Honesty Equality Accountability Respect Teamwork

Putting patients at the HEART of everything we do

NHS
London North West University Healthcare
NHS Trust

Complications of central venous catheters: current perspectives

Mia Small

Nurse Consultant Nutrition and Intestinal Failure

St Mark's Hospital

mia.small@nhs.net

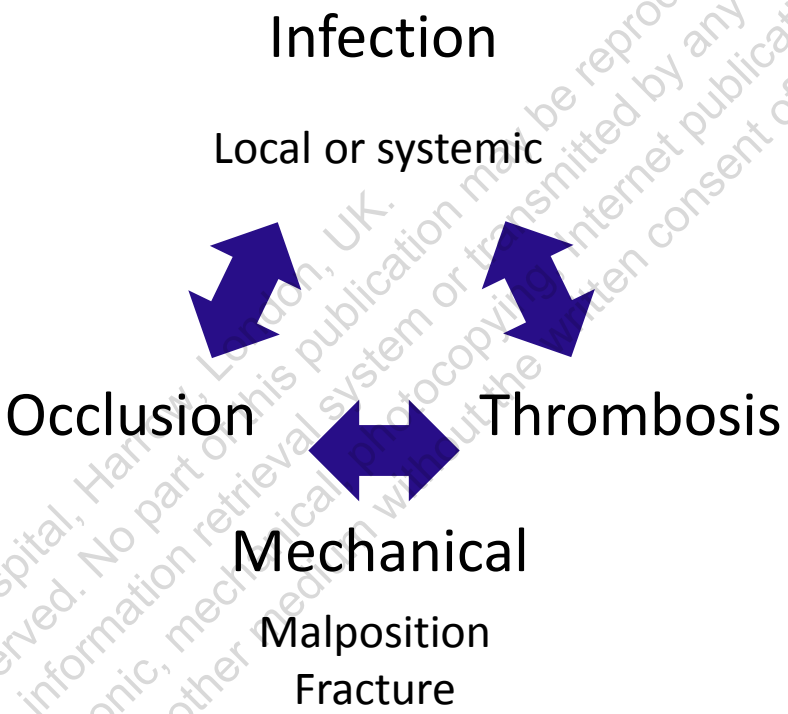
The Lennard-Jones Intestinal Failure Unit

St MARK'S HOSPITAL

Overview

- Outline the principal complications associated with central venous catheters
- Present the evidence base surrounding these strategies & the implications for practice

CVC complications



Wechster et al (1993), Raad et al (1994), Timsit et al (1998), Eastman et al (2001) Pironi et al, ESPEN Guidelines on chronic IF in adults, *Clin Nutr*, 2016, **35**, 247-307

Catheter-related infection (CRI)

Localised	Systemic
Exit site infection	Infusate related
Tunnel infection	Catheter associated
Port pocket infection	Catheter related

In tunnelled CVC local infection is rarely associated with systemic infection

O'Grady et al (2011), Guidelines for the Prevention of Intravascular Catheter-Related Infection

Exit site infection

Erythema or induration within 2cm of exit site in absence of bacteraemia

Tunnel infection

Erythema or induration > 2cm from exit site

Port pocket infection

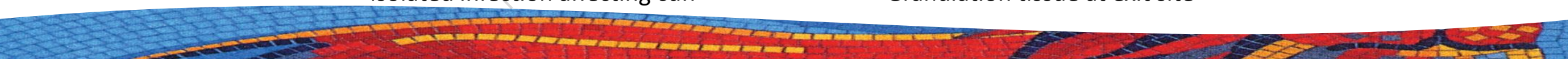
Purulent fluid in skin pocket of implanted port

Cuff infection

Isolated infection affecting cuff

Overgranulation

Granulation tissue at exit site



Medical adhesive related skin injury (MARSI)

- Erythema &/or vesicle, bulla, erosion or skin tear which persists ≥ 30 minutes post dressing removal[1]
- Skin to adhesive attachment is greater than skin cell to skin cell attachment
- Affects almost ⅓ PICC[2]
- Follow manufacturer's guidelines re application & removal of dressings
- Consider skin barrier & adhesive remover

[1]McNichol et al, *J Wound Ostomy Continence Nurs 2013*; **40**(4), 365-80
[2]Zhao et al, *The Journal of Vascular Access, Nov 8 [epub ahead of print]*

And there's CASI too!

