Risk of catheter-related bloodstream infection associated with midline catheters compared with peripherally inserted central catheters: A meta-analysis

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Abstract

Background: Both midline catheters (MCs) and peripherally inserted central catheters (PICCs) can cause catheter-related bloodstream infection (CRBSI), but the prevalence associated with each is not clear.

Objective: To compare the risk of CRBSI between MCs and PICCs with a meta-analysis.

Methods: The Web of Science Core Collection, PubMed, Scopus, Embase, The Cochrane Library and ProQuest were searched. All studies comparing the risk of CRBSI between MCs and PICCs were included. Selected studies were assessed for methodological quality using the Downs and Black checklist. Two authors independently assessed the literature and extracted the data. A fixed effects model was used to generate estimates of CRBSI risk in patients with MCs versus PICCs. Publication bias was evaluated, and meta-analyses were conducted with RevMan 5.3.

Results: A total of 167 studies were identified. Ten studies were collected, involving 33,322 patients. The prevalence of CRBSI with MCs and PICCs was 0.58% (40/6,900) and 0.48% (127/26,422), respectively. Meta-analysis showed that the prevalence of CRBSI was not significantly different between MCs and PICCs (RR = 0.77, 95% CI: 0.50–1.17, p = .22). While the result showed that the prevalence of CRBSI with MCs was lower than that with PICCs (RR = 0.55, 95% CI: 0.33–0.92, p = .02) after poor-quality studies were removed. The sensitivity analysis shows that the results from this meta-analysis are fair in overall studies and non-poor-quality studies. All studies have no significant publication bias.

Conclusions: This study provides the first systematic assessment of the risk of CRBSI between MCs and PICCs and provides evidence for the selection of appropriate vascular access devices for intravenous infusion therapy in nursing. The prevalence of CRBSI was not significantly different between them.

KEYWORDS
- catheter-related bloodstream infection
- complication
- intravenous infusion therapy
- meta-analysis
- midline catheter
- peripherally inserted central catheter
1 | INTRODUCTION

Intravenous infusion therapy is the most widely used therapy in the field of nursing. Catheter-related bloodstream infection (CRBSI) is a serious complication from a catheter. CRBSI, also called catheter-related sepsis, is defined as the presence of bacteraemia originating from an intravenous catheter (Gahlot et al., 2014). It is one of the most frequent, lethal and costly complications of central venous catheterization. It is also the most common cause of nosocomial bacteraemia (Fletcher, 2005; Reigadas et al., 2013). CRBSI may cause a series of potential morbidity, prolonged hospitalizations and increased expense. The attributable cost for CRBSI was $32,000–$69,332 (Goudie et al., 2014; Kaye et al., 2014; Stevens et al., 2014; Wilson et al., 2014; Zimlichman et al., 2013).

A midline catheter (MC) is approximately a 3–8-inches long, thin, soft tube that is inserted through a needle placed into a vein in your arm, and the tip of this catheter is at or below the axillary vein. The prevalence of CRBSI with MCs has been reported in many studies to be 0%–0.9% (Chopra et al., 2019; Cummings et al., 2011; Maki et al., 2006; Mushtaq et al., 2018; Rotta et al., 2015). A peripherally inserted central catheter (PICC) is a form of intravenous access that is inserted in a peripheral vein such as an upper arm vein and the tip reaches the superior vena or right atrium and thus becomes a central catheter. PICCs are used to obtain central venous access. The prevalence of CRBSI 0.13%–7.3% with PICCs (Bhargava et al., 2018; Bouzad et al., 2016; Kagan et al., 2019; Liu et al., 2019; Poletti et al., 2018; Puspos, 2016).

Many studies have shown that the prevalence of CRBSI in MCs and PICCs is controversial. To provide evidence for the selection of appropriate vascular access devices (VAD) for intravenous infusion therapy in the field of nursing, this study provides the first systematic assessment of the risk of CRBSI between them.

