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Catheter type, placement and insertion techniques for preventing catheter-related infections in chronic peritoneal dialysis patients (Review)

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[Intervention Review]

Catheter type, placement and insertion techniques for preventing catheter-related infections in chronic peritoneal dialysis patients

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ABSTRACT

Background

Peritonitis is one of the limiting factors for the growth of peritoneal dialysis (PD) worldwide and is a major cause of technique failure. Several studies have examined the effectiveness of various catheter-related interventions for lowering the risk of PD-related peritonitis. This is an update of a review first published in 2004.

Objectives

To evaluate the role of different catheter implantation techniques and catheter types in lowering the risk of PD-related peritonitis in PD patients.

Search methods

We searched the Cochrane Kidney and Transplant Register of Studies up to 15 January 2019 through contact with the Information Specialist using search terms relevant to this review. Studies in the Register are identified through searches of CENTRAL, MEDLINE, and EMBASE, conference proceedings, the International Clinical Trials Register (ICTRP) Search Portal and ClinicalTrials.gov.

Selection criteria

Studies comparing different catheter insertion techniques, catheter types, use of immobilisation techniques and different break-in periods were included. Studies of different PD sets were excluded.

Data collection and analysis

Two authors independently assessed study quality and extracted data. Statistical analyses were performed using a random effects model and the results expressed as risk ratio (RR) with 95% confidence intervals (CI).

Main results

Forty-two studies (3144 participants) were included: 18 evaluated techniques of catheter implantation, 22 examined catheter types, one assessed an immobiliser device, and one examined break-in period. In general, study quality was variable and almost all aspects of study design did not fulfil CONSORT standards for reporting.

Catheter insertion by laparoscopy compared with laparotomy probably makes little or no difference to the risks of peritonitis (RR 0.90, 95% CI 0.59 to 1.35; moderate certainty evidence), exit-site/tunnel infection (RR 1.00, 95% CI 0.43 to 2.31; low certainty evidence), catheter removal/replacement (RR 1.20, 95% CI 0.77 to 1.86; low certainty evidence), technique failure (RR 0.71, 95% CI 0.47 to 1.08; low certainty evidence), and death (all causes) (RR 1.26, 95% CI 0.72 to 2.20; moderate certainty evidence). It is uncertain whether subcutaneous burying of catheter increases peritonitis (RR 1.16, 95% CI 0.37 to 3.60; very low certainty evidence). Midline insertion compared to lateral insertion probably makes little or no difference to the risks of peritonitis (RR 0.65, 95% CI 0.32 to 1.33; moderate certainty evidence) and may make little or no difference to exit-site/tunnel infection (RR 0.56, 95% CI 0.12 to 2.58; low certainty evidence). Percutaneous insertion compared with open surgery probably makes little or no difference to the exit-site/tunnel infection (RR 0.16, 95% CI 0.02 to 1.30; moderate certainty evidence).

Straight catheters probably make little or no difference to the risk of peritonitis (RR 1.04, 95% CI 0.82 to 1.31; moderate certainty evidence), peritonitis rate (RR 0.91, 95% CI 0.68 to 1.21; moderate certainty evidence), risk of exit-site infection (RR 1.12, 95% CI 0.94 to 1.34; moderate certainty evidence), and exit-site infection rate (RR 1.05, 95% CI 0.77 to 1.43; moderate certainty evidence) compared to coiled catheter. It is uncertain whether straight catheters prevent catheter removal or replacement (RR 1.11, 95% CI 0.73 to 1.66; very low certainty evidence) but straight catheters probably make little or no difference to technique failure (RR 0.82, 95% CI 0.51 to 1.31; moderate certainty evidence) and death (all causes) (RR 0.95, 95% CI 0.62 to 1.46; low certainty evidence) compared to coiled catheter. Tenckhoff catheter with artificial curve at subcutaneous tract compared with swan-neck catheter may make little or no difference to peritonitis (RR 1.29, 95% CI 0.85 to 1.96; low certainty evidence) and incidence of exit-site/tunnel infection (RR 0.96, 95% CI 0.77 to 1.21; low certainty evidence) but may slightly improve exit-site infection rate (RR 0.67, 95% CI 0.50 to 0.90; low certainty evidence).

Authors' conclusions

There is no strong evidence that any catheter-related intervention, including the use of different catheter types or different insertion techniques, reduces the risks of PD peritonitis or other PD-related infections, technique failure or death (all causes). However, the numbers and sizes of studies were generally small and the methodological quality of available studies was suboptimal, such that the possibility that a particular catheter-related intervention might have a beneficial effect cannot be completely ruled out with confidence.

PLAIN LANGUAGE SUMMARY

Catheter type, placement and insertion techniques for preventing peritonitis in peritoneal dialysis patients

What is the issue?

People with kidney failure may be treated with peritoneal dialysis where a catheter is permanently inserted into the peritoneum (lining around abdominal contents) through the abdominal wall and sterile fluid is drained in and out several times overnight or during the day. The most common serious complication is infection of the peritoneum - peritonitis. This may be caused by germs which may be accidentally introduced via the catheter into the peritoneum resulting in peritonitis.

What did we do?

We conducted a review of the literature to examine the effects of different methods of catheter insertion and different types of catheter in prevention of peritonitis in PD patients.

What did we find?

We identified 42 studies (3144 participants) examining the effects of different methods of catheter insertion and types of catheter on peritonitis. The risk of peritonitis was not affected by different types of insertion methods or types of catheters inserted.

Conclusions

There is no evidence to support a specific catheter insertion technique or type of catheter with the aim to prevent peritonitis in peritoneal dialysis patients.

Summary of findings for the main comparison. Laparoscopy versus laparotomy for preventing catheter-related infections in chronic peritoneal dialysis patients

Laparoscopy versus laparotomy for preventing catheter-related infections in chronic peritoneal dialysis patients

Patient or population: chronic peritoneal dialysis patients
Intervention: laparoscopy
Comparison: laparotomy

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants or patient-months (studies)	Certainty of the evidence (GRADE)
	Risk with laparotomy	Risk with laparoscopy			
Peritonitis	242 per 1,000	218 per 1,000 (143 to 327)	RR 0.90 (0.59 to 1.35)	315 (4)	⊕⊕⊕⊖ MODERATE [1]
Peritonitis rate (patient-months)	59 per 1,000	52 per 1,000 (23 to 122)	RR 0.89 (0.39 to 2.07)	375 (1)	⊕⊖⊖⊖ VERY LOW [2]
Exit-site/tunnel infection	125 per 1,000	125 per 1,000 (54 to 289)	RR 1.00 (0.43 to 2.31)	270 (3)	⊕⊕⊖⊖ LOW [3]
Catheter removal or replacement	281 per 1,000	337 per 1,000 (216 to 522)	RR 1.20 (0.77 to 1.86)	167 (3)	⊕⊕⊖⊖ LOW [3]
Technique failure	293 per 1,000	208 per 1,000 (137 to 316)	RR 0.71 (0.47 to 1.08)	283 (4)	⊕⊕⊖⊖ LOW [3]
Death (all causes)	140 per 1,000	176 per 1,000 (101 to 307)	RR 1.26 (0.72 to 2.20)	270 (3)	⊕⊕⊕⊖ MODERATE [1]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1] Downgraded one level: suboptimal quality of studies
[2] Downgraded two levels: single study with suboptimal quality and imprecision
[3] Downgraded two levels: suboptimal quality and imprecision

Summary of findings 2. Buried (subcutaneous) versus non-buried catheter for preventing catheter-related infections in chronic peritoneal dialysis patients

Buried (subcutaneous) versus non-buried catheter for preventing catheter-related infections in chronic peritoneal dialysis patients

Patient or population: chronic peritoneal dialysis patients
Intervention: buried (subcutaneous) catheter
Comparison: non-buried catheter

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants or patient-months (studies)	Certainty of the evidence (GRADE)
	Risk with non-buried	Risk with buried (subcutaneous)			
Peritonitis rate (patient-months)	37 per 1,000	43 per 1,000 (14 to 133)	RR 1.16 (0.37 to 3.60)	2511 (2)	⊕⊖⊖⊖ VERY LOW [1]
Exit-site/tunnel infection rate (patient-months)	31 per 1,000	36 per 1,000 (12 to 106)	RR 1.15 (0.39 to 3.42)	2511 (2)	⊕⊖⊖⊖ VERY LOW [1]
Technique failure	367 per 1,000	268 per 1,000 (125 to 568)	RR 0.73 (0.34 to 1.55)	60 (1)	⊕⊖⊖⊖ VERY LOW [2]
Death (all causes)	169 per 1,000	153 per 1,000 (66 to 353)	RR 0.90 (0.39 to 2.08)	119 (2)	⊕⊕⊕⊖ MODERATE [3]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
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Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1] Downgraded three levels: suboptimal quality, inconsistency, and imprecision
[2] Downgraded three levels: single study, suboptimal quality, and imprecision
[3] Downgraded two levels: suboptimal quality of studies and imprecision

Summary of findings 3. Midline versus lateral insertion for preventing catheter-related infections in chronic peritoneal dialysis patients

Midline versus lateral insertion for preventing catheter-related infections in chronic peritoneal dialysis patients

Patient or population: chronic peritoneal dialysis patients
Intervention: midline insertion
Comparison: lateral insertion

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)
	Risk with lateral	Risk with midline			
Peritonitis	255 per 1,000	166 per 1,000 (82 to 339)	RR 0.65 (0.32 to 1.33)	120 (2)	⊕⊕⊕⊖ MODERATE [1]
Exit-site/tunnel infection	78 per 1,000	44 per 1,000 (9 to 202)	RR 0.56 (0.12 to 2.58)	120 (2)	⊕⊕⊖⊖ LOW [2]
Catheter removal or replacement	514 per 1,000	293 per 1,000 (170 to 504)	RR 0.57 (0.33 to 0.98)	83 (1)	⊕⊖⊖⊖ VERY LOW [3]
Death (all causes)	0 per 1,000	0 per 1,000 (0 to 0)	RR 8.50 (0.50 to 143.32)	37 (1)	⊕⊖⊖⊖ VERY LOW [3]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1] Downgraded one level: suboptimal quality of studies
[2] Downgraded two levels: suboptimal quality and imprecision
[3] Downgraded three levels: single study, suboptimal quality study, and imprecision

Summary of findings 4. Percutaneous insertion versus open surgery for preventing catheter-related infections in chronic peritoneal dialysis patients

Percutaneous insertion versus open surgery for preventing catheter-related infections in chronic peritoneal dialysis patients

Patient or population: chronic peritoneal dialysis patients
Intervention: percutaneous insertion
Comparison: open surgery

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)
	Risk with open surgery	Risk with percutaneous insertion			
Exit-site/tunnel infection	106 per 1,000	17 per 1,000 (2 to 138)	RR 0.16 (0.02 to 1.30)	96 (2 RCTs)	⊕⊕⊕⊖ MODERATE [1]
Catheter removal or replacement	133 per 1,000	32 per 1,000 (4 to 272)	RR 0.24 (0.03 to 2.04)	61 (1 RCT)	⊕⊖⊖⊖ VERY LOW [2]

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
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[1] Downgraded one level: suboptimal quality of studies
[2] Downgraded two levels: single study with suboptimal quality and imprecision

Summary of findings 5. Straight versus coiled catheters for preventing catheter-related infections in chronic peritoneal dialysis patients

Straight versus coiled catheters for preventing catheter-related infections in chronic peritoneal dialysis patients

Patient or population: chronic peritoneal dialysis patients

Intervention: straight
Comparison: coiled

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants or patient-months (studies)	Certainty of the evidence (GRADE)
	Risk with coiled	Risk with straight			
Peritonitis	217 per 1,000	225 per 1,000 (178 to 284)	RR 1.04 (0.82 to 1.31)	818 (9)	⊕⊕⊕⊖ MODERATE [1]
Peritonitis rate (patient-months)	32 per 1,000	29 per 1,000 (22 to 39)	RR 0.91 (0.68 to 1.21)	5882 (5)	⊕⊕⊕⊖ MODERATE [1]
Exit-site/tunnel infection	281 per 1,000	314 per 1,000 (264 to 376)	RR 1.12 (0.94 to 1.34)	826 (10)	⊕⊕⊕⊖ MODERATE [1]
Exit-site/tunnel infection rate (patient-months)	27 per 1,000	28 per 1,000 (21 to 39)	RR 1.05 (0.77 to 1.43)	5286 (4)	⊕⊕⊕⊖ MODERATE [1]
Catheter removal or replacement	249 per 1,000	276 per 1,000 (181 to 413)	RR 1.11 (0.73 to 1.66)	713 (9)	⊕⊖⊖⊖ VERY LOW [1 2 3]
Technique failure	131 per 1,000	108 per 1,000 (67 to 172)	RR 0.82 (0.51 to 1.31)	442 (4)	⊕⊕⊕⊖ MODERATE [1]
Death (all causes)	124 per 1,000	117 per 1,000 (77 to 180)	RR 0.95 (0.62 to 1.46)	703 (8)	⊕⊕⊖⊖ LOW [1 3]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1] Downgraded one level: most studies are of suboptimal quality
[2] Downgrade one level: inconsistency
[3] Downgraded one level: publication bias

Summary of findings 6. Tenckhoff catheter with artificial curve at tunnel tract versus swan-neck for preventing catheter-related infections in chronic peritoneal dialysis patients

Tenckhoff catheter with artificial curve at tunnel tract versus swan-neck for preventing catheter-related infections in chronic peritoneal dialysis patients

Patient or population: preventing catheter-related infections in chronic peritoneal dialysis patients
Intervention: Tenckhoff catheter with artificial curve at tunnel tract
Comparison: swan-neck

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants or patient-months (studies)	Certainty of the evidence (GRADE)
	Risk with swan-neck	Risk with Tenckhoff			
Peritonitis	329 per 1,000	424 per 1,000 (279 to 644)	RR 1.29 (0.85 to 1.96)	140 (2)	⊕⊕⊖⊖ LOW [1]
Peritonitis rate (patient-months)	47 per 1,000	57 per 1,000 (25 to 129)	RR 1.22 (0.54 to 2.75)	2535 (2)	⊕⊕⊖⊖ LOW [2]
Exit-site/tunnel infection	671 per 1,000	645 per 1,000 (517 to 812)	RR 0.96 (0.77 to 1.21)	140 (2)	⊕⊕⊕⊖ MODERATE [3]
Exit-site/tunnel infection rate (patient-months)	83 per 1,000	55 per 1,000 (41 to 74)	RR 0.67 (0.50 to 0.90)	2535 (2)	⊕⊕⊕⊖ MODERATE [3]
Catheter removal or replacement	229 per 1,000	194 per 1,000 (96 to 393)	RR 0.85 (0.42 to 1.72)	140 (2)	⊕⊕⊕⊖ MODERATE [3]
Technique failure	157 per 1,000	101 per 1,000 (41 to 248)	RR 0.64 (0.26 to 1.58)	140 (2)	⊕⊕⊕⊖ MODERATE [3]
Death (all causes)	114 per 1,000	85 per 1,000 (31 to 232)	RR 0.74 (0.27 to 2.03)	140 (2)	⊕⊕⊖⊖ LOW [1]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect

Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1] Downgraded two levels: suboptimal quality of studies and imprecision
[2] Downgraded two levels: suboptimal quality of studies and inconsistency
[3] Downgraded one level: suboptimal quality of studies

Summary of findings 7. Self-locating versus straight Tenckhoff catheter for preventing catheter-related infections in chronic peritoneal dialysis patients

Self-locating versus straight Tenckhoff catheter for preventing catheter-related infections in chronic peritoneal dialysis patients

Patient or population: chronic peritoneal dialysis patients
Intervention: self-locating catheter
Comparison: straight Tenckhoff catheter

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)
	Risk with straight Tenckhoff	Risk with self-locating			
Peritonitis	684 per 1,000	773 per 1,000 (588 to 1,000)	RR 1.13 (0.86 to 1.49)	78 (1)	⊕⊖⊖⊖ VERY LOW [1]
Exit-site/tunnel infection	184 per 1,000	175 per 1,000 (68 to 451)	RR 0.95 (0.37 to 2.45)	78 (1)	⊕⊖⊖⊖ VERY LOW [1]
Catheter removal or replacement	343 per 1,000	110 per 1,000 (10 to 1,000)	RR 0.32 (0.03 to 3.06)	139 (2)	⊕⊖⊖⊖ VERY LOW [2]
Technique failure	414 per 1,000	265 per 1,000 (162 to 431)	RR 0.64 (0.39 to 1.04)	139 (2)	⊕⊕⊕⊖ MODERATE [3]
Death (all causes)	71 per 1,000	73 per 1,000 (8 to 696)	RR 1.02 (0.11 to 9.75)	139 (2)	⊕⊕⊖⊖ LOW [4]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

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[1] Downgraded three levels: single study, suboptimal quality, and imprecision
[2] Downgraded three levels: suboptimal quality, imprecision and inconsistency
[3] Downgraded one level: suboptimal quality of study
[4] Downgraded two levels: suboptimal quality and imprecision

BACKGROUND

Description of the condition

Peritonitis is a serious complication of peritoneal dialysis (PD) that is associated with appreciably higher rates of hospitalisation (Barraclough 2010; Edey 2010; Htay 2018), technique failure (Htay 2017; Kolesnyk 2010) and death (Boudville 2012). Moreover, a previous study (Campbell 2016) has shown that peritonitis has serious impacts on patients' lifestyles (burden on family, financial burden) and quality of life (feeling of pain, loss of control and dignity). In addition, peritonitis and its complications can potentially increase the financial burden on healthcare systems (Li 2017).

Several factors can potentially contribute to a heightened risk of peritonitis, including older age (Kotsanas 2007; McDonald 2004), race (Lim 2011; McDonald 2004; Piraino 2002; Shen 2013), body mass index (Jegatheesan 2018; McDonald 2004), coexisting diseases (for example, diabetes mellitus) (Chow 2005), nasal carriage of *Staphylococcus aureus* (Schaefer 2003; Ong 2016), immunocompromised status, and connection methodology (Strippoli 2004a). However, PD-related infection can be prevented by measures including administering antibiotic prophylaxis prior to catheter implantation (Strippoli 2004a), application of topical antimicrobial agent at catheter exit-site (Xu 2009), and antibiotic prophylaxis prior to invasive gastrointestinal and gynaecological procedures (Wu 2013).

A previous observational study reported that double cuff catheters were associated with a lower risk of exit-site infection compared with single cuff catheters (Lindblad 1988). However, this association was unable to be confirmed in an RCT (Eklund 1997) or meta-analysis (Strippoli 2004; Strippoli 2004b).The International Society for Peritoneal Dialysis (ISPD) has recently issued updated guidelines for PD-related peritonitis prevention, which do not recommend any specific method of catheter implantation or type of catheter for the prevention of peritonitis in PD patients (Li 2016; Szeto 2017). These guidelines are largely based on the previous Cochrane review (Strippoli 2004). Since the last review, there have been several RCTs published on the different catheter types and implantation techniques in PD patients. The present review examined the role of catheter-related interventions, including different catheter types, placement and insertion techniques, in mitigating the risk of peritonitis in PD patients.

Description of the intervention

One of the key strategies employed to prevent PD-related peritonitis is to reduce the risk of microbial contamination via PD catheters. Different catheter-related interventions were examined in the review, including various catheter implantation methods (laparoscopic insertion, open surgery, percutaneous insertion, ureteroscope-assisted insertion, cystoscopy-assisted insertion, radiological insertion, midline or lateral insertion, implantation and subcutaneous burying of catheter with a resting period prior to catheter use, modified surgery with catheter fixation), different catheter types (single-cuff, double-cuff, triple-cuff, straight catheter, coiled catheter, self-locating catheter, swan-neck catheter, Moncrief-Popovich catheter, antibiotic-treated catheter), use of silver rings at exit-sites, immobilization of PD catheters, and break-in periods.

How the intervention might work

A randomised study by Gadallah 1999 reported that early peritonitis episodes (within 2 weeks of catheter placement) were significantly lower in76 patients who underwent catheter insertion via a peritoneoscopic approach compared to 72 patients with surgically placed catheters (2.6% versus 12.5%, P = 0.02). The previous systematic review conducted in 2004 (Strippoli 2004) reported that no specific catheter implantation technique was beneficial in lowering the risk of peritonitis. Since then, the approaches in catheter insertion technique and types of available catheters have evolved, which may have impacted on the risk of peritonitis and in turn translated into improvements in catheter and/or technique survival

Why it is important to do this review

The ISPD guidelines do not recommend any specific implantation method or any specific type of catheter for prevention of peritonitis in PD patients. This recommendation was mainly based on the results of the previous review. Since then, more randomised controlled trials (RCTs) have been published on this topic which this update will include.

OBJECTIVES

To evaluate the role of different catheter implantation techniques and catheter types in lowering the risk of PD-related peritonitis in PD patients.

METHODS

Criteria for considering studies for this review

Types of studies

All RCTs and quasi-RCTs (RCTs in which allocation to treatment was obtained by alternation, use of alternate medical records, date of birth or other predictable methods) investigating the effect of different catheter types, placement and insertion techniques for the prevention of peritonitis in PD patients.

Types of participants

Inclusion criteria

Adults and children undergoing PD treatment for end-stage kidney disease.

Exclusion criteria

Patients not on PD.

Types of interventions

- Surgical catheter insertion techniques (laparoscopy, laparotomy, subcutaneous burying and rest of catheter, standard insertion with resting but no subcutaneous burying of catheter, midline insertion, lateral insertion)
- Catheter types (straight, coiled, self-locating catheter, Tenckhoff catheter with an artificial curve at the subcutaneous tract, single-cuffed, double-cuffed, triple-cuffed, antibiotic treated catheter
- Use of immobilisation techniques
- Break-in periods

- Use of silver ring at exit-site (new intervention identified during updated search).

Types of outcome measures

Primary outcomes

- Peritonitis: number of patients with peritonitis (peritonitis defined as dialysate count of > 100 cells/mm^3 with > 50% being polymorphonuclear leukocytes) and peritonitis rate
- Exit-site and tunnel infection: number of patients with exit-site and tunnel infection and exit-site and tunnel infection rates.

Secondary outcomes

- Catheter removal/catheter replacement
- Technique failure (transfer from PD to haemodialysis)
- Death (all causes)
- Peritonitis relapse
- Peritonitis-related death
- Time to first peritonitis episode.

Search methods for identification of studies

Electronic searches

We searched the Cochrane Kidney and Transplant Register of Studies up to 15 January 2019 through contact with the Information Specialist using search terms relevant to this review. The Register contains studies identified from the following sources.

1. Monthly searches of the Cochrane Central Register of Controlled Trials (CENTRAL)
2. Weekly searches of MEDLINE OVID SP
3. Handsearching of kidney-related journals and the proceedings of major kidney and transplant conferences
4. Searching of the current year of EMBASE OVID SP
5. Weekly current awareness alerts for selected kidney and transplant journals
6. Searches of the International Clinical Trials Register (ICTRP) Search Portal and ClinicalTrials.gov.

Studies contained in the Register are identified through searches of CENTRAL, MEDLINE, and EMBASE based on the scope of Cochrane Kidney and Transplant. Details of search strategies, as well as a list of handsearched journals, conference proceedings and current awareness alerts, are available in the *Specialised Register* section of information about Cochrane Kidney and Transplant.

See Appendix 1 for search terms used in strategies for this review.

Searching other resources

1. Reference lists of review articles, relevant studies and clinical practice guidelines.
2. Letters seeking information about unpublished or incomplete studies to investigators known to be involved in previous studies.

Data collection and analysis

Selection of studies

The search strategies described were used to obtain titles and abstracts of studies that may be relevant to the review. The titles and abstracts were screened independently by two authors, who discarded studies that were not applicable, however studies and reviews that may have included relevant data or information on studies were retained initially. Two authors independently assessed retrieved abstracts and, where necessary the full text, of these studies to determine which studies satisfied the inclusion criteria.

Data extraction and management

Data extraction was carried out independently by two authors using standard data extraction forms. It was planned that studies reported in non-English language journals would be translated before assessment. Where more than one publication of one study existed, reports were grouped together and the publication with the most complete data was included.

Assessment of risk of bias in included studies

The following items were assessed independently by two authors using the risk of bias assessment tool (Higgins 2011) (see Appendix 2).

- Was there adequate sequence generation (selection bias)?
- Was allocation adequately concealed (selection bias)?
- Was knowledge of the allocated interventions adequately prevented during the study?
  - Participants and personnel (performance bias)
  - Outcome assessors (detection bias)
- Were incomplete outcome data adequately addressed (attrition bias)?
- Are reports of the study free of suggestion of selective outcome reporting (reporting bias)?
- Was the study apparently free of other problems that could put it at a risk of bias?

Measures of treatment effect

Data from individual studies were analysed using the risk ratio (RR) measure and its 95% confidence intervals (CI). Subgroup analysis was planned to explore potential sources of variability in observed treatment effect where possible (children versus adult population, diabetic versus non-diabetic, study quality, timing of peritonitis or other outcome). Absolute effects were reported where appropriate.

Unit of analysis issues

Where data on the number of subjects with events (e.g. number of participants with one or more episodes of peritonitis) were available, the RR was calculated as the ratio of the incidence of the event (one or more episodes) in the experimental treatment group over the incidence in the control group. Where data on the number of episodes were available, then the RR was calculated as the ratio of the rate of the outcome (e.g. the peritonitis rate) in the experimental treatment group (given by number of episodes of the outcome over total patient months on PD) over the rate in the control group.

Dealing with missing data

Any further information or clarification required from the authors was requested by written or electronic correspondence and relevant information obtained in this manner was included in the

review. Disagreements were resolved in consultation with the other two authors.

Assessment of heterogeneity

We first assessed the heterogeneity by visual inspection of the forest plot. We then quantified statistical heterogeneity using the I^2 statistic, which describes the percentage of total variation across studies that is due to heterogeneity rather than sampling error (Higgins 2003). A guide to the interpretation of I^2 values was as follows.

- 0% to 40%: might not be important
- 30% to 60%: may represent moderate heterogeneity
- 50% to 90%: may represent substantial heterogeneity
- 75% to 100%: considerable heterogeneity.

The importance of the observed value of I^2 depends on the magnitude and direction of treatment effects and the strength of evidence for heterogeneity (e.g. P-value from the Chi^2 test, or a confidence interval for I^2) (Higgins 2011).

Assessment of reporting biases

It was also planned that if sufficient RCTs were identified, an attempt would be made to assess for publication bias using a funnel plot (Egger 1997).

Data synthesis

When appropriate, summary estimators of treatment effects were calculated using a random effects model with RR and its 95% CI.

Subgroup analysis and investigation of heterogeneity

Subgroup analysis was used to explore possible sources of heterogeneity (e.g. study duration, participants, interventions and study quality). Heterogeneity among participants may have been related to age and co-existing conditions, for example diabetes mellitus. Heterogeneity in interventions may have been related to prior prophylactic antibiotics used and the type and dose of therapy. If subgroup analysis was unable to be performed due to absence of other similar studies, this limitation was acknowledged and discussed in the manuscript.

Sensitivity analysis

Where sufficient studies were available we investigated the following:

- Studies with data from RCTs only or quasi RCTs only
- Studies with different risks of bias together, for example, studies with low attrition bias risk and studies with high attrition bias risk.

Summary of findings' tables

We presented the main results of the review in 'Summary of findings' tables. These tables present key information concerning the quality of the evidence, the magnitude of the effects of the interventions examined, and the sum of the available data for the main outcomes (Schünemann 2011a). The 'Summary of findings' tables also include an overall grading of the evidence related to each of the main outcomes using the GRADE (Grades of Recommendation, Assessment, Development and Evaluation) approach (GRADE 2008; GRADE 2011). The GRADE approach defines the quality of a body of evidence as the extent to which one can be confident that an estimate of effect or association is close to the true quantity of specific interest. The quality of a body of evidence involves consideration of within-trial risk of bias (methodological quality), directness of evidence, heterogeneity, precision of effect estimates and risk of publication bias (Schünemann 2011b). We presented the following outcomes in the 'Summary of findings' tables.

- Incidence of peritonitis (defined as number of patients with peritonitis)
- Peritonitis rate (episode/patient-months)
- Incidence of exit-site/tunnel infection (defined as number of patients of exit-site/tunnel infection)
- Exit-site/tunnel infection rate (episode/patient-months)
- Catheter removal/replacement
- Technique failure (death-censored)
- Death (all causes).

RESULTS

Description of studies

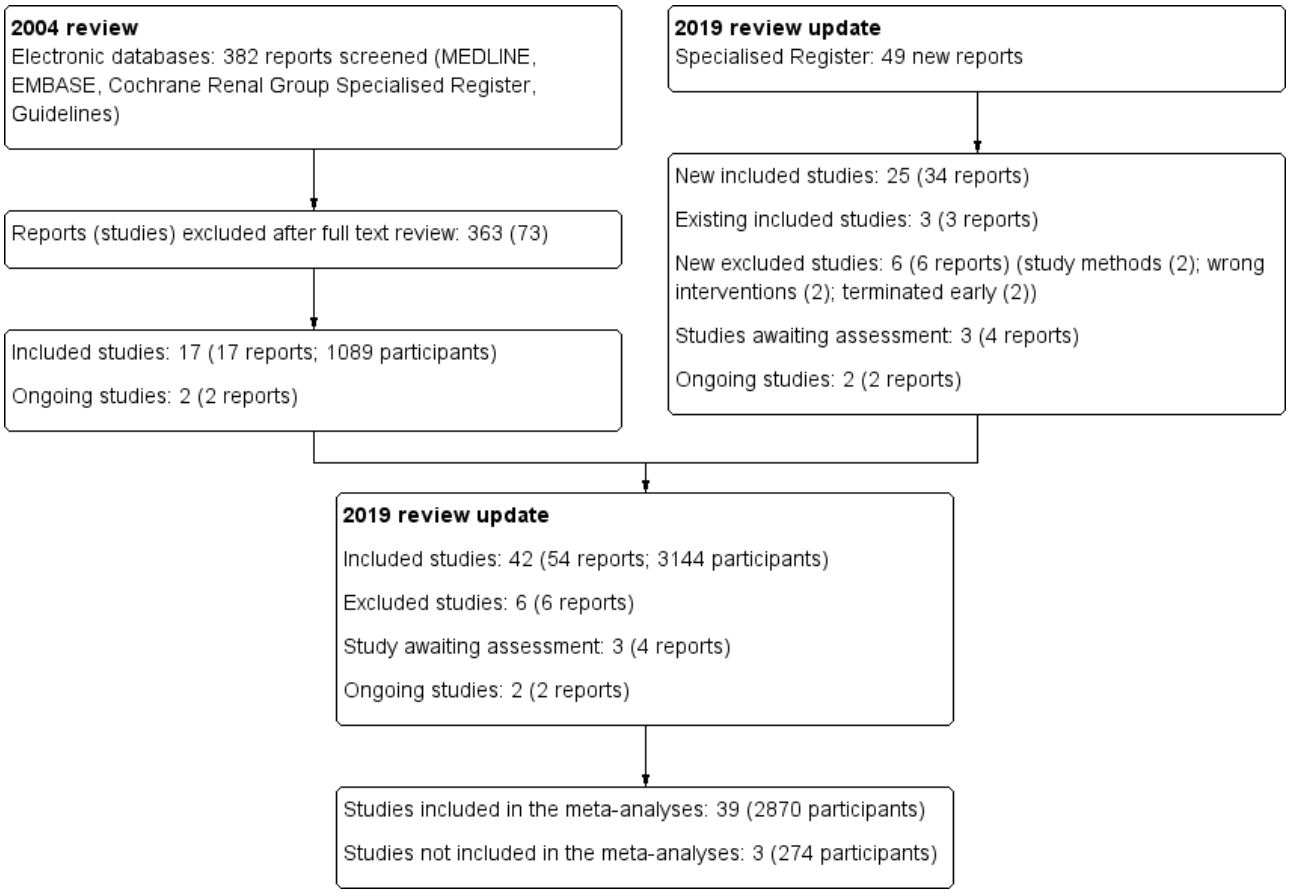
Results of the search

The original Cochrane review contained 17 included studies (Akyol 1990; Danielsson 2002; Dasgupta 1998; Ejlersen 1990; Eklund 1994; Eklund 1995; Eklund 1997; Gadallah 1999; Lye 1996; Moncrief 1998; Nielsen 1995; Park 1998; Rubin 1990; Scott 1994; Tsimoyiannis 2000; Turner 1992; Wright 1999) and two ongoing studies.

