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Review Article

Assessing Discharge Readiness and Factors in Peripherally Inserted Central Catheter Carriers with Malignant Tumors: A Meta-Analysis

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Abstract

Background: The aim of this meta-analysis was to assess the readiness for discharge of patients with malignancy when carrying a peripherally inserted central catheter (PICC) as well as to explore the associated factors affecting readiness for discharge.

Methods: PubMed, EMBASE, Web of Science, CNKI, WanFang and VIP databases from inception to Mar 2024 were systematically searched to collect relevant cross-sectional studies. Fixed-effects and random-effects models were used for effect size synthesis, and the stability of the results was assessed by heterogeneity testing, sensitivity analysis, and publication bias detection.

Results: Eight cross-sectional studies comprising 748 participants were included, and the mean score for patients' readiness to discharge was 146.98 (95% CI: 127.17, 166.79) under a random-effects model, but the analysis showed a very high degree of heterogeneity (I^2=100%, P<0.01). In our in-depth analysis of factors influencing discharge readiness, we found that literacy level (OR=1.30, 95% CI: 1.07, 1.59) and income level (OR=1.77, 95% CI: 1.13, 2.78) were significantly associated with better readiness for discharge, and that age had a non-significant effect on readiness for discharge, with a combined effect size (OR = 1.03, 95% CI: 0.97, 1.08).

Conclusion: Among patients with malignant tumours, self-efficacy, distance from home to the hospital, and income level have a significant impact on discharge readiness in their PICC carriers. Optimising discharge instructions and patient education strategies for these factors may improve patients' readiness for discharge, reduce the risk of PICC-related complications, and improve outcomes.

Keywords: Peripherally inserted central catheter (PICC); Malignancy; Readiness for discharge; Influencing factors; Meta-analysis

Introduction

In contemporary medicine, the widespread prevalence of malignant tumors has attracted widespread global attention as a public health challenge. Malignant tumors not only pose a serious threat to the physiological health of patients, but are also accompanied by far-reaching psychologi-

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cal pressure and economic burden, which significantly reduces the quality of life and survival rate of patients (1-3). With the rapid development of modern medical technology, chemotherapy has been widely recognized as one of the effective therapeutic strategies in the fight against malignant tumors (4-6), a process resulted in an increasing demand for long-term intravenous administration of drugs to meet the need for continuous chemotherapy and nutritional support (7-9).

Among the many intravenous drug delivery modalities, peripherally inserted central catheter (PICC) has emerged as the preferred option for long-term intravenous drug delivery due to its significantly lower complication rate, longer retention period and minimization of patient intervention (8, 10, 11). The widespread use of PICC greatly facilitates the process of chemotherapy for patients with malignant tumors, making continuous drug therapy possible, expected to improve therapeutic efficacy (12, 13). However, the management of the PICC, especially the patient's ability to self-manage the PICC after discharge, is of critical importance in preventing complications such as catheter-related bloodstream infections and thrombosis, safeguarding therapeutic continuity and efficacy (1, 14, 15), and ultimately improving the patient's overall quality of life.

Discharge readiness, as a comprehensive measure of a patient's readiness for subsequent treatment and management when leaving a healthcare facility, encompasses a number of dimensions, such as the patient's mastery of relevant medical knowledge, the ability to apply necessary skills, the state of psychological adaptation, and the support of social resources (16-18). During the treatment of malignant tumors, the readiness of patients to be discharged from hospital is particularly important due to the long-term and complex nature of the treatment, especially as it relates to the use and management of the PICC (19, 20). Good discharge preparation can significantly improve patients' self-management ability, effectively reduce the risk of complications that may occur during the use of PICC, which in turn helps to improve the continuity and effectiveness of treatment, and ultimately promotes the overall improvement of patients' quality of life (15, 21). Nonetheless, the existing literature on discharge readiness and factors influencing PICC carriers in patients with malignant tumors presents some disagreement and inconsistency of results (12, 13, 15-17, 21). This phenomenon may stem from the heterogeneity of study designs, such as differences in sample selection, diversity of assessment tools, and incomplete consideration of influencing factors, among other factors. In addition, limitations in data collection and analysis methods in some of the studies may have led to differences in findings across studies. This situation poses a challenge for the development of scientific, personalized discharge instructions and patient education programmes in clinical practice, which urgently needs to be addressed through a more systematic and integrated research approach.