CVC associated skin Impairment

Broadhurst et al, *JWOCN 2017;* **44**(3); 1-10

Pathogenesis of catheter related sepsis

- Migration of skin organisms at insertion site into the catheter tract with colonization of the catheter tip
- Contamination of catheter hub with intraluminal colonization
- Haematogenous seeding from other infection site
- Infusate contamination

O'Grady et al, *CDC Guidelines for the Prevention of Intravascular Catheter-Related Infections,* 2011

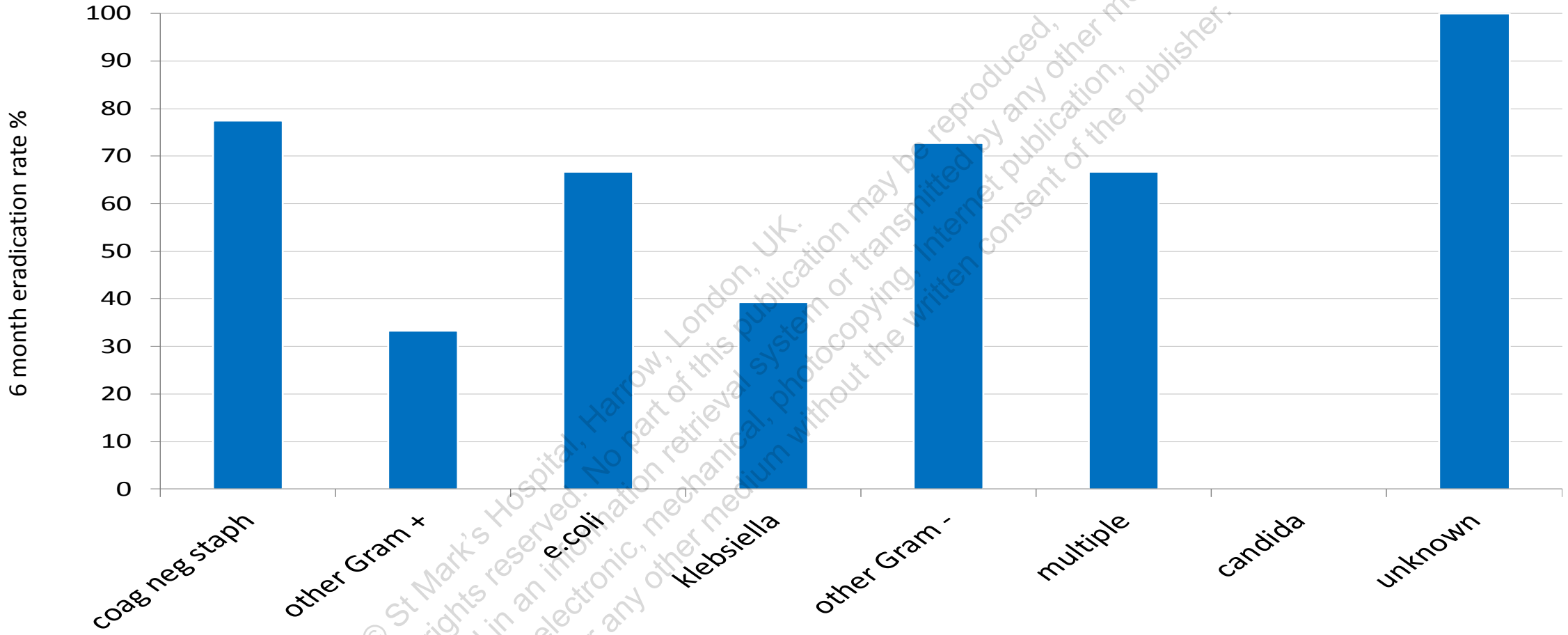
Treating CRBSI

Removal

Salvage

- Removal
  - Septic shock
  - Fungal & staph aureus infections
  - Positive blood cultures after 48 hours of treatment
  - Implanted port
- Salvage
  - Targeted antibiotic therapy via CVC
  - Seek microbiology guidance
  - Optimum duration of therapy has not been determined

CRBSI treatment in HPN



No significant difference between 7 & 10 days antibiotic treatment

CRBSI eradication dependent on the organism type

Antimicrobial line locks

- Treatment or prophylaxis[1]
- Should not be used routinely[2]
- Should include citrate &/or Taurolidine[3]
- May be used but strength of evidence low[4]

[1]O'Grady et al (2011), Guidelines for the Prevention of Intravascular Catheter-Related Infection
[2]Loveday et al, epic3 Guidelines, *J Hosp Infect* 2014, **86** S1, S1-S7
[3]Pittiruti et al, GAVeCeLT Consensus, *J Vasc Access,* 2016 **17**(6), 453-464
[4]ESPEN Guidelines on chronic IF in adults, *Clin Nutr*, 2016, **35**, 247-307

Which lock?