2 | METHODS

2.1 | Literature search

We followed the preferred reporting item for systematic reviews and meta-analyses (PRISMA) guidelines in conducting this meta-analysis (Moher et al., 2009). We performed a serial literature search for English and non-English papers during December 2019. The Web of Science Core Collection (Science Citation Index Expanded: 1900–present; Social Sciences Citation Index: 1900–present; Arts & Humanities Citation Index: 1975–present, Conference Proceedings Citation Index- Science: 1996–present; Conference Proceedings Citation Index- Social Science & Humanities: 1996–present; Emerging Sources Citation Index: 2015–present), PubMed (inception–present), Scopus (inception–present), Embase (inception–present), The Cochrane Library (inception–present) and ProQuest (inception–present) were searched. We used Boolean logic with search terms including “midline catheter”, “midline venous catheter”, “midline peripheral catheter”, “medium-term intravenous access”, “peripherally inserted central catheter”, “percutaneous indwelling central catheter” “peripherally inserted central venous catheter”, “PICC line”, “PICC”, “bacteremia”, “bacteriemia”, “septicemia”, “sepsis”, “bloodstream infection”. To search for all terms that begin with a word, enter the word followed by an asterisk. Text box 1 provides a detailed search strategy in PubMed.

2.2 | Study eligibility and selection criteria

Two authors independently determined study eligibility. Any differences in opinion about eligibility were resolved through another author as third-party consensus. Studies were included if they compared the complication of CRBSI between PICCs and MCs. Studies were excluded if they (a) were case reports, reviews, commentaries, or studies that did not report the prevalence of CRBSI; (b) were non-human studies; (c) were secondary research; (d) included several participants <10; (e) were a duplicate report; and (f) reported incomplete data and the relevant data were not available.

2.3 | Definition of variables and outcome

PICCs was defined as catheters inserted in the basilic, cephalic or brachial veins of the upper extremities with tips that terminated in the superior vena or right atrium. MCs were defined as a typical 8–20-cm long catheter and placed peripherally into the antecubital fossa or upper arm, with the tip located at or below the axillary vein. The primary outcome was the occurrence of CRBSI after MCs or PICCs placement. CRBSI was defined as the presence of bacteremia attributed to MCs or PICCs catheter, positive blood culture with no other explanation.
2.4 | Data abstraction and validity assessment

Data were collected independently from all included studies on a template adopted from the Cochrane collaboration (Li et al., 2019). For all studies, we extracted author, publication year, study design, study location, study period, population, study indicator, number of PICCs and MC, and number of CRBSIs.

2.5 | Assessment of risk bias

The risk bias of the included studies was independently assessed by two authors. Because retrospective cohort studies, randomized controlled trials met the inclusion criteria, the risk of bias was assessed according to the checklist for measuring study quality developed by Downs and Black (1998). This tool included five sections that included reporting (10 questions, total score of 11), external validity (3 questions, total score of 3), internal validity or bias (7 questions, total score of 7), internal validity or confounding (6 questions, total score of 6) and power (1 question, total score of 5). Quality assessment of the studies was determined by the following cut-off points: excellent (≥26), good (20–25), fair (15–19) and poor (≤14) (Ray-Barruel et al., 2019). An overall quality score was assigned to individual studies.

2.6 | Statistical analysis

The meta-analyses were conducted using Review Manager software, version 5.3 (https://community.cochrane.org/help/tools-and-softw are/revman-5). Dichotomous outcomes eligible in each study are demonstrated as a risk ratio (RR) with an estimated 95% confidence interval (CI). Continuous outcomes are shown as the weighted mean difference (WMD) with the 95% CI, which were calculated from the SD. Heterogeneity was assessed using Higgins I², which evaluates the percentage of total variation across studies that were due to heterogeneity rather than by chance: 0% ≤ I² < 25%, 25% ≤ I² < 50%, 50% ≤ I² < 75% and 75% ≤ I² indicated no heterogeneity, low heterogeneity, moderate heterogeneity and severe heterogeneity, respectively. Thus, if I² > 50%, which was considered to reflect substantial heterogeneity, a random effects model was used. If I² ≤ 50%, which was considered to reflect no heterogeneity, a fixed effects model was employed. The chi-square tests were also used to evaluate the heterogeneity: p < .1 means heterogeneity, while p > .1 indicates no heterogeneity. A p < .05 was considered statistically significant. The publication biases were judged by funnel plots.