This study aimed to comprehensively investigate the current status of discharge readiness of PICC carriers in patients with malignant tumors and the factors influencing it by means of systematic evaluation and Meta-analysis. Through an in-depth analysis of the existing literature, this study expects to reveal the key influencing factors of discharge readiness and provide targeted discharge guidance and patient education strategies for the clinic, so as to effectively enhance patients' self-care ability, reduce PICC-related complications, and improve treatment outcomes and quality of life. This study has important theoretical significance and practical value for optimizing the overall treatment and care process for patients with malignant tumors.

Materials and Methods

Inclusion and exclusion criteria

This Meta-analysis strictly followed the preset inclusion and exclusion criteria to screen the literature to ensure the accuracy and reliability of the findings. Inclusion criteria included ① the type of study was randomized controlled trials (RCTs), cohort studies, case-control studies, or cross-sectional studies; ② the study was con-

ducted on patients diagnosed with malignant tumors who underwent PICC implantation; ③ the study assessed indicators of patients' readiness for discharge, including, but not limited to, the level of knowledge, psychological status, ability to care for themselves, and family support; ④ the study provided sufficient data to assess discharge readiness and its influencing factors; ⑤ the language of the article was English. Exclusion criteria were ① case reports, review articles, reviews, and conference abstracts, as they may lack the necessary primary data; ② duplicate published studies or data; ③ studies of low quality that failed to provide a clear methodological design or outcome data; and ④ studies with sample sizes of less than 30 individuals, as this may lead to instability of statistical results.

Literature search strategy

A systematic literature search strategy was adopted in order to comprehensively collect studies related to the readiness of PICC carriers to be discharged from hospitals in patients with malignant tumors and the factors influencing it. The search databases include PubMed, EMBASE, Web of Science, CNKI, WanFang, and VIP, covering major international scientific literature resources. The search timeframe was set from inception to March 2024, and the search language was restricted to English. Keyword combinations were used for medical subject headings (MeSH) and free words to enhance search flexibility and breadth. Specific search strategies included: ("Peripheral Inserted Central Catheter" OR "PICC") AND ("Malignant Neoplasm" OR "Cancer" OR "Tumor") AND ("Discharge Readiness" OR " Preparedness" OR "Self-Care" OR "Family Support") AND ("Discharge Readiness" OR " Preparedness" OR "Self-Care" OR "Family Support").

Literature Screening and Data Extraction

Literature screening was conducted in two stages, initial screening and full text review. In the initial screening stage, two independent researchers judged whether the literature met the inclusion criteria based on the title and abstract, and excluded studies that were not relevant to the study topic. Subsequently, at the full-text review stage, literature that passed the initial screening was analyzed in depth to ensure that studies met all inclusion criteria and to document reasons for exclusion. Any differences of opinion during this process were resolved through discussion or consultation with a third expert. Data extraction was done independently by the same two researchers, using pre-designed data extraction forms to collect basic information and key findings from each study. The extracted information included ① basic information of the literature, such as authors, year of publication, study site and study design; ② basic characteristics of the study subjects, including sample size, age, gender distribution, type of malignant tumor, etc.; and ③ as long as the outcome indicators. After all data were summarized, the accuracy of the information was ensured by cross-validation.

Evaluation of risk of bias of included studies

To ensure the reliability and validity of the results of this Meta-analysis, the risk of bias of the included studies was systematically evaluated. This evaluation was carried out independently by two researchers, using a standardized assessment tool and selecting appropriate assessment criteria for different types of study designs. For observational studies, such as cohort studies, case-control studies and cross-sectional studies, the Newcastle-Ottawa Scale (NOS) was used for assessment, with the main focus on selection bias, comparison bias and bias in outcome assessment. Any disagreements that arose in the assessment were resolved through discussion or recourse to a third expert.

Statistical analysis

Statistical analysis for this meta-analysis was designed to comprehensively assess the readiness to discharge of PICC carriers in patients with malignancy and the effect sizes of the factors influencing them, R 4.3.2 software was used for data synthesis and analysis. Depending on the charac-

teristics of the data, either a fixed-effects model or a random-effects model was chosen for effect size synthesis. For quantitative data, a fixed-effects model was used if there was little clinical and methodological heterogeneity between studies; conversely, a random-effects model was used. Heterogeneity was tested using the I^2 statistic to quantify the extent to which the study results differed. An I^2 value of less than 50% was considered to be low heterogeneity and more than 50% was considered to be high heterogeneity. Single-group rate analysis effect sizes were analyzed using a synthetic analysis of qualitative characteristic influences, using Odds Risk (OR) as the effect size indicator, selecting the appropriate statistical model based on the source of the data, and calculating a 95% Confidence Interval (CI) to assess the precision of the effect sizes. In addition, to assess the possibility of publication bias, Egger's test and Begg's test were used. All statistical analyses were performed at a significance level of $\alpha = 0.05$.