For this update we searched Cochrane Kidney and Transplant's Specialised Register up to January 2019 and identified 49 new reports. After full-text assessment 34 new studies were identified: 25 new studies (34 reports) were included (Akcicek 1995; Al-Hwiesh 2016; Atapour 2011; Buijsen 1994; Chen 2014a; Johnson 2006; Jwo 2010; Li 2009e; Lo 2003b; Merrikhi 2014; Ouyang 2015; Qian 2014; Sanchez-Canel 2016; SIPROCE 1997; Stegmayr 2005a; Stegmayr 2015; Sun 2015a; Timely PD 2010; Trooskin 1990; Voss 2012; Winch 2000; Xie 2011a; Yip 2010; Zhang 2016; Zhu 2015), 6 studies (6 reports) were excluded (Crabtree 2003; ISRCTN87054124; Moncrief 1994; N0547061060; O'Dwyer 2005; Williams 1989), and two ongoing studies were identified (NCT01023191; NCT02479295). Three studies are awaiting assessment (no data available and awaiting author response) (Ahmad 2010; LOCI 2011; Wong 2004b). We also identified three new reports of three existing included studies.

For this update a total of 42 studies (54 reports, 3144 participants) (Figure 1) were included.

Figure 1. Study flow diagram.



Included studies

Eighteen studies (1314 randomised participants) examined different methods of catheter insertion.

- Laparoscopy versus laparotomy: 4 studies (320 participants) (Gadallah 1999; Jwo 2010; Tsimoyiannis 2000; Wright 1999)
- Subcutaneous burying with a period of resting of the catheter versus standard insertion: 3 studies (232 participants) (Danielsson 2002; Moncrief 1998; Park 1998)
- Midline versus lateral insertion: 2 studies (122 participants) (Ejlersen 1990; Rubin 1990)
- Open surgery versus percutaneous implantation: 2 studies (96 participants) (Atapour 2011; Merrikhi 2014)
- Open surgery versus open surgery with omentum folding: 1 study (67 participants) (Chen 2014a)
- Radiological versus surgical implantation: 1 study (113 participants) (Voss 2012)
- Open surgery versus modified open surgery with or without catheter fixation: 1 study (152 participants) (Zhang 2016)
- Conventional open surgery versus vertical tunnel-based low-site implantation: 1 study (89 participant) (Sun 2015a)
- Open surgery versus ureteroscopic-assisted surgery: 1 study (72 participants) (Zhu 2015)
- Cystoscopy-assisted surgery versus open surgery: 1 study (29 participants) (Qian 2014)
- Laparoscopic Moncrief-Popovich technique versus blind trocar technique: 1 study (22 participants) (Akcicek 1995).

Twenty-one studies (1447 randomised participants) examined different types of PD catheters.

- Straight versus coiled catheters: 12 studies (878 participants) (Akyol 1990; Dasgupta 1998; Eklund 1994; Eklund 1995; Johnson 2006; Lo 2003b; Lye 1996; Nielsen 1995; Ouyang 2015; Scott 1994; Stegmayr 2005a; Xie 2011a)
- Straight-tip versus self-locating tip catheters: 2 studies (139 participants) (Sanchez-Canel 2016; Stegmayr 2015)
- Swan-neck straight-tip versus straight-tip with artificial curve at subcutaneous tunnel tract: 2 studies (140 participants) (Li 2009e; Yip 2010)
- Single versus double cuff catheters: 2 studies (109 participants) (Buijsen 1994; Eklund 1997)
- Double versus triple cuff catheters: 1 study (73 participants) (Al-Hwiesh 2016)
- Swan-neck versus straight curled catheter: 1 study (22 participants) (Winch 2000)
- Antibiotic-treated versus standard catheters: 1 study (86 participants) (Trooskin 1990).

There were two additional studies that examined other interventions: one study (195 participants) (SIPROCE 1997) compared a silver ring versus no silver ring at the exit-site, and

one study (66 participants) (Turner 1992) compared immobilisation versus non-immobilisation of PD catheters.

There was one study examining the different break-in periods (122 participants) (Timely PD 2010).

Three studies could not be included in the meta-analyses (Dasgupta 1998; Moncrief 1998; Timely PD 2010).

See Characteristics of included studies.

Excluded studies

Six studies did not meet our inclusion criteria and were excluded (Figure 1). The reasons for exclusion were wrong study methods (Crabtree 2003; N0547061060), wrong interventions (O'Dwyer 2005; Williams 1989), or terminated early (ISRCTN87054124; Moncrief 1994).

Risk of bias in included studies

The quality of the studies was difficult to assess because many details such as the use of intention-to-treat analysis and the number of patients lost to follow-up were difficult to ascertain or were not provided. In general, study quality was variable and almost all aspects of study design did not fulfil CONSORT standards for reporting (CONSORT 2001). Risk of bias for the individual studies is presented in Figure 2 and the summary is presented in Figure 3.

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

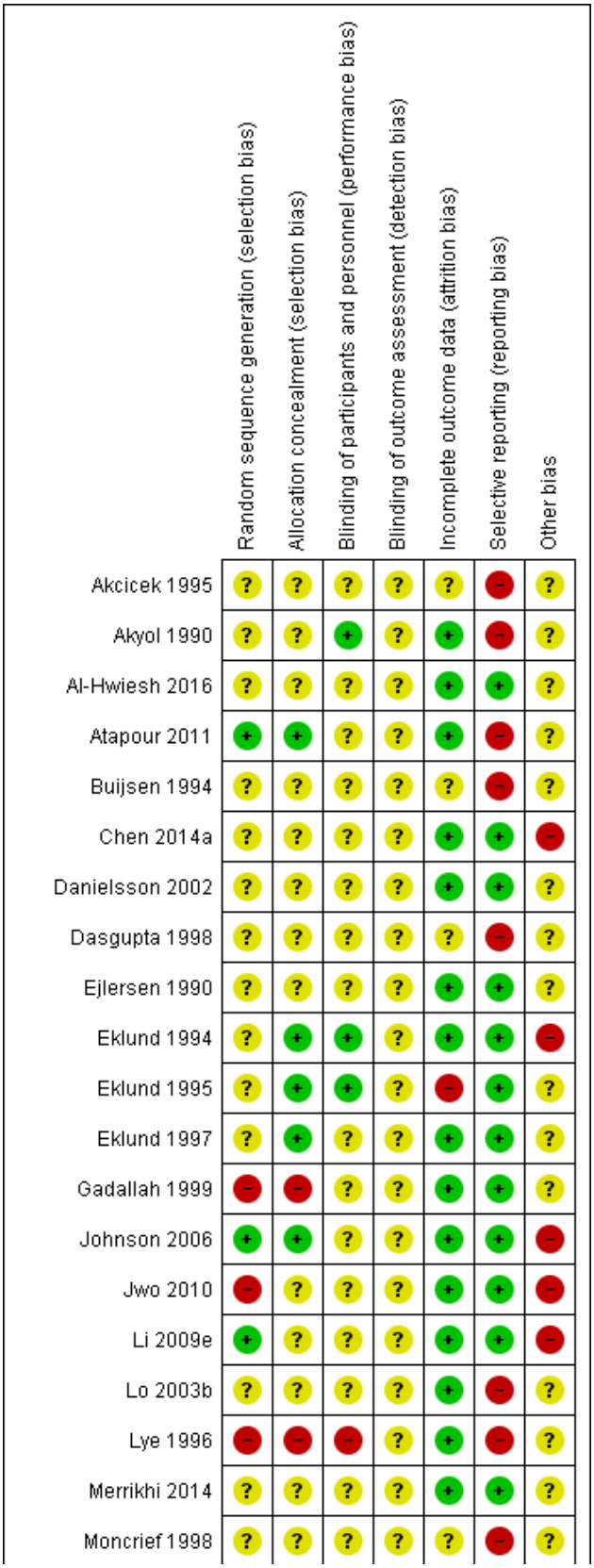


Figure 2. (Continued)

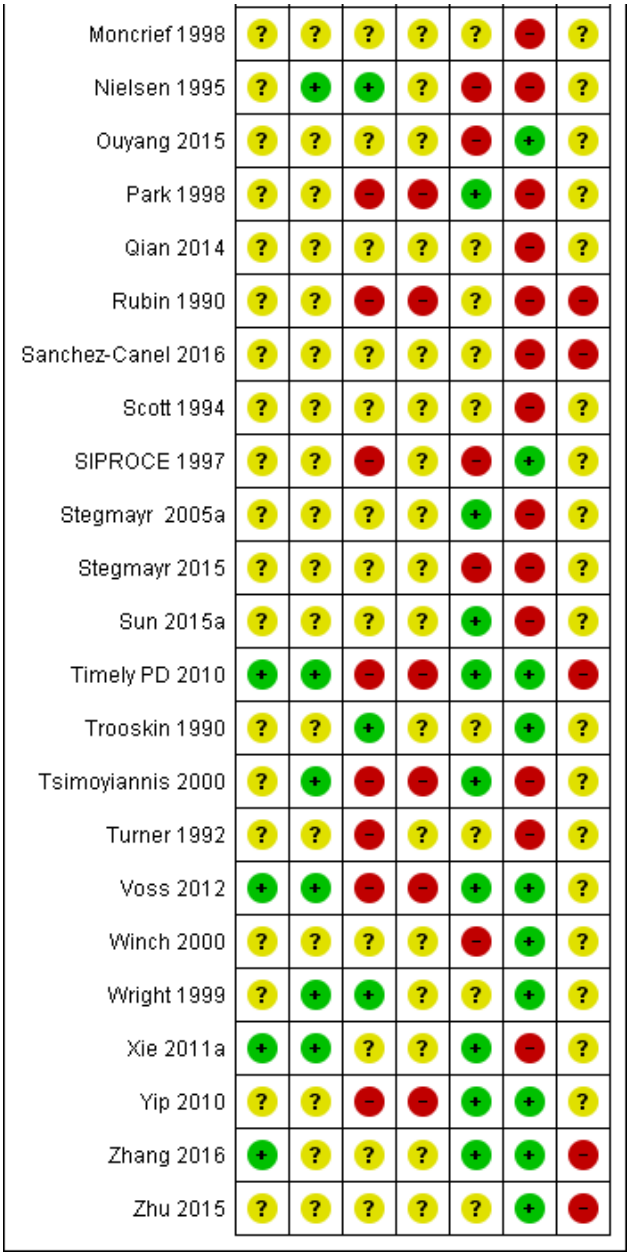
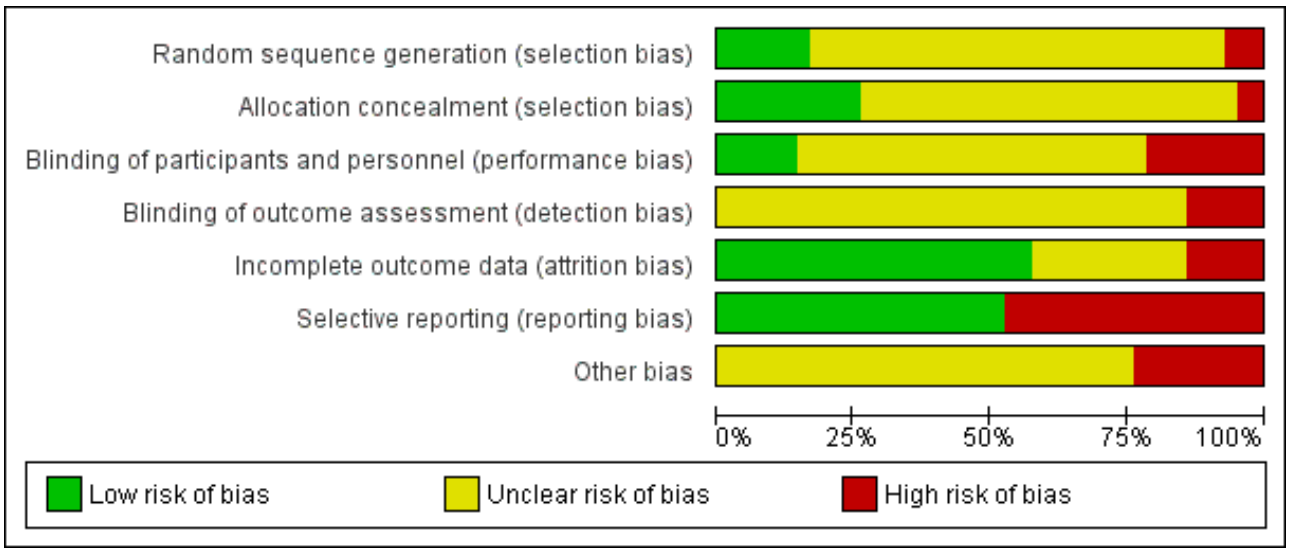


Figure 3. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



Allocation

Random sequence generation

Random sequence generation was judged to be at low risk of bias in seven studies (Atapour 2011; Johnson 2006; Li 2009e; Timely PD 2010; Voss 2012; Xie 2011a; Zhang 2016) and at high risk of bias in three studies (Gadallah 1999; Jwo 2010; Lye 1996). The risk of bias was unclear for the remaining 32 studies.

Allocation concealment

Allocation concealment was judged to be at low risk of bias in 11 studies (Atapour 2011; Eklund 1994; Eklund 1995; Eklund 1997; Johnson 2006; Nielsen 1995; Timely PD 2010; Tsimoyiannis 2000; Voss 2012; Wright 1999; Xie 2011a) and at high risk of bias in two studies (Gadallah 1999; Lye 1996). The risk of bias was unclear in the remaining 29 studies.

Blinding

Performance bias (blinding of participants and investigators) was judged to be at low risk of bias in six studies (Akyol 1990; Eklund 1994; Eklund 1995; Nielsen 1995; Trooskin 1990; Wright 1999) and at high risk of bias in nine studies (Lye 1996; Park 1998; Rubin 1990; SIPROCE 1997; Timely PD 2010; Tsimoyiannis 2000; Turner 1992; Voss 2012; Yip 2010). The risk of bias was unclear in the remaining 27 studies.

Detection bias (blinding of outcome assessors) was judged to be at high risk of bias in six studies (Park 1998; Rubin 1990; Timely PD 2010; Tsimoyiannis 2000; Voss 2012; Yip 2010). The risk of bias was unclear in the remaining 36 studies.

Incomplete outcome data

Attrition bias was judged to be at low risk of bias in 24 studies (Akyol 1990; Al-Hwiesh 2016; Atapour 2011; Chen 2014a; Danielsson 2002; Ejlersen 1990; Eklund 1994; Eklund 1997; Gadallah 1999; Johnson 2006; Jwo 2010; Li 2009e; Lo 2003b; Lye 1996; Merrikhi 2014; Park 1998; Stegmayr 2005a; Sun 2015a; Timely PD 2010; Tsimoyiannis 2000; Voss 2012; Xie 2011a; Yip 2010; Zhang 2016) and at high risk of bias in six studies (Eklund 1995; Nielsen 1995; Ouyang 2015; SIPROCE 1997; Stegmayr 2015; Winch 2000). The risk of bias was unclear in the remaining 12 studies.

Selective reporting

Reporting bias was judged to be at low risk of bias in 22 studies (Al-Hwiesh 2016; Chen 2014a; Danielsson 2002; Ejlersen 1990; Eklund 1994; Eklund 1995; Eklund 1997; Gadallah 1999; Johnson 2006; Jwo 2010; Li 2009e; Merrikhi 2014; Ouyang 2015; SIPROCE 1997; Timely PD 2010; Trooskin 1990; Voss 2012; Winch 2000; Wright 1999; Yip 2010; Zhang 2016; Zhu 2015) and at high risk of bias in 20 studies (Akcicek 1995; Akyol 1990; Atapour 2011; Buijsen 1994; Dasgupta 1998; Lo 2003b; Lye 1996; Moncrief 1998; Nielsen 1995; Park 1998; Qian 2014; Rubin 1990; Sanchez-Canel 2016; Scott 1994; Stegmayr 2005a; Stegmayr 2015; Sun 2015a; Tsimoyiannis 2000; Turner 1992; Xie 2011a).

Other potential sources of bias

Ten studies (23%) were identified as high risk for other potential sources of bias. The potential sources of other risks of bias included: different baseline characteristics between the two groups (Johnson 2006; Jwo 2010; Sanchez-Canel 2016; Zhang 2016; Zhu 2015; 511 participants); use of a different definition for peritonitis (Eklund 1994; 40 participants); premature study closure due to insufficient supply of the intervention (Li 2009e; 39 participants); examination of two distinct interventions (the new method of insertion and new catheter or new method insertion (Rubin 1990) and different connection methods (Chen 2014a)) in the treatment arm (152 participants); and violation of study protocols (Timely PD 2010; 122 participants).

Effects of interventions

See: **Summary of findings for the main comparison** Laparoscopy versus laparotomy for preventing catheter-related infections in chronic peritoneal dialysis patients; **Summary of findings 2** Buried (subcutaneous) versus non-buried catheter for preventing catheter-related infections in chronic peritoneal dialysis patients; **Summary of findings 3** Midline versus lateral insertion for

preventing catheter-related infections in chronic peritoneal dialysis patients; **Summary of findings 4** Percutaneous insertion versus open surgery for preventing catheter-related infections in chronic peritoneal dialysis patients; **Summary of findings 5** Straight versus coiled catheters for preventing catheter-related infections in chronic peritoneal dialysis patients; **Summary of findings 6** Tenckhoff catheter with artificial curve at tunnel tract versus swan-neck for preventing catheter-related infections in chronic peritoneal dialysis patients; **Summary of findings 7** Self-locating versus straight Tenckhoff catheter for preventing catheter-related infections in chronic peritoneal dialysis patients

Laparoscopy versus laparotomy

Laparoscopy insertion compared with laparotomy probably makes little or no difference to the incidence of peritonitis (Analysis 1.1 (4 studies, 315 participants): RR 0.90, 95% CI 0.59 to 1.35, P = 0.60; I^2 = 5%; moderate certainty evidence; 24 fewer per 1000), exit site/tunnel infection (Analysis 1.3 (3 studies, 270 participants): RR 1.00, 95% CI 0.43 to 2.31, P = 0.99; I^2 = 30%; low certainty evidence; 0 fewer per 1000), catheter removal or replacement (Analysis 1.4 (3 studies, 167 participants): RR 1.20, 95% CI 0.77 to 1.86, P = 0.42; I^2 = 0%; low certainty evidence), technique failure (Analysis 1.5 (4 studies, 283 participants): RR 0.71, 95% CI 0.47 to 1.08, P = 0.11, I^2 = 5%; low certainty evidence), and death (all causes) (Analysis 1.6 (3 studies, 270 participants): RR 1.26, 95% CI 0.72 to 2.20, P = 0.42; I^2 = 0%; moderate certainty evidence) (Summary of findings for the main comparison). Wright 1999 reported no difference in peritonitis rate between laparoscopy and laparotomy (Analysis 1.2 (375 patient-months): RR 0.89, 95% CI 0.39 to 2.07). Laparoscopy may make little or no difference to dialysate leak compared with laparotomy insertion (Analysis 1.7 (3 studies, 167 participants): RR 0.85, 95% CI 0.10 to 6.97, P = 0.88; I^2 = 63%; low certainty evidence).

Moderate heterogeneity was resolved by subgroup analysis with different break-in periods. Jwo 2010 reported 3 post-operative bleeding (haematoma or haemoperitoneum) and 2 hernia in laparoscopic insertion compared with 8 bleed and 1 hernia in laparotomy (Table 1).

Implantation and subcutaneous burying of the catheter versus standard insertion with resting but no subcutaneous burying of the catheter

It is uncertain whether the subcutaneous burying of a PD catheter 6 weeks before initiation of PD prevents peritonitis rates (Analysis 2.1 (2 studies, 2511 patient-months): RR 1.16, 95% CI 0.37 to 3.60, P = 0.80; I^2 = 84%; very low certainty evidence). Subcutaneous burying of catheter may make little or no difference to exit site/tunnel infection (Analysis 2.2 (2 studies, 2511 patient-months): RR 1.15, 95% CI 0.39 to 3.42, P = 0.80; I^2 = 67%; low certainty evidence) and probably makes little or no difference to death (all causes) (Analysis 2.4 (2 studies, 119 participants): RR 0.90, 95% CI 0.39 to 2.08, P = 0.81; I^2 = 0%; moderate certainty evidence) compared with standard PD catheter insertion. Danielsson 2002 reported no difference in technique failure between the two groups (Analysis 2.3 (60 participants): RR 0.33, 95% CI 0.04 to 3.03) (Summary of findings 2).

There was considerable heterogeneity in the analysis of peritonitis rate and exit-site/tunnel infection rate. A detailed subgroup analysis was unable to be performed given that only two studies were included. There were differences in study design (single versus multicentre study), catheter types (Moncrief-Popovich catheter versus swan-neck catheter), connection methodology (double bag versus either Y connector or standard spike), and follow-up periods (0.4 to 44 months versus 12 months) between the two studies that could have introduced heterogeneity. Park 1998 reported no difference in post-operative bleeding and dialysate leak between the two groups.

Midline versus lateral insertion of the PD catheter

The midline insertion compared with lateral insertion of PD catheters probably makes little or no difference to the risks of peritonitis (Analysis 3.1 (2 studies, 120 participants): RR 0.65, 95% CI 0.32 to 1.33, P = 0.24; I^2 = 0%; moderate certainty evidence) and may make little or no difference to exit-site/tunnel infection (Analysis 3.2 (2 studies, 120 participants): RR 0.56, 95% CI 0.12 to 2.58, P = 0.45; I^2= 5%; low certainty evidence) compared with lateral insertion of PD catheter. Rubin 1990 reported midline insertion reduced the risk of catheter removal or replacement compared with lateral insertion (Analysis 3.3 (83 participants): RR 0.57, 95% CI 0.33 to 0.98, P = 0.04). Ejlersen 1990 reported no difference in death (all causes) between midline versus lateral insertion of catheter (Analysis 3.4 (37 participants): RR 8.50, 95% CI 0.50 to 143.32) (Summary of findings 3). Rubin 1990 reported 6 dialysate leaks in the midline compared with 3 leaks in the lateral insertion group and 1 haematoma at the exit-site in each group.

Percutaneous insertion versus open surgery

Percutaneous insertion compared with open surgical insertion of a PD catheter probably makes little or no difference to exit-site/tunnel infection (Analysis 4.1 (2 studies, 96 participants): RR 0.16, 95% CI 0.02 to 1.30, P = 0.08; I^2 = 0%; moderate certainty evidence). Atapour 2011 reported no episodes of early peritonitis in either group and similar risks of catheter removal or replacement between the two groups (Analysis 4.2 (1 study, 61 participants): RR 0.24, 95% CI 0.03 to 2.04) (Summary of findings 4). Percutaneous insertion makes little or no difference to post-operative bleeding (haematoma or haemoperitoneum) compared to open surgery (Analysis 4.3 (2 studies, 96 participants) RR 0.22, 95% CI 0.04 to 1.26, I^2= 0%; low certainty evidence). Atapour 2011) reported 1 outflow failure with percutaneous insertion compared with 4 with open surgery. Two studies (Atapour 2011; Merrikhi 2014) reported no viscus perforation or dialysate leak in either group.

Straight versus coiled PD catheter

A straight catheter probably makes little or no difference to the risk of peritonitis (Analysis 5.1 (9 studies, 818 participants): RR 1.04, 95% CI 0.82 to 1.31, P = 0.74; I^2 = 0%; moderate certainty evidence; 9 more per 1000), peritonitis rate (Analysis 5.2 (5 studies, 5882 patient-months): RR 0.91, 95% CI 0.68 to 1.21, P = 0.51, I^2 = 0% moderate certainty evidence), the risk of exit-site/tunnel infection (Analysis 5.3 (10 studies, 826 participants): RR 1.12, 95% CI 0.94 to 1.34, P = 0.22; I^2 = 0%; moderate certainty evidence; 34 more per 1000), and exit-site/tunnel infection rate (Analysis 5.4 (4 studies, 5286 patient-months): RR 1.05, 95% CI 0.77 to 1.43, P = 0.78; I^2 = 0%; moderate certainty evidence) compared with a coiled catheter. It is uncertain whether straight catheters prevent catheter removal or replacement (Analysis 5.5 (9 studies, 713 participants): RR 1.11, 95% CI 0.73 to 1.66, P = 0.63; I^2 = 50%; very low certainty evidence), however, a straight catheter probably makes little or no difference to technique failure (Analysis 5.6 (4 studies, 442

participants): RR 0.82, 95% CI 0.51 to 1.31, P = 0.4; I^2 = 0%; moderate certainty evidence) and death (all causes) (Analysis 5.7 (8 studies, 703 participants): RR 0.95, 95% CI 0.62 to 1.46, P = 0.82; I^2 = 3%; low certainty evidence) compared with coiled catheters, (Summary of findings 5). In a sensitivity analysis in which only studies with a low risk of attrition bias were included, similar results were observed for peritonitis (Analysis 5.8: RR 0.93, 95% CI 0.69 to 1.26), peritonitis rate (Analysis 5.9: RR 0.91, 95% CI 0.61 to 1.35), exit-site infection (Analysis 5.10: RR 1.14, 95% CI 0.94 to 1.39), and exit-site infection rate (Analysis 5.11; RR 1.18, 95% CI 0.76 to 1.82).

There was moderate heterogeneity (50%) in the analysis of catheter removal/replacement between the two groups. This heterogeneity largely disappeared in a subgroup analysis that only included studies with follow-up durations of ≥ 2 years, but increased to 74% when studies with follow-up durations of < 2 years were included in the analysis. The substantial heterogeneity among studies with short follow-up durations might have been due to different catheter types (double cuff versus single cuff and Tenckhoff versus swan-neck catheter) and different follow-up durations (ranged from 12 to 19 months) among the studies. Another possible explanation for the heterogeneity may relate to risk of attrition bias. In sensitivity analysis including only studies with a low risk of attrition bias, the observed heterogeneity was reduced (Analysis 5.12: RR 0.78, 95% CI 0.45 to 1.33; I^2 = 32%).

Straight catheter makes little or no difference to dialysate leak compared with coiled catheter (Analysis 5.13 (7 studies, 550 participants): RR 0.74, 95% CI 0.16 to 3.49, P = 0.70; I^2 = 37%; low certainty evidence). It is uncertain whether straight catheter lead to post-operative bleeding (haematoma or haemoperitoneum) compared with coiled catheter (Analysis 5.14 (4 studies, 358 participants): RR 1.14, 95% CI 0.24 to 5.34, P = 0.87; I^2 = 0%; very low certainty evidence). Nielsen 1995 reported one case of bladder perforation with coiled catheter but none in the straight catheter group.

Tenckhoff catheter with artificial curve at subcutaneous tunnel tract versus swan-neck catheter

Catheter with artificial curve at subcutaneous tract compared with swan-neck catheter may make little or no difference to peritonitis risk (Analysis 6.1 (2 studies, 140 participants): RR 1.29, 95% CI 0.85 to 1.96, P = 0.24; I^2 = 0%; low certainty evidence), peritonitis rate (Analysis 6.2 (2 studies, 2535 patient-months): RR 1.22, 95% CI 0.54 to 2.75, P = 0.63; I^2 = 47%; low certainty evidence), exit-site/tunnel infection (Analysis 6.3 (2 studies, 140 participants): RR 0.96, 95% CI 0.77 to 1.21, P = 0.75; I^2 = 0%; moderate certainty evidence), but may improve exit-site infection rate (Analysis 6.4 (2 studies, 2535 patient-months): RR 0.67, 95% CI 0.50 to 0.90, P = 0.007; I^2 = 0%; low certainty evidence), and probably makes little or no difference to catheter removal or replacement (Analysis 6.5 (2 studies, 140 participants): RR 0.85, 95% CI 0.42 to 1.72, P = 0.65; I^2 = 15%; moderate certainty evidence), technique failure (Analysis 6.6 (2 studies, 140 participants): RR 0.64, 95% CI 0.26 to 1.58, P = 0.3;, I^2 = 0%; moderate certainty evidence), and death, all causes (Analysis 6.7 (2 studies, 140 participants): (RR 0.74, 95% CI 0.27 to 2.03, P = 0.57; I^2 = 0%; moderate certainty evidence) compared with insertion of PD catheters with an artificial curve at the tunnel tract (Summary of findings 6). Yip 2010 reported no dialysate leaks in either group but there was one superficial cuff extrusion in the swan-neck catheter group but none in the other group. Li 2009e reported post-operative bleeding from the main wound (5 versus 9) and exit-site (9 versus 13) in Tenckhoff catheter and swan-neck catheter respectively.