2.7 | IRB approval

This meta-analysis study was approved by the institutional review board of the Department of Hepatobiliary and Pancreas Surgery, The First Affiliated Hospital, Xi’an Jiaotong University.

3 | RESULTS

3.1 | Eligible studies

A total of 167 studies were identified and 25 duplicated studies were excluded. 103 studies, including no CRBSI endpoint (N = 46), reviews (N = 31), case series (N = 6), duplicate reports (N = 5) and other forms of publication (N = 15), were excluded after screening the title and abstract. After full-text articles for eligibility were assessed, an additional 29 studies were excluded due to the following criteria: no CRBSI endpoint (N = 13), reviews (N = 8), infection data only (N = 4) and commentaries (N = 4). Finally, a total of 10 studies were selected for data extraction. The flow diagram of the study selection is summarized in Figure 1.

3.2 | Study characteristic

A total of 10 studies were selected for inclusion in this meta-analysis (Barr et al., 2012; Benali et al., 2013; Caparas & Hu, 2014; Lisova et al., 2015; Moureau et al., 2002; Sargent & Nixon, 1997; Seo et al., 2020; Sharp et al., 2014; Snooks et al., 2019; Xu et al., 2016), with four studies from the United States (Caparas & Hu, 2014; Moureau et al., 2002; Seo et al., 2020; Xu et al., 2016), accounting for 40%, three studies from UK (Barr et al., 2012; Sargent & Nixon, 1997; Snooks et al., 2019) and one study each from Australia (Sharp et al., 2014), Canada (Benali et al., 2013), and the Czech Republic (Lisova et al., 2015). One study was abstracts of meetings (Benali et al., 2013). Overall, 33,322 participants were included: 6,900 (20.71%) were included in the MCs group and 26,422 (79.29%) were included in the PICCs group. A summary of the included studies is presented in Table 1.

3.3 | Study quality

The study quality of 10 studies with meet selected inclusion and two studies with incomplete data reported were evaluated independently and shown in Table 1: four studies were good (Caparas & Hu, 2014; Seo et al., 2020; Sharp et al., 2014; Xu et al., 2016), two studies were fair (Barr et al., 2012; Moureau et al., 2002) and four studies were poor (Benali et al., 2013; Lisova et al., 2015; Sargent & Nixon, 1997; Snooks et al., 2019).

3.4 | Meta-analysis results

A total of 10 studies were analysed that involved 33,322 participates. The prevalence of CRBSI with MCs and PICCs was 0.58% (40/6,900) and 0.48% (127/26422), respectively. Heterogeneity among the studies was low (I² = 40%, p = .11). Thus, a fixed effects model was used. Meta-analysis showed that the prevalence of CRBSI was not significantly different between MCs and PICCs (RR = 0.77, 95% CI: 0.50–1.17, p = .22) (Figure 2).
Subgroup analyses were performed among the US, UK, and the other nations; the other nations subgroup included studies in Australia (Sharp et al., 2014), Canada (Benali et al., 2013) and the Czech Republic (Lisova et al., 2015). In the US subgroup, heterogeneity among the studies was low ($I^2 = 0\%$, $p = .83$). Meta-analysis showed that the prevalence of CRBSI with MCs was lower than that with PICCs ($RR = 0.53$, 95% CI: 0.31–0.89, $p = .02$). In the UK subgroup, heterogeneity among the studies was low ($I^2 = 0\%$, $p = .74$). Meta-analysis showed that the prevalence of CRBSI with MCs was higher than that with PICCs ($RR = 3.67$, 95% CI: 1.18–11.37, $p = .02$). In the other nations subgroup, the prevalence of CRBSI has not been analysed (Figure 2).