Results

Literature screening process and results

The search yielded 181 documents, in the initial screening stage, 10 duplicates were removed and the remaining 171 were excluded by reading the abstracts, 136 documents were excluded. Subsequently, a full-text search was performed on 35 publications, of which 2 were excluded due to unavailability of full text. When the remaining 33 papers were assessed for eligibility, 5 were excluded due to lack of key data, 19 were not relevant to PICC, and 1 was excluded due to low quality. Ultimately, a total of 8 studies (12-18, 21) were included in this analysis (Fig. 1).

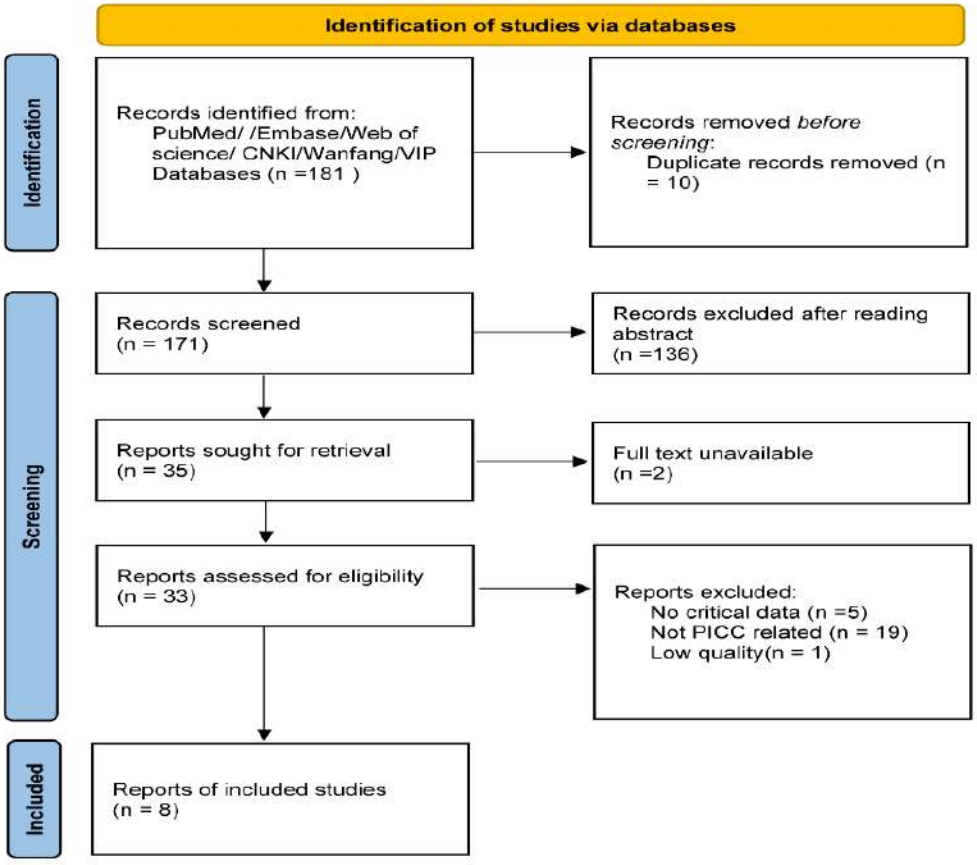

Fig. 1: Schematic diagram of the screening process for inclusion of literature

Basic characteristics and quality assessment of the included literature

In all the included literature were cross-sectional studies covering different types of cancer cases. The sample size ranged from 90 to 279, the age distribution was within the adult range with a mean age of 37.35-59.17 yr, and the study period spanned from 2013 to 2020 (Table 1). The results of the literature quality evaluation showed that all the literature scores were ≥6, which met the quality requirements of this paper (Table 2).