- All have broad spectrum bacteriacidal & fungicidal properties
- Studies underpowered & heterogenous
- Differing concentrations, preparations & presentation of product
- Practical considerations
  - Volume to be instilled
  - Minimum & maximum dwell time
  - Flush through or aspirate

Taurolock™ & CRBSI in HPN patients

CRBSI	Before Taurolock™		After Taurolock™	
	No of CRBSI	Infection rate (per 1000 catheter days)	No of CRBSI	Infection rate (per 1000 catheter days)
Definite	21	6.2	4	1.6*
Possible	7	2.1	0	0˜
Total	28	8.5	4	1.6⁺

*p<0.05, ⁺p<0.01, ˜p<0.001

Raferty et al, *Gut 2010*; **59**(Suppl 1): OC84

70% ethanol

- Most evidence in paediatrics
  - Ethical considerations
- Not recommended by ESPEN
- Concerns raised[1]
  - Systemic toxicity
  - CVC occlusion & damage
  - Altered liver function
  - Increased thrombosis risk
- More study needed

[1]Mermel & Alang, *J Antimicrob Chemo* 2014, **69**(12), 2611-9

Catheter occlusion

- Thought to affect 30% CVC
- Thrombotic or non thrombotic
- Partial, complete, or withdrawal
- Mechanical compression
  - Pinch off
  - Kink memory from clamp
- Lipid, or drug/mineral precipitate
- Blood reflux

Ernst et al, *J of Hosp Med 2014;* **9**(8): 490-496

Blood reflux

Heart failure

Respiration

Patient movement

Syringe plunger rebound

Negative displacement devices

Negative displacement devices

Coughing

Muscle contraction (PICC)

Sneezing

IV infusion runs dry

Syringe connections/disconnections

Venous pressure changes

Vomiting

Crying

Low keep vein open (KVO) rates

Hadaway, *Nursing 2004,* **34**(8), 18

Maintaining patency

- Sterile 0.9% sodium chloride for injection for CVC in frequent use
  - Optimal volume?
- Evidence for Heparin weak (Mitchell et al 2009, Staun et al 2009)
- Flush lumens not used frequently at least weekly
  - Monthly for ports
- Use push pause flushing
- Positive pressure clamping

Loveday et al, epic3 Guidelines, *J Hosp Infect* 2014, **86** S1, S1-S7
O'Grady et al (2011), CDC Guidelines for the Prevention of Intravascular Catheter-Related Infection

Push pause flushing

- Retrieval of fibronectin and albumin[1]
  - 10 mL single bolus
  - 500 mL infusion/24 hours
  - 10 x 1 mL bolus (various time intervals)
  - 10 x 1 mL bolus at 0.4 sec intervals
- Retrieval of staph aureus[2]
  - 10 mL single bolus
  - 10 x 1 mL bolus
  - Less colonisation in pulsed boluses, p<0.001

[1]Guiffant et al (2012) *J Vasc Access* **13**(1), 75-77

[2] Ferroni et al (2014) *Med Devices: Evidence & Research*, **7**: 379-83

Restoring patency

- Fibrin deposits
  - t-PA 2mg, Urokinase 10,000 units (Atkinson et al 1990, Haire & Herbst 2000)
- Lipid deposits
  - Ethanol 70% (Pennington & Pithie 1987)
- Fibrin + lipid
  - Sodium hydroxide 0.1M (Borg et al 1993, Bader et al 2007)

Due to the risk of CVC rupture, restoration of patency should only be attempted by suitably qualified/experienced healthcare staff

Hub clearout

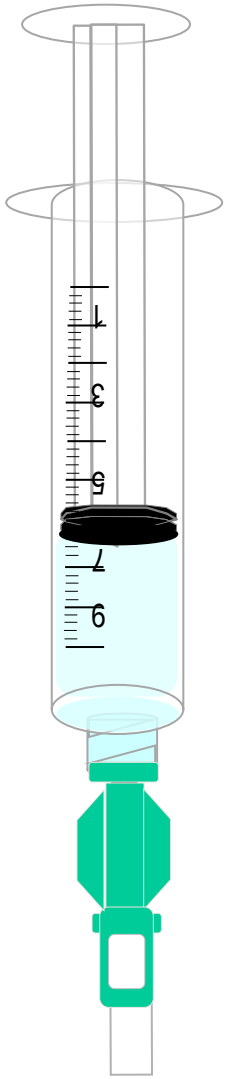
- Manual extraction of debris from the catheter hub with a green needle
- St Mark's practice since 2000
- No CVC damage
- Often only strategy needed to unblock a CVC
- No patient has ever declined