Subgroup analyses also were performed in adults and the others; the others subgroup included studies in children (Benali et al., 2013), adults and children (Moureau et al., 2002), and no reporting age of the participants (Caparas & Hu, 2014; Sargent & Nixon, 1997; Snooks et al., 2019). In the adult subgroup, heterogeneity among the studies was low ($I^2 = 0\%$, $p = .74$). Meta-analysis showed that the prevalence of CRBSI was not significantly different between MCs and PICCs ($RR = 0.82$, 95% CI: 0.31–2.14, $p = .69$). In the others subgroup, heterogeneity among the studies was low ($I^2 = 68\%$, $p = .02$). Meta-analysis showed that the prevalence of CRBSI was not significantly different between MCs and PICCs ($RR = 0.76$, 95% CI: 0.47–1.21, $p = .25$) (Figure 3).

If the four poor-quality studies were removed (Benali et al., 2013; Lisova et al., 2015; Sargent & Nixon, 1997; Snooks et al., 2019), heterogeneity among the studies was low ($I^2 = 0\%$, $p = .82$). Thus, a fixed effects model was used. Meta-analysis showed that the prevalence of CRBSI with MCs was lower than that with PICCs ($RR = 0.55$, 95% CI: 0.33–0.92, $p = .02$).

### 3.5 Sensitivity analyses

Sensitivity analyses were conducted. If Moureau et al. (2002) was rejected, heterogeneity ($I^2 = 0\%$, $p = .98$) and meta-analysis showed the prevalence of CRBSI was not significantly different between MCs and PICCs ($RR = 0.23$, 95% CI: 0.04–1.41, $p = .11$) among the US subgroup. Heterogeneity and meta-analysis results have no significant changed in the UK subgroup, the other nations subgroup, the adult subgroup, the others subgroup and all studies.

If Sargent and Nixon (1997) was rejected, heterogeneity ($I^2 = 0\%$, $p = .70$) and meta-analysis showed that the prevalence of CRBSI with MCs was lower than that with PICCs ($RR = 0.63$, 95% CI: 0.40–1.00, $p = .05$) in all subjects. Heterogeneity ($I^2 = 0\%$, $p = .84$) and meta-analysis showed the prevalence of CRBSI was not significantly different between MCs and PICCs ($RR = 2.07$, 95% CI: 0.27–15.90, $p = .48$) among the UK subgroup. Heterogeneity ($I^2 = 0\%$, $p = .57$) and meta-analysis showed the prevalence of CRBSI was lower than that with PICCs ($RR = 0.59$, 95% CI: 0.35–1.00, $p = .05$) among the others subgroup. Heterogeneity and meta-analysis results have no significant changed in the US subgroup, the other nations subgroup and all studies.
| Study                        | Study design | Study location          | Study period                  | Population | Study indicator                                                                 |
|-----------------------------|--------------|-------------------------|-------------------------------|------------|---------------------------------------------------------------------------------|
| Seo et al. (2020)           | RC           | New York, US            | Nov. 2017 to Jul. 2018       | ≥18 years  | Demographics, catheter-related adverse events, Venous thromboembolism (VTE), extravasation, infection, risk factors for complications, data on catheter gauge, use of ultrasound during placement, service placing the line, anticoagulation and/or antiplatelet therapy, situ time of midline, site of placement, total number of medications infused, medication type, duration of therapy, vesicant properties. |
| Snooks et al. (2019)        | RC           | Southampton, UK         | Jun. 2017 to Dec. 2018       | NR         | Complications (infection, VTE)                                                  |
| Xu et al. (2016)            | RC           | Pennsylvania, US        | Jan-May 2015                  | 19–98 years| Demographics, comorbidity score, length of stay, insertion location, line duration, complications |
| Lisova et al. (2015)        | RC           | Prague, Czech Republic  | During 2013                   | 23–90 years| Complications (infection, VTE, occlusion, displacement)                          |
| Caparas and Hu (2014)       | RCT          | New York, US            | NR                            | ≥1 dose and ≥6 days vancomycin | Demographics, administration of other antibiotics, average number of days on vancomycin, dwell time, complications |
| Sharp et al. (2014)         | RC           | Adelaide, Australia     | 2004 to 2010                  | 18–47 years| Demographics, comorbidity, inpatients/outpatients, severity of exacerbation, lung function, adverse events (CRBSI, DVT, occlusion, pain, infiltration, bleeding, phlebitis, leakage, dislodgement), and whether VAD was removed unexpectedly |
| Benali et al. (2013)        | RCT          | Montreal, Canada        | NR                            | ≤18 years and weighed ≥3 kg | Demographics, dwell time, complications (DVT, infection)                          |
| Barr et al. (2012)          | RC           | Glasgow, UK             | Jan 1, 2001 to May 31, 2011  | adults     | Demographics, Infection, phlebitis, external leakage, extravasation, occlusion, length of IV course (duration line use), type of line, experience, comorbidity |
| Moureau et al. (2002)       | RC           | US                      | Apr. 1999 to Sep. 2000       | 1–101 years| Demographics, type of VAD, principal diagnosis, complications by event and device type, underlying causes and outcomes of DVT dysfunction |
| Sargent and Nixon (1997)    | RC           | London, UK              | late 1995 to early 1996      | AIDS patients | Patient information, practitioners, catheter insertion, catheter use, catheter removal |