Table 1: General information on the included literature

Author, Year	Type of research	Country/Region	Sample size	Age, years	Sex ratio (male/female)	Cancer type	Outcome indicators
Wang 2018 (18)	Cross-sectional studies	China	100	47.2±10.1	54/46	Gastric cancer 23 cases, rectal cancer 38 cases, colon cancer 39 cases	②③④
Li 2017 (17)	Cross-sectional studies	China	152	55.84 ± 8.5	115/37	Lung cancer 152 cases	①②⑦
Li 2018 (13)	Cross-sectional studies	China	207	≥18	/	Malignant tumors (any type) 207 cases	①②③⑤⑥
Zeng 2018 (16)	Cross-sectional studies	China	90	45.8 ± 9.6	/	Nasopharyngeal cancer 35 cases, lung cancer 18 cases, colorectal cancer 6 cases, cervical cancer 10 cases, lymphoma 12 cases, breast cancer 6 cases, other 13 cases	②⑤⑥
Shi 2019 (12)	Cross-sectional studies	China	115	37.35± 9.24	0/115	115 cases of gynecological malignant tumors	①④⑦
Zhuang 2022 (21)	Cross-sectional studies	China	176	48.25±6.74	0/176	176 cases of cervical cancer	①②③④⑥
Tang 2015 (15)	Cross-sectional studies	China	98	≥18	51/47	98 cases of tumor patients	①②③
Tao 2019 (14)	Cross-sectional studies	China	279	59.17±9.07	178/101	279 cases of gastrointestinal tumors	④

Remarks: ①Readiness for discharge score RHDS; ②Literacy level; ③Income level; ④Age; ⑤Emotional state; ⑥Self-efficacy; ⑦Distance between home and hospital.

Table 2: Literature quality assessment (NOS scale)

Author, Year	Selection (0-4 points)	Comparability (0-2 points)	Results (0-3 points)	Overall Rating (0-9 points)
Wang 2018 (18)	3	1	2	6
Li 2017 (17)	4	1	3	8
Li 2018 (13)	4	2	2	8
Zeng 2018 (16)	3	1	2	6
Shi 2019 (12)	3	1	2	6
Zhuang 2022 (21)	4	2	3	9
Tang 2015 (15)	3	1	2	6
Tao 2019 (14)	3	1	2	6

Meta-analysis results

Readiness for discharge

This meta-analysis assessed the readiness of patients for discharge in the included studies, combining five studies (12,13,15,17,21) involving 748 patients. The results showed an MRAW of 146.98 (95% CI: 127.17, 166.79) for readiness for discharge under the random-effects model, indicating significant heterogeneity across studies (I^2 = 100%, P< 0.01), (Fig. 2). Heterogeneity may arise from differences in study design, diversity of patient demographic characteristics, or inhomogeneity in study quality.

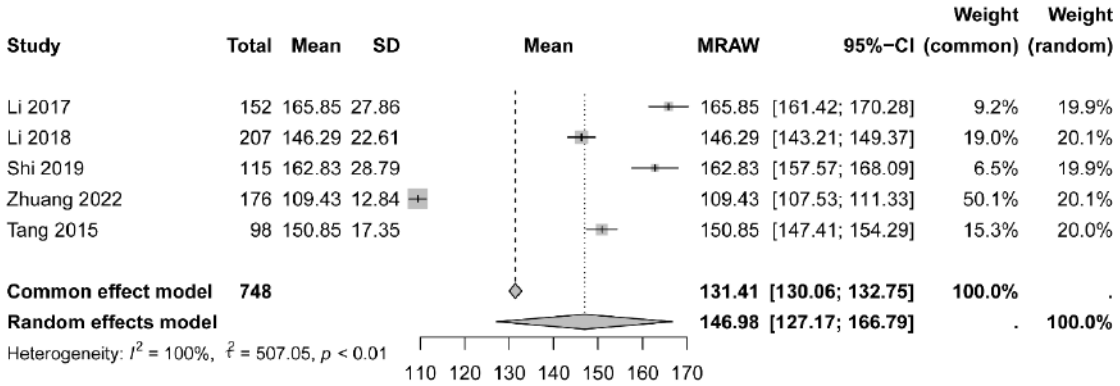

Fig. 2: Forest plot of Meta-analysis of discharge readiness

Effect of literacy level on readiness for discharge

The results of the meta-analysis assessed the impact of literacy level on patient readiness for discharge. Six studies (13, 15, 16, 17, 18, 21) were analyzed, containing a total sample size of multiple independent samples. Under the random-effects model, the combined effect size of literacy was an OR of 1.30, indicative of a positive association between higher literacy and readiness for discharge. The OR under the fixed-effects model was 1.05 (95% CI: 1.02, 1.08), also indicating a positive association, but the magnitude was smaller. Analysis of heterogeneity showed that I^2=84%, P<0.01 indicating a high degree of heterogeneity between the findings, and tests for overall effects showed statistical significance in both models (fixed effects: P<0.01; random effects: P<0.01), (Fig. 3), which supports the conclusion that literacy level has a significant effect on readiness for hospital discharge.