Pop technique

- Generates shock waves through the CVC loosening the obstruction
- Allows obstruction to be extracted, rather than introduced into the patient
- 94% success rate (n=50) no reported complications[1]
- 86% success (n=30) no catheter damage[2]

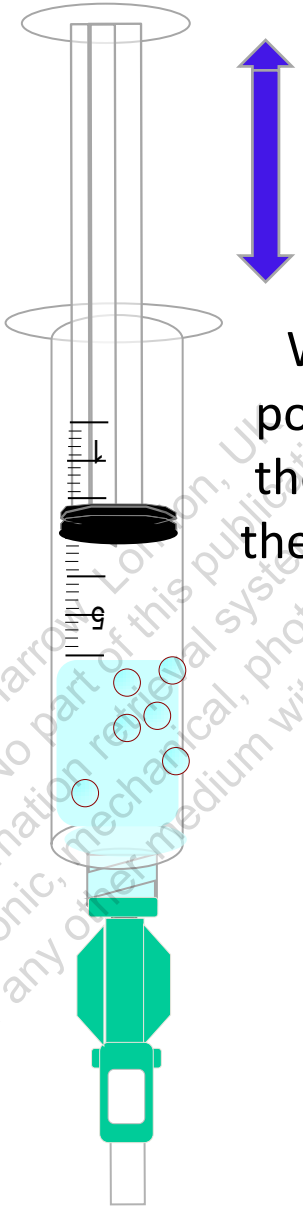
[1]Stewart, *Care of the critically ill 2001;***17**(3)
[2]Fetzer & Manning, *Applied Nursing Research (2004)*, **17**,(4), 297-300

1



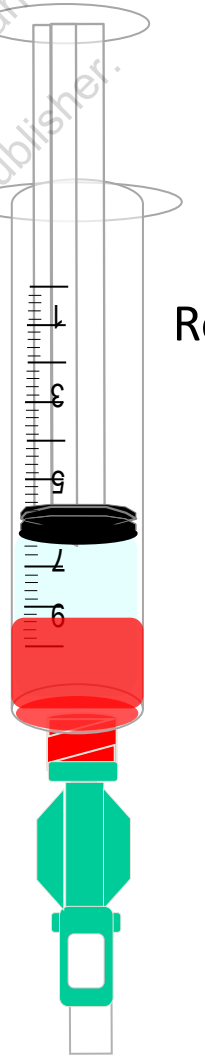
Attach 10ml luer lock syringe with saline or antifibrinolytic agent to CVC hub

2



With the syringe pointing down, pull the plunger back to the end of the barrel and release