Abbreviations: RC, retrospective cohort study; RCT, randomized controlled trial; NR, not reported.
### FIGURE 2
Subgroup analyses by nation for CRBSI between MCs and PICCs

| Study or Subgroup | MC Events | Total | Weight | Risk Ratio | Year |
|-------------------|-----------|-------|--------|------------|------|
| **2.1.1 US**      |           |       |        |            |      |
| Seo et al 2020[21]| 0         | 82    | 1      | 50         | 3.5% | 2020 |
| Xu et al 2016[23] | 0         | 200   | 2      | 206        | 4.6% | 2016 |
| Caparas et al 2014[26]| 0   | 30    | 1      | 28         | 2.9% | 2014 |
| Moureau 2002[29]  | 14        | 5423  | 117    | 25707      | 75.8%| 2002 |
| **Subtotal (95% CI)** | 5735       | 25991 | 86.7%  | 0.53 [0.31, 0.89] |      |
| Total events      | 14        | 121   |        |            |      |
| Heterogeneity: Chi² = 0.88, df = 3 (P = 0.83); I² = 0% | Test for overall effect: Z = 2.40 (P = 0.02) |

| **2.1.2 UK**      |           |       |        |            |      |
| Snooks et al 2019[22]| 2        | 43    | 0      | 22         | 1.2% | 2019 |
| Barr et al 201[28] | 12        | 648   | 0      | 43         | 1.7% | 2012 |
| Sargent et al 1997[30]| 7        | 12    | 2      | 18         | 3.0% | 1997 |
| **Subtotal (95% CI)** | 703        | 83    | 5.9%   | 3.67 [1.18, 11.37] |      |
| Total events      | 21        | 2     |        |            |      |
| Heterogeneity: Chi² = 0.50, df = 2 (P = 0.74); I² = 0% | Test for overall effect: Z = 2.25 (P = 0.02) |

| **2.1.3 The other nations** |           |       |        |            |      |
| Lisova et al 2015[24] | 5         | 162   | 4      | 167        | 7.3% | 2015 |
| Sharp et al 2014[26] | 0         | 231   | 0      | 97         |      | 2014 |
| Benali et al 2013[27] | 0         | 69    | 0      | 84         |      | 2013 |
| **Subtotal (95% CI)** | 462        | 348   | 7.3%   | 1.29 [0.35, 4.71] |      |
| Total events      | 5          | 4     |        |            |      |
| Heterogeneity: Not applicable | Test for overall effect: Z = 0.30 (P = 0.70) |