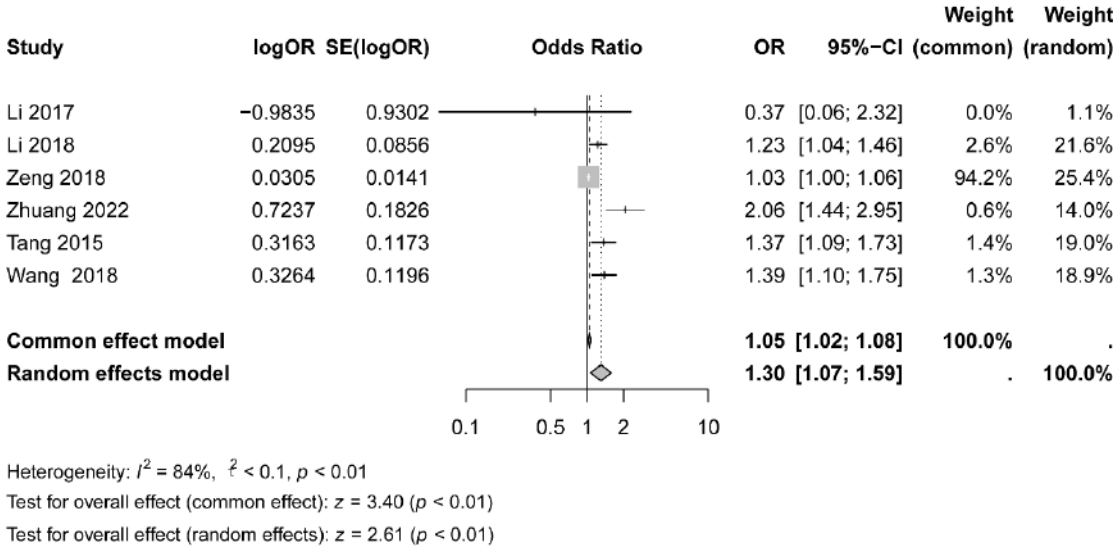

Fig. 3: Forest plot of the effect of literacy level on discharge readiness

Effect of Income Level on Readiness for Hospital Discharge

This meta-analysis examined the effect of income level on patient readiness for discharge. The analysis included four studies (13, 15, 18, 21) that assessed the effect size of income level as an influencing factor. The random-effects model showed a significant effect of income level on readiness for discharge, with a pooled effect size OR of 1.77 (95% CI: 1.13, 2.78), indicating high heterogeneity (I^2 = 89%, P<0.01). The OR under the fixed effects model was 1.48 (95% CI: 1.31, 1.66), indicating a slightly lower effect size when heterogeneity was not considered. Overall effects tests were significant for both models (fixed effects: z=6.52, P<0.01; random effects: z=2.49, P=0.01), as shown in Fig. 4, emphasizing the importance of income level as a significant predictor of readiness for hospital discharge.

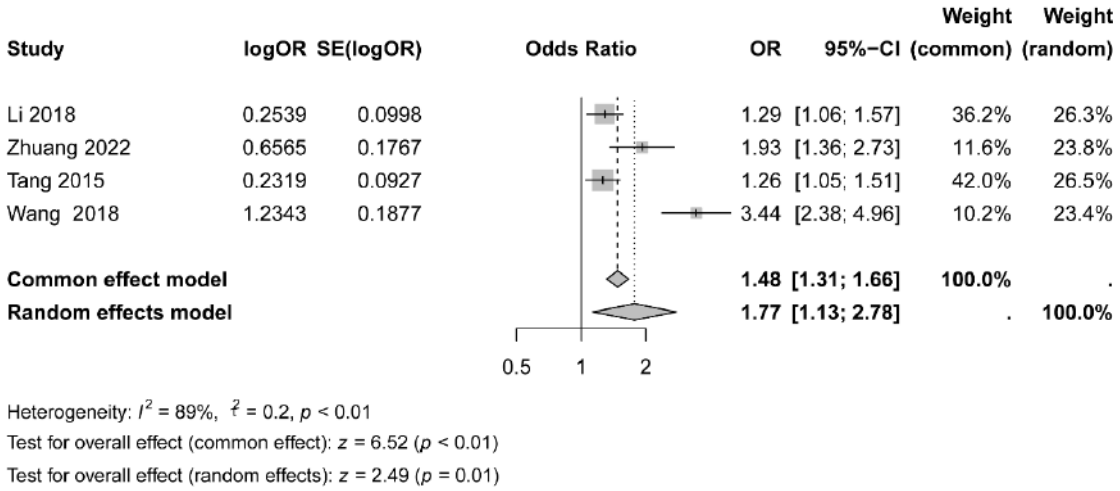

Fig. 4: Forest plot of the effect of income level on readiness for hospital discharge