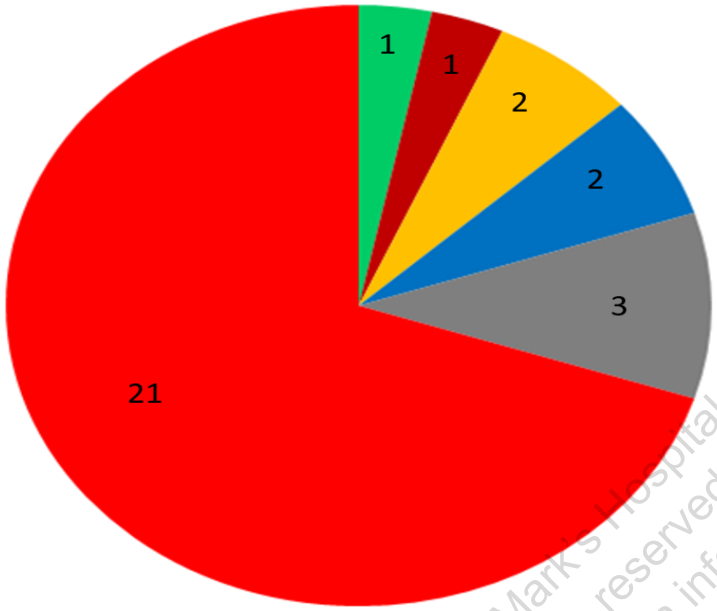
3



Repeat until blood is drawn into the syringe

St Mark's experience

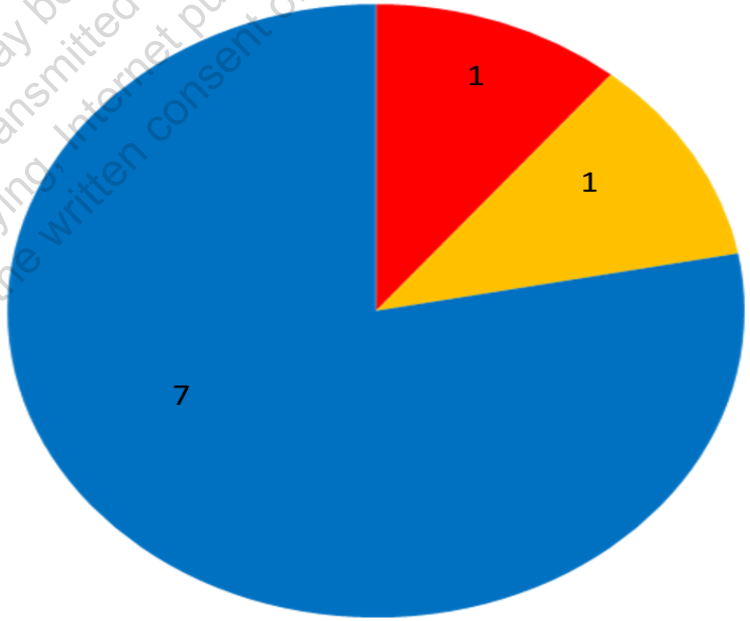
Total occlusion, n=30, 19 patients
17 CVC, 2 implanted port



Patency restored
29 (97%)
occasions

- 70% alcohol
- Urokinase 10,000 using POP
- Urokinase 10,000 and POP
- Hub clearout
- Hub clearout and POP
- POP technique

Partial occlusion, n=9, 8 patients
8 CVC



Patency restored
9 (100%)
occasions

- POP technique
- Urokinase 10,000 and POP
- Hub clearout

Small et al, *Gut 2015*; **64**(Suppl 1): A498 - 499

Catheter fracture

- Causes
  - Flushing against resistance
  - Use of small syringes (<10ml)
  - Power injection of contrast material
  - Use of scissors/sharp objects near CVC
  - Repeatedly clamping in same place
- Prevention
  - Power CVC
  - Routine movement of clamp along reinforcement area
  - Securing end of CVC to prevent contact with sharp objects

Treatment of catheter fracture

- Immediate clamping above fracture to prevent air embolism
- Catheter repair
  - Device specific
- CVC replacement if insufficient undamaged CVC, or if fracture within subcutaneous tunnel
- Repairs not associated with increase in CRBSI[1]
- No guidance as whether a temporary or permanent solution

McNiven et al, *J of Ped Surg 2016*; **51**(3): A498 - 499

Local experience

- 5 year review
- 55 repairs on 44 catheters
  - 11 patients > one repair on a single device
- 48 (78%) repairs successful
  - lasting a mean of 87±468 (2-2052) days, median 156 days
- Most common cause was trauma, n=15 (27%)
  - 12 (22%) being while the patient was infusing
  - 3 (5%) resulting from damage caused by pets
- Only 1 bacteraemia within 30 days thought to be associated with the unreported traumatic fracture rather than the repair process

Small et al (2017) BAPEN Abstract

CVC related thrombosis

Platelet adhesion

Stasis

Endothelial trauma

Virchow's triad

- Affect 35-65% long term devices
  - Often asymptomatic
- Strategies which may influence incidence
  - Avoid dehydration
  - Use the smallest size CVC possible
  - Minimise insertion site trauma
  - Right vs left side placement
  - Tip position
  - Tip integrity

Loveday et al, epic3 Guidelines, *J Hosp Infect* 2014, **86** S1, S1-S7
O'Grady et al (2011), CDC Guidelines for the Prevention of Intravascular Catheter-Related Infection

Reducing thrombosis

The risk of thrombosis is significantly increased with proximal SVC tip position

Catheter tip	Thrombosis %
Proximal	42
Intermediate	5
Distal	3

48% CVC on transfer tip position too high

Cadman et al, *Clin Radiol 2004*; **59**(4): 349-355

Tip integrity

- Trimming catheter tips has been linked with vessel perforation & thrombus formation
  - Cutting the catheter produces rough edges
- Catheters should be cut straight across according to manufacturer's recommendations
  - Scalpels produce less irregularities than scissors

Parvez & Parmar (2004), Trolfer (2004), Pettit (2006), Jegatheeswaran et al (2007)

Treatment options

- Thrombolysis
  - Alteplase +/- heparin
- Mechanical interventions
  - Balloon angioplasty
  - Venoplasty
  - SVC filter
  - Recannalisation
- Surgical interventions
  - Thrombectomy
  - Venous bypass

Pironi et al, ESPEN Guidelines on chronic IF in adults, *Clin Nutr*, 2016, **35**, 247-307