Self-locating catheter versus straight catheter

It is uncertain whether self-locating catheter reduces catheter removal or replacement (Analysis 7.3 (2 studies, 139 participants): RR 0.32, 95% CI 0.03 to 3.06, P = 0.32; I^2 = 64%; very low certainty of evidence). Self-locating catheter probably slightly reduces technique failure (Analysis 7.4 (2 studies, 139 participants): RR 0.64, 95% CI 0.39 to 1.04, P = 0.07; I^2 = 0%; moderate certainty evidence), but may make little or no difference to death (all causes) (Analysis 7.5 (2 studies, 139 participants): RR 1.02, 95% CI 0.11 to 9.75, P = 0.99; I^2 = 49%; low certainty evidence) compared to a straight catheter. Sanchez-Canel 2016 reported no difference in the incidence of peritonitis (Analysis 7.1 (78 participants): RR 1.13, 95% CI 0.86 to 1.49) and exit-site infection (Analysis 7.2 (78 participants): RR 0.95, 95% CI 0.37 to 2.45) (Summary of findings 7). Moderate heterogeneity was observed with analysis for catheter removal/replacement and death (all causes), for which subgroup analysis was unable to be performed given the small number of studies. The potential explanation for heterogeneity might have related to the suboptimal quality of included studies, which did not report the method of randomisation, blinding and follow up duration. In addition, one study reported different baseline BMI values between the treatment and control groups and the other study interrupted recruitment early due to an observed significant reduction in the incidence of catheter removal/replacement in the treatment group. Self-locating catheter makes little or no difference to dialysate leak compared with straight catheter (Analysis 7.6 (2 studies, 139 participants): RR 1.04, 95% CI 0.46 to 2.35, P = 0.93; I^2 = 0%; low certainty evidence). Sanchez-Canel 2016 reported post-operative peritoneal bleed (7 versus 6) in self-locating and straight catheter groups respectively.

Other interventions

The risk of peritonitis and/or peritonitis rate were examined using:

1. Different insertion techniques: open surgery versus open surgery with omentum folding (Analysis 8.1), open surgery versus modified surgery with or without catheter fixation (Analysis 9.1), open surgery versus vertical tunnel-based low-site implantation (Analysis 10.1), open surgery versus ureteroscopic-assisted surgery (Analysis 11.1), radiological versus surgical implantation (Analysis 12.1), cystoscopy-assisted surgery versus open surgery (Analysis 13.1), laparoscopic Moncrief-Popovich technique versus blind trocar technique (Analysis 14.1)
2. Different catheter types: single–cuff versus double-cuff catheter (Analysis 15.1), double-cuff versus triple-cuff catheter (Analysis 16.1), swan-neck versus straight curled catheter (Analysis 17.1), antibiotic-treated catheters versus standard catheter (Analysis 18.1)
3. Immobilizer device versus no immobilizer device (Analysis 19.1)
4. Silver ring at exit-site versus no silver ring (Analysis 20.1)

See (Table 2).

Dasgupta 1998 reported 14 episodes of peritonitis in 19 patients using Moncrief-Popovich catheter compared with 22 episodes of peritonitis in 20 patients using Tenckhoff catheter. The other

outcomes were not different among these studies except that Zhang 2016 reported that catheter removal/replacement was lower with modified surgery with or without catheter fixation compared with open surgery (Analysis 9.3 (152 participants): RR 0.16, 95% CI 0.03 to 0.76).

Break-in periods

Timely PD 2010 (122 participants) examined the effect of different break-in periods (1 week versus 2 weeks versus 4 weeks post catheter insertion) on the composite PD-related infection (defined as exit-site/tunnel infection and/or peritonitis) at 4 weeks after PD initiation and 8 weeks after catheter insertion reported that there was no difference across 3 groups. The study reported higher risk of dialysate leak in break-in period of 1 week compared with 4 weeks (11 versus 1 respectively). There was one post-operative wound haematoma observed in the break-in period of 2 weeks but none in the other groups.

DISCUSSION

Summary of main results

The review demonstrated that no specific PD catheter implantation technique or catheter type significantly reduced the risk of PD peritonitis. In a single study with a small number of participants, midline catheter insertion resulted in a lower risk of catheter removal/replacement compared with lateral insertion and in another small, single-centre study, modified open surgery with or without catheter fixation resulted in a lower risk of catheter removal/replacement compared with open surgery. Similarly, in two other small, methodologically suboptimal studies involving 140 participants, a swan-neck catheter was associated with a higher exit-site/tunnel infection rate than a Tenckhoff catheter with an artificial curve at the subcutaneous tract.

Overall completeness and applicability of evidence

Since the last review in 2004, there have been limited RCTs examining the different new surgical techniques or PD catheter types in the last decade but none has been shown superior to any other in the reduction of peritonitis. However, it should also be acknowledged that there have been general improvements in peritonitis rates globally since the time of the last systematic review (Li 2017; Mehrotra 2016). The general trend in improvement of peritonitis rates might potentially make it difficult for any interventions in this area to achieve further major improvement.

Comparison between the different techniques of PD catheter implantation demonstrated that no specific technique was superior to any other in the prevention of peritonitis and/or exit-site/tunnel infection. Generally, most of the studies were from single-centres and involved small study populations followed for variable periods of time. There was no standardized method of reporting the infection-related outcomes (peritonitis and exit-site/tunnel infection); one study reported early and total infection (Gadallah 1999), two studies reported both early and late infection separately (Jwo 2010; Wright 1999), and the remainder of the studies reported total infection. The definitions of early infection (ranged from ≤ 2 weeks to ≤ 6 weeks) and late infection (ranged from > 2 weeks to > 6 weeks) also varied among studies. Gadallah 1999 postulated that the higher rate of early peritonitis (within 2 weeks of catheter placement) was likely contributed to by a higher exit-site leak incidence related to the technique of catheter insertion.

In the present review, the majority of included studies reported overall infection (peritonitis or exit-site/tunnel infection) rather than separately reporting early and late infections. The potential benefit of catheter insertion technique on prevention of catheter-related infection, especially in the early period of catheter insertion, was not able to be comprehensively assessed in this review.

Moreover, a majority of these studies only reported either the incidence of peritonitis or the peritonitis rate but not both. In addition, some studies did not report details about the use of prophylactic antibiotics prior to catheter implantation, which is a key intervention that has been shown to convincingly reduce the risk of early peritonitis in PD patients in the previous meta-analysis (Strippoli 2004a).

Five studies examined the effects of laparoscopy versus laparotomy and demonstrated that the risks of peritonitis and exit-site/tunnel infection were not significantly different between the two methods.

Moncrief 1998 reported that catheter implantation with subcutaneous burying for three to five weeks was associated with reduced incidence of peritonitis. However, in the present review, subcutaneous burying of a PD catheter for six weeks prior to PD initiation exerted comparable effects on peritonitis, exit-site/tunnel infection and death (all causes) compared to the standard insertion technique. In view of the suboptimal methodologic quality and small numbers of studies and participants, there were insufficient data to draw conclusions regarding the value of this technique.

Spence 1985 reported that paramedian insertion was associated with reduction in the incidence of leak and extrusion of the cuff compared with midline insertion of the PD catheter. In the present review, midline versus lateral insertion of PD catheters did not significantly affect the risks of peritonitis, exit-site/tunnel infection and death (all causes). However, in a single small study, midline insertion resulted in a lower risk of catheter removal/replacement than lateral insertion. In that particular study, there was a potential bias as the study introduced two different interventions (spiral versus straight catheters, and midline versus lateral insertion techniques) at the same time. In another RCT examining midline versus lateral catheter insertion (Ejlersen 1990), one-year catheter survival rates were comparable between the two groups (midline 59% versus lateral 51%). In view of the suboptimal methodologic quality and small number of studies available, there are insufficient data to draw definitive conclusions regarding the effects of midline versus lateral insertion on the outcomes examined in this review.

In a single small study centre, Zhang 2016 reported that a modified catheter placement method, which was characterised by a low implant site, a short intra-abdominal catheter segment and upward straight subcutaneous tunnel, significantly decreased the incidence of catheter removal/replacement compared with open surgery. The authors postulated that a long intra-abdominal catheter segment following a traditional open surgical method might lead to an increased risk of catheter tip migration and omental wrap. However, in that study, there was a trend towards a high incidence of participants with prior abdominal surgery in the open surgery group (20.4%) versus modified open surgery group with or without catheter fixation (11.7%). In view of the single centre design, small study population and suboptimal methodologic quality, no firm conclusion can be drawn regarding the effect of open surgery versus modified open surgery with or

without catheter fixation on the incidence of catheter removal/replacement.

The most commonly examined type of catheter was straight versus coiled catheters, which demonstrated no significant differences in peritonitis, exit-site/tunnel infection, and catheter removal/replacement or death (all causes). There was moderate heterogeneity in the analysis of catheter removal/replacement between the two groups. The heterogeneity was resolved when only studies with follow-up durations of ≥ 2 years were included in the analysis, but increased when studies with follow-up durations of < 2 years were additionally included. The substantial heterogeneity among studies with short follow-up durations might due to different catheter types (double cuff versus single cuff and Tenckhoff versus swan-neck catheter) and different follow-up durations (ranged from 12 to 19 months) among the studies.

Two small studies comparing swan-neck catheters and PD catheters with artificial curves at the subcutaneous tract showed no significant differences in peritonitis risk, peritonitis rate, exit-site/tunnel infection risk, catheter removal/replacement, technique failure and death (all causes). Though the analysis of the risk of exit-site/tunnel infection found no significant difference between the two groups, the rate of exit-site/tunnel infection was significantly higher in the swan-neck catheter group. This finding might be explained by an increased number of participants with repeated/recurrent exit-site/tunnel infection in the swan-neck group. Alternatively, the result might have been a chance finding or related to bias stemming from suboptimal methodologic quality. Reassuringly, there was no difference in the risk of either catheter removal or technique failure.

Quality of the evidence

The methodological quality of evidence for most of the studies was considered suboptimal. The methods of randomisation and allocation concealment were not clearly described in most of the studies. The majority of included studies were single-centre with small sample sizes and had widely variable follow-up periods. A small number of studies (33%) analysed their data using the intention-to-treat method. In addition, most studies were not registered with the clinical trial databases, had not published a protocol of their study, and did not report on many patient-level outcomes which could have contributed to the risk of selective reporting bias. Timely PD 2010 only reported a composite outcome of exit-site infection and peritonitis such that analysis of the individual outcomes was unable to perform. Moreover, the types of interventions examined were numerous with very few studies (either one or two studies) in each category, such that definitive conclusions could not be drawn. Finally, the risk of peritonitis may have been modified by other unreported co-interventions, including the centre protocol for prophylactic antibiotics prior to catheter implantation, PD training protocol and exit-site care, other centre-specific factors, and the skill and experience of interventionists, which were unable to be adjusted for in the review.

Potential biases in the review process

The present review was conducted as per published standardized Cochrane methodology. The review included the up-to-date publications through MEDLINE, EMBASE, and CENTRAL searches with the assistance of the Information Specialist. The review included RCTs and quasi-RCTs. All potential publications were assessed by two independent authors who performed the data extraction, data analysis and assessment of quality of studies independently. Any dispute or concern about the data between the two authors was resolved with additional two authors. The primary authors were contacted to seek the additional data for analysis by the authors. A few abstracts/publications, which were published a decade ago, were not able to be included in the current review as we were unable to contact primary authors for further information. Finally, there is a potential for bias as one of the investigators of the present review (DWJ) was also an author of an included study (Johnson 2006).

Agreements and disagreements with other studies or reviews

Similar to the previously published review (Strippoli 2004), the present study has demonstrated that no specific type of catheter or implantation method was superior in reducing the risk of PD peritonitis. The previous meta-analysis by Xie 2011a reported no significant difference in peritonitis (7 studies: RR 1.12, 95% CI 0.83 to 1.50) or exit-site/tunnel infection (6 studies: RR 1.05, 95% CI 0.79 to 1.39) between straight versus coiled catheters. The results of the present updated review support the findings of the previous reviews.

A meta-analysis by Hagen 2014 that included both RCTs and cohort studies comparing laparoscopic insertion and laparotomy also reported no significant differences in peritonitis (9 studies: OR 0.83, 95% CI 0.48 to 1.42) and exit-site/tunnel infection (7 studies: OR 0.80, 95% CI 0.47 to 1.37) between the two groups. The present review only included RCTs of laparoscopy versus laparotomy and reported similar findings.

The review also demonstrated that catheter removal or replacement and technique failure were not significantly different among the different methods of implantation, including laparoscopically and surgically placed catheters. The finding was contrary to that of a previous meta-analysis (Hagen 2014), which included both RCTs and cohort studies, and reported that one-year catheter survival was significantly higher in the laparoscopy group compared with the laparotomy group. The finding from the previous meta-analysis may have been biased due to the fact that the majority of included studies were non-RCTs (8 cohort studies compared with 3 RCTs). To date, there have only been 4 RCTs comparing laparoscopic versus laparotomy methods: all 4 studies were single-centre design, only 1 study was analysed by intention-to-treat method, all studies practised different antibiotic prophylaxis regimens with varying doses (2 g vancomycin versus 0.5 to 1 g cefazolin) prior to the procedure, and all initiated PD at different time points following the operative procedure (ranging from immediately after procedure to several days post-procedure). The current available data suggested that laparoscopic insertion makes little or no difference to PD-related infection, catheter removal/replacement, technique or patient survival compared to laparotomy.

In the current review, different catheter types, including straight versus coiled/curved (either at the tip or at the subcutaneous tract) catheters, were not significantly associated with catheter removal/replacement and technique failure in PD patients. There was moderate heterogeneity in the analysis of catheter removal/replacement in the review, which was potentially due to the fact that different studies used different types of catheter including

different products from different manufacturing companies, single or double cuff catheters, and different methods of catheter placement (percutaneous versus open surgical methods). Heterogeneity was decreased but not totally resolved following subgroup analysis with straight tip versus coiled/curved tip catheters and straight versus curved catheter at the subcutaneous tract, open surgical method versus percutaneously inserted method, and single cuff versus double cuff catheters. Similarly, the previous meta-analysis by Xie 2011a, which compared straight tip versus coiled tip catheters, reported that although there was a significantly increased risk of catheter tip migration with coiled catheters, overall catheter failure was not significantly different between the two groups.

The present review demonstrated there was no significant difference in death (all causes) between straight and coiled catheters. In contrast, our previous review (Strippoli 2004) reported that there was a survival advantage with straight catheters compared with curved catheters. The discrepancy in findings between the two reviews can be explained by the fact that the present review included a larger number of studies (8 RCTs versus 4 RCTs) and more well-designed studies compared to the previous review.

AUTHORS' CONCLUSIONS

Implications for practice

- No specific catheter implantation method is superior to others in the prevention of PD-related peritonitis or exit-site/tunnel infection in PD patients.
- No specific type of PD catheter is superior to others in the prevention of PD-related peritonitis or exit-site/tunnel infection in PD patients.
- No other additional catheter-related intervention is proven to be beneficial in the prevention of PD-related peritonitis or exit-site/tunnel infection in PD patients.
- In general, most of the available studies to date on this topic were small, single centre studies which primarily examined non-infection-related outcomes.
- The findings of this review support the current ISPD Guideline recommendations (Li 2016; Szeto 2017).

Implications for research

Future well designed studies addressing the effects of catheter-specific interventions on the risk of PD-related infection (peritonitis and/or exit-site/tunnel infection) as the primary outcome are needed.

These studies should examine the effects of the catheter-related intervention on:

- early (day 30) and late (day 90) peritonitis rather than overall peritonitis;
- early (day 30) and late (day 90) catheter removal rather than overall catheter removal;
- early (day 30) technique failure, in addition to overall technique failure.

Outcomes should be reported using consistent outcome measures, for example, standardised definition of the outcome 'technique failure'.

Future studies should also examine patient-reported outcomes in addition to the other clinical outcomes.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Akcicek 1995

Methods	• Study design: parallel RCT • Study time frame/recruitment period: not reported • Follow-up period: not reported
Participants	• Country: Turkey • Setting: single centre • Patients undergoing PD catheter insertion • Number: treatment group (10); control group (12) • Mean age ± SD (years): treatment group (45.6 ± 12.8); control group (48.7 ± 12.5) • Sex (M/F): not reported • Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group • Laparoscopic Moncrief-Popovich technique Control group • Blind Trocar technique

Akcicek 1995 *(Continued)*

Outcomes	• Exit-site infection • Peritonitis • Catheter tip migration
Notes	• Abstract-only publication • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Akyol 1990

Methods	• Study design: parallel RCT; randomly allocated at time of surgery • Study time frame/recruitment period: October 1986 to July 1987 • Follow-up period: 72 weeks
Participants	• Country: Scotland • Setting: single centre • Consecutive patients for CAPD • Number (catheters/patients): treatment group (20/20); control group (20/19) • Mean age, range (years): treatment group (49, 22 to 70); control group (45, 19 to 73) • Sex (M/F): treatment group (15/5); control group (8/11) • Diabetes: treatment group (3/20); control group (2/19) • Exclusion criteria: not reported
Interventions	Treatment group • Straight tip

Akyol 1990 *(Continued)*

	Control group • Coiled tip Other information • All catheters were double-cuff Tenckhoff with 4 cm (curled) and 5 cm (straight) between cuffs • 1g vancomycin by IV infusion preoperatively on day of surgery. Catheters inserted in an operating theatre with general or local anaesthetic
Outcomes	• Exit-site, wound and tunnel infection: defined as isolation of a pathogenic organism on culture in the presence of local signs of inflammation or infection i.e. swelling, redness, pain or discharge of any nature • Peritonitis: defined as either a positive culture form dialysis effluent or a WCC > 100/mm^3 in the effluent associated with clinical evidence of peritonitis • Mechanical complications
Notes	• Follow-up terminated at the date of catheter removal or at the last clinic visit before the analysis • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Quote " Neither the patients nor the staff supervising their care thereafter were aware of the type of catheter used."
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	5% dropout (2/40)
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Al-Hwiesh 2016

Methods	• Study design: parallel RCT • Study time frame/recruitment period: December 2012 to June 2014 • Follow-up period: 18 months
Participants	• Country: Saudi Arabia • Setting: single centre

Al-Hwiesh 2016 *(Continued)*

- Incident PD patient followed up in the study unit
- Number: treatment group (36); control group (37)
- Median age, IQR (years): treatment group (54, 42 to 63); control group (50, 45 to 61)
- Sex (M/F): treatment group (11/25); control group (11/26)
- Diabetes: treatment group (21/36); control group (23/37)
- Exclusion criteria: previous abdominal or pelvic surgery; history of peritonitis; pregnancy

Interventions	Treatment group • Triple cuff Control group • Double cuff Other information • Antibiotic prophylaxis with first generation cephalosporin was given IV prior to the procedure. APD was instituted 14 days after PD catheter insertion
Outcomes	• Exit-site, wound and tunnel infection • Peritonitis • Mechanical complications: bowel perforation, haemorrhage, poor drainage, omental wrapping, catheter migration, early leak, catheter replacement • Technique survival
Notes	• Additional data requested from authors: yes • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomised using adaptive randomisation method
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	Most outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Atapour 2011

Methods	• Study design: parallel RCT • Study time frame/recruitment period: 2009 to 2010 • Follow-up period: 2 months
Participants	• Country: Iran • Setting: single centre • Aged ≥ 18 years; CKD stage 5 which needed RRT; self-care ability; patient's consent and having family support of choosing CAPD as a choice of RRT • Number: treatment group (31); control group (30) • Mean age ± SD (years): treatment group (58.5 ± 14.7); control group (51.5 ± 19.2) • Sex (M/F): treatment group (21/10); control group (12/18) • Diabetes: treatment group (14/31); control group (14/30) • Exclusion criteria: morbid obesity (BMI > 35kg/m^2); ventral or inguinal hernia or any history of abdominal surgery
Interventions	Treatment group • Percutaneously inserted catheter Control group • Surgically inserted catheter
Outcomes	• Exit-site infection • Peritonitis • Mechanical complications: outflow failure, leak, haemoperitoneum, hollow viscous perforation, incisional site hernia
Notes	• 3 patients from percutaneous group were excluded post intervention due to cardiac death • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random allocation software
Allocation concealment (selection bias)	Low risk	Random allocation software
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts

Atapour 2011 *(Continued)*

Selective reporting (reporting bias)	High risk	The incidence of infection was reported for the first two weeks only, did not report infection at the end of study
Other bias	Unclear risk	No information was provided for who performed the procedures for both groups

Buijsen 1994

Methods	• Study design: parallel RCT • Study time frame/recruitment period: 1991 to 1993 • Follow-up period: not reported
Participants	• Country: Netherlands • Setting: single centre • Patients newly starting on CAPD • Number: treatment group (25); control group (24) • Mean age ± SD (years): not reported • Sex (M/F): not reported • Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group • Single cuff straight Tenckhoff catheter Control group • Double cuff straight Tenckhoff catheter
Outcomes	• Technique failure • Exit-site/tunnel infection
Notes	• Implantation via a laparotomy was performed, if there was a history of abdominal surgery, the catheter was inserted by needlescope • Abstract-only publication • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias)	Unclear risk	Insufficient information to permit judgement

Buijsen 1994 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Chen 2014a

Methods	• Study design: parallel RCT • Study time frame/recruitment period: March 2008 to December 2012 • Follow-up period: mean follow-up days were 487 in open surgery group (control) and 522 in omental folding group (treatment)
Participants	• Country: China • Setting: single centre • Aged 18 to 80 years; initiation of PD; presence of greater omentum below the abdominal incision (accessible through the incision) • Number: treatment group (34); control group (33) • Mean age ± SD (years): treatment group (51 ± 13); control group (50 ± 14) • Sex (M/F): treatment group (16/18); control group (17/16) • Diabetes: treatment group (7/34); control group (7/33) • Exclusion criteria: previous open abdominal surgery history; history of psychological illness or condition that interfered with the ability to understand or comply with requirements of the study
Interventions	Treatment group • Open insertion of PD catheter with omentum folding (where a 2 cm incision was made in the peritoneum and the greater omentum was gently drawn out of the abdominal cavity. The distal corners of the greater omentum were fixed to the proximal (gastrocolic) parts of the omentum with three stitches of 2-0 silk suture) Control group • Regular open insertion of PD catheter
Outcomes	• Catheter tip migration with drainage failure • Irreversible catheter dysfunction • All-cause catheter failure: defined as necessary to remove or reposition the catheter by surgical methods • First catheter-related infections including peritonitis, exit-site infection, and tunnel infection • Technique survival: defined as time to permanent transfer to HD or kidney transplant
Notes	• Additional data requested from authors: yes • Funding source: " This work was supported in part by the Research Award Fund for Young Teachers in Central South University (2011QNZT165) to G.C. and the National Natural Science Foundation of China (No. 81070610) to F.L"
Risk of bias	

Chen 2014a *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	All the outcomes are reported
Other bias	High risk	Assessment of presence of greater omentum was only possible during operation hence it is unclear randomisation was occurred after surgical incision was made

Danielsson 2002

Methods	• Study design: parallel RCT • Study time frame/recruitment period: September 1992 to October 1995 • Follow-up period: 0.4 to 44 months
Participants	• Country: Sweden • Setting: multicentre (2 sites) • ESKD patients scheduled for PD and judged not to need PD for at least 6 weeks after catheter insertion • Number: treatment group (30); control group (30) • Median age, range (years): treatment group 54.6, 32 to 80(); control group (60.8, 31 to 76) • Sex (M/F): treatment group (18/12); control group (16/14) • Diabetes: treatment group (8/30); control group (9/30) • Exclusion criteria: required PD shortly after catheter insertion
Interventions	Treatment group • Buried catheter • The tip of the catheter was buried in the subcutaneous tissue. Prior to PD the tip was exteriorised through an exit site Control group • Non-buried catheter • Moncrief-Popvich catheter used in both groups Other information

Danielsson 2002 *(Continued)*

	• All patients were given IV infusion of 2g cloxacillin followed by 1g flucloxacillin orally, twice/day for 5 days • Procedures performed by one experience nephrologist at HS and one senior surgeon to KS
Outcomes	• Death • Peritonitis rate: peritonitis defined as any combination of abdominal pain, turbid dialysate, and a dialysate leukocyte count > 100 x 10^9/L • Exit-site/tunnel infection rate: exit-site infection defined as peri-catheter erythema and/or exudation from the exit site • Technique failure
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	1.5% dropout (1/60)
Selective reporting (reporting bias)	Low risk	Most outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Dasgupta 1998

Methods	• Study design: parallel RCT • Study time frame/recruitment period: not reported • Follow-up period: 14.3 months for Moncrief-Popovich catheter group and 15.8 months for Tenckhoff catheter group
Participants	• Country: Canada • Setting: Single centre • PD patients • Number: treatment group (19); control group (20) • Mean age ± SD (years): not reported • Sex (M/F): not reported

Dasgupta 1998 *(Continued)*

	• Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group • Moncrief-Popovich catheter Control group • Tenckhoff catheter
Outcomes	• Catheter survival
Notes	• Unable to contact author for additional data • Abstract-only publication

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	High risk	Reported few outcomes
Other bias	Unclear risk	Insufficient information to permit judgement

Ejlersen 1990

Methods	• Study design: parallel RCT • Study time frame/recruitment period: 1 June 1986 to 1 April 1988 • Follow-up period: 450 days
Participants	• Country: Denmark • Setting: Single centre • All patients with chronic uraemia requiring the insertion of a permanent PD catheter for future CAPD • Number: treatment group (16); control group (21) • Median, range (years): treatment group (57, 28 to 74); control group (58, 28 to 75)

Ejlersen 1990 *(Continued)*

- Sex (M/F): treatment group (9/7); control group (10/11)
- Diabetes: not reported
- Exclusion criteria: no prior history of extensive peritoneal adherences requiring laparotomy

Interventions	Treatment group • Lateral insertion Control group • Midline insertion Other information • Catheter insertions performed by a senior registrar in urology. • Right-angled modified Tenckhoff catheter, single-cuff L-catheter • Local anaesthetic used for both techniques • IV antibiotic prophylaxis just prior to procedure using 2g ampicillin or 2g cefalothin if penicillin allergy suspected • CAPD was not initiated until at least 2 weeks after insertion. Patients placed on intermittent PD or HD
Outcomes	• Death • Peritonitis • Tunnel infection • Surgical/mechanical failure
Notes	• Stop/end-points: surgical or mechanical catheter failure requiring catheter removal: incurable peri-catheter leakage, irreversible displacement and malfunction, peri-catheter herniation • Funding source: The statistical support from the Danish Medical Research Council is acknowledged (J.no. 5.52.16.90.)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	Most outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Eklund 1994

Methods	• Study design: parallel RCT • Study time frame/recruitment period: August 1987 to February 1989 • Follow-up period: 5 years (31 October 1992)
Participants	• Country: Finland • Setting: single centre • Consecutive patients selected for CAPD • Number: treatment group (20); control group (20) • Mean age, range (years): treatment group (42.8, 19.5 to 61.0); control group (49.0, 28.5 to 65.3) • Sex (M/F): treatment group (9/11); control group (12/8) • Diabetes: treatment group (3/20); control group (10/20) • Exclusion criteria: not reported
Interventions	Treatment group • Single-cuff, straight Tenckhoff catheter Control group • One-bubble, slanted flange, single-cuff Swan neck catheter Other information • Catheters inserted surgically by the same surgeon, spinal anaesthesia was the preferred choice • Prior to insertion catheter was soaked in vancomycin 500 mg/10 mL saline solution and rest of antibiotic injected into rectus muscle • After implantation peritoneal cavity flushed with 1 to 3, 1L exchanges until effluent clear. Catheter was then filled with 2 mL saline and 1 mL heparin (5000 U) • CAPD training and treatment was started 10-14 days after implantation
Outcomes	• Peritonitis: diagnosed when 2 of the following criteria were fulfilled: abdominal pain; cloudy dialysate with leucocytes > 50/mm^3; positive microbiological culture from dialysate) • Peritonitis rate • Exit-site infection: erythema with or without skin induration and/or purulent discharge from exit site) • Exit-site infection rate • Catheter removal or replacement • Death
Notes	• Dropout definitions: catheter removal due to successful transplantation, elective transfer to HD or death from concurrent disease were regarded as lost to follow-up • Funding source: "This study was supported by the Sigrid Juselius Foundation"

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Low risk	Sequentially numbered sealed envelopes containing catheter configurations in random order
Blinding of participants and personnel (performance bias)	Low risk	Blinded

Eklund 1994 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	All outcomes were reported
Other bias	High risk	Definition of peritonitis was different from the ISPD guidelines

Eklund 1995

Methods	• Study design: parallel RCT • Study time frame/recruitment period: March 1990 to September 1991 • Follow-up period: to 30 September 1994
Participants	• Country: Finland • Setting: Single centre • 40 consecutive patients selected for CAPD • Number: treatment group (20); control group (20) • Mean age, range (years): treatment group (48.5, 26 to 68); control group (43.7, 23 to 66) • Sex (M/F): treatment group (11/9); control group (11/9) • Diabetes: treatment group (6/20); control group (10/20) • Exclusion criteria: not reported
Interventions	Treatment group • 2 cuff straight Tenckhoff catheter (straight intraperitoneal segment) Control group • 2 cuff Swan neck catheter (straight intraperitoneal segment) Other information • Catheters inserted surgically, spinal anaesthesia was used in all instances • Prior to insertion catheter was soaked in vancomycin 500 mg/10 mL saline solution and rest of antibiotic injected into rectus muscle
Outcomes	• Peritonitis: diagnosed when 2 of the following criteria were fulfilled: abdominal pain; cloudy dialysate with leucocyte count of 100 cells/mm^3 or more with 50% polymorphonuclear cells; positive microbiological culture from dialysate • Peritonitis rate • Exit-site infection: erythema with or without skin induration and/or purulent discharge from exit site • Exit-site infection rate • Catheter removal or replacement • Death
Notes	• Dropout definitions: catheter removal due to successful transplantation, elective transfer to HD or death from concurrent disease with functioning catheter were censored at the time of the event

Eklund 1995 *(Continued)*

- Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Low risk	Sequentially numbered sealed envelopes containing catheter configurations in random order
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	High dropout (14/40, transferred to HD or death)
Selective reporting (reporting bias)	Low risk	All outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Eklund 1997

Methods	• Study design: parallel RCT • Study time frame/recruitment period: October 1991 to June 1993 • Follow-up period: 1841 days
Participants	• Country: Finland • Setting: single centre • Consecutive patients selected for CAPD • Number: treatment group (30); control group (30) • Mean age, range (years): treatment group (42.8, 22 to 67); control group (45.1, 25 to 64) • Sex (M/F): treatment group (20/10); control group (20/10) • Diabetes: treatment group (6/30); control group (10/30) • Exclusion criteria: not reported
Interventions	Treatment group • Single-cuff Tenckhoff, straight tip Control group • Double-cuff Tenckhoff, straight tip Other information • Spinal anaesthesia used for all patients