Effect of age on readiness for hospital discharge

In this meta-analysis, the effect of age on readiness for discharge was explored and two studies (13, 16) were included in the analysis to assess the effect size of the variable age. According to the random effects model, the effect of age on readiness for discharge was not statistically significant, with a combined effect size OR of 1.03 (95% CI: 0.97, 1.08) and relatively high heterogeneity (I^2 =74%, *P*=0.05). Under the fixed-effects model, the OR of the effect size was 1.00 (95% CI: 1.00, 1.01), and the overall effects test showed borderline statistical significance (z=2.37, *P*=0.02) (Fig. 5). Age may not be an important influence on discharge readiness after accounting for potential heterogeneity between studies.

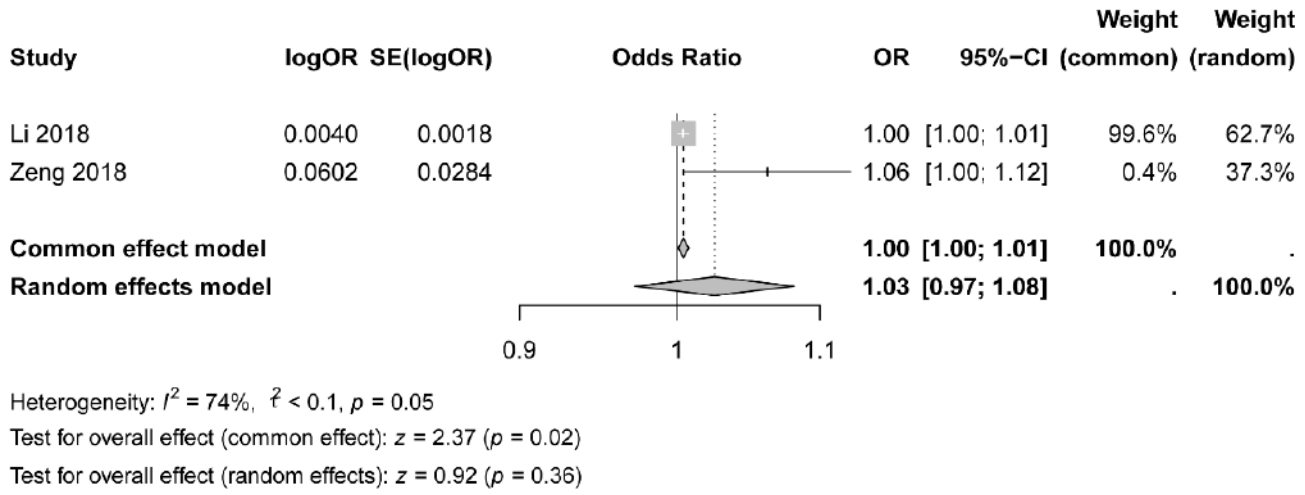

Fig. 5: Forest plot of the effect of age on discharge readiness

Effect of emotional status on readiness for hospital discharge

Meta-analysis was conducted to address the effect of emotional status on patients' readiness for discharge, and two studies (13,16) were included in this analysis. The random-effects model showed an OR of 1.03 (95% CI: 0.97, 1.08) for the effect size of emotional status on readiness for discharge, indicating that the effect size did not reach statistical significance and there was a high degree of heterogeneity between the studies (I^2 = 74%, *P*=0.05). The fixed effects model indicated an OR of 1.00 (95% CI: 1.00, 1.01) and the overall effects test showed borderline statistical significance (z=2.37, *P* = 0.02). Although the fixed-effects model noted the presence of borderline statistical significance, the random-effects model, due to its wide confidence interval and non-significant *P*-value (z=0.92, *P*=0.36) (Fig. 6). We could not be sure of the exact effect of emotional state on readiness for discharge.