| **Total (95% CI)** | 6900     | 26422 | 100.0% | 0.77 [0.50, 1.17] |      |
| Total events      | 40        | 127   |        |            |      |
| Heterogeneity: Chi² = 11.74, df = 7 (P = 0.11); I² = 40% | Test for overall effect: Z = 1.23 (P = 0.22) |
| Test for subgroup differences: Chi² = 9.93, df = 7 (P = 0.007); I² = 79.9% |

### FIGURE 3
Subgroup analyses by age for CRBSI between MCs and PICCs

| Study or Subgroup | MC Events | Total | Weight | Risk Ratio | Year |
|-------------------|-----------|-------|--------|------------|------|
| **2.2.1 Adults**  |           |       |        |            |      |
| Seo et al 2020[21]| 0         | 82    | 1      | 50         | 3.5% | 2020 |
| Xu et al 2016[23] | 0         | 200   | 2      | 206        | 4.6% | 2016 |
| Lisova et al 2015[24]| 5      | 162   | 4      | 167        | 7.3% | 2015 |
| Sharp et al 2014[26]| 0    | 231   | 0      | 97         |      | 2014 |
| Benali et al 2013[27] | 0  | 69    | 0      | 84         |      | 2013 |
| Barr et al 201[28] | 12        | 647   | 0      | 43         | 1.7% | 2012 |
| **Subtotal (95% CI)** | 1322      | 563   | 17.1%  | 0.82 [0.31, 2.14] |      |
| Total events      | 17        | 7     |        |            |      |
| Heterogeneity: Chi² = 2.25, df = 3 (P = 0.52); I² = 0% | Test for overall effect: Z = 0.40 (P = 0.69) |

| **2.2.2 The others** |           |       |        |            |      |
| Snooks et al 2019[22]| 2        | 43    | 0      | 22         | 1.2% | 2019 |
| Caparas et al 2014[25]| 0       | 30    | 1      | 28         | 2.9% | 2014 |
| Benali et al 2013[27] | 0       | 69    | 0      | 84         |      | 2013 |
| Moureau 2002[29]  | 14        | 5423  | 117    | 25707      | 75.8%| 2002 |
| Sargent et al 1997[30]| 7       | 12    | 2      | 18         | 3.0% | 1997 |
| **Subtotal (95% CI)** | 5577      | 25859 | 82.9%  | 0.76 [0.47, 1.21] |      |
| Total events      | 23        | 120   |        |            |      |
| Heterogeneity: Chi² = 9.45, df = 3 (P = 0.02); I² = 68% | Test for overall effect: Z = 1.16 (P = 0.25) |

| **Total (95% CI)** | 6899     | 26422 | 100.0% | 0.77 [0.50, 1.17] |      |
| Total events      | 40        | 127   |        |            |      |
| Heterogeneity: Chi² = 11.74, df = 7 (P = 0.11); I² = 40% | Test for overall effect: Z = 1.23 (P = 0.22) |
| Test for subgroup differences: Chi² = 0.02, df = 1 (P = 0.88); I² = 0% |
and the adult subgroup. There was no significant change in the heterogeneity and meta-analysis results after other studies were rejected one by one.

3.6 | Publication bias analyses

Funnel plots of publication bias for studies examining CRBSI were assessed (Figure 4). The symmetric funnel plots indicated no publication bias. However, partial studies at the bottom of the funnel are poor quality.