Eklund 1997 *(Continued)*

Outcomes	• Peritonitis: 2 of the following criteria - abdominal pain, cloudy dialysate with leucocytes > 100/mm^3 with > 50% polymorphonuclear cells, or positive dialysate culture • Exit-site infection: erythema with or without skin induration and/or purulent discharge for the exit site • Death
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	Unclear, unable to totally exclude reporting bias
Other bias	Unclear risk	Insufficient information to permit judgement

Gadallah 1999

Methods	• Study design: parallel quasi-RCT • Study time frame/recruitment period: October 1992 to October 1995 • Follow-up period: 3 years
Participants	• Country: USA • Setting: single centre • Patients undergoing PD catheter placement (no further details) • Number: treatment group (76); control group (72) • Mean age ± SD (years): treatment group (45.0 ± 1.8); control group (47.2 ± 2.4) • Sex (M/F): treatment group (37/39); control group (22/34) • Diabetes: not reported • Race (White/Black/Latino): treatment group (25/50/1); control group (17/55/0) • Exclusion criteria: not reported
Interventions	Treatment group • Peritoneoscopic placement

Gadallah 1999 *(Continued)*

	• Performed by the same 3 nephrologists in a special procedure room under local anaesthesia and sterile conditions Control group • Surgical placement • Performed by the same 3 surgeons in the operating room under general anaesthetic Other information • Both groups received 1g vancomycin IV preoperatively • Postoperatively both groups had daily irrigation with 200 ml 1.5% dianeal and dialysis was not study until 1 week from the date of surgery
Outcomes	• Early complications • Late complications • Catheter failure • Death • Peritonitis • Exit site/tunnel infection
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomisation method was by alternate months, quasi-RCT
Allocation concealment (selection bias)	High risk	Alternate months
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	3% dropout (5/148)
Selective reporting (reporting bias)	Low risk	All outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Johnson 2006

Methods	• Study design: parallel RCT • Study time frame/recruitment period: February 2003 to February 2006

Johnson 2006 *(Continued)*

	• Follow-up period: All patients were followed up until death, kidney transplantation, completion of PD therapy, or the end of the study on 24 March 2006, whichever came first
Participants	• Country: Australia • Setting: multicentre (2 sites) • Adults patients with ESKD (stage 5 CKD) who required insertion of a Tenckhoff catheter for PD • Number: treatment group (70); control group (62) • Mean age ± SD (years): treatment group (56.3 ± 15.7); control group (57.6 ± 15.7) • Sex (M/F): treatment group (40/30); control group (42/30) • Diabetes: treatment group (29/70); control group (19/62) • Exclusion criteria: history of psychological illness or condition that interfered with the ability to understand or comply with requirements of the study
Interventions	Treatment group • Straight Tenckhoff catheter Control group • Coiled Tenckhoff catheter
Outcomes	• Catheter malposition • Catheter associated infection (peritonitis, exit-site infection) • Technique failure • Death (all causes)
Notes	• Stop of end points: all patients were followed up until death, kidney transplantation, completion of PD therapy, or the end of the study on March 24, 2006, whichever came first • Funding source: none

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random number list with randomisation blocks of 20
Allocation concealment (selection bias)	Low risk	Random number with randomisation blocks of 20
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	Low risk, most outcomes were reported
Other bias	High risk	Unequal baseline characteristics

Jwo 2010

Methods	• Study design: parallel RCT • Study time frame/recruitment period: December 2002 to October 2006 • Follow-up period: not reported
Participants	• Country: Taiwan • Setting: single centre • All incident PD patients • Number: treatment group (37); control group (40) • Mean age ± SD (years): treatment group (56.7 ± 13.4); control group (54.4 ± 16.5) • Sex (M/F): treatment group (12/25); control group (18/22) • Diabetes: treatment group (17/37); control group (13/40) • Exclusion criteria: intolerant to spinal/general anaesthesia; unwilling to participate
Interventions	Treatment group • Laparoscopic insertion of catheter • 500 mg of cefazolin, a prophylactic antibiotic, was given IV before anaesthesia. • Laparoscopic adhesiolysis was performed for those who had peritoneal adhesion due • to previous abdominal surgery or pelvic inflammatory disease. • The postoperative care of the laparoscopic group was identical to that of the open group. Control group • Open surgical method of catheter insertion • 500 mg of cefazolin, a prophylactic antibiotic, was given IV before anaesthesia • No additional surgery such as omentectomy or salpingectomy was performed. PD was started at 7 d postoperatively
Outcomes	• Patient survival • Catheter dropout • Early catheter-related complication including catheter migration, leak, bleeding • Late catheter-related complication including catheter migration, leak, exit-site infection, peritonitis, hernia
Notes	• Additional data requested from authors • Funding source:

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Insufficient information to permit judgement, significantly high number of cirrhosis patients in laparoscopic group
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias)	Unclear risk	Insufficient information to permit judgement

Jwo 2010 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of follow-up
Selective reporting (reporting bias)	Low risk	All the outcomes were reported
Other bias	High risk	Different baseline characteristic between the two groups

Li 2009e

Methods	• Study design: parallel RCT • Study time frame/recruitment period: May 2005 to January 2006 • Follow-up period: 31.8 patient-year for treatment group and 20.7 patient-year for control group
Participants	• Country: China • Setting: single centre • All PD patients entering the PD program • Number: treatment group (20); control group (19) • Mean age ± SD (years): treatment group (57.8 ± 15.7); control group (61.0 ± 19.4) • Sex (M/F): treatment group (10/10); control group (11/8) • Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group • Double-cuff straight-tip Tenckhoff catheter with an artificial subcutaneous swan-neck Control group • Conventional double-cuff straight-tip swan-neck catheter
Outcomes	• Exit-site infection rate • Peritonitis • Catheter-related complication including catheter migration, outflow failure, surgery -related bleeding
Notes	• Funding source: none

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated randomising chart
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement

Li 2009e *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients were followed up and analysed
Selective reporting (reporting bias)	Low risk	All outcomes were reported
Other bias	High risk	Procedures were performed by 3 nephrologists; the study was terminated earlier than planned as they ran out of catheters

Lo 2003b

Methods	• Study design: parallel RCT • Study time frame/recruitment period: August 1997 to January 2001 • Follow-up period: The study endpoint was the removal of the catheter of 31 January 2002 (1 year after the last patient recruitment)
Participants	• Country: Hong Kong • Setting: single centre • All incident PD patients • Number: treatment group 1 (23); treatment group 2 (22); control group (48) • Mean age ± SD (years): treatment groups (62.6 ± 42.6); control group (60.8 ± 13.6) • Sex (M/F): treatment group 1 (10/13); treatment group 2 (11/11); control group (24/24) • Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group 1 • Swan-neck straight tip catheter Treatment group 2 • swan-neck curled tip catheter Control group • Conventional straight double-cuffed Tenckhoff catheter Other information • All catheter implantations were performed by the same group of four trained nephrologists using mini-laparotomy • Cefazolin 1 g was given intravenously as a prophylactic antibiotic just before the operation. • Twice-weekly IPD was started immediately after implantation in almost all cases. Training for CAPD was conducted at about 6 weeks after catheter implantation • Povidone iodine as the standard antiseptic solution for daily exit-site care but chlorhexidine and saline, were also used. Prophylactic mupirocin was not applied to the exit site
Outcomes	• Exit-site infection rate: defined according to the classification by Twardowski and Prowant • Peritonitis • Catheter-related complication including catheter migration, outflow failure, surgery-related bleeding

Lo 2003b *(Continued)*

	• Catheter survival
Notes	• Based on power analysis to show a clinical significance of reducing ESI episodes by one third in the SN group, the original study was designed with a sample size of 60 patients. Because of a failure to show any significant difference in outcome by the time 60 patients had been recruited, the study was extended to recruit 50% more patients • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss to follow-up
Selective reporting (reporting bias)	High risk	Not all of the outcomes were reported
Other bias	Unclear risk	Despite calculate power before the study, no significant difference in the outcomes was observed after complete the recruitment and finally the number of recruitment was increased by 50%

Lye 1996

Methods	• Study design: quasi-RCT • Study time frame/recruitment period: January 1993 to June 1994 • Follow-up period: 1 year
Participants	• Country: Singapore • Setting: single centre • Consecutive patients who were commencing CAPD for the first time • Number: treatment group (20); control group (20) • Mean age ± SD (years): treatment group (64.2 ± 9.8); control group (64.4 ± 10.3) • Sex (M/F): not reported • Diabetes: treatment group (14/20); control group (10/20) • Exclusion criteria: not reported
Interventions	Treatment group

Lye 1996 *(Continued)*

	• Conventional, double-cuff, straight Tenckhoff Control group • Double-cuff, Swan neck coiled catheter Other information • All catheters inserted under local anaesthetic by the same surgeon and immediately post-surgery position of tip was checked by abdominal radiography • Catheters were flushed using 1 L exchanges until effluent was clear. Catheter was then filled with a heparin/saline solution and rested for at least 2 weeks until patient commenced CAPD • If the patient required RRT HD was used unless contraindicated where intermittent PD was performed
Outcomes	• Peritonitis rate • Exit-site infections • Mechanical complications
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Alternate randomisation
Allocation concealment (selection bias)	High risk	Alternate randomisation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	7% lost to follow-up (3/40)
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Merrikhi 2014

Methods	• Study design: parallel RCT • Study time frame/recruitment period: 2010 to 2011 • Follow-up period: 2 months
Participants	• Country: Iran • Setting: single centre

Merrikhi 2014 *(Continued)*

- Patients < 15 years who will be receiving PD and have family support
- Number: treatment group (18); control group (17)
- Mean age ± SD (years): treatment group (6.77 ± 4.87); control group (6.38 ± 4.91)
- Sex (M/F): treatment group (9/9); control group (12/5)
- Diabetes: not reported
- Exclusion criteria: history of prior major abdominal surgery; ventral or inguinal hernia; BMI ≥ 35 kg/m^2

Interventions	Treatment group • Percutaneous placement by 1 cm transverse incision on the skin just below the umbilicus Control group • Open placement by making a left 3to 4 cm paramedian incision approximately 1 to 2 cm superior to the umbilicus
Outcomes	• Catheter-related infection: peritonitis, exit-site infection • Mechanical complication of catheter • Outflow failure of catheter
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss to follow-up
Selective reporting (reporting bias)	Low risk	Study was registered with Iranian Registry of clinical trials
Other bias	Unclear risk	Insufficient information to permit judgement

Moncrief 1998

Methods	• Study design: parallel RCT • Study time frame/recruitment period: not reported • Follow-up period: not reported

Moncrief 1998 *(Continued)*

Participants	• Country: not reported • Setting: not reported • Number: 113 patients; no data available on number per group • Mean age ± SD (years): not reported • Sex (M/F): not reported • Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group • Midline insertion Control group • Lateral insertion
Outcomes	• No outcomes reported
Notes	• Conference proceedings/CARI guidelines report. Unable to confirm data with authors • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	High risk	Outcomes were not reported
Other bias	Unclear risk	Insufficient information to permit judgement

Nielsen 1995

Methods	• Study design: parallel RCT • Study time frame/recruitment period: April 1992 to July 1993 • Follow-up period: 15 months

Nielsen 1995 *(Continued)*

Participants	• Country: Denmark • Setting: single centre • Consecutive patients selected for CAPD programme • Number: treatment group (38); control group (34) • Mean age, range (years): treatment group (50, 18 to 79); control group (55, 29 to 78) • Sex (M/F): treatment group (20/18); control group (20/14) • Diabetes: treatment group (7/38); control group (6/34) • Exclusion criteria: not reported
Interventions	Treatment group • Straight single cuff Tenckhoff Control group • Coiled single cuff Tenckhoff Other information • Catheters inserted by 5 nephrologists. All patients received premedication of a minor tranquillizer and morphine. Local anaesthesia used in all cases (lidocaine 1% containing norepinephrine) • Immediately after implantation, low volume (1 L) supine intermittent PD was initiated for 24 h (60 L) and continued 1 day/week for the first 3 to 4 weeks after implantation • All patients started on a disconnect CAPD system
Outcomes	• Drainage failure • Tunnel or exit-site infection: defined clinically as an inflammation with or without discharge • Peritonitis: two of four of the following: cloudy effluent; abdominal pain; leucocyte count > 100 x 10^6/L (> 50% neutrophils); positive culture
Notes	• Stop or end points: results analyses after 60 patients and due to significant difference in catheter outcome, the study was terminated after the inclusion of 72 patients • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Study described as randomised; method of randomisation not reported
Allocation concealment (selection bias)	Low risk	Sequentially number sealed envelopes with catheter type in random order
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Both participants and personnel are blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	High risk	High dropout rate (32/72)

Nielsen 1995 *(Continued)*

Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Ouyang 2015

Methods	• Study design: parallel RT • Study time frame/recruitment period: November 2007 to August 2008 • Follow-up period: 24 months
Participants	• Country: China • Setting: single centre • All ESKD patients ≥ 18 years who underwent a first PD catheter placement • Number: treatment group (90); control group (99) • Mean age ± SD (years): treatment group (50.3 ± 14.1); control group (49.1 ± 15.6) • Sex (M/F): treatment group (49/41); control group (54/45) • Diabetes: not reported • Exclusion criteria: AKI; referral for kidney transplantation evaluation within 3 months; acute heart failure; acute MI within 3 months; acute respiratory distress syndrome at the time of enrolment; malignant disease; psychiatric disease
Interventions	Treatment group • Coiled tip Tenckhoff Catheter Control group • Straight tip Tenckhoff catheter Other information • All placements were performed by one of two designated experienced nephrologists • A prophylactic 2nd or 3rd-generation cephalosporin was administered intravenously 1 hour before the catheter placement procedure • Patients underwent PD therapy immediately after the successful catheter placement and transited to continuous ambulatory PD 7 days later
Outcomes	• 1-year and 2-year catheter survival • Death, transfer to HD, kidney transplantation, refusal of PD therapy, or recovery of kidney function • Catheter dysfunction • Peritonitis diagnosed when two of the following conditions were present: abdominal pain; cloudy effluent with an effluent white cell count of more than 100/μL (≥ 50% polymorphonuclear neutrophils); or a positive effluent culture • Exit-site infection: defined as erythema with or without skin induration and purulent discharge from the exit site
Notes	• Additional data requested from authors • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement

Ouyang 2015 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	High risk	22% dropout (43/189)
Selective reporting (reporting bias)	Low risk	All the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Park 1998

Methods	• Study design: parallel RCT • Study time frame/recruitment period: April 1991 to January 1995 • Follow-up period: 2 years
Participants	• Country: Korea • Setting: single centre • Patients commencing CAPD • Number: treatment group (30); control group (29) • Mean age, range (years): treatment group (47.8, 16 to 69); control group (46.2, 27 to 71) • Sex (M/F): treatment group (19/11); control group (17/12) • Diabetes: treatment group (13/30); control group (13/29) • Exclusion criteria: not reported
Interventions	Treatment group • Buried catheter • Catheter tip buried for 6 weeks before being exteriorised. Bag exchange commenced the same day Control group • Non-buried catheter • Tip was brought to the surface at the time of surgery and 6 weeks were allowed for wound healing before bag exchange Other information • Double cuff Swan neck bent catheter was used in all patients
Outcomes	• Peritonitis: defined as turbid peritoneal effluent with leukocyte count > 100/mm^3

Park 1998 *(Continued)*

	• Exit-site infection, total number: defined as skin over the tunnel red, war, tender and/or if purulent discharge was observed • Peritonitis rate • Exit-site infection rate • Death
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	2% dropout (1/60)
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Qian 2014

Methods	• Study design: parallel RCT • Study time frame/recruitment period: March 2009 to November 2012 • Follow-up period: not reported
Participants	• Country: China • Setting: single centre • ESKD patients • Number: treatment group (14); control group (15) • Mean age ± SD (years): treatment group (60.2 ± 5.7); control group (62.7 ± 8.6) • Sex (M/F): treatment group (6/8); control group (7/8) • Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group • Cystoscopy-assisted PD catheter insertion

Qian 2014 *(Continued)*

	Control group • Open surgery
Outcomes	• Exit-site infection or tunnel tract • Peritonitis • Peritoneal fluid leak • Catheter migration, catheter obstruction, hernia
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Rubin 1990

Methods	• Study design: parallel RCT • Study time frame/recruitment period: May 1987 to September 1989 • Follow-up period: 2 years
Participants	• Country: USA • Setting: single centre • All patients undergoing placement of initial PD catheters • Number: treatment group (50); control group (35) • Mean age ± SD (years): treatment group (47 ± 18); control group (51 ± 17) • Sex (M/F): 40/45 • Diabetes: not reported • Exclusion criteria: previous abdominal surgery that precluded randomisation of catheter insertion site
Interventions	Treatment group (groups 1 and 3)

Rubin 1990 *(Continued)*

	• Midline insertion, straight catheter/lateral insertion, straight catheter Control group (groups 2 and 4) • Midline insertion, spiral catheter/lateral insertion, spiral catheter Other information • All procedures performed in an operating room environment • Dialysis was started within 2 to 3 hours of returning from the operating theatre
Outcomes	• Exit site/tunnel infection: tunnel infection - obvious purulence from the catheter exit site in association with peritonitis; exit-site infection - purulence of exit site without peritonitis • Peritonitis: dialysate becoming turbid and abdominal pain or a positive culture • Catheter removal/replacement
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	High risk	Introduced new type of catheter and new catheter insertion technique at the same time for the treatment group

Sanchez-Canel 2016

Methods	• Study design: parallel RCT • Study time frame/recruitment period: December 2007 to February 2013 • Follow-up period: not reported
Participants	• Country: Spain • Setting: single centre • PD incident patients ≥18 years

Sanchez-Canel 2016 *(Continued)*

- Number: treatment group (40); control group (38)
- Mean age ± SD (years): treatment group (55.4 ± 14.8); control group (59.1 ± 13.2)
- Sex (M/F): treatment group (21/19); control group (21/17)
- Diabetes: treatment group (11/40); control group (9/38)
- Exclusion criteria: life expectancy of less than 6 months

Interventions	Treatment group • Single-cuff self-locating catheter (with a small tungsten cylinder at the distal end) Control group • Single-cuff, straight Tenckhoff catheter
Outcomes	• Mechanical complication: bleeding, leak, hernia • Infection-related complication: peritonitis, exit-site and tunnel tract infection • Catheter replacement
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	High risk	Some of outcomes were not reported
Other bias	High risk	Different baseline characteristics; BMI significantly higher in the control group

Scott 1994

Methods	• Study design: parallel RCT • Study time frame/recruitment period: not reported • Follow-up period: 19 months
Participants	• Country: UK

Scott 1994 *(Continued)*

- Setting: single centre
- PD patients
- Number: treatment group (30); control groups (59)
- Mean age ± SD (years): not reported
- Sex (M/F): not reported
- Diabetes: not reported
- Exclusion criteria: not reported

Interventions	Treatment group • Double cuff, straight Tenckhoff Control group 1 • Standard coiled catheter Control group 2 • Oreopoulos (Toronto Western double-disk) Other information • Catheters inserted surgically under standard standardised conditions and surgical techniques
Outcomes	• Death • Peritonitis
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement, unclear
Selective reporting (reporting bias)	High risk	Not all the outcomes of interest were reported
Other bias	Unclear risk	Insufficient information to permit judgement

SIPROCE 1997

Methods	• Study design: parallel RCT • Study time frame/recruitment period: October 1994 to April 1996 • Follow-up period: cumulative time of observation in the silver ring group was 857 months compared with 937 months in the control group
Participants	• Country: Germany • Setting: multicentre (7 sites) • All patients undergoing PD treatment • Number: treatment group (97); control group (98) • Mean age ± SD (years): treatment group (44.74 ± 17.6); control group (47.01 ± 18.5) • Sex (M/F): treatment group (63/34); control group (52/46) • Diabetic: treatment group (19/97); control group (21/98) • Exclusion criteria: acute or chronic exit-site infections; sinus tract/tunnel infections; peritonitis during the ascertainment period (October 1994 to April 1995)
Interventions	Treatment group • Silver ring • The silver ring was placed at the skin level of the exit site and, if necessary, fixed by a silicone ring with silicone glue to avoid displacement above or below the skin level. Control group • No silver ring
Outcomes	• First occurrence of exit-site infection: exit-site infection was defined as reddening with purulent discharge from the exit site (grade II of the visual classification scale) and/or a significantly increased sulcus fluid flow rate (SFFR) measurement in relation to the visual appearance of the exit site • First occurrence of peritonitis • Death (all causes) • Catheter removal/replacement • Technique failure
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias)	High risk	High dropout 30% (59/195)

SIPROCE 1997 *(Continued)*
All outcomes

Selective reporting (reporting bias)	Low risk	Most of the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Stegmayr 2005a

Methods	• Study design: parallel RCT • Study time frame/recruitment period: not reported • Follow-up period: not reported
Participants	• Country: Sweden • Setting: single centre • All patients selected for PD • Number: treatment group (10); control group (14) • Mean age ± SD (years): not reported separately • Sex (M/F): not reported • Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group • Straight catheter Control group • Coiled catheter
Outcomes	• Catheter outflow failure • Catheter removal • Peritonitis
Notes	• Initially planned to recruit 50 patients. The study was interrupted because the analysis showed a significantly higher frequency of catheter exchanges due to drainage dysfunction and malposition among coiled catheters • Funding source: not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement

Stegmayr 2005a *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	High risk	Few outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Stegmayr 2015

Methods	• Study design: parallel RCT • Study time frame/recruitment period: February 2007 to June 2013 • Follow-up period: median follow-up was 10 months (range 1 to 76 months; mean 15 ± 17 months)
Participants	• Country: Sweden • Setting: single centre • All patients accepted for PD by physician • Number: treatment group (29); control group (32) • Mean age ± SD (years): treatment group (58 ± 13); control group (60 ± 18) • Sex (M/F): treatment group (20/9); control group (17/15) • Diabetes: treatment group (7/29); control group (12/32) • Exclusion criteria: once the patient was accepted for PD by the physician in charge there were no exclusion criteria for randomisation
Interventions	Treatment group • Double cuffed Wolfram self-locating catheter Control group • Double cuffed Tenckhoff catheter
Outcomes	• Catheter outflow failure • Early and late leak • Death
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "A peritoneal dialysis nurse made randomization from envelopes and provided the surgeon with the respective catheter"
Allocation concealment (selection bias)	Unclear risk	Quote: "A peritoneal dialysis nurse made randomization from envelopes and provided the surgeon with the respective catheter"

Stegmayr 2015 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	High risk	High dropout; loss to follow-up: died (7/61), transfer to HD (20/61), transplant (15/61)
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Significantly large number of patients from treatment group dropped out due to transplant

Sun 2015a

Methods	• Study design: parallel RCT • Study time frame/recruitment period: June 2008 to June 2012 • Follow-up period: 12 months
Participants	• Country: China • Setting: Single Centre • Patients with CKD stage 5 • Number: treatment group (48); control group (41) • Mean age ± SD (years): treatment group (52.3 ± 17.6); control group (54.9 ± 14.9) • Sex (M/F): treatment group (27/21); control group (23/18) • Diabetes: treatment group (15/48); control group (12/41) • Exclusion criteria: history of abdominal surgery; extensive adhesion; severe COPD; PKD
Interventions	Treatment group • Vertical tunnel-based low-site PD catheter implantation Control group • Traditional open surgery
Outcomes	• Catheter malfunction • Peritonitis, exit-site infection and tunnel infection • PD fluid leakage, outer cuff extrusion, and inflow or outflow pain
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement

Sun 2015a *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low dropout rate
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Timely PD 2010

Methods	• Study design: parallel RCT • Study time frame/recruitment period: 1 March 2008 to 31 May 2013 • Follow-up period: day 180 post catheter insertion
Participants	• Country: Australia • Setting: multicentre (2 sites) • ESKD patients over 18 years of age, who will be receiving CAPD or APD within 4 weeks of insertion of a PD catheter • Number: treatment group 1 (39); treatment group (42); control group (41) • Mean age ± SD (years): treatment group 1 (60.92 ± 15.2); treatment group 2 (57.55 ± 17.9); control group (54.41 ± 15.5) • Sex (M/F): treatment group 1 (22/17); treatment group 2 (20/22); control group (26/15) • Diabetes: treatment group 1 (15/39); treatment group 2 (14/42); control group (14/41) • Exclusion criteria: a history of psychological illness or condition which resulted in inability to understand or comply with the requirements of the study or if there is an acute infectious episode in the last month before enrolment
Interventions	Treatment group 1 • One-week break-in period Treatment group 2 • Two-week break-in period Control group • Four-week break-in period
Outcomes	• Composite of exit-site infection or tunnel tract or peritonitis • Peritoneal fluid leak • Technique failure

Timely PD 2010 *(Continued)*

Notes	• Funding source: "This study is partly funded by research grants from the Baxter Renal Division Clinical Evidence Council"

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation sequence was generated using STATA software (permuted block)
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropout
Selective reporting (reporting bias)	Low risk	Published protocol before study
Other bias	High risk	Protocol violation present

Trooskin 1990

Methods	• Study design: parallel RCT • Study time frame/recruitment period: not reported • Follow-up period: not reported
Participants	• Country: USA • Setting: multicentre (number of sites not reported) • Patients with CKD selected for PD • Number: treatment group (44); control group (42) • Mean age (years): treatment group (52); control group (49) • Sex (M/F): not reported • Diabetes: not reported • Exclusion criteria: known penicillin allergies
Interventions	Treatment group • Surfactant-treated catheter • Single and double-cuff straight and spiral catheters were used. Catheters (BioGuard ABTM) pretreated with 5% tridodecylmethylammonium chloride (TDMAC) in ethanol Control group

Trooskin 1990 *(Continued)*

	• Surfactant-untreated control catheter
Outcomes	• Peritonitis • Exit-site/tunnel infection • Death • Catheter related complication • Technique failure
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Double blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	Low risk	Most of the outcomes of interest were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Tsimoyiannis 2000

Methods	• Study design: parallel RCT • Study time frame/recruitment period: not reported • Follow-up period: 4-36 months (mean 21 ± 10)
Participants	• Country: Greece • Setting: single centre • Adult patients undergoing insertion of Tenckhoff catheter • Number: treatment group (25); control group (25) • Mean age, range (years): treatment group (62, 48 to 72); control group (58, 25 to 74) • Sex (M/F): treatment group (16/4); control group (18/7) • Diabetes: not reported • Exclusion criteria: problem for general anaesthesia
Interventions	Treatment group

Tsimoyiannis 2000 *(Continued)*

	• Open laparotomy technique with local anaesthesia. No intra-abdominal fixation used. CAPD was commenced 24 to 48 hours with small amounts of fluid and the full program started several days later Control group • Laparoscopic placement with general anaesthesia. Catheter secured to the back wall of the uterus in women or to the peritoneum overlaying the back wall of the bladder in men. Immediately after the end of the procedure CAPD was started
Outcomes	• Mean operative time • Peritonitis • Tip catheter migration • Removal of catheter • Fluid leaks • Technique failure
Notes	• Five patients were excluded from laparoscopic group because they developed severe cardiovascular or respiratory disease, which contraindicated general anaesthesia • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Low risk	Quote: "Closed envelope contained information regarding placement into group A or B"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	10% dropout (5/50)
Selective reporting (reporting bias)	High risk	Not all the outcomes of interest were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Turner 1992

Methods	• Study design: parallel RCT • Study time frame/recruitment period: March 1990 - March 1991 • Follow-up period: 60 weeks
Participants	• Country: UK

Turner 1992 *(Continued)*

- Setting: single centre
- All patients who had a Tenckhoff catheter inserted
- Number: treatment group 1 (22); treatment group 2 (23); control group (21)
- Mean age ± SD (years): treatment group 1 (45 ± 15.51); treatment group 2 (40 ± 14.26); control group (43 ± 15.8)
- Sex (M/F): not reported
- Diabetes: treatment group 1 (4/22); treatment group 2 (5/23); control group (4/21)
- Exclusion criteria: not reported

Interventions	Treatment group 1 • Immobilisation via device • Immediately upon insertion of catheter the immobilisation device was placed over the catheter 1-3 inches from the exit site by the surgeon. It was kept in place at all times and replaced daily after showering. A new immobiliser was positioned before removal of the old one Treatment group 2 • Immobilisation via tape • Immediately upon insertion of catheter the tape was placed over the catheter 1-3 inches from the exit site by the surgeon. It was kept in place at all times and replaced daily after showering. A new tape was positioned before removal of the old one Control group • No immobilisation
Outcomes	• Exit-site/tunnel infection: defined as clinically apparent infection (purulent drainage, redness, swelling, warmth and tenderness) at the exit site with/without a positive culture • Exit-site/tunnel infection rate • Peritonitis
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement

Turner 1992 *(Continued)*

Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Voss 2012

Methods	• Study design: parallel RCT • Study time frame/recruitment period: April 1999 to August 2004 • Follow-up period: 12 months
Participants	• Country: New Zealand • Setting: multicentre (within the Counties-Manukau District Health Board, Auckland, New Zealand) • Patients planned for PD; ≥ 18 years; suitable for both laparoscopic and radiological PD catheter insertions • Number: treatment group (57); control group (56) • Mean age, range (years): treatment group (61.1, 53.3 to 71.4); control group (60.8, 51 to 69.7) • Sex (M/F): treatment group (28/29); control group (30/26) • Diabetes: treatment group (30/57); control group (28/56) • Exclusion criteria: severe obesity (BMI > 35); previous abdominal surgery; history consistent with adhesions; severe medical comorbidity precluding general anaesthesia; bleeding diatheses; anticoagulation; HIV infection; ongoing corticosteroid or immunosuppressant use; severe psychiatric disease; definite plans for live donor kidney transplantation
Interventions	Treatment group • Percutaneous insertion by radiologists using a modified Seldinger technique under fluoroscopic guidance Control group • Laparoscopic insertion by surgeons under direct vision
Outcomes	• Complication-free catheter survival • Complications secondary to mechanical causes (insertion failure, patency failure defined as an inadequate inflow/outflow, hernia, dialysate leak or an abdominal hernia) • PD related peritonitis, exit-site infection, catheter tunnel infection
Notes	• Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote "allocated by simple randomization... performed by the research staff not involved with the care of the subjects"
Allocation concealment (selection bias)	Low risk	Sequentially numbered opaque, sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded

Voss 2012 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Winch 2000

Methods	• Study design: parallel RCT • Study time frame/recruitment period: January 1996 to January 1997 • Follow-up period: follow up till September 1998
Participants	• Country: Australia • Setting: single centre • Incident PD patients • Number: treatment group (11); control group (11) • Mean age (range): 63 years (34 to 77) • Sex (M/F): 12/10 • Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group • Swan neck catheter Control group • Straight curved catheter
Outcomes	• Exit-site infection • Peritonitis • Technique failure
Notes	• Abstract-only publication • Funding source: not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement

Winch 2000 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	High risk	High dropout (8/22)
Selective reporting (reporting bias)	Low risk	Reported most of outcomes
Other bias	Unclear risk	Insufficient information to permit judgement

Wright 1999

Methods	• Study design: parallel RCT • Study time frame/recruitment period: not reported • Follow-up period: 24 months
Participants	• Country: UK • Setting: single centre • All patients fit enough to undergo general anaesthetic and starting PD • Number: treatment group (21); control group (24) • Mean age ± SD (years): treatment group (46.4 ± 14.8); control group (49.3 ± 20.2) • Sex (M/F): treatment group (14/7); control group (15/9) • Diabetes: not reported • Exclusion criteria: not reported
Interventions	Treatment group • Laparoscopic Control group • Conventional/laparotomy Other information • One consultant performed all operations • All patients received 2 g of vancomycin IV prior to surgery as prophylaxis • Dressings were applied to the same position for all patients in order to blind the ward staff to the technique used
Outcomes	• Death • Peritonitis • Peritonitis rate • Catheter removal • Technique failure • Exit-site infection: data was unclear for patient numbers and has been excluded at this stage

Wright 1999 *(Continued)*

Notes	• Four laparoscopic procedures were converted to conventional in theatre due to technical difficulties (3) and obesity (1) • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Low risk	"Sealed enveloped containing cards with 'laparoscopic" or "conventional". Cards stored in theatre anaesthetic room and one envelope opened after each patient was anaesthetized"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Blinded
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Low dropout rate (5/50)
Selective reporting (reporting bias)	Low risk	Most outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Xie 2011a

Methods	• Study design: parallel RCT • Study time frame/recruitment period: October 2006 and February 2008 • Follow-up period: Coiled (median: 31 months), straight (44 months); all patients are followed up until death, kidney, transplant, completion of CAPD or end of the study in December 2010, whichever came first
Participants	• Country: China • Setting: single centre • Aged 18 to 80 years with presence of ESKD and initiated PD in the hospital; expected survival > 6 months • Number: treatment group (40); control group (40) • Mean age ± SD (years): treatment group (63 ± 13); control group (60 ± 13) • Sex (M/F): treatment group (24/16); control group (25/15) • Diabetes: treatment group (8/40); control group (8/40) • Exclusion criteria: unstable or poorly controlled CAD; severe congestive heart failure; severe chronic respiratory disease; malignant disease; clinically significant liver disease; AKI; psychiatric disease; previous abdominal surgery; pregnant or lactating women
Interventions	Treatment group

Xie 2011a *(Continued)*

	• Double-cuffed coiled Swan neck catheter Control group • Double-cuff straight-end swan neck catheter (Quinton; straight group)
Outcomes	• Catheter tip migration with dysfunction • All-cause catheter failure: defined as necessity to remove or reposition the catheter by surgical methods • Catheter-related infections: including peritonitis, exit-site infection, and tunnel infection • Technique survival: defined as time to permanent transition to HD therapy • Overall patient survival
Notes	• Funding source: "This work was supported by the National Basic Research Program of China 973 Program No. 2012CB517600 (No.2012CB517604), the National Natural Science Foundation of China (No. 81000295), Leading Academic Discipline Project of Shanghai Health Bureau (05III 001 and 2003ZD002) and Shanghai Leading Academic Discipline Project (T0201). Dr Xie is supported by the Schrier Family Fellowship from the International Society of Nephrology"

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer generated random numbers
Allocation concealment (selection bias)	Low risk	"Randomization was performed using sequentially numbered opaque sealed envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low dropout (1/80)
Selective reporting (reporting bias)	High risk	Not all the outcomes were reported
Other bias	Unclear risk	Insufficient information to permit judgement

Yip 2010

Methods	• Study design: parallel RCT • Study time frame/recruitment period: January 2001 onward • Follow-up period: 24 month, mean duration of follow-up was 18.9 ± 8.0 months
Participants	• Country: Hong Kong, China • Setting: single centre • New patients entering chronic PD program

Yip 2010 *(Continued)*

- Number: treatment group (50); control group (51)
- Mean age ± SD (years): treatment group (61.5 ± 14.9); control group (64.3 ± 13.7)
- Sex (M/F): treatment group (30/20); control group (28/23)
- Diabetes: not reported
- Exclusion criteria: previous PD; patients requiring laparoscopic implantation of the PD catheter

Interventions	Treatment group • Conventional double-cuffed Tenckhoff catheter with straight tunnel which was converted to an arcuate one using the triple incision method resulting in a downward directed exit Control group • Swan neck catheter
Outcomes	• Complications including leakage, wound bleeding, wound infection, catheter malposition • Exit-site infection and peritonitis • Death (all causes)
Notes	• The study end point was removal of the catheter or 24 months after implantation, whichever was earlier • Additional data requested from authors • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low dropout rate (6/101)
Selective reporting (reporting bias)	Low risk	All the outcomes were reported
Other bias	Unclear risk	No prophylactic antibiotic for exit site. The study reported the procedures were performed by trained nephrologists in the unit, but unclear about the grade and training experience of the procedurists

Zhang 2016

Methods	• Study design: parallel RCT • Study time frame/recruitment period: January 2013 to December 2015 • Follow-up period: 6 months
Participants	• Country: China • Setting: single centre • ESKD patients required RRT • Number: treatment group 1 (49); treatment group 2 (54); control group (49) • Mean age ± SD (years): treatment group 1 (55.9 ± 17.1); treatment group 2 (57.2 ± 16.6); control group (53.8 ± 19) • Sex (M/F): treatment group 1 (32/17); treatment group 2 (29/25); control group (31/18) • Diabetes: treatment group 1 (12/49); treatment group 2 (11/54); control group (13/49) • Exclusion criteria: contraindications for PD or refuse to choose PD
Interventions	Treatment group 1 • Modified open surgery group • Lower position of catheter implantation; shorter length of intra-abdominal catheter section which was set during operation based on a real-time measurement of the distance between the peritoneal opening and the Douglas or rectovesical pouch Treatment group 2 • Modified open surgery with catheter fixation group Control group • Traditional open surgery group
Outcomes	• Catheter malfunction: defined as insufficient inflow and/or outflow of dialysate, including catheter tip migration and non-migration problems, mainly refractory obstruction • Peritonitis, exit-site and tunnel infections • Bleeding, leakage, inflow or outflow pain, hernia and delayed wound healing
Notes	• Funding source: "This work was supported by The National Natural Science Foundation of China (81500537)"

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random number table
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias)	Low risk	No dropouts

Zhang 2016 *(Continued)*

All outcomes

Selective reporting (reporting bias)	Low risk	All the outcomes were reported
Other bias	High risk	Percentage of patients with pervious abdominal surgery was appear to be higher than the other two modified surgery group (20.4% versus 10.2% and 13.0%)

Zhu 2015

Methods	• Study design: parallel RCT • Study time frame/recruitment period: March 2010 and March 2013 • Follow-up period:12 months
Participants	• Country: China • Setting: single centre • Patients diagnosed with CKD 5; aged < 70 years; no history of abdominal trauma or surgery (open group) while patients with history of appendectomy, nephrectomy, cholecystectomy and caesarean section can be included in “Mini-Perc” group; no history of serious lung and chest disease; BMI < 25; can live independently • Number: treatment group (35); control group (37) • Mean age ± SD (years): treatment group (54.3 ± 16.2); control group (56.8 ± 14.7) • Sex (M/F): treatment group (21/14); control group (25/11) • Diabetes: treatment group (8/35); control group (10/37) • Exclusion criteria: serious abnormalities of coagulation tests; tumour, psychosis, drug addiction, alcoholism, and other special status
Interventions	Treatment group • Ureteroscope-assisted “Mini-Perc” technique Control group • Modified open surgery
Outcomes	• Success rate of procedure • Intra-operative anaesthetic dose, the average operation time, the bleeding and blood transfusion rate • Catheter migration, catheter blockage, fluid leaking4.Infections of exit site or tunnel, and loss of function
Notes	• Though it is RCT, there was some pre-specified criteria eligible for each group "no history of abdominal trauma or surgery (open group) while patients with history of appendectomy, nephrectomy, cholecystectomy and caesarean section can be included in “Mini-Perc” group" • Funding source: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Quote: "Randomization was done on the day of intervention using the closed envelope method"

Zhu 2015 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	Low risk	All the outcomes were reported
Other bias	High risk	Unequal baseline characteristics between groups, significantly more patients in the treatment had history of abdominal surgery

AKI - acute kidney injury; APD - automated peritoneal dialysis; BMI - body mass index; CAD - coronary artery disease; CAPD - continuous ambulatory peritoneal dialysis; CKD - chronic kidney disease; COPD - chronic obstructive pulmonary disease; ESKD - end-stage kidney disease; HD - haemodialysis; HIV - human immunodeficiency virus; IQR - interquartile range; IPD - intermittent peritoneal dialysis; IV - intravenous; M/F - male/female; MI - myocardial infarction; PD - peritoneal dialysis; PKD - polycystic kidney disease; RCT - randomised controlled trial; RRT - renal replacement therapy; WCC - white cell count

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Crabtree 2003	Issues with randomisation: 5 patients entered the study twice, another 5 patients were not randomised
ISRCTN87054124	Study terminated due to recruitment issues
Moncrief 1994	Study terminated for incomplete recruitment
N0547061060	Unable to obtain sufficient information on the study type, populations or interventions to determine if the study meets all the review criteria
O'Dwyer 2005	Wrong intervention: compared two types of tunnelled HD catheters
Williams 1989	Wrong intervention: compared different methods of therapy for peritonitis

HD - haemodialysis

Characteristics of studies awaiting assessment *[ordered by study ID]*

Ahmad 2010

Methods	• Country: Mexico • Setting: single centre • Follow-up period: 1 month post insertion
Participants	• Total 136 patients who meet inclusion criteria were randomised

Ahmad 2010 *(Continued)*

Interventions	Treatment group • Peritoneoscopic Control group • Open surgery
Outcomes	• Early complications including peritonitis, exit-site/tunnel infection, leak, catheter block, migration
Notes	• Unable to confirm whether the study is complete or not. Attempted to contact the authors for further information but unsuccessful

LOCI 2011

Methods	• Multicentre RCT
Participants	• All patients with an indication for PD • ≥ 18 years
Interventions	Treatment group • Laparoscopic Control group • Open insertion
Outcomes	• Catheter survival • QoL
Notes	• Attempted to contact the authors for further information but unsuccessful

Wong 2004b

Methods	• RCT • Drawing envelopes on the last day of antibiotic treatment
Participants	• Patients who had peritonitis successfully treated with antibiotics
Interventions	Treatment group • Changing transfer set on relapse of bacterial peritonitis Control group • No change of transfer set
Outcomes	• relapsing peritonitis
Notes	• Unable to contact the author for information. It is unlikely that the results will be published

PD - peritoneal dialysis; QoL - quality of life; RCT - randomised controlled trial

Characteristics of ongoing studies *[ordered by study ID]*

NCT01023191

Trial name or title	A prospective randomized controlled trial of local anaesthetic percutaneous insertion versus general anaesthetic open surgical placement of continuous peritoneal dialysis catheters in a university teaching hospital
Methods	• Study design: parallel RCT • Country: UK • Setting: single centre
Participants	Inclusion criteria • Patients referred to vascular consultants for CAPD catheter insertion • Ability to give informed written consent Exclusion criteria • Previous abdominal surgery via midline incision • Unfit for general anaesthetic • Aged under 18 at time of referral • Inability to give informed written consent • Inability to attend follow up appointments
Interventions	Treatment group • Percutaneous Insertion catheter Control group • Open insertion catheter
Outcomes	• Catheter survival • Peri-operative complications • Mechanical complications • Infective complications: exit-site/tunnel infection, peritonitis • Length of admission • Patient-reported pain post procedure • Operative time
Starting date	December 2011
Contact information	Contact: Ian C Chetter, MB ChB
Notes	

NCT02479295

Trial name or title	Randomized controlled trial of straight versus coiled peritoneal dialysis
Methods	• Study design: parallel RCT • Country: Hong Kong
Participants	Inclusion criteria

NCT02479295 *(Continued)*	• Requires dialysis catheter insertion for maintenance PD • Aged ≥ 18 years • Willingness to give written consent and comply with the study protocol Exclusion criteria • Known contraindication to PD • Participation in another interventional study within last 30 days of randomisation • History of a psychological illness or condition that would interfere with the patient's ability to understand the requirement of the study and/or comply with the dialysis procedures
Interventions	Treatment group • Tenckhoff catheter with straight intra-abdominal part Control group • Tenckhoff catheter with coiled intra-abdominal part
Outcomes	• Catheter dysfunction required intervention • Time to catheter dysfunction • Infusion pain • Risk of peritonitis • Technique failure • Catheter survival
Starting date	June 2015
Contact information	Kai Ming Chow, MBChB, FRCP
Notes	

PD - peritoneal dialysis; RCT - randomised controlled trial

DATA AND ANALYSES

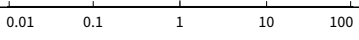
Comparison 1. Laparoscopy versus laparotomy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	4	315	Risk Ratio (M-H, Random, 95% CI)	0.90 [0.59, 1.35]
2 Peritonitis rate (patient-months)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Exit-site/tunnel infection	3	270	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.43, 2.31]
4 Catheter removal or replacement	3	167	Risk Ratio (M-H, Random, 95% CI)	1.20 [0.77, 1.86]
5 Technique failure	4	283	Risk Ratio (M-H, Random, 95% CI)	0.71 [0.47, 1.08]
6 Death (all causes)	3	270	Risk Ratio (M-H, Random, 95% CI)	1.26 [0.72, 2.20]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
7 Dialysate leak	3	167	Risk Ratio (M-H, Random, 95% CI)	0.85 [0.10, 6.97]

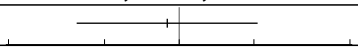
Analysis 1.1. Comparison 1 Laparoscopy versus laparotomy, Outcome 1 Peritonitis.

Study or subgroup	Laparoscopy n/N	Laparotomy n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Tsimoyiannis 2000	3/20	5/25		9.73%	0.75[0.2,2.77]
Jwo 2010	10/37	6/40		19.63%	1.8[0.73,4.47]
Gadallah 1999	11/76	16/72		32.34%	0.65[0.32,1.31]
Wright 1999	9/21	12/24		38.3%	0.86[0.45,1.62]
Total (95% CI)	**154**	**161**		**100%**	**0.9[0.59,1.35]**
Total events: 33 (Laparoscopy), 39 (Laparotomy)					
Heterogeneity: Tau^2=0.01; Chi^2=3.17, df=3(P=0.37); I^2=5.36%					
Test for overall effect: Z=0.52(P=0.6)					



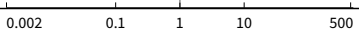
Analysis 1.2. Comparison 1 Laparoscopy versus laparotomy, Outcome 2 Peritonitis rate (patient-months).

Study or subgroup	Laparoscopy n/N	Laparotomy n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Wright 1999	9/171	12/204		0.89[0.39,2.07]



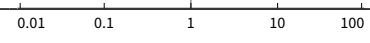
Analysis 1.3. Comparison 1 Laparoscopy versus laparotomy, Outcome 3 Exit-site/tunnel infection.

Study or subgroup	Laparoscopy n/N	Laparotomy n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Gadallah 1999	0/76	4/72		7.78%	0.11[0.01,1.92]
Jwo 2010	6/37	5/40		37.55%	1.3[0.43,3.89]
Wright 1999	8/21	8/24		54.66%	1.14[0.52,2.51]
Total (95% CI)	**134**	**136**		**100%**	**1[0.43,2.31]**
Total events: 14 (Laparoscopy), 17 (Laparotomy)					
Heterogeneity: Tau^2=0.18; Chi^2=2.86, df=2(P=0.24); I^2=30.19%					
Test for overall effect: Z=0.01(P=0.99)					



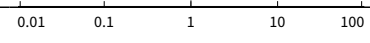
Analysis 1.4. Comparison 1 Laparoscopy versus laparotomy, Outcome 4 Catheter removal or replacement.

Study or subgroup	Laparoscopy n/N	Laparotomy n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Tsimoyiannis 2000	1/20	3/25		4.06%	0.42[0.05,3.71]
Wright 1999	8/21	8/24		31.41%	1.14[0.52,2.51]
Jwo 2010	17/37	14/40		64.53%	1.31[0.76,2.27]
Total (95% CI)	**78**	**89**		**100%**	**1.2[0.77,1.86]**
Total events: 26 (Laparoscopy), 25 (Laparotomy)					
Heterogeneity: Tau^2=0; Chi^2=1.04, df=2(P=0.59); I^2=0%					
Test for overall effect: Z=0.81(P=0.42)					



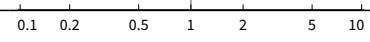
Analysis 1.5. Comparison 1 Laparoscopy versus laparotomy, Outcome 5 Technique failure.

Study or subgroup	Laparoscopy n/N	Laparotomy n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Jwo 2010	1/37	0/40		1.68%	3.24[0.14,77.06]
Tsimoyiannis 2000	1/20	3/25		3.52%	0.42[0.05,3.71]
Wright 1999	8/21	8/24		25.3%	1.14[0.52,2.51]
Gadallah 1999	19/58	32/58		69.49%	0.59[0.38,0.92]
Total (95% CI)	**136**	**147**		**100%**	**0.71[0.47,1.08]**
Total events: 29 (Laparoscopy), 43 (Laparotomy)					
Heterogeneity: Tau^2=0.01; Chi^2=3.16, df=3(P=0.37); I^2=5.17%					
Test for overall effect: Z=1.61(P=0.11)					

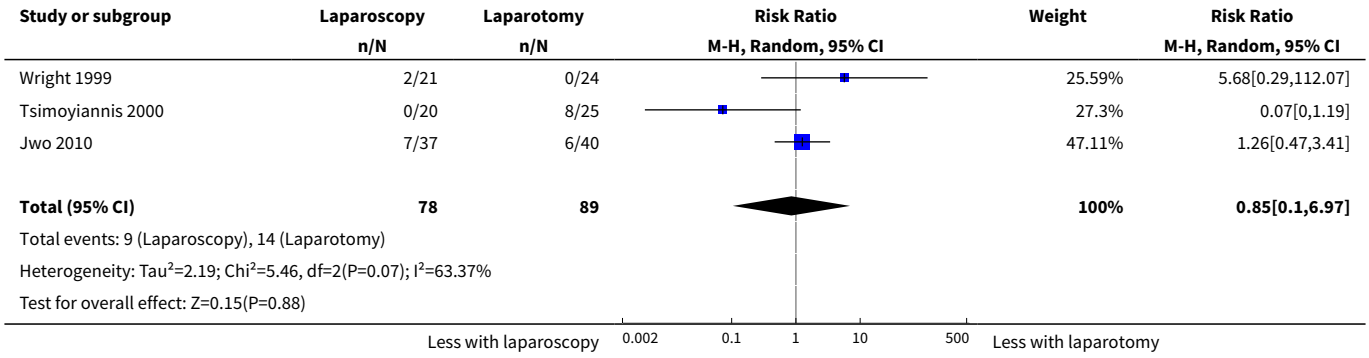


Analysis 1.6. Comparison 1 Laparoscopy versus laparotomy, Outcome 6 Death (all causes).

Study or subgroup	Laparoscopy n/N	Laparotomy n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Wright 1999	4/21	3/24		16.34%	1.52[0.38,6.04]
Gadallah 1999	9/76	9/72		41.36%	0.95[0.4,2.25]
Jwo 2010	10/37	7/40		42.3%	1.54[0.66,3.64]
Total (95% CI)	**134**	**136**		**100%**	**1.26[0.72,2.2]**
Total events: 23 (Laparoscopy), 19 (Laparotomy)					
Heterogeneity: Tau^2=0; Chi^2=0.71, df=2(P=0.7); I^2=0%					
Test for overall effect: Z=0.81(P=0.42)					



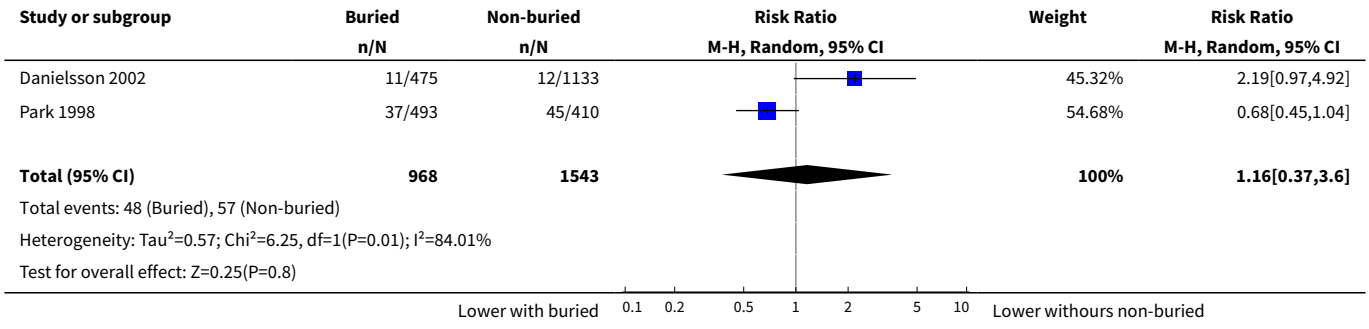
Analysis 1.7. Comparison 1 Laparoscopy versus laparotomy, Outcome 7 Dialysate leak.



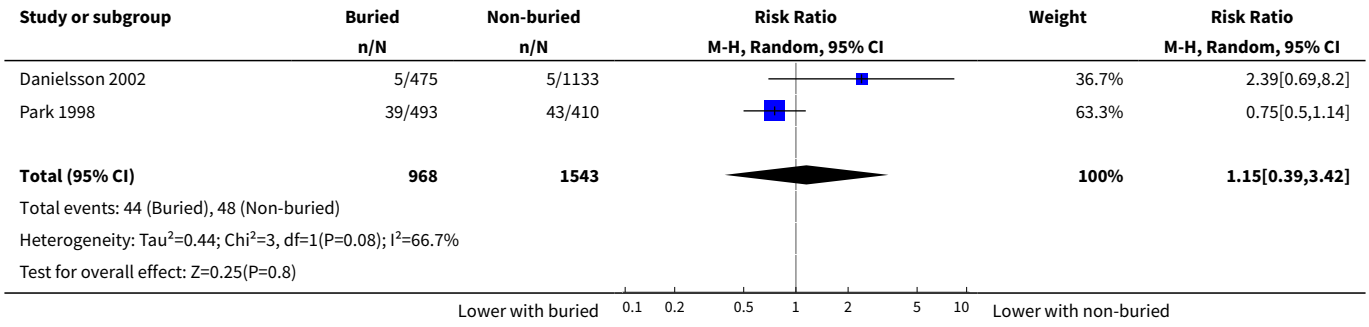
Comparison 2. Buried (subcutaneous) versus non-buried catheter

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis rate (patient-months)	2	2511	Risk Ratio (M-H, Random, 95% CI)	1.16 [0.37, 3.60]
2 Exit-site/tunnel infection rate (patient-months)	2	2511	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.39, 3.42]
3 Technique failure	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Death (all causes)	2	119	Risk Ratio (M-H, Random, 95% CI)	0.90 [0.39, 2.08]

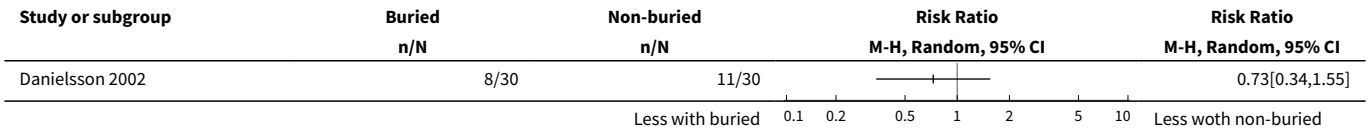
Analysis 2.1. Comparison 2 Buried (subcutaneous) versus non-buried catheter, Outcome 1 Peritonitis rate (patient-months).



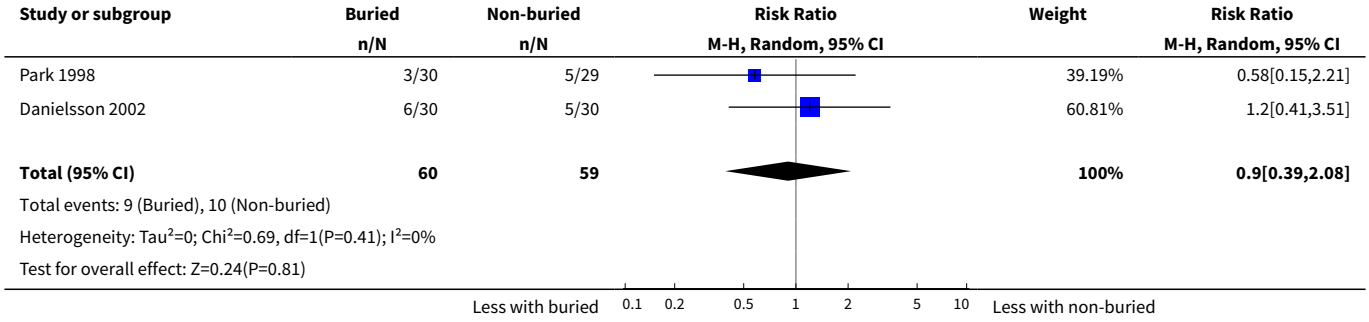
Analysis 2.2. Comparison 2 Buried (subcutaneous) versus non-buried catheter, Outcome 2 Exit-site/tunnel infection rate (patient-months).



Analysis 2.3. Comparison 2 Buried (subcutaneous) versus non-buried catheter, Outcome 3 Technique failure.



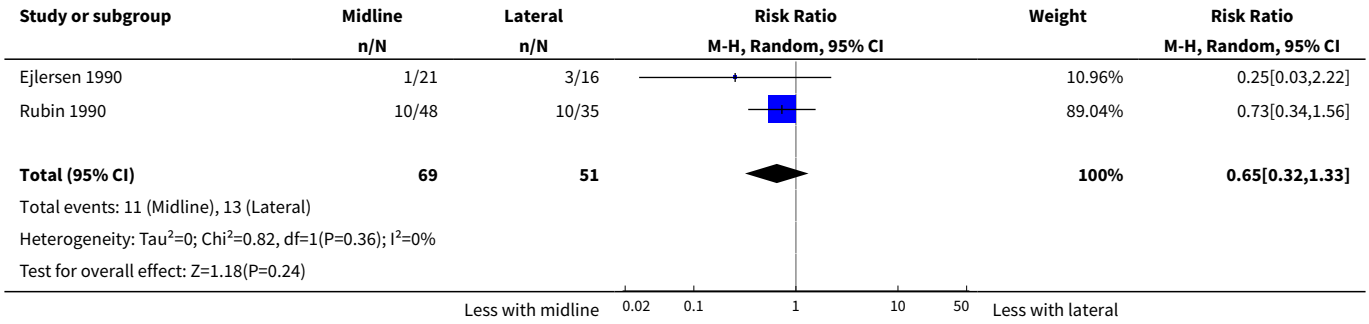
Analysis 2.4. Comparison 2 Buried (subcutaneous) versus non-buried catheter, Outcome 4 Death (all causes).



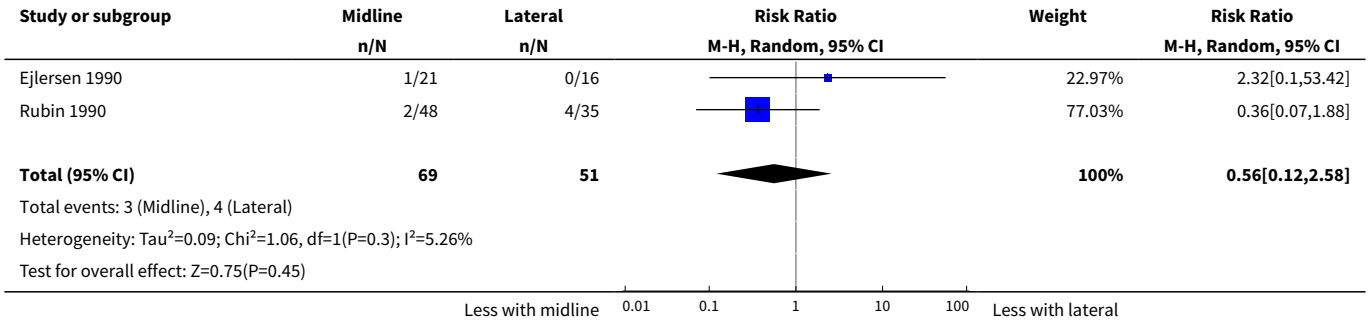
Comparison 3. Midline versus lateral insertion

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	2	120	Risk Ratio (M-H, Random, 95% CI)	0.65 [0.32, 1.33]
2 Exit-site/tunnel infection	2	120	Risk Ratio (M-H, Random, 95% CI)	0.56 [0.12, 2.58]
3 Catheter removal or replacement	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Death (all causes)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

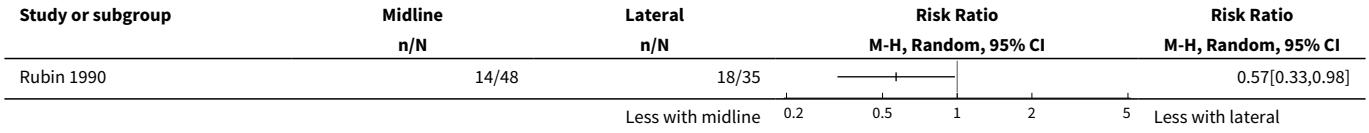
Analysis 3.1. Comparison 3 Midline versus lateral insertion, Outcome 1 Peritonitis.



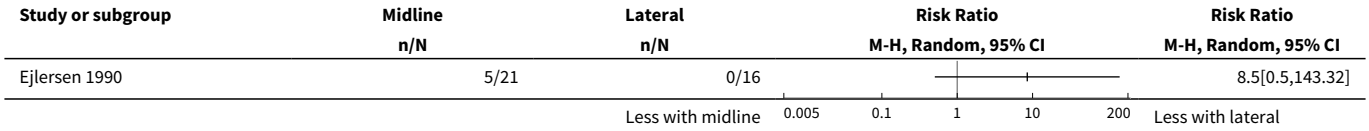
Analysis 3.2. Comparison 3 Midline versus lateral insertion, Outcome 2 Exit-site/tunnel infection.



Analysis 3.3. Comparison 3 Midline versus lateral insertion, Outcome 3 Catheter removal or replacement.



