et al (2004)[17]  | 57 | Prospective cohort | Single centre, Turkey | Haemodialysis patients with temporary catheters. [Right internal jugular vein (RIJV); right subclavian vein (RSCV); left – LIJV; left LSCV] | N/A | • 32/57 (56%) patients had only one temporary catheter, the rest had more than one (mean 1.8±1.1)  
• Percatheter sleeve formation was detected in 32 patients (56%) and was more common in women (p<0.05)  
• Thrombus formation was detected in 16 patients (28%)  
• Percatheter sleeve or thrombus formation alone or in |

Vascular Access  
July 2012  
Page 11 of 14
<table>
<thead>
<tr>
<th>Study ID (author, year)</th>
<th>N</th>
<th>Study Design</th>
<th>Setting</th>
<th>Participants</th>
<th>Follow up (months)</th>
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<tbody>
<tr>
<td>Fry et al (2008)[20]</td>
<td>492 patients (812 catheters)</td>
<td>Prospective audit</td>
<td>Multicentre, England</td>
<td>Haemodialysis patients dialysing via central venous catheters</td>
<td>72</td>
<td>Inserted Tunnelled venous catheters included: Tesio catheters 395 (49%); Split-caths 181 (22%); Hemosplits 127 (16%); Permcaths 109 (13%); 380 cases the TVC was the first catheter for the patient, 432 cases had received one or more previous TVCs; Significant survival difference was identified between first and any subsequent TVC insertion (p&lt;&lt;0.0001) (median 607 and 403 days respectively); Diabetic status had a significant negative influence on TVC survival (p=0.01); The right internal jugular route is the most favourable and is better than the left IJ (p=0.002); the LJ is better than the femoral route (p=0.0001). Survival times were: 633 (RIJV), 430 (LIJV) and 116 (FV) days; Overall the Hemosplit and Tesio catheters survived significantly longer than the Permcath and Split-Cath (p&lt;0.0001)</td>
</tr>
<tr>
<td>Powell et al (2010)[22]</td>
<td>54 patients (57 procedures; 19 study group; 19 control 1; 19 control 2))</td>
<td>Retrospective analysis</td>
<td>Single centre, UK</td>
<td>Haemodialysis patients requiring central venous catheter insertion. There were 19 study patients compared with two control groups of 19 patients each (CG1 and CG2)</td>
<td>24</td>
<td>Mean longevity of tunnelled haemodialysis catheters (THCs) was 169.3 days in the study group (SG) compared with 175.9 and 119.4 days in control groups one and two, respectively (p=0.89 and p=0.45); The SG had higher number of previous THCs 4.3 compared with 0.9 in CG1 (p&lt;0.001) and 0.5 in CG2 (p&lt;0.001); In the SG 5 THCs were inserted into occluded jugular veins and 4 THCs into occluded groin veins; Patients in the SG had been on dialysis for longer: mean 48 months compared to 23 months (p=0.03) and 19 months (p=0.05) for CG1 and CG2 respectively; Catheter-related bacteraemia was 1.6 episodes per 1000 days for all groups; Exit site infection was also non-significant between the groups: SG 2.9, CG1 and CG2 1.4 and 3.2 episodes/1000 days respectively</td>
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<tr>
<td>Funaki et al</td>
<td>24 patients</td>
<td>Prospective</td>
<td>Single centre,</td>
<td>Haemodialysis patients</td>
<td>6,234</td>
<td>6 catheters were inserted in thrombosed internal jugular veins;</td>
</tr>
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| (2001)[23] | (25 procedures) | cohort | USA | with known occlusions of the central veins and requiring central venous catheter insertion. | (days) | 5 were inserted in thrombosed external jugular veins; 2 in thrombosed left subclavian veins; and 9 in thyrocervical collateral veins  
- Recanalization was unsuccessful in 3 patients  
- Primary patency was: 90%, 71%, 25% at one, six and 12 months, respectively  
- Secondary patency was: 100% and 70% at six and 12 months respectively  
- Catheter malfunction requiring exchange occurred at a rate of 0.67 per 100 catheter days |
| Tapping et al (2012)[28] | 140 | Prospective cohort | Single centre, UK | All haemodialysis patients requiring replacement of their tunnelled dialysis catheter (TDC) were included. | 60 | Insertion site for TDC was: right internal jugular vein (RIJV) in 60 cases; left internal jugular vein (LIJV) in 70 cases; right femoral vein in six cases and left femoral vein in four cases  