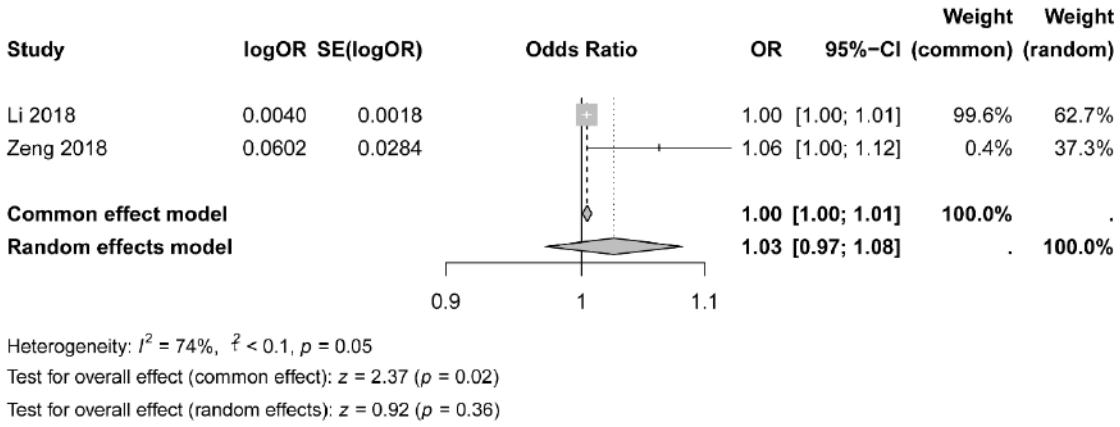

Fig. 6: Forest plot of the effect of emotional status on discharge readiness

Impact of self-efficacy on readiness for hospital discharge

Meta-analysis exploring the potential impact of self-efficacy on patients' readiness for discharge included three studies (13,16,21). According to the fixed-effects model, the combined effect size OR of self-efficacy on readiness for discharge was 1.05 (95% CI: 1.02, 1.09), and a test of the overall effect showed statistical significance (z=3.25, *P*<0.01), pointing out that self-efficacy was positively associated with readiness for discharge to some extent. However, in the random effects model, self-efficacy did not reach statistical significance (z=1.17, *P*=0.24*)* with an OR of 1.23 (95% CI: 0.87, 1.74) for readiness for discharge (Fig. 7).

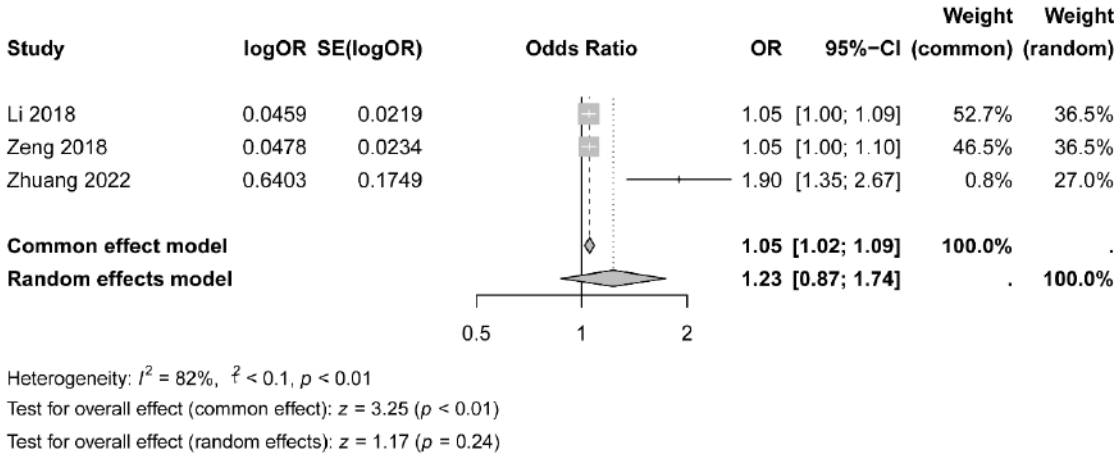

Fig. 7: Forest plot of the effect of self-efficacy on discharge readiness

Impact of distance between home and hospital on readiness for hospital discharge

This meta-analysis examined the potential impact of home-hospital distance on readiness for discharge and included two studies (12,17). Home-hospital distance had a significant positive effect on discharge readiness under both fixed and random effects models, with a combined effect size OR of 1.22 (95% CI: 1.09, 1.37), and the overall effects test showed statistical significance (z=3.44, *P*<0.01). In addition, there was no significant heterogeneity between the two studies (I^2=0%, *P*=0.83), suggesting a good agreement between the results obtained (Fig. 8).