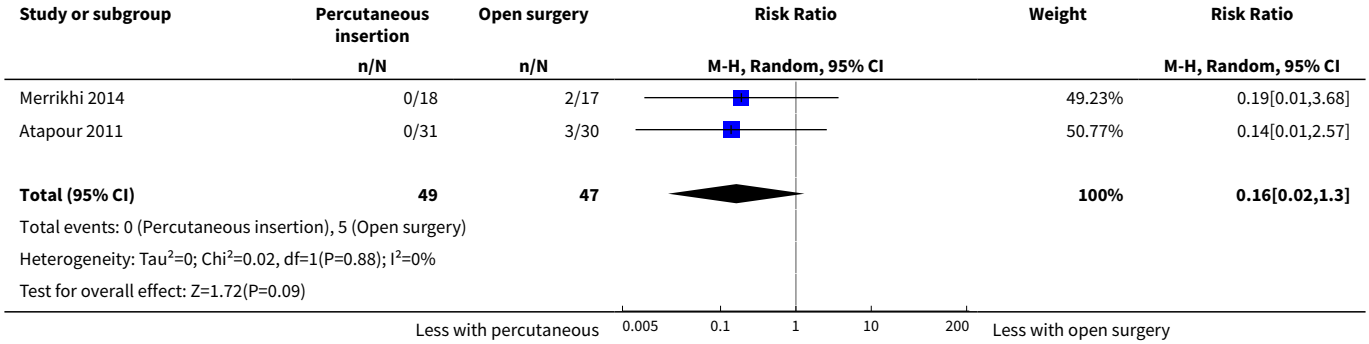
Analysis 3.4. Comparison 3 Midline versus lateral insertion, Outcome 4 Death (all causes).



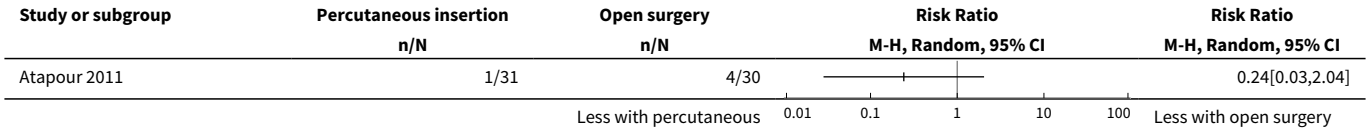
Comparison 4. Percutaneous insertion versus open surgery

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exit-site/tunnel infection	2	96	Risk Ratio (M-H, Random, 95% CI)	0.16 [0.02, 1.30]
2 Catheter removal or replacement	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Postoperative bleed (haematoma or haemoperitoneum)	2	96	Risk Ratio (M-H, Random, 95% CI)	0.22 [0.04, 1.26]

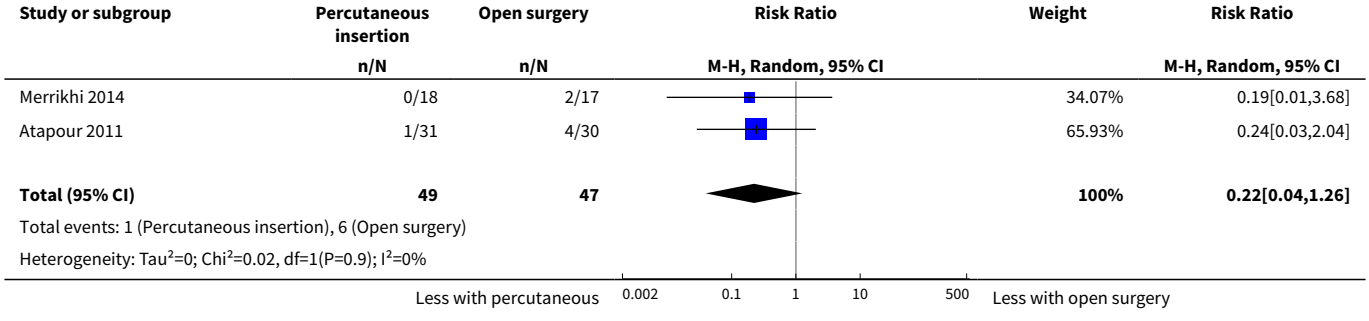
Analysis 4.1. Comparison 4 Percutaneous insertion versus open surgery, Outcome 1 Exit-site/tunnel infection.

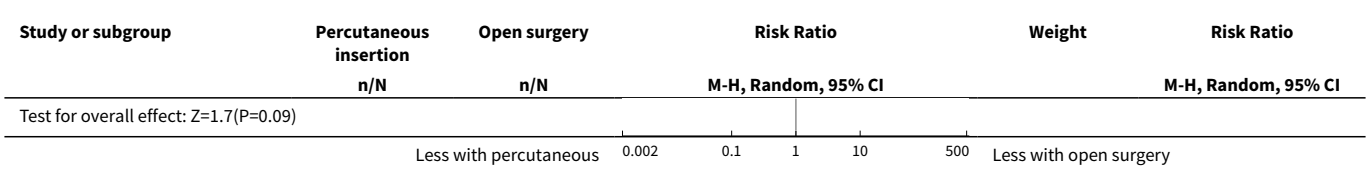


Analysis 4.2. Comparison 4 Percutaneous insertion versus open surgery, Outcome 2 Catheter removal or replacement.



Analysis 4.3. Comparison 4 Percutaneous insertion versus open surgery, Outcome 3 Postoperative bleed (haematoma or haemoperitoneum).

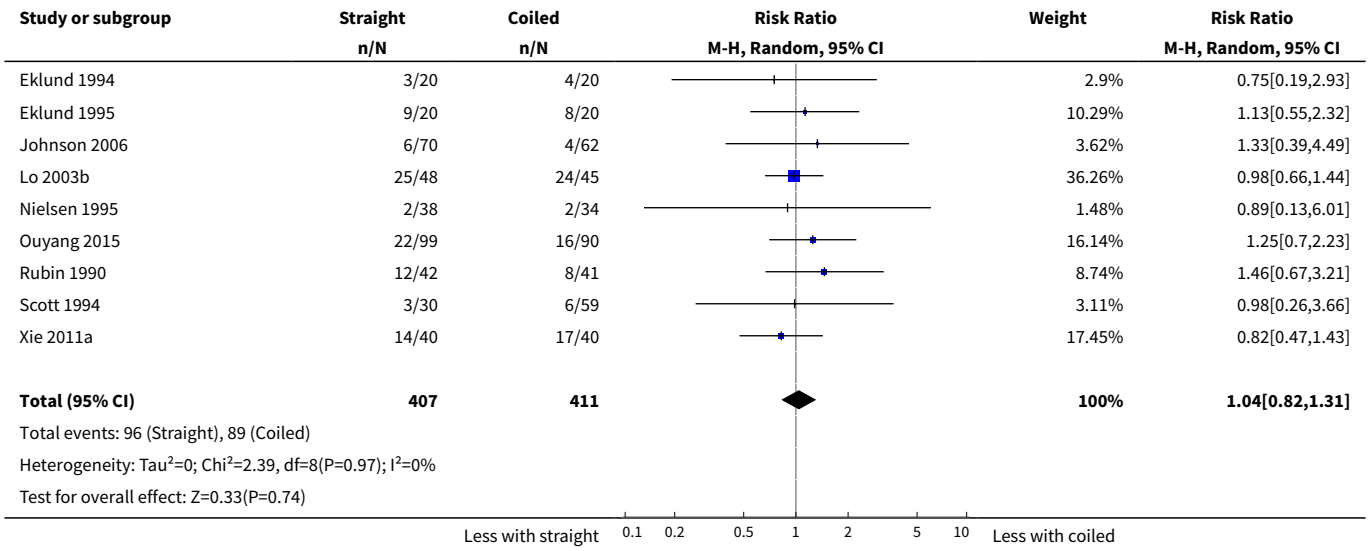




Comparison 5. Straight versus coiled catheters

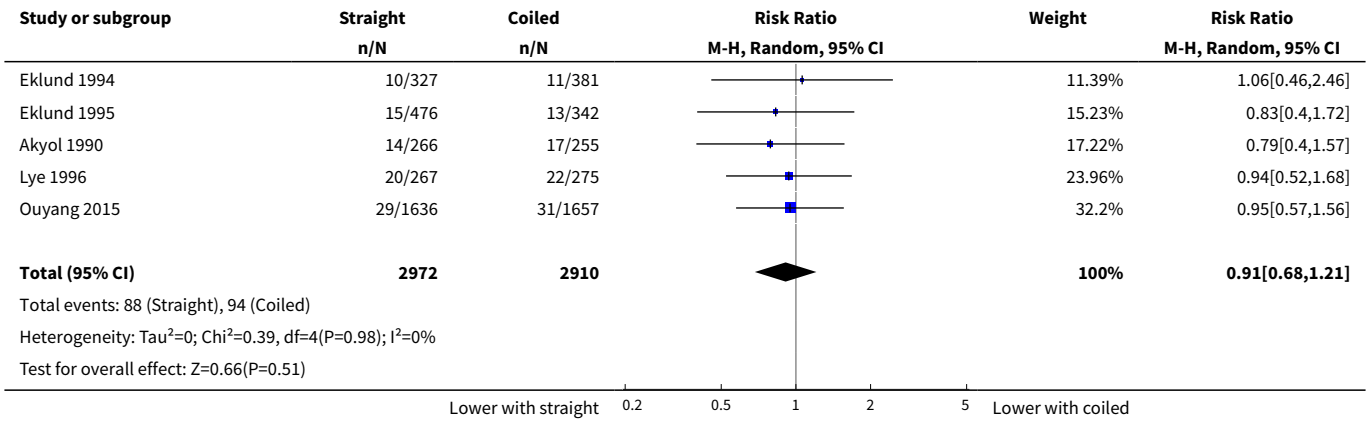
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	9	818	Risk Ratio (M-H, Random, 95% CI)	1.04 [0.82, 1.31]
2 Peritonitis rate (patient-months)	5	5882	Risk Ratio (M-H, Random, 95% CI)	0.91 [0.68, 1.21]
3 Exit-site/tunnel infection	10	826	Risk Ratio (M-H, Random, 95% CI)	1.12 [0.94, 1.34]
4 Exit-site/tunnel infection rate (patient-months)	4	5286	Risk Ratio (M-H, Random, 95% CI)	1.05 [0.77, 1.43]
5 Catheter removal or replacement	9	713	Risk Ratio (M-H, Random, 95% CI)	1.11 [0.73, 1.66]
6 Technique failure	4	442	Risk Ratio (M-H, Random, 95% CI)	0.82 [0.51, 1.31]
7 Death (all causes)	8	703	Risk Ratio (M-H, Random, 95% CI)	0.95 [0.62, 1.46]
8 Peritonitis (studies with low risk of attrition bias)	4	345	Risk Ratio (M-H, Random, 95% CI)	0.93 [0.69, 1.26]
9 Peritonitis rate (patient-months) (studies with low risk of attrition bias)	3	1771	Risk Ratio (M-H, Random, 95% CI)	0.91 [0.61, 1.35]
10 Exit-site/tunnel infection (studies with low risk of attrition bias)	6	425	Risk Ratio (M-H, Random, 95% CI)	1.14 [0.94, 1.39]
11 Exit-site/tunnel infection rate (patient-months) (studies with low risk of attrition bias)	2	1175	Risk Ratio (M-H, Random, 95% CI)	1.18 [0.76, 1.82]
12 Catheter removal or replacement (studies with low risk of attrition bias)	5	329	Risk Ratio (M-H, Random, 95% CI)	0.78 [0.45, 1.33]
13 Dialysate leak	7	550	Risk Ratio (M-H, Random, 95% CI)	0.74 [0.16, 3.49]
14 Postoperative bleeding (haematoma or haemoperitoneum)	4	358	Risk Ratio (M-H, Random, 95% CI)	1.14 [0.24, 5.34]

Analysis 5.1. Comparison 5 Straight versus coiled catheters, Outcome 1 Peritonitis.



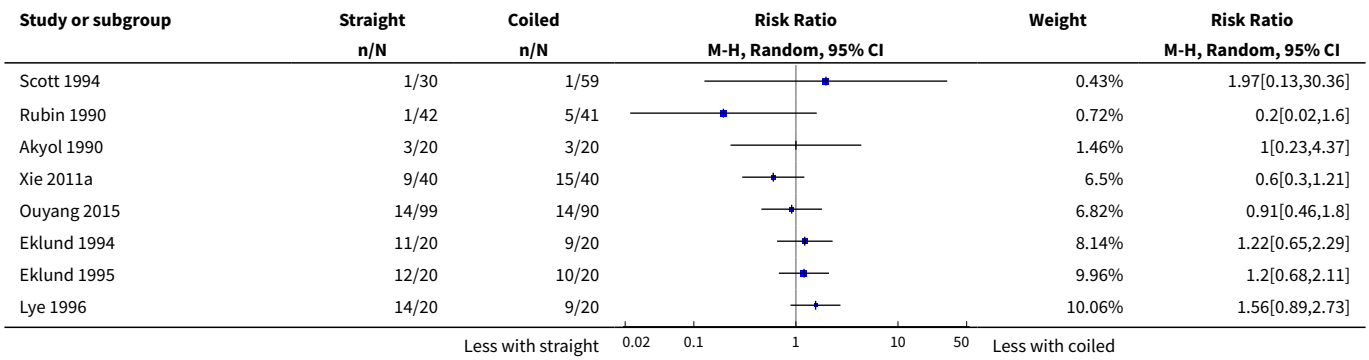
Study or subgroup	Straight n/N	Coiled n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Eklund 1994	3/20	4/20		2.9%	0.75[0.19,2.93]
Eklund 1995	9/20	8/20		10.29%	1.13[0.55,2.32]
Johnson 2006	6/70	4/62		3.62%	1.33[0.39,4.49]
Lo 2003b	25/48	24/45		36.26%	0.98[0.66,1.44]
Nielsen 1995	2/38	2/34		1.48%	0.89[0.13,6.01]
Ouyang 2015	22/99	16/90		16.14%	1.25[0.7,2.23]
Rubin 1990	12/42	8/41		8.74%	1.46[0.67,3.21]
Scott 1994	3/30	6/59		3.11%	0.98[0.26,3.66]
Xie 2011a	14/40	17/40		17.45%	0.82[0.47,1.43]
Total (95% CI)	**407**	**411**		**100%**	**1.04[0.82,1.31]**
Total events: 96 (Straight), 89 (Coiled)					
Heterogeneity: Tau^2=0; Chi^2=2.39, df=8(P=0.97); I^2=0%					
Test for overall effect: Z=0.33(P=0.74)					

Analysis 5.2. Comparison 5 Straight versus coiled catheters, Outcome 2 Peritonitis rate (patient-months).

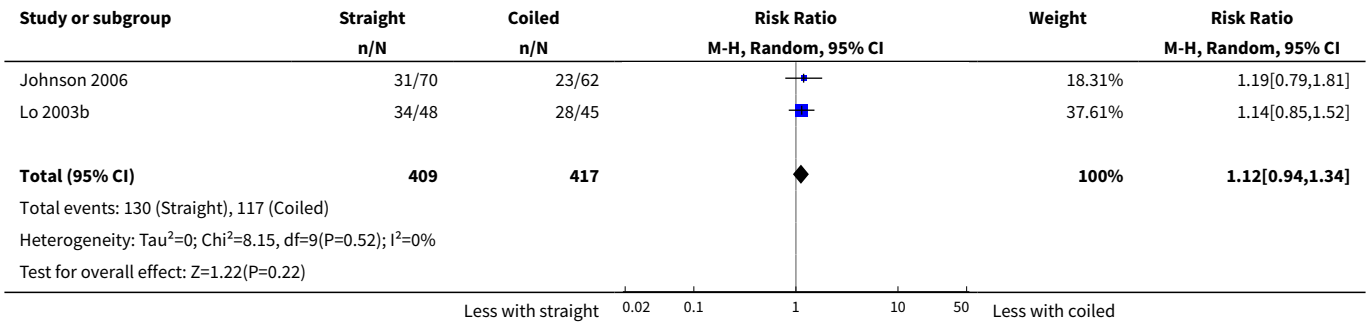


Study or subgroup	Straight n/N	Coiled n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Eklund 1994	10/327	11/381		11.39%	1.06[0.46,2.46]
Eklund 1995	15/476	13/342		15.23%	0.83[0.4,1.72]
Akyol 1990	14/266	17/255		17.22%	0.79[0.4,1.57]
Lye 1996	20/267	22/275		23.96%	0.94[0.52,1.68]
Ouyang 2015	29/1636	31/1657		32.2%	0.95[0.57,1.56]
Total (95% CI)	**2972**	**2910**		**100%**	**0.91[0.68,1.21]**
Total events: 88 (Straight), 94 (Coiled)					
Heterogeneity: Tau^2=0; Chi^2=0.39, df=4(P=0.98); I^2=0%					
Test for overall effect: Z=0.66(P=0.51)					

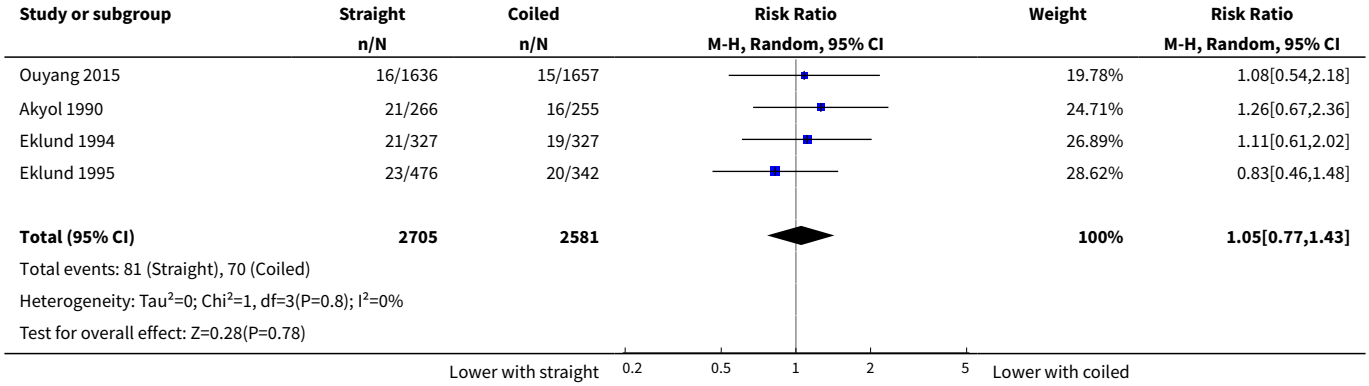
Analysis 5.3. Comparison 5 Straight versus coiled catheters, Outcome 3 Exit-site/tunnel infection.



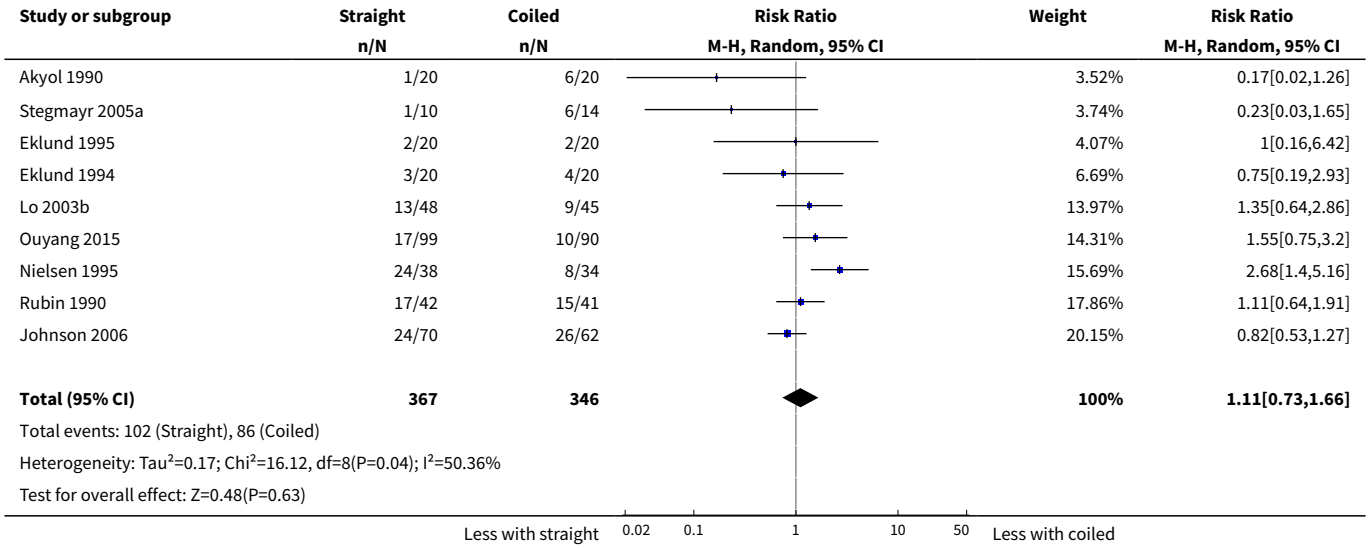
Study or subgroup	Straight n/N	Coiled n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Scott 1994	1/30	1/59		0.43%	1.97[0.13,30.36]
Rubin 1990	1/42	5/41		0.72%	0.2[0.02,1.6]
Akyol 1990	3/20	3/20		1.46%	1[0.23,4.37]
Xie 2011a	9/40	15/40		6.5%	0.6[0.3,1.21]
Ouyang 2015	14/99	14/90		6.82%	0.91[0.46,1.8]
Eklund 1994	11/20	9/20		8.14%	1.22[0.65,2.29]
Eklund 1995	12/20	10/20		9.96%	1.2[0.68,2.11]
Lye 1996	14/20	9/20		10.06%	1.56[0.89,2.73]



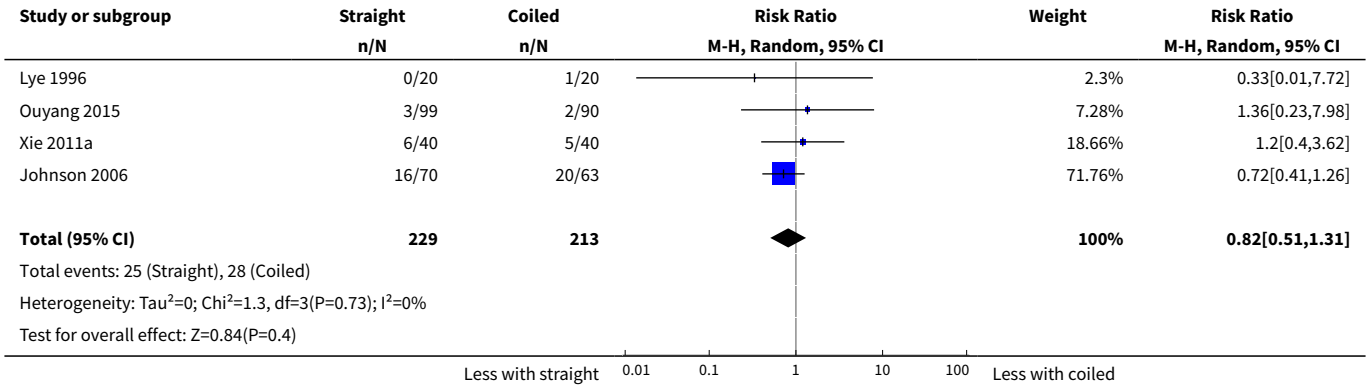
Analysis 5.4. Comparison 5 Straight versus coiled catheters, Outcome 4 Exit-site/tunnel infection rate (patient-months).



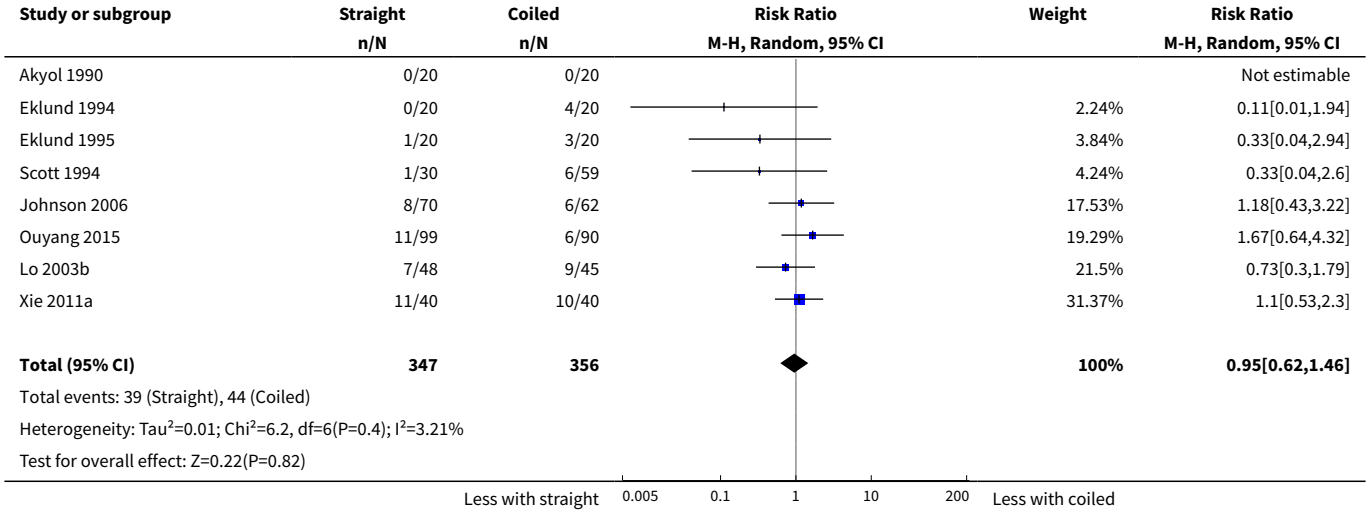
Analysis 5.5. Comparison 5 Straight versus coiled catheters, Outcome 5 Catheter removal or replacement.



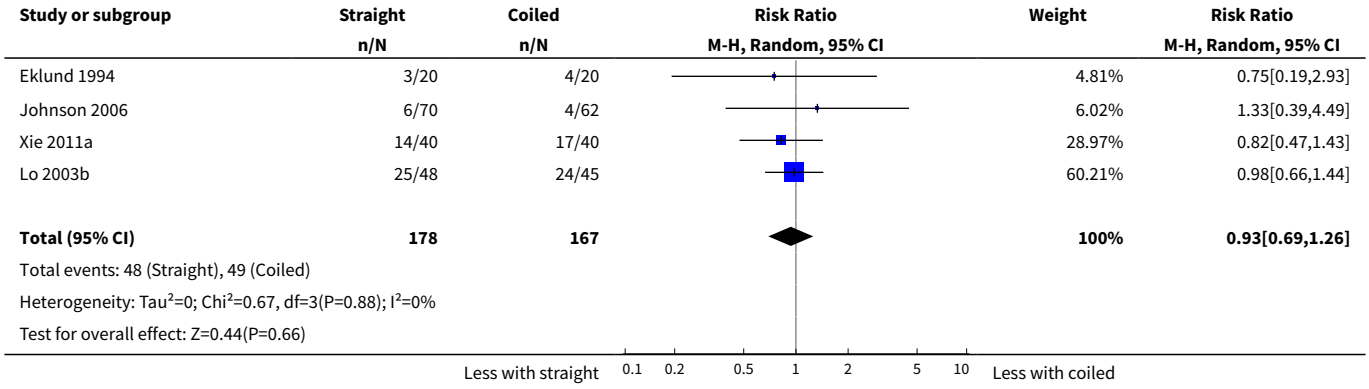
Analysis 5.6. Comparison 5 Straight versus coiled catheters, Outcome 6 Technique failure.



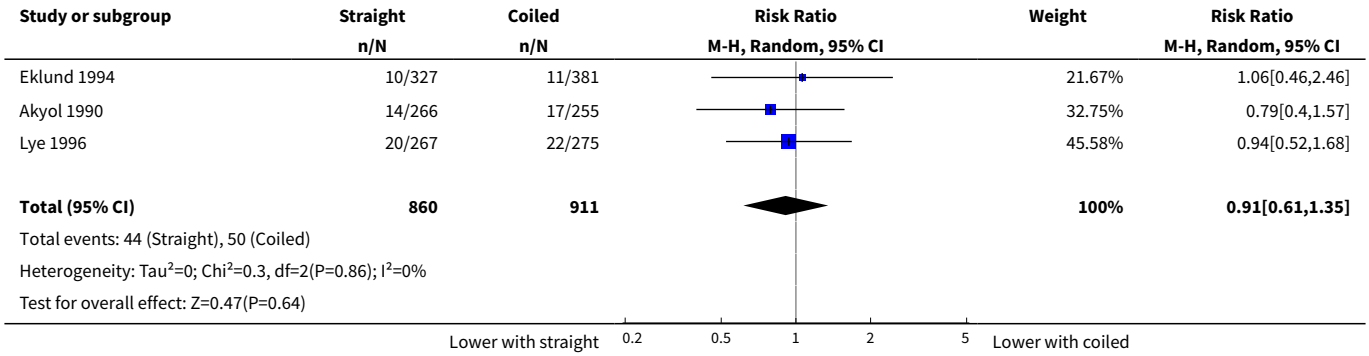
Analysis 5.7. Comparison 5 Straight versus coiled catheters, Outcome 7 Death (all causes).



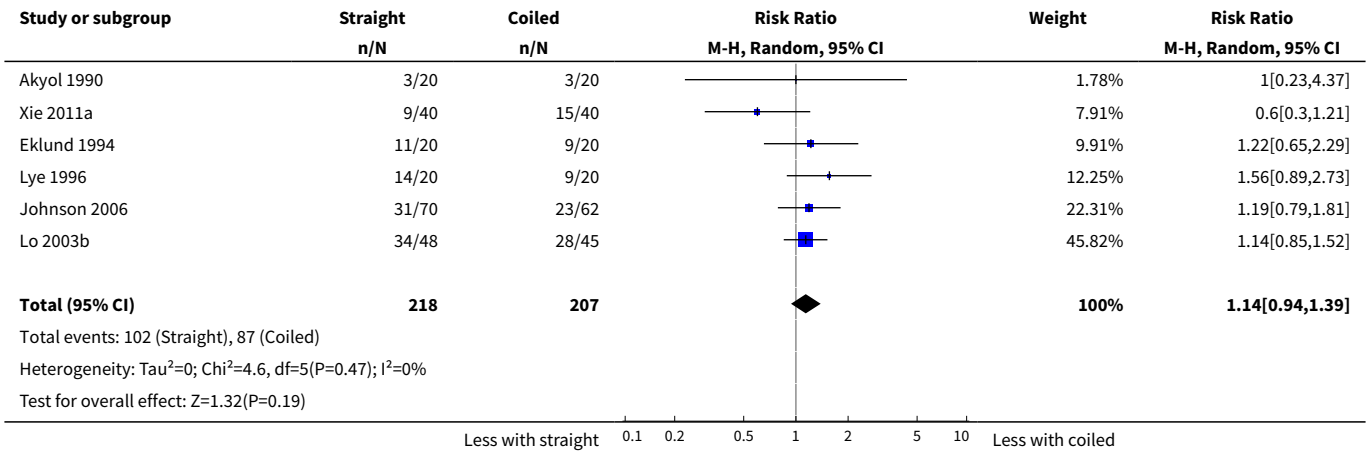
Analysis 5.8. Comparison 5 Straight versus coiled catheters, Outcome 8 Peritonitis (studies with low risk of attrition bias).