- There were 6 immediate complications, 42 early complications and 37 late complications  
- Immediate complications were significantly related to: same site TDC in the past OR 4.1 (95%CI: 2.2-5, P=0.014) and prothrombin time >15s OR 4.1 (95%CI: 2.4-8, P=0.002)  
- Early complications were significantly associated with: female gender OR 2.9 (95%CI: 2.3-5, P=0.003); catheter exchange OR 3.8 (95%CI: 2.7-5.1, P=0.038); same site TDC in the past OR 2.0 (95%CI: 1.5-2.3, P=0.033); albumin <30 g/l OR 4.4 (95%CI: 3.2-5.6, P=0.007); CRP >50 mg/l OR 4.6 (95%CI: 3.5-5.8, P=0.007) and Hb <11 g/dl OR 3.6 (95%CI: 2.4-4, P=0.033)  
- Late complications were significantly associated to: female gender OR 1.9 (95%CI:1.2-2.3, P=0.04); history of smoking OR1.8 (95%CI: 1.5-2.3, P=0.034); diabetes OR 2.3 (95%CI: 2-3, P=0.003); and albumin <30 g/l, OR 1.5 (95%CI: 1.2-3.8, P=0.002) |
| Guttman et al (2011)[27] | 61 patients | Retrospective (quality assurance) | Single centre, USA | Patients with tunnelled infusion catheters exchanged either over the guide-wire or removed and replaced | | Catheter exchange was done in 25 patients and removal-replacement was done in 36 patients  
- Exchanged catheters lasted a median of 102 days (range 2 to 570) compared to 238 days (range 1 to 292) p=0.12  
- Infection rates post replacement were: 4.4 per 1000 catheter days for the exchange group compared to 2.3 for the removal and replacement group (p=0.05)  
- The catheter exchange group had 3.2 greater odds (95%CI: 1.04-10.2) of infection compared with the removal-replacement group  
- Rates of malfunction were similar between the groups: 2.0 and 1.7 per 1000 catheter days for the exchange and removal-replacement groups respectively (p=0.73) |
<p>| Casey et al | 329 patients | Retrospective | Single centre, USA | Patients with non- | | 362 (88.7%) NS replacements and 46 (11.3%) GE |</p>
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| (2008)[24]             | (408 catheters) | analysis     | UK      | tunnelled catheters requiring tunnelled catheter replacement. Comparison between guide wire exchange (GE) and new site (NS) replacement group |                     | • Bacteraemia from NS insertion group was 3.0 per 1000 catheter days compared with 2.8 for the GE group  
|                        |         |              |         |                                                                               |                    | • Catheter survival rates did not differ between the groups  
|                        |         |              |         |                                                                               |                    | • Local infection rates were the same for both groups: 1.2 per 1000 catheter days  
| Falk and Parthasarathy (2005)[28] | 42 patients (42 catheters) | Retrospective analysis | Single centre, USA | Patients with temporary haemodialysis catheters requiring tunnelled haemodialysis catheters | 71 days (median) | • All temporary catheters were successfully exchanged to tunnelled haemodialysis catheters  
|                        |         |              |         |                                                                               |                    | • 9 catheters were removed due to infection; 3 due to blood flow <200ml/min; 13 were removed as they were no longer needed  
|                        |         |              |         |                                                                               |                    | • Catheter infection rate following exchange, was 0.3/100 catheter days  
|                        |         |              |         |                                                                               |                    | • Patency rate was 72% at one month                                                                                                       |