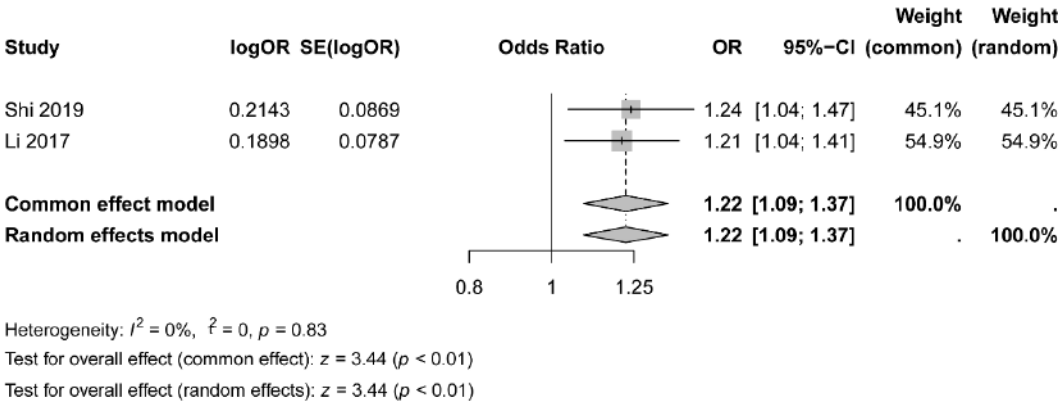

Fig. 8: Forest plot of the effect of distance between home and hospital on readiness for discharge

Sensitivity analysis and publication bias

Sensitivity analyses assessed the robustness of the results by excluding individual studies one by one, and the sensitivity analyses of this meta-analysis showed that excluding any of the studies individually did not significantly change the amount of the combined effect, suggesting that the results have good robustness. In addition, the likelihood of publication bias was assessed by visual inspection of funnel plots and the Egger's test. The Egger's test result was not significant (P>0.05), suggesting a low risk of publication bias.

Discussion

This meta-analysis synthesised several studies with the aim of exploring the factors that influence patients' readiness for hospital discharge. The main findings analysed included that self-efficacy, distance between home and hospital, and income level all had a significant effect on patient readiness for discharge (12, 13, 16). Of particular interest is the fact that greater home-to-hospital distance is positively associated with higher discharge readiness, which may suggest that patients or their family members are more actively involved in pre-discharge preparation because of distance (12, 21). However, age and emotional state did not have a significant effect on readiness for discharge (13, 16), which may suggest that the effect of these factors is masked by other variables, or that their relationship with readiness for discharge may be more complex, influenced by different study designs or demographic characteristics.

Although these findings provide important insights for clinical practice, the limitations of this study should also be recognized. First, the number of studies was limited, which constrained us from conducting subgroup analyses to explore effects in specific populations or conditions. Second, the quality of the included studies varied and some of them did not report all possible moderators, which may have led to biased results. In addition, all studies were from China, which may limit the generalizability of our findings. Future studies should focus on more countries and populations to increase the broad applicability of our findings. More detailed data collection is also needed to allow for more in-depth subgroup analyses to explore differences between different patient groups. In addition, qualitative research may provide insight into understanding the more subtle psychosocial factors of discharge readiness.

Overall, this meta-analysis highlights multiple factors that influence discharge readiness and provides valuable information for improving discharge planning and patient education strategies. By gaining a better understanding of these factors, health professionals can more accurately design discharge readiness procedures to meet individualized patient needs, thereby promoting

patient health outcomes and reducing readmission rates (22). Further research into these influencing factors will not only enhance patients' discharge experience, but may also help to optimize the allocation and use of healthcare resources. In clinical practice, it is recommended that healthcare teams should emphasize the patient's socio-economic background, mental health status and self-management skills and include these factors in discharge planning (23). For example, discharge readiness for patients with lower income levels or low self-efficacy can be improved by providing additional social support and education that enhances their self-management skills (15, 17, 21).

Finally, the findings of this study also suggest the need for policymakers to assess the potential impact of service accessibility on patient health outcomes when considering the layout of health services. Expanding patient access to high-quality health services may have a positive effect on patient readiness for discharge. Future studies should also consider the inclusion of more data from randomized controlled trials to increase the level of evidence in the analysis and the use of uniform measurement tools to enhance comparability across studies. In addition, conducting prospective studies may help to determine causality, leading to a more complete understanding of the factors that influence readiness for discharge.

Conclusion

Among patients with malignant tumors, self-efficacy, distance from home to the hospital, and income level have a significant impact on discharge readiness in their PICC carriers. Optimizing discharge instructions and patient education strategies for these factors may improve patients' readiness for discharge, reduce the risk of PICC-related complications, and improve outcomes.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

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