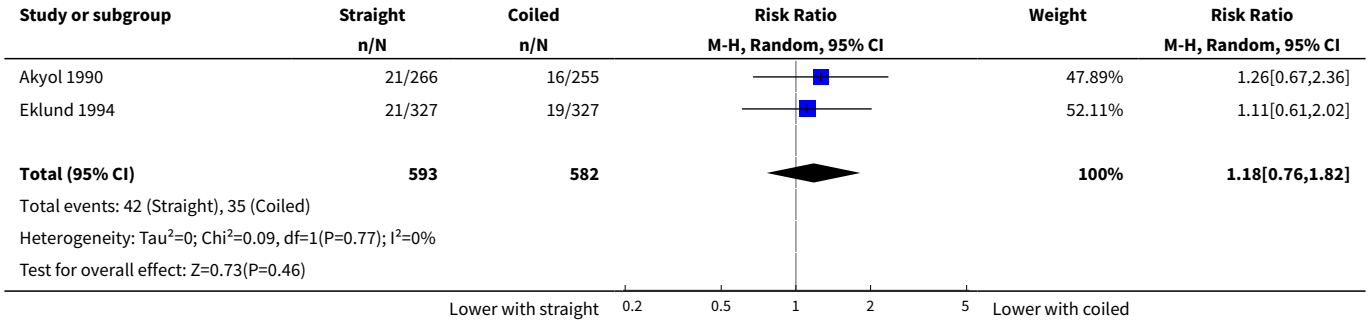
Analysis 5.9. Comparison 5 Straight versus coiled catheters, Outcome 9 Peritonitis rate (patient-months) (studies with low risk of attrition bias).



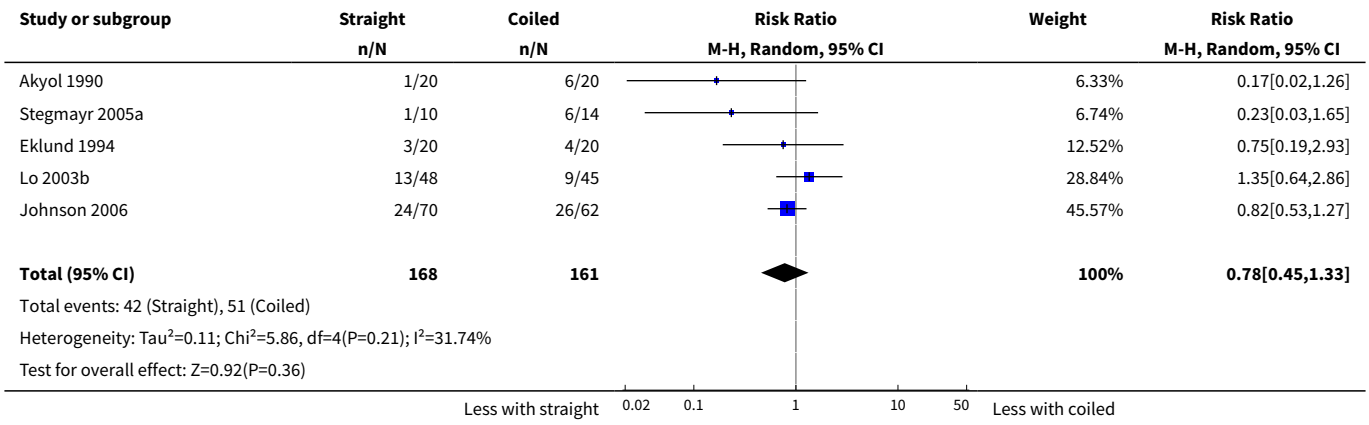
Analysis 5.10. Comparison 5 Straight versus coiled catheters, Outcome 10 Exit-site/tunnel infection (studies with low risk of attrition bias).



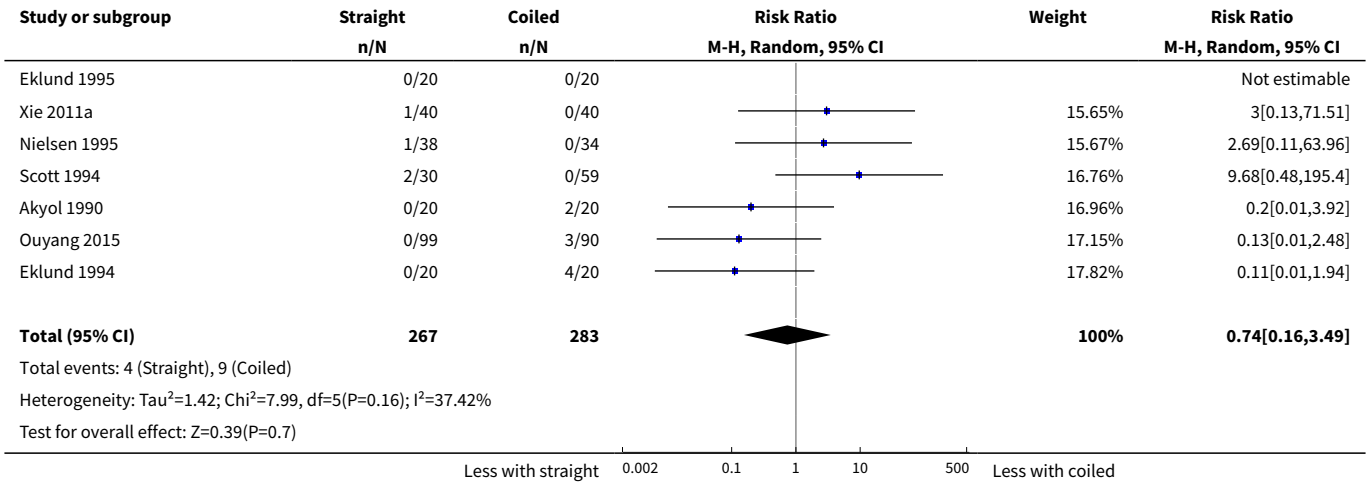
Analysis 5.11. Comparison 5 Straight versus coiled catheters, Outcome 11 Exit-site/tunnel infection rate (patient-months) (studies with low risk of attrition bias).



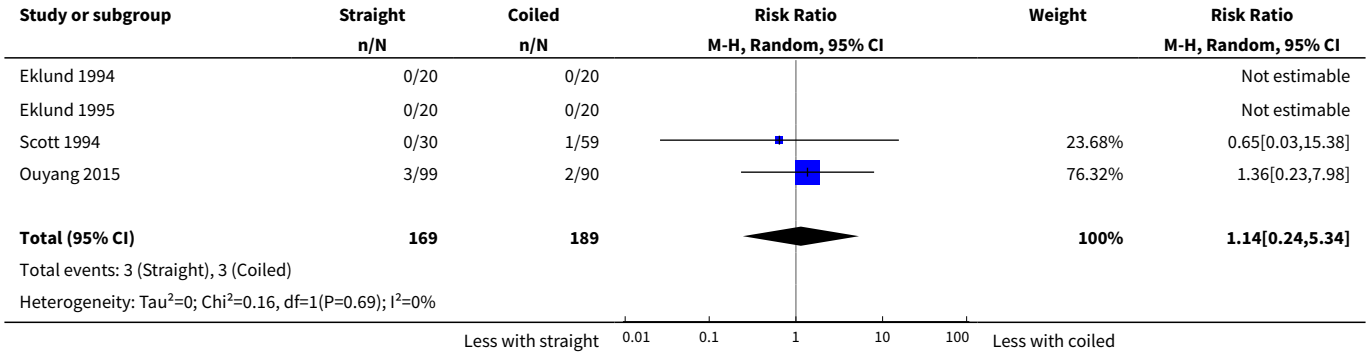
Analysis 5.12. Comparison 5 Straight versus coiled catheters, Outcome 12 Catheter removal or replacement (studies with low risk of attrition bias).

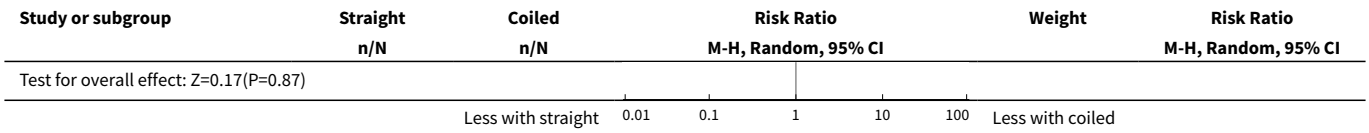


Analysis 5.13. Comparison 5 Straight versus coiled catheters, Outcome 13 Dialysate leak.



Analysis 5.14. Comparison 5 Straight versus coiled catheters, Outcome 14 Postoperative bleeding (haematoma or haemoperitoneum).

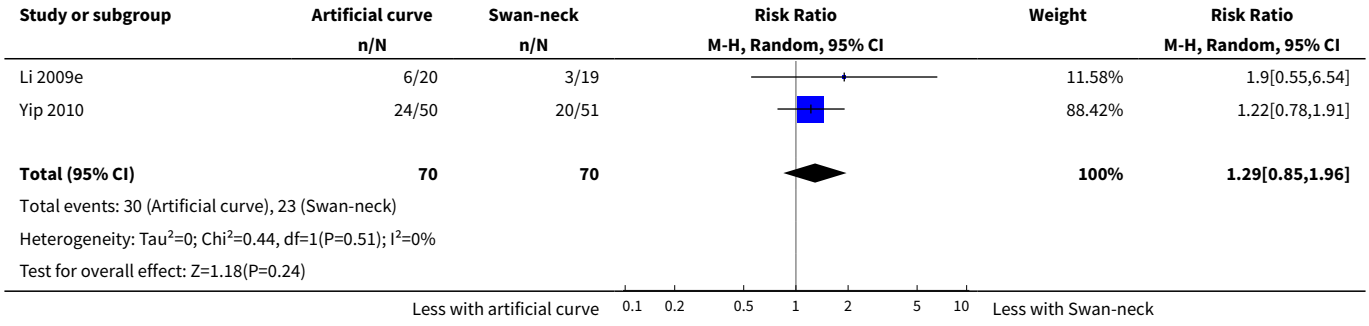




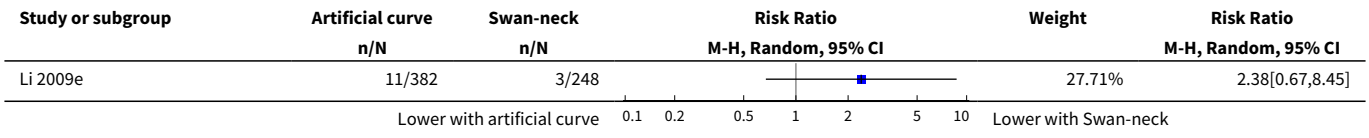
Comparison 6. Tenckhoff catheter with artificial curve at tunnel tract versus Swan-neck

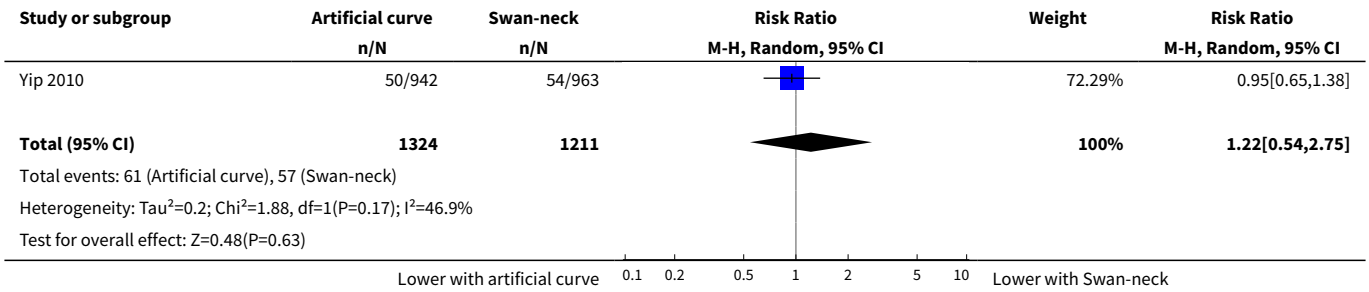
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	2	140	Risk Ratio (M-H, Random, 95% CI)	1.29 [0.85, 1.96]
2 Peritonitis rate (patient-months)	2	2535	Risk Ratio (M-H, Random, 95% CI)	1.22 [0.54, 2.75]
3 Exit-site/tunnel infection	2	140	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.77, 1.21]
4 Exit-site/tunnel infection rate (patient-months)	2	2535	Risk Ratio (M-H, Random, 95% CI)	0.67 [0.50, 0.90]
5 Catheter removal or replacement	2	140	Risk Ratio (M-H, Random, 95% CI)	0.85 [0.42, 1.72]
6 Technique failure	2	140	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.26, 1.58]
7 Death (all causes)	2	140	Risk Ratio (M-H, Random, 95% CI)	0.74 [0.27, 2.03]

Analysis 6.1. Comparison 6 Tenckhoff catheter with artificial curve at tunnel tract versus Swan-neck, Outcome 1 Peritonitis.

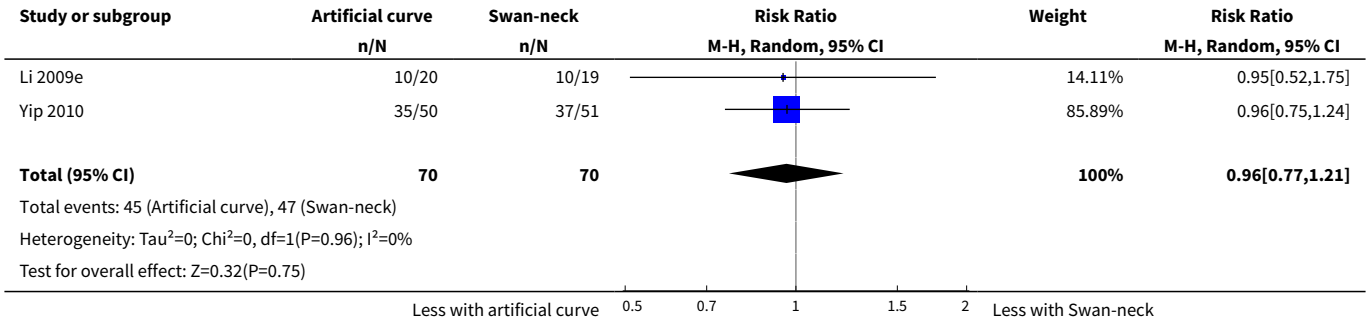


Analysis 6.2. Comparison 6 Tenckhoff catheter with artificial curve at tunnel tract versus Swan-neck, Outcome 2 Peritonitis rate (patient-months).

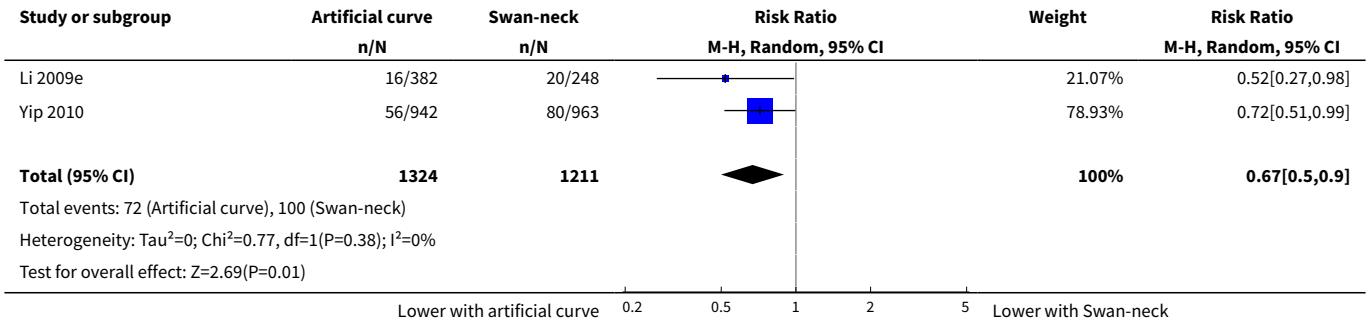




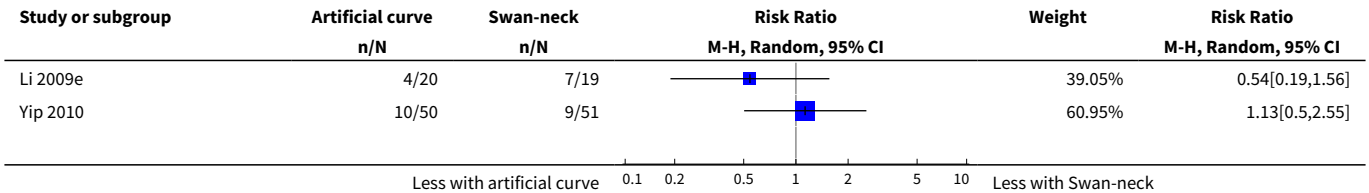
Analysis 6.3. Comparison 6 Tenckhoff catheter with artificial curve at tunnel tract versus Swan-neck, Outcome 3 Exit-site/tunnel infection.

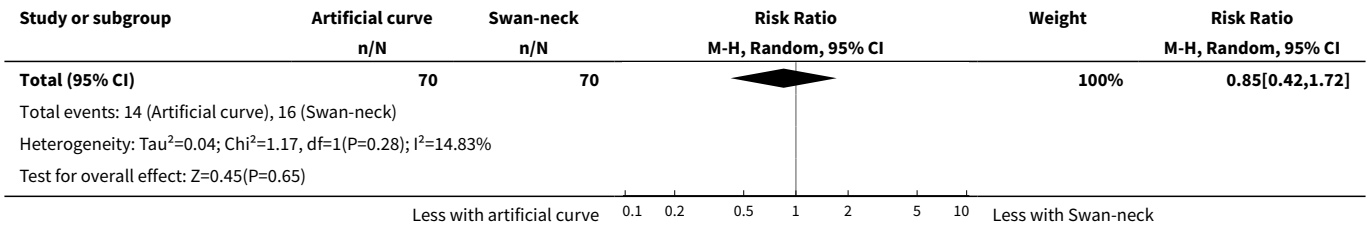


Analysis 6.4. Comparison 6 Tenckhoff catheter with artificial curve at tunnel tract versus Swan-neck, Outcome 4 Exit-site/tunnel infection rate (patient-months).

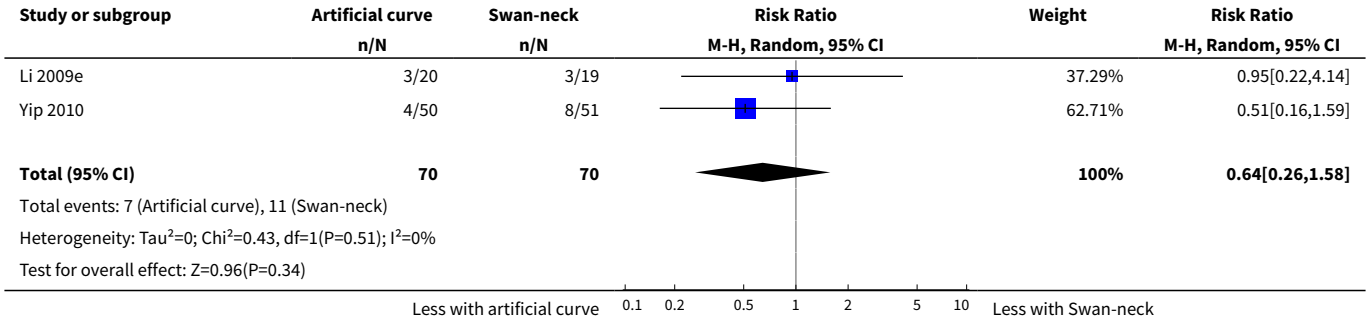


Analysis 6.5. Comparison 6 Tenckhoff catheter with artificial curve at tunnel tract versus Swan-neck, Outcome 5 Catheter removal or replacement.

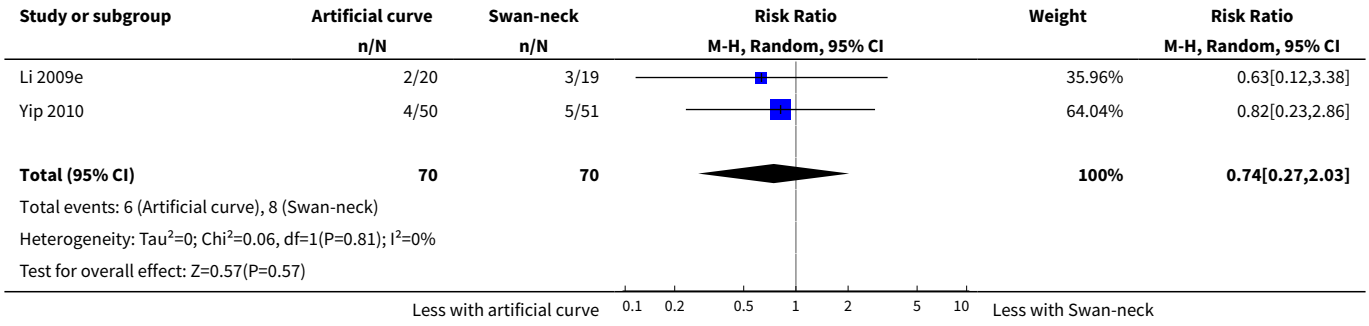




Analysis 6.6. Comparison 6 Tenckhoff catheter with artificial curve at tunnel tract versus Swan-neck, Outcome 6 Technique failure.



Analysis 6.7. Comparison 6 Tenckhoff catheter with artificial curve at tunnel tract versus Swan-neck, Outcome 7 Death (all causes).



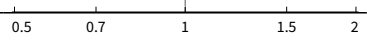
Comparison 7. Self-locating catheter versus straight tenckhoff catheter

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Catheter removal or replacement	2	139	Risk Ratio (M-H, Random, 95% CI)	0.32 [0.03, 3.06]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4 Technique failure	2	139	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.39, 1.04]
5 Death (all causes)	2	139	Risk Ratio (M-H, Random, 95% CI)	1.02 [0.11, 9.75]
6 Dialysate leak	2	139	Risk Ratio (M-H, Random, 95% CI)	1.04 [0.46, 2.35]

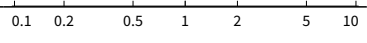
Analysis 7.1. Comparison 7 Self-locating catheter versus straight tenckhoff catheter, Outcome 1 Peritonitis.

Study or subgroup	Self-locating catheter n/N	Straight catheter n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Sanchez-Canel 2016	31/40	26/38		1.13[0.86,1.49]



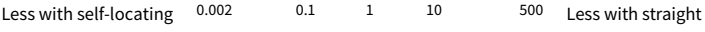
Analysis 7.2. Comparison 7 Self-locating catheter versus straight tenckhoff catheter, Outcome 2 Exit-site/tunnel infection.

Study or subgroup	Self-locating catheter n/N	Straight catheter n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Sanchez-Canel 2016	7/40	7/38		0.95[0.37,2.45]



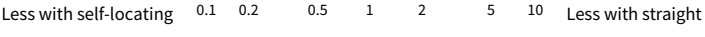
Analysis 7.3. Comparison 7 Self-locating catheter versus straight tenckhoff catheter, Outcome 3 Catheter removal or replacement.

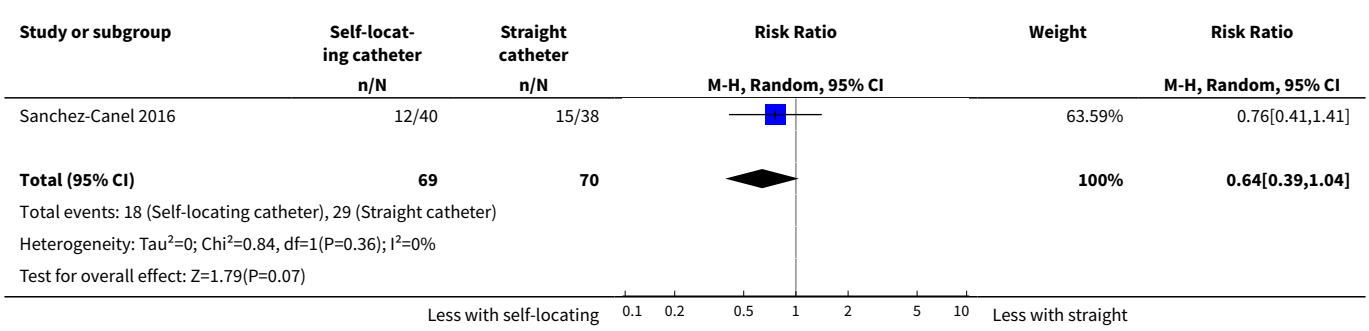
Study or subgroup	Self-locating catheter n/N	Straight catheter n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Stegmayr 2015	0/29	7/32		33.39%	0.07[0,1.23]
Sanchez-Canel 2016	12/40	17/38		66.61%	0.67[0.37,1.21]
Total (95% CI)	**69**	**70**		**100%**	**0.32[0.03,3.06]**
Total events: 12 (Self-locating catheter), 24 (Straight catheter)					
Heterogeneity: Tau^2=1.9; Chi^2=2.76, df=1(P=0.1); I^2=63.73%					
Test for overall effect: Z=0.99(P=0.32)					



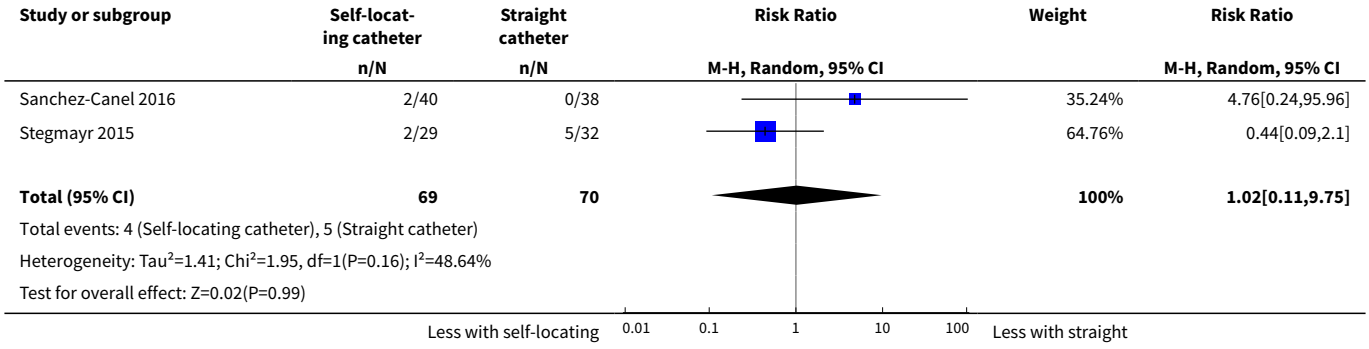
Analysis 7.4. Comparison 7 Self-locating catheter versus straight tenckhoff catheter, Outcome 4 Technique failure.

Study or subgroup	Self-locating catheter n/N	Straight catheter n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Stegmayr 2015	6/29	14/32		36.41%	0.47[0.21,1.07]

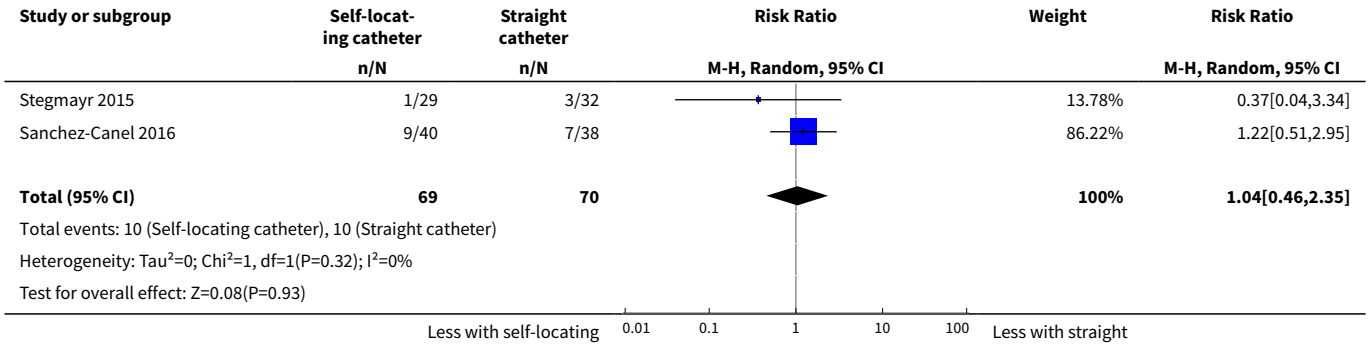




Analysis 7.5. Comparison 7 Self-locating catheter versus straight tenckhoff catheter, Outcome 5 Death (all causes).



Analysis 7.6. Comparison 7 Self-locating catheter versus straight tenckhoff catheter, Outcome 6 Dialysate leak.



Comparison 8. Open insertion with omentum folding versus open surgery

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Peritonitis rate (patient-months)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Exit-site/tunnel infection rate (patient-month)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5 Catheter removal or replacement	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
6 Technique failure	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
7 Death (all causes)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
8 Dialysate leak	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
9 Postoperative bleed (haematoma or haemoperitoneum)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 8.1. Comparison 8 Open insertion with omentum folding versus open surgery, Outcome 1 Peritonitis.

Study or subgroup	Omentum folding n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Chen 2014a	3/34	2/32		1.41[0.25,7.91]

Less with omentum folding 0.1 0.2 0.5 1 2 5 10 Less with open surgery

Analysis 8.2. Comparison 8 Open insertion with omentum folding versus open surgery, Outcome 2 Peritonitis rate (patient-months).

Study or subgroup	Omentum folding n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Chen 2014a	3/597	2/557		1.4[0.23,8.34]

Lower with omentum folding 0.1 0.2 0.5 1 2 5 10 Lower with open surgery

Analysis 8.3. Comparison 8 Open insertion with omentum folding versus open surgery, Outcome 3 Exit-site/tunnel infection.

Study or subgroup	Omentum folding n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Chen 2014a	5/34	6/33		0.81[0.27,2.4]

Less with omentum folding 0.2 0.5 1 2 5 Less with open surgery

Analysis 8.4. Comparison 8 Open insertion with omentum folding versus open surgery, Outcome 4 Exit-site/tunnel infection rate (patient-month).