4 | DISCUSSION

CRBSI is a serious complication in intravenous infusion therapy. CRBSI can increase the length of hospitalizations, costs and mortality (Bessis et al., 2020; Velissaris et al., 2019). The prevalence of CRBSI was different with different VADs. PICCs is long-term use of central venous access, which causes high CRBSI is an important problem (Lee et al., 2020; Silva et al., 2020). MCs is a new type of VAD, which has been widely used. Both MCs and PICCs can cause CRBSI in intravenous therapy. Many studies have shown that the risk of CRBSI in MCs and PICCs is different. In this study, the risk of CRBSI between MCs and PICCs was compared with a systematic review and meta-analysis, to provide evidence for the selection of appropriate VADs for intravenous therapy. This is the first systematic assessment of the risk of CRBSI between MCs and PICCs.

In this study, we found that the prevalence of CRBSI was not significantly different between MCs and PICCs (RR = 0.77, 95% CI: 0.50–1.17, \( p = .22 \)) in all subjects. If the four poor-quality studies were removed, the result showed that the prevalence of CRBSI with MCs was lower than that with PICCs (RR = 0.55, 95% CI: 0.33–0.92, \( p = .02 \)), while the meta-analysis was sensitive when some good or fair-quality studies were removed.

The studies from the US show that the prevalence of CRBSI with MCs was lower than with PICCs (RR = 0.53, 95% CI: 0.31–0.89, \( p = .02 \)). The finding is consistent with Park, Eklund, Riesenber, & White (2019), Banton and Leahy-Gross (1998), and DeVries et al. (2019), while the meta-analysis of research from the US is contrary to that from the United Kingdom. This result may be explained by the fact that the results of meta-analysis were still sensitive. If Moureau et al. (2002) or Sargent and Nixon (1997) were rejected, the results in subgroup and all subjects will change. As the principal investigator of the Moureau study, this was primarily a home care patient outcomes report which may provide reasoning for the sensitivity rejection. The distinction between hospital and home may be wide in terms of infection prevalence and should be concerned. This limitation indicated that study findings need to be interpreted cautiously. So, more high-quality contrastive studies of CRBSI between MCs and PICCs in adults still need in the future.

4.1 | Limitations

Some study limitations are listed: a. Ten studies were included; one studies were abstracts presented at meetings and four studies are poor quality; b. only published literature is included; unpublished results are not included. Maybe some studies were not retrieved; and c. most of the subjects were adults, but few of them were children. This limitation means that study findings need to be interpreted cautiously.

4.2 | Conclusions

The purpose of the current study was to determine the risk of CRBSI associated with MCs compared with PICCs with a meta-analysis. The findings indicate that the prevalence of CRBSI was not significantly different between MCs and PICCs (RR = 0.77, 95% CI: 0.50–1.17, \( p = .22 \)). This study provides the first systematic assessment of the risk of CRBSI between MCs and PICCs and provides evidence for the selection of appropriate vascular access devices (VAD) for intravenous infusion therapy in nursing. The prevalence of CRBSI was not significantly different between them. The limitation means that study findings need to be interpreted cautiously. More contrastive studies of CRBSI between MCs and PICCs are still needed in the future.

ETHICS STATEMENT

This meta-analysis study was approved by the institutional review board of the Department of Hepatobiliary and Pancreas Surgery, The First Affiliated Hospital, Xi’an Jiaotong University.

6 | IRB APPROVAL

This meta-analysis study was approved by the institutional review board of the Department of Hepatobiliary and Pancreas Surgery, The First Affiliated Hospital, Xi’an Jiaotong University.
ADDENDUM ON AUTHOR CONTRIBUTION
HL contributed to the design, acquisition, analysis, interpretation of data and drafting of the manuscript. YL, JC, YG and LL contributed to the design, acquisition, analysis, interpretation of data and critical revision of the manuscript. XZ, XX, LY contributed to the interpretation of data and critical revision of the manuscript. LH and YQ had full access to all the study and take responsibility for the integrity of the data accuracy of the data analysis.

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CONFLICT OF INTEREST
None of the authors have any financial and personal relationships with other people or organizations that could inappropriately influence their work.

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DATA AVAILABILITY STATEMENT
All data generated or analysed during this study are included in this article.

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