Study or subgroup	Omentum folding n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Chen 2014a	5/597	6/557		0.78[0.24,2.53]

Lower with omentum folding — 0.2 — 0.5 — 1 — 2 — 5 — Lower with open surgery

Analysis 8.5. Comparison 8 Open insertion with omentum folding versus open surgery, Outcome 5 Catheter removal or replacement.

Study or subgroup	Omentum folding n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Chen 2014a	3/34	6/33		0.49[0.13,1.78]

Less with omentum folding — 0.1 — 0.2 — 0.5 — 1 — 2 — 5 — 10 — Less with open surgery

Analysis 8.6. Comparison 8 Open insertion with omentum folding versus open surgery, Outcome 6 Technique failure.

Study or subgroup	Omentum folding n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Chen 2014a	2/34	1/33		1.94[0.18,20.4]

Less with omentum folding — 0.02 — 0.1 — 1 — 10 — 50 — Less with open surgery

Analysis 8.7. Comparison 8 Open insertion with omentum folding versus open surgery, Outcome 7 Death (all causes).

Study or subgroup	Omentum folding n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Chen 2014a	3/34	4/33		0.73[0.18,3.01]

Less with omentum folding — 0.1 — 0.2 — 0.5 — 1 — 2 — 5 — 10 — Less with open surgery

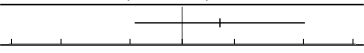
Analysis 8.8. Comparison 8 Open insertion with omentum folding versus open surgery, Outcome 8 Dialysate leak.

Study or subgroup	Omentum folding n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Chen 2014a	2/34	1/32		1.88[0.18,19.77]

Less with omentum folding — 0.02 — 0.1 — 1 — 10 — 50 — Less with open surgery

Analysis 8.9. Comparison 8 Open insertion with omentum folding versus open surgery, Outcome 9 Postoperative bleed (haematoma or haemoperitoneum).

Study or subgroup	Omentum folding n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Chen 2014a	7/34	4/32		1.65[0.53,5.1]



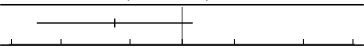
Less with omentum folding — Less with open surgery

Comparison 9. Modified surgery with or without catheter fixation versus open surgery

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Catheter removal or replacement	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Dialysate leak	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5 Postoperative bleed (haematoma or haemoperitoneum)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 9.1. Comparison 9 Modified surgery with or without catheter fixation versus open surgery, Outcome 1 Peritonitis.

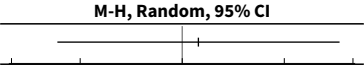
Study or subgroup	Modified surgery n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Zhang 2016	6/103	7/49		0.41[0.14,1.15]



Less with modified surgery — Less with open surgery

Analysis 9.2. Comparison 9 Modified surgery with or without catheter fixation versus open surgery, Outcome 2 Exit-site/tunnel infection.

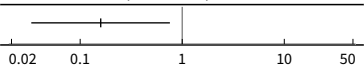
Study or subgroup	Modified surgery n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Zhang 2016	1/103	0/49		1.44[0.06,34.78]



Less with modified surgery — Less with open surgery

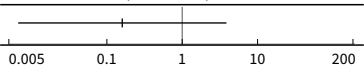
Analysis 9.3. Comparison 9 Modified surgery with or without catheter fixation versus open surgery, Outcome 3 Catheter removal or replacement.

Study or subgroup	Modified surgery n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Zhang 2016	2/103	6/49		0.16[0.03,0.76]



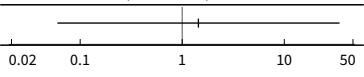
Analysis 9.4. Comparison 9 Modified surgery with or without catheter fixation versus open surgery, Outcome 4 Dialysate leak.

Study or subgroup	Modified surgery n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Zhang 2016	0/103	1/49		0.16[0.01,3.86]



Analysis 9.5. Comparison 9 Modified surgery with or without catheter fixation versus open surgery, Outcome 5 Postoperative bleed (haematoma or haemoperitoneum).

Study or subgroup	Modified surgery n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Zhang 2016	1/103	0/49		1.44[0.06,34.78]

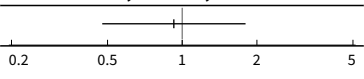


Comparison 10. Vertical tunnel-based low-site insertion versus open surgery

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

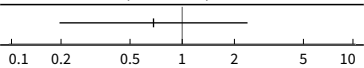
Analysis 10.1. Comparison 10 Vertical tunnel-based low-site insertion versus open surgery, Outcome 1 Peritonitis.

Study or subgroup	Low-site insertion n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Sun 2015a	13/48	12/41		0.93[0.48,1.8]



Analysis 10.2. Comparison 10 Vertical tunnel-based low-site insertion versus open surgery, Outcome 2 Exit-site/tunnel infection.

Study or subgroup	Low-site insertion n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Sun 2015a	4/48	5/41		0.68[0.2,2.38]

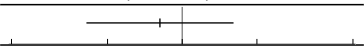


Comparison 11. Ureteroscope-assisted technique versus modified open surgery

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Death (all causes)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

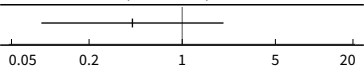
Analysis 11.1. Comparison 11 Ureteroscope-assisted technique versus modified open surgery, Outcome 1 Peritonitis.

Study or subgroup	Ureteroscope-assisted n/N	Modified open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Zhu 2015	10/35	13/37		0.81[0.41,1.61]



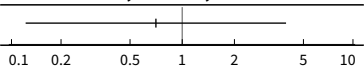
Analysis 11.2. Comparison 11 Ureteroscope-assisted technique versus modified open surgery, Outcome 2 Exit-site/tunnel infection.

Study or subgroup	Ureteroscope-assisted n/N	Modified open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Zhu 2015	2/35	5/37		0.42[0.09,2.04]



Analysis 11.3. Comparison 11 Ureteroscope-assisted technique versus modified open surgery, Outcome 3 Death (all causes).

Study or subgroup	Ureteroscope-assisted n/N	Modified open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Zhu 2015	2/35	3/37		0.7[0.13,3.97]



Comparison 12. Radiological versus surgical implantation

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis rate (patient-month)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection (patient-months)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Catheter removal or replacement	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Death (all causes)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5 Dialysate leak	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 12.1. Comparison 12 Radiological versus surgical implantation, Outcome 1 Peritonitis rate (patient-month).

Study or subgroup	Radiological n/N	Surgical n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Voss 2012	16/100	24/100		0.67[0.38,1.18]
		Lower with radiological	0.2 0.5 1 2 5	Lower with surgical

Analysis 12.2. Comparison 12 Radiological versus surgical implantation, Outcome 2 Exit-site/tunnel infection (patient-months).

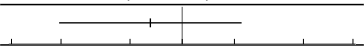
Study or subgroup	Radiological n/N	sSurgical n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Voss 2012	14/100	17/100		0.82[0.43,1.58]
		Lower with radiological	0.2 0.5 1 2 5	Lower with surgical

Analysis 12.3. Comparison 12 Radiological versus surgical implantation, Outcome 3 Catheter removal or replacement.

Study or subgroup	Radiological n/N	Surgical n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Voss 2012	9/57	14/56		0.63[0.3,1.34]
		Less with radiological	0.2 0.5 1 2 5	Less with surgical

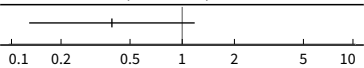
Analysis 12.4. Comparison 12 Radiological versus surgical implantation, Outcome 4 Death (all causes).

Study or subgroup	Radiological n/N	Surgical n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Voss 2012	4/57	6/56		0.65[0.2,2.2]



Analysis 12.5. Comparison 12 Radiological versus surgical implantation, Outcome 5 Dialysate leak.

Study or subgroup	Radiological n/N	Surgical n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Voss 2012	4/57	10/56		0.39[0.13,1.18]

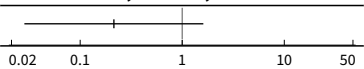


Comparison 13. Cystoscopy-assisted surgery versus open surgery

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Dialysate leak	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

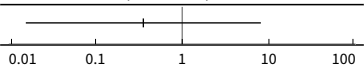
Analysis 13.1. Comparison 13 Cystoscopy-assisted surgery versus open surgery, Outcome 1 Peritonitis.

Study or subgroup	Cystoscopy-assisted n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Qian 2014	1/14	5/15		0.21[0.03,1.61]



Analysis 13.2. Comparison 13 Cystoscopy-assisted surgery versus open surgery, Outcome 2 Exit-site/tunnel infection.

Study or subgroup	Cystoscopy-assisted n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Qian 2014	0/14	1/15		0.36[0.02,8.07]



Analysis 13.3. Comparison 13 Cystoscopy-assisted surgery versus open surgery, Outcome 3 Dialysate leak.

Study or subgroup	Cystoscopy-assisted n/N	Open surgery n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Qian 2014	0/14	1/15		0.36[0.02,8.07]

Less with cystoscopy 0.01 0.1 1 10 100 Less with open surgery

Comparison 14. Laparoscopic Moncrief-Popovich versus Trocar technique

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Dialysate leak	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 14.1. Comparison 14 Laparoscopic Moncrief-Popovich versus Trocar technique, Outcome 1 Peritonitis.

Study or subgroup	Laparoscopic MP technique n/N	Trocar technique n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Akcicek 1995	3/10	6/12		0.6[0.2,1.81]

Less with laparoscopic MP 0.1 0.2 0.5 1 2 5 10 Less with Trocar

Analysis 14.2. Comparison 14 Laparoscopic Moncrief-Popovich versus Trocar technique, Outcome 2 Exit-site infection.

Study or subgroup	Laparoscopic MP technique n/N	Trocar technique n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Akcicek 1995	4/10	8/12		0.6[0.25,1.42]

Less with laparoscopic MP 0.2 0.5 1 2 5 Less with Trocar

Analysis 14.3. Comparison 14 Laparoscopic Moncrief-Popovich versus Trocar technique, Outcome 3 Dialysate leak.

Study or subgroup	Laparoscopic MP technique n/N	Trocar technique n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Akcicek 1995	2/10	4/12		0.6[0.14,2.62]

Less with laparoscopic MP 0.1 0.2 0.5 1 2 5 10 Less with Trocar

Comparison 15. Single versus double cuff

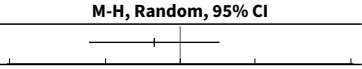
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Catheter removal or replacement	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Technique failure	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5 Death (all causes)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 15.1. Comparison 15 Single versus double cuff, Outcome 1 Peritonitis.

Study or subgroup	Single cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Eklund 1997	14/30	17/30		0.82[0.5,1.35]

Analysis 15.2. Comparison 15 Single versus double cuff, Outcome 2 Exit-site/tunnel infection.

Study or subgroup	Single cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Eklund 1997	11/30	14/30		0.79[0.43,1.44]

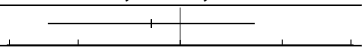


Analysis 15.3. Comparison 15 Single versus double cuff, Outcome 3 Catheter removal or replacement.

Study or subgroup	Single cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Eklund 1997	6/30	3/30		2[0.55,7.27]

Analysis 15.4. Comparison 15 Single versus double cuff, Outcome 4 Technique failure.

Study or subgroup	Single cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Buijsen 1994	1/24	2/25		0.52[0.05,5.38]



Analysis 15.5. Comparison 15 Single versus double cuff, Outcome 5 Death (all causes).

Study or subgroup	Single cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Eklund 1997	2/30	5/30		0.4[0.08,1.9]

Less with single cuff 0.05 0.2 1 5 20 Less with double cuff

Comparison 16. Triple cuff versus double catheter

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Peritonitis rate (patient-months)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Exit-site/tunnel infection (patient-months)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5 Catheter removal or replacement	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
6 Dialysate leak	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 16.1. Comparison 16 Triple cuff versus double catheter, Outcome 1 Peritonitis.

Study or subgroup	Triple cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Al-Hwiesh 2016	2/36	6/37		0.34[0.07,1.59]

Less with triple cuff 0.05 0.2 1 5 20 Less with double cuff

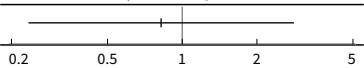
Analysis 16.2. Comparison 16 Triple cuff versus double catheter, Outcome 2 Peritonitis rate (patient-months).

Study or subgroup	Triple cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Al-Hwiesh 2016	2/475	6/488		0.34[0.07,1.69]

Lower with triple cuff 0.05 0.2 1 5 20 Lower with double cuff

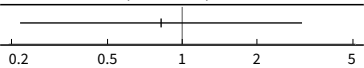
Analysis 16.3. Comparison 16 Triple cuff versus double catheter, Outcome 3 Exit-site/tunnel infection.

Study or subgroup	Triple cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Al-Hwiesh 2016	4/36	5/37		0.82[0.24,2.82]



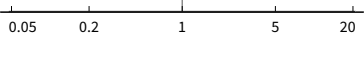
Analysis 16.4. Comparison 16 Triple cuff versus double catheter, Outcome 4 Exit-site/tunnel infection (patient-months).

Study or subgroup	Triple cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Al-Hwiesh 2016	4/475	5/488		0.82[0.22,3.04]



Analysis 16.5. Comparison 16 Triple cuff versus double catheter, Outcome 5 Catheter removal or replacement.

Study or subgroup	Triple cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Al-Hwiesh 2016	3/36	10/37		0.31[0.09,1.03]



Analysis 16.6. Comparison 16 Triple cuff versus double catheter, Outcome 6 Dialysate leak.

Study or subgroup	Triple cuff n/N	Double cuff n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Al-Hwiesh 2016	2/36	3/37		0.69[0.12,3.86]

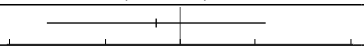
Comparison 17. Swan-neck versus straight curled catheter

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Peritonitis rate (patient-months)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Exit-site/tunnel infection rate (patient-months)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5 Technique failure	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6 Dialysate leak	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

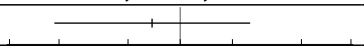
Analysis 17.1. Comparison 17 Swan-neck versus straight curled catheter, Outcome 1 Peritonitis.

Study or subgroup	Swan-neck n/N	Straight curled n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Winch 2000	4/11	5/11		0.8[0.29,2.21]



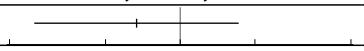
Analysis 17.2. Comparison 17 Swan-neck versus straight curled catheter, Outcome 2 Peritonitis rate (patient-months).

Study or subgroup	Swan-neck n/N	Straight curled n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Winch 2000	4/215	5/185		0.69[0.19,2.53]



Analysis 17.3. Comparison 17 Swan-neck versus straight curled catheter, Outcome 3 Exit-site/tunnel infection.

Study or subgroup	Swan-neck n/N	Straight curled n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Winch 2000	4/11	6/11		0.67[0.26,1.72]

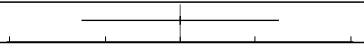


Analysis 17.4. Comparison 17 Swan-neck versus straight curled catheter, Outcome 4 Exit-site/tunnel infection rate (patient-months).

Study or subgroup	Swan-neck n/N	Straight curled n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Winch 2000	6/215	11/185		0.47[0.18,1.24]

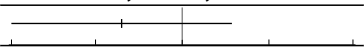
Analysis 17.5. Comparison 17 Swan-neck versus straight curled catheter, Outcome 5 Technique failure.

Study or subgroup	Swan-neck n/N	Straight curled n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Winch 2000	5/11	5/11		1[0.4,2.5]



Analysis 17.6. Comparison 17 Swan-neck versus straight curled catheter, Outcome 6 Dialysate leak.

Study or subgroup	Swan-neck n/N	Straight curled n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Winch 2000	0/11	2/11		0.2[0.01,3.74]

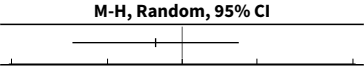


Comparison 18. Antibiotic-treated catheter versus none

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Catheter removal or replacement	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Death (all causes)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

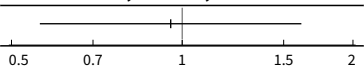
Analysis 18.1. Comparison 18 Antibiotic-treated catheter versus none, Outcome 1 Peritonitis.

Study or subgroup	Antibiotic-treated n/N	Standard n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Trooskin 1990	9/44	11/42		0.78[0.36,1.69]



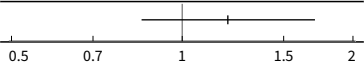
Analysis 18.2. Comparison 18 Antibiotic-treated catheter versus none, Outcome 2 Exit-site/tunnel infection.

Study or subgroup	Antibiotic-treated n/N	Standard n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Trooskin 1990	17/44	17/42		0.95[0.57,1.61]



Analysis 18.3. Comparison 18 Antibiotic-treated catheter versus none, Outcome 3 Catheter removal or replacement.

Study or subgroup	Antibiotic-treated n/N	Standard n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Trooskin 1990	29/44	23/42		1.2[0.85,1.7]



Analysis 18.4. Comparison 18 Antibiotic-treated catheter versus none, Outcome 4 Death (all causes).

Study or subgroup	Antibiotic-treated n/N	Standard n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Trooskin 1990	0/44	0/42		Not estimable
		Less with antibiotic	0.01 0.1 1 10 100	Less with standard

Comparison 19. Immobilisation versus no immobilisation

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 19.1. Comparison 19 Immobilisation versus no immobilisation, Outcome 1 Peritonitis.

Study or subgroup	Immobilisation n/N	No immobilisation n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Turner 1992	18/45	7/21		1.2[0.59,2.42]
		Less with immobilization	0.2 0.5 1 2 5	Less with no immobilization

Analysis 19.2. Comparison 19 Immobilisation versus no immobilisation, Outcome 2 Exit-site/tunnel infection.

Study or subgroup	Immobilisation n/N	No immobilisation n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
Turner 1992	14/45	10/21		0.65[0.35,1.22]
		Less with immobilization	0.2 0.5 1 2 5	Less with no immobilization

Comparison 20. Silver ring versus no silver ring

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peritonitis	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Exit-site/tunnel infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Technique failure	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Death (all causes)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 20.1. Comparison 20 Silver ring versus no silver ring, Outcome 1 Peritonitis.

Study or subgroup	Silver ring n/N	No silver ring n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
SIPROCE 1997	16/97	18/98		0.9[0.49,1.66]

Less with silver ring 0.2 0.5 1 2 5 Less with no silver ring

Analysis 20.2. Comparison 20 Silver ring versus no silver ring, Outcome 2 Exit-site/tunnel infection.

Study or subgroup	Silver ring n/N	No silver ring n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
SIPROCE 1997	23/97	16/98		1.45[0.82,2.58]

Less with silver ring 0.2 0.5 1 2 5 Less with no silver ring

Analysis 20.3. Comparison 20 Silver ring versus no silver ring, Outcome 3 Technique failure.

Study or subgroup	Silver ring n/N	No silver ring n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
SIPROCE 1997	14/97	15/98		0.94[0.48,1.85]

Less with silver ring 0.2 0.5 1 2 5 Less with no silver ring

Analysis 20.4. Comparison 20 Silver ring versus no silver ring, Outcome 4 Death (all causes).

Study or subgroup	Silver ring n/N	No silver ring n/N	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI
SIPROCE 1997	8/97	5/98		1.62[0.55,4.77]

Less with silver ring 0.2 0.5 1 2 5 Less with no silver ring

ADDITIONAL TABLES

Table 1. Adverse events

Study ID	Intervention group		Control group	
	Events	Total	Events	Total
Haematoma or haemoperitoneum				
Atapour 2011	1	31	4	30
Chen 2014a	7	34	4	32
Sanchez-Canel 2016	7	40	6	38
Al-Hwiesh 2016	0	36	0	37

Table 1. Adverse events *(Continued)*

Merrikhi 2014	0	18	2	17
Ouyang 2015	3	99	2	90
Eklund 1994	0	20	0	20
Eklund 1995	0	20	0	20
Li 2009e	14	20	22	19
Rubin 1990	1	48	1	35
Scott 1994	0	30	1	59
Zhang 2016	1	103	0	49
Dialysate leak				
Chen 2014a	2	34	1	32
Sanchez-Canel 2016	9	40	7	38
Jwo 2010	7	40	6	37
Atapour 2011	1	31	1	30
Al-Hwiesh 2016	2	36	3	37
Akcicek 1995	2	10	4	12
Akyol 1990	0	20	2	20
Eklund 1994	0	20	4	20
Eklund 1995	0	20	0	20
Nielsen 1995	1	38	0	34
Ouyang 2015	0	99	3	90
Qian 2014	0	14	1	15
Rubin 1990	6	48	3	35
Scott 1994	2	30	0	59
Stegmayr 2015	1	29	3	32
Voss 2012	4	57	10	56
Winch 2000	2	11	0	11
Wright 1999	2	21	0	24
Xie 2011a	1	40	0	40

Table 1. Adverse events *(Continued)*

Yip 2010	0	50	0	51
Zhang 2016	0	103	1	49
Viscus perforation				
Nielsen 1995 (bladder perforation)	0	38	1	34
Al-Hwiesh 2016 (bowel perforation)	0	36	0	37
Merrikhi 2014 (hollow viscus perforation)	0	18	0	17
Atapour 2011	0	31	0	30
Outflow failure or catheter tip migration				
Atapour 2011	1	31	4	30
Li 2009e	2	20	1	19
Sanchez-Canel 2016	12	40	25	38
Voss 2012	3	57	4	56
Al-Hwiesh 2016	1	36	11	37
Scott 1994	1	30	2	59
Lye 1996	3	20	1	20
Qian 2014	0	14	1	15
Akcicek 1995	1	10	3	12
Winch 2000	1	11	1	11
Hernia				
Chen 2014a	0	34	1	32
Jwo 2010	2	40	1	37
Sanchez-Canel 2016	7	40	7	38
Ouyang 2015	4	99	6	90
Xie 2011a	2	40	2	40
Voss 2012	4	57	8	56
Zhang 2016	0	103	1	49

Table 2. Methods of insertion, catheter types and other interventions on the incidence of peritonitis and peritonitis rate

Name of studies	Relative risk	95% CI	P value
Peritonitis			
Methods of catheter implantation			
Chen 2014a	1.41	0.25 to 7.91	0.69
Turner 1992	1.20	0.59 to 2.42	0.61
Sun 2015a	0.93	0.48 to 1.80	0.82
Zhang 2016	0.39	0.11 to 1.42	0.15
Zhu 2015	0.81	0.41 to 1.61	0.55
Qian 2014	0.21	0.03 to 1.61	0.13
Akcicek 1995	0.60	0.20 to 1.81	0.36
Types of catheter			
Eklund 1997	0.82	0.50 to 1.35	0.44
Al-Hwiesh 2016	0.34	0.07 to 1.59	0.17
Winch 2000	0.80	0.29 to 2.21	0.67
Trooskin 1990	0.78	0.6 to 1.69	0.53
Other intervention			
SIPROCE 1997	0.90	0.49 to 1.66	0.73
Turner 1992	1.20	0.59 to 2.42	0.61
Peritonitis rate (patient-month)			
Methods of catheter implantation			
Chen 2014a	1.40	0.23 to 8.34	0.71
Voss 2012	0.67	0.38 to 1.18	0.16
Types of catheters			
Al-Hwiesh 2016	0.34	0.07 to 1.69	0.19
Winch 2000	0.69	0.19 to 2.53	0.57

CI: confidence interval

APPENDICES

Appendix 1. Electronic search strategies

Database searched	Search terms
CENTRAL	1. MeSH descriptor: [Peritoneal Dialysis] explode all trees 2. peritoneal dialysis*:ti,ab,kw (Word variations have been searched) 3. PD or CAPD or CCPD:ti,ab,kw (Word variations have been searched) 4. {or #1-#3} 5. MeSH descriptor: [Catheters, Indwelling] this term only 6. MeSH descriptor: [Catheters] this term only 7. MeSH descriptor: [Vascular Access Devices] this term only 8. MeSH descriptor: [Central Venous Catheters] this term only 9. MeSH descriptor: [Catheters] this term only 10.MeSH descriptor: [Catheterization] this term only 11.MeSH descriptor: [Catheterization, Central Venous] this term only 12.catheter*:ti,ab,kw (Word variations have been searched) 13.{or #5-#12} 14.MeSH descriptor: [Peritonitis] this term only 15.peritonitis:ti,ab,kw (Word variations have been searched) 16.{or #14-#15} 17.{and #4, #13, #16}
MEDLINE (OVID)	1. exp Peritoneal Dialysis/ 2. peritoneal dialysis.tw. 3. (PD or CAPD or CCPD).tw. 4. or/1-3 5. Catheters, Indwelling/ 6. Catheters/ 7. Vascular access devices/ 8. Central venous catheters/ 9. Cannula/ 10.Catheterization, central venous/ 11.Catheterization/ 12.catheter$.tw. 13.or/5-12 14.Peritonitis/ 15.peritonitis.tw 16.or/14-15 17.and/4,13, 16
EMBASE (OVID)	1. Peritoneal Dialysis/ 2. Continuous Ambulatory Peritoneal Dialysis/ 3. peritoneal dialysis.tw. 4. (PD or CAPD or CCPD or APD).tw. 5. or/1-4 6. peritoneal dialysis catheter/ 7. catheter/ 8. peritoneal catheter/ 9. catheterization/ 10.central venous catheter/

(Continued)

11.indwelling catheter/
12.catheter$.tw.
13.or/6-12
14.Peritonitis/
15.peritonitis.tw
16.or/14-15
17.and/4,13, 16

Appendix 2. Risk of bias assessment tool

Potential source of bias	Assessment criteria
Random sequence generation Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence	*Low risk of bias:* Random number table; computer random number generator; coin tossing; shuffling cards or envelopes; throwing dice; drawing of lots; minimisation (minimisation may be implemented without a random element, and this is considered to be equivalent to being random).
	High risk of bias: Sequence generated by odd or even date of birth; date (or day) of admission; sequence generated by hospital or clinic record number; allocation by judgement of the clinician; by preference of the participant; based on the results of a laboratory test or a series of tests; by availability of the intervention.
	Unclear: Insufficient information about the sequence generation process to permit judgement.
Allocation concealment Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment	*Low risk of bias:* Randomisation method described that would not allow investigator/participant to know or influence intervention group before eligible participant entered in the study (e.g. central allocation, including telephone, web-based, and pharmacy-controlled, randomisation; sequentially numbered drug containers of identical appearance; sequentially numbered, opaque, sealed envelopes).
	High risk of bias: Using an open random allocation schedule (e.g. a list of random numbers); assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or non-opaque or not sequentially numbered); alternation or rotation; date of birth; case record number; any other explicitly unconcealed procedure.
	Unclear: Randomisation stated but no information on method used is available.
Blinding of participants and personnel Performance bias due to knowledge of the allocated interventions by participants and personnel during the study	*Low risk of bias*: No blinding or incomplete blinding, but the review authors judge that the outcome is not likely to be influenced by lack of blinding; blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken.
	High risk of bias: No blinding or incomplete blinding, and the outcome is likely to be influenced by lack of blinding; blinding of key study participants and personnel attempted, but likely that the blinding could have been broken, and the outcome is likely to be influenced by lack of blinding.
	Unclear: Insufficient information to permit judgement
Blinding of outcome assessment Detection bias due to knowledge of the allocated interventions by outcome assessors.	*Low risk of bias:* No blinding of outcome assessment, but the review authors judge that the outcome measurement is not likely to be influenced by lack of blinding; blinding of outcome assessment ensured, and unlikely that the blinding could have been broken.
	High risk of bias: No blinding of outcome assessment, and the outcome measurement is likely to be influenced by lack of blinding; blinding of outcome assessment, but likely that the blinding could have been broken, and the outcome measurement is likely to be influenced by lack of blinding.

(Continued)

	Unclear: Insufficient information to permit judgement
Incomplete outcome data Attrition bias due to amount, nature or handling of incomplete outcome data.	*Low risk of bias:* No missing outcome data; reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias); missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups; for dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate; for continuous outcome data, plausible effect size (difference in means or standardised difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size; missing data have been imputed using appropriate methods.
	High risk of bias: Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups; for dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate; for continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size; 'as-treated' analysis done with substantial departure of the intervention received from that assigned at randomisation; potentially inappropriate application of simple imputation.
	Unclear: Insufficient information to permit judgement
Selective reporting Reporting bias due to selective outcome reporting	*Low risk of bias:* The study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way; the study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon).
	High risk of bias: Not all of the study's pre-specified primary outcomes have been reported; one or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. sub-scales) that were not pre-specified; one or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect); one or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis; the study report fails to include results for a key outcome that would be expected to have been reported for such a study.
	Unclear: Insufficient information to permit judgement
Other bias Bias due to problems not covered elsewhere in the table	*Low risk of bias:* The study appears to be free of other sources of bias.
	High risk of bias: Had a potential source of bias related to the specific study design used; stopped early due to some data-dependent process (including a formal-stopping rule); had extreme baseline imbalance; has been claimed to have been fraudulent; had some other problem.
	Unclear: Insufficient information to assess whether an important risk of bias exists; insufficient rationale or evidence that an identified problem will introduce bias.

WHAT'S NEW

Date	Event	Description
17 May 2019	New search has been performed	New studies added
17 May 2019	New citation required but conclusions have not changed	25 new studies added, no major change to conclusions

HISTORY

Protocol first published: Issue 1, 2004
Review first published: Issue 4, 2004

Date	Event	Description
14 January 2010	Amended	Contact details updated.
13 May 2009	Amended	Contact details updated.
22 September 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

- Screening of titles and abstracts: HH, YJ
- Study eligibility: HH, YJ
- Data collection for the review was carried out independently by HH and YJ
- Quality assessment, data analysis: HH, YJ, GFMS
- Writing of review: HH, YC, DJ, GFMS, JC
- Providing general advice on the review; DJ, GFMS, JC, FPS, AT
- Disagreements were resolved in consultation with DJ, GFMS and JC

DECLARATIONS OF INTEREST

Professor David Johnson is a current recipient of a National Health and Medical Research Council Practitioner Fellowship. Professor David Johnson has received consultancy fees, research grants, speaker's honoraria and travel sponsorships for Baxter Healthcare and Fresenius Medical Care. He has also received a consulting fee from AstraZeneca and travel grants from Amgen

Yeoungjee Cho is a current recipient of a National Health and Medical Research Council Early Career Fellowship and has in the past received research grants from Fresenius Medical Care.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Peritonitis relapse and time to the first episode of peritonitis and peritonitis-related death were unable to examine in the review as all the included studies did not specifically report these outcomes.

INDEX TERMS

Medical Subject Headings (MeSH)

*Peritoneal Dialysis [instrumentation]; Catheter-Related Infections [*prevention & control]; Catheterization [*methods]; Catheters, Indwelling; Peritonitis [*prevention & control]; Randomized Controlled Trials as Topic

MeSH check words

Humans